APPENDIX A – TAXING DISTRICT'S MILL LEVY

	TAX DISTRICTS:	100		101		200		300		400		500		501		502		503		504	
LEVYING BODIES	Change in mill levy from 2011 to 2012	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011
GUNNISON COUNTY	**No change**	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	
RE1J - GUNNISON SCHOOL DISTRICT	**No change**	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	
50J - DELTA SCHOOL DISTRICT	**No change**																				
RE1J-M - MONTROSE SCHOOL DISTRICT	**Decreased - 0.114**																				
TOWN OF CRESTED BUTTE	**No change**					**10.585**	10.585														
CITY OF GUNNISON	**No change**	**3.868**	3.868	**3.868**	3.868																
TOWN OF MARBLE	**No change**									**6.505**	6.505										
TOWN OF MT CRESTED BUTTE	**No change**											**10.378**	10.378	**10.378**	10.378	**10.378**	10.378	**10.378**	10.378	**10.378**	
TOWN OF PITKIN	**Increased - 0.230**							**5.790**	5.560												
ARROWHEAD FIRE PROTECTION DISTRICT	**No change**																				
BOSTWICK PARK WATER DISTRICT	**Decreased - 0.003**																				
CARBONDALE & RURAL FIRE PROTECTION DISTRICT	**Decreased - 0.076**									**9.965**	10.041										
COLORADO RIVER WATER DISTRICT	**Increased - 0.014**	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	
CRAWFORD WATER DISTRICT	**No change**																				
CRESTED BUTTE FIRE PROTECTION DISTRICT	**Decreased - 0.869**					**3.843**	4.712					**3.843**	4.712	**3.843**	4.712	**3.843**	4.712	**3.843**	4.712	**3.843**	
CRESTED BUTTE SOUTH METRO DISTRICT	**Decreased - 0.817**																				
EAST RIVER REGIONAL SANITATION DISTRICT	**No change**																				
GUNNISON CEMETERY DISTRICT	**Increased - 0.015**	**0.768**	0.753	**0.768**	0.753			**0.768**	0.753												
GUNNISON COUNTY FIRE PROTECTION DISTRICT	**No change**			**4.513**	4.513			**4.513**	4.513												
GUNNISON COUNTY METROPOLITAN RECREATION DISTRICT	**Increased - 0.026**	**0.450**	0.424	**0.450**	0.424	**0.450**	0.424	**0.450**	0.424			**0.450**	0.424	**0.450**	0.424	**0.450**	0.424	**0.450**	0.424	**0.450**	
MT CRESTED BUTTE WATER & SANITATION DISTRICT	**Increased - 0.847**											**9.082**	8.235	**9.082**	8.235	**9.082**	8.235	**9.082**	8.235	**9.082**	
NORTH FORK WATER DISTRICT	**No change**																				
RAGGED MOUNTAIN FIRE PROTECTION DISTRICT	**Increased - 0.070**																				
RESERVE METRO DIST. 2	**Decreased - 42.000**																	**3.000**	45.000		
RESERVE METRO DIST. 2 BOND	**Increased - 52.676**																	**52.676**		**52.676**	
SKYLAND METROPOLITAN DISTRICT	**No change**																				
UPPER GUNNISON WATER DISTRICT	**Decreased - 0.246**	**1.524**	1.770	**1.524**	1.770	**1.524**	1.770	**1.524**	1.770			**1.524**	1.770	**1.524**	1.770	**1.524**	1.770	**1.524**	1.770	**1.524**	
TOTAL		**44.152**	44.343	**48.665**	48.856	**53.944**	55.019	**50.587**	50.548	**54.012**	54.074	**62.819**	63.047	**62.819**	63.047	**62.819**	63.047	**118.495**	108.047	**115.495**	

	601		602		603		606		607		608		609		610		611		612	
LEVYING BODIES	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011
GUNNISON COUNTY	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328
RE1J - GUNNISON SCHOOL DISTRICT	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972
50J - DELTA SCHOOL DISTRICT																				
RE1J-M - MONTROSE SCHOOL DISTRICT																				
TOWN OF CRESTED BUTTE																				
CITY OF GUNNISON																				
TOWN OF MARBLE																				
TOWN OF MT CRESTED BUTTE																				
TOWN OF PITKIN																				
ARROWHEAD FIRE PROTECTION DISTRICT																				
BOSTWICK PARK WATER DISTRICT													**0.983**	0.986						
CARBONDALE & RURAL FIRE PROTECTION DISTRICT																				
COLORADO RIVER WATER DISTRICT	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228
CRAWFORD WATER DISTRICT															**0.469**	0.469				
CRESTED BUTTE FIRE PROTECTION DISTRICT							**3.843**	4.712	**3.843**	4.712										
CRESTED BUTTE SOUTH METRO DISTRICT																				
EAST RIVER REGIONAL SANITATION DISTRICT																				
GUNNISON CEMETERY DISTRICT	**0.768**	0.753															**0.768**	0.753		
GUNNISON COUNTY FIRE PROTECTION DISTRICT	**4.513**	4.513	**4.513**	4.513									**4.513**	4.513					**4.513**	4.513
GUNNISON COUNTY METROPOLITAN RECREATION DISTRICT	**0.450**	0.424	**0.450**	0.424			**0.450**	0.424	**0.450**	0.424			**0.450**	0.424					**0.450**	0.424
MT CRESTED BUTTE WATER & SANITATION DISTRICT									**9.082**	8.235										
NORTH FORK WATER DISTRICT											**0.561**	0.561								
RAGGED MOUNTAIN FIRE PROTECTION DISTRICT																				
RESERVE METRO DIST. 2																				
RESERVE METRO DIST. 2 BOND																				
SKYLAND METROPOLITAN DISTRICT																				
UPPER GUNNISON WATER DISTRICT	**1.524**	1.770	**1.524**	1.770			**1.524**	1.770	**1.524**	1.770							**1.524**	1.770		
TOTAL	**44.797**	44.988	**44.029**	44.235	**37.542**	37.528	**43.359**	44.434	**52.441**	52.669	**38.103**	38.089	**43.488**	43.451	**38.011**	37.997	**39.834**	40.051	**42.505**	42.465

	TAX DISTRICTS:	613		614		615		616		617		619		620		621		622		623		701		702		703		704		801		802	
LEVYING BODIES	Change in mill levy from 2011 to 2012	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011	**2012**	2011
GUNNISON COUNTY	**No change**	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328	**11.328**	11.328
RE1J - GUNNISON SCHOOL DISTRICT	**No change**	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972	**25.972**	25.972												
50J - DELTA SCHOOL DISTRICT	**No change**																					**27.550**	27.550	**27.550**	27.550	**27.550**	27.550	**27.550**	27.550				
RE1J-M - MONTROSE SCHOOL DISTRICT	**Decreased - 0.114**																													**23.539**	23.653	**23.539**	23.653
TOWN OF CRESTED BUTTE	**No change**																																
CITY OF GUNNISON	**No change**																																
TOWN OF MARBLE	**No change**																																
TOWN OF MT CRESTED BUTTE	**No change**																																
TOWN OF PITKIN	**Increased - 0.230**																																
ARROWHEAD FIRE PROTECTION DISTRICT	**No change**																	**4.518**	4.518	**4.518**	4.518											**4.518**	4.518
BOSTWICK PARK WATER DISTRICT	**Decreased - 0.003**																																
CARBONDALE & RURAL FIRE PROTECTION DISTRICT	**Decreased - 0.076**									**9.965**	10.041																						
COLORADO RIVER WATER DISTRICT	**Increased - 0.014**	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228	**0.242**	0.228
CRAWFORD WATER DISTRICT	**No change**																																
CRESTED BUTTE FIRE PROTECTION DISTRICT	**Decreased - 0.869**					**3.843**	4.712	**3.843**	4.712			**3.843**	4.712																				
CRESTED BUTTE SOUTH METRO DISTRICT	**Decreased - 0.817**					**12.676**	13.493																										
EAST RIVER REGIONAL SANITATION DISTRICT	**No change**							**4.274**	4.274			**4.274**	4.274																				
GUNNISON CEMETERY DISTRICT	**Increased - 0.015**	**0.768**	0.753	**0.768**	0.753																												
GUNNISON COUNTY FIRE PROTECTION DISTRICT	**No change**													**4.513**	4.513															**4.513**	4.513		
GUNNISON COUNTY METROPOLITAN RECREATION DISTRICT	**Increased - 0.026**					**0.450**	0.424	**0.450**	0.424			**0.450**	0.424					**0.450**	0.424	**0.450**	0.424									**0.450**	0.424	**0.450**	0.424
MT CRESTED BUTTE WATER & SANITATION DISTRICT	**Increased - 0.847**																																
NORTH FORK WATER DISTRICT	**No change**																					**0.561**	0.561			**0.561**	0.561						
RAGGED MOUNTAIN FIRE PROTECTION DISTRICT	**Increased - 0.070**															**2.050**	1.980									**2.050**	1.980	**2.050**	1.980				
RESERVE METRO DIST. 2	**Decreased - 42.000**																																
RESERVE METRO DIST. 2 BOND	**Increased - 52.676**																																
SKYLAND METROPOLITAN DISTRICT	**No change**							**27.080**	27.080																								
UPPER GUNNISON WATER DISTRICT	**Decreased - 0.246**	**1.524**	1.770			**1.524**	1.770	**1.524**	1.770			**1.524**	1.770					**1.524**	1.770														
TOTAL		**39.834**	40.051	**38.310**	38.281	**56.035**	57.927	**74.713**	75.788	**47.507**	47.569	**47.633**	48.708	**42.055**	42.041	**39.592**	39.508	**44.034**	44.240	**42.510**	42.470	**39.681**	39.667	**39.120**	39.106	**41.731**	41.647	**41.170**	41.086	**40.072**	40.146	**40.077**	40.151

APPENDIX B – EQUIPMENT INVENTORY

EQUIPMENT INVENTORY

ITEM DESCRIPTION	OWNERSHIP	PURCHASED COST	VALUE
REAL ESTATE/BUILDINGS			
RMFPD NEW PURCHASE TBD HWY 133, SOMERSET	RMFPD	$65,000.00	
“HAWKS” NEST PROPERTY			
EQUIPMENT , FIRE TRUCKS, AND ATTACHED EQUPIMENT			
2009 GMC 5500 BRUSH TRUCK - VER 3/2013	RMFPD - AT PFD	$150,352.00	
VIN:1GDG5E39X9F408647			
2 - SATELITTE PHONES			
1 - 800MG MOBILE RADIO			
1 - HUSQAVARNA 455 RANCHER CHAINSAW			
1 - SOCKET SET (NO SIZE GIVEN)			
1 - TOOL BOX W/TOOLS			
3 - 1-1/2" NOZZLES			
3 - 1:" NOZZLES			
1 - 2-1/2" STRAINER			
1 - 2-1/2" DOUBLE MALE			
3 - 3/4" NOZZLES			
1 - 1-1/2" DOUBLE MALE			
1 - BACKPACK W/ 3/4" HOSE			
5 - 1" x 50' FORESTRY HOSE			
14 - 3/4" X 50' FORESTY HOSE			
6 - 1-1/2" x 100' FORESTRY HOSE			
2 - 2-1/2" x 10' SUCTION HOSE			
1 - FLOATING PUMP			
1 - HYDRANT WRENCH			
2 - SPANNER WRENCH			
2 - PULASKI			
1 - PICK AXE			
1 - 1 - AXE			

ITEM DESCRIPTION	OWNERSHIP	PURCHASED COST	VALUE
1 36" BOLT CUTTER			
2 - GAS CANS			
2 - WATER BACKPACKS			
1 - HONDA 1" UTILITY PUMP			
2 - SHOVELS			
1 - MCCLOUD			
1978 FORD 800 PUMPER	AT PFD		$30,000.00
VIN: K90AVCF4490			
2 - HALOGEN			
1 - PICK AXE			
4 - 1-1/2" NOZZLES			
2 - 2-1/2" NOZZLES			
2 - 2-1/2" DOUBLE FEMALE			
1 - 2-1/2" DOUBLE MALE			
1 - 2-1/2" X 1-1/2" REDUCER			
1 - 1-1/2" DOUBLE MALE			
2 - 1-1/2" X 1" REDUCER			
1 - 6" X 5" REDUCER			
1 - STHL 460 RESCUE CHAINSAW			
1 - STIHL CHAINSAW KIT			
1 - RESPONDER FLASHLIGHT			
1 - CHAINSAW CHAIN			
1 - 2-1/2" X 1-1/2" GATED Y			
2 - BUNKER GLOVES			
6 - SPANNER WRENCHES			
1 - 2-1/2" SUCTION SCREEN			
2 - 2-1/2" X 10' SUCTION HOSE			
1 - 5" X 25' HOSE			
1 - FLOATING PUMP			
1 - MCCLOUD			

ITEM DESCRIPTION	OWNERSHIP	PURCHASED COST	VALUE
1 - FAN			
1 - GAS CAN			
3 - BACKPACKS			
1997 PETERBILT TANKER - Ver 3/2013	AT PFD	$78,500.00 8/2007	
VIN: 1XP5D69X4VD440024			
1 - TOOL BOX W/MISC. TOOLS			
2 - SPANNER WRENCH			
1 - HYDRANT WRENCH			
1 - 2-1/2" X 1-1/2" GATED Y			
2 - 1-1/2" NOZZLE			
1 - 2-1/2" NOZZLE			
1 - HOSE CLAMP			
1 - VHF MOBILE RADIO			
1 - 2-1/2" STACK TIPS			
FIRE HOUSE EQUIPMENT (NOT INCLUDED IN TRUCK INVENTORY)			
HYDRATIC TOOLS (EXTRACTION TOOLS BROWN BOX)	WILL HANDVILLE		
2 - HOMELITE FIRE PUMP	WILL HANDVILLE		
REFRIGERATOR	WILL HANDVILLE		
2 - GAS CANS	WILL HANDVILLE		
RADIOS (OLD IN DRAWER)	WILL HANDVILLE		
MISC BRACKETS AND LIGHTS	WILL HANDVILLE		
TOOL BOX ON COUNTER	WILL HANDVILLE		
MISC. PARTS IN DRAWER	WILL HANDVILLE		
HONDA TRASH PUMP	AT PFD WILL NOT START	$800.00 3/2005	$350.00
8 - WILD LAND BACK PACKS SETS			
RESCUE BASKET		DONATED	$50.00
2 - PORTA TANKS		DONATED	$100.00
NAPA BATTERY CHARDER			
500 GALLON FUEL TAK AND STAND			

ITEM DESCRIPTION	OWNERSHIP	PURCHASED COST	VALUE
HURST TOOLS (EXTRACTION EQUIPMENT)	AT PFD OLD & NEVER USED	DONATED	
RMFPD OFFICE EQUIPMENT			
COMPUTERS:			
HP PAVILION DESKTOP COMPUTER (MS Windows XP 2002)		$698.48 5/2006	$600.00
HYUNDAI MONITOR		$322.37 5/2006	$250.00
HP COLOR LASERJET 2840		$967.13 5/2006	$800.00
SEAGATE BACKUP PLUS 1 TB PORTABLE EXTERNAL HARD DRIVE WITH CASE		$95.26 4/2013	
DESK, FILE CABINETS, CHAIRS BOOK CASE, ETC.			
1 - WOODEN DESK			
2 - 4-DRAWER FILE CABINETS (LEGAL SIZE)			
1 - FILE CABINET STILL IN BOX			
7 - CHAIRS		DONATED	$50.00
2 - HIGH BACK DESK CHAIRS			
6 - BLACK/WHITE CLOTH COVERED STACKING CHAIRS			
2 - MISC CLOTH COVERED STACKING CHAIRS			
18 – FOLDING METAL CHAIRS			
1 – DESK STILL IN BOX			
1 – HUTCH STILL IN BOX			
1 – SHELF STILL IN BOX			
1 – FILE CABINET STILL IN BOX			
HOSE			
RMFH - 1.5" - 01		DONATED	NONE
RMFH - 1.5" - 02		DONATED	NONE
RMFH - 1.5" - 03		DONATED	NONE
RMFH - 1.5" - 04		DONATED	NONE
RMFH - 1.5" - 05		DONATED	NONE
RMFH - 1.5" - 06		DONATED	NONE
RMFH - 1.5" - 07		DONATED	NONE

ITEM DESCRIPTION	OWNERSHIP	PURCHASED COST	VALUE
RMFH - 1.5" - 08		DONATED	NONE
RMFH - 1.5" - 09		DONATED	NONE
RMFH - 1.5" - 10		DONATED	NONE
RMFH - 1.5" - 11		DONATED	NONE
RMFH - 1.5" - 12		DONATED	NONE
RMFH - 1.5" - 13		DONATED	NONE
RMFH - 1.5" - 14		DONATED	NONE
RMFH - 1.5" - 15		DONATED	NONE
RMFH - 1.5" - 16		DONATED	NONE
RMFH - 1.5" - 17		DONATED	NONE
RMFH - 1.5" - 18		DONATED	NONE
RMFH - 1.5" - 19		DONATED	NONE
RMFH - 1.5" - 20		DONATED	NONE
RMFH - 1.5" - 21		DONATED	NONE
RMFH - 1.5" - 22		DONATED	NONE
RMFH - 1.5" - 23		DONATED	NONE
RMFH - 1.5" - 24		DONATED	NONE
RMFH - 1.5" - 25		DONATED	NONE
RMFH - 1.5" - 26		DONATED	NONE
RMFH - 1.5" - 27		DONATED	NONE
RMFH - 1.5" - 28		DONATED	NONE
RMFH - 1.5" - 29		DONATED	NONE
RMFH - 1.5" - 30		DONATED	NONE
RMFH - 1.5" - 31		DONATED	NONE
RMFH - 1.5" - 32		DONATED	NONE
RMFH - 1.5" - 33		DONATED	NONE
RMFH - 2.5 - 01		DONATED	NONE
RMFH - 2.5 - 02		DONATED	NONE
RMFH - 2.5 - 03		DONATED	NONE
RMFH - 2.5 - 04		DONATED	NONE
RMFH - 2.5 - 05		DONATED	NONE

ITEM DESCRIPTION	OWNERSHIP	PURCHASED COST	VALUE
RMFH - 2.5 - 06		DONATED	NONE
RMFH - 2.5 - 07		DONATED	NONE
RMFH - 2.5 - 08		DONATED	NONE
RMFH - 2.5 - 09		DONATED	NONE
RMFH - 2.5 - 10		DONATED	NONE
RMFH - 2.5 - 11		DONATED	NONE
RMFH - 2.5 - 12		DONATED	NONE
RMFH - 2.5 - 13		DONATED	NONE
RMFH - 2.5 - 14		DONATED	NONE
RMFH - 2.5 - 15		DONATED	NONE
RMFH - 3 - 01		DONATED	NONE
RMFH - 3 - 02		DONATED	NONE
RMFH - 3 - 03		DONATED	NONE
RMFH - 3 - 04		DONATED	NONE
RMFH - 3 - 05		DONATED	NONE
RMFH - 3 - 06		DONATED	NONE
RMFH - 3 - 07		DONATED	NONE
RMFH - 3 - 08		DONATED	NONE
RMFH - 3 - 09		DONATED	NONE
RMFH - 3 - 10		DONATED	NONE
RMFH - 3 - 11		DONATED	NONE
RMFH - 3 - 12		DONATED	NONE
RMFH - 3 - 13		DONATED	NONE
RMFH - 3 - 14		DONATED	NONE
RMFH - 3 - 15		DONATED	NONE
RMFH - 3 - 16		DONATED	NONE
RMFH - 3 - 17		DONATED	NONE
RMFH - 3 - 18		DONATED	NONE
RMFH - 3 - 19		DONATED	NONE
RMFH - 3 - 20		DONATED	NONE
RMFH - 3 - 21		DONATED	NONE

ITEM DESCRIPTION	OWNERSHIP	PURCHASED COST	VALUE
RMFH - 3 - 22		DONATED	NONE
RMFH - 3 - 23		DONATED	NONE
RMFH - 3 - 24		DONATED	NONE
RMFH - 3 - 25		DONATED	NONE
RMFH - 3 - 26		DONATED	NONE
RMFH - 3 - 27		DONATED	NONE
RMFH - 3 - 28		DONATED	NONE
RMFH - 3 - 29		DONATED	NONE
RMFH - 3 - 30		DONATED	NONE
RMFH - 3 - 31		DONATED	NONE
RMFH - 3 - 32		DONATED	NONE
RMFH - 3 - 33		DONATED	NONE
RMFH - 3 - 34		DONATED	NONE
RMFH - 3 - 35		DONATED	NONE
LOCATED AT PAONIA FIRE DEPT POS LISTED ON THIS INVENTORY			
11 - HEAD LAMPS			
22 - BUNKER HELMETS			
12 - WILDLAND HELMETS			
8 - FIRE SHELTERS (OBSOLETE)			
7 - PAIRS LEATHER GLOVES			
1 - NOMEX HOOD			
4 - PAIR BUNKER GLOVES (ADDITIONAL)			
6 - WILDLAND GOGGLES			
6 - PAIR RUBBER BUNKER BOOTS			
3 - VHF BENDIX RADIOS			
1 - HALOGEN WORK LIGHT (ADDITIONAL)			
33 - 1-1/2" STRUCTURE HOSE			
20 - 2-1/2" STRUCTURE HOSE			
6 -1" FORESTRY HOSE			
8 - 1" FORESTRY HOSE			

ITEM DESCRIPTION	OWNERSHIP	PURCHASED COST	VALUE
4 - 1-1/2" FORESTRY HOSE			
1 - 1-1/2" GATED Y			
1 - FORESTRY HOSE CLAMP			
1 - 2-1/2" X 1-1/2" REDUCER			
1 - 1" NOZZLE			
1 - 1-1/2" DOUBLE FEMAL			
1 - 1-1/2" DOUBLE MALE			
1 - SPANNER WRENCH			
3 - WATER PACKS			
2 - GAS CANS			
1 - FLOATING PUMP			
5 - SHOVELS			
2 - MCCLOUDS			
4 - PULASKI			
1 - STIHL MS260 CHAINSAW			
1 - ROPE BAG			
2 - 1-1/2" X 10' SUCTION HOSE			
3 - CANTEENS			
4 - BACKPACKS			
RADIOS			
100 - LPH5142A - BENDIX KING		DONATED	$178.78
101 - EPH5140A - BENDIX KING		DONATED	$178.78
102 - EPH5141A - BENDIX KING		DONATED	$178.78
103 - LPH5142A - BENDIX KING		DONATED	$178.78
TRUCK RADIO - ENGINE 1			$375.00
TRUCK RADIO - ENGINE 2			$375.00
TRUCK RADIO - TENDER 1			$375.00
TRUCK RADIO - WILDLAND TRUCK			$375.00
MOBILE TWO-WAY 45WATT - 70100511 - KENWOOD VHF			$488.00
MOBILE TWO-WAY 45WATT - 70100512 - KENWOOD VHF			$488.00

ITEM DESCRIPTION	OWNERSHIP	PURCHASED COST	VALUE
MOBILE TWO-WAY 45WATT - 70100514 - KENWOOD VHF			$488.00
MOBILE TWO-WAY 45WATT 70100515 - KENWOOD VHF			$488.00
PAGERS			
PAGER – 136WFS1629 - MOTOROLA/MINITOR V		$482.00	$400.00
PAGER - 136WFS1623 - MOTOROLA/MINITOR V		$482.00	$400.00
PAGER - 136WFS1620 - MOTOROLA/MINITOR V		$482.00	$400.00
PAGER - 136WFS1637 - MOTOROLA/MINITOR V		$482.00	$400.00
PAGER - 136WFS1634 - MOTOROLA/MINITOR V		$482.00	$400.00
PAGER - 136WFS1633 - MOTOROLA/MINITOR V		$482.00	$400.00
PAGER - 136WFS1630 - MOTOROLA/MINITOR V		$482.00	$400.00
PAGER - 136WFQ6052 - MOTOROLA/MINITOR V		$482.00	$400.00
PAGER - 136WFQ6051 - MOTOROLA/MINITOR V		$482.00	$400.00
PAGER - 136WFQ6050 - MOTOROLA/MINITOR V		$482.00	$400.00
FACEMASKS/PACKS			
6 – FACEMASKS			
6 – MSA PACKS			
BOTTLES			
2 – STEEL BOTTLE		DONATED	
1 – ALUMINUM BOTTLE		DONATED	
2 – ALUMINUM BOTTLE		$1,000.00	$35.71/EA.
BUNKER GEAR			
7 – COATS		DONATED	
7 – PANTS		DONATED	
10 – HELMETS			

APPENDIX C – 2015 BUDGET

	A	B	D	E
1	**RAGGED MOUNTAIN FIRE PROTECTION DISTRICT BUDGET**			
2		**2013 ACTUAL**	**2014 ESTIMATE**	**2015 BUDGET**
3	Beginning Reserve	$ 1,069,291.91	$ 1,165,597.50	$ 1,113,524.21
4	Beginning Emergency Reserve	$ 5,676.60	$ 3,922.97	$ 8,472.83
5	**Net Reserve**	$ 1,063,615.31	$ 1,161,674.53	$ 1,105,051.38
6				
7	**REVENUE**			
8	Real Property Tax	$ 213,928.66	$ 221,485.48	$ 244,726.91
9				
10	One Year Temp Reduction (0.89)	$ -		$ (65,017.00)
11	Net Property Tax	$ 213,928.66	$ 221,485.48	$ 179,709.91
12	Specific Ownership Tax	$ 11,004.42	$ 7,762.48	$ 7,500.00
13	Penalties & Interest			
14	Interest on Deposits	$ 1,222.92	$ 1,106.31	$ 800.00
15	Miscellaneous	$ -	$ -	
16	**TOTAL**	$ 226,156.00	$ 230,354.27	$ 188,009.91
17				
18	**EXPENDITURES**			
19	**Administration**			
20	Wages	$ 9,789.37	$ 11,355.25	$ 30,000.00
21	Payroll Tax	$ -	$ -	$ -
22	Payroll Expenses	$ 157.75	$ -	$ -
23	FPPA Volunteer D & D	$ -	$ -	$ -
24	Health Benefits	$ -	$ -	$ -
25	Insurance	$ 5,878.00	$ 5,860.00	$ 6,000.00
26	Workman's Compensation	$ -	$ -	$ 500.00
27	Directors Fees	$ 5,060.00	$ 3,900.00	$ 6,000.00
28	North Fork Ambulance Fees	$ 1,225.00	$ 3,185.00	$ 6,000.00
29	Bank & Finance Charges	$ 104.92	$ 150.00	$ 150.00
30	Accounting & Bookkeeping	$ 500.00	$ 850.00	$ 1,000.00
31	Audit	$ 593.75	$ -	$ 600.00
32	Legal Expenses	$ 1,615.60	$ 2,000.00	$ 5,000.00
33	Legal Notices	$ 167.94	$ 200.00	$ 250.00
34	Vehicle License, title	$ -	$ -	$ -
35	Freight & Postage	$ 325.40	$ 500.00	$ 500.00
36	Office Expense & Supplies	$ 1,053.96	$ 1,487.53	$ 1,500.00
37	Office Equipment	$ 1,629.16	$ -	$ 2,500.00
38	Office Equipment Repair	$ -	$ -	$ 1,000.00
39	Delta Co. Fire District #2	$ 90,000.00	$ 90,000.00	$ 90,000.00
40	Miscellaneous Admin Exp.	$ 253.25	$ -	$ 1,000.00
41	Facilities Rental Charges	$ 700.00	$ 1,200.00	$ 1,200.00
42	Election Expenses	$ 545.93	$ 773.24	$ 1,000.00
43	Telephone and Internet Service	$ 1,219.02	$ 2,304.60	$ 3,000.00
44	Travel Expenses	$ -	$ -	$ -
45	Treasurer's Fees	$ 6,385.88	$ 6,593.74	$ 7,000.00
46	**Total Administration**	$ 127,204.93	$ 130,359.36	$ 164,200.00
47				
48	**Fire Fighting**			
49	Firefighting Expenses	$ -	$ -	$ -
50	Fire Supplies	$ -	$ -	$ -
51	**Total Fire Fighting Exp.**	$ -	$ -	$ -

	A	B		D		E	
52							
53	**Buildings**						
54	Capital Expenditures	$	-	$	-	$	-
55	Repair & Maintenance	$	164.00	$	-	$	10,000.00
56	Engineering & Consulting	$	-	$	150,000.00	$	200,000.00
57	Electric	$	-	$	-	$	3,500.00
58	Propane	$	-	$	-	$	3,000.00
59	Miscellaneous	$	-	$	-	$	-
60	**Total Building Expenses**	$	164.00	$	150,000.00	$	216,500.00
61							
62	**Equipment/Vehicles**						
63	Capital Expenditures - Equip	$	-	$	-	$	-
64	Capital Expenditures - Vehicles	$	-	$	-	$	-
65	Radios, Pagers & Satellite Phone	$	1,673.28	$	1,260.00	$	1,400.00
66	Repair, Maintenance & storage	$	808.20	$	808.20	$	3,000.00
67	Vehicle Repairs	$	-	$	-	$	-
68	Vehicle Supplies, Parts, Tires	$	-	$	-	$	-
69	Miscellaneous	$	-	$	-	$	1,000.00
70	**Total Equipment**	$	2,481.48	$	2,068.20	$	5,400.00
71							
72	**TOTAL EXPENDITURES**	$	129,850.41	$	282,427.56	$	386,100.00
73							
74	Excess Revenue	$	96,305.59	$	(52,073.29)	$	(198,090.09)
75	Beginning Reserve	$	1,069,291.91	$	1,165,597.50	$	1,113,524.21
76	Ending Reserve	$	1,165,597.50	$	1,113,524.21	$	915,434.12
77							
78							
79							
80	2014 Assessed Valuation (11/25)	$	73,052,810.00				
81	Historical Mill Levy		3.350				
82	Taxes Generated	$	244,726.91				
83	Maximum Tabor Mill Levy						
84	Maximum Tax Revenue	$	-				
85	Temporary Credit		0.890				
86	Temporary Reduction	$	65,017.00				
87	Final Mill Levy		2.460				
88	Final tax revenue	$	179,709.91				

APPENDIX D – LOCAL LAND OWNER SURVEY RESULTS

LOCAL LAND OWNER SURVEY RESULTS

Question/Response Options	Number	Percent
1. Contact Information – Response Confidential		
2. Which option best described your relationship?		
I live in Ragged Mountain Fire Protection District	36	63.2%
I own a business in Ragged Mountain Fire Protection District	6	10.5%
I manage a business in Ragged Mountain Fire Protection District	1	1.8%
I am an employee of a business in Ragged Mountain Fire Protection District	1	1.8%
None of the above	13	22.8%
Total Responses	57	
3. If you own, manage, or are an employee of a business in Ragged Mountain Fire Protection District, what type of business is it?		
Agriculture related business	14	50.0%
Energy related business	2	7.1%
Commercial business	0	0.0%
Other	12	42.9%
Total Responses	28	
4. If you are a resident, is your residency		
Full-time	21	41.2%
Part-time (months/year)	17	33.3%
Seasonal (what season)	13	25.5%
Total Responses	51	
5. How long do you intend to remain at your current residence?		
less than 1 year	0	0.0%
1-5 years	4	8.0%
6-10 years	2	4.0%
11-15 years	5	10.0%
More than 15 years	39	78.0%
Total Responses	50	
6. What is your age?		
Less than 20 years old	0	0.0%
21-30 years old	0	0.0%
31-40 years old	5	8.8%
41-50 years old	9	15.8%
51-60 years old	9	15.8%
61-70 years old	20	35.1%
Over 70 years old	14	24.6%
Total Responses	57	
7. Gender		
Male	43	74.1%
Female	15	25.9%
Total Responses	58	
8. What is the highest level of education you have completed?		
High School/GED	11	21.2%

Question/Response Options	Number	Percent
Tech School/Some College	12	23.1%
College Graduate	17	32.7%
Postgraduate Work	12	23.1%
Total Responses	52	
9. What is your average gross household income?		
Less than $24,999	7	16.7%
$25,000 -$49,999	6	14.3%
$50,000-$74,999	8	19.1%
$75,000-$99,999	8	19.1%
$100,000 or more	13	31.0%
Total Responses	42	
10. Does your household have dependents?		
Yes	19	35.2%
No	35	64.8%
Total Responses	54	
11. Have you ever used any of the following services?		
Fire Services	4	23.5%
Emergency Medical Services	16	94.1%
Total Responses	17	
12. Have you ever used the local fire or emergency medical services?		
Never	41	74.6%
Yes, within the past 6 months	1	1.8%
Yes, within the past 1 year	3	5.5%
Yes, within the past 5 years	5	9.1%
Yes, within the past 10 years	3	5.5%
Yes, within the past 25 years	2	3.6%
Total Responses	55	
13. In the last five years, have you used the local fire or emergency medical services?		
Never	45	81.8%
Yes, 1-2 calls	9	16.4%
Yes, 3-5 calls	1	1.8%
Yes, 6-10 calls	0	0.0%
Total Responses	55	
14. How would you rate the overall level of local fire-based emergency services?		
Very Poor	2	3.6%
Poor	6	10.9%
Average	7	12.7%
Good	6	10.9%
Excellent	2	3.6%
No Opinion	32	58.2%
Total Responses	55	
15. How would you rate the overall level of local emergency medical services?		
Very poor	2	3.6%
Poor	2	3.6%
Average	7	12.7%

Question/Response Options	Number	Percent
Good	5	9.1%
Excellent	6	10.9%
No Opinion	33	60.0%
Total Responses	55	
16. Check all services below that you feel are needed in the Ragged Mountain Fire Protection District.		
Fire Suppression (i.e> putting out fires)	51	98.1%
Fire code inspections	14	26.9%
Response to medical emergencies	43	82.7%
Fire investigations	16	30.8%
Response to hazardous materials emergencies	23	44.2%
Response to other perceived emergencies (e.g. carbon monoxide alarms)	19	36.5%
Response to motor vehicle rescues	29	55.8%
Land-based water rescues	17	32.7%
Public education events and programs	14	26.9%
Total Responses	52	
17. Do you currently have a working smoke alarm in your home and/or business?		
Yes, on all floors	34	63.0%
At least one	13	24.1%
Unsure	1	1.9%
No	6	11.1%
Total Responses	54	
18. Have you undertaken any of the following wildfire mitigation efforts on your property?		
Create defensible space around your home (thinning out 30 feet or to your property line, whichever comes first).	36	75.0%
Keep rain gutters clear of leaves and pine needles.	28	58.3%
Do not store combustibles on or under decks, including fire wood.	28	58.3%
Rake up pine needles and leaves within 30 feet of any structure.	26	54.2%
Select plant species with fire resistant characteristics.	3	6.3%
Keep grasses mowed to a maximum height of 4 inches.	38	79.2%
Incorporate landscaping designs to break up fuel continuity (i.e. paths, rock walls, gravel, mulch).	20	41.7%
Keep addresses clearly marked and visible from both directions of traffic.	24	50.0%
Prune lower branches and remove dead or diseased trees and brush.	30	62.5%

APPENDIX E – REGULATORY STANDARDS

NFPA® 450

Guide for

Emergency Medical Services and Systems

2009 Edition

This edition of NFPA 450, *Guide for Emergency Medical Services and Systems,*was prepared by the Technical Committee on Emergency Medical Services. It was issued by the Standards Council on May 30, 2008, with an effective date of July 18, 2008, and supersedes all previous editions.

This edition of NFPA 450 was approved as an American National Standard on July 18, 2008.

Origin and Development of NFPA 450

In January 1999, the NFPA Standards Council considered NFPA's role in Emergency Medical Services (EMS). After a review of extensive information submitted on the need for such a project, the council voted to create a new EMS project to address EMS-related topics not presently covered by other existing NFPA projects. A forum on EMS was scheduled at the May 1999 Association meeting in Baltimore, Maryland. In June 1999, NFPA held a focus group meeting to further discuss NFPA's role in EMS. A request for persons interested in being members of this new project was sent out, and a Technical Committee was formed. The first meeting of the Technical Committee was held in Tampa, Florida, to discuss what specific projects the Technical Committee wanted to address. NFPA 450, *Guide for Emergency Medical Services and Systems*, was developed to assist individuals, agencies, organizations, or systems, as well as those interested or involved in emergency medical services system design, by providing EMS guidelines and recommendations.

For the 2009 edition, the Technical Committee reviewed and revised a number of definitions in Chapter 3 and added new definitions for new material in Chapter 5. The committee also revised material in Section 5.6, Essential System Analysis Components. The table from Annex B was modified and moved to Chapter 5, and Annex B was deleted.

Technical Committee on Emergency Medical Services

Jack J. Krakeel, *Chair*
Fayette County Fire & Emergency Services, GA [E]

Kyle R. Gorman, *Secretary*
Clackamas County Fire District #1, OR [E]

Gary L. Aleshire, Jr., Snohomish County Fire District 1, WA [E]
Rep. Western Fire Chiefs Association

David A. Bradley, Volunteer Firemen's Insurance Services, Inc., PA [I]

Michael Chiaramonte, Lynbrook Volunteer Fire Department, NY [E]
Rep. Volunteer & Combination Officers Section

Richard D. Grulich, U.S. Army Corps of Engineers, AL [C]

Barbara Klingensmith, Florida State Fire College, FL [SE]

Kenneth R. Knipper, Campbell County Office of Emergency Management, KY [U]
Rep. National Volunteer Fire Council

Kurt Krumperman, Rural/Metro Medical Services, AZ [E]
Rep. American Ambulance Association

Kevin J. McGee, Prince William County, VA [E]

Jonathan W. Moore, International Association of Fire Fighters, DC [L]

John Milke Myers, Las Vegas Fire Rescue, NV [U]

Ronald G. Pirrallo, Medical College of Wisconsin, WI [U]
Rep. National Association of EMS Physicians

Franklin D. Pratt, Los Angeles County Fire Department, CA [U]
Rep. American College of Emergency Physicians

Lorraine Probert, U.S. Department of Labor, DC [E]

David O. Simmons, Firemen’s Association of the State of New York, NY [U]

Robert A. Ungar, Robert A. Ungar, P.C., NY [L]
Rep. American Federation of State, County & Municipal Employees

Michael H. Vincent, Vincent Fire Equipment, DE [M]
Rep. NFPA Fire Service Section

Fred K. Walker, U.S. Department of the Air Force, FL [U]

Charles W. Wills, Potomac Heights Volunteer Fire Dept. & Rescue Squad, Inc., MD [U]
Rep. Maryland State Firemen's Association

Alternates

Ben Hinson, Mid Georgia Ambulance Service, Inc., GA [E]
(Alt. to K. Krumperman)

Frank E. Florence, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the training and education requirements for personnel, personal protective equipment, health and safety programs, and quality assurance programs which incorporate physicians and the community planning process. It shall also be responsible for documents relating to emergency medical services, except those covered by other NFPA committees that may have primary responsibility.

NFPA 450
Guide for
Emergency Medical Services and Systems
2009 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in advisory sections of this document are given in Chapter 2 and those for extracts in the informational sections are given in Annex B. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text should be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex B.

Chapter 1 Administration

1.1 Scope.

This document is designed to assist individuals, agencies, organizations, or systems as well as those interested or involved in emergency medical services (EMS) system design.

1.2 Purpose.

The purpose of this document is to provide guidelines and recommendations to assist those interested or involved in EMS system design. Provision of local prehospital care requires the coordination and cooperation of disparate elements. This document provides a template for local stakeholders to evaluate EMS systems and make improvements based on that evaluation. While other resources on this topic exist, this document provides a framework for designing and/or evaluating a comprehensive EMS system.

Chapter 2 Referenced Publications

2.1 General.

The documents or portions thereof listed in this chapter are referenced within this guide and should be considered part of the recommendations of this document.

2.2 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1071, *Standard for Emergency Vehicle Technician Professional Qualifications*, 2006 edition.

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services*

Communications Systems, 2007 edition.

NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments,* 2004 edition.

2.3 Other Publications.

2.3.1 AHA Publications.

American Heart Association, National Center, 7272 Greenville Avenue, Dallas, TX 75231.

"Advanced Cardiovascular Life Support: Section 1: Introduction to ACLS 2000: Overview of Recommended Changes in ACLS From the Guidelines 2000 Conference," *Circulation 2000* 102(Suppl. I), p. I-89.

2.3.2 AMA Publications.

American Medical Association, 515 N. State Street, Chicago, IL 60610.

"Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care. Emergency Cardiac Care Committee and Subcommittees, American Heart Association. Part I. Introduction,"*JAMA* 268:16;1992.

2.3.3 FEMA Publications.

Federal Emergency Management Agency, 500 C Street, S.W., Washington, DC 20402.

Civil Preparedness Guide (CPG).

National Fire Incident Reporting System (NFIRS).

2.3.4 NHTSA Publications.

National Highway Traffic Safety Administration, 400 Seventh Street, S.W., Washington, DC 20590.

Delbridge, T. R., et al., "Emergency Medical Services: Agenda for the Future." August 1996. DOT HS 808-441, NTS-42.

National EMS Education and Practice Blueprint.

NHTSA Uniform Prehospital Data Set.

2.3.5 NIH Publications.

National Institutes of Health, 9000 Rockville Pike, Bethesda, MD 20892.

Pub. No. 93-3304, *Staffing and Equipping EMS Systems: Rapid Identification and Treatment of Acute Myocardial Infarction,* National Heart, Lung, and Blood Institute, September 1993.

2.3.6 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Advisory Sections.

NFPA 79, *Electrical Standard for Industrial Machinery*, 2007 edition.

NFPA 402, *Guide for Aircraft Rescue and Fire-Fighting Operations*, 2008 edition.

NFPA 901, *Standard Classifications for Incident Reporting and Fire Protection Data*, 2006 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 2007 edition.

NFPA 1521, *Standard for Fire Department Safety Officer*, 2008 edition.

NFPA 1581, *Standard on Fire Department Infection Control Program*, 2005 edition.

NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*, 2004 edition.

NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus*, 2007 edition.

Chapter 3 Definitions

3.1 General.

The definitions contained in this chapter apply to the terms used in this guide. Where terms are not defined in this chapter or within another chapter, they should be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, is the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Guide. A document that is advisory or informative in nature and that contains only nonmandatory provisions. A guide may contain mandatory statements such as when a guide can be used, but the document as a whole is not suitable for adoption into law.

3.2.4 Should. Indicates a recommendation or that which is advised but not required.

3.2.5 Standard. A document, the main text of which contains only mandatory provisions using the word “shall” to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Address. A number or other code and the street name identifying a location.

3.3.2 Alarm. A signal or message from a person or device indicating the existence of an emergency or other situation that requires immediate action.

3.3.3 Ambulance. A vehicle designed, equipped, and operated for the treatment and transport of ill and injured persons.

3.3.4 Ambulance Service. An organization that exists to provide patient transportation by ambulance.

3.3.5 American College of Emergency Physicians (ACEP). A national organization of emergency medical physicians.

3.3.6 Arrival. The point at which a vehicle is stopped on the scene of a response destination or address.

3.3.7 Arrived at Destination. The time that the responding unit arrived at the hospital or transfer point.

3.3.8 Automated Vehicle Locator (AVL). A computerized mapping system used to track the location of vehicles.

3.3.9 Available for Service. The time the unit was available for response.

3.3.10 Bloodborne Pathogens. Microorganisms that are present in human blood and can cause diseases in humans. [**1581,** 2005]

3.3.11 Call. A request for assistance to which equipment and personnel are deployed.

3.3.12 Call for Help. The time that a third party or the patient first attempts to contact outside assistance.

3.3.13 Call Intake. The procedure for answering the phone or other device that is used to receive a signal or message from a person or device indicating the need for medical assistance, learning the nature of the emergency, and verifying the address of the emergency.

3.3.14 Call Processing. The interval from call intake by the unit-dispatching agency to the time of unit notification, including answering the phone (alarm), gathering vital information, and initiating a response by dispatching the appropriate unit(s).

3.3.15* Chain of Survival. A metaphor to communicate the interdependence of a community's emergency response to cardiac arrest.

3.3.16 Compliance. Adherence or conformance to laws, regulations, and standards.

3.3.17 Cross-Trained/Dual Role (CT/DR). An emergency service that allows personnel trained in two service functions, such as fire suppression and emergency medical care, to function in either role.

3.3.18 Defibrillation. The delivery of an electrical shock to the heart intended to reverse abnormal electrical activity.

3.3.19 Defibrillator.

3.3.19.1 Automated External Defibrillator (AED). A device that administers an electric shock through the chest wall to the heart using built-in computers to assess the patient's heart rhythm and defibrillate as needed.

3.3.19.2 Manual Defibrillator. A device that delivers an electric shock through the chest wall to the heart and that requires operation by trained medical personnel.

3.3.20 Deployment. The procedures by which resources are distributed throughout the service area.

3.3.21 Dispatch. To send out emergency response resources promptly to an address or incident location for a specific purpose.

3.3.21.1 Computer-Aided Dispatch (CAD). A dispatching method or process in which a computer and its associated terminal(s) are used to provide relative dispatch data to the concerned telecommunicator.

3.3.21.2 Emergency Medical Dispatch. The receipt and management of requests for emergency medical assistance in the emergency medical services (EMS) system.

3.3.22 Dispatch Time. The time the responding unit was notified by the telecommunicator.

3.3.23 Documentation. The process of gathering, classifying, and storing information. [**1911,** 2007]

3.3.24 Emergency. A condition or situation in which an individual perceives a need for immediate response.

3.3.25 Emergency Medical Dispatcher (EMD). EMS personnel specifically trained and certified in interviewing techniques, pre-arrival instructions, and call prioritization.

3.3.26 Emergency Medical Services (EMS). Providing patient services that might include the provision of assessment, treatment such as first aid, CPR, BLS, ALS, and other prehospital procedures, including ambulance transportation of patients.

3.3.27 Emergency Medical Services for Children (EMS-C). A national initiative to reduce child and youth disability and death from severe illness or injury.

3.3.28 Emergency Medical Technician (EMT). A term for any prehospital provider trained and certified at the EMT-Basic level or higher.

3.3.28.1 Emergency Medical Technician–Basic (EMT–B). A prehospital basic life support (BLS) provider with training based on the National Highway Traffic Safety Administration (NHTSA) National Standard Curriculum.

3.3.28.2 Emergency Medical Technician-Intermediate (EMT–I). A prehospital provider trained according to the National Highway Traffic Safety Administration (NHTSA) National Standard Curriculum to intermediate levels.

3.3.28.3 Emergency Medical Technician-Paramedic (EMT–P). A prehospital provider trained according to National Highway Traffic Safety Administration (NHTSA) National Standard Curriculum to advanced levels.

3.3.29 Emergency Operations. Activities of the emergency responders relating to rescue, fire suppression, emergency medical care, and special operations.

3.3.30 Employee Illness and Injury. A work-related illness or injury requiring evaluation or medical follow-up.

3.3.31 Employee Turnover. Termination of employment with the organization for any reason.

3.3.32 Fire Suppression. The activities involved in controlling and extinguishing fires. [**1500,** 2007]

3.3.33 First Intervention Time. The time that the first intervention, such as an IV, defibrillation, CPR, extrication, and so on, is begun.

3.3.34 First PSAP Call Time. The time the telephone begins to ring in the first public safety answering point (or other designated entity).

3.3.35 First Responder (EMS). Functional provision of initial assessment (i.e., airway, breathing, and circulatory systems) and basic first-aid intervention, including CPR and automatic external defibrillator (AED) capability. [**1710,** 2004].

3.3.36 GSA KKK Specifications. A set of federal specifications relating to purchasing requirements for ambulance design and manufacture.

3.3.37 Hazard. A source of possible injury or damage to health. [**79,** 2007]

3.3.38 Hazardous Material. A substance that presents an unusual danger to persons due to toxicity, chemical reactivity, or decomposition, corrosiveness, explosion or detonation, etiological hazards, or similar properties.

3.3.39 Health Care Financing Administration (HCFA). The former name of the Center for Medicare and Medicaid Services (CMS).

3.3.40 Health Maintenance Organization (HMO). An organized system of health care that provides or arranges for a range of basic and supplemental health care services to a voluntarily enrolled group of persons under a prepayment plan.

3.3.41 Incident Location. The address or other identifiable area of an event.

3.3.42 Incident or Onset Time. The time the incident occurred or the time that the symptoms developed.

3.3.43 In-Service Utilization Ratio. An efficiency ratio that divides the cumulative unit-elapsed intervals by the total time that the unit is on duty.

3.3.44 Interval.

- **3.3.44.1** Fractile Response Interval. A method of describing response intervals that uses frequency distribution as its basis for reporting.

- **3.3.44.2*** Turnout Interval. The time beginning when units acknowledge notification of the emergency to the beginning point of response time. [**1710,** 2004]

3.3.45 Interview Ends. The time that the PSAP telecommunicator completes the interview with the caller. This time stamp can occur before or after resources are identified, or before or after units arrive on the scene.

3.3.46 Life Support.

3.3.46.1 Advanced Cardiac Life Support (ACLS). A nationally recognized curriculum to teach advanced methods of treatment for cardiac and other emergencies.

3.3.46.2 Advanced Life Support (ALS). Emergency medical treatment beyond basic life support level as defined by the medical authority having jurisdiction. [**1500,** 2007]

3.3.46.3 Basic Life Support (BLS). Emergency medical treatment at a level as defined by the medical authority having jurisdiction. [**1500,** 2007]

3.3.47 Management.

3.3.47.1 Critical Incident Stress Management (CISM). A program designed to reduce acute and chronic effects of stress related to job functions.

3.3.47.2 Total Quality Management (TQM). A management system fostering continuously improving performance at every level of function and focusing on customer satisfaction.

3.3.48 Medical Director. A physician trained in emergency medicine, designated as a medical director for the local EMS agency.

3.3.49* Medical Oversight. The authorization for treatment by medical directors in local, regional, or state EMS systems.

3.3.49.1 Direct or On-Line Medical Control or Oversight. The clinical advice or instructions given directly to emergency medical services (EMS) personnel by specially trained medical professionals.

3.3.49.2 Indirect Medical Oversight. The administrative medical direction that can be in the form of system design, protocols and procedures, training, and quality assessment.

3.3.50 Multiple Casualty. Injury or death of more than one individual in an incident.

3.3.51 Mutual Aid. Reciprocal assistance by emergency services under a prearranged plan. [**402,** 2008]

3.3.52 National Association of EMS Physicians (NAEMSP). A national organization of emergency medical physicians and other professionals.

3.3.53 National Highway Traffic Safety Administration (NHTSA). The agency under the Department of Transportation that is responsible for preventing motor vehicle injuries.

3.3.54 National Institutes of Health (NIH). An agency of the Public Health Service of the Department of Health and Human Services, responsible for promoting the nation's health.

3.3.55 Outcome. The result, effects, or consequences of an emergency system encounter on the health status of the patient.

3.3.56 Patient Contact. The time that responding personnel first arrived at the patient's side.

3.3.57 Phone "Off-Hook" (answered in first PSAP). The time that the telephone is answered in the first PSAP center.

3.3.58 Protocol. Protocols define the prehospital care management of specific patient problems.

3.3.59 Public Safety Answering Point (PSAP). A facility in which 9-1-1 or other emergency calls are answered, either directly or through rerouting.

3.3.60 Quality Assessment (QA). An assessment of the performance of structure, processes, and outcomes within the EMS system and their comparison against a standard.

3.3.61 Quality Assurance. The activities undertaken to establish confidence that the products or services available maintain the standard of excellence set for those products or services.

3.3.62 Quality Improvement. The activities undertaken to continuously examine and improve the products and services.

3.3.63 Response. The deployment of an emergency service resource to an incident. [**901,** 2006]

3.3.64 Response Resources Are Identified. The time that the PSAP telecommunicator, through computer-aided dispatch or other means, identifies the appropriate resources to send to the scene of the emergency. For example, the telecommunicator might identify ambulance, fire apparatus, quick-response vehicles, police vehicles, specialty vehicles, or other appropriate resources.

3.3.65 Secondary Dispatch Phone "Off-Hook" Answered (if appropriate). The time that the second PSAP or second dispatcher answers the phone, begins the interview, collects caller data, begins pre-arrival instructions.

3.3.66 Secondary Dispatch Phone Rings (if appropriate). The time the telephone begins to ring in the second public safety answering point (or the call screener). Many systems will not use secondary dispatch centers.

3.3.67 Staffing. The number and level of training of personnel deployed on an emergency call.

3.3.68 Standard Operating Procedures (SOPs). A written organizational directive that establishes or prescribes specific operational or administrative methods to be followed routinely for the performance of designated operations or actions. [**1521,** 2008]

3.3.69 Standing Orders. A direction or instruction for delivering patient care without on-line medical oversight backed by authority of the system medical director.

3.3.70 System.

3.3.70.1 EMS System. A comprehensive, coordinated arrangement of resources and functions that are organized to respond in a timely, staged manner to medical emergencies regardless of their cause.

3.3.70.2 Geographic Information System (GIS). A system of computer software, hardware, data, and personnel to describe information tied to a spatial location.

3.3.71 Time.

3.3.71.1 Dispatch Time. A discrete time stamp that represents unit notification.

3.3.72 Time of Discovery of Event. The time that a third party or the patient becomes aware of the need for assistance.

3.3.73 Time of Result of First Intervention. The time that the responder first identifies results of the first intervention. For example, when extrication occurred, when return of spontaneous circulation occurred, and so forth.

3.3.74 Transfer of Care. The time that responsibility for treatment was transferred from a prehospital provider to another — when the hospital personnel physically take over care of the patient.

3.3.75 Turnout Activation. Personnel preparation, boarding the vehicle, starting the vehicle, placing the vehicle in gear, and moving the vehicle toward the emergency scene.

3.3.76 Unit. A staffed and equipped emergency response vehicle.

3.3.77 Unit Acknowledgment. The time that the response unit(s) acknowledge that they have received the notification.

3.3.78 Unit Arrived on Scene. The time that the vehicle comes to a complete stop at the scene.

3.3.79 Unit en Route. The time that the vehicle first begins moving toward the scene.

3.3.80 Unit Left Scene. The time that the vehicle first begins moving from the scene.

Chapter 4 System Regulation and Policy

4.1 General.

System regulation and policy is fundamental to providing emergency medical services and is the basis for effective system design. Consistent with this recognition is the core principle that a single entity has system oversight and responsibility for the effective coordination of system elements. This entity ensures that the EMS system components are clearly articulated and defined. Furthermore, appropriate mechanisms are instituted to ensure participation of system stakeholders in developing policies and regulations. This chapter of the guide outlines the core elements of an effective process for developing and implementing EMS system regulations and policies.

4.2 Oversight.

Within the boundaries of the EMS system, the authority having jurisdiction (AHJ) should provide a process for overseeing all system elements.

4.2.1 EMS Oversight. EMS system oversight should be the responsibility of a single entity.

4.2.2 Designation of Lead Agencies. The AHJ should designate a lead agency to implement and enforce system policies.

4.3 Authorization.

Provider agencies and personnel should be authorized to provide services. The AHJ should ensure that processes or mechanisms are in place to authorize personnel and agency(ies) to provide services consistent with determined levels of need *(see Chapter 5)*.

4.4 Evaluation.

The AHJ should ensure that mechanisms are in place to continually evaluate and re-evaluate the components of the EMS system. The lead agency should develop a process to identify components of the EMS system, establish requirements for those components, and develop an evaluation process to ensure that components meet established requirements.

4.5 Roles and Responsibilities.

The lead agency should establish and articulate roles and responsibilities for EMS system participation. Establishing roles and responsibilities for EMS participants should be accomplished through a comprehensive system assessment as described in Chapter 5.

4.6 Service Levels.

The lead agency should identify service levels and develop guidelines or performance standards for each service level in the community. Service levels, guidelines, and performance standards should be determined by considering factors consistent with local resources and needs, such as community expectations, measurable patient outcomes, resource availability, and financial capability.

4.7 Management Structure.

The lead agency should have a clear management structure and lines of accountability. The management structure of the lead agency should be defined according to depth and breadth appropriate to the system. Each position within the lead agency should be defined according to its role(s), responsibility(ies), and reporting relationships. EMS system participants should know and understand the management structure and function of the lead agency.

4.8 Planning.

The lead agency should provide planning for EMS system design. The lead agency should ensure that the EMS system design is based on a systematic planning process. While planning processes may vary significantly between EMS systems, the lead agency should ensure that the process occurs in a manner consistent with identified needs.

4.9 Authority to Implement Plans.

The lead agency should be empowered to implement plans. Within the system, the AHJ should formally vest the lead agency with responsibility and authority to implement plans.

4.10 Resources.

The lead agency should have the resources necessary to carry out its function. The AHJ should ensure that adequate fiscal and nonfiscal resources are available and accessible, thereby allowing the lead agency to function effectively.

4.11 Participation in Policy Development.

Representatives of user groups and system stakeholders should be involved in designing expectations and developing system policy. The lead agency should identify appropriate participants for system design and policy development. For example, stakeholders may include consumers or users of EMS services, health care providers, hospitals, public health agencies, nursing homes, special populations, educators, governmental officials, and payers.

4.12 Authority for Policy, Procedure, and Operation.

The lead agency should have the authority to convene EMS expertise to assist in designing and implementing policies, procedures, and operations. The lead agency should be vested with the authority to establish advisory bodies or committees for specific EMS system design elements.

4.13 Patient Information Protection.

The lead agency should ensure that appropriate policies and procedures are in place to protect patient and quality assurance records. The lead agency and the AHJ should work closely with state legislative bodies to establish boundaries for disclosure.

Chapter 5 EMS System Analysis and Planning

5.1 Introduction.

5.1.1 Virtually all communities have some form of emergency medical services (EMS) system. For any one community, the *components* of the system and the *level of service* should be tailored to the needs and wants of that community. While an EMS system is unique to the jurisdiction, the industry recognizes a standard approach to assessing local needs and meeting those needs with specific service elements. This chapter of the guide outlines a systematic approach for evaluating and analyzing a jurisdiction's existing EMS system or for determining the system design for a jurisdiction without a dedicated EMS system in place.

5.1.2 As specified in “Emergency Medical Services: Agenda for the Future,” “Before creating an EMS system or implementing any EMS system design changes a community should conduct a comprehensive community analysis that considers available resources, customers, geography, demographics, political conditions, and other unique and special needs of the system. This analysis should focus on these areas, identifying their potential impact on the effectiveness of EMS system components including human resources, medical direction, legislation and regulation, education systems, public education, training, communications, transportation, prevention, public access, communications systems, clinical care, information systems (data collection), and evaluation.” (Delbridge, T.R., et al.)

5.2 Analysis of System Resources.

The EMS system should analyze the resources available to serve the system, including financial resources, equipment and facilities, providers, and participants in the system.

5.2.1 Finances.

5.2.1.1 Comprehensive Financial Analysis. The financial status of the community and its capacity to support the EMS system should be evaluated. The analysis includes the financial status of all the entities within the EMS system based on generally accepted accounting principles. *(See Chapter 6.)*

5.2.1.2 Solvency. The provider(s) of each EMS system component should be financially solvent by maintaining the financial resources to allow the uninterrupted delivery of essential services.

5.2.1.3 Funding Stability. Funding for each component may be through a variety of sources, such as municipal budget/taxes, fee for services, subscription programs, grants, or private donations. Each component should be self-supporting, with adequate reserves to continue to function if the primary funding mechanism is temporarily interrupted or if operating costs exceed available funding.

5.2.1.4 Budget. The system should evaluate both an annual operating budget and a capital budget consistent with generally accepted accounting principles.

5.2.2 Providers. The system should identify the roles, responsibilities, staffing requirements, and training levels of each provider required for the EMS system to function.

5.2.2.1 Provider Resources. EMS systems are composed of the personnel, vehicles, equipment, and facilities used to deliver emergency and nonemergency care to individuals outside a hospital. Key services of EMS systems include public access through a coordinated communications system, public safety and EMS response, and patient transportation. Resources of other nonconventional agencies such as nonemergency ambulance and municipal mass transportation services should be considered.

5.2.2.2 Role Description. Each type of service within the system should be clearly defined and fully described in the system design (e.g., the response system may be different from the transportation system).

5.2.2.3 Role Definition. Based on the needs and wants of the community, several different types and levels of providers may be required. Roles and responsibilities for each type and level of provider should be identified in order to ensure that the desired level of care is delivered continually and effectively. Examples of provider types are described in 5.2.2.3.1 through 5.2.2.3.5.

5.2.2.3.1 Enhanced 9-1-1 Operators. Basic operators are limited to verification of the incident address and notification of closest EMS system provider. Trained emergency medical dispatchers (EMDs) provide verification of the incident address; notification of the closest, most appropriate provider; and provision of pre-arrival patient care instructions.

5.2.2.3.2 Medical First Responders. The roles of medical first responders are defined by the NHTSA EMS division.

5.2.2.3.3 Basic Life Support. The roles of basic life support responders are defined by the NHTSA EMS division.

5.2.2.3.4 Advanced Life Support. The roles of advanced life support responders are defined by the NHTSA EMS division.

5.2.2.3.5 Patient Transportation Provider(s). Patient transportation providers may offer emergency, nonemergency, or prescheduled medical transportation. The role of each provider type should be clearly defined by the AHJ over the EMS system.

5.2.3 Participants. The system identifies the roles and responsibilities of each organization type needed for the EMS system to function.

5.2.3.1 Structure. The provider types listed in 5.2.2.3 may be supplied by a single organization or through the combined efforts of multiple organizations, including but not limited to those described in 5.2.3.1.1 through 5.2.3.1.6.

5.2.3.1.1 Fire Department-Based. The response and patient transportation system uses cross-trained/dual-role fire fighters.

5.2.3.1.2 Fire Department–Based Oversight. The response and patient transportation system uses EMS personnel who are not cross-trained as fire suppression personnel.

5.2.3.1.3 Public Single-Role EMS System. The response and patient transportation system utilizes single-role public employees.

5.2.3.1.4 Private Ambulance Provider System. The response and patient transportation system uses nongovernmental staff.

5.2.3.1.5 Combined System. Some other combination of public and private resources is used to provide out-of-hospital care.

5.2.3.1.6 Additional Provider Types. Additional provider types such as police-based, hospital-based, wilderness, public corporation, military, nonprofit, and others may provide services independently or in combination with other provider types.

5.2.3.2 Participant Roles. The roles and responsibilities for each participant should be organized in a manner that ensures that every component of the system contributes to the effectiveness of the system as a whole, without conflicts in roles and responsibilities.

5.3 Community Needs Analysis.

While an EMS system is unique to the jurisdiction, a standardized approach should be established for assessing local needs and meeting those needs with specific service elements. The system plan identifies the medical needs of the community for patient care and transport.

5.3.1 Retrospective Evaluation.

5.3.1.1 Existing Systems. For existing EMS systems, community needs and system components should be established based on response data, patient care records, and other information, including the following:

(1) Demographic data

(2) Historical patient data and call history

(3) Unique geographical or environmental conditions

(4) Local hazards

(5) Call/incident severity

(6) Other local data resources as appropriate

5.3.1.2 No Existing Systems. For areas without an existing EMS system, system design should be based on established industry standards.

5.3.2 Prevention Targets. The system plan should identify vulnerable population groups that would benefit from prevention programs. The community should include primary illness- and injury-prevention programs for age-related hazards, special needs, or special hazard groups, based on an analysis of the community's population.

5.4 System Goals and Objectives Analysis.

System goals and objectives determine service levels as a function of community needs identified through EMS system evaluation and analysis and community needs assessments.

5.4.1 System Design. System design should be dynamic and based on continual evaluation of the EMS system according to defined indicators and performance measures.

5.4.2 Cost/Benefit. System design should consider both the costs and benefits of service delivery options.

5.4.3 Prevention Efforts. Illness and injury prevention and education efforts should be linked to community needs and resource availability.

5.4.4 Service Levels. Service levels should be linked to community needs and expectations.

5.5 System Design Analysis.

5.5.1 Data Collection and Evaluation. The EMS system should be examined in detail over time using indicators set forth in existing industry standards, guidelines, or specific performance measures.

5.5.2 Existing Industry Standards and Regulations.

5.5.2.1 Existing Regulatory Standards. Community EMS agencies should comply with local and state ordinances and rules and regulations. State and local regulations typically regulate local authority, ambulance services and equipment, EMTs, scopes of practice, training, and certification or licensing requirements.

5.5.2.2 NFPA 1710. NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*, is an industry standard on which fire department–based EMS system design analysis may be based. This voluntary standard contains minimum requirements relating to the organization and deployment of emergency medical operations to the public by “substantially all career fire departments.”

5.5.2.3 Existing EMS Guidelines.

5.5.2.3.1 First Response Unit Guidelines. The National Institutes of Health has recommended guidelines for first response units. *(See NIH 93-3304, Staffing and Equipping EMS Systems: Rapid Identification and Treatment of Acute Myocardial Infarction.)* These guidelines or others may be applied to local EMS systems.

5.5.2.3.2 Early Defibrillation Guidelines. The American Heart Association has recommended guidelines for early defibrillation. *(See Circulation 2000, American Heart Association.)* These guidelines or others may be applied to local EMS systems. For people in cardiac arrest, rapid defibrillation in less than 5 minutes is a high-priority goal.

5.5.2.3.3 Advanced Life Support (ALS) Unit Deployment Guidelines. The National Institutes of Health has recommended guidelines for ALS response units. *(See NIH No. 93-3304, Staffing and Equipping EMS Systems: Rapid Identification and Treatment of Acute Myocardial Infarction.)* These guidelines or others may be applied to local EMS systems.

5.5.2.3.4 Personnel Deployment Guidelines. The American Heart Association has recommendations for personnel deployment. These guidelines or others may be applied to local EMS systems. "In systems that have attained survival rates higher than 20 percent for patients with ventricular fibrillation, the response teams have a minimum of two ACLS providers plus a minimum of two BLS personnel at a scene. Most experts agree that four responders (at least two trained in ACLS and two trained in BLS) are the minimum required to provide ACLS to cardiac arrest victims." *(See American Heart Association's "Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care," JAMA 1992.)*

5.5.2.4 Chain of Survival. The American Heart Association uses the term *chain of survival* to describe the following four EMS system components critical to the survival of cardiac arrest victims:

(1) Early access to the EMS system, facilitated by the availability of a 9-1-1 system that allows callers to obtain police, fire, or EMS assistance by calling a single telephone number

(2) Early CPR by either bystanders or first-responder rescuers

(3) Early defibrillation by first responders, emergency medical technicians (EMTs), paramedics, or other on-scene trained personnel. In addition, public access defibrillation, using automatic or semiautomatic external defibrillators accessible to the lay public, can improve survival in cardiac arrest.

(4) Early advanced life support

5.5.3 Performance Measures as System Design Features.

5.5.3.1 EMS system performance measures are designed to function as a framework for a new system design or as a tool through which a community may monitor the performance of the existing EMS system. Several indicators serve as system design data collection points. Through the continuous measurement of a system's structure, processes, and outcomes using designated indicators and performance measures, EMS system planners may identify areas of the system design that require modification or enhancement.

5.5.3.2 If subsequent data show that the original goals and objectives of the EMS system are not being met, modification of the EMS system design should be made. Data collection and evaluation is required to assess the EMS system modification and ensure that the system continues to be effective.

5.5.3.2.1 Performance Measures. One example of performance measures has been developed by the International Association of Fire Fighters (IAFF). The set of measurable EMS system indicators includes the following:

(1) *Call processing measure*: Total time from call intake by unit dispatching agency to response unit notification. This includes answering the phone, asking call intake questions (e.g., "What is your emergency?"), verifying addresses, asking primary EMD questions, and communicating the address and the nature of the call to the responding unit (dispatch).

(2) *Turnout time measure*: Total time from response unit notification to wheels rolling toward the incident location.

(3) *Travel time measure*: Time elapsed from vehicle wheels turning to arrival of apparatus/vehicle at response address/incident location. This is one time component of overall response time.

(4) *Staffing measure*: The staffing pattern for ALS level responses.

(5) *Deployment measure*: Percentage of calls in which units are available to respond immediately. Lack of available units may be due to excessive call volume or other resource-depleting situations and may cause a deviation from standard deployment procedures.

(6) *Road structure coverage capability measure*: A measure intended to determine whether the department has optimized the location of fixed assets from which mobile assets are deployed. Measurement is done typically via a recognized computer software model, geographic information system (GIS) analysis/ARCVIEW. ARCVIEW is industry standard software from the Environmental Systems Research Institute (ESRI). This measurement model considers road type, impedance, and travel speed in its measure. Measurement may also be conducted via the hand-tracking of addresses on a standard road map. Departments may utilize addresses from historical responses to estimate road coverage capability.

(7) *Patient care protocol compliance measure*: Compliance with established patient care protocol. The data are collected through comparison of patient care documentation with established written (recognized) patient care protocol. This indicator is measured by the medical director, quality assurance, or similarly designated/assigned officer.

(8) *Patient outcome measure*: A measure of the patient's status following EMS encounter relative to patient status upon initial contact by EMS personnel. This measure instrument may be located on patient care report or documentation form. The information reported by attending EMS professional considers patient feedback and signs and symptoms. Note: This measure excludes obvious death upon EMS scene arrival when no treatment is given.

(9) *Defibrillation availability measure*: Percentage of first shocks delivered within 5 minutes of collapse. “Defibrillator” includes automated external defibrillators (AEDs) as well as manual defibrillators.

(10) *Extrication capability measure*: Percentage of calls requiring an extrication tool having one delivered to the scene within 8 minutes of call dispatch.

(11) *Employee illness and injury measure*: Percentage of employees acquiring an illness or injury as a result of participating in an EMS call.

(12) *Employee turnover measure*: Percentage turnover of EMS-trained employees per year.

(13) *Quality program measure*: Determination of whether an overall quality program, as described in (1) through (12), exists within the EMS system.

(14) *System user opinion measure*: Mail/phone survey to assess the satisfaction of system users with the system's performance.

(15) *Multicasualty event response plan measure*: An established plan to mitigate a multiple casualty disaster while maintaining sufficient resources to respond to the normal volume of emergency calls within the jurisdiction.

5.5.3.2.2 NHTSA. The National Highway Traffic Safety Administration (NHTSA) is currently working on a consensus process to develop performance measures for EMS.

5.5.3.2.3 Other Measurement Methods. Accrediting bodies such as the Commission on Fire Accreditation International, the Commission on Accreditation of Ambulance Services, and others have published measurements and criteria for EMS systems.

5.6 Essential System Analysis Components.

The nature of time presents a classic problem in semantics: The same term can have different meanings to different people. Additionally, tradition and unique EMS system design have created a language of time incomparability. The NFPA 450 EMS time template, shown in Table 5.6, is an attempt to solve this problem with consensus terms. The key to this time template is to differentiate clearly between discrete points versus intervals of time. Column A represents discrete points in time or time stamps that occur during an EMS call. Columns B and C label uniquely the elapsed time or intervals between the time stamps.

Table 5.6 Essential System Analysis Components

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Table 5.6 Essential System Analysis Components

Column A Discrete Time Stamps	Column B Functional Intervals	Column C Process Intervals
(1) Incident or onset time	(1) Recognition interval (1 to 2)	(1) Event activation (1 to 4)
(2) Time of discovery of event	(2) System access interval (2 to 3)	(2) Citizen reaction (2 to 4)
(3) Call for help	(3) Switching interval (3 to 4)	(3) Call processing (4 to 11)
(4) First PSAP call time	(4) Answer interval "A" (4 to 5)	(4) System response (4 to 14
(5) Phone "off-hook" (answered in first PSAP)	(5) Routing interval (5 to 6)	(5) Unit response (11 to 14)
(6) Secondary dispatch phone rings — secondary (PSAP) (if appropriate)	(6) Answer interval "B" (6 to 7)	(6) Patient management (14 t
(7) Secondary dispatch phone "off-hook" answered (if appropriate)	(7) Interrogation interval (5, 7 to 8)	(7) Event to treatment (1 to 1
(8) Interview ends	(8) Resource selection interval (8 to 9)	(8) Scene management (13 to
(9) Response resources are identified	(9) Alert interval (9 to 10)	(9) Unit cycle (11 to 20)
(10) Dispatch time	(10) Acknowledgment interval (10 to 11)	
(11) Unit acknowledgment	(11) Turn-out interval (11 to 12)	
(12) Unit en route	(12) Travel interval (12 to 13)	
(13) Unit arrived on scene (wheels stopped)	(13) Patient access interval (13 to 14)	
(14) Patient contact	(14) Initial treatment interval (14 to 15)	
(15) First intervention time	(15) Initial result interval (15 to 16)	
(16) Time of result of first intervention	(16) On-scene patient care interval (16 to 17)	
(17) Unit left scene (wheels turning)	(17) Transport interval (17 to 18)	
(18) Arrived at destination	(18) Care transfer interval (18 to 19)	
(19) Transfer of care	(19) Unit-ready interval (19 to 20)	
(20) Available for service		

5.6.1 The lists in Table 5.6 are not exhaustive but represent typical core points in time and common operational situations. It is not expected that every time stamp be reported. Depending on the EMS system's complexity and level of technology, it is understood that a function interval may be long or instantaneous. However, when reporting EMS system performance, these consensus terms should be used.

5.6.2 Discrete Time Stamp. The term *time stamp* refers to the historical tradition in EMS during which call events were recorded by stamping a card that printed the hour and minute that was displayed at that moment on that clock. Today, times are often recorded automatically by computerized dispatch systems in hours, minutes, and seconds and are synchronized using the U.S. Naval Observatory's atomic clock. These time stamps define discrete moments at which certain events occur, recorded in hour:minute:second [hh:mm:ss] format. Discrete time stamps, collected in this way, allow the user to measure the interval between events. The system must have the ability to capture time stamps in a reliable, consistent, and accurate manner. Not all time stamps are available or collectible, while others are reported with varying degrees of accuracy. Sharing time stamp data across system components and synchronizing time recording devices are critical to establishing an accurate and reliable measurement process.

5.6.2.1 Function Intervals. An interval is the elapsed time between two discrete time stamps. Function intervals are the intervals between consecutive time stamps. The function interval describes the activity occurring at the task level of a single call. Function intervals allow analysis of each function that is taking place throughout the continuum of the event. Certain groups of consecutive functions describe processes.

5.6.2.2 Process Intervals. A process interval is made up of multiple, consecutive function intervals. A process interval is used to describe the elapsed time required to complete the agency's or system's objective. The process interval allows decision makers to establish baselines, monitor changes, benchmark to other systems, and create long-term plans.

5.6.3 Reporting System Data. When decision makers compare systems to benchmark performance, they must use consistent language to describe the function and process intervals. For example, the term *response time* is commonly used but not commonly defined. Therefore caution must be exercised to ensure that the term describes the identical functions or processes. Yet even when common definitions are used, response times may not be accurately compared. For example, some systems report “average” response times, which fail to adequately describe performance. Comparisons should therefore be based on “fractile” reporting, which, for example, may describe time performance with 90 percent reliability.

5.6.4 The terms defined in 5.6.4(A) through 5.6.4(C) are used in Table 5.6.

(A) Column A Definitions.

(1) *Incident or Onset Time*. The time the incident occurred or the time that the symptoms developed.

(2) *Time of discovery of event*. The time that a third party or the patient becomes aware of the need for assistance.

(3) *Call for help*. The time that a third party or the patient first attempts to contact outside assistance.

(4) *First PSAP call time*. The time the telephone begins to ring in the first public safety answering point (or other designated entity).

(5) *Phone “off-hook” (answered in first PSAP)*. The time that the telephone is answered in the first PSAP center.

(6) *Secondary dispatch phone rings — secondary PSAP (if appropriate)*. The time the telephone begins to ring in the second public safety answering point (or the call screener). Many systems will not use secondary dispatch centers.

(7) *Secondary dispatch phone "off-hook" answered (if appropriate)*. The time that the second PSAP or second dispatcher answers the phone, begins the interview, collects caller data, begins pre-arrival instructions.

(8) *Interview ends*. The time that the PSAP telecommunicator completes the interview with the caller. This time stamp may occur before or after resources are identified, or before or after units arrive on the scene.

(9) *Response resources are identified*. The time that the PSAP telecommunicator, through computer-aided dispatch or other means, identifies the appropriate resources to send to the scene of the emergency. For example, the telecommunicator may identify ambulance, fire apparatus, quick-response vehicles, police vehicles, specialty vehicles, or other appropriate resources.

(10) *Dispatch time*. The time the responding unit was notified by the telecommunicator.

(11) *Unit acknowledgment*. The time that the response unit(s) acknowledged that they have received the notification.

(12) *Unit en route*. The time that the vehicle first begins moving toward the scene.

(13) *Unit arrived on scene*. The time that the vehicle comes to a complete stop at the scene.

(14) *Patient contact*. The time that responding personnel first arrived at the patient's side.

(15) *First intervention time*. The time that the first intervention, such as an IV, defibrillation, CPR, extrication, and so on, is begun.

(16) *Time of result of first intervention*. The time that the responder first identifies results of the first intervention. For example, when extrication occurred, when return of spontaneous circulation occurred, and so forth.

(17) *Unit left scene*. The time that the vehicle first begins moving from the scene.

(18) *Arrived at destination*. The time that the responding unit arrived at the hospital or transfer point.

(19) *Transfer of care*. The time that responsibility for treatment was transferred from a prehospital provider to another — when the hospital personnel physically take over care of the patient.

(20) *Available for service*. The time the unit was available for response.

(B) Column B.

(1) *Recognition interval (1 to 2).* The elapsed period starting with (1), Incident or onset

time, and ending at (2), Time of discovery of event.

(2) *System access interval (2 to 3).* The elapsed period starting with (2), Time of discovery of event, and ending at (3), Call for help.

(3) *Switching interval (3 to 4).* The elapsed period starting with (3), Call for help, and ending at (4), First PSAP call time.

(4) *Answer interval "A" (4 to 5).* The elapsed period starting with (4), First PSAP call time, and ending at (5), Phone "off-hook" (answered in first PSAP).

(5) *Routing interval (5 to 6).* The elapsed period starting with (5), Phone "off-hook" (answered in first PSAP), and ending at (6), Secondary dispatch phone rings.

(6) *Answer interval "B" (6 to 7).* The elapsed period starting with (6), Secondary dispatch phone rings, and ending with (7), Secondary dispatch phone "off hook" answered.

(7) *Interrogation interval (5 or 7 to 8).* The elapsed period starting with Phone "off-hook" answered in primary or secondary PSAP and ending with (8), Interview ends.

(8) *Resource selection interval (8 to 9).* The elapsed period starting with (8), Interview ends, and ending with (9), Response resources are identified.

(9) *Alert interval (9 to 10).* The elapsed period starting with (9), Response resources are identified, and ending with (10), Dispatch time.

(10) *Acknowledgment interval (10 to 11).* The elapsed period starting with (10), Dispatch time, and ending with (11), Unit acknowledgment.

(11) *Turn-out interval (11 to 12).* The elapsed period starting with (11), Unit acknowledgment, and ending with (12), Unit en route.

(12) *Travel interval (12 to 13).* The elapsed period starting with (12), Unit en route, and ending with (13), Unit arrived on scene (wheels stopped).

(13) *Patient access interval (13 to 14).* The elapsed period starting with (13), Unit arrived on scene (wheels stopped), and ending with (14), Patient contact.

(14) *Initial treatment interval (14 to 15).* The elapsed period starting with (14), Patient contact, and ending with (15), First intervention.

(15) *Initial result interval (15 to 16).* The elapsed period starting with (15), First intervention, and ending with (16), Result of first intervention.

(16) *On-scene patient care interval (16 to 17).* The elapsed period starting with (16), Result of first intervention, and ending with (17), Unit left scene (wheels turning).

(17) *Transport interval (17 to 18).* The elapsed period starting with (17), Unit left scene (wheels turning), and ending with (18), Arrived at destination.

(18) *Care transfer interval (18 to 19).* The elapsed period starting with (18), Arrived at

destination, and ending with (19), Transfer of care.

(19) *Unit-ready interval (19 to 20).* The elapsed period starting with (19), Transfer of care, and ending with (20), Available for service.

(C) Column C.

(1) *Event activation (1 to 4).* The elapsed time between the event and when the telephone first rings in the first PSAP. This process includes the recognition interval, the system access interval, and the switching interval, and is intended to measure a system's ability — using education, technology, or other means — to recognize that an emergency exists and to take immediate steps to access assistance.

(2) *Citizen reaction (2 to 4).* The citizen reaction process begins when an event is first discovered and ends when the telephone rings in the first PSAP. The citizen reaction process is intended to measure the system access interval and the switching interval. The process measures the system's ability to reinforce certain citizen behaviors and provides the means for those citizens to make appropriate access.

(3) *Call processing (4 to 11).* The call processing interval is the process that begins when the telephone first rings at the first PSAP and ends when responding units acknowledge that they are aware of the event. The processing interval includes the time required to appropriately answer the telephone in the PSAP, triage and route the call, interview the caller, provide instructions, identify and alert resources, and recognize that the alert has been received. This interval is intended to measure the system's ability to quickly process a request for assistance and notify the appropriate responding units.

(4) *System response (4 to 14).* The system response interval is the process that begins when the telephone first rings at the first PSAP and ends when the responders arrive at the patient's side. The system response interval is intended to measure the system's performance in responding to a call for assistance by considering the call processing interval, as well as the turnout, travel, and patient access intervals.

(5) *Unit response (11 to 14).* The unit response interval is the process that begins when the individual unit acknowledges that a response is required and ends when with patient contact. The unit response interval is intended to measure an individual unit's performance in responding to a call for assistance by considering the turnout, travel, and patient access intervals.

(6) *Patient management (14 to 19).* The patient management interval is the process that begins when responders first make contact with the patient and ends when responsibility for the patient is transferred to another medical provider. The patient management interval is intended to measure the time committed by the system to meet the needs of the patient and reflects the system's ability to manage and monitor resources.

(7) *Event to treatment (1 to 15).* The event to treatment interval is intended to measure the

system's ability to initiate treatment once an event exists. This interval is intended to measure the process that begins when the event occurs and ends when the first treatment is provided. This process may measure the time that responders, dispatchers, citizens, or others intervene as part of an organized EMS system design.

(8) *Scene management (13 to 17).* The scene management interval begins when the first vehicle stops at the scene of an event, and ends when the last patient leaves the scene. The interval is intended to measure the time required to manage the logistics of accessing the patient, providing initial treatment, packaging for transport, and leaving the scene.

(9) *Unit cycle (11 to 20).* The unit cycle process reflects the cycle time of an individual unit from activation to availability. The unit cycle process measures the time that a unit is assigned to an event and unavailable for other assignments.

5.6.5 Call Processing. System analysis considers call processing the manner in which calls are processed, as well as evaluation of the intervals required to complete the call and notify appropriate providers.

5.6.6 Call Processing Method. Community needs should dictate the way that resources are assigned and prioritized.

5.6.7 Call Processing Time Interval Standards. Call processing performance objectives should comply with existing standards. For example, NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, has established a standard that 95 percent of all emergency calls must be answered in 30 seconds. Dispatch of emergency response aid should be made within 60 seconds of the completed receipt of an emergency alarm.

5.6.8 Turnout (Activation) Interval. Turnout interval performance objectives should comply with existing standards. System analysis should consider the provider turnout interval, or the interval from response unit notification to movement of that unit to the location of the incident. For example, NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*, establishes turnout interval objectives of no more than 1 minute (60 seconds).

5.6.9 Geography. System analysis should consider geography and the implications of local geography on service delivery.

5.6.9.1 Geographic Response Tools. A geographic information system (GIS) may be used as a tool to model existing service delivery for each EMS system component, such as first response, BLS or ALS care, or patient transportation services. Response capabilities for each mobile system component based on desired travel intervals can be modeled using a GIS system, identifying underserved areas of a jurisdiction, for either current or planned system designs.

5.6.9.2 Travel Interval. Travel interval objectives examined by a GIS analysis should parallel standards as established by the lead agency.

5.6.9.3 First Response. The community should establish response intervals for first responders that are appropriate for that community. The standards should be suitable for the local demographics, resources, medical needs, and geography. The intervals should be systematically monitored for compliance with the local standard.

5.6.9.4 Advanced Life Support. The community should establish response intervals for advanced life support, where available, that are appropriate for the community. The standards should be suitable for the local demographics, resources, medical needs, and geography. The intervals should be systematically monitored for compliance with the local standard.

5.6.10 Geographic Barriers. A GIS model may also identify potential barriers to delivery of care (for example, interruption of the road network by construction, flooding, or railroad crossings).

5.6.11 Distribution of Demand. A GIS may also identify the distribution of calls in a community and areas undergoing development that would require the expansion of services in the future.

5.6.12 Demographics. The system analysis should consider local demographics and the implications of those demographics on service requirements for a range of constituency groups.

5.6.12.1 Age. Age-related injuries and illnesses (for example, pediatric, adolescent, geriatric) should be considered.

5.6.12.2 Socioeconomics. A community's socioeconomic structure and its associated injuries and illnesses (e.g., violent crime, lack of prenatal care, neglect) should be considered.

5.6.12.3 Gender. Gender-related injuries and illnesses (e.g., disease rates and treatment plans) should be considered.

5.6.12.4 Culture and Ethnicity. Language, cultural diversity, and ethno-specific disease processes should be considered.

5.6.12.5 Local Industry. Industrial area injuries and illnesses (e.g., exposure to hazardous materials, injuries from machinery) should be considered.

5.6.13 Regulatory Environment. The EMS system should monitor the political and regulatory environments to analyze impacts on operations, funding, and personnel.

5.6.14 Additional System Needs. The system analysis should consider other features unique to the system, such as special hazards, needs, and conditions that will affect service delivery.

5.6.15 Disasters. The potential for disasters as a function of unique jurisdictional features, characteristics, and risks should be considered.

5.6.16 Medical Center Resources. The system analysis should consider resources available through local hospitals (e.g., frequency of hospital “diversion” status, resource hospital training, resupply of disposables and medications, ALS quality assurance).

5.7 EMS System Planning.

Based on the comprehensive system analysis and the identified system priorities, the system should develop a plan for ongoing system design and improvements. Plan development should include the components specified in 5.7.1 through 5.7.7.5.

5.7.1 Roles. Identification should be made of the roles and responsibilities of each position type needed for the EMS system to function, based on the needs and wants of the community.

5.7.2 Financing. Annual operating budgets and capital budgets consistent with generally accepted accounting principles should be established.

5.7.3 Resource Allotment. Resources should be allocated appropriately between agencies in the system.

5.7.4 Master Planning/Forecasting. A master plan should be available that ensures that the necessary resources are available to the system and will meet the needs of future system requirements.

5.7.5 Disaster/Catastrophe Planning. The system should ensure that a plan is available to manage overwhelming or catastrophic events, including coordinating activities between and among providers.

5.7.6 Public Education and Injury/Illness Prevention. The system plan should include components required to prevent the need for emergency responses.

5.7.6.1 Traditional Programs. Traditional illness and injury prevention programs such as CPR and “Stop, Drop, and Roll” should be available and regularly provided to citizens in the system.

5.7.6.2 Other Programs. The prevention and public education plan should include analysis of the environment and an analysis of the need for special prevention programs such as water/cold safety, immunization, and basic emergency care.

5.7.6.3 Disaster Preparedness. The system should coordinate with emergency management programs to ensure that citizens are prepared.

5.7.7 Provider Support. The system plan should address and consider methods to support individual providers in the system.

5.7.7.1 Provider Training. Provider training and support programs should ensure that providers receive training sufficient to meet local needs and support to ensure their continued participation.

5.7.7.2 Provider Safety. The following provider safety programs should be in place to reduce the amount and severity of injuries incurred by providers:

(1) Equipment

(2) Training

(3) Accountability systems

5.7.7.3 CISM. Critical incident stress management (CISM) programs designed to reduce acute and chronic effects of stress related to job functions should be established.

5.7.7.4 Wellness. Health and wellness programs should be in place to monitor and support the overall wellness of providers.

5.7.7.5 Emergency Management. Disaster preparedness programs should be in place to meet the unique needs of providers during catastrophic events.

5.8 Continual Risk Assessment and Planning.

The system should have in place a comprehensive process, articulated in a risk assessment plan and overall system design that provides continual analysis and mitigation of risk. The primary risk management processes include risk assessment (internal and external), risk elimination, risk avoidance and prevention, risk control, and loss control.

5.8.1 Internal System Liabilities Risks. Internal system liabilities place individual agencies or the EMS system at risk. Examples of such risks include workplace violence, financial improprieties, discrimination, and harassment.

5.8.2 External-Community Risks. External system liabilities place community members at risk. Examples include risks to the community from provider negligence, inappropriate vehicle operation, lack of compliance with training standards, improper maintenance, and inadequate quality assurance processes.

5.8.3 Risk Control. Measures should be taken to guard against and protect personnel from potential exposures to risks.

5.8.4 Loss Control. Measures should be taken to limit losses through processes such as early-return-to-work programs.

5.9 System Assessment Cycle.

The system should have a process in place to continually review and analyze the EMS system using an assessment cycle that includes the following components:

(1) Data collection

(2) Evaluation

(3) Analysis

(4) Proposing

(5) Planning

(6) Implementation

5.10 Current Conditions.

System data should be used to identify current conditions and trends.

5.10.1 Changing Needs. The data should consider the nature of a changing geography over time, population distribution, and the alteration of the transportation network.

5.10.1.1 Changes in Transportation. Transportation network changes should be monitored and considered.

5.10.1.2 Changing Political Boundaries. The plan should include new annexations and the effect of such annexations on service provision or system financing.

5.10.1.3 Regional Changes. Regional changes (e.g., changing regional disaster risk areas, financial trends affecting entire regions) should be monitored, evaluated, and planned for.

5.10.2 Changing Demographics. The regular review should, at a minimum, re-evaluate the changing demographic trends in the system.

5.10.2.1 Short-Term Changes. Individual events, such as concerts and sporting events, may cause short-term demographic shifts.

5.10.2.2 Long-Term Changes. Long-term changes (such as an aging population) should be considered when re-evaluating the plan.

5.10.3 Changing Public Health Conditions. The system should conduct external environmental scans to anticipate or identify new public health threats in order to prepare the EMS system to respond to such threats.

5.10.4 Unique Local Needs. Unique features and hazards should be monitored when the EMS system plan is updated.

5.11 Data Element/Collection/Analysis/Reporting.

Regular analysis of system component data should be conducted to determine dynamic needs.

5.11.1 Regular Re-evaluation of Data. EMS system performance measure data should be reviewed at least annually to evaluate the specific components within the system. Each component should be evaluated more often based on the original intent of the system and established protocols.

5.11.2 Data Sharing. System data should be shared, as legally appropriate, among agencies and medical facilities in the system.

5.12 Feedback Loop.

A feedback mechanism should be in place to ensure that proposed and implemented changes in the system result in the desired improvements and meet the goals and objectives identified by

EMS system planners.

Chapter 6 Finance

6.1 Determining Cost of System.

The system plan should include a method for determining costs. Methodologies have been specified to identify all costs associated with EMS elements or components. Different methods exist for determining costs for public and private organizations; costing of services may have different applications. Therefore, a number of national organizations have developed cost allocation methods, each with its own applications, benefits, and shortcomings.

6.1.1 Specification and Categorization of Direct Costs. The EMS system should be able to define the direct costs of each system element.

6.1.1.1 Direct operating costs should be established for each phase of operations. The direct costs are those that can be assigned directly to a particular component of the operation, and should include start-up and ongoing costs. The EMS system should be able to understand and recognize the nature of the costs required to start up a new phase of operations and perpetuate those operations.

6.1.1.2 The system should identify the start-up costs of the operation. At a minimum, the system should be able to identify and calculate the start-up costs for the following:

(1) Emergency medical and other equipment

(2) Vehicles

(3) Supplies and materials

(4) Facilities

(5) Primary personnel

(6) Direct labor

(7) Support personnel

(8) Training, including certification and licensing fees

6.1.1.3 The system should identify the ongoing or continuous costs of delivering EMS services. At a minimum, the system should be able to identify and calculate and, if appropriate, allocate the ongoing replacement and maintenance costs for the following:

(1) Emergency medical and other equipment

(2) Vehicles

(3) Fuel

(4) Supplies and materials

(5) Facilities

(6) Ongoing personnel

(7) Primary personnel costs, including salaries and all associated pay-related costs

(8) Personnel benefits

(9) Support personnel

(10) Ongoing communications system

(11) Ongoing training, including certification and licensing fees

6.1.2 Specification and Categorization of Indirect Costs. The EMS system should be able to identify the indirect cost of each system element. The indirect cost should be allocated based on the level of effort required to perform different types of work. Some examples of such costs include the following:

(1) Insurance noncovered expenses

(2) Legal services and consultation

(3) Medical oversight

(4) Contract services

(5) Regulatory compliance

(6) Billing services

(7) Information management

6.2 Method for Anticipating System Funding Sources.

The EMS system should be able to identify and predict the revenue sources available to support a viable EMS system. Given the diversity of funding sources for EMS systems, the system should take into consideration the following potential funding sources:

(1) Fee-for-service resources such as the following:

- (a) Private pay
- (b) Third-party pay
- (c) Bad debt or contractual allowances based on uncollected revenues

(2) Government reimbursement, such as the following:

- (a) Medicare
- (b) Medicaid

(c) Military/government and dependent care

(3) Contractual agreements such as the following:

(a) Capitated agreement

(b) Contract service

(c) Special event

(4) Public and private grants

(5) Public funding, such as the following:

(a) Taxes

(b) EMS operating levies

(c) Bond levies

(6) Statutory revenue

(7) Corporate funding, if available

(8) Civic group funding

(9) Public and private donations

(10) Subscription programs

(11) Investment revenues

(12) Other subsidies

(13) Foundations

6.3 Use of Revenue and Cost Analysis.

System planning should use revenue and cost analyses to establish system priorities, goals, and objectives, and allow the system to predict future financial capabilities.

6.4 Financial Plans.

A financial plan should be developed that reflects sound analysis and planning of short- and long-term operating need. While financial planning at the system level may not be achievable for all types of systems, all EMS systems should be concerned about the financial ability of agencies to ensure ongoing operations.

6.4.1 Short-Term Financial Plan. A short-term financial plan should be created for providing ongoing services. Short-term financial planning should be represented through annual operating and capital budgets.

6.4.1.1 An operating budget should be prepared, approved, and reviewed regularly.

6.4.1.2 A capital budget should be prepared, approved, and reviewed regularly.

6.4.2 Long-Term Plan. A long-term financial plan should be developed to forecast long-term capital needs, potential changes in revenue streams, and potentials for new or alternate methods of providing services. The following are considerations for long-term financial planning for EMS systems:

(1) The potential for new services

(2) The potential for changes in reimbursement structures

(3) Development of a contingency plan for unknown or unanticipated expenditures

(4) Justification for resources and requirements

(5) A cash flow forecast

(6) A revenue projection

6.5 Business Analysis.

A business analysis should be conducted at regular intervals. A business analysis allows the EMS system to monitor its performance and compares its performance against contemporary benchmarks. The following are recognized elements that should be considered in a business analysis:

(1) Financial performance measures

(2) Market analysis, including prevailing rates

(3) Cost shifting, if present

(4) Maintenance of adequate reserves to ensure ongoing operations

(5) Matching resources to requirements to ensure that funding is adequate

(6) Development of a standardized cost analysis tool

6.6 Additional Financial Issues.

The system should consider additional issues. Given the diversity of local EMS systems, local agencies should be able to identify or recognize fiscal considerations that are beyond the scope of standard financial practices.

6.6.1 The collection methodology should be appropriate and reviewed regularly. The EMS system should recognize the uniqueness, importance, and value of the financial reimbursement and collection process. The EMS system should regularly evaluate billing methodologies.

6.6.1.1 Regulatory restrictions should be considered with respect to the billing process. Collection methods should recognize and consider the following local, state, and federal requirements:

(1) Health Insurance Portability and Accountability Act (HIPAA)

(2) Medicare and Medicaid

(3) Employee Retirement Income Security Act

(4) State and federal insurance regulations

6.6.1.2 The collection process should be appropriate to the system. The EMS system should ensure that methods are in place to evaluate collection processes and should ensure that those processes are consistent with community expectations. The following collection processes should be considered by the EMS system:

(1) In-house collections

(2) Regular evaluation of collection rates

(3) Contracted collection

(4) Payer requirements

(5) Appropriate documentation for the system, and provision of training to ensure appropriate documentation

6.6.2 The system should be prepared to provide financial reporting information that articulates the financial health and performance of the system. At a minimum, the financial report should include the following:

(1) Gross billings

(2) Collection rate

(3) Billing mix (ALS, BLS, scheduled, unscheduled, miles per transport, and other billing codes according to local standards)

(4) Payer mix, including uninsured

(5) Accounts receivable turnover rate

(6) Bad debt expense

(7) Contractual allowances

(8) Write-offs

(9) Net revenues

6.6.3 Partnerships should be considered. The system should take steps to forge partnerships when appropriate. In an effort to reduce overall system expenditures, the EMS system should consider taking advantage of fiscal and operating synergies where opportunities exist for collaborative relationships within the system.

Chapter 7 Medical Oversight

7.1 General.

Effective medical direction ensures that physician(s) have appropriate clinical oversight of the emergency medical system. This includes, for example, oversight of on- and off-line medical direction, protocol development, clinical quality assurance and improvement, understanding of emergency operations, and field observations.

7.2 Single Medical Authority.

The system should have in place a single medical authority, or medical authority structure, responsible for patient care oversight and responsibility. Individual agencies in the system may have medical directors that provide agency-specific oversight.

7.3 System Support of Medical Authority.

The system should provide the resources necessary to ensure that the medical authority can fulfill his or her obligations. Some examples may include physical infrastructure, staff support, communications, and liability coverage.

7.4 Medical Authority Role.

The medical authority should provide oversight for the EMS system; however, the medical authority, in some cases, may be the same person as the medical director. The role of the medical authority for the system should be clearly defined and should include the following responsibilities:

(1) Recommending certification, recertification, and decertification of nonphysician prehospital personnel to the appropriate certifying agency

(2) Establishing an EMS advisory committee to review system medical issues

(3) Providing direction and authorization for the development and revision of systemwide protocols, policies, and procedures for all patient care activities from dispatch through triage, treatment, and transport

(4) Establishing criteria for the provider training level of initial emergency response

(5) Establishing criteria for determining the most appropriate patient destination

(6) Ensuring the competency of personnel who provide direct medical oversight to prehospital personnel including, but not limited to, physicians, EMTs, and nurses

(7) Establishing the procedures or protocols under which nontransport of patients is permitted

(8) Providing direction and authorization for educating and testing to the level of proficiency approved for different certification levels within the EMS system

(9) Providing direction for an effective systemwide quality improvement program

(10) Providing direction and authorization for personnel eligibility to provide patient care

(11) Removing authorization for personnel eligibility to provide patient care for due cause, using an approved review and appeals mechanism

(12) Establishing functional criteria for equipment used in patient care

7.5 Medical Director Responsibilities.

The primary responsibility of the agency's medical director should be to ensure quality patient care, from EMS system access to transfer to definitive care. In addition, the physician(s) should perform the following:

(1) Serve as patient advocate

(2) Set and ensure compliance with patient care standards, including communication standards and medical protocols

(3) Provide direction and authorization for the development and revision of systemwide protocols, policies, and procedures for all patient care activities from dispatch through triage, treatment, and transport

(4) Develop and implement the process for the provision of direct medical oversight

(5) Establish the appropriateness of initial qualifications of prehospital personnel involved in patient care and emergency medical dispatch

(6) Ensure that the qualifications of prehospital personnel involved in patient care and emergency medical dispatch are maintained

(7) Provide direction for effective quality improvement programs for continuous system and patient care improvement

(8) Promote EMS research

(9) Maintain liaison with the medical community, including but not limited to hospitals, emergency departments, physicians, prehospital providers, and nurses

(10) Interact with regional, state, and local EMS authorities to ensure that standards, needs, and requirements are met and resources are optimized

(11) Participate in planning activities such as mutual aid, disaster planning and management, and hazardous materials response

(12) Promote public education consistent with system goals

(13) Maintain knowledge levels appropriate for an EMS medical director through continued

education

(14) Actively participate in on-scene activities with appropriate training

7.6 Direct and Indirect Medical Oversight.

Medical directors may provide direct and indirect (on-line and off-line) medical oversight.

7.6.1 During direct medical oversight, the medical director (or designee) should provide voice or other real-time communication to the practitioner.

7.6.2 Indirect medical oversight includes prospective medical oversight and retrospective medical evaluation.

7.6.2.1 Prospective methods may include participating in the training, testing, and certification of providers: protocol development, operational policy and procedures development, and legislative activities.

7.6.2.2 Retrospective activities should include participation in medical audit and review of care.

7.6.2.3 Various aspects of prospective and retrospective medical oversight can be handled by committees functioning under the medical director with representation from appropriate medical and EMS personnel.

7.6.3 Standards should be established for the certification, training, and monitoring of other system physicians.

7.7 Medical Director Qualifications.

To optimize medical oversight of all prehospital emergency medical services, physicians should have the following qualifications as described by the American College of Emergency Physicians (ACEP) and National Association of EMS Physicians (NAEMSP):

(1) License to practice medicine or osteopathy within the system's boundaries

(2) Familiarity with the design and operation of prehospital EMS systems

(3) Experience or training in prehospital emergency care

(4) Experience or training in medical oversight of prehospital emergency units

(5) Active participation in the emergency department management of the acutely ill or injured patient

(6) Experience or training in the instruction of prehospital personnel

(7) Experience or training in the EMS quality improvement process

(8) Knowledge of EMS laws and regulations

(9) Knowledge of EMS dispatch and communications

(10) Knowledge of local mass casualty and disaster plans

(11) Preferred board certified in emergency medicine: American Board of Emergency Medicine (ABEM); American Osteopathic Board of Emergency Medicine (AOBEM)

(12) Preferred completed fellowship training in EMS

Chapter 8 Quality Management, Clinical Quality, and Data Reliability

8.1 Quality Management Program.

A defined quality management program should be developed. The program should identify areas for improvement, evaluate system performance, prioritize development, establish system controls, monitor performance indicators, and re-evaluate system impact.

8.2 Performance Objectives.

A defined quality management program should establish performance objectives based on accepted industry standards and guidelines.

8.2.1 Patient care objectives should be developed systemwide based on community needs and expectations, desired patient outcomes, and local resources. Appropriate medical destinations should be incorporated as part of the patient care objectives. Compliance with established protocols should be monitored. Customer satisfaction and feedback should be incorporated into the system.

8.2.2 System evaluation should be integrated into the quality management program.

8.2.2.1 Performance measures should be established and data collected. *(See 5.5.3 through 5.5.3.2.3.)*

8.2.2.2 The system should measure both resources and availability for the following:

(1) Defibrillator

(2) Extrication tool(s)

(3) Ancillary resources

(4) Medical facilities for availability and diversion policies

(5) Unit availability

8.2.2.3 Staffing and deployment objectives should be monitored and appropriate for the system.

8.2.2.4 Standard operating procedures and guidelines should be established, periodically reviewed, and updated.

8.2.2.5 Training should be evaluated for continuity and content based on industry guidelines and desired system performance.

8.2.2.6 Staff turnover should be evaluated for causes and effects.

8.2.2.7 Equipment maintenance should be monitored and appropriate for the system.

8.2.2.8 System design and changes should be evaluated using a cost/benefit analysis.

8.2.2.9 The communications system should be evaluated based on industry performance guidelines.

8.2.2.10 Interagency relationships and agreements should be reviewed periodically for effectiveness and system needs.

8.2.3 The system should use uniform data element definitions. The system should identify and capture appropriate data points. A uniform prehospital patient care record should be used throughout the EMS system. A method should be in place to capture and review data at the system, agency, and individual provider level.

8.2.3.1 The system should use a uniform data set. Examples of data sets are available through NHTSA, *National Fire Incident Reporting System* (NFIRS), and others.

8.2.3.2 The data should be available for inclusion in a national EMS data clearinghouse.

8.3 Public Health Outcome Parameters.

Public health outcome parameters should be developed for each performance objective through the use of benchmarking if possible.

8.3.1 Standardized outcome measures should be specified based on contemporary professional standards.

8.3.2 U.S. Public Health Service outcome models, which include the measurement of the reduction of discomfort, disability, death, destitution, dissatisfaction, and disease, should be referenced.

8.3.3 A system should be in place to share information between system participants, including patient care facilities, and to obtain information from outside databases, such as the following:

(1) Medical examiner reports

(2) Hospital records

(3) Trauma registry

(4) Cardiac registry

(5) Stroke registry

(6) Transport registry reports

(7) Discharge data

(8) Other appropriate databases

8.4 Physician Participation.

A quality management program should include physician participation.

8.5 Patient Confidentiality.

All data management programs should maintain patient confidentiality, at a minimum in accordance with federal, state, and local regulations.

8.6 Injury/Illness Reduction and Prevention.

The quality management program should incorporate standards directed at reducing injuries and illnesses in the community based on the system data.

8.7 Complaints.

A consistent process should be in place to address complaints.

8.8 Participation in Studies and Research.

The system participants may develop relationships with academic institutions and/or researchers to take an active role in studies and research using system data as follows:

(1) Establish credible data collection process

(2) Identify research issues

(3) Provide linkage (to other studies)

(4) Identify research funding sources

(5) Publish study results in recognized peer-reviewed journals

8.9 System Review.

All quality management systems should be reviewed on a regular basis for effectiveness.

8.10 Documentation.

The EMS system should be able to provide documentation of its quality management program, including quality assessment and improvement methods, provider training programs, prevention strategies, and system performance measures.

8.11 Multiple Clocks Within a System.

Most EMS systems use one clock to record certain events, while other clocks record time stamps for other events. When more than one clock is used, time discrepancies are much more likely. For example, a 9-1-1 center dispatch clock may not be synchronized with the clock used by a responding agency. Therefore, when multiple clocks are used in a system to record discrete time stamps, all efforts should be made to synchronize those clocks.

Chapter 9 Public Information, Education, and Relations (PIER)

9.1 Public Education.

The local EMS system should take steps to establish a coordinated program of public information and relations.

9.1.1 Education efforts should be coordinated to ensure public awareness of system access in the education efforts. The participants in the system should work collaboratively to ensure that the telephone number for appropriate system access is properly promoted.

9.1.2 Education efforts should ensure coordinated delivery systems for PIER activities. The education messages delivered by system providers should be coordinated to ensure consistency. Education messages should use appropriate methods of delivery (e.g., print media, electronic media, television, radio) that are consistent among providers.

9.1.3 Education efforts should be coordinated to ensure public awareness of injury and illness prevention programs. Education efforts should attempt to reduce the incidence of injuries and illness. Providers should work together to design programs that focus on preventing injuries and illnesses by analyzing local or regional data, researching methods of intervening, and implementing the most appropriate methods.

9.1.4 Messages should be delivered according to the diverse needs of constituent groups.

9.1.5 Community and bystander response principles should be included in education efforts. Education efforts should be designed to evaluate opportunities for bystander and community intervention.

9.2 Public Education System Goals.

The participants in the system should evaluate the existing system and plan for improvements *(see 5.7.6 through 5.7.6.3)*. Such efforts should address public access, recognition, and intervention to improve patient outcomes.

9.3 Qualifications of Personnel for PIER Activities.

Specialized skills are required to provide effective public communications. The EMS system should have one or more such personnel.

9.4 PIER Activities.

The participants in the system should work together to develop a working group of public education specialists. The PIER group should include EMS personnel, educators, and public information specialists, as well as local or national experts on specialized topics.

9.5 PIER Activities Related to Mass Gatherings.

9.5.1 Methods for accessing EMS may differ during mass gatherings, and participants at mass gatherings may travel from other areas.

9.5.2 Planning for mass gatherings should be conducted uniformly throughout the system. The participants in the system should collaborate to effect planning for mass gatherings that could be different from EMS system planning. Planning methods should include providing information to patrons about locating and accessing emergency medical assistance.

9.5.2.1 Information should be provided during the event. Emergency medical resources should be easily identified and accessed by patrons, and known to all event workers.

9.5.2.2 After the event, PIER personnel should participate in evaluating the event, focusing on improving communication for future gatherings. That evaluation should consider the ability of patrons to locate and access medical resources.

9.6 PIER Activities.

PIER activities should be directed at the general public, EMS personnel, and medical personnel. Public education personnel in the system should target activities to ensure the best outcomes. EMS and medical personnel should be included in the public education efforts so that messages are consistent.

9.7 EMS Agenda for the Future.

Prevention activities should be targeted to parallel the EMS agenda for the future. Local EMS agencies should consider the agenda for the future as a fundamental building block of public information programs for EMS.

9.8 Disaster Education.

Disaster education should be provided according to system goals. The local EMS PIER personnel, in cooperation with emergency management agencies, should provide plans for preparing for, responding to, and recovering from catastrophic events.

9.9 Collaborative Efforts.

The EMS system should develop plans for mutual aid, cooperation, collaboration, and coordination of PIER activities Not only should the system create those collaborative efforts, but also individual organizations such as prehospital providers, fire agencies, hospitals, public safety agencies, emergency management organizations, local governments, law enforcement agencies, and other public and private entities.

9.10 Identification of Available Public Media Resources.

PIER planning personnel should identify the media resources that are available to the system and the appropriate information that may be provided. Resources may include print and electronic media and printed and audio/visual publications.

9.11 Identification of Funding Resources.

The EMS system should identify funding sources and partners to ensure stable funding for PIER activities.

Chapter 10 Communications

10.1 Introduction.

Communications serve as the entry point to access prehospital response. In addition, communications systems provide the infrastructure and operational support for responders to link resources for EMS activities. Policies and procedures should ensure that access and use of all components comprising communication system resources are in place and ensure efficient and effective delivery of service.

10.2 Access of Emergency Services.

A single number (enhanced 9-1-1 is optimal) should be used to access emergency services. The 9-1-1 emergency number is the preferred access number because it is a nationally recognized emergency telephone number. The nature of 9-1-1 calls necessitates responding directly to the caller with minimal delay even when the caller cannot provide information to the public safety answering point (PSAP).

10.2.1 Emergency Access Number. Policies and procedures should be established to differentiate the emergency access number (9-1-1) from advertised nonemergency access numbers.

10.2.2 Automatic Number Identification (ANI). ANI displays the phone number of the party calling E9-1-1. The data displayed should be verified with the caller.

10.2.3 Automatic Location Identification (ALI). ALI should be available and should display the phone number, name, address, and appropriate agencies for response for the telephone that was used to call 9-1-1. ALI serving a single-line, multiline, or wireless telephone system should associate a location with the caller's telephone number. Additional information such as apartment number, space number, building hazards, unique access requirements, phone location in the building, and pre-existing medical conditions should be displayed.

10.2.4 Access to Nonemergency Services. When other nonemergency help lines exist (such as 2-1-1, 3-1-1, and other numbers), policies and procedures should be in place to ensure that emergency calls received by alternative systems are immediately directed to the appropriate PSAP.

10.2.5 Multilanguage Interpretation. The system should provide multilingual interpretation for non-English-speaking people through established linguistic services.

10.2.6 Hearing Impaired Telephone Services. Services for the hearing impaired, such as telephone devices for the deaf (TDD), should be available and used in the system.

10.3 Lead Agency.

A single lead agency should be responsible for coordinating EMS communications. The lead agency is the agency, usually a public agency, that has the principal responsibility, assigned by the AHJ.

10.3.1 Communication Center Coordination. The communication centers should incorporate EMS system goals and objectives into center operations. The communication centers should have a defined administrative structure.

10.3.2 User Agencies. A user agency is any agency other than the lead agency having a specific interest in EMS communication in the jurisdiction it serves. User agencies should be represented within the communication center governing structure.

10.4 Centralized Communication Plan.

A systemwide communication plan should be in place that functionally consolidates dispatch centers.

10.4.1 Plan Outcomes. The EMS system should describe methods to optimize administrative costs, improve administrative services, lower economic costs of service, and improve service benefits from the communication infrastructure. The communication plan should articulate how these benefits will be achieved.

10.4.2 Communication Relationships. The EMS communication plan should describe and define the communications relationships between system agencies. Such relationships may include managing emergency information, providing a unified communication control system, transferring or handling (without duplicating) event information, and ensuring compatibility of communication devices.

10.5 Computer-Aided Dispatch.

The system should include computer-aided dispatch (CAD), which allows for reference location information such as location of previous incidents, duplicate incidents, or premise/hazard information. The CAD system should provide a method of selecting appropriate response units.

10.5.1 Automatic vehicle locaters (AVL), when used, will assist the CAD system in selecting the closest appropriate unit.

10.5.2 Mobile data computers (MDCs) allow the CAD system to automatically gather and report appropriate response information.

10.6 Capture of Key Data Elements.

The communications system should capture key data elements and report performance.

10.6.1 Data Capture and Reporting Elements. The communications system should, at a minimum, be able to capture and report on the following data elements:

(1) Response intervals

(2) E9-1-1 system access

(3) Call processing interval

(4) Dispatch time

(5) Turnout interval

(6) Travel interval

(7) Patient contact time

(8) En route to hospital (or other facility) time

(9) Arrival at hospital time

(10) Unit available for service

10.6.2 Additional Data and CAD Elements.

10.6.2.1 CAD Interface Capabilities. The CAD should be able to interface with other dispatch computers within the EMS system.

10.6.2.2 Data Retrieval. The CAD system should ensure ease of data input and retrieval.

10.6.2.3 National Fire Incident Reporting System (NFIRS). The CAD system should be able to capture and report information according to the requirements of *NFIRS*.

10.6.2.4 National Highway Traffic Safety Administration (NHTSA). The CAD should be able to capture essential data elements recommended by NHTSA.

10.6.3 Data Integration. A system of integrating and reporting data should be available for all responders in the system.

10.7 Quality Management.

A system should be in place to monitor the quality of the communications system. Communications improvements should be made based on quality evaluations and technological advancements.

10.8 Communications Equipment.

The age and reliability of equipment should be monitored regularly.

10.8.1 Equipment Maintenance. An equipment maintenance plan should be developed and followed.

10.8.2 Financial Plans. Financial plans should anticipate repair and maintenance needs. Funding methodologies should be established that minimize the impacts of capital expenditures for new or replacement equipment.

10.9 Operability.

The communications system should allow communications between all providers in all operating environments.

10.9.1 Operating Security. The system should ensure that secured or dedicated frequencies are available that are not affected by private users (especially cellular telephone users) and should ensure the physical and electronic security of communication resources.

10.9.2 Tactical Frequencies. Tactical operating frequencies should be available to reduce high-traffic radio communications and for use during multiagency events.

10.9.3 Disaster Operations. Disaster communication frequencies should be available and used during disasters, mass casualty incidents, and other multiple-patient scenes according to the standards of the system.

10.9.3.1 The disaster communication process should be dependable to minimize loss of service.

10.9.3.2 Backup systems should be in place in case of the primary system's interruption.

10.9.3.3 High incident response levels (HIRL) should support major events and minimize dispatch volumes. Primary dispatch activities should be limited to emergent incidents; routine calls should be managed by local jurisdiction on an “as available” assignment.

10.10 Criteria-Based Dispatch.

Criteria-based dispatch (CBD) protocols should be used to prioritize requests for service and dispatch resources according to pre-established criteria.

10.10.1 Pre-Arrival Instructions. The dispatch center should establish standards for providing medically approved pre-arrival instructions.

10.10.2 Quality Assurance. The system should use quality assurance measures, such as outcome, comparison, and validation information, to ensure continuous improvement.

10.11 Training.

Call receivers/dispatchers should participate in and complete a nationally recognized and accepted emergency medical dispatch certification program and should receive on-the-job, site-specific training. Call receivers/dispatchers should regularly participate in continuing education.

10.12 Direct Medical Control.

The EMS system should ensure that direct medical control is available for all field responders.

10.13 Nonemergency Services.

Methods should be in place to provide alternative medical services for those requests that do not require emergency medical responses.

Chapter 11 Equipment and Facilities

11.1 Standard for First Response and Ambulance Transportation.

The system should have a standard for first response and ambulance transportation equipment. The EMS system should have a standard or method to determine the equipment and related specifications needed in the system for all patients. The method could permit individual agencies to make equipment determinations.

11.1.1 Vehicles. The EMS system should create specifications for first response and transport vehicles used within the system. A part of the vehicle standard may include allowing individual agencies to make purchasing decisions within the restrictions established by the EMS specification or by state or national standards.

11.1.2 Biomedical Equipment. The EMS system should create specifications for first response and transport biomedical equipment used within the system.

11.1.3 Durable Equipment. The EMS system should create specifications for first response and transport durable equipment used within the system.

11.2 Replacement Plan.

A replacement plan should be developed at the time the equipment is purchased, based the life expectancy of each equipment type.

11.3 Response Vehicle Licenses.

EMS system equipment should be licensed according to local or statewide emergency medical regulations.

11.4 Inspecting Emergency Equipment.

The EMS system should develop plans for inspecting equipment and inventory carried aboard emergency response vehicles. Regular inspections should be conducted every shift, every day, every week, and every month by on-duty personnel. EMS system regulators should conduct announced and unannounced inspections on a regular basis. Inspection lists should be developed based, at a minimum, on manufacturers' recommendations.

11.5 Personnel Education and Training.

All personnel should receive the training necessary to ensure that they can effectively operate emergency vehicles. In addition to driver training, the training courses should include basic inspection requirements for ambulances and other emergency vehicles.

11.5.1 Maintenance of Driving Licenses. Periodic records checks should ensure that licenses are in place and not suspended or revoked.

11.5.2 Operator Assessment. The system should have processes in place to identify at-risk vehicle operators and should develop measures to ensure safe vehicle operation.

11.6 Maintenance Plans.

The maintenance program should have plans in place that provide a schedule for maintenance and carefully articulated maintenance plans for all major equipment used in the system, including vehicles, biomedical equipment, or other medical equipment. The plans should include a replacement schedule and plans to provide reserve equipment or equipment “on loan” during repair periods.

11.7 Maintenance Personnel for Emergency Equipment.

The maintenance program should provide vehicle, biomedical, and hardware maintenance using specially trained personnel. The EMS system should adopt policies to ensure that maintenance personnel are appropriately trained for that maintenance. *(See* NFPA 1071, *Standard for Emergency Vehicle Technician Professional Qualifications.)*

11.8 Response Facilities.

Ambulance and other responders' facilities should be located based on analysis of demand and/or risk-hazard evaluation. Agencies should participate in joint efforts to cooperatively determine the best location for facilities.

11.8.1 EMS facilities may be available (designed) for other medical or clinical services. If appropriate to the local jurisdiction, the EMS participants should consider enhancing facilities for use in advanced medical services.

11.8.2 Ambulance and other response facilities should be designed consistent with system demands and community needs.

11.8.3 The EMS system should designate receiving facilities based on capability, capacity, and location.

Chapter 12 Human Resources

12.1 Introduction.

Human resources are important to both individual agencies and to the broader EMS system. As such, while EMS system planners and regulators should ensure that minimum standards exist in the system for monitoring, managing, and ensuring appropriate staff performance, they also must ensure that individual agencies have appropriate personnel management structures in place.

12.2 Recruitment.

The EMS system should recruit according to its needs, as determined by system analysis, design, and planning.

12.2.1 Selection. The system should have a process for candidate selection that includes procedures for hiring or membership.

12.2.2 Wages/Benefits. The plan for any compensation should be clearly spelled out in system documents.

12.3 Education/Training/Certification.

The system should ensure that employees maintain required certification and/or licensure.

12.3.1 Training Program. The system should have a comprehensive training plan.

12.3.1.1 The training plan should provide uniform curricula based on established standards.

12.3.1.2 The training program and instructors should be regularly monitored and evaluated.

12.3.2 Certification. Certification standards should be appropriate and uniform throughout the system.

12.3.2.1 System requirements for recertification should be disseminated to employees.

12.3.2.2 The system should include the capability to track individual certification/licensure and the need for renewal thereof.

12.3.2.3 The system should ensure that the training programs necessary for certification and recertification are available in or to the system.

12.3.3 Educational Opportunities. Educational opportunities should be made available to employees in the system.

12.3.4 Training/Education Records. Personnel training and/or education records should be maintained by system administrators.

12.4 Retention.

The system or region should take steps to encourage continued participation of personnel. Programs should be appropriate to the local area but may include the following:

(1) Length of service award programs (LOSAPs)

(2) Incentive plans

(3) Recognition plans

(4) Educational/training opportunities

(5) Job advancement/advancement opportunity programs

(6) Provider support

12.5 Personnel.

12.5.1 Processes. The system should have one or more processes in place to ensure effective working relationships between working groups and agencies.

12.5.2 Employee/Member.

12.5.2.1 The lead agency should ensure that a regularly scheduled, objective personnel evaluation process is in place.

12.5.2.2 Job specifications should be clearly defined.

12.5.2.3 Levels of training should be appropriate to meet service needs.

12.5.2.4 The agency should use the criteria covered by 12.5.2.4.1 and 12.5.2.4.2.

12.5.2.4.1 Agencies in the system should have appropriate staffing and scheduling methods to ensure adequate delivery of services based upon the community needs assessment.

12.5.2.4.2 Quality assurance and improvement programs should be in place for each agency participating in the system.

12.5.2.5 The system should ensure that employee/members have agency and provider level identification.

12.6 Rules and Regulations.

Rules and regulations should be structured to provide for uniform management of personnel in the system.

12.6.1 The system should have established rules and regulations for acceptable behavior, activities, and actions.

12.6.2 The system should have established minimum operational policies and guidelines.

12.6.3 The system should have a process in place to manage discipline, appeals, grievances, and other personnel actions.

12.6.4 The system should have a process in place to ensure compliance with occupational safety regulations.

12.7 Health and Safety.

The system should ensure that each agency has and implements a written comprehensive health and safety plan.

12.7.1 Personal protective equipment should be available to all personnel and should be used according to system standards and manufacturer recommendations.

12.7.2 Health and wellness programs should be in place to prevent participant illness and injury.

12.7.3 A critical incident stress management (CISM) process should be in place.

12.7.4 An employee assistance program should be in place.

Chapter 13 Operations

13.1 Implementation of System Design (Operations).

The EMS system operations include the coordination of multiple system elements. That is why each component should be considered not only in the context of its operational application but also in relationship to other factors within the system.

13.2 System Preparation.

EMS operations should be implemented based on EMS system planning, analysis, and financial capability.

13.3 Communications Coordination.

EMS communications should be coordinated based on EMS system design and available local resources.

13.4 Response Coordination.

Plans for first or initial response, ambulance response and transport, and alternate methods of transport should be in place as determined by EMS system analysis and planning, including the availability of additional resources as required by system demands.

13.5 Incident Management.

The function of incident management is the overall management and coordination of, and accountability for, all responding personnel and resources.

13.5.1 The incident management system should be consistent throughout all agencies that can be expected to interact.

13.5.2 The system should be based on a strategy of efficient and effective utilization of resources. It should address chain of command, including transfer of authority of any officer or position. It should provide for delineation of responsibilities and authority for all involved response personnel and agencies.

13.6 Treatment Guidelines.

Patient care should be consistent with AHJ guidelines, industry standards, medical oversight, established protocols, and desired patient outcomes.

13.7 Patient Destination (Transport).

Patient destination guidelines should be consistent with AHJ guidelines, medical oversight, established protocols, and desired patient outcomes.

13.8 Functional Capabilities of Health Care Facilities.

The EMS system, in concert with the local medical community, should create standards for functional capabilities of health care facilities and determine the types of patients who should be delivered to those facilities.

13.8.1 The functional information should be disseminated to emergency care personnel. The system should have a plan in place to provide functional information to emergency personnel, and the plan should be monitored to ensure that patients are transported to the appropriate facility.

13.8.2 The system should define medical center capabilities for the following:

(1) Primary, secondary, and tertiary medical facilities

(2) Alternate health care facilities

(3) Hospice

(4) Specialized care facilities, such as trauma, burn, pediatric, cardiac, hyperbaric, psychiatric, obstetric, spinal cord, and sexual assault

(5) Other facilities appropriate to the local system

13.8.3 The prehospital triage program and destination policies should provide for transport to appropriate facilities and for backup plans for facilities that are on diversion.

13.9 Coordinated Medical Oversight.

A plan should be implemented that allows for direct and indirect medical oversight, coordinating acute medical care, patient care protocol development, and additional components of the quality management program.

13.10 Quality Management/Documentation.

All EMS activities including patient care, transport, training, and research documentation should be included in the implementation of a quality management program.

13.11 Logistics.

Systemwide supply and equipment programs such as the following should be implemented to standardize equipment selection and to facilitate interagency supply and equipment use and sharing:

(1) Restocking of materials, disposables, and consumables

(2) Decontamination of equipment and vehicles

(3) Equipment repair and replacement

(4) Data collection and management

(5) Support for extended duration incident operations

13.12 Staff Management.

Staff recruitment, development, evaluation, education, training, and retention programs should be in place to ensure that sufficient numbers and types of qualified providers are available based on EMS system design.

13.13 Public Information, Education, and Relations.

A program should be in place to allow for an information interface with the community, including EMS access information, public education, system public relations, and incident information management.

13.14 Regulatory Compliance.

The system should ensure that systemwide operations comply with local, state, and federal regulations and laws, including but not limited to, state-mandated reporting, federal health and safety regulations, certification requirements, financial reporting, communicable disease reporting, and communications component authorization.

13.15 Automatic and Mutual Aid.

Automatic and mutual aid agreements should provide for system and backup responses.

13.16 Alternative Patient Transport.

A plan for alternative patient transport should be in place.

13.17 Training.

EMS agencies within a region should jointly train and prepare for emergency responses.

13.17.1 Training Requirements. Each EMS agency and jurisdiction should establish training requirements and should develop and utilize a training program based on the needs assessment of the community.

13.17.2 Coordinated Training Plan. The plan should be a coordinated interagency effort. Appropriate agencies should have regular interaction.

13.17.3 Training for Disasters and Multicasualty Incidents. EMS personnel at all levels within their respective organizations should be trained to meet their responsibilities in the course of a multicasualty incident.

13.18 Emergency Response Planning.

13.18.1 Participants in the local EMS system should be familiar with local emergency management agencies' local annexes and emergency operation plans as defined in the Federal Emergency Management Agency (FEMA) publication *Civil Preparedness Guide (CPG).*

13.18.2 The system should ensure that each agency or jurisdiction has a plan to meet its own needs within its capabilities.

13.18.3 The system should encourage each EMS agency or jurisdiction to enter into mutual aid agreements with other local or regional jurisdictions.

13.19 Joint Coordination and Planning.

Participants in the local EMS system should be involved in planning, needs assessment, training, integration, coordination, mutual aid, provision of resources, and evaluation of the response of a local EMS organization to a multiple-patient incident.

13.19.1 The EMS system's plan should conform to appropriate regional and state plans.

13.19.2 The plan should be a coordinated interagency effort. Responsible participants should have regular interaction in order to facilitate working relations during an incident.

13.20 Research and Development.

The system should participate in research-based evaluation of all system components and should use objective criteria to evaluate, develop, and purchase equipment.

Annex A Explanatory Material

Annex A is not a part of the recommendations of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.3.15 Chain of Survival. The chain of survival is composed of four distinct links: early access, early CPR, early defibrillation, and early ACLS.

A.3.3.44.2 Turnout Interval. This interval includes personnel preparation for response, boarding the responding apparatus/vehicle, placing the apparatus/vehicle in gear for response, and wheels rolling toward the emergency scene.

A.3.3.49 Medical Oversight. Oversight is provided on-line, by direct communications or telecommunications, or off-line by standing orders and established protocols.

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Annex B Informational References

B.1 Referenced Publications. (Reserved)

B.2 Informational References.

The following documents or portions thereof are listed here as informational resources only. They are not directly referenced in this guide.

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F1086-94, *Standard Guide for Structures and Responsibilities of Emergency Medical Services Systems Organizations*, 2002.

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F1221-89, *Standard Guide for Interagency Information Exchange,* 2001.

F1224-89(1996)e1, *Standard Guide for Providing System Evaluation for Emergency Medical Services*, 1996.

F1229-01, *Standard Guide for the Qualification and Training of EMS Air-Medical Patient Care Providers,* 2001.

F1254-90, *Standard Practice for Performance of Prehospital Manual Defibrillation,* 2001.

F1255-90,*Standard Practice for Performance of Prehospital Automated Defibrillation,* 2002.

F1256-90, *Standard Guide for Selection and Practice of Emergency Medical Services Instructor for Basic Life Support/Emergency Medical Technician (BLS/EMT) Training Programs,* 2002.

F1257-90, *Standard Guide for Selection and Practice of Emergency Medical Services Instructor for Advanced Life Support/Emergency Medical Technician (ALS/EMT) Training Programs,* 2002.

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F1286-90,*Standard Guide for Development and Operation of Level 1 Pediatric Trauma Facilities,* 2002.

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F1339-92, *Standard Guide for Organization and Operation of Emergency Medical Services Systems*, 2003.

F1381-92, *Standard Guide for Planning and Developing 9-1-1 Enhanced Telephone Systems,* 2003.

F1418-01, *Standard Guide for Training the Emergency Medical Technician (Basic) in Roles and Responsibilities*, 2001.

F1419-00, *Standard Guide for Training the Emergency Medical Technician (Basic) to Manage Shock,* 2000.

F1420-01, *Standard Guide for Training the Emergency Medical Technician (Basic) to Perform Patient Management Techniques,* 2001.

F1421-01, *Standard Guide for Training the Emergency Medical Technician (Basic) to Manage Obstetrical Emergencies,* 2001.

F1453-92, *Standard Guide for Training and Evaluation of First Responders Who Provide Emergency Medical Care,* 2003.

F1493-93, *Standard Guide for Financing and Financial Accountability of Medical Transportation Systems*, 2003.

F1517-94, *Standard Guide for Scope of Performance of Emergency Medical Services Ambulance Operations,* 2002.

F1552-94, *Standard Practice for Training Instructor Qualification and Certification Eligibility of Emergency Medical Dispatchers,* 2002.

F1555-94, *Standard Guide for Characteristics for Extremity Splints*, 2002.

F1556-94,*Standard Guide for Spinal Immobilization and Extrication (Spined) Device*

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1124-91, and F 1146-91.

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B.3 References for Extracts in Informational Sections. (Reserved)

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2013 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex G. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex G.

Chapter 1 Administration

1.1 Scope. This standard shall contain minimum requirements for a fire service–related occupational safety and health program.

1.2 Purpose.

1.2.1 The purpose of this standard shall be to specify the minimum requirements for an occupational safety and health program for a fire department.

1.2.2 This standard shall specify safety requirements for those members involved in rescue, fire suppression, emergency medical services, hazardous materials operations, special operations, and related activities.

1.2.3* The authority having jurisdiction shall identify which performance objectives of this standard existing programs or policies meet.

1.2.4 Nothing herein shall be intended to restrict any jurisdiction from exceeding these minimum requirements.

1.3 Application.

1.3.1 The requirements of this standard shall be applicable to organizations providing rescue, fire suppression, emergency medical services, hazardous materials mitigation, special operations, and other emergency services, including public, military, private, and industrial fire departments.

1.3.2 This standard shall not apply to industrial fire brigades that might also be known as emergency brigades, emergency response teams, fire teams, plant emergency organizations, or mine emergency response teams.

1.4 Equivalency.

1.4.1* The authority having jurisdiction shall be permitted to approve an equivalent level of qualifications for the requirements specified in Chapter 5 of this standard.

1.4.2 The fire department shall provide technical documentation to demonstrate equivalency.

1.5 Adoption Requirements.

1.5.1* When this standard is adopted by a jurisdiction, the authority having jurisdiction (AHJ) shall set a date or dates for achieving compliance with the requirements of this standard.

1.5.2* The AHJ shall be permitted to establish a phase-in schedule for compliance with specific requirements of this standard.

1.5.3 The fire department shall adopt a risk management plan as specified in Section 4.2 of this standard.

1.5.3.1 This risk management plan shall include a written plan for compliance with this standard.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2010 edition.

NFPA *101*®, *Life Safety Code*®, 2012 edition.

NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, 2013 edition.

NFPA 473, *Standard for Competencies for EMS Personnel Responding to Hazardous Materials/Weapons of Mass Destruction Incidents*, 2013 edition.

NFPA 1001, *Standard for Fire Fighter Professional Qualifications*, 2013 edition.

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NFPA 1003, *Standard for Airport Fire Fighter Professional Qualifications*, 2010 edition.

NFPA 1006, *Standard for Technical Rescuer Professional Qualifications*, 2008 edition.

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NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2013 edition.

NFPA 1403, *Standard on Live Fire Training Evolutions*, 2012 edition.

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NFPA 1984, *Standard on Respirators for Wildland Fire-Fighting Operations,* 2011 edition.

NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies,* 2005 edition.

NFPA 1994, *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents,* 2012 edition.

NFPA 5000®, Building Construction and Safety Code®, 2012 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 Official NFPA Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Shall. Indicates a mandatory requirement.

3.2.4 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

3.3.1 Advanced Life Support (ALS). See 3.3.62.1.

3.3.2 Aerial Device. An aerial ladder, elevating platform, or water tower that is designed to position personnel, handle materials, provide continuous egress, or discharge water. [**1901,** 2009]

3.3.3* Air Transfer. The process of transferring air from one SCBA cylinder to another SCBA cylinder of the same rated pressure capacity by connecting them together with properly designed fittings and a high-pressure transfer line.

3.3.4* Aircraft Rescue and Fire Fighting. The fire-fighting actions taken to rescue persons and to control or extinguish fire involving or adjacent to aircraft on the ground.

3.3.5 Atmosphere.

3.3.5.1* ***Hazardous Atmosphere.*** Any atmosphere that is oxygen deficient or that contains a toxic or disease-producing contaminant.

3.3.5.2 ***Oxygen-Deficient Atmosphere.*** Air atmospheres containing less than 19.5 percent oxygen by volume at one standard atmosphere pressure.

3.3.6 Basic Life Support (BLS). See 3.3.62.2.

3.3.7 Biological Terrorism Agents. Liquid or particulate agents that can consist of a biologically derived toxin or pathogen to inflict lethal or incapacitating casualties, generally on a civilian population as a result of a terrorist attack. [**1994,** 2012]

3.3.8* Candidate. A person who has submitted an application to become a member of the fire department.

3.3.9 CBRN. An abbreviation for chemicals, biological agents, and radiological particulate hazards.

3.3.10* Chemical Flash Fire. The ignition of a flammable and ignitible vapor or gas that produces an outward expanding flame front as those vapors or gases burn. This burning and expanding flame front, a fireball, will release both thermal and kinetic energy to the environment. [**1991,** 2005]

3.3.11 Chemical Terrorism Agents. Liquid, solid, gaseous, and vapor chemical warfare agents and toxic industrial chemicals used to inflict lethal or incapacitating casualties, generally on a civilian population as a result of a terrorist attack. [**1994,** 2012]

3.3.12* Clear Text. The use of plain language in radio communications transmissions.

3.3.13 Closed-Circuit SCBA. See 3.3.89.1.

3.3.14 Cold Zone. See 3.3.19.1.

3.3.15 Communicable Disease. See 3.3.24.1.

3.3.16* Company. A group of members (1) under the direct supervision of an officer; (2) trained and equipped to perform assigned tasks; (3) usually organized and identified as engine companies, ladder companies, rescue companies, squad companies, or multi-functional companies; (4) operating with one piece of fire apparatus (pumper, aerial fire apparatus, elevating platform, quint, rescue, squad, ambulance) except where multiple apparatus are assigned that are dispatched and arrive together, continuously operate together, and are managed by a single company officer; (5) arriving at the incident scene on fire apparatus.

3.3.17* Confined Space. An area large enough and so configured that a member can bodily enter and perform assigned work but which has limited or restricted means for entry and exit and is not designed for continuous human occupancy.

3.3.18 Contaminant. A harmful, irritating, or nuisance material foreign to the normal atmosphere.

3.3.19 Control Zones. The areas at an incident that are designated based upon safety and the degree of hazard.

3.3.19.1 ***Cold Zone.*** The control zone of an incident that contains the command post and such other support functions as are deemed necessary to control the incident.

3.3.19.2 ***Hot Zone.*** The control zone immediately surrounding a hazardous area, which extends far enough to prevent adverse effects to personnel outside the zone.

3.3.52.2 ***Rescue Incident.*** An emergency incident that primarily involves the rescue of persons subject to physical danger and that can include the provision of emergency medical services.

3.3.52.3 ***Traffic Incident.*** An emergency road user occurrence, a natural disaster, or other unplanned event that affects or impedes the normal flow of traffic.

3.3.53 Incident Action Plan. The objectives reflecting the overall incident strategy, tactics, risk management, and member safety that are developed by the incident commander. Incident action plans are updated throughout the incident.

3.3.54 Incident Commander (IC). The individual responsible for all incident activities, including the development of strategies and tactics and the ordering and the release of resources. [**472,** 2013]

3.3.55* Incident Management System (IMS). A system that defines the roles and responsibilities to be assumed by responders and the standard operating procedures to be used in the management and direction of emergency incidents and other functions.

3.3.56* Incident Safety Officer. A member of the command staff responsible for monitoring and assessing safety hazards and unsafe situations, and for developing measures for ensuring personnel safety.

3.3.57 Industrial Fire Brigade. An organized group of employees within an industrial occupancy who are knowledgeable, trained, and skilled in at least basic fire-fighting operations, and whose full-time occupation might or might not be the provision of fire suppression and related activities for their employer. [**600,** 2010]

3.3.58* Infection Control Program. The fire department's formal policy and implementation of procedures relating to the control of infectious and communicable disease hazards where employees, patients, or the general public could be exposed to blood, body fluids, or other potentially infectious materials in the fire department work environment.

3.3.59 Infectious Disease. See 3.3.24.2.

3.3.60 Interface Component. Any material, part, or subassembly used in the construction of the compliant product that provides limited protection to interface areas.

3.3.61 Life Safety Rope. Rope dedicated solely for the purpose of supporting people during rescue, fire-fighting, other emergency operations, or during training evolutions.

3.3.62 Life Support.

3.3.62.1 ***Advanced Life Support (ALS).*** Emergency medical treatment beyond basic life support level as defined by the medical authority having jurisdiction.

3.3.62.2 ***Basic Life Support (BLS).*** Emergency medical treatment at a level as defined by the medical authority having jurisdiction.

3.3.63* Liquefied Gas. A gas that, under its charged pressure, is partially liquid at 70°F (21°C).

3.3.64* Member. A person involved in performing the duties and responsibilities of a fire department, under the auspices of the organization.

3.3.65 Member Assistance Program (MAP). A generic term used to describe the various methods used in the fire department for the control of alcohol and other substance abuse, stress, and personal problems that adversely affect member performance.

3.3.66 Member Organization. An organization formed to represent the collective and individual rights and interests of the members of the fire department, such as a labor union or fire fighters' association.

3.3.67 No-Entry Zone. Those areas at an incident scene that no person(s) are allowed to enter, regardless of what personal protective equipment (PPE) they are wearing due to dangerous conditions. [**1521,** 2008]

3.3.68 Occupational Illness. An illness or disease contracted through or aggravated by the performance of the duties, responsibilities, and functions of a fire department member.

3.3.69 Occupational Injury. An injury sustained during the performance of the duties, responsibilities, and functions of a fire department member.

3.3.70 Offensive Operations. See 3.3.71.4.

3.3.71 Operations.

3.3.71.1* ***Defensive Operations.*** Actions that are intended to control a fire by limiting its spread to a defined area, avoiding the commitment of personnel and equipment to dangerous areas.

3.3.71.2 ***Emergency Operations.*** Activities of the fire department relating to rescue, fire suppression, emergency medical care, and special operations, including response to the scene of the incident and all functions performed at the scene.

3.3.71.3 ***Hazardous Materials Operations.*** All activities performed at the scene of a hazardous materials incident that expose fire department members to the dangers of hazardous materials.

3.3.71.4 ***Offensive Operations.*** Actions generally performed in the interior of involved structures that involve a direct attack on a fire to directly control and extinguish the fire.

3.3.71.5* ***Special Operations.*** Those emergency incidents to which the fire department responds that require specific and advanced training and specialized tools and equipment.

3.3.72 Oxygen-Deficient Atmosphere. See 3.3.5.2.

3.3.73* Particulates. Solid matter that is dispersed in air as a mixture.

3.3.74 Personnel Accountability System. A system that readily identifies both the location and function of all members operating at an incident scene.

3.3.75 Primary Eye Protection. A protective device specifically intended to shield the eyes from certain hazards while permitting vision. *(See also 3.3.30, Faceshield; 3.3.41, Goggle; and 3.3.92, Spectacles.)*

3.3.76 Procedure. An organizational directive issued by the authority having jurisdiction or by the department that establishes a specific policy that must be followed. [**1561,** 2008]

3.3.77* Protective Ensemble. Multiple elements of compliant protective clothing and equipment that when worn together provide protection from some risks, but not all risks, of emergency incident operations.

4.2.2 The risk management plan shall at least cover the risks associated with the following:

(1) Administration
(2) Facilities
(3) Training
(4) Vehicle operations, both emergency and non-emergency
(5) Protective clothing and equipment
(6) Operations at emergency incidents *(see Annex C)*
(7) Operations at non-emergency incidents
(8) Other related activities

4.2.3* The risk management plan shall include at least the following components *(see Annex D)*:

(1) Risk identification — actual and potential hazards
(2) Risk evaluation — likelihood of occurrence of a given hazard and severity of its consequences
(3) Establishment of priorities for action — the degree of a hazard based upon the frequency and risk of occurrence
(4) Risk control techniques — solutions for elimination or mitigation of potential hazards; implementation of best solution
(5) Risk management monitoring — evaluation of effectiveness of risk control techniques

4.3 Safety and Health Policy.

4.3.1* The fire department shall adopt an official written departmental occupational safety and health policy that identifies specific goals and objectives for the prevention and elimination of accidents and occupational injuries, exposures to communicable disease, illnesses, and fatalities.

4.3.2 It shall be the policy of the fire department to seek and to provide for its members an occupational safety and health program that complies with this standard.

4.3.3* The fire department shall evaluate the effectiveness of the occupational safety and health program at least once every 3 years.

4.3.3.1 An audit report of the findings shall be submitted to the fire chief and to the members of the occupational safety and health committee.

4.4 Roles and Responsibilities.

4.4.1 It shall be the responsibility of the fire department to research, develop, implement, and enforce an occupational safety and health program that recognizes and reduces the inherent risks involved in the operations of a fire department.

4.4.2 The fire department shall be responsible for compliance with all applicable laws and legal requirements with respect to member safety and health.

4.4.3* The fire department shall establish and enforce rules, regulations, and standard operating procedures to meet the objectives of this standard.

4.4.4 The fire department shall be responsible for developing and implementing an accident investigation procedure.

4.4.5* All accidents, near misses, injuries, fatalities, occupational illnesses, and exposures involving members shall be investigated.

4.4.5.1 All accidents involving fire department vehicles, equipment, or fire department facilities shall be investigated.

4.4.5.2 The fire department shall take the corrective action necessary to avoid repetitive occurrences of accidents and exposure to communicable diseases.

4.4.5.3 Records of such investigations shall be kept in accordance with the applicable provisions of 4.6.1.

4.4.5.4* The fire department shall develop, adopt, and maintain a written policy related to the documentation and dissemination of information related to internal near-miss investigations and provide information to members.

4.4.6 Each individual member of the fire department shall cooperate, participate, and comply with the provisions of the occupational safety and health program.

4.4.7 It shall be the right of each member to be protected by an effective occupational safety and health program and to participate or be represented in the research, development, implementation, evaluation, and enforcement of the program.

4.4.8 The member organization, where such an organization exists, shall cooperate with the fire department by representing the interests and the welfare of the members in the research, development, implementation, and evaluation of the occupational safety and health program.

4.4.8.1 The member organization shall have the right to represent the individual and collective rights of its members in the occupational safety and health program.

4.5 Occupational Safety and Health Committee.

4.5.1* An occupational safety and health committee shall be established and shall serve the fire chief in an advisory capacity.

4.5.1.1 The committee shall include the following members:

(1) The designated fire department health and safety officer
(2) Representatives of fire department management
(3) Individual members or representatives of member organizations

4.5.1.2 The committee shall also be permitted to include other persons.

4.5.1.3 Representatives of member organizations shall be selected by their respective organizations, but other committee members shall be appointed to the committee by the fire chief.

4.5.2 The purpose of this committee shall be to conduct research, develop recommendations, and study and review matters pertaining to occupational safety and health within the fire department.

4.5.3* The committee shall hold regularly scheduled meetings and shall be permitted to hold special meetings whenever necessary.

4.5.3.1 Regular meetings shall be held at least once every 6 months.

4.5.3.2 Written minutes of each meeting shall be retained and shall be made available to all members.

4.6 Records.

4.6.1* The fire department shall establish a data collection system and maintain permanent records of all accidents, injuries, illnesses, exposures to infectious agents and communicable diseases, or deaths that are job related.

5.2.2* All driver/operators shall meet the requirements of NFPA 1002, *Standard for Fire Apparatus Driver/Operator Professional Qualifications.*

5.2.3 All aircraft rescue fire fighters (ARFF) shall meet the requirements of NFPA 1003, *Standard for Airport Fire Fighter Professional Qualifications.*

5.2.4 All fire officers shall meet the requirements of NFPA 1021, *Standard for Fire Officer Professional Qualifications.*

5.2.5 All wildland fire fighters shall meet the requirements of NFPA 1051, *Standard for Wildland Fire Fighter Professional Qualifications.*

5.2.6* All members responding to hazardous materials incidents shall meet the operations level as required in NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents.*

5.3 Training Requirements.

5.3.1* The fire department shall adopt or develop training and education curriculums that meet the minimum requirements outlined in professional qualification standards covering a member's assigned function.

5.3.2 The fire department shall provide training, education, and professional development programs as required to support the minimum qualifications and certifications expected of its members.

5.3.3 Members shall practice assigned skill sets on a regular basis but not less than annually.

5.3.4 The fire department shall provide specific training to members when written policies, practices, procedures, or guidelines are changed and/or updated.

5.3.5* The respiratory protection training program shall meet the requirements of NFPA 1404, *Standard for Fire Service Respiratory Protection Training.*

5.3.6 Members who perform wildland fire fighting shall be trained at least annually in the proper deployment of an approved fire shelter.

5.3.7* All live fire training and exercises shall be conducted in accordance with NFPA 1403, *Standard on Live Fire Training Evolutions.*

5.3.8* All training and exercises shall be conducted under the direct supervision of a qualified instructor.

5.3.9* All members who are likely to be involved in emergency medical services shall meet the training requirements of the AHJ.

5.3.10* Members shall be fully trained in the use, limitations, care, and maintenance of the protective ensembles and ensemble elements assigned to them or available for their use.

5.3.11 All members shall meet the training requirements as outlined in NFPA 1561, *Standard on Emergency Services Incident Management System.*

5.3.12 All members shall meet the training requirements as outlined in NFPA 1581, *Standard on Fire Department Infection Control Program.*

5.4 Special Operations Training.

5.4.1 The fire department shall provide specific and advanced training to members who engage in special operations as a technician.

5.4.2 The fire department shall provide specific training to members who are likely to respond to special operations incidents in a support role to special operations technicians.

5.4.3 Members expected to perform hazardous materials mitigation activities shall meet the training requirements of a technician as outlined in NFPA 472.

5.4.4 Members expected to perform technical operations at the technician level as defined in NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents,* shall meet the training requirements specified in NFPA 1006, *Standard for Technical Rescuer Professional Qualifications.*

5.5 Member Proficiency.

5.5.1 The fire department shall develop a recurring proficiency cycle with the goal of preventing skill degradation and potential for injury and death of members.

5.5.2 The fire department shall develop and maintain a system to monitor and measure training progress and activities of its members.

5.5.3* The fire department shall provide an annual skills check to verify minimum professional qualifications of its members.

Chapter 6 Fire Apparatus, Equipment, and Drivers/Operators

6.1 Fire Department Apparatus.

6.1.1* The fire department shall consider safety and health as primary concerns in the specification, design, construction, acquisition, operation, maintenance, inspection, and repair of all fire department apparatus.

6.1.1.1* The fire department shall specify restraint devices for fire apparatus, including those restraint devices for emergency medical service (EMS) members operating in the patient compartment of the ambulance.

6.1.2 All new fire apparatus shall be specified and ordered to meet the applicable requirements of NFPA 1901, *Standard for Automotive Fire Apparatus.*

6.1.2.1 If the fire apparatus is equipped with a vehicle data recorder, the AHJ shall develop operating procedures for uploading, monitoring, and reviewing the data.

6.1.3 All new wildland fire apparatus shall be specified and ordered to meet the requirements of NFPA 1906, *Standard for Wildland Fire Apparatus.*

6.1.3.1 If the fire apparatus is equipped with a vehicle data recorder, the AHJ shall develop operating procedures for uploading, monitoring, and reviewing the data.

6.1.4 All marine fire-fighting vessels shall be specified and ordered to meet the requirements of NFPA 1925, *Standard on Marine Fire-Fighting Vessels.*

6.1.5* Where tools, equipment, or respiratory protection are carried within enclosed seating areas of fire apparatus or the patient compartment of an ambulance, such items shall be secured by either a positive mechanical means of holding the item in its stowed position or by placement in a compartment with a positive latching door.

6.2.14.2.2 Emergency lighting equipment and audible warning devices shall not be installed without the fire department's approval.

6.3 Riding in Fire Apparatus.

6.3.1* All persons riding in fire apparatus shall be seated and belted securely by seat belts in approved riding positions at any time the vehicle is in motion other than as allowed in 6.3.4 and 6.3.5. Standing or riding on tail steps, sidesteps, running boards, or in any other exposed position shall be specifically prohibited.

6.3.2 Seat belts shall not be released or loosened for any purpose while the vehicle is in motion, including the donning of respiratory protection equipment or protective clothing.

6.3.3* Members actively performing necessary emergency medical care while the vehicle is in motion shall be secured to the vehicle by a seat belt, or by a vehicle safety harness designed for occupant restraint, to the extent consistent with the effective provision of such emergency medical care.

6.3.3.1 All other persons in the vehicle shall be seated and belted in approved riding positions while the vehicle is in motion.

6.3.4* Fire departments permitting hose loading operations while the vehicle is in motion shall develop written standard operating procedures addressing all safety aspects.

6.3.5* Fire departments permitting tiller training, where both the instructor and the trainee are at the tiller position, shall develop written standard operating procedures addressing all safety aspects.

6.3.6* Helmets shall be provided for and used by members riding in open cab apparatus or open tiller seats.

6.3.6.1 Helmets shall not be worn by persons riding in an enclosed cab.

6.3.7* Eye protection shall be provided for members riding in open cab apparatus or open tiller seats.

6.3.8* On existing fire apparatus where there is an insufficient number of seats available for the number of members assigned to or expected to ride on that piece of apparatus, alternate means of transportation that provide seated and belted positions shall be used.

6.4 Inspection, Maintenance, and Repair of Fire Apparatus.

6.4.1* All fire apparatus shall be inspected, maintained, and tested in accordance with the applicable requirements of NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus.*

• **6.4.2** Fire pumps on apparatus shall be service tested in accordance with the applicable requirements of NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus.*

6.4.3 All aerial devices shall be inspected and service tested in accordance with the applicable requirements of NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus.*

6.4.4 All fire apparatus shall be cleaned and disinfected in accordance with NFPA 1581, *Standard on Fire Department Infection Control Program.*

6.5 Tools and Equipment.

6.5.1 The fire department shall consider safety and health as primary concerns in the specification, design, construction, acquisition, operation, maintenance, inspection, and repair of all tools and equipment.

6.5.2 The hearing conservation objectives of this standard shall be taken into account in the acquisition of new power tools and power equipment.

6.5.3 All new fire department ground ladders shall be specified and ordered to meet the applicable requirements of NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders.*

6.5.4 All new fire hose shall be specified and ordered to meet the applicable requirements of NFPA 1961, *Standard on Fire Hose.*

6.5.5 All new fire department spray nozzles shall be specified and ordered to meet the applicable requirements of NFPA 1964, *Standard for Spray Nozzles.*

6.5.6* All equipment carried on fire apparatus or designated for training shall be inspected at least weekly and within 24 hours after any use.

6.5.7 Inventory records shall be maintained for the equipment carried on each vehicle and for equipment designated for training.

6.5.8 All equipment carried on fire apparatus or designated for training shall be tested at least annually in accordance with manufacturers' instructions and applicable standards.

6.5.9 Fire-fighting equipment found to be defective or in unserviceable condition shall be removed from service and repaired or replaced.

6.5.10 All fire department equipment and tools shall be cleaned and disinfected in accordance with NFPA 1581.

6.5.11 All ground ladders shall be inspected and service tested in accordance with the applicable requirements of NFPA 1932, *Standard on Use, Maintenance, and Service Testing of In-Service Fire Department Ground Ladders.*

6.5.12 All fire hose shall be inspected and service tested in accordance with the applicable requirements of NFPA 1962, *Standard for the Inspection, Care, and Use of Fire Hose, Couplings, and Nozzles and the Service Testing of Fire Hose.*

6.5.13 All fire extinguishers shall be inspected and tested in accordance with the applicable requirements of NFPA 10, *Standard for Portable Fire Extinguishers.*

6.5.14 All fire department powered rescue tools shall meet the requirements of NFPA 1936, *Standard on Powered Rescue Tools.*

Chapter 7 Protective Clothing and Protective Equipment

7.1 General.

7.1.1* The fire department shall provide each member with protective ensembles, ensemble elements, and protective equipment designed to provide protection from hazards to which the member is likely to be exposed and that is suitable for the tasks the member is expected to perform.

7.3.4 Where SCBA is worn over or outside the proximity protective garment, the fire department shall inform the member of the potential high levels of radiant heat that can result in the failure of the SCBA.

7.3.4.1 The fire department shall require additional approved radiant reflective criteria, including but not limited to a protective cover, for the expected proximity fire-fighting exposures when the SCBA is worn over or outside the proximity protective garment.

7.4* Protective Clothing for Emergency Medical Operations.

7.4.1 The fire department shall develop standard operating procedures outlining the minimum required levels of protection based on a risk assessment of the medical care activities involved.

7.4.1.1 Members who perform emergency medical care or are otherwise likely to be exposed to blood or other body fluids shall be provided with emergency medical garments, emergency medical face protection devices, emergency medical examination gloves, emergency medical work gloves, and emergency medical footwear or emergency medical footwear covers that are compliant with NFPA 1999, *Standard on Protective Clothing for Emergency Medical Operations.*

7.4.2* Members shall wear emergency medical examination gloves when providing emergency medical care.

7.4.2.1 Patient care shall not be initiated before the gloves are in place.

7.4.2.2 Emergency medical work gloves shall be permitted to be used in place of emergency medical examination gloves in situations involving physical hazards.

7.4.3 Each member shall use emergency medical garments and emergency medical face protection devices, including particulate filtering masks, prior to any patient care during which large splashes of body fluids can occur, such as childbirth or situations involving spurting blood.

7.4.4 Contaminated emergency medical protective clothing shall be cleaned and disinfected or disposed of as specified in NFPA 1581, *Standard on Fire Department Infection Control Program.*

7.4.4.1 Emergency medical examination gloves and emergency medical footwear covers shall not be reused and shall be disposed of after use.

7.4.4.2 Any item of emergency medical protective clothing that is not designated for "multiple use" shall not be reused and shall be disposed of after use.

7.5* Chemical-Protective Clothing for Hazardous Materials Emergency Operations.

7.5.1* Vapor-Protective Ensembles.

7.5.1.1 Members who engage in operations during hazardous materials emergencies where there is the potential for exposure to known chemicals in gaseous or vapor form that pose skin hazards, to chemicals that have not been identified, or to chemical environments that are classified as immediately dangerous to life or health (IDLH) shall be provided with and shall use vapor-protective ensembles that meet the applicable requirements of NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies.*

7.5.1.2 Prior to use of the ensemble, members who engage in hazardous materials operations shall consult the technical data package, manufacturers' instructions, and manufacturers' recommendations as provided and required by NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies,* to ensure that the ensemble is designed to provide the member protection for the specific hazardous materials emergency.

7.5.1.3 All members who engage in operations during hazardous materials emergencies where there is potential for exposure to known chemicals in gaseous or vapor form that pose skin hazards, to chemicals that have not been identified, or to chemical environments that are classified as IDLH shall be provided with and shall use SCBA that meet the applicable requirements of Section 7.12.

7.5.1.3.1 Additional outside air supplies shall be permitted to be utilized in conjunction with SCBA, provided such systems are positive pressure and have been certified by NIOSH under 42 CFR 84, *Approval of respiratory protective devices.*

7.5.1.4 Vapor-protective ensembles, certified to the 2005 edition of NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies,* shall be permitted to be used for protection from chemical agents, biological agents, and radioactive particulate encountered during terrorism incidents.

7.5.1.5 Where the risk assessment shows that members will also be exposed to liquefied gases, members shall be provided with and shall use vapor-protective ensembles that meet the additional optional requirements for liquefied gas protection in NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies.*

7.5.1.6 Where the risk assessment shows that members will also be exposed to potential chemical flash fires, members shall be provided with and shall use vapor-protective ensembles that meet the additional optional requirements for chemical flash fire protection in NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies.*

7.5.1.7* Vapor-protective ensembles shall not be used alone for any fire-fighting applications or for protection from ionizing radiation, cryogenic liquid hazards, or explosive atmospheres.

7.5.1.8 Vapor-protective ensembles shall be permitted to be used for protection from liquid splashes or solid chemicals and particulates.

7.5.2* Liquid Splash-Protective Ensembles and Clothing.

7.5.2.1 Members who engage in operations during hazardous materials emergencies that will expose them to known chemicals in liquid-splash form shall be provided with and shall use liquid splash-protective ensembles or clothing that meet the applicable requirements of NFPA 1992, *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies.*

7.5.2.2 Prior to use of the ensemble or clothing, members who engage in hazardous materials operations shall consult the technical data package, manufacturers' instructions, and manufacturers' recommendations as provided and required by NFPA 1992, to ensure that the ensemble or clothing is designed to provide the member protection for the specific hazardous chemical emergency.

(1) Exposure is at levels below IDLH conditions.
(2) Exposure to liquids is expected to be incidental through contact with contaminated surfaces or victims well after the release has occurred.
(3) Victims are symptomatic but ambulatory.

7.5.3.5.1 All members who engage in operations for incidents involving CBRN terrorism agents and who are required to wear NFPA 1994, *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents,* Class 3 ensembles shall use one of the following types of respirators:

(1) Open-circuit SCBA that are certified by NIOSH as compliant with NIOSH *Standard for Chemical, Biological, Radiological, and Nuclear (CBRN) Open Circuit Self-Contained Breathing Apparatus (SCBA)*
(2) Air-purifying respirators (APRs) with a minimum rated service life of at least 30 minutes that are certified by NIOSH as compliant with NIOSH *Standard for Chemical, Biological, Radiological, and Nuclear (CBRN) Full Facepiece Air Purifying Respirator (APR)*

7.5.3.6* Where the risk assessment indicates the potential presence of biological or radiological particulates only, all members who will be performing the operations for incidents involving CBRN terrorism agents shall be provided with and shall use at least Class 4 ensembles certified as compliant with NFPA 1994, *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents.*

7.5.3.6.1 All members who engage in operations during chemical and biological terrorism incidents and who are required to wear NFPA 1994, *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents,* Class 4 ensembles shall use one of the following types of respirators:

(1) Open-circuit SCBA that are certified by NIOSH as compliant with NIOSH *Standard for Chemical, Biological, Radiological, and Nuclear (CBRN) Open Circuit Self-Contained Breathing Apparatus (SCBA)*
(2) APR with a minimum rated service life of at least 30 minutes that are certified by NIOSH as compliant with NIOSH *Standard for Chemical, Biological, Radiological, and Nuclear (CBRN) Full Facepiece Air Purifying Respirator (APR)*

7.5.3.7 Vapor-protective ensembles, certified as compliant with NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies,* that are used in operations involving any exposure to CBRN terrorism agents, shall be decontaminated following that use or shall be disposed of where decontamination will not stop the chemical or biological assault on the ensemble and the protective qualities would be diminished or nullified.

7.5.3.8 All NFPA 1994, *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents,* Class 2, Class 3, and Class 4 protective ensembles and NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting,* protective ensembles with the CBRN option that are used in operations involving any exposure to chemical or biological terrorism agents shall be disposed of following that use.

7.5.3.9 Disposal shall be in accordance with applicable local, state/provincial, and federal regulations.

7.5.3.10 All protective ensembles that are to be used for incidents involving CBRN terrorism agents shall be inspected and maintained as required by the technical data package and the manufacturer's instructions.

7.6 Inspection, Maintenance, and Disposal of Chemical-Protective Clothing.

7.6.1 All chemical-protective clothing shall be inspected and maintained as required by the technical data package, manufacturers' instructions, and manufacturers' recommendations.

7.6.2 All chemical-protective clothing that receives an exposure to a chemical or a chemical mixture shall be disposed of if decontamination will not stop the chemical assault on the garment and the protective qualities will be diminished or nullified.

7.6.2.1 Disposal shall be in accordance with applicable state or federal regulations.

7.7 Protective Clothing and Equipment for Wildland Fire Fighting.

7.7.1* The fire department shall establish standard operating procedures for the use of wildland protective clothing and equipment.

7.7.2 Members who engage in or are exposed to the hazards of wildland fire-fighting operations shall be provided with and use protective garments and protective equipment that meet the requirements of NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting.*

7.7.3* Members who engage in or are exposed to the hazards of wildland fire-fighting operations shall be provided with a fire shelter, in a crush-resistive case, and wear it in such a way as to allow for rapid deployment.

7.8 Protective Ensembles for Technical Rescue Operations.

7.8.1 Members of special teams whose primary function is search, rescue, recovery, and site stabilization operations for technical rescue incidents other than wilderness or water rescue incidents shall be provided with and shall use a protective ensemble that is certified as compliant with NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents.*

7.8.1.1 Before emergency response personnel are assigned to technical rescue incidents, the incident commander shall perform a risk assessment of the expected hazards to determine the type of protective ensembles and other protective equipment that is needed.

7.8.1.2 Where the risk assessment indicates exposure to physical and thermal hazards are expected, utility technical rescue protective ensembles and ensemble elements shall be used.

7.8.1.3 Where the risk assessment indicates exposure to physical, thermal, liquid, and body fluid-borne pathogen hazards are expected, rescue and recovery technical rescue protective ensembles and ensemble elements shall be used.

7.8.1.4 Where the risk assessment indicates exposure to physical, thermal, liquid, and body fluid-borne pathogen hazards and CBRN agents is vapor, liquid splash, and particulate forms are expected during terrorism incident operations, CBRN technical rescue protective ensemble and ensemble elements requirements shall be used.

7.8.2 The protective coat and protective trousers shall have at least a 2 in. (50 mm) overlap of all layers so there is no gaping of the total thermal and barrier protection when the protective garments are worn.

7.12.1.3* Closed-circuit SCBA shall be permitted when long-duration SCBA is required.

7.12.1.4 Closed-circuit SCBA shall be NIOSH certified with a minimum rated service life of at least 2 hours and shall operate in the positive-pressure mode only.

7.12.2 Supplied-Air Respirators.

7.12.2.1 Supplied-air respirator units used shall be of the type and manufacture employed by the AHJ.

7.12.2.2 Supplied-air respirators other than SCBA shall not be used in IDLH atmospheres unless equipped with a NIOSH-certified emergency escape air cylinder and a pressure-demand facepiece.

7.12.2.3 Supplied-air respirators, Type C Pressure-Demand Class, shall not be used in IDLH atmospheres unless they meet manufacturers' specifications for that purpose.

7.12.3 Air-Purifying Respirators.

7.12.3.1 Air-purifying respirators (APRs) shall be used only in non-IDLH atmospheres for those contaminants that NIOSH certifies them against.

7.12.3.2 The AHJ shall provide NIOSH-certified respirators that protect the user and ensure compliance with all other OSHA requirements.

7.12.3.3* The AHJ shall establish a policy to ensure canisters and cartridges are changed before the end of their service life.

7.12.3.4 Wildland fire fighting respirators shall be compliant with NFPA 1984, *Standard on Respirators for Wildland Fire-Fighting Operations.*

7.13 Fit Testing.

7.13.1* The facepiece seal capability of each member qualified to use RPE shall be verified by quantitative fit testing following procedures set forth in 29 CFR 1910.134, *Respiratory protection*, and ANSI Z88.2, *Practices for Respiratory Protection*, on an annual basis and whenever new types of RPE or facepieces are issued.

7.13.2 The fit of the RPE of each new member shall be tested before the members are permitted to use RPE in a hazardous atmosphere.

7.13.2.1 Only members with a properly fitting facepiece shall be permitted by the fire department to function in a hazardous atmosphere with RPE.

7.13.3 Fit testing of tight-fitting atmosphere-supplying respirators and tight-fitting powered air-purifying respirators shall be accomplished by performing quantitative fit testing in the negative-pressure mode, regardless of the mode of operation (negative or positive pressure) that is used for respiratory protection.

• **7.13.4** Records of facepiece fitting tests shall include at least the following information:

(1) Name of the member tested
(2) Type of fitting test performed
(3) Specific make and model of facepieces tested
(4) Pass/fail results of the tests

7.13.5* The protection factor produced shall be at least 500 for negative-pressure facepieces for the person to pass the fitting test with that make of full facepiece.

7.13.6* If a satisfactory fit cannot be achieved for an individual with one design of facepiece, the fire department shall work with the manufacturer of the respiratory protection equipment (RPE) to find a facepiece design that fits satisfactorily for that member.

7.14 Using Respiratory Protection.

7.14.1 Respirators shall not be worn when a member has any conditions that prevent a good face seal.

7.14.2 Nothing shall be allowed to enter or pass through the area where the respiratory protection facepiece is designed to seal with the face, regardless of the specific fitting test measurement that can be obtained.

7.14.3* Members who have a beard or facial hair at any point where the facepiece is designed to seal with the face or whose hair could interfere with the operation of the unit shall not be permitted to use respiratory protection at emergency incidents or in hazardous or potentially hazardous atmospheres.

7.14.3.1 These restrictions shall apply regardless of the specific fitting test measurement that can be obtained under test conditions.

7.14.4 When a member must wear spectacles while using full facepiece respiratory protection, the facepiece shall be fitted with spectacles in such a manner that they shall not interfere with the facepiece-to-face seal.

7.14.5 Spectacles with any strap or temple bars that pass through the facepiece-to-face seal area shall be prohibited.

7.14.6* Use of contact lenses shall be permitted during full facepiece respiratory protection use, provided that the member has previously demonstrated successful long-term contact lens use.

7.14.7 Any head covering that passes between the sealing surface of the respiratory protection facepiece and the member's face shall be prohibited.

7.14.8 The respiratory protection facepiece and head harness with straps shall be worn under the protective hoods.

7.14.9 The respiratory protection facepiece and head harness with straps shall be worn under the head protection of any hazardous chemical-protective clothing.

7.14.10 Helmets shall not interfere with the respiratory protection facepiece-to-face seal.

7.15 SCBA Cylinders.

7.15.1* SCBA cylinders made of aluminum alloy 6351-T6 shall be inspected annually, both externally and internally, by a qualified person.

7.15.2 SCBA cylinders shall be hydrostatically tested as required by the manufacturers and applicable governmental agencies.

7.15.3 In-service SCBA cylinders shall be stored fully charged.

7.15.4 In-service SCBA cylinders shall be inspected weekly, monthly, and prior to filling, according to NIOSH requirements, CGA standards, and manufacturers' recommendations.

7.15.5* During filling of SCBA cylinders, all personnel and operators shall be protected from catastrophic failure of the cylinder, except as provided in 7.14.8.

7.19.3* The fire department shall engage in a hearing conservation program to identify and reduce or eliminate potentially harmful sources of noise in the work environment.

7.20 New and Existing Protective Clothing and Protective Equipment.

7.20.1 All new protective clothing and protective equipment shall meet the requirements of the current edition of the respective NFPA standard for that protective clothing or protective equipment.

7.20.2 Existing protective clothing and protective equipment shall have been in compliance with the edition of the respective NFPA standard that was current when the protective clothing or protective equipment was manufactured.

7.20.3 Members' protective ensembles for structural fire fighting and protective ensembles for proximity fire fighting shall be retired in accordance with NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting.*

Chapter 8 Emergency Operations

8.1 Incident Management.

8.1.1* Emergency operations and other situations that pose similar hazards, including but not limited to training exercises, shall be conducted in a manner that recognizes hazards and prevents accidents and injuries.

8.1.2 An incident management system that meets the requirements of NFPA 1561, *Standard on Emergency Services Incident Management System,* shall be established with written standard operating procedures applying to all members involved in emergency operations.

8.1.3 The incident management system shall be utilized at all emergency incidents.

8.1.4 The incident management system shall be applied to drills, exercises, and other situations that involve hazards similar to those encountered at actual emergency incidents and to simulated incidents that are conducted for training and familiarization purposes.

8.1.5* At an emergency incident, the incident commander shall be responsible for the overall management of the incident and the safety of all members involved at the scene.

8.1.6 As incidents escalate in size and complexity, the incident commander shall divide the incident into tactical-level management components and assign an incident safety officer to assess the incident scene for hazards or potential hazards.

8.1.7* At an emergency incident, the incident commander shall establish an organization with sufficient supervisory personnel to control the position and function of all members operating at the scene and to ensure that safety requirements are satisfied.

8.1.8* At an emergency incident, the incident commander shall have the responsibility for the following:

(1) Arrive on-scene before assuming command
(2) Assume and confirm command of an incident and take an effective command position
(3) Perform situation evaluation that includes risk assessment
(4) Initiate, maintain, and control incident communications
(5) Develop an overall strategy and an incident action plan and assign companies and members consistent with the standard operating procedures
(6) Initiate an accountability and inventory worksheet
(7) Develop an effective incident organization by managing resources, maintaining an effective span of control, and maintaining direct supervision over the entire incident, and designate supervisors in charge of specific areas or functions
(8) Review, evaluate, and revise the incident action plan as required
(9) Continue, transfer, and terminate command
(10) On incidents under the command authority of the fire department, provide for liaison and coordination with all other cooperating agencies
(11) On incidents where other agencies have jurisdiction, implement a plan that designates one incident commander or that provides for unified command

8.1.8.1 Interagency coordination shall meet the requirements of NFPA 1561, *Standard on Emergency Services Incident Management System.*

8.2 Communications.

8.2.1 The fire department shall establish and ensure the maintenance of a fire dispatch and incident communications system that meets the requirements of NFPA 1561 and NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems.*

8.2.2* The fire department standard operating procedures shall provide direction in the use of clear text radio messages for emergency incidents.

8.2.2.1 The standard operating procedures shall use "emergency traffic" as a designator to clear the radio traffic for an emergency affecting the incident.

8.2.2.2 This "emergency traffic" shall be permitted to be declared by any member who becomes aware of an emergency affecting the incident.

8.2.3* When a member has declared "emergency traffic," that person shall use clear text to identify the type of emergency, change in conditions, or tactical operations.

8.2.3.1 The member who has declared the "emergency traffic" shall conclude the "emergency traffic" message by transmitting "all clear, resume radio traffic" to end the emergency situation or to re-open the radio channels to communication after announcing the emergency message.

8.2.3.2 The standard operating procedures shall use "mayday" as a designator to identify when a member is in a life-threatening situation and in need of immediate assistance.

8.2.3.3 This "mayday" shall be permitted to be declared by any member who is in or who becomes aware of a member who is in a life-threatening situation and in need of immediate assistance.

8.2.3.4 The incident commander shall conclude the "mayday" by transmitting "Mayday cleared, resume normal radio traffic."

8.2.4* The fire department communications center shall start an incident clock when the first arriving unit is on-scene of a working structure fire or hazardous materials incident, or when other conditions appear to be time sensitive or dangerous.

8.2.4.1* The dispatch center shall notify the incident commander at every 10-minute increment with the time that re-

8.5.8.1 After size-up, the incident commander shall adjust the IDLH designation as the situation dictates, to meet operational needs.

8.5.8.2 Aircraft rescue fire-fighting operations inside the area identified as the IDLH shall be in accordance with 8.5.4.

8.5.9* When members are performing special operations, the highest available level of emergency medical care shall be standing by at the scene with medical equipment and transportation capabilities. Basic life support (BLS) shall be the minimum level of emergency medical care.

8.5.10 Emergency medical care and medical monitoring at hazardous materials incidents shall be provided by or supervised by personnel who meet the minimum requirements of NFPA 473, *Standard for Competencies for EMS Personnel Responding to Hazardous Materials/Weapons of Mass Destruction Incidents.*

8.5.11 At all other emergency operations, the incident commander shall evaluate the risk to the members operating at the scene and, if necessary, request that at least BLS personnel and patient transportation be available.

8.5.12 When members are operating from aerial devices, they shall be secured to the aerial device with a system in compliance with NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services.*

8.5.13 The incident commander shall ensure fire investigators or other members that enter an IDLH atmosphere or hazardous area use the PPE, SCBA, or both, as appropriate for risks that might be encountered.

8.5.14* Members involved in water rescue shall be issued and wear personal flotation devices that meet U.S. Coast Guard requirements.

8.5.15 Fire departments shall develop a standard operating procedure for operating near energized lines or equipment.

8.5.15.1* Procedures shall be developed for isolating personnel from the energized conductor.

8.5.15.2 All fire fighters shall be made aware of the increased danger involving downed power lines when working, especially in limited visibility.

8.5.15.3 Fire department personnel shall not be permitted to move or cut electrical meters.

8.5.15.4 Fire fighters shall locate and isolate downed electrical wires and wait for utility company personnel to disconnect the power to those wires.

8.5.15.4.1 In cases of known immediate life-threatening situations, properly trained and equipped personnel shall be permitted to mitigate the hazard.

8.5.15.5 Fire fighters shall keep a minimum distance from an overhead or downed power line until the line is de-energized and always function under the premise that a line is hot.

8.5.15.6 The incident commander shall convey and continually re-evaluate strategic decisions related to fireground electrical hazards to all personnel on the scene.

8.5.15.7 All fire fighters shall be made aware of the hazards of applying a solid-stream water application around energized electrical conductors.

8.5.15.8 All fire fighters shall be repeatedly trained in safety-related practices for working around electrical energy.

8.6 Hazard Control Zones.

8.6.1 Hazard control zones shall be established at every emergency incident to identify the level of risk to emergency responders and the appropriate level of PPE.

8.6.2 The perimeters of the hazard control zones shall be designated by the incident commander.

8.6.3 If the perimeters change during the course of the incident, these changes shall be communicated to all members on the scene.

8.6.4* Hazard control zones shall be as follows:

(1) Designated as hot, warm, and cold (similar to hazardous materials incidents)
(2) Marked with the applicable colored hazard tape, signage, or other appropriate means wherever possible
(3) Communicated to all personnel attending the incident prior to being assigned to a hazard zone

8.6.4.1* Hot zone (red tape) is the area presenting the greatest risks to members, will often be classified as an IDLH atmosphere, and presents the highest risk of human injury and/or exposure; therefore all members shall wear all of the PPE appropriate for the risks that might be encountered while in the hot zone.

8.6.4.1.1* All members operating within the hot zone shall have an assigned task.

8.6.4.2* Warm zone (yellow tape) shall serve as a limited access area for members directly aiding or in support of operations in the hot zone where significant risk of human injury can still exist.

8.6.4.3 Cold zone (green tape) shall establish the public exclusion or clean zone where there are minimal risks for human injury or exposure, or both, in this zone.

8.6.4.4 Where a no-entry zone is designated, no personnel shall enter the no-entry zone due to imminent hazard(s) or the need to protect evidence.

8.6.5 The incident commander shall ensure that the designation of the appropriate protective clothing and equipment is commensurate with the hazard in the zone the member will be operating in.

8.6.6 All officers and members shall ensure the appropriate use of personnel protective equipment within that zone.

8.6.7 The process of utilizing hazard control zones shall continue until the incident hazards have been mitigated or the incident is over.

8.7* Traffic Incidents.

8.7.1 When members are operating at an emergency incident and their assignment places them in potential conflict with motor vehicle traffic, all efforts shall be made to protect the members.

8.7.2 Each department shall establish, implement, and enforce standard operating procedures regarding emergency operations for traffic incidents.

8.7.3 Apparatus and warning devices shall be placed to take advantage of topography and weather conditions (uphill / upwind) and to protect fire fighters from traffic.

the dedicated rapid intervention crew (RIC) shall on arrival of these additional resources be either one of the following:

(1) On-scene members designated and dedicated as an RIC
(2) On-scene crew/company or crews/companies located for rapid deployment and dedicated as RICs

8.8.3.1 During fire fighter rescue operations each crew/company shall remain intact.

8.8.4 An RIC shall consist of at least two members and shall be available for immediate rescue of a member or a crew.

8.8.4.1 Each RIC shall be fully equipped with protective clothing, protective equipment, SCBA, and any specialized rescue equipment that could be needed given the specifics of the operation under way.

8.8.5 At incidents where any SCBA being used is equipped with an RIC universal air connection (UAC), the RIC shall have the specialized rescue equipment necessary to complete the RIC UAC connection to a supplied air source .

8.8.5.1 Where applicable, the breathing air source and any hoses and connections shall meet the requirements of NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, and be NIOSH certified to 42 CFR 84.

8.8.5.2 The breathing air source shall have no less than 1200 L of breathing air before entering the hazard area.

8.8.6 The composition and structure of a RIC shall be permitted to be flexible based on the type of incident and the size and complexity of operations.

8.8.7* The incident commander shall evaluate the situation and the risks to operating crews and shall provide one or more RICs commensurate with the needs of the situation.

8.8.8 In the early stages of an incident, which includes the deployment of a fire department's initial attack assignment, the RIC shall be in compliance with 8.2.4.1 and 8.8.2.5 and be either one of the following:

(1) On-scene members designated and dedicated as an RIC
(2) On-scene members performing other functions but ready to redeploy to perform RIC functions

8.8.9 The assignment of any personnel shall not be permitted as members of the RIC if abandoning their critical task(s) to perform rescue clearly jeopardizes the safety and health of any member operating at the incident.

• **8.8.10** During fire fighter rescue operations each crew/company shall remain intact.

8.8.11 At least one dedicated RIC shall be standing by with equipment to provide for the rescue of members that are performing special operations or for members that are in positions that present an immediate danger of injury in the event of equipment failure or collapse.

8.9 Rehabilitation During Emergency Operations.

8.9.1* The fire department shall develop standard operating procedures that outline a systematic approach for the rehabilitation of members operating at incidents.

8.9.2* The incident commander shall consider the circumstances of each incident and initiate rehabilitation in accordance with the standard operating procedures and with NFPA 1561.

8.9.3* Such on-scene rehabilitation shall include at least rest, hydration, active cooling where required, basic life support care, food where required, and protection from extreme elements.

8.9.4 Each member operating at an incident shall be responsible to communicate rehabilitation needs to their supervisor.

8.9.5* Each member who engages in wildland fire-fighting operations shall be provided with 2 qt (2 L) of water.

8.9.5.1 A process shall be established for the rapid replenishment of water supplies.

8.10 Scenes of Violence, Civil Unrest, or Terrorism.

8.10.1* Fire department members shall not become involved in any activities at the scene of domestic disturbance, civil unrest, or similar situations where there is ongoing violence, without the confirmed presence of law enforcement personnel who have deemed the scene secure.

8.10.2 Under no circumstances shall fire department equipment or personnel be used for crowd control or dispersement purposes.

8.10.3* The fire department shall develop and maintain written standard operating procedures that establish a standardized approach to the safety of members at incidents that involve violence, unrest, or civil disturbance.

8.10.4 The fire department shall be responsible for developing an interagency agreement with its law enforcement agency counterpart to provide protection for fire department members at situations that involve violence.

8.10.5* The fire department shall develop a standard communication method that indicates that an incident crew is faced with a life-and-death situation requiring immediate law enforcement intervention.

8.10.6 Such violent situations shall be considered essentially a law enforcement event, and the fire department shall coordinate with the law enforcement incident commander throughout the incident.

8.10.7 The fire department incident commander shall identify and react to situations that do involve or are likely to involve violence.

8.10.8 In such violent situations, the fire department incident commander shall communicate directly with the law enforcement incident commander to ensure the safety of fire department members.

8.10.9 In such violent situations, the fire department incident commander shall stage all fire department resources in a safe area until the law enforcement agency has secured the scene.

8.10.10 When violence occurs after emergency operations have been initiated, the fire department incident commander shall either secure immediate law enforcement agency protection or shall withdraw all fire department members to a safe staging area.

8.10.11 At civil disturbances or similar incidents where protective equipment generally considered as law enforcement–related, such as body armor, shall be utilized only by members who are trained and qualified to use such equipment.

8.10.12 Fire department companies or crews that provide support to law enforcement agency special weapons and tactics (SWAT) operations shall receive special training.

10.2.4 Members who do not meet the required level of physical performance shall not be permitted to engage in emergency operations.

10.2.5 Members who are unable to meet the physical performance requirements shall enter a physical performance rehabilitation program to facilitate progress in attaining a level of performance commensurate with the individual's assigned duties and responsibilities.

10.3 Health and Fitness.

10.3.1 The fire department shall establish and provide a health and fitness program that meets the requirements of NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*, to enable members to develop and maintain a level of fitness that allows them to safely perform their assigned functions.

10.3.2 The maintenance of fitness levels specified in the program shall be based on fitness standards determined by the fire department physician that reflect the individual's assigned functions and activities and that are intended to reduce the probability and severity of occupational injuries and illnesses.

10.3.3 The fire department health and fitness coordinator shall administer all aspects of the physical fitness and health enhancement program.

10.3.4 The health and fitness coordinator shall act as a direct liaison between the fire department physician and the fire department in accordance with NFPA 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments.*

10.4 Confidential Health Data Base.

10.4.1* The fire department shall ensure that a confidential, permanent health file is established and maintained on each individual member.

10.4.2 The individual health file shall record the results of regular medical evaluations and physical performance tests, any occupational illnesses or injuries, and any events that expose the individual to known or suspected hazardous materials, toxic products, or contagious diseases.

10.4.3* Health information shall be maintained as a confidential record for each individual member as well as a composite data base for the analysis of factors pertaining to the overall health and fitness of the member group.

10.4.4* If a member dies as a result of occupational injury or illness, autopsy results, if available, shall be recorded in the health data base.

10.5 Infection Control.

10.5.1* The fire department shall actively attempt to identify and limit or prevent the exposure of members to infectious and contagious diseases in the performance of their assigned duties.

10.5.2 The fire department shall operate an infection control program that meets the requirements of NFPA 1581, *Standard on Fire Department Infection Control Program.*

10.6 Fire Department Physician.

10.6.1 The fire department shall have an officially designated physician who shall be responsible for guiding, directing, and advising the members with regard to their health and fitness for various duties.

10.6.2 The fire department physician shall provide medical guidance in the management of the occupational safety and health program.

10.6.3* The fire department physician shall be a licensed medical doctor or osteopathic physician qualified to provide professional expertise in the areas of occupational safety and health as they relate to emergency services.

10.6.4* The fire department physician shall be readily available for consultation and to provide professional services on an urgent basis.

10.6.4.1 Availability shall be permitted to be accomplished by providing access to a number of qualified physicians.

10.6.5 The fire department shall require that the health and safety officer and the health fitness coordinator maintain a liaison with the fire department physician to ensure that the health maintenance process for the fire department is maintained.

10.7 Fitness for Duty Evaluations.

10.7.1 Fire departments shall establish a process to evaluate the ability of a member to perform essential job functions.

10.7.2 The process to evaluate the fitness of a member to perform essential job functions shall be conducted by a qualified person and confirmed by the fire department physician.

10.7.3 When a member is determined to be unable to perform the essential job functions, the member shall be provided assistance, treatment, or both that is intended to return the member to a condition that will allow him or her to perform the essential job functions.

10.7.4 A member who has been determined to be unable to perform the essential job functions will only be returned to duty when a qualified person has confirmed that the member can perform the essential job functions.

Chapter 11 Behavioral Health and Wellness Programs

11.1* Behavioral Health Program.

11.1.1* The fire department shall provide access to a behavioral health program for its members and their immediate families.

11.1.1.1 The behavioral health assistance program shall include the capability to provide assessment, basic counseling, stress crisis intervention assistance, and triage and assessment regarding, at a minimum, alcohol and substance abuse, stress and anxiety, depression, and personal problems that adversely affect fire department work performance.

11.1.2* The behavioral health program shall, when clinically indicated, refer members and their immediate families for appropriate clinical and specialty care from providers equipped to deliver evidence-based treatment consistent with current best practices and standards of care.

11.1.3* The fire department shall adopt and follow clear, written policies regarding alcoholism, substance abuse, and other behavioral conditions that can adversely affect performance or fitness for duty, or both.

11.1.3.1 When fitness for duty is in question, such fitness shall be evaluated and determined in accordance with Section 10.7.

lic safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.3.3 Air Transfer. Air is allowed to flow from the cylinder with a higher pressure to the cylinder with a lower pressure until the pressure equalizes, at which time the transfer line is disconnected between the two cylinders.

A.3.3.4 Aircraft Rescue and Fire Fighting. Such rescue and fire-fighting actions are performed both inside and outside of the aircraft.

A.3.3.5.1 Hazardous Atmosphere. A hazardous atmosphere can be immediately dangerous to life and health.

A.3.3.8 Candidate. In an employment context, the Americans with Disabilities Act (discussed in further detail in Annex B of NFPA 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments*) requires that any medical examination to be conducted take place after an offer of employment is made and prior to the commencement of duties. Therefore, in the employment context, the definition of *candidate* should be applied so as to be consistent with that requirement. Volunteer fire fighters have been deemed to be "employees" in some states or jurisdictions. Volunteer fire departments should seek legal counsel as to their legal responsibilities in these matters.

A.3.3.10 Chemical Flash Fire. A policy of wearing protective clothing is needed that recognizes the significant threat to fire fighters who can be exposed to flash fires in either structural fire-fighting or hazardous materials environments. It is hoped that fire fighters utilize awareness training on burn injuries caused by the ignition of the environment. There is a distinct difference between chemical flash fires and flashovers occurring in structural fire-fighting environments.

Flashover is a phenomenon that generates temperatures in the range of 1200°F to 1500°F (650°C to 815°C). A chemical flash fire requires an ignition source and a chemical atmosphere that contains a concentration above the lower explosive limit (LEL) of the chemical. Chemical flash fires generate heat from 1000°F to 1900°F (540°C to 1040°C). As a rule, a structural fire flashover is confined to a designated area with walls as a boundary. The size of a chemical flash fire depends on the size of the gas or vapor cloud and, when ignited, the flame front expands outward in the form of a fireball. The resulting effect of the fireball's energy with respect to radiant heat significantly enlarges the hazard areas around the gas released. [**1991,** 2005]

A.3.3.12 Clear Text. Ten codes or agency-specific codes should not be used when using clear text.

A.3.3.16 Company. For fire suppression, jurisdictions exist where the response capability of the initial arriving company is configured with the response of two apparatus. In some jurisdictions, apparatus is not configured with seated and belted positions for four personnel and therefore would respond with an additional vehicle in consort with the initial arriving engine to carry additional personnel. This response would be to ensure that a minimum of four personnel are assigned to and deployed as a company. The intent of this definition and the requirements in the standard is to ensure that these two (or more) pieces of apparatus would always be dispatched and respond together as a single company. Some examples of this include the following:

(1) Engine and tanker/tender that would be responding outside a municipal water district
(2) Multiple-piece company assignment, specified in a fire department's response standard operating procedures, such as an engine company response with a pumper and a hose wagon
(3) Engine with a vehicle personnel carrier
(4) Engine with an ambulance or rescue unit

Company, as used in this standard, is synonymous with company unit, response team, crew, and response group, rather than a synonym for a fire department.

A.3.3.17 Confined Space. Additionally, a confined space is further defined as having one or more of the following characteristics:

(1) The area contains or has a potential to contain a hazardous atmosphere, including an oxygen-deficient atmosphere.
(2) The area contains a material with a potential to engulf a member.
(3) The area has an internal configuration such that a member could be trapped by inwardly converging walls or a floor that slopes downward and tapers to a small cross section.
(4) The area contains any other recognized serious hazard.

A.3.3.21 Cryogenic Liquid. Cryogenic liquids include, but are not limited to, helium, nitrogen, and oxygen. [**1991,** 2005]

A.3.3.24.1 Communicable Disease. Also known as contagious disease.

A.3.3.30 Faceshield. Faceshields should be used only in conjunction with spectacles and/or goggles.

A.3.3.34 Fire Department. The term *fire department* can include any public, governmental, private, industrial, or military organization engaging in this type of activity.

A.3.3.35 Fire Department Facility. This does not include locations where a fire department can be summoned to perform emergency operations or other duties, unless such premises are normally under the control of the fire department.

A.3.3.37.1 Proximity Fire Fighting. Specialized thermal protection from exposure to high levels of radiant heat, as well as thermal protection from conductive and convective heat, is necessary for persons involved in such operations due to the scope of these operations and the close distance to the fire at which these operations are conducted, although direct entry into flame is *not* made. These operations usually are exterior operations but could be combined with interior operations. Proximity fire fighting is not structural fire fighting but could be combined with structural fire-fighting operations.

A.3.3.39 Fire Suppression. Fire suppression includes all activities performed at the scene of a fire incident or training exercise that expose fire department members to the dangers of heat, flame, smoke, and other products of combustion, explosion, or structural collapse.

department that operates entirely within the private sector, such as an industrial fire department, could legally establish and operate a fire protection organization by the adoption of a corporate policy as described in the organizational statement.

In addition to specifically defining the organization that is expected to comply with this standard, 4.1.1 requires that the organizational structure, membership, expected functions, and training requirements be contained in documents that are accessible for examination. These requirements are intended to reinforce the fact that the fire department is an identifiable organization that operates with known and specific expectations.

Where a fire department functions as a unit of a larger entity, such as one of several municipal departments or a particular unit of a private corporation, the larger organization is often able to provide some of the same elements that are required to be provided by the fire department. This would satisfy the requirements for the fire department to provide those elements.

A.4.1.2 Additional information on fire department organization and operations can be found in Section 7 of the NFPA *Fire Protection Handbook* and in Chapter 4 of *Managing Fire and Rescue Services*, published by the International City/County Management Association.

A.4.1.4 They should be done in accordance with NFPA 1620, *Standard for Pre-Incident Planning*, to provide assistance to responding personnel in effectively managing emergencies for the protection of occupants, responding personnel, property, and the environment.

A.4.1.4.1 They should be done in accordance with NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*.

A.4.2.1 The risk management plan should consider all fire department operations, the duties and responsibilities of members (uniform and civilian), and policies and procedures. The risk management plan should include goals and objectives to ensure that the risks associated with the daily operations of the fire department are identified and effectively managed.

For additional guidance on the development of a risk management plan, see NFPA 1250, *Recommended Practice in Fire and Emergency Services Organization Risk Management*.

A.4.2.3 The entire risk management decision-making process can be summarized as follows:

(1) Identify or recognize
(2) Evaluate
(3) Establish priorities for action
(4) Act and control
(5) Monitor and re-evaluate

Discussions about frequency and risk arise in the evaluation phase. What are the real or potential risks in terms of frequency and severity to fire department members? How will the organization develop effective control measures to ensure a safe work environment for all members?

Since no two fire departments are alike, there is no standard scale to measure and evaluate frequency and risk. Some fire departments will have a greater or lesser degree of tolerance for risk than others. The intent of the risk management process is for a fire department to develop a standard level of safety. This standard level of safety defines the parameters of the acceptable degree of risk for which members perform their job functions.

By definition, frequency is how often something does, or might, happen. Risk is a measure of the consequences if an undesirable event occurs. There are many factors that enter into the risk discussion, including cost, time lost from work, loss of use of resources, inability to deliver services, and fewer services available. Each risk will have its own set of factors that will dictate how the fire department will try to determine how severe the consequences might be.

This scale is used to establish the degree of priority. Priority of the risk is in direct relation to inherent risks that have had a harmful effect on the department and its members.

A primary purpose of the risk management plan is to focus efforts on incidents that might not occur very often (low frequency) but that could have severe consequences associated with them (high risk). The reason for the focus on low frequency/high risk incidents is that since they do not occur on a frequent basis, responders might not be as prepared to deal with them, and the outcomes can be harmful or detrimental to fire fighters. Examples of low frequency/high risk events could include high rise fires, technical rescues, multi-alarm fires, or mass casualty incidents.

There are two factors that will ensure that a low frequency/high risk event will be successful. The first factor is an aggressive training program. Every day is a training day. With an aggressive training program, this will ensure the successful outcome of an incident. The second factor is rapid prime decision making. Personnel, through training and continuous retraining, have the necessary knowledge, skills, and abilities (KSA) to ensure the successful outcome of a low frequency/high risk incident.

Figure A.4.2.3 illustrates the relationship between frequency and risk, and emphasizes the importance of addressing low frequency/high risk incidents.

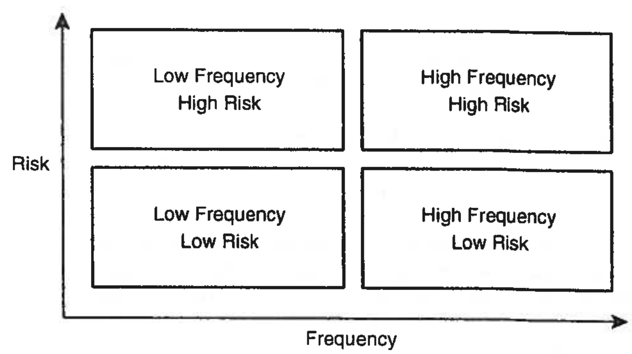


FIGURE A.4.2.3 Risk and Frequency Graph.

A.4.3.1 The following is an example of a safety policy statement:

It is the policy of the fire department to provide and to operate with the highest possible levels of safety and health for all members. The prevention and reduction of accidents, injuries, and occupational illnesses are goals of the fire department and shall be primary considerations at all times. This concern for safety and health applies to all members of the fire department and to any other persons who could be involved in fire department activities.

of fire fighter fatalities and injuries associated with vehicle operations. Fire departments respond with a variety of apparatus, and the members operating this apparatus must have the appropriate knowledge, skills, and abilities to operate this apparatus.

The first step in this process is to properly train and educate members on the various types of apparatus they could be required to operate. NFPA 1451, *Standard for a Fire Service Vehicle Operations Training Program*, provides the curriculum for members to develop the necessary knowledge, skills, and abilities to meet the requirements of 5.2.2. The second step is to ensure that the fire department performs an annual proficiency evaluation of all drivers/operators as required by Section 5.5. Also, the training and education should address the standard operating procedures associated with vehicle operations, especially emergency response.

These are necessary components of the department's plan to reduce the risks associated with vehicle operations. This is a systems approach to ensure the safety and health of members and the citizens they serve.

A.5.2.6 In the United States, federal regulations require a minimum amount of training for fire service personnel who respond to hazardous materials incidents. These requirements can be found in 29 CFR 1910.120, *Hazardous waste operations and emergency response* (OSHA), and in 40 CFR 311, *Worker protection* (EPA). These regulations affect all fire departments in the United States whether full-time career, part-time, combination career and volunteer, or fully volunteer. These regulations apply in all states and not just in those states with federally approved state OSHA programs.

In the U.S. federal regulations, First Responder Operations Level is defined as follows:

"First responders at the operations level are individuals who respond to releases or potential releases of hazardous substances as part of the initial response to the site for the purpose of protecting nearby persons, property, or the environment from the effects of the release. They are trained to respond in a defensive fashion without actually trying to stop the release. Their function is to contain the release from a safe distance, keep it from spreading, and prevent exposure. First responders at the operational level shall have received at least 8 hours of training or have had sufficient experience to objectively demonstrate competency in the following areas in addition to those listed in the awareness level and the employer shall so certify:

(1) Knowledge of the basic hazard and risk assessment techniques
(2) Knowing how to properly select and use proper personal protective equipment provided to the First Responder Operations Level
(3) An understanding of basic hazardous materials terms
(4) Knowing how to perform basic control, containment, and/or confinement operations within the capabilities of the resources and personal protective equipment available with their unit
(5) Knowing how to implement basic decontamination procedures
(6) An understanding of the relevant standard operating procedures and termination procedures"

The First Responder Operations Level in both the U.S. federal regulations and NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, is similar. Whereas the U.S. federal regulations (29 CFR 1910.120 or 40 CFR 311) govern the fire service in every state in the United States, the minimum level of training for all fire fighters must be the First Responder Operations Level.

A.5.3.1 In order to ensure compliance with the minimum requirements of NFPA 1001, *Standard for Fire Fighter Professional Qualifications*, fire department training programs should be accredited by a training organization such as a state fire training agency. In addition, NFPA 1405, *Guide for Land-Based Fire Departments That Respond to Marine Vessel Fires*, provides recommended guidelines for those members who respond to marine vessel fires.

A.5.3.5 The essence of any successful respiratory protection training program is the establishment of written operational policies and the reinforcement of those policies through comprehensive training.

The AHJ should ensure that each member demonstrates knowledge of at least the following:

(1) Why respiratory protection equipment (RPE) is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator
(2) What the limitations and capabilities of the RPE are
(3) How to use the RPE effectively in emergency situations, including situations in which the RPE malfunctions
(4) How to inspect, put on and remove, use, and check the seals of the facepiece
(5) What the procedures are for maintenance and storage of the respiratory protection equipment
(6) How to recognize medical signs and symptoms that can limit or prevent the effective use of RPE
(7) The requirements of Section 7.10

A.5.3.7 Several accidents have occurred where smoke bombs or other smoke-generating devices that produce a toxic atmosphere have been used for training exercises. Where training exercises are intended to simulate emergency conditions, smoke-generating devices that do not create a hazard are required.

A.5.3.8 Fire departments can utilize instructors who are not necessarily trained and/or certified to the requirements of NFPA 1041, *Standard for Fire Service Instructor Professional Qualifications*. However, in using these instructors they should ensure that they are familiar with the fire department, its organization, and its operations and, in addition, are qualified in that particular area of expertise.

A.5.3.9 Members can be trained and/or certified at the local, state, or national level in basic life support (BLS) or advanced life support (ALS). Jurisdictions can require specialty skills within certain levels.

A.5.3.10 To reduce the risk of an injury or illness members should wear protective ensemble elements that are suitable and appropriate and maintained in a clean and serviceable condition. Members should exercise caution when wearing personal clothing, accessories, or personal equipment items that these items do not adversely affect the performance of the protective ensemble or ensemble element. It is recommended that clothing meeting the requirements of NFPA 1975, *Standard on Station/Work Uniforms for Emergency Services*, be worn whenever possible. Clothing that can melt, drip, burn, shrink, transmit heat, or ignite should not be worn. For care and maintenance of structural and proximity PPE, refer to NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

To avoid the possibility of injury or burns, members should wear clothing made of material that will provide the best protective levels available. It is recommended that Nomex or reduce the risk to fire department members and the citizens of the community from unnecessary harm. The response can always be upgraded to emergency response if the situation warrants based upon additional information.

Fire department water tankers (tenders) provide a mobile water supply to support fire fighting and other fire department operations. They are generally used in rural areas without fire hydrant coverage but can also be found in the fleets of many suburban and urban fire departments.

Although their number as a percent of the overall apparatus fleets is small, estimated at just 2 percent, they are involved in a disproportionate number of crashes that are fatal to fire fighters and others. A study of fire fighter fatalities from 1990 through 2000 found that fire tankers were the second most common vehicle type involved in crashes that killed fire fighters. Tankers/tenders were second only to personal vehicles in the number of fatal crashes.

The United States Fire Administration (USFA) produced a report entitled *Safe Operation of Fire Tankers* in 2003. The report (FA-248) is available free from the USFA in print and can be downloaded from the USFA web site at www.usfa.fema.gov. The report provides comprehensive information on the safe construction, use, and operation of fire department tankers/tenders. The report deals with fire apparatus with water tanks sizes of 1000 gal (3800 L) or more. The recommendations contained in the report, therefore, can apply to any piece of fire apparatus with a large water tank.

Attention to a small number of operational recommendations can make the operation of fire tankers/tenders safer for fire fighters and those that share the road with this type of apparatus.

The following recommendations should become part of standard operating procedures for departments operating tankers (tenders):

(1) Fire fighters should always wear seat belts when driving or as the passenger in any vehicle, including tankers/tenders. The fire fighter's best chance for survival is to remain with the vehicle during a crash and to be protected by the structure of the vehicle. During the period from 1990 to 2001, 82 percent of the fire fighters killed in tanker/tender crashes were not wearing seat belts.

(2) If the right-hand wheels of the apparatus leave the paved surface of the roadway for any reason, the apparatus should be slowed before attempting to return all wheels to the roadway. In 66 percent of the fatal tanker/tender crashes from 1990 to 2001, the right wheels of the apparatus left the roadway. If the vehicle is returned to the roadway surface at speed, the apparatus can veer violently to the left. Drivers then often overcompensate by steering to the right, and the apparatus either begins to roll or leaves the roadway and crashes. Slowing the vehicle prior to returning to the roadway will minimize the chances of such an event.

(3) *Slow down.* Speed was cited as a factor in 55 percent of fatal crashes of fire department tankers/tenders from 1990 to 2001. The weight of the water and the weight of the apparatus combine to make fire department tankers/tenders very heavy vehicles. They cannot stop quickly, and their handling characteristics are unlike other fire apparatus. The USFA *Safe Operation of Fire Tankers* report recommends that tankers/tenders never be operated over the posted speed limit and that they be controlled to speeds at or less than the cautionary speeds listed on yellow signs on curves.

(4) Make sure that the apparatus is up to the task. Fuel or milk tankers converted to fire department water tankers usually do not have the brake capacity or tank baffles that are needed to transport water — fuel and milk are lighter than water. The total weight of a tanker/tender should not exceed the rated capacity of the vehicle's braking system. In addition to weight concerns, tankers/tenders must be maintained in a ready state. Their mechanical systems must be checked and maintained on a regular basis.

(5) Ensure that drivers/operators have the necessary knowledge, skills, and abilities to specifically drive and operate tankers/tenders. Tankers/tenders do not operate or have the same driving characteristics as other fire apparatus. Drivers should be specifically trained on each vehicle, and untrained drivers should not be allowed to operate tankers/tenders.

(6) Drive with the tank completely full or completely empty. Even with proper baffling, a semi-full water tank will allow water to move more freely. This water movement can create control problems for the apparatus operator. If the full tank of water is not used, dump the rest of the load in a safe place and drive the tanker/tender empty until the entire tank can be filled.

A.6.2.8 Accidents at intersections contribute to both civilian and fire fighter deaths and injuries while fire department vehicles are responding to or returning from an emergency incident. Coming to a complete stop when there are any intersection hazards and proceeding only when the driver can do so safely will reduce accidents and the risk of injury or death. It is recommended that intersection control devices be installed that allow emergency vehicles to control traffic lights at intersections.

A.6.2.10 Vehicle accidents at railroad crossings have resulted in a number of deaths and injuries to fire department members. A study by NTSB concluded that a train's warning horn becomes an ineffective device for warning large vehicles or trucks unless the vehicle driver stops, idles the engine, turns off all radios, fans, wipers, and other noise-producing equipment in the cab, lowers the window, and listens for a train's horn before entering a grade crossing.

A.6.2.14 When members respond to incidents or to the fire station in their own vehicles, the operation of these vehicles is governed by all applicable traffic laws and codes as enacted by the AHJ. All members should be held strictly accountable for compliance with the applicable traffic laws and regulations as well as fire department rules, regulations, and procedures relating to emergency response. Where traffic laws and regulations allow for private vehicles to be operated as emergency vehicles, the fire department should only allow members who have met the requirements to drive fire department vehicles in an emergency mode to drive privately owned vehicles in an emergency mode.

A.6.2.14.2 For more information, see FA-220, *Firefighter Fatality Retrospective Study*, Federal Emergency Management Agency, United States Fire Administration, April 2002.

A.6.3.1 It is intended that the requirements of Section 6.3 apply to all situations when persons or members are riding on fire apparatus other than for the specific variances in 6.3.4 and 6.3.5. Included in the "seated and belted" requirement are any times the fire apparatus is traveling to, participating in, or returning from any funeral, parade, or public relations/education event. Fire fighters cannot be allowed to ride on the outside of apparatus in order to fight wildland fires. The Fire Line Safety Committee (FLSC) of the National Wildfire Coordinating Group (NWCG) represents the U.S. Forest Service, Bureau of Land

A.6.5.6 See A.6.4.1.

A.7.1.1 The provision and use of protective ensemble, ensemble elements, and protective equipment should include safety shoes, gloves, goggles, safety glasses, and any other items appropriate to the members' activities. This applies to all activities members are expected to perform, including non-emergency activities. The applicable regulations pertaining to industrial worker safety should be consulted to determine the need for protective equipment in non-emergency activities. For proper PPE selection, risk assessment as specified in NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, should be conducted.

A.7.1.2 The fire department should provide body armor for all members who operate in areas where a potential for violence or civil unrest exists.

A.7.1.4 Because it is impossible to ensure that every member — whether a volunteer, call, or off-duty career member — will respond to an incident in a station/work uniform or will change into station/work uniform clothing before donning protective garments, it is very important that members understand the hazards of some fabrics that more easily melt, drip, burn, shrink, or transmit heat rapidly and cause burns to the wearer.

Clothing made from 100 percent natural fibers or blends that are principally natural fibers should be selected over other fabrics that have poor thermal stability or that ignite easily.

The very fact that members are fire fighters indicates that all clothing that they wear should be flame resistant (as children's sleepwear is required to be) to give a degree of safety if unanticipated happenings occur that expose the clothing to flame, flash, sparks, or hot substances.

A.7.1.6.1 Fire departments need to be especially diligent in the handling of protective ensembles and ensemble elements that are or are suspected of being exposed to blood and body fluids. Fire departments are encouraged to review the criteria specified in NFPA 1581, *Standard on Fire Department Infection Control Program*, and 29 CFR 1910.1030, *Bloodborne Pathogen Standard*.

A.7.1.6.3 Examples of the proper type of safety equipment should include MSDSs, eye protection (safety glasses and goggles), nitrile gloves, rubber gloves, fluid-resistant suit or waterproof apron, optional dust mask, uniforms; sharp containers, and eyewash station.

A.7.2.1 The fire department should consider providing each member with two complete sets of structural fire-fighting protective clothing that meet the requirements of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, whenever possible. It is not reasonable to expect that a fire department would have enough stock protective clothing available to all members in the event that the protective clothing became soiled, wet, or contaminated during daily activities. Fire fighters provided with two complete sets of structural fire-fighting protective clothing can change easily into proper-fitting garments and will not be unnecessarily exposed or expose the public to contaminants. Structural protective clothing that is cleaned and properly and completely dried before the next use will last longer and provide greater protection than soiled or damp garments.

A.7.2.2 Properly fitting protective clothing is important for the safety of the fire fighter. It is important to understand that all protective clothing should be correctly sized to allow for freedom of movement. Protective garments that are too small or too large and protective trouser legs that are too long or too short are safety hazards and should be avoided. Protective coat sleeves should be of sufficient length and design to protect the coat/glove interface area when reaching overhead or to the side. For proper fitting of a fire fighter, the protective clothing manufacturer should be contacted to provide sizing instructions.

A.7.2.4.2 Some protective coats, particularly those certified as part of a protective ensemble with the CBRN option, can include different interface components instead of wristlets to provide increased integrity against penetration of CBRN terrorism agents.

A.7.3.1 The technical committee's intent is that members utilize the appropriate protective clothing designed specifically for the type of emergency incident or fire-fighting activities for which the member is regularly engaged.

A.7.4 Fire department personnel involved in emergency medical operations should be protected against potential medical hazards. These hazards include exposure to blood or other body fluids contaminated with infectious agents such as hepatitis and human immunodeficiency viruses. The purpose of emergency medical protective clothing is to shield individuals from these medical hazards and conversely to protect patients from potential hazards from the emergency responder. Emergency medical gloves are to be used for all patient care. Emergency medical garments and face protection devices are to be used for any situation where the potential for contact with blood or other body fluids is high.

NFPA 1999, *Standard on Protective Clothing for Emergency Medical Operations*, covers garments, gloves, and face protection devices that are designed to prevent exposure to blood or other body fluids for those individuals engaged in emergency medical patient care and similar operations. NFPA 1999, *Standard on Protective Clothing for Emergency Medical Operations* specifies a series of requirements for each type of protective clothing. Garments can be full-body clothing or clothing items such as coveralls, aprons, or sleeve protectors. For the intended areas of body protection, the garment must allow no penetration of virus, offer "liquidtight" integrity, and have limited physical durability and hazard resistance. Gloves must allow no penetration of virus, offer "liquidtight" integrity, and meet other requirements for tear resistance, puncture resistance, heat aging, alcohol resistance, sizing, and dexterity. Face protection devices can be masks, hoods, visors, safety glasses, or goggles. Any combination of items can be used to provide protection to the wearer's face, principally the eyes, nose, and mouth. For the intended areas of face protection, these devices must allow no penetration of virus, offer "liquidtight" integrity, and provide adequate visibility for those portions of the device covering the wearer's eyes.

A.7.4.2 In order to avoid all potential exposure to infectious diseases, it is important that all members use medical gloves when providing patient care. All members who could come in contact with the patient should use medical gloves.

A.7.5 See Annex E, Hazardous Materials PPE Information.

A.7.5.1 NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*, covers vapor-protective ensembles that are designed to provide "gastight" integrity and are intended for response situations where no chemical con-

NFPA 1994 sets requirements for different classes of protective ensembles for use at incidents involving CBRN terrorism agents as used by first responders. Class 2 ensembles provide the highest level of protection against CBRN terrorism agents, including vapors, liquids, and particulates, and have performance consistent with SCBA use for IDLH conditions. Class 3 ensembles also protect against CBRN terrorism agents that include vapors, liquids, or particulates, but are at conditions of exposure that are less than IDLH, which would permit the use of air-purifying respirators (APRs).

There are two primary areas of evaluation: tests for integrity of the ensemble against the hazardous environment, and tests of the material to demonstrate how it acts as a barrier against different CBRN terrorism agents. There are three different integrity tests. An inward leakage test is applied to Class 2 and Class 3 ensembles using the Man-in-Simulant test (MIST). This test measures the inward leakage of a surrogate agent into the clothing while worn by a test subject. The higher the MIST result or protection factor, the better the integrity. Class 2 performance has been set for levels that are consistent based on SCBA use while Class 3 performance is consistent with APR use. MIST does not apply to Class 4 because these ensembles are not intended to provide chemical protection. Class 4 protective ensembles provide only biological or radiological particulate protection. A liquid integrity test is applied to each ensemble. A longer test is used for Class 2 than for Class 3 and Class 4. The liquid integrity test is applied to Class 4 because this clothing could be subjected to wet decontamination. For Class 4, a particle integrity test is used where a test subject wears the ensemble inside a closed environment with fluorescent particles. Particle leakage is detected using ultraviolet light. This particle test is not applied to Class 2 and Class 3 because it is believed that successful MIST evaluations indicate particle holdout. For material tests, permeation testing as described in A.7.5.1 is used for Class 2 and Class 3 ensembles. For Class 2, permeation testing with gases is carried out at levels that are used for CBRN approvals of APRs. The liquid chemical permeation tests for Class 2 are performed using the more rigorous closed-top procedures compared to open-top procedures for Class 3. All ensemble materials are evaluated for viral-penetration resistance using a bloodborne pathogen surrogate.

The CBRN option for NFPA 1971 is based on Class 2 performance. The same integrity and material barrier requirements are applied; however, ensemble elements and materials are subjected to extensive conditioning involving laundering, heat exposures, repeated flexing, and abrasion prior to testing integrity and barrier characteristics. The tests are intended to simulate extensive use of the ensemble prior to encountering CBRN terrorism agents. *(See also A.7.5.3.6).*

A.7.5.3.2 Any response plan involving a biological or weapons of mass destruction (WMD) biological hazard should be based on relevant infectious disease or biological safety recommendations by the Centers for Disease Control and Prevention (CDC) and other expert bodies.

A.7.5.3.6 The CBRN option for structural and proximity fire-fighting protective ensembles in NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting,* can only be applied to complete ensembles of garments, helmet, gloves, footwear, and hood with a specified SCBA that has been certified by NIOSH as compliant with the NIOSH *Standard for Chemical, Biological, Radiological, and Nuclear (CBRN) Full Facepiece Air Purifying Respirator (APR).* Non-CBRN elements cannot be used with the CBRN ensemble. CBRN ensembles are only intended to allow members escape and provide rescue during the escape when CBRN agents are encountered.

A.7.7.1 Fire departments that provide both wildland and structural fire-fighting services should establish guidelines for members on which ensemble to wear for a given fire-fighting or other emergency incident.

A.7.7.3 Fire shelters are no longer addressed in NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting.* Specifications for fire shelters are provided in USDA Forest Service Specification 5100-606, *Shelter Fire.*

A.7.8.3.1 NIOSH provides nine classes of particulate filters (three classes of filter efficiency — 95 percent, 99 percent, and 99.97 percent), each with three categories of resistance to filter efficiency degradation (N, R, and P). Additionally, performance against toxic industrial gases, vapors, and certain CBRN agents are also specified by NIOSH.

A.7.8.3.2 APRs and PAPRs do not supply oxygen. Use should be limited to known contaminants and known exposure levels and used only in adequately ventilated areas. APRs and PAPRs cannot be used when concentrations of contaminants are unknown, or when appropriate exposure limit is not known, or when cartridge or filter service life is unknown.

A.7.9 Fire department personnel involved in surface water operations should be protected against potential hazards. These hazards include exposure to physical, environmental, thermal, and certain common chemical and biological hazards.

NFPA 1952, *Standard on Surface Water Operations Protective Clothing and Equipment,* covers full body suits, helmets, gloves, footwear, and personal flotation devices for those individuals engaged in surface water operations and similar operations. NFPA 1952 specifies a series of requirements for each type of protective clothing. Requirements are established for dry suit environments, wet suit environments, and ice suit environments.

A.7.10.1.1 Selection of respiratory protection devices is an important function, particularly where resources are limited and respirators have to be used for different applications with different equipment. Urban search and rescue (USAR), CBRN, confined space, hazardous materials, and other operations can require different filter elements, SCBA breathing air cylinders, umbilical connections, and features that are easier to ascertain and coordinate with a selection stage.

A.7.10.4 At least one additional reserve SCBA should be available at the incident scene for each 10 SCBA in use, to provide for replacement if a failure occurs.

A.7.10.7 Hazardous atmospheres requiring SCBA can be found in, but are not limited to, the following operations: structural fire fighting, aircraft fire fighting, shipboard fire fighting, confined space rescue, and any incident involving hazardous materials.

A.7.10.8 The required use of SCBA means that the user should have the facepiece in place, breathing air from the SCBA only. Wearing SCBA without the facepiece in place does not satisfy this requirement and should be permitted only under conditions in which the immediate safety of the atmosphere is assured. All members working in proximity to areas where SCBA use is required should have SCBA on their backs or immediately available for donning. Areas where the atmosphere can rapidly become hazardous could include rooftop areas during ventilation operations and areas where an explosion or container rupture could be anticipated.

A hazardous atmosphere would be suspected in overhaul areas and above the fire floor in a building. Members working tion (DOT) are aware of only 12 ruptures within the United States. Eleven of the 12 ruptures occurred during refilling, six of these 12 ruptures involved SCBA cylinders. Forensic analysis has determined that most of these cylinders failed due to SLC failure. However, in some cases, evidence of other factors such as external mechanical damage was also present."

Changes have now been made in materials specification and design of cylinders. Since 1988, manufacturers have been using aluminum alloy 6061-T6 in the manufacture of all of their cylinders and cylinder liners. Alloy 6061-T6 has become the "standard of the industry" because it is not susceptible to sustained load cracking.

The failed cylinders belong to a relatively small population of a particular type of cylinder, and there has been no occurrence of cylinder failure during filling of any other type of SCBA cylinders. Full-wrapped composite cylinders, which are predominantly being purchased by the fire service at this time, have been used since 1988 without failure during refilling. There is, therefore, reason to believe that these other types of SCBA cylinders can continue to be used in the fire service without risk of failure during filling.

A.7.15.5 To facilitate this, it is recommended that industry develop an inexpensive, lightweight chamber, or other means, to provide protection at the fire scene during routine cylinder filling. There is no current commonly accepted standard or specifications for protective enclosures in which to fill SCBA cylinders. Until such a standard is defined, such equipment should comply with the standards defined for fragmentation tanks in NFPA 1901, *Standard for Automotive Fire Apparatus.*

A number of SCBA manufacturers have developed systems to quickly fill cylinders. They enable cylinders to be filled while the user is wearing the SCBA. Even though some of these systems have been in use without incident for many years, it is felt that fire fighter and support personnel safety are paramount. This standard therefore recommends that personnel be protected when routinely refilling SCBA cylinders.

Until a commonly accepted standard for providing protection during routine refilling of cylinders is defined, the AHJ should determine how best to provide protection for its personnel during routine cylinder filling.

Without a commonly accepted standard defining a concise method of protecting personnel during cylinder refilling, the AHJ can choose which method best applies to its personnel. Such protection can consist of refilling cylinders in an enclosure considered acceptable to the AHJ. The protection can consist of using a refill system with a safe record of operation, with no experience of failures or damage to cylinders, supported by sufficient data, or it can consist of an alternate practice considered as safe by the AHJ.

A.7.15.6 The possibility exists for catastrophic failure of SCBA cylinders during refilling.

A.7.15.11 Table Table A.7.15.11 shows the approximate pressures associated with the 600 L minimums when exiting procedures should have already begun to take place.

A.7.16.1 Technology has provided the integration of PASS devices with SCBA. When the SCBA unit is activated to an operational mode, the PASS device is activated. Fire departments are encouraged to utilize this technology. The use of PASS devices should be coupled with a solid incident management system, a personnel accountability system, and adequate communications to properly ensure the safety of fire fighters.

Table A.7.15.11 Pressure Associated with 600 L Minimum Exit Volume

	2216 psi	3000 psi	4500 psi
30 minute/1200 L	1100 psi	NA	2250 psi
30 minute/1700 L	NA	1050 psi	NA
45 minute/1800 L	750 psi	NA	1500 psi
60 minute/2400 L	550 psi	NA	1100 psi

NA: Not applicable.

A.7.16.2 The mandatory use and operation of a PASS by fire fighters involved in rescue, fire suppression, or other hazardous duty is imperative for their safety. The primary intent of this device is to serve as an audible device to warn fellow fire fighters in the event a fire fighter becomes incapacitated or needs assistance.

Past fire fighter fatality investigation reports document the critical need to wear and operate PASS devices when fire fighters operate in hazardous areas. Investigation results show that fire fighters most often failed to activate the PASS unit prior to entering a hazardous area. Training and operational procedures are imperative to ensure activation of the PASS whenever PASS devices are used.

A.7.17.3 Life safety rope can be significantly weakened by abrasion, misuse, contamination, wear, and stresses approaching its breaking strength, particularly impact loading. Because there is no approved method to service test a rope without compromising its strength, rope rescue and training operations should be carefully observed and monitored for conditions that could cause immediate failure or result in undetectable damage to the rope. If a rope has been used in a situation that could not be supervised or where potential damage could have occurred, it should be removed from service and destroyed.

It is important that ropes be inspected for signs of wear by qualified individuals after each use. If indications of wear or damage are noted, or if the rope has been stressed in excess of the manufacturers' recommendations or has been impact loaded, it should be destroyed.

The destruction of the rope means that it should be removed from service and altered in such a manner that it could not be mistakenly used as a life safety rope. This alteration could include disposal or removal of identifying labels and attachments and cutting the rope into short lengths that could be used for utility purposes.

The assignment of disposable life safety ropes to members or to vehicles has proven to be an effective system to manage ropes that are provided for emergency use and are used infrequently. Special rescue teams, which train frequently and use large quantities of rope, should include members who are qualified to manage and evaluate the condition of their ropes and determine the limitations upon their reuse.

A.7.18.1.1 Some examples of primary eye protection are goggles and safety glasses, as they provide specific and substantial eye protection against penetration and impact. Helmet faceshields are not primary eye protection, as they do not provide eye protection and should not be relied upon for eye protection. Faceshields should be used to protect the face as secondary protection to primary eye protection. Faceshields currently are often used incorrectly as the only form of eye protection. It is evident that when faceshields are exposed to ultraviolet degradation, abrasion, and products of combus-

A.8.1.8 The following explains the responsibilities of the incident commander:

(1) The incident commander should always integrate fire fighter health and safety considerations into the command process. This integration ensures that safety will always be considered and will not be reserved for unusual or high-risk situations when the incident commander is under a high degree of stress. An incident action plan that addresses fire fighter safety should be a routine function of command.
(2) Early evaluation enables the incident commander to consider current conditions in a standard manner and then predict the sequence of events that will follow. The consideration of fire fighter safety should be incorporated into this evaluation and forecasting.
(3) Effective communications are essential to ensure that the incident commander is able to receive and transmit information, obtain reports to maintain an awareness of the situation, and communicate with all component parts of the incident organization to provide effective supervision and controls.
(4) Strategic decisions establish the basic positioning of resources and the types of functions they will be assigned to perform at the scene of a fire or emergency incident. The level of risk to which members are exposed is driven by the strategy; offensive strategy places members in interior positions where they are likely to have direct contact with the fire, while defensive strategy removes members from interior positions and high-risk activities. The attack plan is based on the overall strategy and drives the tactical assignments that are given to individual or groups of companies/crews and the specific functions they are expected to perform. Risk identification, evaluation, and management concepts should be incorporated into each stage of the command process.
(5) Tactical level management component people are command agents and are able to both monitor companies/crews at the actual location where the work is being done (geographic) and to provide the necessary support (functional). The incident commander uses a tactical-level management unit as off-site (from the command post) operational/communications/safety managers-supervisors. The incident commander uses the incident organization along with communications to stay connected. Some incident management systems identify tactical-level management components such as a *division* or a *group* for a functional position within the system, whereas other systems use the term *sectors* for either geographical or functional areas. As incidents escalate, the incident management system should be utilized to maintain an effective span of control ratio of not greater than 1 to 7 with an optimum ratio of 1 to 5.
(6) The incident commander should routinely evaluate and re-evaluate conditions and reports of progress or lack of progress in reaching objectives. This process will allow the incident commander to determine if the strategy and attack plans should be continued or revised. The failure to revise an inappropriate or outdated attack plan is likely to result in an elevated risk of death or injury to fire fighters.
(7) Effective command and control should be maintained from the beginning to the end of operations, particularly if command is transferred. Any lapse in the continuity of command and the transfer of information increases the risk to fire fighters.

A.8.2.2 The intent of the use of "clear text" for radio communications is to reduce confusion at incidents, particularly where multiple agencies are operating at the same incident.

A.8.2.3 Examples of emergency conditions could be "evacuate the building/area," "wind shift from the north to south," "change from offensive to defensive operations."

Examples of situations where the term "mayday" should be used include a lost or missing member, an SCBA malfunction or loss of air, a member seriously injured or incapacitated, a member trapped or entangled, or any life-threatening situation that cannot be immediately resolved.

When a fire fighter experiences a life-threatening situation, he or she must quickly and efficiently be able to take the steps necessary to survive and alert rescuers. This is the time when an individual fire fighter will be tested on his or her knowledge of self-survival techniques. Paramount to surviving such an experience is being able to communicate the emergency to rescuers. The terms used to communicate these needs must be chosen carefully. The terms used must be easily understood over the radio in times when operational noise is high. The terms used must also be recognizable as an emergency call for assistance by those on the incident. All persons, regardless of language accent, must easily be able to annunciate the terms used. And finally, the terms used must be short with two syllables maximum to allow for a simple single inflexion of the voice to recognize the term.

"Mayday" satisfies all of the above demands for a term that can be used to communicate a fire fighter's need for immediate assistance. "Mayday" is approved for fire service use by the National Search and Rescue Committee and is currently being used by most fire departments in the United States. Most importantly, "mayday" is easily remembered and understood over the radio when operational noise challenges radio communications.

The concern over "mayday" causing confusion with aeronautical and nautical emergencies is unfounded. In April 2002, Dr. Burton A. Clark, EFO, CFO, Management Science Program chair at the National Fire Academy, and operations chief for DHS/FEMA during national disasters wrote to Rear Admiral Ken Venuto (USCG), chairman of the National Search and Rescue Committee, requesting clarification on the use of "mayday." In August 2002, Captain Steve Sawyer (USCG) returned a letter to Dr. Clark stating, "Your recent letter inquired about use by fire departments of the term "mayday" over ground fire radios when the life of a fire fighter is in danger. Use of "mayday" under such circumstances is permissible under U.S. law and regulations. The radio frequencies concerned are different from the aeronautical and maritime frequencies, so use of the term should not cause confusion. Further, any effective means of calling for help is authorized under both national and international radio regulations for true distress situations. Within the letter Captain Sawyer gives further insight on the appropriate use of "mayday." On page 2 of the letter it states, 'Mayday' is recognized nationally and internationally as a signal meaning life is in danger and immediate assistance is required, although federal regulations only mention its use for ship aircraft. The above guidance is based on review of the regulations and consultation with experts of the Coast Guard, FCC, International Civil Aviation Organization, and others. We trust that this explanation will help not only for your local training and operations; you may also find it useful seeking to update relevant guidance in NFPA or other standards, as appropriate."

In addition to "emergency traffic" and "mayday," the fire department can use additional signals such as an air horn signal for members to evacuate as part of their standard operating procedures. Some fire departments have developed an tion. The components of the personnel accountability system should be modular and expand with the size and complexity of the incident.

At major incidents, this function should be separate from the role of the incident commander. The function of personnel accountability should be assigned to an accountability officer (resource status and situation status) who is responsible for maintaining the status of all assigned resources at an incident. As the incident escalates, this function would be placed under the planning section.

A.8.4.11 These accountability supervisors should work with the incident commander and tactical-level management component supervisor to assist in the ongoing tracking and accountability of members.

A.8.5.1.1 The limitation of emergency scene operations to those that can be safely conducted by the number of personnel on the scene is intended to reduce the risk of fire fighter death or injury due to understaffing. While members can be assigned and arrive at the scene of an incident in many different ways, it is strongly recommended that interior fire-fighting operations not be conducted without an adequate number of qualified fire fighters operating in companies under the supervision of company officers.

It is recommended that a minimum acceptable fire company staffing level should be four members responding on or arriving with each engine and each ladder company responding to any type of fire. The minimum acceptable staffing level for companies responding in high-risk areas should be five members responding or arriving with each engine company and six members responding or arriving with each ladder company. These recommendations are based on experience derived from actual fires and in-depth fire simulations and are the result of critical and objective evaluation of fire company effectiveness. These studies indicate significant reductions in performance and safety where crews have fewer members than the above recommendations. Overall, five member crews were found to provide a more coordinated approach for search and rescue and fire-suppression tasks.

During actual emergencies, the effectiveness of companies can become critical to the safety and health of fire fighters. Potentially fatal work environments can be created very rapidly in many fire situations. The training and skills of companies can make a difference in the need for additional personnel and in reducing the exposure to safety and health risks to fire fighters where a situation exceeds their capabilities.

A.8.5.4 For additional information, see 29 CFR 1910.134, *Respiratory protection.*

A.8.5.8 Studies have shown that the severity of incidents involving ARFF can rapidly escalate to catastrophic proportions. If fire fighting and rescue operations are to be effective, fully assembled ARFF companies should be on-scene within the time requirements as specified in NFPA 403, *Standard for Aircraft Rescue and Fire-Fighting Services at Airports.* Experience has shown that it is extremely difficult to assemble personnel who are responding from separate locations for individual ARFF companies within these time constraints. It is strongly recommended that the minimum ARFF company staffing level be three on-duty members responding on or with each ARFF vehicle.

It is also recommended that structural fire apparatus responding in support of ARFF operations should be staffed in accordance with A.8.5.1.1. *(See also* NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments.)*

A.8.5.9 If advanced life support personnel are available, this level of service would be preferred. Basic life support is the minimum acceptable level.

A.8.5.14 Consideration for rescue of members working over, in, and around water should be addressed by the incident commander and incident safety officer within the incident action plan.

A.8.5.15.1 Examples include protective shields, mechanical/human barriers, or alerting techniques that are distinguishable and effective under the conditions.

A.8.6.4 Figure A.8.6.4 shows the concept of hazard control zones. The hot zone is the area presenting the greatest risks to members and will often be classified as an IDLH atmosphere. The hot zone can include no-entry zones. Examples of no-entry zones could be holes in floors, explosive devices, crime scenes, and so forth.

The warm zone is a limited-access area for members directly aiding or in support of operations in the hot zone. Significant risk of human injury (respiratory, exposures, etc.) can still exist in the warm zone.

The cold zone establishes the public exclusion or clean zone. There are minimal risks for human injury and/or exposure in this zone.

It might not always be possible or practical to mark the hazard control zones with colored tape, signage, or other appropriate means, depending on the nature or location of the incident, available resources, and so forth. If possible, these hazard control zones should be clearly marked. Other means of marking hazard control zones can include flashing beacons, streets, fences, and so forth. It is essential that the perimeters of these zones are communicated to all members at the incident and that they are aware of these zones and their implications.

When colored tape is being used to mark control zones, it is recommended that the following tape colors be used:

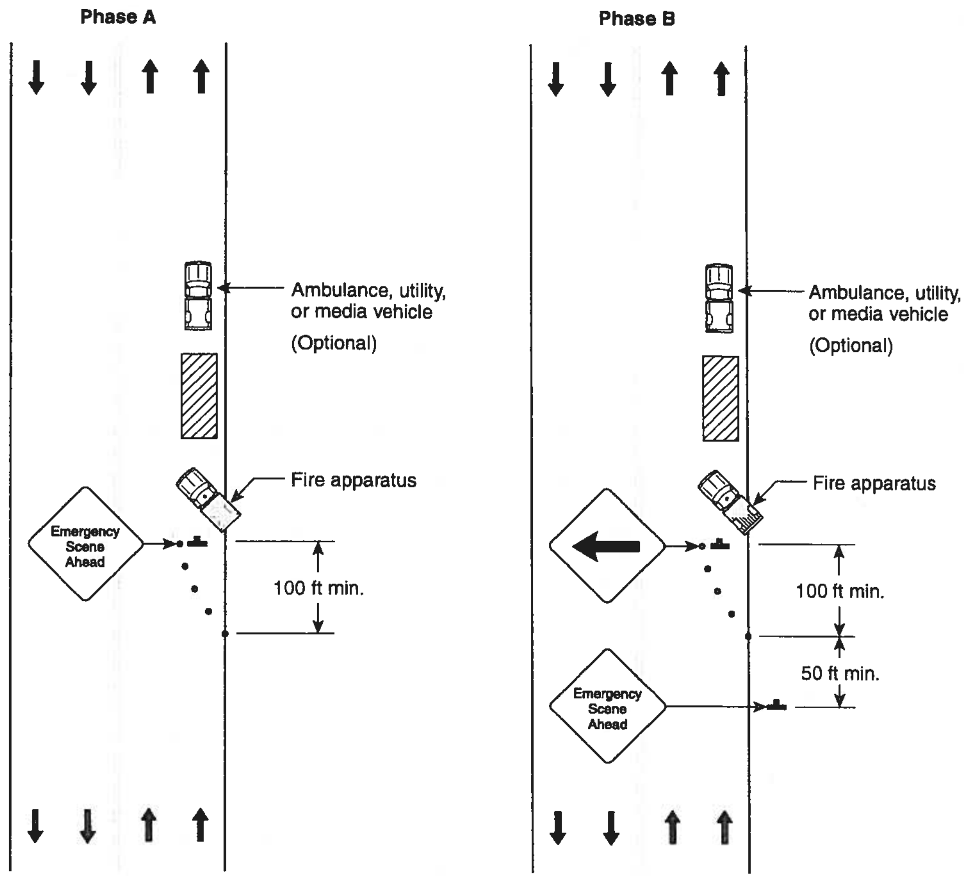
(1) No-entry zone: red/white chevron
(2) Hot zone: red
(3) Warm zone: yellow
(4) Cold zone: green

A.8.6.4.1 A hot zone can include a no-entry zone (marked with red and white chevron tape or other means). No personnel should enter the no-entry zone due to imminent hazard(s) or the need to protect evidence. Examples of no-entry zones could be holes in floors, explosive devices, crime scenes, and so forth. Examples of the PPE are SCBA, flash hood, and so forth.

A.8.6.4.1.1 The hot zone is an area with greater potential for risk of injury or exposure. Members entering the hot zone without an assigned task are placing themselves at greater risk for no reason. In addition, they can be increasing the risk of others operating within this zone by creating some confusion.

A.8.6.4.2 Examples of significant risk of human injury include respiratory and exposures.

A.8.7 For additional information on establishing safe practices at highway incidents, see the NFSIMSC publication, "Model Procedures Guide for Highway Incidents," the U.S. Fire Administration publication FA-272, *Emergency Vehicle Safety Initiative,* and the U.S. DOT publication, *Manual on Uniform Traffic Control Devices for Streets and Highways,* Chapter 61.



Phase A: Install sign after arrival, channelizing devices within 15 minutes of arrival.
Phase B: Install within 15 minutes after arrival of second apparatuses.

FIGURE A.8.7.5 Typical Emergency Scene Application.

A.8.9.1 Having a preplanned rehabilitation program that is applicable to most incident types is essential for the health and safety of members. The rehabilitation plan should outline an ongoing rehabilitation for simple or short-duration incidents as well as a process to transition into the rehabilitation needs of a large or long-duration incident.

A.8.9.2 See NFPA 1584, *Standard on the Rehabilitation Process for Members During Emergency Operations and Training Exercises,* for guidelines for implementing incident scene rehabilitation.

A.8.9.3 Rest should be provided away from potentially toxic exposures and loud noises, preferably with the opportunity to dress down and sit down.

Adequate water supplies should allow for up to 1 qt (1 L) per person for incidents lasting an hour or more. Water must be potable, such as in sealed individualized plastic bottles. Avoid caffeinated and high-sugar beverages.

In hot, humid conditions, and/or where members have been working hard for more than 40 minutes, a means to actively cool core body temperature should be provided to prevent heat stress. Forearm immersion in cool water, misting fans, cooling vests, and so forth are types of active cooling. For more information on active cooling, see "Active Versus Passive Cooling During Work in Warm Environments While Wearing Firefighting Protective Clothing," by G. A. Selkirk, T. M. McLellan, and J. Wong.

Medical evaluation and treatment in the on-scene rehabilitation area should be conducted according to EMS protocols developed by the fire department in consultation with the fire department physician and the EMS medical director. If ALS personnel are available, this level of EMS care is preferred.

The assignment of an ambulance or other support crew to the rehabilitation function is essential during long-duration or heavy-exertion incident operations. This crew can assist with rehabilitation functions as well as be available to provide immediate life support needs for members.

Food should be made available for longer-duration incidents (more than three hours). If possible, supplied food should be nutritious. Members should be provided with a means to wash contaminants from their hands and faces before refueling.

Weather factors during emergency incidents can impact severely on the safety and health of members, particularly during extremes of heat or cold. Where these factors combine with long-duration incidents or situations that require heavy exertion, the risks to members increase rapidly. The fire de-substance that impairs the member's mental or physical capacity, this situation cannot be tolerated.

Evidence of substance abuse could include a combination of various factors such as slurred speech, red eyes, dilated pupils, incoherence, unsteadiness on feet, smell of alcohol or marijuana emanating from the member's body, inability to carry on a rational conversation, increased carelessness, erratic behavior, inability to perform a job, or other unexplained behavioral changes.

The possibility of liability exists if a member who is under the influence of alcohol or drugs is allowed to remain on duty, to operate or drive vehicles or equipment on duty, or to drive a private vehicle from the duty site. A member who is believed to be under the influence of alcohol or drugs cannot be allowed to operate equipment or drive a vehicle, including a private vehicle, until the condition of the member has been determined and verified.

A.10.2.1 Fire departments should consider use of the recruiting, mentoring, and training process found in the physical performance requirements referenced in the IAFF/IAFC Candidate Physical Ability Test (CPAT) Manual.

A.10.4.1 The health data base for a fire department should include the reports of regular physical evaluations, injury and illness reports, health exposures, and any supporting information that could be useful in tracking, analyzing, or predicting the health effects of various events on individuals or the group. This process should comply with the medical recordkeeping requirements of 29 CFR 1910.120, *Hazardous waste operations and emergency response.*

A.10.4.3 This information should be managed in a manner that respects the confidentiality of doctor-patient relationships. Electronic data processing is often employed to facilitate management of such a data base.

A.10.4.4 The fire department should try to obtain autopsy or other medical information for all deceased employees or former employees. This information could be useful in establishing relationships between occupational factors and resulting fatalities at some time in the future. Autopsies for fire fatalities should be conducted and recorded according to a standard protocol.

A.10.5.1 Where fire department members routinely respond to emergency medical incidents, the fire department should consult with medical professionals and agencies on measures to limit the exposure of members to infectious and contagious diseases. This should include the provision and maintenance of equipment to avoid or limit direct physical contact with patients, when feasible.

A.10.6.3 A fire department physician should have specific expertise and experience relating to the needs of fire department members and a thorough knowledge of the physical demands involved in emergency operations. If possible, the fire department physician should be a specialist in the field of occupational medicine.

A.10.6.4 Depending on the size and the needs of a fire department, the fire department physician might or might not be required on a full-time basis. A fire department should have a primary relationship with at least one officially designated physician. This physician can serve as the primary medical contact and, in turn, deal with a number of other physicians and specialists. A large fire department can designate more than one fire department physician or might determine that a relationship with a group practice or multiple-provider system is more appropriate to its needs. In any case, the option to consult with a physician who is particularly aware of the medical needs of fire department members and who is available on an immediate basis should exist.

A.11.1 The term *behavioral health program* is recommended in place of the prior designation (*member assistance program*) to minimize conflation of the services to be delivered with the model of service delivery.

The emphasis here is specifically directed toward behavioral health services to be provided, leaving the model for their provision to the discretion of the sponsoring department and its vendors.

A.11.1.1 Basic levels of assistance as enumerated in the standard should be available at the first step of access. The objective should be to provide these services in a manner that facilitates ease of access and usage, minimizes delays and obstacles, and encourages proactive utilization. Members and their families should be informed about the program, its services, and how to access its resources, both at the time that they enter the organization and regularly throughout their tenure. The behavioral health assistance program should also serve as a resource for identification of and access to other important community resources such as self-help groups (e.g., Alcoholics Anonymous, Alanon, Alateen), community health resources, parenting resources, and the like. The behavioral health assistance program should articulate with the fire department's program to address occupational exposure to atypically stressful events (*see Chapter 12*).

The fire department behavioral health assistance program does not need to be operated or financed by the fire department. Many community/county/state mental health agencies provide such services and these can be available without charge or at reduced fees. Labor and employee organizations can also sponsor and/or operate such programs. The fire department need have only the ability to identify when pertinent problems exist and be able to provide confidential referral for professional services when indicated. Program standards developed by the Association of Labor-Management Administrators and Consultants on Alcoholism (ALMACA) recommend the following:

(1) The physical location at which services are provided should facilitate easy access while ensuring confidentiality.
(2) Medical and disability plans should be reviewed to ensure that plans provide adequate coverage for alcohol, substance, and mental health needs (including, where feasible, outpatient care and day treatment options).
(3) Staff should be sufficiently familiar with medical and disability benefit plans to facilitate adequate advising regarding the extent, nature, and cost of the recommended treatment and the reimbursement available.

Primary staff for the program should hold the following:

(1) Appropriate managerial and administrative experience
(2) Skill in problem identification, interviewing, client motivation, and appropriate referral
(3) Appropriate training, licensure, and certification with respect to any direct clinical or counseling services that can be provided by primary staff

Active and appropriately prepared peer personnel are often critical to the success of a fire service behavioral health program. These personnel serve most effectively as a bridge and a link between the professional services and service providers of the program and their coworkers, friends, and asso-

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FIRE DEPARTMENT OCCUPATIONAL SAFETY AND HEALTH PROGRAM WORKSHEET

Fire Department: ______________________________ Date: ____________

Person(s) Completing Worksheet

Name: ______________________ Title: ______________________

Name: ______________________ Title: ______________________

Name: ______________________ Title: ______________________

Reference in Standard	Percent in Compliance	Estimated Cost to Comply	Expected Compliance Date	Remarks
Chapter 1 Administration				
1.4 Equivalency				
1.4.1 Equivalency levels of qualifications				
1.4.2 Training, education, competency, safety				
Chapter 4 Organization				
4.1 Fire Department Organizational Statement				
4.1.1 Written statement or policy				
4.1.2 Operational response criteria				
4.1.3 Statement available for inspection				
4.2 Risk Management Plan				
4.2.1 Written risk management plan				
4.2.2 Risk management plan coverage				
4.2.3 Risk management plan components				
4.3 Safety and Health Policy				
4.3.1 Written fire department occupational safety and health policy				
4.3.2 Program complies with NFPA 1500				
4.3.3 Evaluate effectiveness of plan				
4.4 Roles and Responsibilities				
4.4.1 Fire department responsibility				
4.4.2 Comply with laws				
4.4.3 Fire department rules, regulations, and SOPs				
4.4.4 Accident investigation procedure				
4.4.5 Accidents and illnesses investigated				
4.4.6 Individuals cooperate, participate, and comply				

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FIGURE B.2 Fire Service Occupational Safety and Health Program Worksheet.

NFPA 1500
FIRE DEPARTMENT OCCUPATIONAL SAFETY AND HEALTH PROGRAM WORKSHEET *(continued)*

Reference in Standard	Percent in Compliance	Estimated Cost to Comply	Expected Compliance Date	Remarks
Chapter 5 Training, Education, and Professional Development *(continued)*				
5.1.8 Training on operation, limitation, maintenance, and retirement criteria for personal protective equipment				
5.1.9 Maintaining proficiency in skills and knowledge				
5.1.10 Training includes safe exiting and accountability				
5.1.11 Training includes incident management and accountability system used by the fire department				
5.2 Member Qualifications				
5.2.1 Fire fighters meet NFPA 1001				
5.2.2 Drivers/operators meet NFPA 1002				
5.2.3 Airport fire fighters meet NFPA 1003				
5.2.4 Fire officers meet NFPA 1021				
5.2.5 Wildland fire fighters meet NFPA 1051				
5.2.6 Hazardous materials responders trained to at least operations level per NFPA 472				
5.3 Training Requirements				
5.3.1 Adopt or develop training and education curriculums				
5.3.2 Training supports minimum qualifications and certifications of members				
5.3.3 Members practice assigned skill sets on a regular basis but not less than annually				
5.3.4 Training for members when written policies, practices, procedures, or guidelines are changed				
5.3.5 SCBA training program per NFPA 1404				
5.3.6 Wildland fire fighters trained at least annually in the proper deployment of fire shelter				
5.3.7 Live fire training in accordance with NFPA 1403				
5.3.8 Supervised training				
5.3.9 Emergency medical services training				

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FIGURE B.2 *Continued*

NFPA 1500
FIRE DEPARTMENT OCCUPATIONAL SAFETY AND HEALTH PROGRAM WORKSHEET *(continued)*

Reference in Standard	Percent in Compliance	Estimated Cost to Comply	Expected Compliance Date	Remarks
Chapter 6 Fire Apparatus, Equipment, and Drivers/Operators *(continued)*				
6.2.3 Rules and regulations for operating fire department vehicles				
6.2.4 Drivers are responsible				
6.2.5 All persons secured				
6.2.6 Drivers obey all traffic laws				
6.2.7 SOPs for non-emergency and emergency response				
6.2.8 Emergency response, drivers bring vehicle to a complete stop				
6.2.9 Proceed only when safe				
6.2.10 Stop at unguarded railroad grade crossings				
6.2.11 Use caution at guarded railroad grade crossings				
6.2.12 SOPs — engine, transmission and driveline retarders				
6.2.13 SOPs — manual brake limiting valves				
6.2.14 Rules and regulations for private vehicles for emergency response				
6.3 Riding in Fire Apparatus				
6.3.1 Tail steps and standing prohibited				
6.3.2 Seat belts not released while the vehicle is in motion				
6.3.3 Secured to vehicle while performing emergency medical care				
6.3.4 Hose loading operations				
6.3.5 Tiller training				
6.3.6 Helmets for riding in unenclosed areas				
6.3.7 Eye protection for riding in unenclosed areas				
6.3.8 Alternative transportation				
6.4 Inspection, Maintenance, and Repair of Fire Apparatus				
6.4.1 Fire apparatus inspection, maintenance, and repair per NFPA 1911				
6.4.2 Pumpers service tested per NFPA 1911				
6.4.3 Aerial ladders and elevating platforms tested per NFPA 1911				
6.4.4 Apparatus and equipment disinfected per NFPA 1581				

FIGURE B.2 *Continued*

NFPA 1500
FIRE DEPARTMENT OCCUPATIONAL SAFETY AND HEALTH PROGRAM WORKSHEET *(continued)*

Reference in Standard	Percent in Compliance	Estimated Cost to Comply	Expected Compliance Date	Remarks
Chapter 7 Protective Clothing and Protective Equipment *(continued)*				
7.2.3 Overlap not required on single-piece protection coveralls				
7.2.4.2 Gloves have proper interface				
7.2.5.1 Program in place for selection, care, maintenance, and use of protective clothing				
7.2.6 Require all members to wear appropriate protective ensemble				
7.3 Protective Clothing for Proximity Fire-Fighting Operations				
7.3.1 Risk assessment performed as required by Chapter 5 of NFPA 1851 to determine need for proximity ensembles				
7.3.2 Proximity fire-fighting protective equipment meeting NFPA 1971 provided and used				
7.3.3 Overlap not required on single-piece protection coveralls				
7.3.4 SCBA protected				
7.4 Protective Clothing for Emergency Medical Operations				
7.4.1.1 Emergency medical protective clothing meeting NFPA 1999 provided and used				
7.4.2 Members use emergency medical gloves				
7.4.3 Members use emergency medical body and face protection				
7.4.4 Infection control program for EMS protective clothing meets NFPA 1581				
7.5 Chemical-Protective Clothing for Hazardous Material Emergency Operations				
7.5.1.1 Members have and use vapor-protective garments that meet NFPA 1991 when appropriate				
7.5.2.1 Members have and use liquid splash-protective garments that meet NFPA 1992 when appropriate				
7.5.3.1 Members have and use appropriate protective ensemble for CBRN terrorism incidents				
7.6 Inspection, Maintenance, and Disposal of Chemical-Protective Clothing				
7.6.1 Inspected and maintained per manufacturer's recommendation				
7.6.2 Dispose of contaminated garments				

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FIGURE B.2 *Continued*

NFPA 1500
FIRE DEPARTMENT OCCUPATIONAL SAFETY AND HEALTH PROGRAM WORKSHEET *(continued)*

Reference in Standard	Percent in Compliance	Estimated Cost to Comply	Expected Compliance Date	Remarks
Chapter 7 Protective Clothing and Protective Equipment *(continued)*				
7.10.7 SCBA provided that meets NFPA 1981 and required to be used				
7.10.8 Members understand keeping facepiece in place				
7.11 Breathing Air				
7.11 Breathing air meets NFPA 1989				
7.12 Respiratory Protection Equipment				
7.12.1 SCBA meet appropriate standards				
7.12.2 Supplied-air respirators appropriate for intended application				
7.12.3 Air-purifying respirators NIOSH certified with policy for use				
7.13 Fit Testing				
7.13.1 Quantitative fit test annually				
7.13.2 New members fit tested before permitted in hazardous atmospheres				
7.13.3 Respirators quantitative fit testing in negative pressure mode				
7.13.4 Records of facepiece fitting test				
7.13.5 Protection factor at least 500 for negative-pressure facepieces				
7.14 Using Respiratory Protection				
7.14.1 Facepiece-to-face seal required				
7.14.2 Nothing passes through area of seal				
7.14.3 No beard and facial hair in area of seal				
7.14.4 Spectacles fitted to inside of facepiece				
7.14.5 Spectacle strap or temple bars prohibited				
7.14.6 Contact lenses permitted				
7.14.7 Head covering breaking seal prohibited				
7.14.8 SCBA facepiece/head harness worn under protective hood				
7.14.9 SCBA facepiece/head harness worn under hazardous chemical-protective helmet				
7.14.10 Helmet does not interfere with the facepiece-to-face seal				

FIGURE B.2 *Continued*

NFPA 1500
FIRE DEPARTMENT OCCUPATIONAL SAFETY AND HEALTH PROGRAM WORKSHEET *(continued)*

Reference in Standard	Percent in Compliance	Estimated Cost to Comply	Expected Compliance Date	Remarks
Chapter 7 Protective Clothing and Protective Equipment ***(continued)***				
7.19 Hearing Protection				
7.19.1 Provided and used when apparatus noise in excess of 90 dBA				
7.19.2 Provided and used when tool and equipment noise in excess of 90 dBA				
7.19.3 Hearing conservation program				
7.20 New and Existing Protective Clothing and Protective Equipment				
7.20.1 New PPE meets current standards				
7.20.2 Existing PPE met standards when manufactured				
7.20.3 PPE retired in accordance with NFPA 1851				
Chapter 8 Emergency Operations				
8.1 Incident Management				
8.1.1 Prevent accidents and injuries				
8.1.2 Incident management system in writing and meets NFPA 1561				
8.1.3 IMS used at all emergency incidents				
8.1.4 IMS applied to drills, exercises, and training				
8.1.5 Incident commander responsible for safety				
8.1.6 Incident safety officer assigned when needed				
8.1.7 Span of control				
8.1.8 Incident commander's responsibility				
8.2 Communications				
8.2.1 Dispatch and incident communication systems meet NFPA 1561 and NFPA 1221				
8.2.2 SOPs for use of clear text radio messages				
8.2.3 Procedures for emergency traffic				
8.2.4 Incident clock used				
8.3 Risk Management During Emergency Operations				
8.3.1 Risk management integrated in incident command				

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FIGURE B.2 *Continued*

NFPA 1500
FIRE DEPARTMENT OCCUPATIONAL SAFETY AND HEALTH PROGRAM WORKSHEET *(continued)*

Reference in Standard	Percent in Compliance	Estimated Cost to Comply	Expected Compliance Date	Remarks
Chapter 8 Emergency Operations *(continued)*				
8.5.6 Crew members operate in proximity to each other				
8.5.7 Two in, two out in initial stages				
8.5.8 At aircraft rescue and fire fighting, IDLH area within 75 ft (23 m) of aircraft				
8.5.9 Highest available level of EMS available for special operations				
8.5.10 EMS personnel at hazmat operations meet NFPA 473				
8.5.11 IC requests EMS to be available				
8.5.12 Members secured to aerial device				
8.5.13 PPE and SCBA used by fire investigators and others in IDLH atmosphere				
8.5.14 Water rescue members wear personal flotation devices				
8.6 Hazard Control Zones				
8.6.1 Hazard control zones established with members wearing appropriate level of PPE				
8.6.2 Hazard control zone perimeters established				
8.6.3 Changes in perimeters communicated to all members on scene				
8.6.4 Hazard control zones identified				
8.6.5 The IC ensures that the designation of the appropriate protective clothing and equipment is commensurate with the hazard zone the member is operating in				
8.6.6 All officers and members using appropriate PPE within that zone				
8.6.7 The use of hazard control zones continued until the hazards have been mitigated				
8.7 Traffic Incidents				
8.7.1 Appropriate measures taken to protect members				
8.7.2 SOPs for operations involving traffic incidents				
8.7.3 Apparatus and warning devices used to protect members				
8.7.4 Apparatus positioned to protect members				
8.7.5 Warning devices used for oncoming traffic				

FIGURE B.2 *Continued*

NFPA 1500
FIRE DEPARTMENT OCCUPATIONAL SAFETY AND HEALTH PROGRAM WORKSHEET *(continued)*

Reference in Standard	Percent in Compliance	Estimated Cost to Comply	Expected Compliance Date	Remarks
Chapter 8 Emergency Operations ***(continued)***				
8.9 Rehabilitation During Emergency Operations				
8.9.1 SOP for rehabilitation of members				
8.9.2 IC initiates rehabilitation per SOPs and NFPA 1561				
8.9.3 On-scene rehabilitation to include complete support				
8.9.4 Each member responsible to communicate rehabilitation needs				
8.9.5 Each wildland fire fighter provided with 2 qt (2 L) of water				
8.10 Violence, Civil Unrest, or Terrorism				
8.10.1 Fire department not involved in activity without law enforcement present				
8.10.2 Fire department personnel not involved in crowd control				
8.10.3 SOPs for member safety at civil disturbance				
8.10.4 Interagency agreement for protection of members				
8.10.5 Communication to indicate life-and-death situations				
8.10.6 Fire department to coordinate with law enforcement				
8.10.7 Fire department IC identifies and reacts to violent situations				
8.10.8 Fire department IC communicates with law enforcement IC				
8.10.9 Stage resources in a safe area until scene secure				
8.10.10 Secure law enforcement or withdraw when violence occurs				
8.10.11 Body armor used only by members trained and qualified				
8.10.12 Members supporting SWAT operations trained and operating under SOPs				
8.11 Post-Incident Analysis				
8.11.1 SOPs for standardized post-incident critique				
8.11.2 Incident safety officer involved in critique				
8.11.3 Review of conditions and actions on the safety and health of members				

FIGURE B.2 *Continued*

NFPA 1500
FIRE DEPARTMENT OCCUPATIONAL SAFETY AND HEALTH PROGRAM WORKSHEET *(continued)*

Reference in Standard	Percent in Compliance	Estimated Cost to Comply	Expected Compliance Date	Remarks
Chapter 10 Medical and Physical Requirements *(continued)*				
10.2 Physical Performance Requirements				
10.2.1 Fire department develops requirements				
10.2.2 Candidates qualified prior to training				
10.2.3 Members annually qualified				
10.2.4 Members not qualified not involved in emergency operations				
10.2.5 Physical performance rehabilitation program available				
10.3 Health and Fitness				
10.3.1 Health and fitness program meets NFPA 1583				
10.3.2 Fitness levels determined by individual's assigned functions				
10.3.3 Health and fitness coordinator administers the program				
10.3.4 Health and fitness coordinator acts as liaison				
10.4 Confidential Health Data Base				
10.4.1 Individual health file for each member				
10.4.2 Health file complete				
10.4.3 Composite data base for analysis				
10.4.4 Autopsy results in health data base				
10.5 Infection Control				
10.5.1 Fire department limits or prevents member's exposure				
10.5.2 Infection control program meets NFPA 1581				
10.6 Fire Department Physician				
10.6.1 Fire department physician officially designated				
10.6.2 Provides medical guidance in management of safety and health program				
10.6.3 Physician licensed				
10.6.4 Available on urgent basis				
10.6.5 Health and safety officer and health fitness coordinator liaison with physician				

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FIGURE B.2 *Continued*

Annex C Building Hazard Assessment

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 Fire fighters are being exposed to increased risks on the fireground. Buildings are being occupied in a manner different from that for which they were originally designed. The design of some buildings has changed so that the roofs and floors can and do fail at a faster rate. Mezzanines over the floor area have created hazards during fire-fighting operations. These changes have created safety hazards, which have increased the risks to fire fighters.

Fire departments should take appropriate measures to identify buildings that can cause hazardous conditions during emergency operations. A method that could be used is to add a letter or letters to the bottom white "specific hazard" area on existing placards as specified in NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response.* Some buildings are constructed utilizing several types of roof construction. The local fire department should determine which identifier is used based upon the construction feature or hazard that creates the greatest risk to fire fighters.

The identifier letter or letters that could be used are as follows:

(1) **A** — Artisans living in a commercial building
(2) **LT** — Lightweight trusses used in roof or floor construction (e.g., roofs-open web, wooden I-beams)
(3) **AT** — Arch trusses used in roof construction
(4) **P** — Panelized roof construction
(5) **M** — Mezzanines above floor area

Fire departments should initiate local actions that allow for the local adoption of NFPA 704 placards, with the same identifiers to be installed on nonplacarded buildings.

The NFPA 704 marking system could prove beneficial for first-responding companies and move-up companies, including companies used during mutual and automatic aid.

It is recommended that fire departments develop tactical plans to address safety concerns for fire fighters confronted with buildings placarded with specific hazards.

Annex D Risk Management Plan Factors

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

D.1 Essentially, a risk management plan serves as documentation that risks have been identified and evaluated and that a reasonable control plan has been implemented and followed.

Some factors to consider for each step of the process are listed in D.1.1 through D.1.6.

D.1.1 Risk Identification. For every aspect of the operation of the fire department, list potential problems. The following are examples of sources of information that could be useful in the process:

(1) A list of the risks to which members are or can be exposed
(2) Records of previous accidents, illnesses, and injuries, both locally and nationally
(3) Facility and apparatus surveys, inspections, and so forth

D.1.2 Risk Evaluation. Evaluate each item listed in the risk identification process using the following two questions:

(1) What is the potential frequency of occurrence?
(2) What is the potential severity and expense of its occurrence?

This will help to set priorities in the control plan.

Some sources of information that could be useful are the following:

(1) Safety audits and inspection reports
(2) Prior accident, illness, and injury statistics
(3) Application of national data to the local circumstances
(4) Professional judgment in evaluating risks unique to the jurisdiction

D.1.3 Establishment of Priorities for Action. Determining the frequency and severity of occurrence of risks will serve as a method for establishing priorities. Any risk that has a low probability of occurrence but will have serious consequences (high risk) deserves immediate action and would be considered a high-priority item. Non-serious incidents with a low likelihood of occurrence are a lower priority and can be placed near the bottom of the "action required" list.

D.1.4 Risk Control. Once risks are identified and evaluated, a control for each should be implemented and documented. The two primary methods of controlling risk, in order of preference, are as follows:

(1) Wherever possible, totally eliminate/avoid the risk or the activity that presents the risk. For example, if the risk is falling on the ice, then do not allow members to go outside when icy conditions are present.
(2) Where it is not possible or practical to avoid or eliminate the risk, steps should be taken to control it. In the example in D.1.4(1), some methods of control would be sand/salt procedures, the wearing of proper footwear, and so forth.

D.1.5 Other Methods of Control. Other methods of control to consider are the following:

(1) Safety program development, implementation, and enforcement
(2) Standard operating procedures development, dissemination, and enforcement
(3) Training
(4) Inspections

D.1.6 Risk Management Monitoring and Follow-Up. As with any program, it is important to evaluate whether the plan is working. Periodic evaluations should be made, and, if the program elements are not working satisfactorily, then modifications should be made.

D.2 Figure D.2 shows a sample risk management plan. For additional information the user should refer to NFPA 1250, *Recommended Practice in Fire and Emergency Services Organization Risk Management.*

Annex E Hazardous Materials PPE Information

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

E.1 Fire department personnel involved in a hazardous materials incident should be protected against potential chemical hazards. The purpose of chemical-protective clothing and equipment is to shield or isolate individuals from the chemical hazards that can be encountered during hazardous materials responses. Adequate chemical-protective clothing should be carefully selected and used to protect the respiratory system, skin, eyes, face, hands, feet, head, body, and hearing.

Structural fire-fighting protective clothing and equipment should not be used for hazardous materials incidents. Even where certified to the appropriate NFPA standards for structural fire fighting, these clothing and equipment items provide little or no protection against hazardous materials. Use of this clothing for hazardous materials emergency response can result in serious injury or death, as explained in E.1.1 through E.1.3.

E.1.1 Structural fire-fighting protective clothing materials are easily permeated or penetrated by most hazardous materials. Some parts of structural fire-fighting clothing can actually absorb chemical liquids or vapors, increasing the likelihood of serious exposure.

E.1.2 Many hardware items will fail or lose function when contacted by chemicals (e.g., etching of visors, deterioration of straps, corrosion of hooks or other metal items).

E.1.3 Contamination of structural fire-fighting protective clothing might not be effectively removed by laundering. Reuse of contaminated clothing can cause chronic exposure and accelerate physiological effects produced by contact with the chemical. Fire fighters should realize that no single combination of protective equipment and clothing is capable of protecting them against all hazards. Therefore, chemical-protective clothing should be used in conjunction with other protective methods. The use of such clothing can create significant wearer hazards, such as heat stress and physical and psychological stress, as well as impaired vision, mobility, and communication. In general, the greater the level of chemical clothing protection, the greater are the associated risks. For any given situation, equipment and clothing should be selected that provide an adequate level of protection. Overprotection as well as underprotection can be hazardous and should be avoided. The approach to selecting personal protective clothing and equipment should encompass an ensemble of clothing and equipment items that are easily integrated to provide both an appropriate level of protection and the ability to carry out emergency response activities. The following is a checklist of components that can form the chemical-protective ensemble:

(1) Protective clothing (i.e., suit, coveralls, hoods, gloves, boots)
(2) Respiratory equipment (i.e., SCBA, combination SCBA/SAR)
(3) Cooling system (i.e., ice vest, air circulation, water circulation)
(4) Communications device
(5) Head protection
(6) Ear protection
(7) Inner garments
(8) Outer protection (i.e., overgloves, overboots, flashcovers)

E.2 Emergency Response PPE Information. For emergency response, the only acceptable types of protective clothing include fully or totally encapsulating suits and nonencapsulating or "splash" suits combined with accessory clothing items such as chemical-resistant gloves and boots. These descriptions apply to how the clothing is designed, not to its performance. NFPA has classified chemical-protective suits by their performance in the following two standards:

(1) Vapor-protective suits (NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*) (Level A)
(2) Liquid splash-protective suits (NFPA 1992, *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies*) (Level B with SCBA)

Protective clothing should completely cover both the wearer and the wearer's breathing apparatus. Wearing SCBA or other respiratory equipment outside the suit subjects this equipment to the chemically contaminated environment. The SCBA used for hazardous materials emergency response are generally the same as those used in structural fire fighting. Respiratory protective equipment is not designed to resist chemical contamination and should be protected from these environments. NFPA 1991 vapor-protective suits require that respiratory protection SCBA be worn on the inside. NFPA 1992 liquid splash-protective suits can be configured with the SCBA on either the inside or the outside. However, it is strongly recommended that respiratory equipment be worn inside the ensemble to prevent its failure and to reduce decontamination problems.

A variety of accessories are available for chemical-protective ensembles. As with protective clothing and respirators, it is important that these components integrate easily into an ensemble without a decrease in the protective integrity offered by any one component. For the most part, the protective suit is the main integrating ensemble component because it should accommodate all other equipment while completely covering the wearer. Nevertheless, selection of an ensemble configuration should consider all items simultaneously.

Fire departments are faced with selecting a number of available chemical-protective garments and sorting through the variety of information provided by the manufacturer. What follows are some guidelines that can be used in selecting chemical-protective suits.

E.2.1 It must be determined if the clothing item is intended to provide vapor or liquid splash protection. Vapor-protective suits also provide liquid splash protection. Both vapor- and liquid splash-protective suits also provide protection against solid chemicals and particles. **Many garments can be labeled as totally encapsulating but do not provide gastight integrity due to inadequate seams or closures.** Splash suits must still cover the entire body when combined with the respirator, gloves, and boots. **Applying duct tape to a splash suit does not enable it to protect against vapors.** Gastight integrity can only be determined by performing a pressure or inflation test of the respective protective suit, which should be done per the manufacturer's recommendation. ASTM F 1052, *Standard Test Method for Pressure Testing Vapor Protective Ensembles*, offers a procedure for conducting this test. This test involves the following:

(1) Closing off suit exhalation valves
(2) Inflating the suit to a prespecified pressure
(3) Observing whether the suit holds the above pressure for a designated period of time

Liquid splash-protective suits should provide "liquidtight" integrity. Liquidtight integrity is best evaluated by determining how the chemical-protective suit and other clothing prevent

FACILITY SAFETY CHECKLIST

Facility: ______________________________ **Date:** ______________

I. GENERAL

____ The required OSHA workplace poster shall be displayed in the station, as required, where all employees are likely to see it.

____ Emergency instructions and telephone numbers shall be available for the general public, in the event of an emergency and fire personnel are out of quarters.

Comments: ______________________________

II. HOUSEKEEPING

____ All rooms, offices, hallways, storage rooms, and the apparatus floor shall be kept clean and orderly and in a sanitary condition.

____ All hallways and/or passageways shall be free from any type of hazards.

____ All waste containers shall be emptied regularly.

____ Waste containers shall be provided in the kitchen and/or eating areas. These containers shall be maintained in a clean and sanitary condition. Waste container liners are required in all waste containers kept in kitchen and/or eating areas.

____ All areas of the station shall be adequately illuminated.

____ Stairways shall be in good condition with standard railings provided for every flight having four or more risers.

____ Portable ladders shall be adequate for their purpose, in good condition, and have secure footing.

____ Fixed ladders shall be equipped with side rails, cages, or special climbing devices.

____ Containers of all cleaning agents shall be carefully labeled per OSHA standards.

____ First aid supplies shall be available and clearly identified as to location.

____ Shower curtains shall provide adequate protection to prevent floors from becoming excessively wet and slippery.

____ Cooking appliances, including gas and charcoal grills, and eating utensils shall be kept clean and in good working order.

Comments: ______________________________

III. EXITS

____ All exits shall be visible and unobstructed.

____ All exits shall be marked with a readily visible sign that is illuminated if required by building code.

____ Doors that might be mistaken for exits shall be marked "Not an Exit" if required by building code.

____ Exits and exit signs shall be free of decoration, draperies, and/or furnishings.

____ Primary exit routes shall be obvious, marked, and free of obstruction.

____ Exits shall be wide enough for easy access.

Comments: ______________________________

IV. WALKING AND WORKING SURFACES

____ Floors shall be kept as clean and dry as possible.

____ Fire fighters' routes to slide poles or to apparatus shall be completely free of projections, tripping hazards, loose objects, or other impediments.

____ All slide pole floor openings shall be provided with safety enclosures.

____ A safety mat shall be provided at the bottom of the slide pole.

____ The slide pole shall be regularly inspected and maintained.

Comments: ______________________________

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FIGURE F.1 Sample Facilities Safety Checklist.

FACILITY SAFETY CHECKLIST *(continued)*

VIII. DECONTAMINATION ROOMS

____ The decontamination room shall be clean and orderly and free of storage not related to decontamination.

____ The decontamination room shall have instructions clearly posted as to how to proceed through decontamination.

____ There shall be an inventory on hand in the decontamination room, and the inventory shall be complete with the supplies on hand.

____ The decontamination washer and dryer shall be clean and in working condition.

____ There shall be instructions posted as to the use of the washer and dryer.

Comments: ____

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IX. FIRE PREVENTION AND PROTECTION

____ Portable fire extinguishers shall be maintained in a fully operable condition and kept in designated places when not in use. They shall be inspected on a monthly basis.

____ Fire extinguishers shall be of the proper size/type for the expected hazard.

____ The fire extinguisher shall have a durable tag securely attached to show the maintenance or recharge date. Also, the initials or signature of the person who performed the inspection shall be on the tag.

____ If the station is equipped with a fire alarm system, the system shall be maintained and tested by a qualified person to the requirements of NFPA 72.

____ If the station is equipped with a sprinkler system, the system shall be maintained and tested by a qualified person to the requirements of NFPA 25.

____ The minimum clearance of 18 in. shall be maintained below the sprinkler heads.

____ Smoke detectors shall be inspected and tested quarterly.

____ Carbon monoxide detectors shall be inspected and tested quarterly.

Comments: ____

____

____

X. HAZARDOUS MATERIALS

____ Cylinders of compressed gas shall be stored away from combustible materials, in an upright position, and properly secured to prevent cylinders from falling over.

____ Flammable and combustible materials shall be stored in tanks or closed containers per NFPA 30 and building code requirements. Flammable and combustible liquids in excess of 30 gallons must be stored in an approved storage locker. The containers must be made of metal, or the containers must be stored in a storage cabinet approved for flammable materials.

____ Safety containers shall have self-closing lids and shall be used for the storage of flammable liquids and soiled, oily rags.

Comments: ____

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XI. ELECTRICAL WIRING, FIXTURES, AND CONTROLS

____ Electrical cords shall be strung so they do not hang on pipes, nails, hooks, etc.

____ Conduit shall be attached to all supports and tightly connected to junction and outlet boxes.

____ All electrical cords shall be checked for fraying.

____ All equipment shall be securely mounted to the surface on which it sits.

____ Flexible cords and cables shall not be used as a substitute for fixed wiring.

____ All extension cords shall be properly grounded and approved.

____ All electrical tools, whether department owned or personal property, shall be properly protected for damaged power cords, plugs, worn switches, defective ground circuits, or other faults that might render them unsafe for use.

____ Electrical panel boxes and circuit breakers shall be marked to show their purpose.

____ Electrical switches, outlets, panel boxes, and junction boxes shall be properly covered.

Comments: ____

____

____

____

FIGURE F.1 *Continued*

Annex G Informational References

G.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

G.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1, *Fire Code*, 2012 edition.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2010 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2011 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2012 edition.

NFPA 70®, *National Electrical Code®*, 2011 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2013 edition.

NFPA *101®*, *Life Safety Code®*, 2012 edition.

NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, 2009 edition.

NFPA 403, *Standard for Aircraft Rescue and Fire-Fighting Services at Airports*, 2009 edition.

NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, 2013 edition.

NFPA 473, *Standard for Competencies for EMS Personnel Responding to Hazardous Materials/Weapons of Mass Destruction Incidents*, 2013 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response*, 2012 edition.

NFPA 901, *Standard Classifications for Incident Reporting and Fire Protection Data*, 2011 edition.

NFPA 1001, *Standard for Fire Fighter Professional Qualifications*, 2013 edition.

NFPA 1002, *Standard for Fire Apparatus Driver/Operator Professional Qualifications*, 2009 edition.

NFPA 1003, *Standard for Airport Fire Fighter Professional Qualifications*, 2010 edition.

NFPA 1006, *Standard for Technical Rescuer Professional Qualifications*, 2008 edition.

NFPA 1021, *Standard for Fire Officer Professional Qualifications*, 2009 edition.

NFPA 1041, *Standard for Fire Service Instructor Professional Qualifications*, 2012 edition.

NFPA 1051, *Standard for Wildland Fire Fighter Professional Qualifications*, 2012 edition.

NFPA 1071, *Standard for Emergency Vehicle Technician Professional Qualifications*, 2011 edition.

NFPA 1250, *Recommended Practice in Fire and Emergency Services Organization Risk Management*, 2010 edition.

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2013 edition.

NFPA 1401, *Recommended Practice for Fire Service Training Reports and Records*, 2012 edition.

NFPA 1403, *Standard on Live Fire Training Evolutions*, 2012 edition.

NFPA 1404, *Standard for Fire Service Respiratory Protection Training*, 2006 edition.

NFPA 1405, *Guide for Land-Based Fire Departments That Respond to Marine Vessel Fires*, 2011 edition.

NFPA 1451, *Standard for a Fire Service Vehicle Operations Training Program*, 2007 edition.

NFPA 1521, *Standard for Fire Department Safety Officer*, 2008 edition.

NFPA 1561, *Standard on Emergency Services Incident Management System*, 2008 edition.

NFPA 1581, *Standard on Fire Department Infection Control Program*, 2010 edition.

NFPA 1582, *Standard on Comprehensive Occupational Medical Program for Fire Departments*, 2013 edition.

NFPA 1583, *Standard on Health-Related Fitness Programs for Fire Department Members*, 2008 edition.

NFPA 1584, *Standard on the Rehabilitation Process for Members During Emergency Operations and Training Exercises*, 2008 edition.

NFPA 1620, *Standard for Pre-Incident Planning*, 2010 edition.

NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*, 2010 edition.

NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, 2008 edition.

NFPA 1901, *Standard for Automotive Fire Apparatus*, 2009 edition.

NFPA 1906, *Standard for Wildland Fire Apparatus*, 2012 edition.

NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus*, 2012 edition.

NFPA 1912, *Standard for Fire Apparatus Refurbishing*, 2011 edition.

NFPA 1925, *Standard on Marine Fire-Fighting Vessels*, 2008 edition.

NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders*, 2010 edition.

NFPA 1932, *Standard on Use, Maintenance, and Service Testing of In-Service Fire Department Ground Ladders*, 2010 edition.

NFPA 1936, *Standard on Powered Rescue Tools*, 2010 edition.

NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents*, 2013 edition.

NFPA 1961, *Standard on Fire Hose*, 2013 edition.

NFPA 1962, *Standard for the Inspection, Care, and Use of Fire Hose, Couplings, and Nozzles and the Service Testing of Fire Hose*, 2008 edition.

NFPA 1964, *Standard for Spray Nozzles*, 2008 edition.

NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, 2013 edition.

NFPA 1975, *Standard on Station/Work Uniforms for Emergency Services*, 2009 edition.

NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*, 2011 edition.

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, 2007 edition.

NFPA 1982, *Standard on Personal Alert Safety Systems (PASS)*, 2007 edition.

NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services*, 2012 edition.

NFPA 1989, *Standard on Breathing Air Quality for Emergency Services Respiratory Protection*, 2008 edition.

NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*, 2005 edition.

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NFPA® 1720

Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments

2010 Edition

NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471
An International Codes and Standards Organization

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NFPA® 1720

Standard for the

Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments

2010 Edition

This edition of NFPA 1720, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments,* was prepared by the Technical Committee on Fire and Emergency Service Organization and Deployment—Volunteer. It was issued by the Standards Council on May 26, 2009, with an effective date of June 15, 2009, and supersedes all previous editions.

This edition of NFPA 1720 was approved as an American National Standard on June 15, 2009.

Origin and Development of NFPA 1720

In 2001, the first edition of NFPA 1720 was issued. The development of that benchmark standard was the result of a considerable amount of hard work and tenacity by the Technical Committee members and the organizations they represented. That standard was the first organized approach to defining levels of service, deployment capabilities, and staffing levels for substantially volunteer fire departments. Research work and empirical studies in North America were used by the Committee as a basis for developing response times and resource capabilities for those services, as identified by the fire department.

Following the issuance of the first edition, the NFPA Standards Council asked the Technical Committee to begin the revision process for a 2004 edition of the standard. The Committee reviewed and revised the first edition of NFPA 1720. Existing definitions were cleaned up and new definitions added where needed to assist users of the standard. A new section on community risk management was added as was an annex titled "Risk Management Model." New sections were also added on "reporting requirements" and "initial attack." Annex material that included extracted figures from NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems,* was added to assist users in determining if calls for service were being properly handled.

This edition of NFPA 1720 standardizes and refines terminology and definitions used in the document. Table 4.3.2 has been editorially revised to make it more understandable and the requirement that the fire department have the capability to initiate an attack within 2 minutes of having necessary resources at the scene in remote areas was moved from the footnotes to a new paragraph and made applicable to all operations. Introductory material for Table 4.3.2 was modified to indicate the requirements apply to a structure fire in a typical 2000 ft^2 (186 m^2), two-story single family dwelling without basement and with no exposures. Text was added in the annex to assist users in calculating the percentage of times they meet the objective.

A new section on sustained fire-fighting operations was added and several sections were revised and reorganized to present the requirements in a more logical order.

The annex material that discusses the requirements in NFPA 1221 was expanded and the two figures extracted from NFPA 1221 updated. Annex B was extensively revised to make it more concise by removing ambiguous text and figures. Annex C was deleted in its entirety.

The work done by the Committee provides the user with a template for developing an implementation plan on the standard. Most important, it provides the body politic and the citizens a true picture of the risks in their community and the fire department's capabilities to respond to and manage those risks.

Technical Committee on Fire and Emergency Service Organization and Deployment—Volunteer

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Carl E. Peterson, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the organization, operation, deployment, and evaluation of substantially all volunteer public fire protection and emergency medical services.

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NFPA 1720

Standard for the

Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments

2010 Edition

NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex C. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1* Scope. This standard contains minimum requirements relating to the organization and deployment of fire suppression operations, emergency medical operations, and special operations to the public by volunteer and combination fire departments.

1.1.1* The requirements address functions and outcomes of fire department emergency service delivery, response capabilities, and resources.

1.1.2 This standard also contains minimum requirements for managing resources and systems, such as health and safety, incident management, training, communications, and pre-incident planning.

1.1.3 This standard addresses the strategic and system issues involving the organization, operation, and deployment of a fire department and does not address tactical operations at a specific emergency incident.

1.1.4 This standard does not address fire prevention, community education, fire investigations, support services, personnel management, and budgeting.

1.2 Purpose.

1.2.1 The purpose of this standard is to specify the minimum criteria addressing the effectiveness and efficiency of the volunteer and combination public fire suppression operations, emergency medical service, and special operations delivery in protecting the citizens of the jurisdiction.

1.2.2 Nothing herein is intended to restrict any jurisdiction from exceeding these minimum requirements.

1.3 Application.

1.3.1* The authority having jurisdiction determines if this standard is applicable to its fire department.

1.3.2 The standard is a benchmark for a common response and a platform for developing the appropriate plans for deployment of resources for fires in higher hazard occupancies or more complex incidents.

1.4* Equivalency. Nothing in this standard is intended to prohibit the use of systems, methods, or approaches of equivalent or superior performance to those prescribed in this standard, provided technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, 2008 edition.

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2010 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 2007 edition.

NFPA 1561, *Standard on Emergency Services Incident Management System*, 2008 edition.

2.3 Other Publications.

2.3.1 FEMA Publications. Federal Emergency Management Agency, 500 C Street SW, Washington, D.C. 20472

National Incident Management System, March 1, 2004, available at http://www.fema.gov/pdf/emergency/nims/nims_doc_full.pdf.

National Response Framework, January 2008, available at http://www.fema.gov/pdf/emergency/nrf/nrf-core.pdf.

2.3.2 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, 2008 edition.

NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting*, 2007 edition.

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2010 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 2007 edition.

NFPA 1521, *Standard for Fire Department Safety Officer*, 2008 edition.

NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*, 2010 edition.

NFPA 1901, *Standard for Automotive Fire Apparatus*, 2009 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Shall. Indicates a mandatory requirement.

3.2.4 Should. Indicates a recommendation or that which is advised but not required.

3.2.5 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard

3.3 General Definitions.

3.3.1 Advanced Life Support (ALS). See 3.3.27.1.

3.3.2 Aid.

3.3.2.1* ***Automatic Aid.*** A plan developed between two or more fire departments for immediate joint response on first alarms. [**1142,** 2007]

3.3.2.2 ***Mutual Aid.*** Reciprocal assistance by emergency services under a written plan among AHJs that is part of communication center's dispatch protocol.

3.3.3* Alarm. A signal or message from a person or device indicating the existence of an emergency or other situation that requires action by an emergency response agency [**1221,** 2010].

3.3.4 Area.

3.3.4.1 ***Remote Area.*** A geographic area that requires a travel distance of at least 8 miles from a fire station to provide emergency services.

3.3.4.2 ***Rural Area.*** As defined by the U.S. Census Bureau, an area with fewer than 500 people per square mile.

3.3.4.3 ***Suburban Area.*** As defined by the U.S. Census Bureau, an area with between 500 people and 1000 people per square mile.

3.3.4.4 ***UrbanArea.*** As defined by the U.S. Census Bureau, an area with at least 1000 people per square mile.

3.3.5 Automatic Aid. See 3.3.2.1.

3.3.6 Basic Life Support (BLS). See 3.3.27.2.

3.3.7 Combination Fire Department. See 3.3.15.1.

3.3.8 Company. A group of members assembled at the scene that operate under direct supervision and are trained and equipped to perform assigned tasks.

3.3.9* Company Officer. A supervisor of a crew/company of personnel. [**1710,** 2010]

3.3.10 Crew. See 3.3.39, Team.

3.3.11* Demand Zones. An area used to define or limit the management of a risk situation.

3.3.12 Emergency Incident. Any situation to which an emergency services organization responds in order to deliver emergency services, including rescue, fire suppression, emergency medical service, special operations, law enforcement, and other forms of hazard control and mitigation.

3.3.13 Emergency Medical Service. The treatment of patients using first aid, cardiopulmonary resuscitation, basic life support, advanced life support, and other medical procedures prior to arrival at a hospital or other health care facility. *[See also 3.3.27.1, Advanced Life Support (ALS); 3.3.27.2, Basic Life Support (BLS); and 3.3.20, First Responder (EMS).]*

3.3.14 Fire Apparatus. A vehicle designed to be used under emergency conditions to transport personnel and equipment, and to support the suppression of fires and mitigation of other hazardous situations. [**1901,** 2009]

3.3.15 Fire Department. An organization providing rescue, fire suppression, emergency medical services, and related activities to the public.

3.3.15.1 ***Combination Fire Department.*** A fire department having emergency service personnel comprising less than 85 percent majority of either volunteer or career membership.

3.3.15.2 ***Volunteer Fire Department.*** A fire department having volunteer emergency service personnel comprising 85 percent or greater of its department membership.

3.3.16 Emergency Operations. See 3.3.30.1.

3.3.17 Fire Department Member. See 3.3.28, Member.

3.3.18 Fire Protection. Methods of providing fire detection, control, and extinguishment.

3.3.19* Fire Suppression. The activities involved in controlling and extinguishing fires. [**1500,** 2007]

3.3.20* First Responder (EMS). Functional provision of initial assessment (i.e., airway, breathing, and circulatory systems) and basic first-aid intervention, including CPR and automatic external defibrillator (AED) capability. [**1710,** 2010]

3.3.21* Hazard. A condition that presents the potential for harm or damage to people, property, or the environment.

3.3.22 Hazardous Area. The area where members might be exposed to a hazard or hazardous atmosphere. A particular substance, device, event, circumstance, or condition that presents a danger to members of the fire department.

3.3.23 Hazardous Material. A substance that is capable of creating harm to people, the environment, or property due to its toxicity, chemical reactivity, decomposition, or corrosivity; is capable of explosion or detonation; or presents etiological hazards, whether used for its intended purpose or as a weapon of mass destruction (WMD), for illicit lab purposes, environmental crimes, or industrial sabotage.

3.3.24 Incident Commander (IC). The individual responsible for all incident activities, including the development of strategies and tactics and the ordering and the release of resources. [**472,** 2008]

3.3.25* Incident Management System (IMS). An organized system that defines the roles and responsibilities to be assumed by responders and the standard operating procedures to be used in the management and direction of emergency incidents and other functions.

3.3.26 Initial Attack. Fire-fighting efforts and activities that occur in the time increment between the arrival of the fire department on the scene of a fire and the tactical decision by the Incident Commander that the resources dispatched on the original response are insufficient to control and extinguish the fire, or that the fire is extinguished.

3.3.27 Life Support.

3.3.27.1 ***Advanced Life Support (ALS).*** Emergency medical services beyond basic life support that provide for advanced airway management, including intubation, advanced cardiac monitoring, defibrillation, establishment and maintenance of intravenous access, and drug therapy.

3.3.27.2* ***Basic Life Support (BLS).*** A specific level of prehospital emergency medical service provided by trained responders that is focused on rapidly evaluating a patient's condition; maintaining a patient's airway, breathing, and circulation; controlling external bleeding; preventing shock; and preventing further injury or disability by immobilizing potential spinal or other bone fractures.

3.3.28* Member. A person involved in performing the duties and responsibilities of a fire department, under the auspices of the organization. [**1500,** 2007]

3.3.29 Mutual Aid. See 3.3.2.2.

3.3.30 Operations.

3.3.30.1 ***Emergency Operations.*** Activities of the fire department relating to rescue, fire suppression, emergency medical service, and special operations, including response to the scene of the incident and all functions performed at the scene.

3.3.30.2* ***Special Operations.*** Those emergency incidents to which the fire department responds that require specific and advanced training and specialized tools and equipment. [**1500,** 2007]

3.3.31* Rapid Intervention Crew (RIC). A dedicated crew of fire fighters who are assigned for rapid deployment to rescue lost or trapped members.

3.3.32 Remote Area. See 3.3.4.1.

3.3.33 Rescue. Those activities directed at locating endangered persons at an emergency incident, removing those persons from danger, treating the injured, and providing for transport to an appropriate health care facility. [**1500,** 2007]

3.3.34 Rural Area. See 3.3.4.2.

3.3.35 Special Operations. See 3.3.30.2.

3.3.36 Standard Operating Procedure. A written organizational directive that establishes or prescribes specific operational or administrative methods to be followed routinely for the performance of designated operations or actions. [**1521,** 2008]

3.3.37 Structural Fire Fighting. The activities of rescue, fire suppression, and property conservation in buildings or other structures, vehicles, rail cars, marine vessels, aircraft, or like properties. [**1710,** 2010]

3.3.38 Suburban Area. See 3.3.4.3.

3.3.39 Team. Two or more members who have been assigned a common task and are in communication with each other, coordinate their activities as a work group, and support the safety of one another.

3.3.40 Urban Area. See 3.3.4.4.

3.3.41 Volunteer Fire Department. See 3.3.15.2.

Chapter 4 Organization, Operation, and Deployment

4.1* Fire Suppression Organization. Fire suppression operations shall be organized to ensure that the fire department's fire suppression capability includes sufficient personnel, equipment, and other resources to deploy fire suppression resources efficiently, effectively, and safely.

4.1.1* The authority having jurisdiction (AHJ) shall promulgate the fire department's organizational, operational, and deployment procedures by issuing written administrative regulations, standard operating procedures (SOPs), and departmental orders.

4.1.2* Fire department procedures shall clearly state the succession of command responsibility.

4.2* Community Risk Management. The fire department shall participate in a process that develops a community fire and emergency medical services risk management plan.

4.2.1 The specific role of the fire department and other responding agencies shall be defined by the community risk management plan.

4.2.2* The number and type of units assigned to respond to a reported incident shall be determined by risk analysis and/or prefire planning.

4.2.3 Hazardous Materials.

4.2.3.1 The fire department shall participate in a process that develops a community risk management plan with respect to the risks associated with the storage, use, and transportation of hazardous materials.

4.2.3.2 The specific role of the fire department and other responding agencies shall be defined by the community risk management plan for hazardous materials and other special operations.

4.3 Staffing and Deployment.

4.3.1 The fire department shall identify minimum staffing requirements to ensure that a sufficient number of members are available to operate safely and effectively.

4.3.2* Table 4.3.2 shall be used by the AHJ to determine staffing and response time objectives for structural fire fighting, based on a low-hazard occupancy such as a 2000 ft^2 (186 m^2), two-story, single-family home without basement and exposures and the percentage accomplishment of those objectives for reporting purposes as required in 4.4.2.

Table 4.3.2 Staffing and Response Time

Demand Zone[a]	Demographics	Minimum Staff to Respond[b]	Response Time (minutes)[c]	Meets Objective (%)
Urban area	>1000 people/mi^2	15	9	90
Suburban area	500–1000 people/mi^2	10	10	80
Rural area	<500 people/mi^2	6	14	80
Remote area	Travel distance ≥ 8 mi	4	Directly dependent on travel distance	90
Special risks	Determined by AHJ	Determined by AHJ based on risk	Determined by AHJ	90

[a] A jurisdiction can have more than one demand zone.
[b] Minimum staffing includes members responding from the AHJs department and automatic aid
[c] Response time begins upon completion of the dispatch notification and ends at the time interval shown in the table.

4.3.3 Upon assembling the necessary resources at the emergency scene, the fire department shall have the capability to safely commence an initial attack within 2 minutes 90 percent of the time.

4.3.4* Personnel responding to fires and other emergencies shall be organized into company units or response teams and shall have required apparatus and equipment.

4.3.5* Standard response assignments and procedures, including mutual aid response and mutual aid agreements predetermined by the location and nature of the reported incident, shall regulate the dispatch of companies, response groups, and command officers to fires and other emergency incidents.

4.4 Reporting Requirements.

4.4.1* Incident Reports. The fire department shall maintain a standardized reporting system that collects specific information on each incident.

4.4.1.1 The incident report shall include the location and nature of the fire or emergency and describe the circumstances of the incident and the operations performed.

4.4.1.2 This report shall identify the members responding to the incident.

4.4.2 Annual Evaluation.

4.4.2.1 The fire department shall evaluate its level of service, deployment delivery, and response time objectives on an annual basis.

4.4.2.2 The evaluation shall be based on data relating to level of service, deployment, and the achievement of each response time objective in each demand zone within the jurisdiction of the fire department.

4.4.3 Quadrennial Report. The fire department shall provide the AHJ with a written report, quadrennially, which shall be based on the annual evaluations required by 4.4.2.

4.4.3.1 The quadrennial report shall define demand zones and/or circumstances in which the requirements of this standard are not being met.

4.4.3.2 This report shall explain the predictable consequences of identified deficiencies and address the steps within a fire department strategic plan necessary to achieve compliance.

4.5 Fire Suppression Operations.

4.5.1* Incident Commander. One individual shall be assigned as the incident commander.

4.5.1.1* The assumption and identification of command shall be communicated to all units responding to or involved at the incident scene.

4.5.1.2 The incident commander shall be responsible for the overall coordination and direction of all activities for the duration of the incident.

4.5.1.3 The incident commander shall ensure that a personnel accountability system is immediately utilized to rapidly account for all personnel at the incident scene.

4.5.2 Company Officer. The company officer/crew leader shall at all times be aware of the identity, location, and activity of each member assigned to the company.

4.5.2.1 Each member of the company shall be aware of the identity of the company officer/crew leader.

4.5.2.2 Orders addressed to individual members, particularly verbal orders and orders at incident scenes, shall be transmitted through the company officer.

4.6 Initial Fire-Fighting Operations.

4.6.1 Initial fire-fighting operations shall be organized to ensure that at least four members are assembled before interior fire suppression operations are initiated in a hazardous area.

4.6.2 In the hazardous area, a minimum of two members shall work as a team.

4.6.3* Outside the hazardous area, a minimum of two members shall be present for assistance or rescue of the team operating in the hazardous area.

4.6.3.1 One of the two members assigned outside the hazardous area shall be permitted to be engaged in other activities.

4.6.3.2 The assignment of a member shall not be permitted if abandoning that member's critical task(s) to perform rescue would jeopardize the safety and health of any fire fighter operating at the incident.

4.6.4 Initial attack operations shall be organized to ensure that if, upon arrival at the emergency scene, initial attack personnel find an imminent life-threatening situation where immediate action could prevent the loss of life or serious injury, such action is permitted with less than four personnel when conducted in accordance with NFPA 1500.

4.7 Sustained Fire-Fighting Operations.

4.7.1 The fire department shall have the capability for sustained operations, including fire suppression; engagement in search and rescue, forcible entry, ventilation, and preservation of property; accountability for personnel; the deployment of a dedicated rapid intervention crew (RIC); and provision of support activities for those situations that are beyond the capability of the initial attack.

4.7.2 The capability to sustain operations shall include sufficient personnel, equipment, and resources to efficiently, effectively, and safely conduct the appropriate operations.

4.7.3 The fire department shall be permitted to use established automatic aid or mutual aid agreements to comply with the requirements of Section 4.7.

4.8 Intercommunity Organization.

4.8.1* Mutual aid, automatic aid, and fire protection agreements among the affected AHJs shall be in writing and shall address issues such as liabilities for injuries, disabilities, and deaths; cost of service; authorization to respond; staffing; and equipment, including the resources to be made available and the designation of the incident commander.

4.8.2 Procedures and training of personnel for all fire departments in mutual aid, automatic aid, and fire protection agreement plans shall be comprehensive enough to produce an effective force to deal with the emergencies they respond to and to ensure uniform operations at those emergencies.

4.8.3 Companies responding to automatic or mutual aid incidents shall be equipped with communications equipment that allow personnel to communicate with the incident commander, division or group supervisors, or branch directors.

4.9* Emergency Medical Services (EMS).

4.9.1* The provisions of this section shall apply only to those fire departments that are involved in EMS delivery.

4.9.2* The fire department shall clearly document its role, responsibilities, functions, and objectives for the delivery of EMS.

4.9.3 EMS operations shall be organized to ensure the fire department's emergency medical capability includes personnel, equipment, and resources to deploy the initial arriving company and additional alarm assignments.

4.9.4 The fire department shall be permitted to use established automatic aid or mutual aid agreements to comply with the requirements of Section 4.9.

4.9.5 System Components.

4.9.5.1 The basic treatment levels within an EMS system, for the purposes of this standard, shall be categorized as first responder, basic life support (BLS), and advanced life support (ALS).

4.9.5.2 The specific patient treatment capabilities associated with each level shall be determined by the AHJ for the approval and licensing of EMS providers within each state or province.

4.9.6 Quality Management.

4.9.6.1 The fire department shall institute a quality management program.

4.9.6.2 All first responder and BLS emergency medical service provided by the fire department shall be reviewed by the fire department medical personnel and that review process shall be documented.

4.9.6.3 All fire departments with ALS services shall have a named medical director with the responsibility to oversee and ensure quality medical care in accordance with state or provincial laws or regulations.

4.9.6.4 Fire departments providing ALS services shall provide a mechanism for immediate communications with EMS supervision and medical oversight.

4.10* Special Operations.

4.10.1 The provisions of this section shall apply to fire departments that are involved in the delivery of special operations response.

4.10.2 The fire department shall adopt a special operations response plan and standard operating procedures (SOPs) that specify the role and responsibilities of the fire department and the authorized functions of members responding to hazardous materials emergency incidents.

4.10.3 Special operations shall be organized to ensure that the fire department's special operations capability includes sufficient personnel, equipment, and resources to safely deploy the initial arriving company and additional alarm assignments providing such services.

4.10.4* The fire department shall limit its operations to only those specific special operations functions for which its personnel are trained and are properly equipped.

4.10.5 The fire department shall be permitted to use established automatic aid or mutual aid agreements to comply with the requirements of Section 4.10.

4.10.6 All fire department members who respond to emergency incidents involving hazardous materials shall be trained to the applicable requirements of NFPA 472.

4.10.7 The fire department shall have the capacity to implement an RIC during all special operations incidents that would subject fire fighters to immediate danger of injury, or in the event of equipment failure or other sudden events, as required by NFPA 1500.

4.10.8 When a higher level of emergency response is needed beyond the capability of the fire department for special operations, the fire department shall determine the availability of outside resources that deploy these capabilities and the procedures for initiating their response.

Chapter 5 Systems

5.1 Safety and Health System.

5.1.1* A fire fighter occupational safety and health program shall be provided in accordance with NFPA 1500 to form the basic structure of protecting the health and safety of fire fighters, regardless of the scale of the department or the emergency.

5.1.2 As a minimum, the fire department shall ensure an AED is available on scene with personnel adequately trained in its use.

5.2* Incident Management System.

5.2.1 An incident management system shall be provided in accordance with NFPA 1561 to form the basic structure of all emergency operations of the fire department, regardless of the scale of the department or the emergency.

5.2.2* An effective incident management system shall be designed to manage incidents of different types, including structure fires, wildland fires, hazardous materials incidents, emergency medical operations, and other types of emergencies that could be encountered by the department.

5.2.3 The incident management system shall be consistent with the National Incident Management System (NIMS) and the National Response Framework (NRF).

5.3 Training Systems. The fire department shall have a training program and policy that ensures that personnel are trained and competency is maintained to safely execute all operations consistent with the department's organization and deployment as addressed in Chapter 4.

5.4* Communications System.

5.4.1* The fire department shall have a reliable communications system to facilitate prompt delivery of public fire suppression, EMS, and special operations.

5.4.2 All communications facilities, equipment, staffing, and operating procedures shall comply with NFPA 1221.

5.4.3 Operating procedures for radio communications shall provide for the use of standard protocols and terminology at all types of incidents.

5.4.4 Standard terminology, in compliance with NFPA 1561, shall be established to transmit information, including strategic modes of operation, situation reports, and emergency notifications of imminent hazards.

5.5 Pre-Incident Planning.

5.5.1* The fire department shall set forth operational requirements to conduct pre-incident planning.

5.5.2 Particular attention shall be provided to target hazards.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 The standard includes minimum requirements that are intended to provide effective, efficient, and safe protective services that operate on a sound basis to prevent fires, reduce risk to lives and property, deal with incidents that occur, and prepare for anticipated incidents. The standard sets minimum standards considered necessary for the provision of public fire protection by volunteer and combination fire departments. It addresses the structure and operation of organizations providing such services, including fire suppression, emergency medical services (EMS), hazardous materials operations, and special operations.

A.1.1.1 The delivery of services that are directed toward saving lives from a variety of perils is generally included in the mission of the fire service, although the nature and extent of these services varies from one jurisdiction to another.

In addition to duties at fires, fire departments should be prepared to perform rescue work and provide emergency care for those injured in connection with incidents such as traffic accidents, train wrecks, aircraft crashes, floods, windstorms, weapons of mass destruction/terrorism, and earthquakes, unless specifically excluded from involvement.

In many areas, the fire department is designated as the primary provider of EMS. This responsibility could involve the delivery of basic or advanced (paramedic) life support services and could include ambulance service. These services could be performed by fire fighters or by members of the fire department specializing in EMS. The impact on fire department resources and the department's continued ability to perform its other responsibilities should be considered when the department undertakes the EMS activity.

A.1.3.1 The authority having jurisdiction (AHJ) generally has the responsibility to determine the following:

(1) Scope and level of service provided by the fire department
(2) Necessary level of funding
(3) Necessary level of personnel and resources, including facilities

In order to provide service, the AHJ can have the power to levy taxes, solicit funding, own property and equipment, and cover personnel costs. The authority necessary is conveyed by law of a local jurisdiction.

In addition, the governing body also should monitor the achievement of the management goals of the department, such as fire prevention, community life safety education, fire suppression, employee training, communications, maintenance, and department administration.

Spelling out the specific parameters of services to be provided allows the fire department to plan, staff, equip, train, and deploy members, career and volunteer, to perform these duties. It also gives the governing body an accounting of the costs of services and allows it to select those services they can afford to provide. Likewise, the governing body should identify services it cannot afford to provide and cannot authorize the fire department to deliver; those services should be assigned to another agency.

The fire department should be no different from any other government agency that has the parameters of its authority and services clearly defined by the governing body.

A.1.4 See Annex B.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.3.2.1 Automatic Aid. Automatic aid is established through a written agreement between AHJs that provides for the simultaneous dispatch of a predetermined response of personnel and equipment to a neighboring jurisdiction upon receipt of an alarm, and is included as part of a communication center's dispatch protocols.

A.3.3.3 Alarm. In some jurisdictions, an alarm is referred to as an incident or call for service.

A.3.3.9 Company Officer. This person could be someone appointed in an acting capacity. The rank structure could be either sergeant, lieutenant, or captain.

A.3.3.11 Demand Zones. A demand zone can be a single building or a group of buildings. It is usually defined in terms of geographical boundaries, called fire management areas or fire management zones.

A.3.3.19 Fire Suppression. Fire suppression includes all activities performed at the scene of a fire incident or training exercise that expose fire department members to the dangers of heat, flame, smoke, and other products of combustion, explosion, or structural collapse. [**1500,** 2007]

A.3.3.20 First Responder (EMS). A first responder also assists higher level EMS providers.

A.3.3.21 Hazard. Hazards include the characteristics of facilities, equipment systems, property, hardware, or other objects; and the actions and inactions of people that create such hazards.

A.3.3.25 Incident Management System (IMS). The system should be consistent with NIMS and the National Response Framework. The system is also referred to as an incident command system (ICS).

A.3.3.27.2 Basic Life Support (BLS). Basic life support could also include expediting the safe and timely transport of the patient to a hospital emergency department for definitive medical care.

A.3.3.28 Member. A fire department member can be a full-time or part-time employee or a paid or unpaid volunteer, can occupy any position or rank within the fire department, and can engage in emergency operations. [**1500,** 2007]

A.3.3.30.2 Special Operations. Special operations include water rescue, extrication, hazardous materials, confined space entry, high-angle rescue, aircraft rescue and fire fighting, and other operations requiring specialized training. [**1500,** 2007]

A.3.3.31 Rapid Intervention Crew (RIC). Emergency services personnel respond to many incidents that present a high risk to personnel safety. Departments in compliance with 29 CFR 1910.134 need to have a minimum of two people on scene fully equipped when members are operating in an immediately dangerous to life and health (IDLH) or potentially IDLH atmosphere. The primary purpose is the rescue of injured, lost, or trapped fire fighters. Departments utilizing an incident management system in accordance with NFPA 1561, or 29 CFR 1910.120 along with a personnel accountability system, have incorporated the RIC into their management system. Many departments have redefined their response plans to include the dispatch of an additional company (i.e., engine, rescue, or truck) to respond to incidents and to stand by as the RIC/company. Incident commanders can assign additional RICs based on the size and complexity of the incident scene. This requirement is also included as part of special operations incidents in NFPA 1500, Chapter 8.

A.4.1 Suppression capability is an expression of how much fire-fighting power can be put into action at a fire. It includes the amount of apparatus, equipment, and personnel available; the time needed to respond and place equipment in action; the water supply; the application of strategy and tactics; the level of training; and all of the components that add up to effective fireground operations.

A.4.1.1 Departmental regulations and operating procedures and orders should be developed for the purpose of ensuring uniformity and effectiveness in department actions and operations. These procedures should be published and circulated to all members, and training should be provided whenever major changes or additions are made. A system should be established that requires each member to read and acknowledge existing and revised regulations and procedures.

Such procedures should cover matters not subject to frequent changes and should be reviewed at least annually to ensure that they are current. All members should have access to the system of orders and directives that relate to their unit. Orders should be reviewed periodically by company officers during company meetings or training sessions.

The departmental procedures should specify the channels through which orders are to be transmitted. All orders should pass through the established chain of command and should be acknowledged. The chain of command also should be followed, in reverse order, for reports and other communications from units to headquarters.

A.4.1.2 The succession of command responsibility is necessary to provide for continuity of operations following death, injury, disability, or the absence of individuals. Succession should include the job title designation "acting" but should not imply automatic reassignment or promotion.

A.4.2 In many communities, the fire department is assigned primary responsibility for the management of hazardous materials emergencies. In some cases, this includes regulatory responsibilities to identify and minimize risks to the community resulting from the storage, use, transportation, and disposal of hazardous materials. *(See 29 CFR 1910.120.)*

The process used to plan response to these emergencies is also a viable tool for planning response (e.g., fire suppression, EMS, and technical rescue) to other risks within the community. The planning process should be coordinated with community and private sector planning processes that are implemented to meet legal requirements. The resulting comprehensive emergency management plan (CEMP) should be developed by the local emergency planning committee (LEPC) and exercised at least annually. The CEMP should include evacuation plans, intervention strategies, sources of expertise, and specialized assistance and disposal plans. The planning process should identify clearly the AHJ for command responsibility during hazardous materials incidents and other emergency responses to incidents within the community

Disaster planning should be coordinated at all levels of government in anticipation of large-scale emergencies. Legislation or legal restrictions could establish the overall controlling authority in disaster operations. All planning and activity should occur within the framework of these restrictions. *(See Annex B.)*

NFPA 1600 is a document that provides additional information to assist users in preparing for, responding to, and mitigating disasters in their jurisdictions. In addition, it covers federal, state, and local disaster agencies' roles and responsibilities within a comprehensive planning process.

See NFPA 1250, which provides additional information and tools to assist in the risk management process.

A.4.2.2 A variety of factors should be taken into account, including the size, height, and configuration of buildings; special life risks; exposures between structures; construction types; occupancy classifications; and other hazards.

A.4.3.2 Table 4.3.2 outlines demographic areas, as defined by the U.S. Census Bureau; staffing and deployment requirements; and fractal measurements. The suburban area is based on the requirements provided in the report by the Ontario Fire Marshal's Office, *Shaping the Future of Fire Ground Staffing and Delivery Systems within a Comprehensive Fire Safety Effectiveness Model*, a report referenced in NFPA 1710, as well. This requirement must be met 80 percent of the time. Rural areas have a lower population density and require six people (two in/two out plus the incident commander and pump operator), a requirement that is derived from the country-UK standards of fire cover and must be met 80 percent of the time. The remote areas reference the OSHA "two in/two out" requirement and the assembly of four persons 90 percent of the time. Travel distances are varied and can be computed utilizing the ISO travel formula. This travel formula is as follows:

$$1.7 \times \text{distance} + 0.65 = \text{travel time}$$

For evaluation of response time objectives based on Table 4.3.2, the fire department needs to record the number of members on the scene at the end of the response time given in the table for each incident. For example, in an urban area, the fire department would record the number of members on scene 9 minutes after the completion of the dispatch notification. They would then determine how many times they had at least 15 members on scene within that 9-minute time interval and calculate a percentage based on the total calls in urban areas. To meet the objective defined in this standard for an urban area, they would need to assemble at least 15 members within 9 minutes for 90 percent of the incidents.

A.4.3.4 The AHJ should determine the number and type of fire company units to be provided. All personnel except those assigned to staff or support units or those serving as chief officers should be assigned to a specific company unit. The fire chief's responsibility is to ensure that the best use is made of personnel and equipment. See NFPA 1561 for additional information.

A.4.3.5 Modern computerized dispatch systems have the capability of providing specific dispatch assignments for individual buildings. Where street fire alarm boxes are provided, a response assignment should be prepared for each box location. Where street boxes are not used, zone numbers should be assigned to different points, sectors, or properties.

The number and type of units assigned to a particular incident depend on the availability of units at the time the incident occurs. Dispatchers should be given the authority to use judgment, within departmental guidelines, when they encounter situations or circumstances that demand modification of normal response assignments.

Procedures for the redistribution of available companies within the jurisdiction should be established in such a manner as to provide the best possible protection in the event of major incidents or high activity. Mutual aid companies should be used for back-up coverage in these situations.

A.4.4.1 Reports on emergencies are essential to providing an accurate record of a department's activities. Reports also serve as a basis for determining local, state, and national fire trends and for establishing the needs of a fire department. NFPA 901 should be used as the basis for classifying data on emergency incidents. The FEMA *National Fire Incident Reporting System* (NFIRS) should form the basis of an incident reporting system. The purpose of 4.4.1 is to inform fire departments of the importance of having a reporting system, even if such a system is not required by local, state, or provincial law.

A.4.5.1 The responsibility for assigning fire companies at an emergency belongs to the incident commander, who establishes priorities and assigns units based on identified objectives. Normally, on a first alarm response, the first engine company and truck company respond directly to the front of the emergency, while other responding units stand by or stage nearby until assigned to a particular task. Whenever an emergency situation demands extended operational activities, additional alarms should be called to provide reinforcements and a reserve supply of personnel and equipment at the scene.

Arriving companies that have not been assigned according to standard operating procedures (SOPs) or directions from the incident commander should proceed automatically to a standby or staging position. These units should stop short and remain uncommitted about a block from the scene until assigned by the incident commander. Staging positions should take into account access to potential operating positions, water supply, and traffic conditions. The primary emphasis is on avoiding the independent commitment of companies to tasks or positions that conflict with the incident commander's objectives. Once the initial command responsibilities are completed, the incident commander should begin to obtain progress reports from operating units and evaluate efforts. The initial action plan should then be revised or refined as necessary.

The convergence of many units at the scene of an incident, particularly units that are not part of a planned response system, can cause major problems. Procedures should be established on a regional basis to provide for orderly response when major incidents occur. All responding multiple alarm companies should gather in a specific area designated by the incident commander. This formal staging area should be located away from the emergency scene in order to provide adequate space for assembly of all response apparatus. The first officer to arrive in this designated location should automatically assume control of the staging area. This officer should maintain an accurate log of available companies and, when requested to by command, should verbally assign companies to report to specific sectors or divisions or for specific functions with instructions on where and to whom to report.

A.4.5.1.1 Fire department SOPs should define operational procedures for the passing of or transferring of command. Command should never be transferred to an individual not on the scene. The arrival of senior officers on the scene does not result in an automatic transfer of command. The identity of incident command could change during the course of an incident, but the continuity of responsibility and accountability should be maintained.

On a typical first alarm assignment, the chain of command is usually transferred on the arrival of a chief officer. The officer being relieved should be prepared to provide the superior with an assessment of the general conditions and tactical priorities, such as the location of companies that are assigned, the identity of companies available for assignment, and the need for additional resources.

The situation faced by a company officer assuming initial command of an incident dictates an operating mode in each case. The basic options available to that officer are as follows:

(1) *Investigation Mode.* If fire is not evident, the first arriving company officer investigates while all other units stand by in staging mode or positions. The company officer assumes command responsibility.
(2) *Initial Attack Mode.* The first arriving company officer assumes command responsibility while leading an initial rapid attack to stabilize the situation. This mode is effective where fast action is critical and will control the situation quickly.
(3) *Command Post Mode.* The first arriving company officer identifies the large, complex situation and assigns resources while setting up a command post operation from the outset.

In each case, the company officer assuming command is fully responsible for the identified tasks assigned to the command function. The degree of personal involvement in tactical actions varies in each mode.

A.4.6.3 RIC members should have the fire fighters' personal protective ensemble and protective equipment, self-contained breathing apparatus, and any specialized rescue equipment that could be needed for the specifics of the operation underway as required by NFPA 1500.

A.4.8.1 Where applicable, the mutual aid agreement should include automatic responses on first alarms (automatic aid). This concept contemplates joint response of designated apparatus and personnel on a predetermined running assignment basis.

Mutual aid concepts should be considered on a regional basis. In an effective mutual aid arrangement, each fire department should retain reserves of personnel and apparatus. Traditionally and legally, overall command of the incident is vested with the senior officer of the jurisdiction experiencing the emergency.

Some areas use consolidated dispatching to coordinate the response of fire companies to assist an outside fire department. The management of responses can be made easier by utilizing computerization, running cards, and other advance planning.

A.4.9 An emergency medical services (EMS) system is defined as a comprehensive, coordinated arrangement of resources and functions that are organized to respond in a timely, staged manner to medical emergencies, regardless of their cause. The term *system* can be applied locally or at the state, provincial, or national level.

The following are the fundamental functions of an EMS system:

(1) System organization and management
(2) Medical direction
(3) Human resources and training
(4) Communications
(5) Emergency response
(6) Transportation
(7) Care facilities
(8) Quality assurance
(9) Public information and education
(10) Disaster medical services
(11) Research
(12) Special populations

A.4.9.1 See requirements as outlined in NFPA 1710.

A.4.9.2 In addition to the resources provided by the fire department to meet these response criteria, other community resources should be considered. The initial treatment could be enhanced by other means, including citizens trained in cardiopulmonary resuscitation (CPR) or self-help instructions from trained communications personnel. The plan for delivering basic life support should include consideration of these alternatives.

A.4.10 Special operations incidents can include, but are not limited to, the following:

(1) Rope rescue including high angle
(2) Water rescue
(3) Trench/collapse rescue
(4) Confined space rescue
(5) Extrication rescue
(6) Air/sea rescue
(7) Urban search and rescue (USAR)
(8) SWAT (special weapons and tactics team) operations

The specific role of the fire department in responding to special operations incidents should be outlined in the community's emergency management plan. This plan defines the scope of activities and responsibilities assigned to the fire department and the level of service that is provided in each area.

A.4.10.4 Although fire departments are called to respond to a variety of incidents and should have the ability to perform special operations to the extent that can be reasonably anticipated, the possibility of being called to a situation that was unanticipated or was impossible to predict is significant. In these situations, the fire department could or could not have the specific training, procedures, or resources to deal with the problem. In those types of incidents, the incident commander is responsible for evaluating the situation, the risks that are involved, and the capabilities of the resources that are available to take action before an action plan can be developed. The operational risk management guidelines should be used to determine the appropriate action in such circumstances.

A.5.1.1 NFPA 1500 addresses all areas of fire service occupational safety and health and serves as an umbrella document for other specific NFPA fire department safety and health documents. In addition, it also meets the intent of 29 CFR 1910.134.

A.5.2 Emergency incidents can involve operations that vary considerably in their complexity and scale. The control of these incidents depends on the planned, systematic implementation of an effective fireground organization to accomplish identified objectives. Every fire department, regardless of size, needs a proper system to regulate and direct emergency forces and equipment at both routine and major incidents.

A.5.2.2 Incident management systems are designed to provide a standard approach and response to all types of incidents and have been developed and implemented by many fire departments. A basic concept of these systems uses an incremental approach in building a command structure, starting with the first officer arriving at the scene of an incident. The development of the command structure should coincide with the commitment of emergency forces assigned to the situation. The specific methods used by various fire departments differ, but the essential operational objectives remain consistent. The main distinguishing characteristics of the various incident management systems currently employed involve terminology and specific details of organization structures.

Individuals with specific expertise, particularly in highly technical areas, perform some functions best. The fire department should endeavor to have more than one qualified individual to perform all essential functions within the incident management system.

A.5.4 The provision and operation of a reliable communications system is essential to the delivery of public fire services. The nature and extent of the system provided varies with the size and nature of the jurisdiction served, the services provided, and other local conditions and preferences.

A fire communications system could serve an individual jurisdiction or multiple jurisdictions. In many cases, a regional system, operating under a valid intergovernmental agreement, provides operational advantages and reduced overall costs as compared with a number of smaller systems serving individual jurisdictions. The benefits could be reflected in a more functional mutual aid system, as well as in operational advantages within the communications system itself.

A.5.4.1 NFPA 1221 covers the time frame from when an alarm is received at a public safety answering point (PSAP) until notification of emergency response units begins. The communications system cannot control the time from the initiation of the event (start of fire, identification of medical problem, etc.) until the emergency is detected and a call is placed to the PSAP or a signal is transmitted from a detection device. Likewise, the fire department cannot initiate a response until the alarm is processed and the appropriate fire department resources are notified. NFPA 1221 requires that 95 percent of alarms received on emergency lines be answered within 15 seconds, and 99 percent of alarms be answered within 40 seconds. It also requires that emergency alarm processing be completed within 60 seconds 90 percent of the time and emergency alarm processing be completed within 90 seconds 99 percent of the time. See Figure A.5.4.1(a). Where alarms are transferred from the primary PSAP to a secondary answering point or communications center, the transfer procedure must not exceed 30 seconds for 95 percent of all alarms processed. See Figure A.5.4.1(b).

A.5.5.1 Fire departments, when conducting prefire planning, should use NFPA 1620 for fires and other related emergencies.

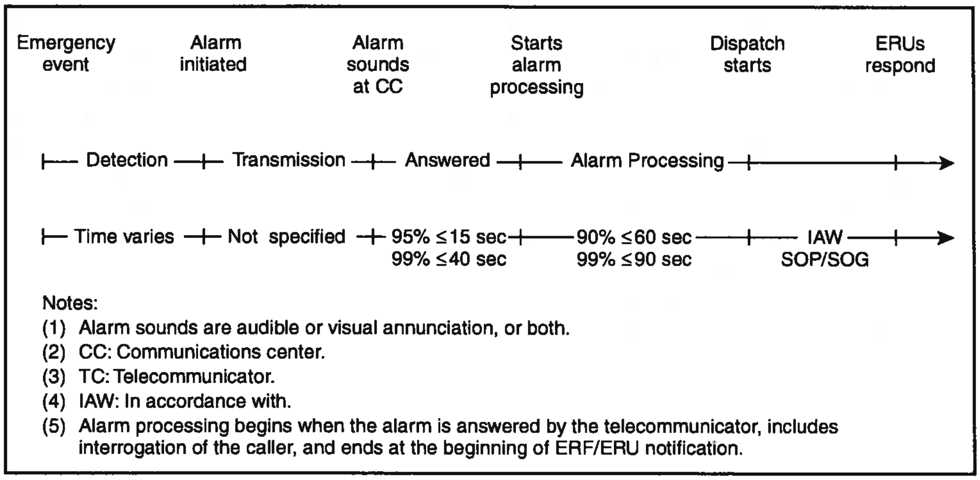

FIGURE A.5.4.1(a) Alarm Time Line Where Primary PSAP Is Communications Center. [1221:Figure A.7.4.1(a)]

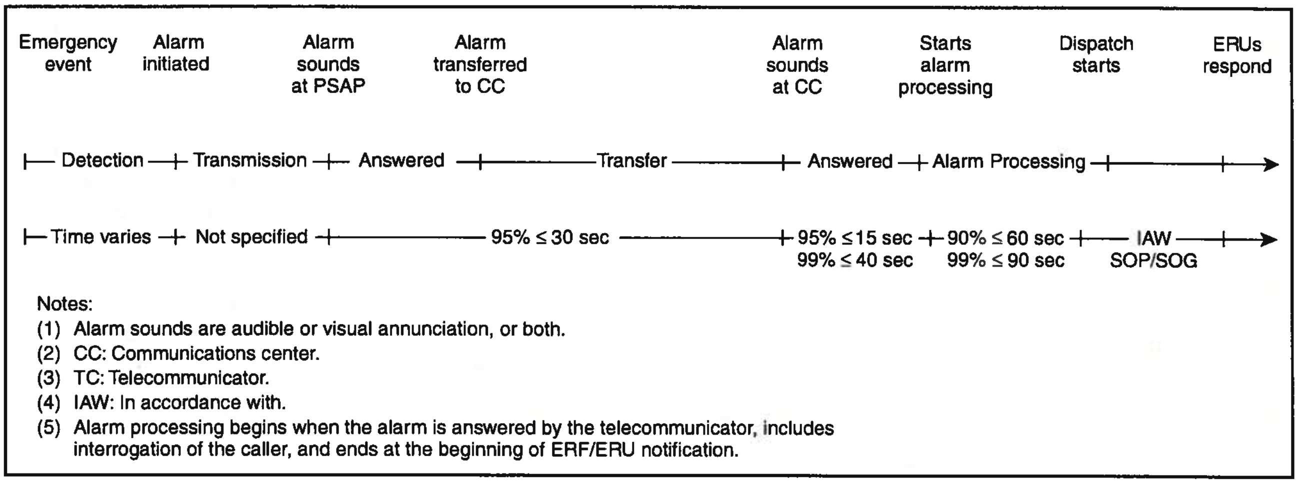

FIGURE A.5.4.1(b) Alarm Time Line Where Primary PSAP Is Other Than Communications Center. [1221:Figure A.7.4.1(b)]

Annex B Risk Management Model

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 This model is used as an example of how a community-wide risk management plan can be utilized to protect both citizens and property. While NFPA 1720 is scoped strictly to focus on deployment, staffing, and service levels, the realization is that this is one component of a total community fire protection planning process. An AHJ can determine that other components could reduce the risks of fire and therefore adopt stronger building and fire prevention codes, enforce those more vigorously, and enhance their public life safety education components. These models are included for that purpose. Figure B.1 illustrates a fire department process map.

B.1.1 This annex addresses the need for fire departments to develop an overall "defense-in-depth" strategy for the delivery of fire services. The development of such a strategy should include an assessment of the tools available to the fire service for accomplishing the goals of fire safety.

B.1.2 Fire safety objectives can be defined as those ideas that a department aspires to deliver. For example, fire department objectives could include such statements as "Maintain injuries and life/property losses as low as reasonably achievable (community and department)." The accomplishment of this objective should not be left to fire-fighting operations alone. See Figure B.1.2 for fire safety concepts.

B.1.3 Fire prevention is not simply preventing fire. It is the systematic application of codes, standards, engineering principles, and an understanding of human behavior to achieve the objective of limiting the loss of life and property.

B.1.3.1 As outlined in NFPA 1, fire prevention includes egress, construction design, building services, fire protection, and occupancy. All of these elements work together to provide the occupants and fire department personnel with a level of fire safety not otherwise available.

B.1.3.2 By ensuring that each of these elements is balanced, the fire department can maintain a reasonable level of risk for the community and the department.

B.1.3.3 To provide risk management, the fire department must utilize all of the tools available. In order of preference, those tools are as follows:

(1) Fire-safe design and construction
(2) Suppression systems
(3) Detection systems
(4) Occupant fire prevention practices
(5) Fire department-conducted fire-safety inspections
(6) Fire rescue response

B.1.3.4 A structure designed and constructed to withstand the effects of fire is the most important asset in achieving fire risk management. A structure relying solely on fire rescue response offers the greatest challenge to the occupants and fire department personnel.

B.1.4 Fire impact management is the ability to manage the impact of a fire on occupants and structures. The participation of the fire department in the design, construction, maintenance, and use of a structure provides defense-in-depth against fire losses.

B.1.4.1 Structures that are designed with noncombustible construction, are protected with fire protection systems, and are routinely inspected to ensure appropriate occupant use are most likely to provide the lowest risk levels and therefore are the least difficult to manage.

B.1.4.2 Fire-fighting operations on fully compliant structures for which the fire fighters know the occupancy conditions can be conducted with a plan that commits resources only as necessary to accomplish the pre-established goals.

B.1.4.3 Pre-established goals for each structure define the commitment of resources in order to limit risk to occupants, the structure, and fire department personnel.

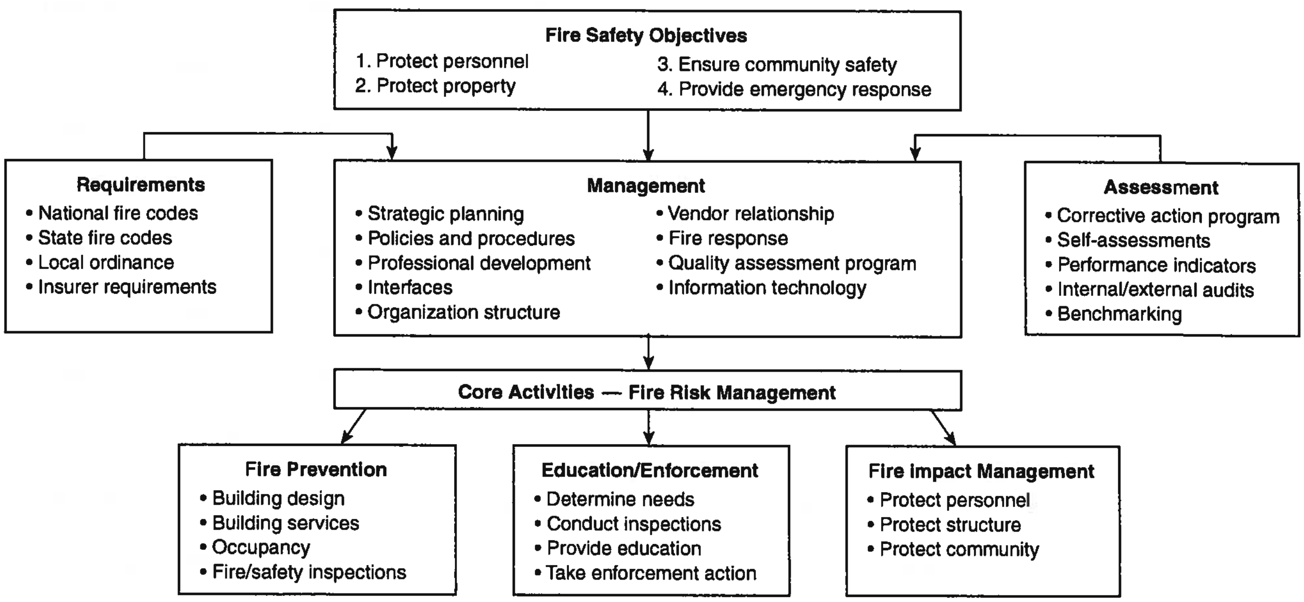

FIGURE B.1 Fire Department Process Map.

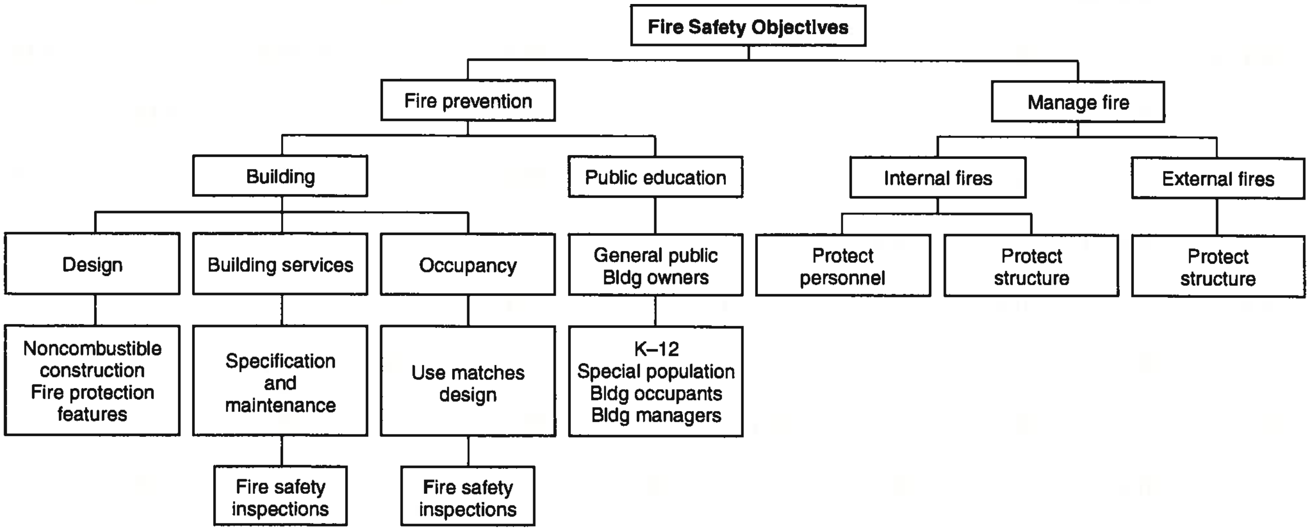

FIGURE B.1.2 Fire Safety Concepts for Fire Department Operations.

Annex C Informational References

C.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1, *Fire Code*, 2009 edition.

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2010 edition.

NFPA 1250, *Recommended Practice in Emergency Service Organization Risk Management*, 2004 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 2007 edition.

NFPA 1561, *Standard on Emergency Services Incident Management System*, 2008 edition.

NFPA 1600®, *Standard on Disaster/Emergency Management and Business Continuity Programs*, 2007 edition.

NFPA 1620, *Recommended Practice for Pre-Incident Planning*, 2003 edition.

NFPA 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*, 2010 edition.

NFPA 1901, *Standard for Automotive Fire Apparatus*, 2009 edition.

C.1.2 Other Publications.

C.1.2.1 FEMA Publications. Federal Emergency Management Agency, 500 C Street, S.W., Washington, DC 20472.

National Fire Incident Reporting System (NFIRS).

C.1.2.2 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 29, Code of Federal Regulations, Part 1910, Section 120(q)(3), "Procedures for handling emergency response," April 3, 2006.

Title 29, Code of Federal Regulations, Part 1910, Section 134, "Respiratory protection," August 24, 2006.

C.1.2.3 Other Publications. Office of the Ontario Fire Marshal, *Shaping the Future of Fire Ground Staffing and Delivery Systems within a Comprehensive Fire Safety Effectiveness Model*, 1993.

C.2 Informational References. (Reserved)

C.3 References for Extracts in Informational Sections. NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2010 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 2007 edition.

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Cou/D 1 2 3 4 5 6 12 11 10 09

Sequence of Events Leading to Issuance of an NFPA Committee Document

Step 1: Call for Proposals

- Proposed new Document or new edition of an existing Document is entered into one of two yearly revision cycles, and a Call for Proposals is published.

Step 2: Report on Proposals (ROP)

- Committee meets to act on Proposals, to develop its own Proposals, and to prepare its Report.
- Committee votes by written ballot on Proposals. If two-thirds approve, Report goes forward. Lacking two-thirds approval, Report returns to Committee.
- Report on Proposals (ROP) is published for public review and comment.

Step 3: Report on Comments (ROC)

- Committee meets to act on Public Comments to develop its own Comments, and to prepare its report.
- Committee votes by written ballot on Comments. If two-thirds approve, Report goes forward. Lacking two-thirds approval, Report returns to Committee.
- Report on Comments (ROC) is published for public review.

Step 4: Technical Report Session

- "*Notices of intent to make a motion*" are filed, are reviewed, and valid motions are certified for presentation at the Technical Report Session. ("Consent Documents" that have no certified motions bypass the Technical Report Session and proceed to the Standards Council for issuance.)
- NFPA membership meets each June at the Annual Meeting Technical Report Session and acts on Technical Committee Reports (ROP and ROC) for Documents with "certified amending motions."
- Committee(s) vote on any amendments to Report approved at NFPA Annual Membership Meeting.

Step 5: Standards Council Issuance

- Notification of intent to file an appeal to the Standards Council on Association action must be filed within 20 days of the NFPA Annual Membership Meeting.
- Standards Council decides, based on all evidence, whether or not to issue Document or to take other action, including hearing any appeals.

Committee Membership Classifications

The following classifications apply to Technical Committee members and represent their principal interest in the activity of the committee.

M	*Manufacturer:* A representative of a maker or marketer of a product, assembly, or system, or portion thereof, that is affected by the standard.
U	*User:* A representative of an entity that is subject to the provisions of the standard or that voluntarily uses the standard.
I/M	*Installer/Maintainer:* A representative of an entity that is in the business of installing or maintaining a product, assembly, or system affected by the standard.
L	*Labor:* A labor representative or employee concerned with safety in the workplace.
R/T	*Applied Research/Testing Laboratory:* A representative of an independent testing laboratory or independent applied research organization that promulgates and/or enforces standards.
E	*Enforcing Authority:* A representative of an agency or an organization that promulgates and/or enforces standards.
I	*Insurance:* A representative of an insurance company, broker, agent, bureau, or inspection agency.
C	*Consumer:* A person who is, or represents, the ultimate purchaser of a product, system, or service affected by the standard, but who is not included in the *User* classification.
SE	*Special Expert:* A person not representing any of the previous classifications, but who has a special expertise in the scope of the standard or portion thereof.

NOTES;
1. "Standard" connotes code, standard, recommended practice, or guide.
2. A representative includes an employee.
3. While these classifications will be used by the Standards Council to achieve a balance for Technical Committees, the Standards Council may determine that new classifications of members or unique interests need representation in order to foster the best possible committee deliberations on any project. In this connection, the Standards Council may make appointments as it deems appropriate in the public interest, such as the classification of "Utilities" in the National Electrical Code Committee.
4. Representatives of subsidiaries of any group are generally considered to have the same classification as the parent organization.

NOTE: All Proposals must be received by 5:00 pm EST/EDST on the published Proposal Closing Date.

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Company Air Canada Pilot's Association **Email**

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1. (a) NFPA Document Title National Fuel Gas Code **NFPA No. & Year** 54, 200X Edition

(b) Section/Paragraph 3.3

2. Proposal Recommends (check one): ☐ new text ☒ revised text ☐ deleted text

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted): [Note: Proposed text should be in legislative format; i.e., use underscore to denote wording to be inserted (<u>inserted wording</u>) and strike-through to denote wording to be deleted (~~deleted wording~~).]

Revise definition of effective ground-fault current path to read:

3.3.78 Effective Ground-Fault Current Path. An intentionally constructed, permanent, low impedance electrically conductive path designed and intended to carry ~~underground~~ <u>electric</u> fault <u>current</u> ~~conditions~~ from the point of a ground fault on a wiring system to the electrical supply source.

4. Statement of Problem and Substantiation for Proposal: (Note: State the problem that would be resolved by your recommendation; give the specific reason for your Proposal, including copies of tests, research papers, fire experience, etc. If more than 200 words, it may be abstracted for publication.)

Change uses proper electrical terms.

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PLEASE USE SEPARATE FORM FOR EACH PROPOSAL

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1 Batterymarch Park · Quincy, MA 02169-7471 OR
Fax to: (617) 770-3500 OR Email to: proposals_comments@nfpa.org

6/11/2009

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Signature (Required)

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6/11/2009

NFPA® 1851

Standard on

Selection, Care, and Maintenance of Protective Ensembles for

Structural Fire Fighting and Proximity Fire Fighting

2008 Edition

This edition of NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, was prepared by the Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment and released by the Technical Correlating Committee on Fire and Emergency Services Protective Clothing and Equipment. It was issued by the Standards Council on June 4, 2007, with an effective date of June 24, 2007, and supersedes all previous editions.

This edition of NFPA 1851 was approved as an American National Standard on June 24, 2007.

Origin and Development of NFPA 1851

The first edition of NFPA 1851, in 2001, was titled *Standard on the Selection, Care, and Maintenance of Structural Fire Fighting Protective Ensembles*, and was developed to be a companion document for NFPA 1971, *Standard on Protective Ensemble for Structural Fire Fighting*. NFPA 1971, which has been in effect since 1975, specifies product design, performance, testing, and certification. NFPA 1971 is written for use by manufacturers to design and produce their products and by certification organizations to evaluate and test those products to determine compliance with the standard as well as to provide checks on production to ensure continuing compliance. While NFPA 1971 is primarily written for those groups, the standard is also used by fire departments and other organizations in developing purchase specifications for structural fire fighting protective ensembles and ensemble elements to ensure that the products they purchase are certified as being compliant with the standard.

NFPA 1851 is written for the organizations that evaluate the risks their emergency responders face and their particular needs for the protective clothing, that develop purchase specifications, and that purchase structural fire fighting protective ensembles and ensemble elements. It is also written for end users of structural fire fighting protective ensembles and ensemble elements to be able to inspect, maintain, and care for the protective ensembles and elements they use during structural fire fighting operations.

The overall protection and safety of fire fighting personnel depend not only on adequate protective clothing but equally on the organization's policies, training, and administration of the correct use of the proper protective ensemble in fire fighting situations. To satisfy the portion of the organization's overall protective clothing and equipment program that addresses structural fire fighting protective ensemble, this document provides criteria for the selection, care, and maintenance of the protective ensemble and ensemble elements.

In this standard, the requirements for several areas are written to begin with the person who actually uses the protective ensemble being constantly aware of the protective ensemble's condition and need for cleaning, repair, or more in-depth inspection. Users can perform the simple actions to improve the condition of the protective ensemble. The more involved actions of advanced inspection, evaluation, cleaning, decontamination, and repair are handled by the organization's designated staff who are trained and authorized to perform more advanced duties. In other areas, the requirements are written for the organization to perform the administrative functions of the program and periodic actions to evaluate the structural fire fighting protective ensemble program to ensure that the program is achieving its goals and that the quality of the protective ensembles and ensemble elements provides optimum safety to fire fighters.

This second edition of NFPA 1851 is a complete revision of the first edition. Because NFPA 1976, *Standard on Protective Ensemble for Proximity Fire Fighting*, was incorporated into the 2007 edition of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, under the Technical Committee on Structural and Proximity Fire Fighting Protective Clothing and Equipment, NFPA 1851 has been expanded to include both structural fire fighting ensembles and proximity fire fighting ensembles.

The complete revision follows the new standards format according to the *Manual of Style for NFPA Technical Committee Documents*, which has Chapter 1 covering scope, purpose, and application; Chapter 2 covering referenced publications; and Chapter 3 covering definitions. Chapter 4 covers the organization's program; Chapter 5, selection; Chapter 6, inspections; Chapter 7, cleaning and decontamination; Chapter 8, repairs; Chapter 9, storage; Chapter 10, retirement, disposition, and special incident procedures; Chapter 11, new requirements for independent service providers (ISPs); and Chapter 12, testing procedures.

New requirements in Chapter 11 for organizations and ISPs and for verification of the ISPs by independent, third-party certification organizations set the criteria for organizations and ISPs to perform the tasks of inspection, cleaning, and repairing of protective ensembles and ensemble elements. New requirements for testing methods for trained personnel in the organization as well as the ISPs set the criteria to determine the functionality and protection afforded by the ensembles and ensemble elements.

Revisions to Chapter 10 for retiring structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements now require retirement not later than 10 years from the date the ensembles or ensemble elements were manufactured. The radiant reflective outer shell of proximity fire fighting ensembles and ensemble elements must be replaced a maximum of 5 years from the date the ensembles or ensemble elements were manufactured. More frequent replacement of fire fighting ensembles and ensemble elements is now required to better ensure that fire fighters have state-of-the-art protection from fire fighting environments. The significant changes that the technology undergoes within two editions of this standard (approximately 10 years), in addition to the normal "wear and tear" of fire fighting, other emergency incident responses, training, and other factors, dictate that protective ensembles and ensemble elements be replaced. Fire departments that respond to a higher than average number of emergency incidents or that have frequent or extensive "working fire" operations might want to plan for replacement of ensembles or ensemble elements on a more frequent cycle.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the design, performance, testing, and certification of protective clothing and protective equipment manufactured for fire and emergency services organizations and personnel, to protect against exposures encountered during emergency incident operations. This Committee shall also have the primary responsibility for documents on the selection, care, and maintenance of such protective clothing and protective equipment by fire and emergency services organizations and personnel.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on protective ensembles, except respiratory protection, that provide head, limb, hand, foot, torso, and interface protection for fire fighters and other emergency services responders during incidents involving structural fire fighting operations or proximity fire fighting operations.

Structural fire fighting operations include the activities of rescue, fire suppression, and property conservation during incidents involving fires in buildings, enclosed structures, vehicles, marine vessels, or like properties.

Proximity fire fighting operations include the activities of rescue, fire suppression, and property conservation during incidents involving commercial and military aircraft fires, bulk flammable gas fires, bulk flammable and combustible liquids fires, combustible metal fires, exotic fuel fires, and other such fires that produce very high levels of radiant heat as well as convective and conductive heat.

Additionally, this Committee shall have primary responsibility for documents on the selection, care, and maintenance of structural and proximity fire fighting protective ensembles by fire and emergency services organizations and personnel.

NFPA 1851
Standard on
Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting
2008 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Information on referenced publications can be found in Chapter 2 and Annex B.

Chapter 1 Administration

1.1 Scope.

1.1.1 This standard shall specify the minimum selection, care, and maintenance requirements for structural fire fighting protective ensembles and the individual ensemble elements that include garments, helmets, gloves, footwear, and interface components that are compliant with NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

1.1.2 This standard shall also specify the minimum selection, care, and maintenance requirements for proximity fire fighting protective ensembles and the individual ensemble elements that include garments, helmets, gloves, footwear, and interface components that are compliant with NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

1.1.3 This standard shall also specify requirements for both structural fire fighting and proximity fire fighting protective ensembles, ensemble elements, clothing, and equipment certified as compliant with previous editions of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*; NFPA 1972, *Standard on Helmets for Structural Fire Fighting*; NFPA 1973, *Standard on Gloves for Structural Fire Fighting*; NFPA 1974, *Standard on Protective Footwear for Structural Fire Fighting*; or NFPA 1976, *Standard on Protective Ensembles for Proximity Fire Fighting*.

1.1.4 This standard shall also specify the minimum selection, care, and maintenance requirements for structural fire fighting protective ensembles with optional CBRN protection and for proximity fire fighting protective ensembles with optional CBRN protection.

1.1.5 This standard shall not specify requirements for other organizational programs such as appropriate use of structural fire fighting or proximity fire fighting protective ensembles for training, for operations, or for infection control, because these programs are under the jurisdiction of other NFPA standards.

1.1.6 This standard shall not apply to protective ensembles or protective clothing that are compliant with NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents*; NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*; NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*; NFPA 1992, *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies*; NFPA 1994, *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents*; and NFPA 1999, *Standard on Protective Clothing for Emergency Medical Operations*.

1.1.7 This standard shall not be construed as addressing all the safety concerns associated with the use of compliant protective ensembles or ensemble elements. It shall be the responsibility of the persons and organizations that use compliant protective ensembles or ensemble elements to establish safety and health practices and to determine the applicability of regulatory limitations prior to use.

1.1.8 This standard shall not be construed as addressing all the safety concerns, if any, associated with the use of this standard by testing or repair facilities. It shall be the responsibility of the persons and organizations that use this standard to conduct testing of protective ensembles or ensemble elements to establish safety and health practices and to determine the applicability of regulatory limitations prior to using this standard for any designing, manufacturing, and testing.

1.1.9 Nothing herein shall restrict any jurisdiction from exceeding these minimum requirements.

1.2 Purpose.

1.2.1 The purpose of this standard shall be to establish a program for structural fire fighting protective ensembles and ensemble elements and for proximity fire fighting protective ensembles and ensemble elements to reduce the safety risks and potential health risks associated with poorly maintained, contaminated, or damaged protective ensembles and ensemble elements.

1.2.2 The purpose of this standard shall also be to establish basic criteria for selection, inspection, cleaning, decontamination, repair, storage, and retirement of structural fire fighting protective ensembles or ensemble elements and proximity fire fighting protective ensembles or ensemble elements.

1.3 Application.

1.3.1 This standard shall apply to structural fire fighting and proximity fire fighting ensembles and ensemble elements certified as compliant with NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

1.3.2 This standard shall also apply to structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements certified as compliant with the previous editions of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting* or NFPA 1976, *Standard on Protective Ensembles for Proximity Fire Fighting*, and to protective clothing and equipment certified as compliant with previous editions of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*; NFPA 1972, *Standard on Helmets for Structural Fire Fighting*; NFPA 1973, *Standard on Gloves for Structural Fire Fighting*; and NFPA 1974, *Standard on Protective Footwear for Structural Fire Fighting*.

1.3.2.1 This standard shall also apply to structural fire fighting protective ensembles with optional CBRN protection and to proximity fire fighting protective ensembles with optional CBRN protection.

1.3.3 This standard shall not apply to other organizational programs such as appropriate use of structural fire fighting or proximity fire fighting protective ensembles for training, operations, or infection control, because these programs are under the jurisdiction of other NFPA standards.

1.3.4 This standard shall not apply to respiratory protective equipment other than where such equipment interfaces with structural fire fighting protective ensembles with optional CBRN protection.

1.3.5 The requirements of this standard shall not apply to accessories attached to any element of the structural fire fighting protective ensemble unless specifically addressed herein.

1.4 Units.

1.4.1 In this standard, values for measurement are followed by an equivalent in parentheses, but only the first stated value shall be regarded as the requirement.

1.4.2 Equivalent values in parentheses shall not be considered as the requirement because these values are approximate.

Chapter 2 Referenced Publications

2.1 General.

The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 600, *Standard on Industrial Fire Brigades,* 2005 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program,* 2007 edition.

NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents,* 2007 edition.

NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting,* 2007 edition.

NFPA 1972, *Standard on Helmets for Structural Fire Fighting.*

NFPA 1973, *Standard on Gloves for Structural Fire Fighting.*

NFPA 1974, *Standard on Protective Ensembles for Proximity Fire Fighting.*

NFPA 1976, *Standard on Protective Ensembles for Proximity Fire Fighting,* 2000 edition.

NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting,* 2005 edition.

NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies,* 2005 edition.

NFPA 1992, *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies,* 2005 edition.

NFPA 1994, *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents,* 2007 edition.

NFPA 1999, *Standard on Protective Clothing for Emergency Medical Operations,* 2003 edition.

2.3 Other Publications.

2.3.1 ACGIH Publications.

American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240.

ACGIH Publication No. 0107, *2007 TLVs and BEIs*.

2.3.2 ISO Publications.

International Organization for Standardization, 1, rue de Varembé, Case postale 56, CH-1211 Genève 20, Switzerland.

ISO 17011, *Conformity assessment — General requirements for accreditation bodies accrediting conformity assessment bodies*, 2004.

ISO/IEC Guide 65, *General requirements for bodies operating product certification systems*, 1996.

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*, 2005.

2.3.3 U.S. Government Publications.

U.S. Government Printing Office, Washington, DC 20402-9325.

NIOSH Publication No 2005-149, *NIOSH Pocket Guide to Chemical Hazards*, September 2005.

2.3.4 Other Publications.

Lewis, R., *Hazardous Chemicals Desk Reference*, John Wiley & Sons, New York, 2002.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections. (Reserved)

Chapter 3 Definitions

3.1 General.

The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Accessory/Accessories. An item, or items, that could be attached to a certified product but that are not necessary for the certified product to meet the requirements of the standard.

3.3.2 Advanced Cleaning. See 3.3.13.1.

3.3.3 Biological Terrorism Agents. Liquid or particulate agents that can consist of a biologically derived toxin or pathogen to inflict lethal or incapacitating casualties.

3.3.4 Body Fluids. Fluids that are produced by the body, including, but not limited to, blood, semen, mucus, feces, urine, vaginal secretions, breast milk, amniotic fluids, cerebrospinal fluid, synovial fluid, and pericardial fluid.

3.3.5 Carcinogen/Carcinogenic. A cancer-causing substance that is identified in one of several published lists, including, but not limited to, *NIOSH Pocket Guide to Chemical Hazards, Hazardous Chemicals Desk Reference*, and the ACGIH *2007 TLVs and BEIs*.

3.3.6 Care. Procedures for cleaning, decontamination, and storage of protective clothing and equipment.

3.3.7 CBRN. An abbreviation for chemicals, biological agents, and radiological particulate hazards. *(See also 3.3.9, CBRN Terrorism Agents.)*

3.3.8* CBRN Barrier Layer. The part of the composite that is intended to provide protection against CBRN terrorism agents.

3.3.9* CBRN Terrorism Agents. Chemicals, biological agents, and radiological particulates that could be released as the result of a terrorist attack. (See also 3.3.3, Biological Terrorism Agents; 3.3.12, Chemical Terrorism Agents; 3.3.74, Radiological Particulate Terrorism Agents;

and 3.3.101, Toxic Industrial Chemicals.)

3.3.10 Certification/Certified. A system whereby a certification organization determines that a manufacturer has demonstrated the ability to produce a product that complies with the requirements of a specific standard(s), authorizes the manufacturer to use a label on listed products that comply with the requirements of that standard(s), and establishes a follow-up program conducted by the certification organization as a check on the methods the manufacturer uses to determine continued compliance of labeled and listed products with the requirements of that standard(s).

3.3.11 Char. The formation of a brittle residue when material is exposed to thermal energy.

3.3.12 Chemical Terrorism Agents. Liquid, solid, gaseous, and vapor chemical warfare agents and toxic industrial chemicals used to inflict lethal or incapacitating casualties, generally on a civilian population as a result of a terrorist attack.

3.3.13 Cleaning. The act of removing soils and contaminants from ensembles and ensemble elements by mechanical, chemical, thermal, or combined processes.

3.3.13.1* Advanced Cleaning. The thorough cleaning of ensembles or elements by washing with cleaning agents.

3.3.13.2 Contract Cleaning. Cleaning conducted by a facility outside the organization that specializes in cleaning protective clothing.

3.3.13.3* Routine Cleaning. The light cleaning of ensembles or ensemble elements performed by the end user without taking the elements out of service.

3.3.13.4* Specialized Cleaning. Cleaning to remove hazardous materials or body fluids.

3.3.14 Coat. See 3.3.87, Structural Fire Fighting Protective Coat, and 3.3.64, Proximity Fire Fighting Protective Coat.

3.3.15 Contamination/Contaminated. The process by which ensembles and ensemble elements are exposed to hazardous materials, body fluids, or CBRN terrorism agents.

3.3.16 Coverall. See 3.3.88, Structural Fire Fighting Protective Coverall, and 3.3.65, Proximity Fire Fighting Protective Coverall.

3.3.17 Craze. The appearance of fine cracks in the surface of a helmet shell or other smooth surface of an ensemble element.

3.3.18 Cross-Contamination. The transfer of contamination from one item to another or to the environment.

3.3.19 Crown. The portion of the helmet that covers the head above the reference plane.

3.3.20 Crown Straps. The part of the helmet suspension that passes over the head.

3.3.21 Decontamination. The act of removing contaminates from protective clothing and equipment by a physical, chemical, or combined process. *(See also 3.3.13, Cleaning.).*

3.3.22 Disinfectant. An agent that destroys, neutralizes, or inhibits the growth of harmful biological agents.

3.3.23* Drag Rescue Device. A component integrated within the protective coat element to aid in the rescue of an incapacitated fire fighter.

3.3.24 DRD. See 3.3.23, Drag Rescue Device.

3.3.25 Ear Covers. An interface component of the protective helmet element that provides limited protection to the helmet/coat interface area.

3.3.26 Elasticity. The ability of a material to return to its original form after being stretched.

3.3.27 Elements. See 3.3.32, Ensemble Elements.

3.3.28 Embrittlement. The hardening of a material that makes it susceptible to easy fracture.

3.3.29* Emergency Medical Operations. Delivery of emergency patient care, including patient transportation, provided prior to arrival at a hospital or other health care facility.

3.3.30 Energy Absorbing System. Materials or systems used to attenuate impact energy.

3.3.31 Ensemble. See 3.3.89, Structural Fire Fighting Protective Ensemble, 3.3.66, and Proximity Fire Fighting Protective Ensemble.

3.3.32* Ensemble Elements. The compliant products that provide protection to the upper and lower torso, arms, legs, head, hands, and feet.

3.3.33 Faceshield. The component of the helmet that provides limited protection to a portion of the wearer's face. Not primary eye protection.

3.3.34 Field Evaluation. The nonlaboratory assessment of an ensemble, ensemble element, or item.

3.3.35 Fit. The quality, state, and manner in which clothing and equipment, when worn, relate to the human body.

3.3.36 Flame Resistance. The property of a material whereby combustion is prevented, terminated, or inhibited following the application of a flaming or nonflaming source of ignition, with or without subsequent removal of the ignition source. Flame resistance can be an inherent property of a material, or it can be imparted by specific treatment. *(See also 3.3.50, Inherent Flame Resistance.)*

3.3.37 Footwear. See 3.3.91, Structural Fire Fighting Protective Footwear, and 3.3.68, Proximity Fire Fighting Protective Footwear.

3.3.38 Functional. The ability of an ensemble element or component of an ensemble element to continue to be utilized for its intended purpose.

3.3.39 Garment. See 3.3.92, Structural Fire Fighting Protective Garments, and 3.3.69, Proximity Fire Fighting Protective Garments.

3.3.40 Gauntlet. An interface component of the protective glove element that provides limited protection to the coat/glove interface area.

3.3.41 Glove. See 3.3.93, Structural Fire Fighting Protective Glove, and 3.3.70, Proximity Fire Fighting Protective Glove.

3.3.42 Glove Wristlet. See 3.3.107, Wristlet.

3.3.43* Goggles. Ensemble element or component that provides limited protection to the wearer's eyes. Goggles may or may not provide primary protection.

3.3.44 Hardware. Nonfabric components of the protective clothing and equipment including, but not limited to, those made of metal or plastic.

3.3.45* Hazardous Materials. Substances (solid, liquid, or gas) that when released are capable of creating harm to people, the environment, and property.

3.3.46 Hazardous Materials Emergencies. Incidents involving the release or potential release of hazardous materials.

3.3.47 Helmet. See 3.3.94, Structural Fire Fighting Protective Helmet, and 3.3.71, Proximity Fire Fighting Protective Helmet.

3.3.48 Hood. See 3.3.95, Structural Fire Fighting Protective Hood.

3.3.49 Independent Service Provider (ISP). An independent third party utilized by an organization to perform any one or any combination of advanced inspection, advanced cleaning, or repair services.

3.3.50 Inherent Flame Resistance. Flame resistance that is derived from the essential characteristics of the fiber or polymer.

3.3.51 Integrity. The ability of an ensemble or ensemble element to remain intact and provide continued minimum performance.

3.3.52 Interface Area. An area of the body where the protective garments, helmet, gloves, footwear, or SCBA facepiece meet. Interface areas include, but are not limited to, the coat/helmet/SCBA facepiece area; the coat/trouser area; the coat/glove area; and the trouser/footwear area.

3.3.53* Interface Component(s). Any material, part, or subassembly used in the construction of the compliant product that provides limited protection to interface areas.

3.3.54 Liner System. The moisture barrier and thermal barrier components as used in a garment.

3.3.55 Maintenance. The inspection, service, and repair of protective clothing and equipment, including the determination for removal from service.

3.3.56 Manufacturer. The entity that directs and controls any of the following: compliant product design, compliant product manufacturing, or compliant product quality assurance; or the entity that assumes the liability for the compliant product or provides the warranty for the compliant product.

3.3.57 Melt. A response to heat by a material resulting in evidence of flowing or dripping.

3.3.58 Moisture Barrier. The component of an ensemble element or item that principally prevents the transfer of liquids.

3.3.59* Organization. The entity that provides the direct management and supervision for the emergency services personnel.

3.3.60 Outer Shell. The outermost component of an ensemble element or item, not including trim, hardware, reinforcing material, pockets, wristlet material, accessories, fittings, or suspension systems.

3.3.61 Protective Clothing. See 3.3.89, Structural Fire Fighting Protective Ensemble, and 3.3.66, Proximity Fire Fighting Protective Ensemble.

3.3.62 Protective Ensemble. See 3.3.89, Structural Fire Fighting Protective Ensemble, and 3.3.66, Proximity Fire Fighting Protective Ensemble.

3.3.63 Proximity Fire Fighting. Specialized fire fighting operations that can include the activities of rescue, fire suppression, and property conservation at incidents involving fires producing high levels of radiant heat as well as conductive and convective heat.

3.3.64 Proximity Fire Fighting Protective Coat. The element of the protective ensemble that provides protection to the upper torso and arms, excluding the hands and head.

3.3.65 Proximity Fire Fighting Protective Coverall. The element of the protective ensemble that provides protection to the torso, arms, and legs, excluding the head, hands and feet.

3.3.66* Proximity Fire Fighting Protective Ensemble. Multiple elements of compliant protective clothing and equipment that when worn together provide protection from some risks, but not all risks, of emergency incident operations.

3.3.67 Proximity Fire Fighting Protective Ensemble with ***Optional*** CBRN Terrorism Agent Protection. A compliant proximity fire fighting protective ensemble that is also certified as an entire ensemble to meet the optional requirements for protection from specific CBRN terrorism agents.

3.3.68 Proximity Fire Fighting Protective Footwear. The element of the protective ensemble that provides protection to the foot, ankle, and lower leg.

3.3.69 Proximity Fire Fighting Protective Garments. The coat, trouser, and coverall elements of the protective ensemble.

3.3.70 Proximity Fire Fighting Protective Glove. The element of the protective ensemble that provides protection to the hand and wrist.

3.3.71 Proximity Fire Fighting Protective Helmet. The element of the protective ensemble that provides protection to the head.

3.3.72 Proximity Fire Fighting Protective Shroud. The component of the helmet that provides limited protection to the helmet/coat interface area.

3.3.73 Proximity Fire Fighting Protective Trouser. The element of the protective ensemble that provides protection to the lower torso and legs, excluding the ankles and feet.

3.3.74* Radiological Particulate Terrorism Agents. Particles that emit ionizing radiation in excess of normal background levels, used to inflict lethal or incapacitating casualties, generally on a civilian population as a result of terrorist attack.

3.3.75 Retirement. The process of permanently removing an ensemble element from emergency operations service in the organization.

3.3.76 Routine Cleaning. See 3.3.13.3.

3.3.77 Seam. Any permanent attachment of two or more materials in a line formed by joining the separate material pieces.

3.3.77.1* Major A Seam. Outermost layer seam assemblies where rupture could reduce the protection of the garment by exposing the garment's inner layers.

3.3.77.2* Major B Seam. Inner layer seam assemblies where rupture could reduce the protection of the garment by exposing the next layer of the garment, the wearer's station/work uniform, other clothing, or skin.

3.3.77.3 Minor Seam. Remaining seam assemblies that are not classified as Major A or Major B seams.

3.3.78 Selection. The process of determining what protective clothing and equipment (PCE) is necessary for protection of fire and emergency services response personnel from an anticipated specific hazard or other activity, the procurement of the appropriate PCE, and the choice of the proper PCE for a specific hazard or activity at an emergency incident.

3.3.79 Separate/Separation. A material response evidenced by splitting or delaminating.

3.3.80 Service Life. The period for which compliant product can be useful before retirement.

3.3.81 Shank. The component of footwear that provides additional support to the instep.

3.3.82 Shroud. See 3.3.72, Proximity Fire Fighting Protective Shroud.

3.3.83 Soiled/Soiling. The accumulation of materials that are not considered hazardous materials, body fluids, or CBRN terrorism agents but that could degrade the performance of the ensemble or ensemble element.

3.3.84 Specialized Cleaning. See 3.3.13.4.

3.3.85 Stress Area. Those areas of the garment that are subjected to more wear, including, but not limited to, crotches, knees, elbows, and shoulders.

3.3.86 Structural Fire Fighting. The activities of rescue, fire suppression, and property conservation in buildings, enclosed structures, vehicles, marine vessels, or like properties that are involved in a fire or emergency situation.

3.3.87 Structural Fire Fighting Protective Coat. The element of the protective ensemble that provides protection to the upper torso and arms, excluding the hands and head.

3.3.88 Structural Fire Fighting Protective Coverall. The element of the protective ensemble that provides protection to the torso, arms, and legs, excluding the head, hands, and feet.

3.3.89* Structural Fire Fighting Protective Ensemble. Multiple elements of compliant protective clothing and equipment that when worn together provide protection from some risks, but not all risks, of emergency incident operations.

3.3.90 Structural Fire Fighting Protective Ensemble with ***Optional*** CBRN Terrorism Agent Protection. A compliant structural fire fighting protective ensemble that is also certified as an entire ensemble to meet the optional requirements for protection from specific CBRN terrorism agents.

3.3.91 Structural Fire Fighting Protective Footwear. The element of the protective ensemble that provides protection to the foot, ankle, and lower leg.

3.3.92 Structural Fire Fighting Protective Garments. The coat, trouser, and coverall elements of the protective ensemble.

3.3.93 Structural Fire Fighting Protective Glove. The element of the protective ensemble that provides protection to the hand and wrist.

3.3.94 Structural Fire Fighting Protective Helmet. The element of the protective ensemble that provides protection to the head.

3.3.95 Structural Fire Fighting Protective Hood. The interface element of the protective ensemble that provides limited protection to the coat/helmet/SCBA facepiece interface area.

3.3.96 Structural Fire Fighting Protective Trousers. The element of the protective ensemble that provides protection to the lower torso and legs, excluding the ankles and feet.

3.3.97 Suspension. The energy attenuating system of the helmet that is made up of the headband and crown strap.

3.3.98 Tensile Strength. The force at which a fiber or fabric will break when pulled in one dimension.

3.3.99 Textile Fabric. A planar structure consisting of yarns or fibers.

3.3.100 Thermal Barrier. The component of an ensemble element or item that principally provides thermal protection.

3.3.101 Toxic Industrial Chemicals. Highly toxic solid, liquid, or gaseous chemicals that have been identified as mass casualty threats that could be used to inflict casualties, generally on a civilian population, during a terrorist attack.

3.3.102 Trim. See 3.3.106, Visibility Markings.

3.3.103 Trouser. See 3.3.96, Structural Fire Fighting Protective Trouser, and 3.3.73, Proximity Fire Fighting Protective Trouser.

3.3.104* Universal Precautions. An approach to infection control in which human blood and certain human body fluids are treated as if known to be infectious for HIV, HBV, and other bloodborne pathogens.

3.3.105 Utility Sink. A separate sink used for cleaning ensembles and ensemble elements.

3.3.106 Visibility Markings. Retroreflective and fluorescent conspicuity enhancements. Retroreflective enhancements improve nighttime conspicuity, and fluorescent enhancements improvement daytime conspicuity.

3.3.107 Winter Liner. An optional component layer that provides added insulation against cold.

3.3.108 Wristlet. The interface component of the protective element or item that provides limited protection to the coat/glove interface area.

Chapter 4 Program

4.1 General.

4.1.1* The organization shall develop and implement a program for the selection, care, and maintenance of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements used by the members of the organization in the performance of their assigned functions.

4.1.2 This program shall have the goal of providing structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that are suitable and appropriate for the intended use; maintaining such protective ensembles and ensemble elements in a safe, usable condition to provide the intended protection to the user; removing from use such protective ensembles and ensemble elements that could cause or contribute to user injury, illness, or death because of their condition; and reconditioning, repairing, or retiring such protective ensembles and ensemble elements.

4.1.3 Where this program for the selection, care, and maintenance of structural and proximity fire fighting protective ensembles and ensemble elements is part of an organization’s overall program on protective clothing and protective equipment, the portion of the organization’s overall program that affects structural and proximity fire fighting protective ensembles and ensemble elements shall be in accordance with Section 4.2.

4.1.4 Manufacturers shall be allowed to exclude proprietary components or specific models from this care and maintenance program.

4.2 Program Organization for Structural Fire Fighting Ensembles and Ensemble Elements and Proximity Fire Fighting Ensembles and Ensemble Elements.

4.2.1 The organization's program specified in Section 4.1 shall incorporate at least the requirements in Chapters 4 through 12 of this standard.

4.2.2* The organization shall develop written standard operating procedures (SOPs) that shall identify and define the various parts of the program and the various roles and responsibilities of the organization and of the members in the program parts specified in Table 4.2.2.

Table 4.2.2 Required Program Parts for Structural and Proximity Fire Fighting Protective Ensembles and Elements

Program Part	Chapter/Section of NFPA 1851
Records	Section 4.3
Protecting the public and personnel from contamination	Section 4.5
Selection	Chapter 5
Inspection	Chapter 6
Cleaning and decontamination	Chapter 7
Repair	Chapter 8
Storage	Chapter 9
Retirement, disposition, and special incident procedures	Chapter 10

4.2.3* The organization shall not add or permit accessories to be added to any ensemble or ensemble element prior to the organization requesting approval in writing and receiving written approval from the ensemble or ensemble element manufacturer for each specific accessory.

4.2.3.1* The organization shall not add or permit accessories to be added to any ensemble or ensemble element where the organization's request for approval has been responded to in writing with a disapproval from the ensemble or ensemble element manufacturer.

4.2.3.2* In the event that the organization cannot make contact with the ensemble or ensemble element manufacturer for a specific accessory to be used on the ensemble or ensemble element, the organization shall be permitted to evaluate the accessory for attachment to an ensemble or ensemble element using recognized tests to determine that the accessory does not degrade the performance of the ensemble or ensemble element.

4.2.3.3* In the event the organization's written requests for permission have not received a reply from the ensemble or ensemble element manufacturer for a specific accessory to be used on the ensemble or ensemble element, the organization shall be permitted to evaluate the accessory for attachment to an ensemble or ensemble element using recognized tests to determine that the accessory does not degrade the performance of the ensemble or ensemble element.

4.2.4 Where the organization performs its own repairs or uses an independent service provider (ISP) to perform garment element repair services, the organization or ISP shall meet the requirements of Chapter 11, Verification, and shall be verified by a third-party certification organization. The repairs identified in Section 8.3 shall be excluded from this requirement.

4.2.4.1 The organization or ISP shall receive written verification from the certification organization to perform garment element repair services.

4.2.4.2* The certification organization's written verification shall specify the categories of repair the organization or the ISP is verified to perform and the processes used to perform these services.

4.2.4.3 The written verification shall indicate that the organization or the ISP has demonstrated a working knowledge of Chapter 8, Repair, of this standard as well as the design and performance requirements of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

4.2.5 Where the organization performs its own advanced inspection or advanced cleaning, the organization shall be trained by the ensemble or ensemble element manufacturer or an ISP. Where the organization uses an ISP to perform advanced inspection or advanced cleaning, the ISP shall be trained by the ensemble or ensemble element manufacturer.

4.2.5.1* The element manufacturer or ISP training provider shall have instructional delivery requisite knowledge and skills for an instructor. Documentation shall be provided upon request to the organization and, where applicable, to the certification organization.

4.2.6* The organization shall develop specific criteria for removal of protective clothing and equipment from service, in accordance with Chapter 10, Retirement, Disposition, and Special Incident Procedure. The criteria for retirement shall include, but not be limited, to issues that are specific to the ensembles or ensemble elements being used by the organization, the manufacturers' instructions, and the experience of the organization.

4.3 Records.

4.3.1* The organization shall compile and maintain records on its structural and proximity fire fighting protective ensembles and ensemble elements.

4.3.2* The records specified in 4.3.1 shall apply to fire fighting protective ensembles and ensemble elements that are utilized by the fire department, including rental or loaner protective ensembles and ensemble elements.

4.3.3 At least the following records shall be kept for each protective ensemble or ensemble element:

(1) Person to whom element is issued

(2) Date and condition when issued

(3) Manufacturer and model name or design

(4) Manufacturer's identification number, lot number, or serial number

(5) Month and year of manufacture

(6) Date(s) and findings advanced inspection(s)

(7) Date(s) and findings of advanced cleaning or decontamination

(8) Reason for advanced cleaning or decontamination and who performed cleaning or decontamination

(9) Date(s) of repair(s), who performed repair(s), and brief description of repair(s)

(10) Date of retirement

(11) Date and method of disposal

4.3.4 The organization shall compile and maintain records as required by 4.3.3 on fire fighting protective ensembles with CBRN protection. The records shall include a list of specific required elements and interface components necessary for structural fire fighting protective ensembles with optional CBRN terrorism agent protection and proximity fire fighting protective ensembles with optional CBRN terrorism agent protection.

4.4 Manufacturer's Instructions.

4.4.1 When issuing new structural fire fighting protective ensembles and ensemble elements or proximity fire fighting protective ensembles and ensemble elements, the organization shall provide users with the instructions provided by the manufacturer on the care, use, and maintenance of the protective ensembles or ensemble elements, including any warnings provided by the manufacturer.

4.4.2 Where the manufacturer's instructions regarding the care or maintenance of the protective ensembles or elements differ from a specific requirement(s) in this standard, the manufacturer's instructions shall be followed for that requirement(s).

4.4.3 The organization shall retain and make accessible to fire department personnel a copy of manufacturers' instructions regarding the care, use, and maintenance of the protective ensembles, for reference purposes.

4.5 Protecting the Public and Personnel from Contamination.

4.5.1 The organization shall develop written SOPs that minimize the public's and the fire department personnel's exposure to soiled or contaminated structural or proximity fire fighting protective ensembles and ensemble elements.

4.5.2* The SOPs shall require that protective ensembles or ensemble elements not be worn or stored in the living areas of fire department facilities.

4.5.3* The public shall not be exposed at any time, except during emergency operations, to soiled or potentially contaminated protective ensembles or ensemble elements.

4.5.4 Soiled or potentially contaminated ensembles or ensemble elements shall not be brought into the home, washed in home laundries, or washed in public laundries.

4.6 Reporting Personal Protective Equipment Health and Safety Concerns.

4.6.1* The organization shall report all personal protective equipment (PPE) health and safety concerns, if caused by a known or suspected element failure, to the element manufacturer and certification organization.

4.6.2* The organization shall notify the manufacturer and the certification organization in writing.

4.6.3 The organization shall request written acknowledgment from the element manufacturer and certification organization within 30 days.

Chapter 5 Selection

5.1* Selection and Purchase.

5.1.1* Prior to starting the selection process of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements, the organization shall perform a risk assessment.

5.1.2 The risk assessment shall include, but not be limited to, the hazards that can be encountered by structural or proximity fire fighters based on the following:

(1) Type of duties performed

(2) Frequency of use of ensemble elements

(3) Organization's experiences

(4) Incident operations

(5) Geographic location and climate

(6)* Likelihood of or response to CBRN terrorism incident

5.1.3* The organization shall review the current edition of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*; NFPA 1994, *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents*; NFPA

1500, *Standard on Fire Department Occupational Safety and Health Program*; NFPA 600, *Standard on Industrial Fire Brigades*; and any applicable federal or state OSHA standards relating to structural fire fighting protective ensembles and ensemble elements to determine how they affect the selection process.

5.1.4* The organization shall ensure that elements under consideration are certified as being compliant with NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, by a third-party certification organization.

5.1.5* Based on the risk assessment, the organization shall compile and evaluate information on the comparative strengths and weaknesses of the elements under consideration.

5.1.6* The organization shall ensure that the ensembles and ensemble elements under consideration interface properly with other personal protective items with which they will be used.

5.1.7* Where a field evaluation of an ensemble or ensemble element is conducted, the organization shall establish criteria to ensure a systematic method of comparing products in a manner related to their intended use and assessing their performance relative to the organization's expectations.

5.1.8* Where the organization develops purchase specifications, at least the following criteria shall be included:

(1) Purchase specifications shall require that the ensemble or ensemble element(s) to be purchased shall be compliant with the current edition of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*. Purchasers shall consider that ensembles that are certified to the optional CBRN requirement are tested and certified as ensembles and must be worn as an ensemble with all elements and interface components present as stated on the element label.

(2)* Where the organization selects criteria that exceed the minimum requirements of the current edition of NFPA 1971, such criteria shall be stipulated in the purchase specifications.

(3)* Purchase specifications shall require that manufacturers' bids include substantiation of certification for each element and model stated in the bid.

(4)* Where applicable, the purchase specifications shall define the process for determining proper fit.

(5)* The organization shall compare each bid submittal against purchase specifications.

5.1.9 Upon receipt, organizations shall inspect purchased protective ensemble element(s) to determine that they meet their specifications and that they were not damaged during shipment. Organizations shall also verify the quantity and sizes of the protective ensemble element(s) received.

5.1.10 Organizations shall examine information supplied with the products, such as instructions, warranties, and technical data.

5.1.11 Procedures shall be established for returning unsatisfactory products if the organization's specifications are not met.

Chapter 6 Inspection

6.1 General.

6.1.1 Universal precautions shall be observed, as appropriate, when handling ensemble elements.

6.1.2 Any ensemble elements that are found to be soiled or contaminated shall be cleaned or decontaminated before any additional inspection is initiated. Where ensemble elements are found to be contaminated by CBRN agents, the ensemble shall be retired.

6.1.3* The organization shall establish guidelines for its members to follow in determining if an element is soiled to an extent that cleaning is necessary.

6.1.4 The organization shall determine appropriate actions to be taken if an element is found to be in need of cleaning, decontamination, or repair.

6.1.4.1 As a minimum, any necessary cleaning or decontamination shall be done in accordance with the requirements specified in Chapter 7.

6.1.4.2 As a minimum, any necessary repairs shall be made in accordance with the requirements specified in Chapter 8.

6.1.4.3 As a minimum, any necessary testing shall be conducted in accordance with the methods specified in Chapter 12.

6.2 Routine Inspection.

6.2.1 Individual members shall conduct a routine inspection of their protective ensembles and ensemble elements after each use.

6.2.2* The routine inspection shall include, as a minimum, the inspections specified in 6.2.2.1 through 6.2.2.7.

6.2.2.1 Coat and trouser garment elements shall be inspected for the following:

(1) Soiling

(2) Contamination

(3) Physical damage such as the following:

  (a) Rips, tears, and cuts

(b) Damaged or missing hardware and closure systems

(c) Thermal damage (charring, burn holes, melting, discoloration of any layer)

(4) Damaged or missing reflective trim

(5) Loss of seam integrity and broken or missing stitches

(6) Correct assembly and size compatibility of shell, liner, and the drag rescue device (DRD)

6.2.2.2 Hood elements shall be inspected for the following:

(1) Soiling

(2) Contamination

(3) Physical damage such as the following:

(a) Rips, tears, and cuts

(b) Thermal damage (charring, burn holes, melting, discoloration of any layer)

(4) Loss of face opening adjustment

(5) Loss of seam integrity and broken or missing stitches

6.2.2.3 Helmet elements shall be inspected for the following:

(1) Soiling

(2) Contamination

(3) Physical damage to the shell such as the following:

(a) Cracks, crazing, dents, and abrasions

(b) Thermal damage to the shell (bubbling, soft spots, warping, discoloration)

(4) Physical damage to the earflaps such as the following:

(a) Rips, tears, and cuts

(b) Thermal damage (charring, burn holes, melting)

(5) Damaged or missing components of the suspension and retention systems

(6)* Damaged or missing components of the faceshield/goggle system, including discoloration, crazing, and scratches to the faceshield/goggle lens limiting visibility

(7) Damaged or missing reflective trim

(8) Loss of seam integrity and broken or missing stitches

6.2.2.4 Glove elements shall be inspected for the following:

(1) Soiling

(2) Contamination

(3) Physical damage such as the following:

  (a) Rips, tears, and cuts

  (b) Thermal damage (charring, burn holes, melting, discoloration of any layer)

  (c) Inverted liner

(4) Shrinkage

(5) Loss of elasticity or flexibility

(6) Loss of seam integrity and broken or missing stitches

6.2.2.5 Footwear elements shall be inspected for the following:

(1) Soiling

(2) Contamination

(3) Physical damage such as the following:

  (a) Cuts, tears, and punctures

  (b) Thermal damage (charring, burn holes, melting, discoloration of any layer)

  (c) Exposed or deformed steel toe, steel midsole, or shank

(4) Loss of water resistance

(5) Closure system component damage and functionality

(6) Loss of seam integrity and broken or missing stitches

6.2.2.6 Drag rescue device (DRD) components shall be inspected for the following:

(1) Installation in garment

(2) Soiling

(3) Contamination

(4) Physical damage such as the following:

  (a) Cuts, tears, punctures, cracking, or splitting

  (b) Thermal damage (charring, burn holes, melting, discoloration)

  (c) Loss of seam integrity and broken or missing stitches

6.2.2.7 Interface components shall be inspected for the following:

(1) Soiling

(2) Contamination

(3) Physical damage

(4) Loss or reduction of properties that allow component to continue as effective interface [e.g., loss of shape or inability to remain attached to the respective element(s) where attachment is required]

(5) Loss of seam integrity and broken or missing stitches

6.2.3 Additional Routine Inspection Requirements for Proximity Fire Fighting Protective Ensembles and Ensemble Elements.

6.2.3.1 Proximity fire fighting coat and trouser garment elements shall be inspected for the following:

(1) Loss of reflectivity

(2) Loss of reflective coating(s)

6.2.3.2 Proximity fire fighting helmet element overcover shall be inspected for the following:

(1) Loss of reflectivity

(2) Loss of reflective coating(s)

(3) Damaged or missing reflective trim, if applicable

(4) Damage and functionality of the overcover to helmet attachment

6.2.3.3 Proximity fire fighting shrouds shall be inspected for the following:

(1) Loss of reflectivity

(2) Loss of reflective coating(s)

(3) If applicable, damage and functionality of the shroud-to-helmet attachment

(4) Distortion of face opening resulting in gaps around the faceshield

6.2.3.4 Proximity fire fighting helmet elements shall be inspected for the following:

(1) Loss of faceshield reflectivity

(2) Loss of shell reflectivity, if applicable

6.2.3.5 Proximity fire fighting glove elements shall be inspected for the following:

(1) Loss of reflectivity

(2) Loss of reflective coating(s)

6.2.3.6 Proximity fire fighting footwear elements shall be inspected for the following:

(1) Loss of reflectivity

(2) Loss of reflective coating(s)

6.3 Advanced Inspection.

6.3.1 Advanced inspection and any necessary testing shall be performed by a verified ISP or the organization’s trained personnel.

6.3.2 The member(s) of the organization who has received training in the advanced inspection of the ensembles or ensemble elements shall be responsible for performing or managing advanced inspections.

6.3.2.1* The ensemble or ensemble element manufacturer or a verified ISP and the organization shall determine the level of training required to perform advanced inspections. The ensemble or ensemble element manufacturer or verified ISP shall provide written verification of training.

6.3.3 Advanced inspections of all protective ensemble elements shall be conducted at a minimum of every 12 months, or whenever routine inspections indicate that a problem could exist.

6.3.4* The findings of the advanced inspection shall be documented on an inspection form.

6.3.5* The advanced inspection shall include, as a minimum, the inspections specified in 6.3.5.1 through 6.3.5.7 and for garment elements only the testing specified in Section 12.1 and Section 12.2.

6.3.5.1* All separable layers of the garment elements shall be individually inspected for the following:

(1) Soiling

(2) Contamination

(3)* Physical damage to all layers, such as the following:

- (a) Rips, tears, cuts, and abrasions
- (b) Damaged or missing hardware
- (c) Thermal damage (charring, burn holes, melting, discoloration of any layer)

(4)* Loss of moisture barrier integrity as indicated by any of the following:

- (a) Rips, tears, cuts, or abrasions
- (b) Discoloration
- (c) Thermal damage

(5) Evaluation of system fit and coat/trouser overlap

(6) Loss of seam integrity and broken or missing stitches

(7)* Loss of material physical integrity [e.g., ultraviolet (UV) or chemical degradation] as evidenced by discoloration, significant changes in material texture, loss of material strength, loss of liner material, and shifting of liner material

(8) Loss of wristlet elasticity, stretching, runs, cuts, or burn holes

(9)* Reflective trim integrity, attachment to garment, reflectivity, or damage

(10)* Label integrity and legibility

(11) Hook and loop functionality

(12) Liner attachment systems

(13) Closure system functionality

(14) Accessories for compliance with 4.2.3

(15) Correct assembly and size compatibility of shell, liner, and DRD

6.3.5.2 Hood elements shall be inspected for the following:

(1) Soiling

(2) Contamination

(3) Physical damage such as the following:

  (a) Rips, tears, and cuts

  (b) Thermal damage (charring, burn holes, melting, discoloration of any layer)

(4) Shrinkage

(5) Loss of material elasticity or stretching out of shape

(6) Loss of seam integrity or broken or missing stitches

(7) Loss of face-opening adjustment

6.3.5.3 Helmet elements shall be inspected for the following:

(1) Soiling

(2) Contamination

(3) Physical damage to the shell such as the following:

  (a) Cracks, dents, and abrasions

  (b) Thermal damage to the shell (bubbling, soft spots, warping, or discoloration)

(4) Physical damage to the ear flaps such as the following:

(a) Rips, tears, and cuts

(b) Thermal damage (charring, burn holes, melting or discoloration of any layer)

(5) Damaged or missing components of the suspension and retention systems

(6) Functionality of suspension and retention systems

(7) Damaged or missing components of the faceshield/goggle system, including discoloration or scratches to the faceshield/goggle lens limiting visibility

(8) Functionality of faceshield/goggle system

(9) Damage to the impact cap

(10) Damaged or missing reflective trim

(11) Accessories for compliance with 4.2.3

(12) Loss of seam integrity and broken or missing stitches

6.3.5.4 Glove elements shall be inspected for the following:

(1) Soiling

(2) Contamination

(3)* Physical damage such as the following:

(a) Rips, tears, and cuts

(b) Thermal damage (charring, burn holes, melting or discoloration of any layer)

(c) Inverted liner

(d) Loss of seam integrity or broken or missing stitches

(4) Shrinkage

(5) Loss of flexibility

(6) Loss of elasticity and shape in wristlets

(7) Accessories for compliance with 4.2.3

6.3.5.5 Footwear elements shall be inspected for the following:

(1) Soiling

(2) Contamination

(3) Physical damage such as the following:

(a) Cuts, tears, punctures, cracking, or splitting

(b) Thermal damage (charring, burn holes, melting or discoloration of any layer)

(c) Exposed or deformed steel toe, steel midsole, or shank

(d) Loss of seam integrity, delamination, or broken or missing stitches

(4) Loss of water resistance

(5) Closure system component damage and functionality

(6)* Excessive tread wear

(7) Condition of lining such as the following:

(a) Tears

(b) Excessive wear

(c) Separation from outer layer

(8) Heel counter failure

(9) Accessories for compliance with 4.2.3

6.3.5.6 Interface components shall be inspected for the following:

(1) Soiling

(2) Contamination

(3) Physical damage

(4) Loss or reduction of properties that allow component to continue as effective interface, such as loss of shape or inability to remain attached to the respective element(s), if attachment is required

(5) Loss of seam integrity and broken or missing stitches

6.3.5.7 DRD components shall be inspected for the following:

(1) Installation in garment

(2) Soiling

(3) Contamination

(4) Physical damage such as the following:

(a) Cuts, tears, punctures, cracking, or splitting

(b) Thermal damage (charring, burn holes, melting, or discoloration)

(c) Loss of seam integrity and broken or missing stitches

6.3.6 Additional Advanced Inspection Criteria for Proximity Fire Fighting Protective Ensembles and Ensemble Elements.

6.3.6.1 Proximity fire fighting garment elements shall be inspected for the following:

(1) Loss of radiant reflectivity

(2) Loss of radiant reflective coating(s)

6.3.6.2 Proximity fire fighting helmet overcover components shall be inspected for the following:

(1) Loss of radiant reflectivity

(2) Loss of radiant reflective coating(s)

(3) Damaged or missing reflective trim, if applicable

(4) Helmet attachment system for damage and functionality

6.3.6.3 Proximity fire fighting shroud components shall be inspected for the following:

(1) Loss of radiant reflectivity

(2) Loss of radiant reflective coating(s)

(3) Helmet attachment system, if applicable, for damage and functionality

(4) Distortion of face opening resulting in gaps around the faceshield

6.3.6.4 Proximity fire fighting helmet elements shall be inspected for the following:

(1) Loss of faceshield radiant reflectivity

(2) Loss of shell radiant reflectivity, if applicable

6.3.6.5 Proximity fire fighting glove elements shall be inspected for the following:

(1) Loss of radiant reflectivity

(2) Loss of radiant reflective coating(s)

6.3.6.6 Proximity fire fighting footwear shall be inspected for the following:

(1) Loss of radiant reflectivity

(2) Loss of radiant reflective coating(s)

6.3.7 Additional Advanced Inspection Criteria for Ensembles with Optional CBRN Protection.

6.3.7.1* CBRN protective ensembles shall be inspected according to the manufacturer's instructions.

6.3.7.2 Complete liner inspection of all garment elements shall be conducted at a minimum after 2 years in service and annually thereafter or whenever advance inspections indicate that a problem may exist.

6.3.7.3* CBRN protective ensembles shall be inspected for loss of integrity, including but not limited to:

(1) Loss of interface functionality

(2) Excessive material or component shrinkage or stretching

6.4 Complete Liner Inspection.

6.4.1 Complete liner inspection of all garment elements shall be performed by a verified ISP or the organization's trained personnel.

6.4.2 The member(s) of the organization who has received training in the complete liner inspection of the garment element shall be responsible for performing or managing the complete liner inspection.

6.4.2.1 The garment element manufacturer or a verified ISP and the organization shall determine the level of training required to perform complete liner inspections. The garment element manufacturer or verified ISP shall provide written verification of training.

6.4.3* Complete liner inspection of all garment elements shall be conducted at a minimum after 3 years in service and annually thereafter or whenever advanced inspections indicate that a problem might exist. The liner system shall be opened to expose all layers for inspection and testing.

6.4.3.1 A complete liner inspection of all garment elements shall be conducted after 2 years in service and annually thereafter following replacement of the moisture barrier, the CBRN barrier, or both.

6.4.4 The findings of the complete liner inspection shall be documented.

6.4.5 The complete liner inspection shall include, as a minimum, the inspection specified in 6.4.5.1 through 6.4.5.3.

6.4.5.1 The moisture barrier and the thermal barrier shall be inspected for the following:

(1) Physical damage to all layers and sides of each layer such as the following:

  (a) Rips, tears, cuts, and abrasions

  (b) Thermal damage (charring, burn holes, melting, or discoloration of any layer)

(2) Loss of seam integrity, broken or missing stitches, and loose or missing moisture barrier seam tape

(3) Material physical integrity; UV or chemical degradation as evidenced by discoloration, significant changes in material texture, loss of material strength, loss of liner material, or shifting of liner material

(4) Delamination as evidenced by separation of film from substrate fabric, flaking, or

powdering

6.4.5.2 The moisture barrier shall be tested using the hydrostatic test to evaluate the water penetration barrier, as specified in Section 12.3 and shall show no leakage.

6.4.5.3 The result of each water penetration barrier evaluation shall be recorded.

Chapter 7 Cleaning and Decontamination

7.1 General.

7.1.1* Organizations shall provide a means for having ensemble elements cleaned and decontaminated.

7.1.2 Ensembles and ensemble elements shall be evaluated by the wearer for application of appropriate cleaning level after each use.

7.1.3 Ensembles and ensemble elements contaminated by CBRN terrorism agents shall be immediately retired after confirmed exposure and shall not be subjected to cleaning or decontamination.

7.1.4* Ensembles and ensemble elements that are known or suspected to be contaminated with hazardous materials shall be evaluated on the incident scene by members of the organization authorized by the organization to conduct a preliminary assessment of the extent of contamination and the need for ensemble or ensemble elements to be isolated, tagged, and bagged on scene.

7.1.4.1 Contaminated ensembles and ensemble elements shall be isolated during the incident personnel decontamination process and removed from service until the contaminant or suspected contaminant is identified and the elements can receive specialized cleaning as necessary to remove the specific contaminant(s).

7.1.4.2* Where possible and where the contaminant and its source have been identified, the organization shall consult the supplier of the contaminant and the manufacturer of the ensemble and ensemble elements for an appropriate decontamination agent and process.

7.1.4.3 A member(s) of the organization who has received training in the cleaning of ensembles and ensemble elements shall be responsible for performing or managing specialized cleaning of elements contaminated with hazardous materials.

7.1.5 Ensembles and ensemble elements that are known or suspected to be contaminated with body fluids shall be evaluated on the incident scene by members of the organization authorized to conduct a preliminary assessment of the extent of contamination and need for the ensemble or ensemble elements to be isolated, tagged, and bagged at the incident scene.

7.1.6* Organizations shall have written procedures detailing the decontamination and cleaning processes for ensembles and ensemble elements contaminated with body fluids. Universal precautions shall be observed at all times by members handling elements known or suspected to be contaminated with body fluids.

7.1.7 Soiled or contaminated elements shall not be brought into the home, washed in home laundries, or washed in public laundries unless the public laundry has a dedicated business to handle protective ensembles and ensemble elements.

7.1.8* Commercial dry cleaning shall not be used as a means of cleaning or decontaminating ensembles and ensemble elements unless approved by the ensemble or ensemble element manufacturer.

7.1.9* When contract cleaning or decontamination is used, the ISP shall demonstrate, to the organization’s satisfaction, that the procedures for cleaning and decontamination do not compromise the performance of ensembles and ensemble elements.

7.2 Routine Cleaning.

7.2.1* The end users shall be responsible for the routine cleaning of their issued ensemble and ensemble elements.

7.2.2 Organizations shall examine the manufacturer’s label and user information for instructions on cleaning and drying that the manufacturer provided with the ensemble or ensemble element. In the absence of manufacturer’s instructions or manufacturer’s approval of alternative procedures for the ensemble or ensemble element, the routine cleaning and drying procedures provided in this section shall be used.

7.2.3 Routine Cleaning Process.

7.2.3.1* Where possible, the contamination levels shall be evaluated and cleaning shall be initiated at the emergency scene.

7.2.3.2 Ensembles and element layers shall be isolated whenever possible to avoid cross contamination.

7.2.3.3 Any dry debris shall be brushed off.

7.2.3.4 Other debris shall be gently rinsed off with water. Heavy scrubbing or spraying with high-velocity water jets such as a power washer shall not be used.

7.2.3.5 Where necessary, a soft bristle brush shall be used to gently scrub, and the ensemble or element shall be rinsed off again.

7.2.3.6 Where necessary, elements for routine cleaning shall be cleaned in a utility sink designated for personal protective equipment (PPE) cleaning and decontamination using the following procedures:

(1)* Heavily soiled or spotted areas shall be pre treated. Chlorine bleach, chlorinated solvents, active-ingredient cleaning agents, or solvents shall not be used without the ensemble or element manufacturer’s approval.

(2)* Water temperature shall not exceed 40°C (105°F).

(3) Mild detergents with a pH range of not less than 6.0 pH and not greater than 10.5 pH as indicated on the product MSDS or original product container shall be used.

(4)* Protective gloves and eye/face splash protection shall be worn.

(5) Element(s) shall be gently scrubbed using a soft bristle brush.

(6) Element(s) shall be thoroughly rinsed.

(7) Element(s) shall be inspected and, where necessary, shall be rewashed or submitted for advanced cleaning procedures. The manufacturer shall be consulted if stronger cleaning agents are required.

(8) Elements shall be dried in accordance with Section 7.4.

(9) Following the routine cleaning procedure, the utility sink shall be rinsed.

7.2.4 Additional Requirements for Routine Cleaning of Garment Elements.

7.2.4.1 Routine cleaning procedures for cleaning garment elements shall be used only for spot cleaning of the element and shall be performed in a utility sink.

7.2.4.2 To avoid cross contamination, garment element layers shall be isolated whenever possible.

7.2.4.3 Cleaning of the entire garment element shall be accomplished using advanced cleaning procedures.

7.2.5 Additional Requirements for Routine Cleaning of Helmet Elements.

7.2.5.1 If it is necessary to totally immerse the helmet, the impact cap shall be separated from the helmet shell. Each element component shall be washed and dried separately before reassembly.

7.2.5.2 Solvents shall not be used to clean or decontaminate helmets or helmet components. The manufacturer shall be consulted if stronger cleaning agents are required.

7.2.5.3 Helmets shall not be machine dried using equipment that produces mechanical action from tumbling or agitation.

7.2.6 Additional Requirements for Routine Cleaning of Glove Elements. Glove elements shall not be machine dried using equipment that produces mechanical action from tumbling or agitation.

7.2.7 Additional Requirements for Routine Cleaning of Footwear Elements. Footwear elements shall not be machine dried using equipment that produces mechanical action from tumbling or agitation.

7.2.8 Additional Requirements for Routine Cleaning of Proximity Fire Fighting

Ensembles and Ensemble Elements. Outer shell and other radiant reflective components of proximity fire fighting protective ensembles and ensemble elements shall not be cleaned with a brush or any other abrasive cleaning devices.

7.2.9 Where routine cleaning fails to render the ensemble or ensemble element(s) sufficiently clean for service, the ensemble or ensemble element(s) shall receive advanced cleaning.

7.3 Advanced Cleaning and Decontamination.

7.3.1 Advanced cleaning shall be performed by a verified ISP or the organization's trained personnel.

7.3.1.1 The advanced cleaning shall be managed by a member of the organization or conducted by members of the organization who have received training in the advanced cleaning of protective ensembles and ensemble elements. The ensemble or ensemble element manufacturer and the organization shall determine the level of training required to perform advanced cleaning. The ensemble or ensemble element manufacturer shall provide written verification of training.

7.3.2* Ensemble and ensemble elements that are soiled shall receive advanced cleaning prior to reuse.

7.3.3 Ensemble and ensemble elements that are issued and used shall receive advanced cleaning at the time of advanced inspection if not subjected to advanced cleaning in the preceding 12 months.

7.3.4 The training of the organization's personnel shall be performed by the element manufacturer or a verified ISP, who will provide written documentation of training.

7.3.5 Organizations shall examine the manufacturer's label and user information for instructions on cleaning and drying that the manufacturer provided with the element. In the absence of manufacturer's instructions or manufacturer's approval of alternative procedures for the ensemble or ensemble element, the advanced cleaning and drying procedures provided in this section shall be used.

7.3.6* Advanced cleaning of ensembles and ensemble elements shall be conducted by machine unless specifically prohibited.

7.3.7 The following procedures shall be used for machine washing:

(1)* The machine shall not be overloaded.

(2)* Heavily soiled or spotted areas shall be pretreated. Chlorine bleach, chlorinated solvents, active-ingredient cleaning agents, or solvents shall not be used without the ensemble or ensemble element manufacturer's approval.

(3) All closures, including pocket closures, hooks and loops, snaps, zippers, and hooks and dees shall be fastened.

(4)* Water temperature shall not exceed 40°C (105° F).

(5) A mild detergent with a pH range of not less than 6.0 pH and not greater than 10.5 pH as indicated on the product MSDS or original product container shall be used.

(6)* Washing machines with the capability of drum RPM adjustment shall be adjusted so the g-force does not exceed 100 g for all elements.

(7)* Machine manufacturer's instructions shall be followed for proper setting or program selection for the specific element being washed.

(8) The element shall be inspected and rewashed if necessary.

(9)* Where the machine is also used to wash items other than protective ensemble elements, it shall be rinsed out by running the machine without a laundry load through a complete cycle with detergent and filled to the maximum level with water at a temperature of 49°C to 52°C (120°F to 125°F).

7.3.8 Ensembles and ensemble elements shall be dried in accordance with Section 7.4.

7.3.9 Additional Requirements for Advanced Cleaning of Garment Elements.

7.3.9.1 If the coat element has a drag rescue device (DRD) and the DRD is removable, the DRD shall be removed prior to the coat being laundered. If the DRD also requires cleaning, it shall be placed in a separate mesh bag for washing and drying.

7.3.9.2* Where the shells and liners of protective garment elements are separable, those items shall be cleaned and decontaminated only with like items, other than as provided for in 7.3.13.

7.3.9.3 Separable liner systems shall be turned inside out so the moisture barrier is on the inside for both machine washing and machine drying.

7.3.10 Additional Requirements for Advanced Cleaning of Helmet Elements.

7.3.10.1* Detachable items shall be removed from the helmet and shall be washed and dried separately.

7.3.10.2 Helmets shall not be machine cleaned or dried using equipment that produces mechanical action by tumbling or agitation.

7.3.11* Additional Requirements for Advanced Cleaning of Glove Elements. Gloves shall not be machine dried using equipment that produces mechanical action by tumbling or agitation.

7.3.12* Additional Requirements for Advanced Cleaning of Footwear Elements. Footwear shall not be machine cleaned or dried using equipment that produces mechanical action by tumbling or agitation.

7.3.13 Additional Requirements for Advanced Cleaning of Hood Elements. Hoods shall be permitted to be machine washed and machine dried with garment liners.

7.3.14 Additional Requirements for Advanced Cleaning of Proximity Fire Fighting Ensembles and Ensemble Elements.

7.3.14.1 Outer shell and other radiant reflective components of proximity fire fighting protective ensembles and ensemble elements shall not be cleaned with a brush or other abrasive cleaning devices.

7.3.14.2 Outer shell and other radiant reflective components of proximity fire fighting protective ensembles and ensemble elements shall not be machine washed.

7.3.14.3 Outer shell and other radiant reflective components of proximity fire fighting protective ensembles and ensemble elements shall not be machine dried.

7.3.15 Additional Requirements for Advanced Cleaning of Ensembles Certified to the Optional CBRN Requirements of NFPA 1971. The manufacturer shall be consulted to determine if any special handling procedures or the removal of interface components or other components must be undertaken prior to advanced cleaning.

7.4 Drying Procedures.

7.4.1* Organizations shall examine the manufacturer's label and user information for instructions on drying procedures that the manufacturer provided with the ensemble or ensemble element. In the absence of manufacturer's instructions or manufacturer's approval of alternative procedures, the drying procedures provided in this section shall be used.

7.4.2* The following procedures shall be used for air drying:

(1)* Place elements in an area with good ventilation.

(2)* Do not dry in direct sunlight.

7.4.3* The following procedures shall be used for machine drying:

(1) The recommended capacity of the machine shall not be exceeded.

(2) All closures, including pocket closures, hooks and loops, snaps, zippers, and hooks and dees shall be fastened.

(3)* A "no heat" or "air dry" option shall be used, if available.

(4)* In the absence of a "no heat" or "air dry" option, the basket temperature shall not exceed 40°C (105°F).

(5)* The use of a heat cycle shall be discontinued prior to the removal of all moisture from the ensemble or ensemble elements.

(6)* The remainder of the drying process shall be accomplished by a "no-heat" machine setting or removal of the ensemble or ensemble elements from the machine dryer to air dry.

Chapter 8 Repair

8.1 Requirements for All Ensembles and Ensemble Elements.

8.1.1 All repairs shall be performed by the original manufacturer, an ISP, or a member of the organization who has received training by the manufacturer or by an ISP in the repair of ensembles or ensemble elements.

8.1.2 The member(s) of the organization who has received training in the repair of the ensembles or ensemble elements shall be responsible for performing or managing repairs.

8.1.3 Ensembles or ensemble elements shall be subjected to advanced cleaning, when necessary, before any repair work is undertaken. Ensembles contaminated by CBRN terrorism agents shall be immediately retired after CBRN exposure is confirmed and shall not be reused.

8.1.4* All repairs and alterations to the ensemble or ensemble element shall be done in a manner and using like materials and components that are compliant with NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

8.1.5 Due to the different methods of construction, the ensemble or ensemble element manufacturer shall be contacted if the organization or ISP is unsure of whether a repair can be accomplished without adversely affecting the integrity of the ensemble or ensemble element.

8.1.6 Replacement interface components shall be installed in a manner consistent with the ensemble or ensemble element manufacturer's method of construction.

8.2 Requirements for Both Basic and Advanced Garment Element Repair.

8.2.1 All repairs and alterations shall be performed in the same manner and using like materials as the garment element manufacturer, including, but not limited to, fabric, thread type, seam construction, hardware, and hardware backing, unless approved by the garment element manufacturer.

8.2.2 Repairs shall be made to all components and to all layers of the composite that have been damaged or that have been affected by the repair.

8.2.3 Repairs of minor tears, char marks, ember burns, and abraded areas shall be limited to those where the damaged area can be covered by a maximum 32 cm^2 (5 in.^{2}) patch of the same material that is compliant with NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

8.2.3.1 The finished edges of the patch shall extend at least 25 mm (1 in.) in all directions beyond the damaged area.

8.2.3.2 To prevent fraying, the patch shall have no raw edges.

8.2.3.3 Where tears, holes, or abrasions are being repaired, the damaged areas shall be mended using flame-resistant (FR) thread that is compliant with NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, to prevent further damage prior to application of the patch.

8.2.4* Replacement hardware shall be installed in a manner consistent with the garment element manufacturer's method of construction.

8.2.4.1 When hardware is replaced, the reinforcement backing material shall be reinstalled or, if it is no longer serviceable, the backing material shall be replaced.

8.2.5 If the complexity of the repair is uncertain, the garment element manufacturer shall be consulted.

8.2.6 Replacement visibility markings shall be installed in a manner consistent with the garment element manufacturer's method of construction, unless an alternative method is approved by the garment element manufacturer.

8.2.6.1 Visibility markings being replaced shall be completely removed so that no new visibility marking is sewn over older visibility marking.

8.2.6.2 No repair or alteration shall result in the reduction of the minimum required visibility marking pattern specified in Section 6.2 of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.

8.2.6.3 Visibility marking patches that do not exceed 75 mm (3 in.) in length shall be permitted. The visibility marking patch shall extend 25 mm (1 in.) beyond the damaged area. A maximum of two visibility marking patches per stripe shall be permitted.

8.2.6.4 Where a repair or alteration necessitates replacing visibility markings, an equal amount of visibility markings shall be installed.

8.2.6.5 Where the complexity of the visibility marking repair is uncertain, the garment element manufacturer shall be consulted.

8.3 Additional Requirements for Basic Garment Element Repair.

The repairs specified in this section shall be performed by the element manufacturer, by both verified and nonverified organizations, or by both verified and nonverified ISPs. Basic repairs shall be limited to the following:

(1) Patching of minor tears, char marks, and ember burns to a separable outer shell

(2) Repairing of skipped, broken, and missing stitches to a separable outer shell

(3) Replacement of missing hardware, excluding positive closure systems to a separable outer shell

(4) Reclosing of the liner of a garment after inspection

8.4 Additional Requirements for Advanced Garment Element Repair.

8.4.1 The repairs specified in this section shall be conducted *only* by the element manufacturer, a verified organization, or a verified ISP meeting the requirements as specified in Chapter 11, Verification.

8.4.2 Major repairs to the garment outer shell shall be performed only by the garment element manufacturer or by a verified ISP consistent with the garment element manufacturer's methods. The garment element manufacturer shall be contacted if the organization is unsure of whether a repair is major or minor.

8.4.3* All repairs to the garment moisture barrier shall be performed only by the garment element manufacturer or by a verified ISP consistent with the moisture barrier manufacturer's methods. The organization shall contact the original garment element manufacturer if the organization is unsure as to whether an area to be repaired contains a moisture barrier.

8.4.4* Repairs to garment thermal liners shall be permitted provided there is no stitching through the moisture barrier.

8.4.5 Due to labeling requirements, as well as the complexity and specialized equipment needed to replace entire garment element component layers (e.g., the outer shell), moisture barrier, or thermal liner, only the garment element manufacturer or the garment element manufacturer's designated verified ISP shall replace entire garment component layers.

8.4.6 Restitching of more than 25 continuous mm (1 continuous in.) of a Major A seam shall require consulting the garment element manufacturer or shall be performed by the garment element manufacturer or by a verified ISP in a manner consistent with the garment element manufacturer's methods.

8.4.7 Major B seams in the moisture barrier shall be repaired or altered only by the garment element manufacturer or by a verified ISP and shall not be repaired by the organization unless the organization is also a verified ISP.

8.4.7.1 Repairs to Major B seams in the thermal liner that do not affect any moisture barrier material shall be permitted. Restitching of more than 25 continuous mm (1 continuous in.) of any Major B seams shall require consulting the garment element manufacturer or shall be performed by the garment element manufacturer or by a verified ISP in a manner consistent with the garment element manufacturer's methods.

8.4.8* All repaired stress areas shall be reinforced in a manner consistent with the garment element manufacturer's methods.

8.4.9 If replacing trim necessitates sewing into a Major A seam, trim replacement shall be done only by the garment element manufacturer or by a verified ISP unless the organization is also a verified ISP.

8.4.10* Replacement zippers shall be installed in a manner consistent with the garment element manufacturer's method of construction. If the complexity of the repair is uncertain, the garment element manufacturer shall be consulted. Zippers that are part of a positive closure system shall not be replaced by the organization unless the organization is also a verified ISP.

8.4.11* Replacement hook-and-loop fastener tape shall be installed in a manner consistent with the garment element manufacturer’s method of construction. If the complexity of the repair is uncertain, the garment element manufacturer shall be consulted.

8.4.12* Replacement reinforcement materials shall be installed in a manner consistent with the garment element manufacturer’s method of construction.

8.5 Helmet Element Repair.

8.5.1 All repairs to helmet components other than as specified herein shall be performed in accordance with the helmet element manufacturer’s instructions.

8.5.2* Where there is indication of a crack, dent, abrasion, bubbling, soft spot, discoloration, or warping in the helmet shell, the helmet element manufacturer or its designated ISP shall be contacted to determine serviceability.

8.5.3 Small surface nicks shall be repaired in accordance with the helmet element manufacturer’s instructions.

8.5.4 Small scratches on the helmet shell shall be permitted to be removed by using mildly abrasive compounds recommended by the helmet element manufacturer.

8.5.5 Helmet faceshield and goggle components that become cracked or badly scratched shall be replaced.

8.6 Glove Element Repair.

All repairs to glove components shall be performed in accordance with the glove element manufacturer’s instructions.

8.7 Footwear Element Repair.

8.7.1 All repairs to footwear components shall be performed in accordance with the footwear manufacturer’s instructions.

8.7.2 Other than the replacement of bootlaces and zipper assemblies, all repairs to boots shall be performed by the footwear element manufacturer or its designated ISP.

8.7.3 All replacement bootlaces and zippers shall be provided by the footwear element manufacturer.

8.8 Structural Fire Fighting Hood and Proximity Fire Fighting Helmet Overcover and Proximity Fire Fighting Shroud Repair.

All repairs to hoods, helmet covers, and proximity shrouds shall be performed in accordance with the element manufacturers’ instructions.

8.9 Additional Requirements for Structural Fire Fighting Ensembles and Proximity Fire Fighting Ensembles with Optional CBRN Protection.

All repairs to ensembles with optional CBRN protection shall be referred to the ensemble manufacturer for repair.

Chapter 9 Storage

9.1* All Ensembles and Ensemble Elements.

9.1.1* Ensembles or ensemble elements shall not be stored in direct sunlight or exposed to direct sunlight while not being worn.

9.1.2* Ensembles and ensemble elements shall be clean and dry before storage.

9.1.3 Ensemble and ensemble elements shall not be stored in airtight containers unless they are new and unissued.

9.1.4* Ensembles and ensemble elements shall not be stored at temperatures below -32°C (-25°F) or above 82°C (180°F).

9.1.5 Ensembles and ensemble elements shall not be stored or transported in compartments or trunks with sharp objects, tools, or other equipment that could damage the ensembles or ensemble elements. Where ensembles or ensemble elements must be transported or stored in such environments, the ensemble or element(s) shall be placed in a protective case or bag to prevent damage.

9.1.6* Soiled ensembles and ensemble elements shall not be stored in living quarters or with personal belongings or taken or transported in the passenger compartment of personal vehicles. Where ensembles or ensemble elements must be stored or transported in such environments, the ensembles or ensemble element(s) shall be placed in a protective case or bag to prevent cross contamination.

9.1.7* Ensembles and ensemble elements shall not be stored in contact with contaminants such as, but not limited to, oils, solvents, acids, or alkalis.

9.1.8 Proximity fire fighting protective coat and trouser elements shall be stored by hanging to limit the damage caused by creasing and shall not be stored folded.

9.1.9 Ensemble and ensemble element storage areas shall be clean, dry, and well ventilated.

Chapter 10 Retirement, Disposition, and Special Incident Procedure

10.1 Retirement.

10.1.1* The organization shall develop specific criteria for removal of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements from service, which includes, but is not limited to, issues that are specific to the ensembles or ensemble elements being used by the organization, the manufacturer's instructions, and the experience of the organization.

10.1.2* Structural fire fighting ensembles and ensemble elements shall be retired in accordance with 10.2.1, no more than 10 years from the date the ensembles or ensemble elements were manufactured.

10.1.3 Proximity fire fighting ensembles and ensemble elements shall be retired in accordance with 10.2.1, no more than 10 years from the date the ensembles or ensemble elements were manufactured.

10.1.3.1* In all cases, the radiant reflective outer shell shall be replaced at a maximum of 5 years.

10.1.4* Structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that are worn or damaged to the extent that the organization deems it not possible or cost effective to repair them shall be retired in accordance with 10.2.1.

10.1.5* Structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that were not in compliance with the edition of the applicable NFPA standard that was current when the ensembles and ensemble elements were manufactured shall be retired in accordance with 10.2.1.

10.1.6 Structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that are contaminated to the extent that the organization deems it not possible or cost effective to decontaminate them shall be retired in accordance with 10.2.1.

10.1.7 Structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that are contaminated by CBRN terrorism agents shall be immediately retired as specified in 10.2.1 after confirmed exposure and shall not be reused.

10.1.8* Structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that are no longer of use to the organization for emergency operations service but are not contaminated, defective, or damaged shall be retired in accordance with 10.2.1 or 10.2.2.

10.2 Disposition of Retired Elements.

10.2.1 Retired structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements shall be destroyed or disposed of in a manner ensuring that they will not be used in any fire fighting or emergency activities, including live fire training.

10.2.2 Retired structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements as determined in 10.1.8 shall be permitted to be used as follows:

(1) For training that does not involve live fire, provided the ensembles and ensemble elements are appropriately marked as being for non–live fire training only

(2) As determined by the organization

10.3 Special Incident Procedure.

10.3.1* The organization shall have procedures for the handling and custody of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements that were worn by fire fighters who were victims at incidents where serious injuries or fatalities to the fire fighters occurred.

10.3.2 In the absence of any other prevailing rules of evidence, the organization's procedures shall include at least the following:

(1) Provisions shall be made for the immediate removal from service and preservation of all structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements utilized by the injured or deceased fire fighter.

(2) Custody of such ensembles and ensemble elements shall be maintained at a secure location with controlled, documented access.

(3) All such structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements shall be nondestructively tagged and stored only in paper or cardboard containers to prevent further degradation or damage. Plastic or airtight containers shall not be used.

(4) Examination of the structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements shall be made by qualified members of the organization or by outside experts to determine the condition thereof.

10.3.3 The organization shall determine a specific period of time for retaining custody of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements.

Chapter 11 Verification

11.1 General.

11.1.1 In order for an organization or ISP to be verified, it shall meet the requirements of this chapter.

11.1.1.1 Verification of the organization or ISP shall be limited to repairs of garment elements only. Verification of the organization or ISP shall not apply to helmet elements, glove elements, footwear elements, hood element, or optional CBRN ensembles.

11.1.2 All verification of the organization or ISP shall be performed by a certification organization that meets at least the requirements specified in Section 11.2 and that is accredited for personal protective equipment in accordance with ISO Guide 65, *General requirements for bodies operating product certification systems*. The accreditation shall be issued by an accreditation body operating in accordance with ISO 17011, *Conformity assessment — General requirements for accreditation bodies accrediting conformity assessment bodies*.

11.1.3 The organization or ISP shall not use the NFPA name or the name or identification of this standard, NFPA 1851, in any statements about its services unless the services are verified as compliant to this standard.

11.1.4 All verified organizations or ISPs shall be listed. The listing shall contain the repair categories that the organization or the ISP is verified to conduct. Repair categories shall be garment outer shell repairs, garment moisture barrier repairs, and garment thermal barrier repairs.

11.2 Verification Program.

11.2.1* The certification organization shall not be owned or controlled by the organization or the ISP being verified.

11.2.2 The certification organization shall be primarily engaged in certification work and shall not have a monetary interest in the organization's or ISP's ultimate profitability.

11.2.3 The certification organization shall be accredited for personal protective equipment in accordance with ISO Guide 65, *General requirements for bodies operating product certification systems*. The accreditation shall be issued by an accreditation body operating in accordance with ISO 17011, *Conformity assessment — General requirements for accreditation bodies accrediting conformity assessment bodies*.

11.2.4 The certification organization shall refuse to verify services to this standard that do not comply with all applicable requirements of this standard.

11.2.5* The contractual provisions between the certification organization and the organization or the ISP shall specify that verification is contingent on compliance with all applicable requirements of this standard.

11.2.6 The certification organization shall not offer or confer any conditional or temporary verification.

11.2.7* The certification organization's shall have laboratory facilities and equipment available for conducting proper tests to determine organization or ISP compliance.

11.2.8 The certification organization's laboratory facilities shall have a program in place and functioning for calibration of all instruments, and procedures shall be in use to ensure proper control of all testing.

11.2.9 The certification organization's laboratory facilities shall follow good practice regarding the use of laboratory manuals, form data sheets, documented calibration and calibration routines, performance verification, proficiency testing, and staff qualification and training programs.

11.2.10 The certification organization shall require the organization or the ISP to establish and maintain a quality management program that meets the requirements of Section 11.4.

11.2.11 The certification organization and the organization or ISP shall evaluate any changes affecting function of the compliant services to determine continued certification to this standard.

11.2.12* The certification organization shall have a follow-up inspection program of the organization's or the ISP's facilities of the compliant services with at least one random and unannounced visit per 12-month period to verify continued compliance.

11.2.13 The certification organization shall be permitted to conduct specific testing to verify continued compliance.

11.2.14 The certification organization's operating procedures shall provide a mechanism for the organization or the ISP to appeal decisions. The procedures shall include the presentation of information from both sides of a controversy to a designated appeals panel.

11.2.15 The certification organization shall be in a position to use legal means to protect the integrity of its name. The name shall be registered and legally defended.

11.3 Inspection and Testing.

11.3.1 For verification of the organization's or ISP's compliant repair services, the certification organization shall conduct both inspection and testing as specified in this section.

11.3.2 All inspections, evaluations, conditioning, and testing for verification of the organization or ISP shall be conducted by a certification organization's testing laboratory that is accredited in accordance with the requirements of ISO 17025, *General requirements for the competence of testing and calibration laboratories*.

11.3.3 The certification organization's testing laboratory's scope of accreditation to ISO 17025, *General requirements for the competence of testing and calibration laboratories*, shall encompass testing of personal protective equipment.

11.3.4 The accreditation of a certification organization's testing laboratory shall be issued by an accreditation body operating in accordance with ISO 17011, *Conformity assessment — General requirements for accreditation bodies accrediting conformity assessment bodies*.

11.3.5 A certification organization shall be permitted to utilize conditioning and testing results conducted by an organization or an ISP for verification provided the organization or the ISP testing laboratory meets the requirements specified in 11.3.5.1 through 11.3.5.5.

11.3.5.1 Where an organization or an ISP provides conditioning and testing results to the certification organization, the organization's or ISP's testing laboratory shall be accredited in accordance with the requirements of ISO 17025, *General requirements for the competence of testing and calibration laboratories*.

11.3.5.2 The organization or ISP testing laboratory's scope of accreditation to ISO 17025, *General requirements for the competence of testing and calibration laboratories*, shall encompass testing of personal protective equipment.

11.3.5.3 The accreditation of an organization's or ISP's testing laboratory shall be issued by an accreditation body operating in accordance with ISO 17011, *Conformity assessment — General requirements for accreditation bodies accrediting conformity assessment bodies*.

11.3.5.4 The certification organization shall also approve the organization's or ISP's testing laboratory.

11.3.5.5 The certification organization shall determine the level of supervision and witnessing of the conditioning and testing for verification conducted at the organization's or ISP's testing laboratory.

11.3.6 Sampling levels for testing and inspection shall be established by the certification organization and the organization or the ISP to ensure reasonable and acceptable reliability at a reasonable and acceptable confidence level that repair services are compliant to this standard, unless such sampling levels are specified herein.

11.3.7 For verification of an organization's or an ISP's repair services, the following series of tests shall be required for each repair category for which the organization or the ISP is verified. Testing shall be conducted using new materials as outlined in Table 11.3.7(a) through Table 11.3.7(c).

Table 11.3.7(a) Outer Shell Repairs

Who Makes Repair	Sample	Material	Test
Organization	5 ft felled seam 5 ft overedge seam	Outer shell material(s) utilized by the organization	NFPA 1971 — 7.1
	Small tear patch	Patched tear made from the outer shell material utilized by the organization	NFPA 1851 — 8.2
ISP	5 ft felled seam 5 ft overedge seam	7.5 osy Nomex IIIa plain weave fabric	NFPA 1971 — 7.1
	Small tear patch	Patched tear made from 7.5 osy Nomex IIIa plain weave fabric	NFPA 1851 — 8.2

Table 11.3.7(b) Thermal Liner Repairs

Table 11.3.7(b) Thermal Liner Repairs

Who Makes Repair	Sample	Material	Test
Organization	5 ft felled seam 5 ft overedge seam	Thermal liner material(s) utilized by the organization	NFPA 1971 — 7.
	Small tear patch	Patched tear made from the thermal liner material utilized by the organization	NFPA 1851 — 8.
ISP	5 ft felled seam 5 ft overedge seam	Blended filament/spun face cloth quilted to two layers of E89	NFPA 1971 — 7.
	Small tear patch	Patched tear made from blended filament/spun face cloth quilted to two layers of E89	NFPA 1851 — 8.

Table 11.3.7(c) Moisture Barrier Repairs

Who Makes Repair	Sample	Material	
Organization	5 ft seam	Moisture barrier material(s) utilized by the organization	NFPA 197
	Hole patch	Patched hole made from the moisture barrier material(s) utilized by the organization	NFPA 185 — 7.1.15 i
	Tear patch	Patched tear made from the moisture barrier material(s) utilized by the organization	NFPA 185 — 7.1.15 i
ISP	5 ft seam	All moisture barrier materials repaired by the ISP	NFPA 197
	Hole patch	Patched hole made from the moisture barrier materials repaired by the ISP	NFPA 185 — 7.1.15 i
	Tear patch	Patched hole made from the moisture barrier materials repaired by the ISP	NFPA 185 — 7.1.15 i

11.3.7.1 For repairs to tears in the outer shell, moisture barrier, and thermal barrier, the certification organization shall create the tear in the material(s) to be repaired in accordance with Figure 11.3.7.1.

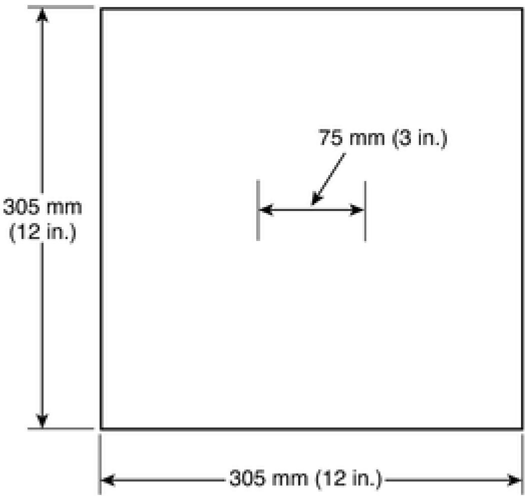

FIGURE 11.3.7.1 Tear Repairs.

11.3.7.2 For moisture barrier hole repairs, the certification organization shall create the hole in the material(s) to be repaired in accordance with Figure 11.3.7.2.

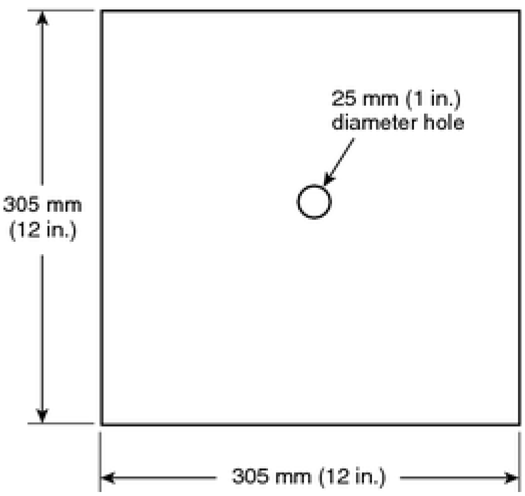

FIGURE 11.3.7.2 Hole Repairs.

11.3.8 The certification organization shall not allow test specimens that have been conditioned and tested for one method to be reconditioned and tested for another test method unless specifically permitted in the test method.

11.3.9 The organization or the ISP shall maintain all inspection and test data from the certification organization used in the verification of the organization's or the ISP's services. The organization or ISP shall provide such data, upon request, to the purchaser or authority having jurisdiction.

11.3.10 All repair categories that are verified in accordance with this standard shall undergo verification on an annual basis.

11.4 Organization or ISP Quality Management Program.

11.4.1 The organization's or the ISP's management shall define and document its policy and objectives for and commitment to quality and shall ensure that this policy is understood, implemented, and maintained at all levels in the organization or the ISP.

11.4.2 The organization or the ISP shall operate an effective quality system appropriate to the type, range, and volume of work performed.

11.4.3 The management of the organization or the ISP shall designate a person who, irrespective of other duties, shall have defined authority and responsibility for quality assurance within the organization or ISP. The quality system shall be maintained relevant and current under the responsibility of the same person.

11.4.4 The quality system shall be fully documented. There shall be a Quality Manual, which shall contain at least the following information:

(1) General information (name, addresses, phone numbers, and legal status)

(2) Management statement on the organization's or ISPs policy on, objectives for, and commitment to quality

(3) Management statement assigning a responsible person for quality assurance

(4) Description of the organization's or ISP's areas of activity and competence

(5) Organization chart(s)

(6) Relevant job descriptions

(7) Policy statement on qualification and training of personnel

(8) Procedures for control of documents

(9) Procedures for internal audits

(10) Procedures for feedback and corrective action

(11) Procedures for management review of the quality system

(12) Distribution list for the Quality Manual

(13) Work instructions or process manuals

(14) Procedure for handling returns and complaints

11.4.5 The organization or ISP shall maintain a system for control of all documentation relating to its activities and shall ensure the following:

(1) That the current revisions of the appropriate documentation are available at all relevant locations and to all relevant staff

(2) That all changes amendments to documents are authorized and processed in a manner that will ensure timely availability at the appropriate location

(3) That superseded documents are removed from use throughout the organization but that one copy is filed for a determined period

(4) That other parties, as necessary, are notified of changes

11.4.6 The organization or the ISP shall carry out a system of planned and documented internal quality audits to verify compliance with the criteria of this standard and the effectiveness of the quality system. The personnel performing the audits shall be suitably qualified and independent from the functions being audited.

11.4.7 The organization or the ISP shall have documented procedures for dealing with feedback and corrective action whenever discrepancies are detected in the quality system or in the performance of inspections.

11.4.8 The management of the organization or the ISP shall review the quality system at least annually to ensure its continuing suitability and effectiveness. The results of such reviews shall be recorded.

Chapter 12 Test Procedures

12.1 Light Evaluation of Liners.

12.1.1* Application. This evaluation method shall apply to liner composites found in structural and proximity fire fighting protective garment elements that are in service.

12.1.2 Evaluation Areas.

12.1.2.1 At a minimum, the front and back body panels of each protective garment element shall be evaluated.

12.1.2.1.1 Specific areas of the body panels that shall be evaluated include the upper back, shoulders, underarms, sleeves, waist area, and crotch area.

12.1.2.1.2 Liner evaluation areas shall also be any areas of the garment where damage or loss of thermal protection is detected or expected.

12.1.3 Evaluation Apparatus. The apparatus used to perform the light evaluation shall have the following characteristics:

(1) The apparatus shall consist of a light source that provides enough light to show the changes in density of the liner materials when viewed.

(2) The light source shall not produce enough heat to damage the liner composite.

(3) The light source shall be configured to prevent the bulbs from directly contacting the

liner composite.

(4) The light source shall be appropriately sized to fit into the sleeves of the liner.

12.1.4 Procedure.

12.1.4.1 The evaluation procedure shall be performed at room temperature.

12.1.4.2 The evaluation shall be conducted using the following procedure:

(1) If possible, separate the liner from the outer shell.

(2) Orient the liner such that the thermal barrier is on the outside.

(3) Position the light source near the moisture barrier such that the light passes through the moisture barrier and then through the thermal barrier.

(4) Evaluate the liner by examining the amount of light coming through the thermal liner.

12.1.5 Results.

12.1.5.1 Results shall be determined by evaluating areas where the light is brighter through some areas than others.

12.1.5.2 Brighter areas could be an indication of insulating material shifting or migrating, resulting in a thin or bare spot.

12.1.5.3 To further evaluate a suspected area of shifting or migration, an advanced inspection shall be performed.

12.2 Leakage Evaluation.

12.2.1* Application. This evaluation method shall apply to moisture and thermal barrier liners found in structural or proximity fire fighting protective garment elements that are in service.

12.2.2 Evaluation Areas.

12.2.2.1 At a minimum, the front and back body panels of each protective garment element shall be evaluated using three different moisture barrier material areas and three different moisture barrier areas with a seam.

12.2.2.1.1 Liner evaluation areas shall be from high-abrasion areas of the garment elements, including, but not limited to:

(1) Broadest part of the shoulders

(2) Back waist area of the coat

(3) Knees

(4) Crotch area

(5) Seat area

12.2.2.1.2 In addition to the areas listed in 12.2.2.1.1 where potential damage to the garment outer shell or thermal barrier has been detected, the evaluation shall be conducted on the corresponding area of the moisture barrier. Where potential damage to the garment moisture barrier has been detected, the evaluation shall also be conducted on that area.

12.2.2.2 The liner composite shall be positioned in the evaluation apparatus so that the moisture barrier is oriented upward and is contacted with the liquid exposure in the evaluation apparatus.

12.2.2.3 Moisture barrier material areas with seams shall be positioned on the evaluation apparatus so that the seam divides the specimen into two equal halves.

12.2.3 Evaluation Apparatus.

12.2.3.1* An alcohol–tap water mixture shall be made by combining 1 part rubbing alcohol, 70 percent isopropanol alcohol with 6 parts of tap water.

12.2.3.2 A 5 gal bucket or similar container shall be used to support the liner during evaluation.

12.2.4 Procedure.

12.2.4.1 The evaluation procedure shall be performed at room temperature.

12.2.4.2 The evaluation shall be conducted using the following procedure:

(1) If possible, separate the liner from the outer shell.

(2) Orient the liner such that the moisture barrier is on the outside.

(3) Position the dry liner over the bucket with the thermal barrier facing down and the moisture barrier side facing up.

(4) Cup the liner area that is being evaluated, so that it is lower than the surrounding liner.

(5) Pour 1 cup of the alcohol–tap water mixture specified in 12.2.3.1 onto the moisture barrier in the cupped area of the liner.

12.2.5 Results.

12.2.5.1 The liner shall be visually inspected for leakage on the thermal barrier side after 3 minutes.

12.2.5.2 If any liquid passes through the moisture barrier and wets the thermal barrier, the liner shall be removed from service and repaired or replaced.

12.2.5.3 After the evaluation procedure has been performed, the liner shall be cleaned and allowed to completely dry to remove all traces of the alcohol–tap water mixture.

12.3 Water Penetration Barrier Evaluation.

12.3.1 Application. This evaluation method shall apply to moisture barrier materials and moisture barrier seams found in structural or proximity fire fighting protective garment elements that are in service.

12.3.2 Evaluation Areas.

12.3.2.1 A minimum of three moisture barrier material areas and a minimum of three moisture barrier areas with a seam shall be tested on each garment element.

12.3.2.1.1 Moisture barrier material areas shall be from high-abrasion areas of the garment elements, including, but not limited to:

(1) Broadest part of the shoulders

(2) Back waist area of the coat

(3) Knees

(4) Crotch area

(5) Seat area

12.3.2.1.2 In addition to the areas listed in 12.3.2.1.1 where potential damage to the garment outer shell or the thermal barrier has been detected, the evaluation shall be conducted on the corresponding area of the moisture barrier. Where potential damage to the garment moisture barrier has been detected, the evaluation shall also be conducted on that area.

12.3.2.2 Moisture barrier material areas shall be positioned in the evaluation apparatus such that the side of the barrier that is against the outer shell faces the water in the evaluation apparatus.

12.3.2.3 Moisture barrier material areas with seams shall be positioned on the evaluation apparatus so that the seam divides the specimen into two equal halves.

12.3.3 Evaluation Apparatus.

12.3.3.1* The apparatus used to evaluate water penetration shall have the following characteristics:

(1) The apparatus shall consist of a means of clamping the area to be evaluated in a horizontal position, providing a watertight seal with the pressurized portion of the apparatus and water reservoir.

(2) The apparatus shall accommodate evaluations of moisture barriers and seams without the removal of the specimens.

(3) The apparatus shall have a clamping area that provides a water exposure and viewing area that is at least 50 mm (2 in.) in diameter.

(4) The apparatus shall have a water reservoir containing sufficient water for carrying out the evaluation.

(5) The apparatus shall provide for the pressurization of water against the garment element moisture barrier area at a pressure of 6.9 kPa (1 psi) for at least 15 seconds. The 6.9 kPa (1 psi) pressure shall be achieved within 10 seconds.

(6) The apparatus shall be equipped with a pressure gauge that is accurate to the nearest 0.2 kPa (0.1 psi).

(7) The apparatus shall be equipped with a means of bleeding air pressure and permit the drainage of water from the pressurized portion of the apparatus.

12.3.3.2 A stopwatch or other timer shall be used to ensure that pressure is applied for the specified duration of 15 seconds.

12.3.4 Procedure.

12.3.4.1 The evaluation shall be conducted using the following procedure:

(1) Place the selected area of moisture barrier in the apparatus and clamp to provide a watertight seal with the apparatus.

(2) Introduce a water pressure of 1 psi against the moisture barrier for a period of not less than 15 seconds.

(3) Visually inspect the visible side of the moisture barrier after 15 seconds to determine if water penetration has occurred.

12.3.5 Results.

12.3.5.1 If any water passes through the moisture barrier or moisture barrier seam, the liner shall be removed from service and repaired or replaced.

12.3.5.2 If no water passes through the moisture barrier or moisture barrier seam, the liner shall be allowed to dry completely before being returned to service.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase “authority having jurisdiction,” or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.8 CBRN Barrier Layer. While it is recognized that the entire composite will affect the performance of the ensemble in preventing the penetration of CBRN agents, the identification of the CBRN barrier layer is intended to assist application of specific ensemble and element tests.

A.3.3.9 CBRN Terrorism Agents. Chemical terrorism agents include solid, liquid, and gaseous chemical warfare agents and toxic industrial chemicals. Chemical warfare agents include, but are not limited, to GB (Sarin), GD (Soman), HD (sulfur mustard), VX, and specific toxic industrial chemicals. Many toxic industrial chemicals (e.g., chlorine and ammonia) are identified as potential chemical terrorism agents because of their availability and the degree of injury they could inflict.

Biological terrorism agents are bacteria, viruses, or toxins derived from biological material. The CBRN ensemble protects against biological particles dispersed as aerosols and liquid-borne pathogens. Airborne biological terrorism agents could be dispersed in the form of liquid aerosols or solid aerosols (e.g., a powder of bacterial spores). Liquid-borne pathogens could be encountered during a terrorism incident as a result of deliberate disposal or from body fluids released by victims of other weapons (e.g., explosives, firearms).

CBRN ensembles protect from radiological particulates dispersed as aerosols. The protection is defined for blocking or filtering airborne particulate matter and liquid and solid aerosols but not for radiological gases or vapors. Airborne particulates have the ability to emit alpha and beta particles and ionizing radiation from the decay of unstable isotopes.

A.3.3.13.1 Advanced Cleaning. Advanced cleaning usually requires that ensemble elements be temporarily taken out of service. Examples include hand washing, machine washing, and contract cleaning.

A.3.3.13.3 Routine Cleaning. Examples include brushing off dry debris, rinsing off debris with a water hose, and spot cleaning.

A.3.3.13.4 Specialized Cleaning. This level of cleaning involves specific procedures and specialized cleaning agents and processes.

A.3.3.23 Drag Rescue Device. The drag rescue device (DRD) is intended solely to assist in pulling or dragging an incapacitated fire fighter and is not intended for vertical rescue operations where the victim fire fighter would be raised or lowered.

A.3.3.29 Emergency Medical Operations. Patient care includes, but is not limited to, first aid, cardiopulmonary resuscitation, basic life support, and advanced life support.

A.3.3.32 Ensemble Elements. The proximity fire fighting protective ensemble includes, but is not limited to, garments, helmets, shrouds, gloves, and footwear. The structural fire fighting protective ensemble includes, but is not limited to, garments, helmets, hoods, gloves, and footwear.

A.3.3.43 Goggles. To provide primary protection, goggles must be certified to ANSI/ASSE Z87.1, *Occupational and Educational Personal Eye and Face Protection Devices*.

A.3.3.45 Hazardous Materials. Hazardous materials are any solid, particulate, liquid, gas, aerosol, or mixture thereof that can cause harm to the human body through respiration, ingestion, skin absorption, injection, or contact.

A.3.3.53 Interface Component(s). Interface components are evaluated and tested individually or are evaluated and tested as a part of the protective element.

A.3.3.59 Organization. Examples of organizations include, but are not limited to, fire departments, police and other law enforcement departments, rescue squads, EMS providers, and hazardous materials response teams.

A.3.3.66 Proximity Fire Fighting Protective Ensemble. A proximity fire fighting protective ensemble includes, but is not limited to, garments, helmets, shrouds, gloves, and footwear.

A.3.3.74 Radiological Particulate Terrorism Agents. This standard addresses protective ensembles that provide only partial protection from certain radiation sources. By their nature, these ensembles provide protection from alpha particles; the element materials and distance will significantly attenuate beta particles. These ensembles do not provide any protection from ionizing radiation such as gamma- and X-rays other than to keep the actual radiological particulates from direct skin contact.

A.3.3.77.1 Major A Seam. Outermost layer seam assemblies include outer shell seams. Rupture of the outer shell could reduce the protection of the garment by exposing inner layers such as the moisture barrier and the thermal barrier.

A.3.3.77.2 Major B Seam. Inner layer seam assemblies include moisture barrier and thermal barrier seams.

A.3.3.89 Structural Fire Fighting Protective Ensemble. A structural fire fighting protective ensemble includes, but is not limited to, garments, helmets, hoods, gloves, and footwear.

A.3.3.104 Universal Precautions. Under circumstances in which differentiation between body fluids is difficult or impossible, all body fluids should be considered potentially infectious materials.

A.4.1.1 NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, and NFPA 1581, *Standard on Fire Department Infection Control Program*, also provide requirements and information on cleaning and decontamination.

Protective ensembles and ensemble elements are important tools that enable fire fighters to perform their jobs in a safe and effective manner. Organizations need to recognize that these items do not have an indefinite life span and that regular inspections are a necessary part of any protective equipment program.

A.4.2.2 The following sample outline for an SOP is provided as a guide to aid organizations in the development of their program SOPs. Organizations should consider addressing each point in the outline based on their types of protective clothing, operations, situation, needs, and so forth. The SOP should also include the responsibilities of the organization and the responsibilities of the individual members for each point in outline.

(1) Records
- (a) Issued
- (b) Manufacturer information
- (c) Maintenance
- (d) Retirement

(2) Protecting the public and personnel from contamination
- (a) Risk assessment
- (b) Contamination containment
- (c) Public access
- (d) Procedures
  - i. Public areas
  - ii. Living areas
  - iii. Food preparation and eating areas
  - iv. Training areas
  - v. Other

(3) Selection

   (a) Risk assessment

   (b) Compliance with NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*

   (c) Element evaluation

(4) Inspection

   (a) Routine inspection

   (b) Routine inspection procedure points

   (c) Advanced inspection

   (d) Advanced inspection procedure points

(5) Cleaning and decontamination

   (a) Routine cleaning

   (b) Routine cleaning procedure points

   (c) Advanced cleaning and decontamination

   (d) Advanced cleaning and decontamination procedure points

   (e) Drying procedures points

(6) Repair

   (a) Basic repairs

   (b) Advanced repairs

   (c) Moisture barrier repairs

(7) Storage

   (a) Unissued Storage

   (b) Issued Storage

(8) Retirement, disposition, and special incident procedures

   (a) Condition

   (b) Age

   (c) Disposal method

A.4.2.3 Emergency response organizations are cautioned that accessories could degrade the protection or performance of the certified ensemble or ensemble element; interfere with form, fit, or function of the certified ensemble or ensemble element; or become a hazard to the wearer.

Accessories are not part of the certified ensemble or ensemble element but could be attached to a certified ensemble or ensemble element by means not engineered, manufactured, or authorized by the certified ensemble or ensemble element manufacturer. If an accessory or its means of attachment causes the structural integrity of the certified ensemble or ensemble element to be compromised, the certified ensemble or ensemble element might not be compliant with the standard with which it was originally certified.

Additionally, if an accessory or the accessory's means of attachment is not designed and manufactured from suitable materials for the hazardous environments of emergency incidents, the failure of the accessory or the means of attachment could cause injury to the emergency responder.

Users are also cautioned that the means of attachment for an accessory that fails to safely and securely attach the accessory to a certified ensemble or ensemble element can allow the accessory to become inadvertently dislodged from the certified ensemble or ensemble element, possibly posing a risk to emergency response personnel in the vicinity.

Organizations should consider evaluating the ensemble with tests provided in NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, in which the accessory could negatively impact the performance of the ensemble element, when in place. One test that is not part of NFPA 1971 but could be used to evaluate the performance of an externally placed accessory is ASTM F 1930, *Standard Test Method for Evaluation of Flame Resistant Clothing for Protection Against Flash Fire Simulations Using an Instrumented Manikin*. This test provides a simulation of a flash fire exposure using a static manikin. The effects of the flash fire on the accessory can be determined and compared to an ensemble that does not have the accessory in place. A minimum exposure time of 10 seconds is recommended for evaluating structural or proximity fire fighting ensembles. While this test provides a demonstration of ensemble/accessory performance under emergency conditions, it does not simulate all fire ground hazards, and other evaluations should be considered.

A.4.2.3.1 See A.4.2.3.

A.4.2.3.2 Organizations should consider evaluating the ensemble or ensemble element with tests provided in NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, in which the accessory could negatively affect the performance of the ensemble or ensemble element, depending on how the element might be affected by the attachment of the accessory (see Table A.4.2.3.2).

Another test that can be used to evaluate the performance of an externally placed accessory is ASTM F 1930, *Standard Test Method for Evaluation of Flame Resistant Clothing for Protection Against Flash Fire Simulations Using an Instrumented Manikin*. This test simulates a flash fire exposure using a static manikin. The effects of the flash fire on an ensemble or ensemble element with the accessory can be determined and compared to the effects on an ensemble or ensemble element that does not have the accessory in place. A minimum exposure time of 10 seconds is recommended when evaluating structural or proximity fire fighting ensembles. While this test demonstrates ensemble/accessory performance under emergency conditions, it does not simulate all fire ground hazards, and other evaluations should be considered.

Table A.4.2.3.2 Evaluating Possible Negative Effects of Accessory Attachments on Ensembles or Ensemble Elements

Ensemble and Ensemble Element Properties	Applicable Sections of NFPA 1971
Garments	
Flame resistance	Section 8.2
Heat resistance	Section 8.6
Whole-garment liquid integrity	Section 8.48
Helmets	
Flame resistance	Section 8.3
Heat resistance	Section 8.6
Top-impact resistance	Section 8.15
Impact resistance	Section 8.16
Electrical insulation	Section 8.31
Gloves	
Flame resistance	Section 8.4
Heat resistance	Section 8.6
Overall liquid integrity	Section 8.33
Glove–hand function	Section 8.38
Grip	Section 8.39
Footwear	
Flame resistance	Section 8.5
Heat resistance	Section 8.6
Electrical insulation	Section 8.48
Slip resistance	Section 8.41
Overall liquid integrity	Section 8.71
Hoods	
Flame resistance	Section 8.2
Heat resistance	Section 8.6
CBRN protective ensembles	
Man-in-simulant test (MIST)	Section 8.66

A.4.2.3.3 See A.4.2.3.2.

A.4.2.4.2 The end user should always request a product verification list from the ISP.

A.4.2.5.1 Requirements for instructional delivery requisite knowledge and skills can be found in NFPA 1041, *Standard for Fire Service Instructor Professional Qualifications*. An Instructor II level or equivalent is recommended.

A.4.2.6 Retirement criteria should be based on a number of factors, including, but not limited to, the overall condition of the item, specific deterioration of materials or components beyond their repair economically, or the inability to adequately remove hazardous materials and other contaminants. Physical damage from use or improper cleaning are other factors that can affect when an item should be retired. The actual service life of ensembles and ensemble elements varies, depending on the amount of their use and the care they receive.

A.4.3.1 Records are an important part of an overall protective ensemble management program. Records can be used to provide information about the life cycle of protective ensembles and ensemble elements, to document repair and decontamination efforts, and to compare the effectiveness of elements that are made of different materials or by different manufacturers. These records can be compiled and maintained by the organization, the ISP, another third party selected by the organization, or any combination thereof.

A.4.3.2 Some departments utilize rental or loaner gear. Records should also be maintained on these ensembles and ensemble elements in order to maintain a history on the care and maintenance of the products. The fire department should require that the entity providing the gear provide the records of prior care and maintenance at the time of rental.

A.4.5.2 Living areas include kitchen and dining areas, dayrooms, sleeping areas and dormitories, dedicated fitness rooms, bath and shower areas, office areas, and meeting and conference rooms.

A.4.5.3 Extra caution should be practiced to avoid exposing children to soiled protective equipment because they usually are more interested in actually touching or handling the equipment than are adults. Children are also less likely to wash off any dirt or soot that they might pick up from handling ensembles or ensemble elements. Departments should consider dedicating PPE solely for use at public education events to minimize public exposure to soils and contaminants.

Fire fighters often have a need to enter public facilities such as restaurants, grocery stores, and other businesses as part of their routine activities. PPE should not be worn during those times.

A.4.6.1 The purpose of this subsection is to require notification to the manufacturer and the certification organization of all health and safety concerns related to PPE identified through use or inspection. If a known or suspected failure of an ensemble element is identified, the element manufacturer and certification organization are the appropriate parties to be notified.

PPE health and safety concerns include, but are not limited to, the following:

(1) An occurrence resulting in loss of life or that which is likely to cause loss of life

(2) An injury resulting in permanent bodily damage, which can be instantaneous or cause a life-limiting disease or disorder eventually resulting in death

(3) An injury that requires hospitalization or medical or surgical treatment and that is not likely to result in a permanent disorder but is likely to necessitate loss of work for more than one day

A.4.6.2 The manufacturer and the certification organization information can be found on the product label.

A.5.1 The organization should consider establishing a committee to oversee the process of selecting ensembles or ensemble elements. The committee should consist of interested individuals representing a cross section of the organization (i.e., from both labor and management who collectively have several years of experience in fire fighting activities). The role of the committee should be to set and define goals and requirements and identify areas of responsibility for each member, plus provide recommendations to the authority making the final decisions.

Copies of specifications on the organization's current ensembles and ensemble elements should be distributed to the committee as a point of reference. The committee should consider if there are possible areas for improvement to the existing specifications. Examples of improvement criteria over existing specifications include heat stress, weight, design, style, interface with other components, durability, comfort, flexibility, safety, performance, price, customer service, delivery, compliance, reliability, and warranty.

A.5.1.1 In general, some hazards that can be encountered include, but are not limited to, physical, environmental, thermal, chemical, biological, electrical, radiation, operational, and ergonomic hazards. The organization should also consider the frequency and severity of the identified hazards when conducting the risk assessment.

The safety officer is the logical individual to perform this function since that is his or her role in the organization. The safety officer should consider national trends when performing this task. NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program,* substantiates OSHA's regulations as follows:

(1) Section 4.3: Mandatory evaluation of safety and health programs

(2) Subsection 4.4.2: Mandatory compliance with state and federal laws

(3) Section 4.7: Safety officer's responsibilities also defined in NFPA 1521, *Standard for Fire Department Safety Officer*

(4) Section 7.1: Requirements for ensembles and ensemble elements

In the identification of hazards, the organization should consider those hazards that fire fighters are likely to encounter. A list of hazards is provided in Table A.5.1.1. In determining risk, the organization should consider the frequency or likelihood of exposure to the hazard along with its potential severity (consequence) if exposure occurs.

its potential severity (consequences) if exposure occurs.

Table A.5.1.1 List of Potential Fire Ground and Other Related Emergency Hazards

Physical Hazards	***Chemical Hazards***
Falling objects	Inhalation
Flying debris	Skin absorption or contact
Projectiles or ballistic objects	Chemical ingestion or injection
Abrasive or rough surfaces	Liquefied gas contact
Sharp edges	Chemical flashover
Pointed objects	Chemical explosions
Slippery surfaces	***Electrical Hazards***
Excessive vibration	High voltage
Environmental Hazards	Electrical arc flashover
High heat and humidity	Static charge buildup
Ambient cold	***Radiation Hazards***
Wetness	Ionizing radiation
High wind	Non-ionizing radiation
Insufficient or bright light	***Person–Position Hazards***
Excessive noise	Daytime visibility
Thermal Hazards	Nighttime visibility
High convective heat	Falling
Low radiant heat	Drowning
High radiant heat	***Person–Equipment Hazards***
Flame impingement	Material biocompatibility
Steam	Ease of contamination
Hot liquids	Thermal comfort
Molten metals	Range of motion
Hot solids	Hand function
Hot surfaces	Ankle and back support
Biological Hazards	Vision clarity
Bloodborne pathogens	Communications ease
Airborne pathogens	Fit (poor)
Biological toxins	Ease of donning and doffing
Biological allergens	

A.5.1.2(6) In determining the need for CBRN protection, the organization should determine homeland security priorities for their jurisdiction, including, but not limited to, whether the organization would be responding to a CBRN terrorism incident, the specific roles and missions to be undertaken in response to a CBRN terrorism incident, the expected types of hazards that might be encountered for its members during a CBRN terrorism incident, and the capabilities of the organization to provide sufficient training and support for the use of CBRN protective ensembles (e.g., decontamination for safe doffing of ensemble elements). If it is determined that CBRN protection is needed, the organization should review both the CBRN terrorism agent protection option in NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, the different classes of ensembles addressed in NFPA 1994*, Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents*, and the protective ensemble defined in NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*, together with its intended CBRN terrorism agent response or action plan to determine the suitability of requiring protective ensembles meeting the CBRN terrorism agent protection option of NFPA 1971 versus obtaining separate ensembles that comply with specific classes of ensembles for NFPA 1994 or ensembles meeting NFPA 1991.

A.5.1.3 These standards provide minimum requirements. In order to fully utilize this standard, organizations should be familiar with the performance requirements in NFPA 1971. Additional requirements can be necessary. Organizations should also solicit information from and exchange information with other organizations.

A.5.1.4 Certification of protective elements can be checked by examination of the product label for the mark of the certification organization. The organization should further check the certification of the specific protective element by contacting the certification organization and asking if the item is listed as being certified as compliant with NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*. Finally, the organization can check the legitimacy of the certification organization by asking for documentation that shows that the certification organization has been accredited to ISO Guide 65, *General requirements for bodies operating product certification systems.*

A.5.1.5 The majority of tests in NFPA 1971 provide quantitative results; however, some tests are established on the basis of pass or fail results and cannot be readily compared. Specific tests that offer comparative performance results include, but are not limited to, the following:

(1) Protective garment elements

(a) Thermal protective performance of the material composite

(b) Total heat loss of the material composite

(c) Conductive and compressive heat resistance of reinforcements

(d) Thermal shrinkage of the material layers (outer shell, moisture barrier, thermal barrier)

(e) Flame resistance of material layers and other components (outer shell, moisture barrier, thermal barrier, other material layers and components)

(f) Tear resistance of the material layers (outer shell, moisture barrier, thermal barrier)

(g) Cleaning shrinkage of the material layers (outer shell, moisture barrier, thermal barrier)

(h) Water absorption resistance of the outer shell

(i) Tensile strength of the outer shell

(j) Seam strength of outer shell, moisture barrier, and thermal barrier layers

(k) Visibility properties of the trim

(l) Radiant reflectance of the outer shell (for proximity fire fighting protective clothing)

(2) Protective helmet elements

(a) Impact resistance (top and acceleration) after selected preconditions

(b) Flame resistance

(c) Heat resistance (level of sagging)

(3) Protective glove elements

(a) Thermal protective performance of glove body and, if present, wristlet

(b) Conductive heat resistance of glove body

(c) Thermal shrinkage of glove and innermost material

(d) Cut resistance of glove body

(e) Puncture resistance of glove body

(f) Burst strength of wristlet material

(g) Dexterity of whole gloves

(h) Grip of whole gloves

(4) Protective footwear elements

(a) Flame resistance

(b) Radiant heat resistance of upper

(c) Conductive heat resistance of sole and upper

(d) Puncture resistance of sole and upper

(e) Cut resistance of upper

(f) Abrasion resistance of sole

(5) Protective hood interface elements

(a) Thermal protective performance of hood material

(b) Flame resistance of hood material

(c) Thermal shrinkage of hood material

(d) Burst strength of hood material

(e) Cleaning shrinkage of hood material

Additional testing can also be specified for performance properties not addressed in NFPA 1971 based on the organization's hazard and risk assessment. When additional testing is specified, standard test methods should be used when available, and testing should be conducted at accredited, independent laboratories.

Organizations should consider the use of an RFI (Request for Information) or an RFP (Request for Proposal) format when soliciting quotations for structural or proximity fire fighting protective ensemble elements. The advantage of an RFI or an RFP proposal is that it allows manufacturers the option of providing all of the most current technologies for organization review (the offering is then not limited to the requirements of the specification). The organization can then choose among proposals for offered items finally accepted. Typically an RFI and an RFP have the following characteristics:

(1) Minimum requirements, such as NFPA product certification, required materials, or available options

(2) Inclusion of current specifications and a requirement that each manufacturer explain how its offering differs from the currently specified product

(3) Background on the offering firm's finances, capabilities, and references

(4) Field test procedures and results (see 5.1.6) of offered products

Using this approach, the organization can then employ a rating system that assigns values and weights to several factors, including but not limited to product design, manufacturer references, and field test results.

In this approach, a separately sealed cost proposal is opened only after the point ratings have been assigned to each offering. The organization can then apply separate criteria considering both technical merits and cost. This approach allows fire departments to compare prices and product acceptability.

Organizations should also consider integrated personal protective equipment programs that address various levels of care and maintenance as provided by or coordinated by the manufacturer of the fire fighter personal protective equipment. These programs can address many of the aspects of care and maintenance that are addressed in this standard, including, but not limited to, cleaning, inspection, and repairs, in addition to the offer of program guidance and reporting and documentation of procedures.

A.5.1.6 The organization should consider the interface of items, such as helmets with hoods and SCBA; gloves and hoods with coats; trousers with boots; and so forth.

A.5.1.7 Organizations should contact manufacturers or vendors about field evaluation programs. Many provide sample items for tests. The following criteria should be used to conduct an effective field evaluation:

(1) Test participants should be selected based on a cross section of personnel, willingness to participate, objectivity, and level of operational activity.

(2) Participants should conduct field evaluations of each different product model being evaluated from each manufacturer for a particular ensemble element. Participants should be fitted for each product model being evaluated from each manufacturer. Evaluations should be conducted with the same participants to use and evaluate each ensemble.

(3) A product evaluation form should be developed for each element and interface area. The form should include a rating system for those characteristics considered important to the organization, facilitating a quantitative evaluation. Evaluation forms should include general performance criteria, a specific length of time for the field evaluation, and criteria addressing ease of movement, ability to work, and so forth. Size and fit issues should be addressed since they relate to comparative evaluation of ensembles and ensemble elements. Evaluation forms that provide only narrative responses should be avoided.

(4) The organization should solicit periodic reports from participants in the field evaluation. At least three evaluation reports should be completed and filled out independently.

(5) The organization should conclude the evaluation process in a timely manner and analyze the results.

A.5.1.8 Specifications translate the organization’s needs into performance or design requirements that can be met by manufacturers of protective equipment. Specifications should clearly address every aspect of the department’s needs and expectations in regard to both the performance and the delivery of the ensembles or ensemble elements.

Organizations should specify delivery time requirements and, if appropriate, penalty assessments for not meeting delivery dates. Warehousing requirements, if desired, should also be established in the procurement specification.

Organizations should be careful not to write specifications that are redundant or contradictory or that cannot be met by manufacturers of ensembles or ensemble elements. For example, the organization should be sure the thermal protection performance (TPP) specified can be achieved with the materials specified. A prebid meeting with participation by potential bidders or manufacturers is useful in eliminating inconsistencies and explaining requirements that might be unclear in the specifications.

Organizations should continuously review and document how their specifications and ensembles and ensemble elements meet their needs and applicable standards. There are many ways to improve the quantity and quality of information received from prospective bidders. Additionally, increased purchasing power potential can be gained by forming collective buys with other organizations for possible volume discounts.

Purchase specifications should indicate the organization’s selection of choice for the following required NFPA 1971 ensemble element components:

(1) Garments

- (a) Outer shell material: fabric, weight, color
- (b) Thermal liner material
- (c) Moisture barrier material: base fabric, film, or coating
- (d) Trim: configuration, material, color
- (e) Closure system
- (f) Wristlets: material, design

(2) Hoods

- (a) Material
- (b) Face opening design

(3) Gloves

- (a) Composite materials
- (b) Wristlet or gauntlet
- (c) Wristlet material

(4) Helmets

- (a) Material
- (b) Color
- (c) Retention system
- (d) Trim configuration
- (e) Trim color

(f) Ear cover material

(g) Ear cover dimension

(h) Eye protection

(5) Boots: composite materials

A.5.1.8(2) An organization should consider its needs for performance or features in excess of the minimum requirements of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, such as the following:

(1) Garment elements

(a) Any styling issues

(b) Any specific range-of-motion requirements

(c) Any sleeve retraction requirements

(d) Any garment rise with overhead reach requirements

(e) Any winter liner requirements

(f) Any additional reinforcement needs (recognizing that multiple layering can modify protective performance in several areas, especially breathability)

(g) Any specific additional thread requirements

(h) Any specific additional requirements for stitch characteristics

(i) Any customized sizing requirements

(j) Any attachment requirements for liners and outer shells

(k) Any specific requirements for placement of visibility marking, visibility marking materials, and reflective lettering

(l) Any specific material choices

(m) Any requirements for weight reduction

(n) Any specific details of required suspender construction or suspender/garment interface

(o) Any requirements for spot or localized enhanced insulative performance

(p) Any requirements for field interchangeability or replacement of reinforcement pieces

(q) Any requirements for enhanced flexibility at movement-sensitive areas

(r) Any requirements for notification systems to indicate liner absence

(s) Any requirements for moisture barrier substrate or thermal fill accessibility to allow field inspection

(t) Any requirements for lumbar support systems

(u) Any customization requirements

(v) Any passport or accountability system requirements

(w) Any specialized or additional pocketing requirements

(x) Any flashlight clips required

(y) Any PASS (personal alert safety system) interface features required

(z) Any requirements for personal escape or rescue features

(aa) Any requirements for sizing adjustment

(ab) Any requirements for temperature-sensing features

(ac) Any requirements for interface area compatibilities

(2) Helmet elements

(a) Any styling requirements

(b) Any customization requirements

(c) Any faceshield or goggles requirements

(d) Any reflective marking requirements

(e) Any customized sizing requirements

(f) Any specific material choices

(g) Any specific requirements for earflaps (design, materials, dimensions, attachment to shell specifics)

(h) Any specific requirements for suspension construction

(i) Any requirements for weight reduction

(3) Glove elements

(a) Any specific material choices

(b) Any overall styling requirements

(c) Any details of cuff styling (wristlet or gauntlet)

(4) Boot elements

(a) Any specific material choices

(b) Any overall styling requirements

(c) Any trouser interface requirements

(5) Hood interface elements

(a) Any specific material choices

(b) Any styling requirements

(c) Any coverage requirements

(6) All ensemble elements

(a) Any additional certification requirements (e.g., Project FIRES, state OSHA, federal OSHA)

(b) Any requirements for interface with existing elements of the protective ensemble

(c) Any warranty requirements

(d) Any requirements for cleaning and repair support

(e) Any requirements for manufacturer or dealer references

(7) CBRN ensembles

(a) Method of deploying the CBRN protection

(b) Position of CBRN barrier layer in the material systems of each element and its ease of its inspection

(c) Manner in which ensemble interfaces are designed to prevent inward leakage

(d) Specialized donning or doffing procedures in the wearing of the ensemble

(e) Ensemble resistance to contamination and ease of ensemble doffing for safe exit of wearer from ensemble

(f) Specific types of SCBA for which ensemble is certified

A.5.1.8(3) Depending on the items being purchased and the size of the order, organizations should consider requiring product representatives to provide samples with their proposals. Manufacturers should also be required to provide complete user instructions and warranty information with each bid. Organizations should review the past record of each manufacturer concerning length of time for delivery, repair turnaround times, and similar customer service issues.

A.5.1.8(4) Organizations can obtain assistance in garment sizing from ASTM F 1731, *Standard Practice for Body Measurements and Sizing of Fire and Rescue Services Uniforms and Other Thermal Hazard Protective Clothing*. Helmets are adjustable and fit a wide range of sizes. If a helmet is not adjusted correctly, it might not stay on the user's head during periods of active wear. In addition to the sizing and depth adjustments, many models are available with quick adjusters to accommodate varying conditions for proper fitting (e.g., with or without SCBA facepiece).

A.5.1.8(5) Organizations should consider comparing a preproduction sample from the apparent winning submitter against the purchase specifications before awarding the bid.

A.6.1.3 It is not the intent of this standard to require the cleaning of ensembles and ensemble elements if the elements are not soiled. Organizations should establish guidelines for judging the extent of soiling that requires cleaning based on the organization’s needs and experience. In applying such judgment, organizations should take into consideration the importance of keeping ensembles and ensemble elements clean. Soiled ensemble elements can pose a health risk to the wearer and the levels of protective performance.

A.6.2.2 Table A.6.2.2 provides a quick reference guide to routine inspection criteria.

Table A.6.2.2 Routine Inspection Criteria

Criteria	Coats and Trousers	Hoods	Helmets	Gloves	I
Soiling	X	X	X	X	
Contamination	X	X	X	X	
Tears and cuts	X	X	X	X	
Damaged missing hardware or closure system	X				
Charring, burn holes, melting	X	X	X	X	
Shrinkage	X	X	X	X	
Material discoloration	X	X	X	X	
Damaged or missing visibility markings	X				
Loss of face opening elasticity or adjustability		X			
Cracks, dents, abrasions			X	X	
Bubbling, soft spots, warping			X		
Damaged or missing components of suspension or retention systems			X		
Damaged or missing components of faceshield/goggle system, including discoloration and scratched lenses			X		
Inverted liner				X	
Exposed or deformed steel toe, steel midsole, or shank					
Loss of water resistance					
Closure system component damage and functionality					
Earflaps: rips, tears, or cuts; thermal damage such as charring, burn holes, or melting			X		
Size compatibility	X				

A.6.2.2.3(6) The inspection should ensure that the sides and edges of faceshields and goggles are maintained to preserve peripheral vision.

A.6.3.2.1 For any inspection program to be effective, ensembles and ensemble elements should be evaluated by trained individuals. The individuals evaluating the ensembles and ensemble elements should understand the limitations of each element and recognize the signs of failure. Utilizing trained individuals provides consistency on whether an item should be repaired or retired. The manufacturer and organization should determine the level of training required to perform advanced inspections. Resources for training that should be considered, as a minimum, are the manufacturer(s) of the elements in use; the Fire and Emergency Manufacturers and Services Association (FEMSA) user guides; NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*; and professional cleaning and repair facilities.

A.6.3.4 The following inspection grading scale is designed to assist fire department personnel in identifying and documenting the condition of ensembles and ensemble elements:

(1) *New or as-new condition.* Newly purchased items that are in like-new condition.

(2) *Good condition.* Items in good serviceable condition; might show wear, but replacement or repair is not necessary.

(3) *Maintenance needed.* Items in need of repair. The organization determines if an item is to be retired. Maintenance details are described in the "Comments" section of the inspection form.

(4) *Immediate replacement.* Unsafe items that should be removed from service.

A.6.3.5 Table A.6.3.5 provides a quick reference guide to advanced inspection criteria.

Table A.6.3.5 Advanced Inspection Criteria

Criteria	Coats and Trousers	Hoods	Helmets	Gloves
Soiling	X	X	X	X
Contamination	X	X	X	X
Tears and cuts	X	X	X	X
Damaged or missing hardware or closure system	X	X	X	X
Charring, burn holes, melting	X	X	X	X
Shrinkage				X
Material degradation (UV or chemical damage)	X	X	X	X
Material discoloration	X	X	X	X
Visibility marking integrity, attachment to garment, reflectivity damage	X		X	
Loss of face opening elasticity or adjustability		X		
Cracks, dents, abrasions			X	
Bubbling, soft spots, warping			X	
Damaged or missing components of the suspension and retention systems			X	
Earflaps: rips, tears or cuts, thermal damage (charring, burn holes, melting)			X	

Table A.6.3.5 Advanced Inspection Criteria

Criteria	Coats and Trousers	Hoods	Helmets	Gloves
Damaged or missing components of faceshield/goggle system, including discoloration and scratched lenses			X	
Inverted glove liner				X
Exposed or deformed steel toe, steel midsole, or shank				
Loss of water resistance				X
Evaluation of system fit and coat/trouser overlap	X			
Loss of seam integrity				X
Broken or missing stitches		X		X
Loss or shifting of liner material	X			X
Loss of wristlet elasticity, stretching of wristlet				X
Label integrity and legibility	X	X	X	X
Hook and loop functionality	X		X	
Liner attachment system	X			
Material elasticity, stretching out of shape		X		
Damage to the impact cap			X	
Loss of flexibility			X	
Punctures, cracking, or splitting		X		
Excessive tread wear				
Condition of lining: tears, excessive wear, separation from outer layer				
Size compatibility	X			

A.6.3.5.1 It is important to realize during the inspection of different layers of garment elements that some portions of the material might be more susceptible to damage than others. For example, one side of a multilayer laminate material or quilted material might show damage while the other side might not. Moreover, certain fibers in a single-layer material might be more susceptible to damage than other fibers. Each of these effects could be cause for repair or retirement of the garment element, depending on the extent of observed damage. When garments have an optional winter liner, the winter liner should be inspected during each advanced inspection.

A.6.3.5.1(3) All charred, burned, or discolored areas should be thoroughly checked for strength and integrity by aggressive flexing of the material and attempts to push a finger or thumb through the fabric. Any loss of strength or weakening of the materials to the degree that the material can be torn with manual pressure is a sign of deterioration, and the garment should be removed from service.

A.6.3.5.1(4) While all materials and components in garment elements are susceptible to different types of damage from wear or abuse, the moisture barrier is one of the most difficult parts of the garment element to inspect and evaluate. That is because the film or coating side of most moisture barriers faces the interior of the liner and is hidden from easy examination. Even if a garment element is equipped with a means of opening the liner to view the film or coating side, it is difficult to conduct a visual evaluation of the moisture barrier film or coating. Even a physical examination of the moisture barrier film or coating side will not detect all types of damage or defects that can lead to loss of liquid penetration resistance for the garment element.

Moisture barrier coatings or films can become abraded, tear, or have pinholes from use. In severe cases, the degradation in some moisture barrier materials can take the form of separation, cracking, or flaking. Tapes used on moisture barrier seams, to ensure garment element integrity against liquid penetration, can crack, lift, or completely separate. Because only the most obvious damage is usually observable, the field evaluation procedures in Sections 12.2 and 12.3 are necessary.

A.6.3.5.1(7) Material discoloration can indicate many types of possible damage, including, but not limited, to dye loss, heat degradation, UV damage, and chemical contamination.

A.6.3.5.1(9) Visibility markings can appear to the human eye to be undamaged when actually they have lost much of their ability to reflect. Retroreflective properties can be checked with the following simple flashlight test:

(1) Stand approximately 12 m (40 ft) from a sample of the trim being tested and a sample of new trim.

(2) Hold a bright, focused flashlight at eye level, either next to the temple or on the bridge of the nose, and aim the light beam at the samples.

(3) Compare the brightness of the reflected lights. If the reflected light from the trim being tested is substantially less than the light reflected from the new trim, the trim should be replaced.

While this simple test provides a practical evaluation of trim retroreflective performance, it does not evaluate trim fluorescence or mean that the trim will provide adequate fire fighter visibility. Trim can lose fluorescence (daytime visibility) and still remain retroreflective. Trim can also appear to be retroreflective and not have sufficient intensity for nighttime visibility at far distances. Only testing under laboratory conditions can provide an accurate determination of trim visibility properties.

A.6.3.5.1(10) If a label problem is identified, the organization should contact the manufacturer of the ensemble or ensemble element.

A.6.3.5.4(3) The watertight integrity of gloves can be evaluated by the following test. Have a test subject wear the gloves with lightweight cotton gloves under the gloves being inspected.The test subject then immerses the groves in water up to the wrist crease, repeatedly flexes his or her hands for 2 minutes, and then takes them out of the water. Remove the test gloves and examine the cotton gloves for signs of watermarks. Gloves showing signs of leakage should be removed from service.

A.6.3.5.5(6) Excessive tread wear significantly reduces traction and safe footing on many surfaces such as wet flooring and roads, roofs, ladder rungs, and apparatus steps and platforms.

Inspection of tread wear should focus on the heel and the ball of foot areas since those two areas carry the majority of a fire fighter's body weight and are the most critical in maintaining adequate traction. The organization should consult with the manufacturer and set guidelines for a minimum tread depth that has to be present for footwear to remain in service.

A.6.3.7.1 Organizations should consult with the manufacturer of the ensemble with optional CBRN protection for any additional or specific advanced inspection requirements for this type of ensemble.

A.6.3.7.3 Loss of integrity can be determined by evaluating the inward leakage for representative CBRN protective ensembles. One evaluation method that could be used is the CBRN Ensemble Inward Leakage Resistance Evaluation. The procedure in this section is based on procedures established by the Occupational Safety and Health Administration (OSHA) for the evaluation of totally encapsulated suits, as found in Appendix A of OSHA 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response." Modifications to the procedures have been made to evaluate structural fire fighting protective ensembles that do not encapsulate both the wearer and the breathing apparatus.

For this testing, the entire CBRN protective ensemble should be evaluated, including protective garments, gloves, footwear, and hood. The protective helmet should be included, if it is part of the CBRN protective ensemble. The appropriate CBRN SCBA should be included as specified as part of the CBRN ensemble.

The suggested test procedure involves placement of commercially available colorimetric dosimeters (sensors) on the ensemble wearer's body at different locations at or near interface areas of the ensemble. An ammonia challenge atmosphere is then created by the placement of a volume of household ammonia (aqueous ammonium hydroxide, approximately 58 percent by weight) in a shallow pan in a closed room, such as a large closet. The procedure generates an ammonia atmosphere of approximately 500 to 1500 ppm; the test concentration can be assessed using length of stain detection tubes specific for ammonia. After the placement of the colorimetric dosimeters, the ensemble wearer dons the ensemble and respirator well away from the test area, enters the test area, and goes through a series of exercises to stress various parts of the ensemble. Following the exercises, the ensemble wearer goes to an area well away from the test area, the ensemble is removed, and the colorimetric dosimeters are examined for color changes. Indications of color change for any of the colorimetric dosimeters that cannot be rationalized from cross contamination or error in procedure are then deemed as requiring the ensemble to be removed for reevaluation, inspected, and repaired, if necessary.

The CBRN ensemble should be evaluated as specified in Test B, Totally-Encapsulating Chemical Protective Suit Qualitative Leak Test in Appendix A of 29 CFR 1910.120, with the following modifications:

(1) All safety precautions must be followed.

(2) The CBRN protective ensemble should be substituted for the totally encapsulating chemical protective suit.

(3) Specific colorimetric dosimeters should be used in lieu of bromophenol blue–indicating paper that have a specific range of sensitivity of at least 1 ppm when exposed to ammonia for a period of 2 minutes.

(4) Eight colorimetric dosimeters should be placed on the test subject at the following locations under the CBRN ensemble:

   (a) Neck area

   (b) Center lower front chest near waist

   (c) Center lower back near waist

   (d) Each wrist

   (e) Front of each leg above the ankle

   (f) Forehead above where the SCBA facepiece and the test subject’s face form the seal
   These placements are intended to evaluate possible inward leakage in interface areas. Additional colorimetric dosimeters can be added at other locations where inward leakage is suspected to occur. Colorimetric indicators that have been found suitable are the Permea-Tec™ aliphatic amine sensors, part no. 3005, available from CLI Laboratories, 1261A Rand Road, Des Plaines, Illinois 60016-3402, 847-803-3737, www.clilabs.com. These adhesive bandage–like sensors are placed on the skin at the recommended locations. The sensors turn a reddish-purple if ammonia at concentrations over 1 ppm is detected.

(5) Performance is deemed as passing if no color changes are noted for any of the colorimetric dosimeters. If color changes are found, a determination should be made that the procedures were done correctly and that no cross contamination of the colorimetric dosimeters occurred. If the results are determined to be valid, the ensemble should be removed from service, repaired, or replaced.

A.6.4.3 It should be noted that this standard's requirement that a complete liner inspection be performed after the first 3 years of service and every year thereafter should not negate the necessity of conducting a complete liner inspection sooner than the required time frame if circumstances or appearances dictate. For example, inside layers that show marked discoloration or physical deterioration should trigger a complete liner inspection.

A.7.1.1 The importance of maintaining the cleanliness of ensembles and ensemble elements should not be underestimated. Soiled or contaminated ensembles and ensemble elements are a hazard to fire fighters because soils and contaminants can be flammable, toxic, or carcinogenic. Additionally, soiled or contaminated ensembles and ensemble elements can have reduced protective performance. Clean ensembles and ensemble elements offer the emergency responder better protection and can add to the life of the ensemble and ensemble elements. Ensembles and ensemble elements should be cleaned whenever they become soiled.

In everyday use, personal protective equipment gets dirty by the absorption of sweat from the wearer and of soils, soot, and so forth from the outside environment. Cleaning of ensembles and ensemble elements removes those substances. Ensembles and ensemble elements can also become contaminated with other substances, principally hazardous materials, particulates, and body fluids. The removal of those substances is most often referred to as *decontamination*. In structural and proximity fire fighting, both general cleaning and decontamination of ensembles and ensemble elements might be necessary.

Health risks of soiled or contaminated ensembles and ensemble elements. Soiled or contaminated ensembles and ensemble elements can expose fire fighters to toxins and carcinogens that enter the body through ingestion, inhalation, or absorption. Repeated small exposures to some contaminants can add up over time and cause health problems.

Although emphasis is placed on safety to avoid injury or inhalation hazards to personnel working on the fire ground, many of the toxins that lead to health risks are carried away from the fire scene on the personal protective equipment used by the fire fighters.

Toxins that fire fighters come into contact with can be trapped in the fibers of soiled ensembles and ensemble elements or absorbed into the materials themselves. Contact with the soiled ensembles and ensemble elements increases the risk of the toxic contaminants being introduced into the body.

Ensembles and ensemble elements contaminated with body fluids present a potential risk of a communicable disease being transmitted to persons coming into contact with the contaminated ensembles or ensemble elements.

Reduced performance hazards of contaminated ensembles and ensemble elements. Ensembles or ensemble elements laden with particles and chemicals present problems in addition to exposure to toxins, such as the following:

(1) Soiled ensembles and ensemble elements typically reflect less radiant heat. Materials that are saturated with hydrocarbons tend to absorb rather than reflect the radiant heat from a surrounding fire.

(2) Ensembles and ensemble elements heavily contaminated with hydrocarbons are more likely to conduct electricity, increasing the danger to fire fighters entering a building or vehicle where wiring can still be live.

(3) Ensembles and ensemble elements impregnated with oil, grease, and hydrocarbon deposits from soot and smoke can ignite and cause severe burns and injuries, even if the materials are normally flame resistant.

Even though the number of specialized hazardous materials response teams is growing, individual fire fighters still encounter various chemicals in their normal fire fighting activities. Exposure to oils, gasolines, and lubricants can occur around fire station vehicles. During responses, exposure to liquids ranging from pesticides to acids to chemical solvents can occur, knowingly or unknowingly. In addition to being hazardous, such contaminants can also degrade ensembles and ensemble elements as follows:

(1) Fabrics can become weakened and tear more easily.

(2) Thread or seam sealing tape can become loose.

(3) Flame-retarding or water-repelling treatments can be removed.

(4) Visibility markings can lose reflective properties or markings, becoming less visible.

(5) Helmet shells, helmet faceshields, or goggles can pit or craze.

(6) Ensemble and ensemble elements hardware can become corroded.

A.7.1.4 Organizations should consult the local hazardous materials team or health department and seek their assistance in determining what the contaminant(s) is and if the contamination is a true hazardous materials situation. Should it be determined that the contamination is not a hazardous material, advanced cleaning should be performed.

A.7.1.4.2 Organizations should be aware that decontamination of protective equipment is a complicated process and that there is no guarantee that the protective elements will be free from contamination.

While the purpose of decontamination is to remove all contaminant(s) from an ensemble element, decontamination procedures or cleaning processes are not always 100 percent effective in removing all contamination. The actual success of a decontamination process can be determined only by measuring the concentration of the contaminant(s) in the element before and after the selected decontamination or cleaning process. The majority of tests that can be applied for measuring the concentration of contaminant(s) in the element require destructive sampling of the element that may render the element unusable or nonrepairable. The sole evaluation of contamination levels in rinse water is not an appropriate measure of decontamination effectiveness. Claims for protective elements being contaminant free based on statements from ISPs or from the use of specific cleaning products should be viewed with caution.

Procedures used for measuring contamination levels should be specific for the contaminant(s), if known. Useful analytical procedures for measuring levels of semivolatile organic chemicals in materials are found in EPA SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*: Method 3540, “Soxhlet Extraction,” and Method 8270, “Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS).” These procedures involve extracting a small piece of fabric in a solvent such as methylene chloride and analyzing the extract solution using gas chromatography in conjunction with mass spectrometry. The gas chromatography separates chemical contaminants and quantifies their amount, while the mass spectrometry identifies the specific chemical.

Similar analytical procedures for measuring levels of inorganic chemicals (such as heavy metal contaminants like chromium and lead) in materials are found in EPA SW-846: Method 3015, “Microwave Assisted Acid Digestion of Aqueous Samples and Extracts,” and Method 6010, “Inductively Coupled Plasma-Atomic Emission Spectrometry.” These procedures similarly involve analysis of a small material specimen: the specimen is digested in nitric acid and then treated with 50 percent hydrogen peroxide. The solution of the digested specimen is then diluted for analysis by atomic absorption or ion coupled plasma spectroscopy to identify and determine the amount of different inorganic substances.

Because these procedures are very sensitive for quantifying many forms of contamination, any testing for measuring contamination levels should involve control tests. Control tests are separate measurements used to determine other background contamination that might be present in the material or in residue left from the cleaning agents or cleaning procedures. Failure to consider such chemicals can interfere with the accuracy of measurements for actual contaminants. In general, the following control tests are needed:

(1) A test of the same material being analyzed without the contaminant present (this could be taken from personal protective equipment that has a similar history but that was unexposed to the contaminants)

(2) A test of the same material after washing that has been subjected to the cleaning process (this could be accomplished on a piece of new material that has been cleaned using the subject cleaning agent and procedures)

The levels of residual contaminants from these control tests should be subtracted from the after-cleaning samples. The residual contamination from the first control test should be subtracted from the before-cleaning samples.

Decontamination effectiveness can be determined by calculating the proportion of contaminant removed using the following equation:

$$\begin{array}{c}\text{Percent}\\\text{decontamination}\\\text{efficiency}\end{array} = \frac{\text{Initial level of } C - \text{Final level of } C}{\text{Initial level of } C} \times 100$$

where:

C = contaminant

The decontamination effectiveness will vary with each contaminant because some contaminants can be removed more easily than other contaminants, given differences in the properties of the contaminant and the properties of the contaminated element materials. For example, chemicals such as hexane and benzene that evaporate easily usually will be removed relatively easily compared with nonvolatile (nonevaporating) chemicals found in tars and oily chemicals.

The remaining level of contaminant in a protective element can be used to determine the potential risk to the wearer. However, there are no established safe levels of surface concentration for most contaminants. The decision to reuse a protective element based on known, measured levels of contamination should be undertaken by a trained professional familiar with the properties and hazards of the contaminant. Any uncertainty in the risk presented by residual contamination in the protective element can be cause for retirement and disposal of the protective item.

The procedures for measuring contamination levels in protective elements are usually destructive in that they require that a specimen be taken from the protective element and subjected to extraction or digestion with a solvent. This requirement, in addition to the expense of the analytical testing, can make the decision to investigate contamination levels in protective elements cost prohibitive.

Specimens of protective elements taken for determination of contamination levels cannot be representative for all areas of the protective element being sampled. For example, a specimen taken from the pocket of the coat will not reflect the contamination level for the back of the coat or the bottom of the trousers. In addition, sampling of one protective element will not be representative of all elements from a certain group that are or are suspected of being contaminated. Contamination levels for different protective elements of the same type depend on the type of exposure, the condition of the protective element, and the care provided to the protective element.

Concerns over protective element contamination can arise from a single incident involving a contamination event or can be an ongoing consideration as contaminants from routine situations accumulate in the ensemble element(s). Organizations can periodically sample ensemble elements to determine the effectiveness of cleaning processes in removing harmful contaminants, but they should understand the limitations of the approach, specifically that sampling cannot be representative of all the protective ensemble elements in use.

Further details about this information are provided in the report for the U.S. Fire Administration, “Research, Testing, and Analysis on the Decontamination of Fire Fighting Protective Clothing and Equipment.” A synopsis of that report is provided in ASTM STP 1237, *Performance of Protective Clothing.*

A.7.1.6 Members should follow universal precautions when handling cleaning and decontamination of any ensemble or ensemble element contaminated by body fluids. Universal precautions include member self-protection with the use of gloves, aprons, full torso covers, arm covers, and eye/face protection. In addition, cleaning of contaminated ensembles and ensemble elements should take place in a designated area with sinks and counters made of materials, such as stainless steel, that can be adequately decontaminated following an element-cleaning procedure. Organizations should ensure that appropriate decontamination agents are available for member use as well as applicable procedures for each type of ensemble and ensemble element. NFPA 1581, *Standard on Fire Department Infection Control Program*, should be consulted for additional guidance. As a minimum, persons involved in cleaning contaminated ensembles and ensemble elements should wear cleaning gloves, an apron, and a faceshield that conform to NFPA 1999, *Standard on Protective Clothing for Emergency Medical Operations*.

A.7.1.8 Some dry cleaning solvents that are used in lieu of water can damage components of the ensembles and ensemble elements. Reflective trim, helmets, and leather gloves, in particular, can be adversely affected by such solvents. The manufacturer should be consulted prior to dry cleaning to confirm that ensembles and ensemble elements will not be damaged.

A.7.1.9 For ensembles and ensemble elements that are to be cleaned or decontaminated by contract cleaning, the following questions should be asked to determine if the ISP is knowledgeable enough to provide adequate service and not cause damage to the ensembles and ensemble elements:

(1) Can the ensembles or ensemble elements be effectively cleaned or decontaminated? *(See information following this list.)*

(2) Does the ISP have references for cleaning and/or decontamination of ensembles and ensemble elements?

(3) Does the ISP have liability insurance to clean protective clothing (i.e., for the repair or replacement of ensembles and ensemble elements damaged in laundry, from wash water contamination, etc.)?

(4) Does the ISP take reasonable precautions to protect its personnel from contaminant exposures while handling ensembles and ensemble elements?

(5) Is the ISP familiar with the requirements of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, and NFPA 1581, *Standard on Fire Department Infection Control Program*, as well as federal, state, and local regulations?

(6) Does the ISP have a quality assurance program?

(7) What type of process does the ISP use? Are Material Safety Data Sheets (MSDS) available? If the process is proprietary, is it approved by the manufacturer of the ensemble or the ensemble element?

(8) Does the ISP take appropriate steps to prevent cross contamination between any and all products laundered in the facility?

(9) How does the ISP demonstrate the effectiveness of the cleaning process?

(10) What testing or evaluation method(s) are used to ensure that decontaminated ensembles or ensemble elements are truly decontaminated and safe to wear?

(11) Does the ISP comply with applicable federal, state, and local wastewater discharge regulations and standards?

(12) Does the ISP provide delivery and pick-up services for soiled and/or contaminated ensembles and ensemble elements?

(13) Does the ISP have the capability to restore water-repellent properties of ensembles and ensemble elements?

(14) What is the turnaround time?

It is important that the organization request information from the ISP or the cleaning agent supplier about the effectiveness of cleaning agents and cleaning procedures and about the effects of the cleaning agents and cleaning procedures on ensembles and ensemble elements. Although there are few established procedures for making these determinations, the following guidelines are offered.

Request information about the cleaning effectiveness of the process or the cleaning agent. Actual cleaning effectiveness should be demonstrated by washing ensembles or ensemble elements that either have become soiled from use or have been intentionally soiled. Cleaning effectiveness is typically confirmed by a visual comparison of the before and after cleaned samples. It is important to note that ensembles and ensemble elements that appear clean might not be fully clean and can contain chemical contaminants.

Request data about the effects of the cleaning process or cleaning agent on protective ensembles or ensemble elements. The effects of the cleaning agent or cleaning process should be judged on the basis of tests performed on representative material samples following several cleaning cycles (washing and drying). The samples should be subjected to at least 10 cleaning cycles; however, organizations might want suppliers or the ISP to demonstrate effects after as many as 25 cleaning cycles. Ideally, ensemble element(s) should be evaluated for each of the performance properties listed in NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*; however, key properties can be selected. Table A.7.1.9 provides a recommended list of key properties for evaluation.

Table A.7.1.9 Recommended Performance Tests for Evaluating Effects of Cleaning Agents

Performance Property	Test Method*	Type of Sample(s)	Specimens
Thermal protective performance	Section 8.10	Composite	Three 150 r
Flame resistance	Section 8.2	Outer shell, moisture barrier, thermal barrier	Five 75 mm rectangles (
Tear strength	Section 8.12	Outer shell, moisture barrier, thermal barrier	Five 75 mm rectangles (
Tensile strength	Section 8.50	Outer shell	Five 100 m rectangles (
Water absorption	Section 8.26	Outer shell	Three 200 r
Cleaning shrinkage	Section 8.25	Outer shell, moisture barrier, thermal barrier	Five 375 m
Fuel C penetration resistance	Section 8.28	Moisture barrier seams	Three 75 m
Viral penetration	Section 8.29	Moisture barrier seams	Four 75 mn
Retroreflectivity and fluorescence	Section 8.46	Trim sections	Four 305 m

*Sections are from NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire*

†Either specimens removed from ensemble elements or representative material samples.

Other properties can be evaluated that are of interest to the organization, including the following:

(1) Composite weight

(2) Composite thickness

(3) Composite total heat loss (breathability)

(4) Outer shell colorfastness to washing

(5) Outer shell colorfastness to light exposure

(6) Outer shell or thermal barrier abrasion resistance

The effects of cleaning properties are evaluated by comparing the measured property after washing with the same property measured for new material. It is important to review both the after-cleaning level and the change for the measured property. Properties should remain at or above the minimum performance requirements established in NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*. It is also important to take note of large changes in clothing material properties. For example, the tear strength of a material can be measured at a level of 11.4 kg (25 lb) before cleaning and then 10 kg (22 lb) after several cycles, whereas a different material could begin at 18.2 kg (40 lb) and drop to 11.4 kg (25 lb) after the same number of cleaning cycles. This particular case points out that one material might be more susceptible to cleaning.

It is also possible for some measured properties to increase after multiple cleaning cycles. For example, thermal insulation as measured in the thermal protective performance test often improves after cleaning because the thickness (or loft) of the materials increases. Conversely, the total heat loss (THL) value of the same ensemble can decrease as a result of cleaning.

The loss of water absorption resistance for an outer shell can be reduced by the reapplication of water-repellent finishes. It is essential that chemicals used in this process be determined to be safe and without any adverse effects on the ensemble element(s).

In evaluating the effects of cleaning agents or cleaning procedures on ensembles and ensemble elements, it is important to realize that applying multiple cleaning cycles does not simulate its use. Cleaning is but one factor in the “wear” of protective ensemble and ensemble elements. Cleaning when properly applied might also extend the life of the ensemble and ensemble element.

A.7.2.1 Routine cleaning is a light cleaning of ensembles and ensemble elements performed by the end user without the elements being taken out of service. Routine cleaning can be accomplished by brushing off dry debris, rinsing off debris with a water hose, and spot cleaning.

A.7.2.3.1 Routine cleaning immediately after the termination of an incident can remove substantial amounts of surface contaminants before they have a chance to set in and can help limit the transfer of contaminants to apparatus and stations. Many of the contaminants that can cause damage to visibility markings also can be removed if routine cleaning is done as soon as possible after an exposure to those contaminants.

A.7.2.3.6(1) Care must be exercised in the use of aggressive cleaning agents that contain active ingredients such as sodium percarbonate, found in oxy-type additives, and d-limonene, found in citrus-type additives and degreasers, as well as other solvents. Chlorine will damage the fibers of the protective fabrics used in ensemble elements. Use of aggressive cleaning agents must be accomplished in strict accordance with manufacturer’s instructions for such chemicals, or serious damage to the elements can result. Elements that contain leather, such as footwear, helmets, and gloves, are extremely susceptible to damage from such chemicals. In addition, use of those chemicals with more absorbent element materials without extreme care taken to fully rinse out the chemical can create an extremely hazardous condition for the member by impregnating protective elements with a flammable substance.

A.7.2.3.6(2) Water above 40°C (105°F) can cause scalding of the hands when washing is performed in a utility sink. Water above 40°C (105°F) can also cause damage to some components on protective ensemble element(s).

A.7.2.3.6(4) Appropriate precautions should be taken to provide protection from possible exposure to contaminants during the cleaning process.

A.7.3.2 Advanced cleaning is a thorough cleaning of ensembles and ensemble elements accomplished by washing them with cleaning agents. Advanced cleaning usually requires elements to be temporarily taken out of service. Advanced cleaning can be accomplished by hand washing in a utility sink, by machine washing, or by an ISP.

Soiling is not always visible and can be difficult to observe on darkly colored materials. In addition, exposure can occur where ensemble elements are contaminated with fire gases, resulting in ensemble elements that can be relatively unsafe for use. Ensemble elements that have not been cleaned and appear to be unsoiled have been shown to contain numerous fire gas chemicals, including carcinogenic polynuclear aromatic compounds. Periodic cleaning is required to avoid use of ensemble elements that could be contaminated without visible evidence of soiling.

A.7.3.6 Machine cleaning is the most effective method for cleaning ensemble elements such as coats, trousers, coveralls, and hoods. It is the most effective means of loosening and removing dirt, soot, and other debris. Two basic types of automatic washing machines are commonly available for use by end users: top- loading agitator style machines and front-loading washer/extractors. New technologies are emerging every day in the cleaning industry that will affect the options available to both the end user as well as the ISP. It is generally accepted that front-loading machines are more appropriate for protective ensembles and ensemble elements, where allowed by the element manufacturer. It is very important for machine operators to ensure correct water temperatures and proper detergent and additive selection and to carefully monitor and adjust the g forces of the spinning/extraction cycle for each element type being laundered. Careful adherence to manufacturers' recommendations of cleaning processes has a significant impact on cleaning thoroughness and maintenance of protection factors inherent in each element, as well as extending the life expectancy of elements. Some of the advantages and disadvantages of each type of machine follow.

Top-Loading Washers. Top-loading machines are similar to those used in most homes. They use a center post agitator to whisk water through the fibers of garments. They are designed to clean multiple garments of minimum bulk. As a result of the center post agitation, it is generally accepted that top-loading machines are more damaging to ensembles and ensemble elements than front-loading machines. Top-loading, agitating machines have the potential to reduce the longevity of garments due to mechanical damage. If top-loading machines are used, stainless steel wash tubs are recommended to protect against rusting, chipping, and the associated wear on garments.

Front-Loading Washers. Front-loading washers have a door on the front of the machine through which garments are loaded. They clean by lifting garments out of the water and gently dropping them back into the water. These units provide better mechanical action because of the size and type of rotation, as well as the degree of extraction. They have various capacities and are designed to handle heavy loads of bulky items and also to save water and energy. For those reasons, it is generally accepted that front-loading machines are more appropriate for protective clothing.

A.7.3.7(1) For example, no more than one set of garments should be placed in a top-loading machine, and machine manufacturer's instructions should be followed for front-loading machines. Proper load size is essential for effective cleaning.

A.7.3.7(2) The garments should be soaked according to the detergent manufacturer's instructions. The garment should be removed and the soak water should be drained. If necessary, a soft bristle brush should be used to gently scrub the garment. Extra care should be taken with liner assembles.

A.7.3.7(4) It is important to check with the manufacturer as to the appropriate wash temperature for machine washing of protective garments, because different materials and components in the garment can have different susceptibilities to wash temperatures and other washing conditions. For example, leather, rubber-coated materials, and some fluorescent film-based materials can be affected by relatively high wash temperatures and can degrade prematurely when repeatedly washed under those conditions.

A.7.3.7(6) Preliminary research suggests excessive *g* forces created by washing machine drums that spin at high RPMs can damage protective garments. The type and severity of damage will depend on the *g* forces created, exposure time, the number of exposures, condition of the ensemble or ensemble element, and the materials used to construct the ensemble or element. Thermal and moisture barriers are the most vulnerable. Thermal barriers can hold several times their weight in water. Extracting at high RPMs creates very high *g* forces, resulting in the shifting of nonwoven insulating materials. Moisture barrier materials and seams by their very nature are designed to impede the flow of liquid water. Extraction at excessively high RPMs can severely damage moisture barriers and moisture barrier seams as water pushes against the barriers in an attempt to escape toward the outer perimeter of the drum. A vast majority of ISPs are monitoring extraction RPMs and have adjusted their commercial machines to create less than 100 g when cleaning all protective ensembles and ensemble elements. End users should make every effort to control and lower the RPM of laundering machines used for protective ensemble and ensemble elements laundering to preserve the integrity and increase the longevity of PPE elements.

A.7.3.7(7) If the machine does not automatically have a second rinse, an additional complete cycle without detergent should be run.

A.7.3.7(9) When possible, organizations should provide a washing machine(s) for the sole purpose of cleaning protective ensemble elements.

A.7.3.9.2 Ensembles and ensemble elements should be cleaned and decontaminated only with like elements, including but not limited to outer shells with outer shells, liners with liners, hoods with hoods, gloves with gloves, and boots with boots. It is highly recommended that garment liner systems be removed if possible and cleaned separately to avoid contamination with the debris found in the shell. Because the moisture barrier will limit the flow of water through the outer shell fabric, removing the liner will result in better cleaning. Separating the liner from the outer shell will also reduce drying time.

A.7.3.10.1 Advanced cleaning includes washing both the inside and outside surfaces of the helmet carefully, using a soft brush to reach between components and into difficult-to-access spaces, and washing the eye/face protection. It is usually not necessary to completely submerge a helmet for cleaning unless it is being inspected for damage or repairs are being performed in conjunction with the cleaning. The helmet should be thoroughly washed prior to disassembly to prevent the migration of dirt and contamination.

A.7.3.11 The thermal protective capability of leather gloves is seriously degraded when gloves are washed in any machine that develops excessive *g* forces to extract water from the materials. Studies indicate that the outer leather shell material becomes compressed and does not fully recover once dry. This loss of thickness directly relates to a loss of thermal protection as well as a loss of dexterity, both important factors of fire fighter PPE safety. Alternative commercial machine technologies are available that are suitable for gloves but should be used only with approval of the glove manufacturer.

A.7.3.12 Unless specifically approved by the manufacturer, footwear should not be machine laundered. Damage to both the footwear and the machine can result. Alternative commercial machine technologies as well as specific procedures for different footwear materials and construction are available but should be used only after consultation with and approval from the footwear manufacturer.

A.7.4.1 The decision of how to dry ensembles and ensemble elements after cleaning should be made with the following factors in mind:

(1) Time constraints

(2) Effect of the drying method on the ensembles and ensemble elements

A.7.4.2 Air drying is the most appropriate method for drying ensembles and ensemble elements. It causes no mechanical damage and little or no shrinkage. The most efficient method of air drying involves forced air ventilation. This method of drying can be achieved by simply using fans to recirculate air in the room with the ensembles and ensemble elements. The basic drying room should include floor drains, a method to exchange the air to the outside environment, and drying racks for hanging ensembles and ensemble elements to provide maximum air exposure. Overall drying time will depend on the efficiency of the drying room and the ambient conditions. Heating the room or the inlet air up to 38°C (100°F) can further improve the efficiency of the drying process. Drying ensembles and ensemble elements in ambient air, as opposed to drying rooms, takes a considerable length of time, depending on the ambient environmental conditions.

A.7.4.2(1) The use of racks to provide maximum air exposure of the ensembles and ensemble elements will decrease the overall drying time.

A.7.4.2(2) Exposure to direct sunlight will cause degradation of fibers in protective garments, resulting in loss of fabric strength.

A.7.4.3 Machine drying of ensembles and ensemble elements is generally not recommended. Dryers can reach very high basket temperatures during operation, potentially damaging ensemble elements. Machine drying also includes mechanical action that can cause damage to ensembles and ensemble elements.

A.7.4.3(3) “No heat” is the preferred method of machine drying because it effectively accomplishes forced air ventilation.

A.7.4.3(4) Excessive temperatures can cause damage to ensembles and ensemble elements, excessive garment shrinkage, and potentially premature failure and retirement of protective equipment. Temperatures can rise as the garments in the basket dry out.

A.7.4.3(5) Removal of garments before they are completely dry prevents exposure to excessive heat and reduces the potential for premature retirement of ensemble and ensemble elements. Ensembles and ensemble elements should be air dried to complete the drying process. Mechanical dryers may be used on a “no heat” setting.

A.7.4.3(6) Ensembles and ensemble elements should be completely dry before reuse to avoid the potential for steam burns caused by moisture remaining in the layers of the ensemble or ensemble element.

A.8.1.4 Although repairs can bring ensembles or ensemble elements back to a serviceable level of performance, repaired ensembles or ensemble elements may not provide the same levels of protection and performance as new ensembles or ensemble elements.

A.8.2.4 Although some hardware can be replaced in the field, it should be noted that field application might not be as permanent or as strong as when the hardware is replaced at the factory or by a verified ISP.

A.8.4.3 Due to the complexity and specialized equipment needed to conduct moisture barrier repairs, it is mandated that the garment be returned to the manufacturer or to a verified ISP. The equipment needed to conduct these repairs is typically not found in the field but in specialized repair facilities or manufacturing facilities. Moisture barrier materials are found in collars, collar closure systems, and other assemblies, including, but not limited to, storm flaps and sleeve wells.

A.8.4.4 While some loss of quilting threads on thermal liners is the normal result of wear, excessively large areas where quilt stitching is broken or missing can indicate the need to replace the liner.

A.8.4.8 Stress areas are generally considered to be the corners of pockets and flaps, the base of the fly, the top and bottom of the storm flap, and any place where the stitching begins or ends.

A.8.4.10 Depending on the method of construction, broken zippers can be replaced in the field, providing it can be accomplished without causing a breach to any moisture barrier material and without affecting the garment integrity.

A.8.4.11 Depending on the method of construction, hooks and loops can be replaced in the field, providing doing so can be accomplished without causing a breach to any moisture barrier material and without affecting the garment integrity.

A.8.4.12 Reinforcing materials are those fabrics, including, but not limited to, suede leather and outer shell fabrics, that are used to reinforce specific areas of an element, for example, a knee or elbow on a garment.

A.8.5.2 The manufacturer's literature supplied with the helmet should be consulted for disassembly instructions. If the manufacturer's instructions cannot be located, the manufacturer should be contacted for a new set of inspection and maintenance instructions. Accessories to structural fire fighting helmets should include only those items that are provided by or recommended by the manufacturer. Because aftermarket accessories affect the weight and balance of the helmet, they should not be utilized unless they have the approval of the manufacturer. Pre-existing holes should never be enlarged to accommodate aftermarket accessories.

A.9.1 Proper storage of ensembles and ensemble elements extends their life, maintains their performance, and reduces potential health risks. Improper storage can result in damage to the ensemble or ensemble element and can compromise the fire fighter's safety. Certain conditions can result in deterioration of performance of the ensemble or element or create potential health hazards.

A.9.1.1 Ultraviolet (UV) light, especially from sunlight, is a known cause of protective ensemble degradation. Storage in direct sunlight causes degradation of fibers in protective garments, resulting in fabric strength loss, and can cause accelerated aging of other equipment. In addition, other UV light sources, such as fluorescent light, can cause similar degradation, although ongoing research suggests that the degradation from fluorescent light is far less severe than exposure to direct sunlight. Therefore, ensembles and ensemble elements should be stored to minimize exposure to all sources of UV light.

A.9.1.2 Storage of wet or moist ensembles and ensemble elements promotes the growth of mildew and bacteria, which can lead to skin irritation, rashes, or more serious medical conditions. Mildew and bacteria growth can also affect the strength of some materials.

A.9.1.4 Storage in extreme temperatures for extended periods can accelerate deterioration of ensembles and ensemble elements. A cold performance parameter of -32°C (-25°F) is used in NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*. Temperatures above 82°C (180°F) can cause some adhesives to lose their integrity.

A.9.1.6 Soiled ensembles and ensemble elements can present a health risk to individuals who come into contact with them and need to be segregated. To prevent the spread of disease or infections through cross contamination, soiled elements should not be cleaned with other items of clothing or laundry.

A.9.1.7 Storage in contact with hydraulic fluids, solvents, hydrocarbons, hydrocarbon vapors, or other contaminants can cause material degradation, transfer toxins to individuals, and reduce self-extinguishing properties of ensembles and ensemble elements.

A.10.1.1 Retirement criteria should be based on a number of factors, including, but not limited to, the following:

(1) Overall condition of the item

(2) Specific deterioration of materials or components beyond their economic repair

(3) Ability to adequately remove hazardous materials and other contaminants

(4) Age of structural or proximity ensemble or ensemble elements

Physical damage from use, detrimental effects from improper cleaning procedures, and fabric failure of an ensemble and ensemble elements that can make repairs impossible are other factors that can affect when an item should be retired.

Where ensembles and ensemble elements are worn, damaged, or contaminated, organizations should determine if it would be more appropriate for them to be repaired, decontaminated, or replaced. One general guideline is if the cost of the repair or decontamination is greater than 50 percent of the replacement cost of the ensemble or ensemble elements, replacement should be considered. A typical guideline that can be used involves the use of a matrix that takes into account the current age of the gear and the cost of the repair versus the replacement cost of the item. *(See A.10.1.4.)*

Experience suggests that ensembles and ensemble elements that are approaching 10 years since the date of their manufacture have a high likelihood of performance deficiencies in multiple areas that can often be detected only by destructive testing. Additionally, experience suggests that the reflective outer shell of proximity elements that are approaching 5 years since the date of their manufacture have a high likelihood of performance failures that can be detected only by destructive testing. Such performance failures could compromise fire fighter safety.

It is important to understand that the actual service life of ensembles and ensemble elements varies depending on the amount of their use and the care they receive. Factors such as the size of the department, area covered, types of exposures, and the aggressiveness of the individual fire fighter are all considerations in how long any ensemble element will last. It is possible that a protective element could be exposed to circumstances that totally destroy it the first time it is utilized. Since the purpose of fire fighters' protective elements is to protect the wearer, if the element has saved a life or prevented serious injury, even just once, it has done its job. In many cases, an ensemble or ensemble element will need to be retired sooner than 10 years (or 5 years for the proximity reflective outer shell component).

Organizations should use members who have received training in the inspection of ensembles and ensemble elements, who understand the limitations of each ensemble and ensemble element, and who recognize the signs of failure to help make decisions as to the integrity of an ensemble or ensemble element.

An additional consideration that can influence the decision to repair or replace an ensemble or ensemble element centers on the advances in technology that occur through each revision of NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*. These technological advances might be deemed important enough by an organization to influence its criteria for replacement of ensembles or ensemble elements.

A.10.1.2 After discussion of the concept of mandatory retirement for protective elements, the consensus of the technical committee, led by the fire service segment, is that the life of a turnout suit is generally less than 10 years. Regardless of when the element was originally produced, it is imperative that the protective elements be routinely inspected to ensure that they are clean, well maintained, and still safe. Just knowing the age of the elements cannot do that.

A.10.1.3.1 Specific to proximity elements, the consensus of the technical committee is that the life of a proximity outer shell is considerably less than that of a structural shell and that the life span is entirely dependent on the type and amount of field use to which each separate element has been exposed. Given the characteristics of the aluminized outer materials necessary to obtain the required radiant and reflective properties, this type of fabric is especially susceptible to abrasion, which can result in a loss of the protective qualities in a very short time. Regardless of when the element was originally produced, it is imperative that the protective elements be routinely inspected to ensure that they are clean, well maintained, and still safe. Just knowing the age of the elements cannot do that.

A.10.1.4 Organizations can use various methods to determine whether it is cost effective to repair or replace structural ensembles or ensemble elements and proximity ensembles or ensemble elements. One commonly used method involves the use of a matrix that compares factors such as the age of the gear, the cost of the repair, and the replacement cost or the original cost of the ensemble. Table A.10.1.4 is an example of such a matrix.

Table A.10.1.4 Sample Calculator for Turnout Gear Repair Limits

factors such as the age of the gear, the cost of the repair, and the replacement cost of the original cost of the ensemble. Table A.10.1.4 is an example of such a matrix.

Table A.10.1.4 Sample Calculator for Turnout Gear Repair Limits

Year of Service	Year-of-Service End Date	Amount of Original Cost ($1000) Allowed for Repair	Amount Allowed per
1st year	01/11/05	70%	$700
2nd year	01/11/04	50%	$500
3rd year	01/11/03	40%	$400
4th year	01/11/02	25%	$250
5th year	01/11/01	20%	$200
6th year	01/11/00	15%	$150
7th year	01/11/99	10%	$100
8th year	01/11/98	5%	$50
9th year	01/11/97	5%	$50
10th year	01/11/96	0%	$0

A.10.1.5 All structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements are required by NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, to be certified by an independent, third-party certification organization. For an ensemble or ensemble element to meet the requirements of NFPA 1971, the item should carry a statement on the product label stating compliance and the label, symbol, or other identifying mark of that certifying organization.

Third-party certification is an important means of ensuring the quality of ensembles and ensemble elements. To be certain than an item is properly certified, labeled, and listed, NFPA strongly recommends that prospective purchasers require appropriate evidence of certification for the specific product and model from the manufacturer before purchase. Prospective purchasers also should contact the certification organizations and request copies of the certification organization’s list of certified products to the appropriate NFPA standard. This listing is required for third-party certification by NFPA 1971 and is a service performed by the certification organization.

Details about certification and product labeling can be found in Chapters 4 and 5 of NFPA 1971. Also, the definitions of *certification/certified* in NFPA 1971, Section 3.3, and *labeled* and *listed* in Section 3.2 of this standard should be reviewed.

From time to time, NFPA receives complaints that certain items of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements might be carrying labels falsely identifying them as compliant with an NFPA standard. NFPA advises those purchasing structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements to be aware that any structural fire fighting ensemble or ensemble element or proximity fire fighting ensemble or ensemble element that does not bear the appropriate compliance statement AND the mark of an independent, third-party certification organization is NOT COMPLIANT with NFPA 1971, even if the product label states that the ensemble or ensemble element is compliant.

When an organization is in doubt as to the authenticity of a certification claim, the certification organization or the consumer protection agency of the state/provincial government should be contacted *directly*.

A.10.1.8 Changes in the type of structural fire fighting ensembles and ensemble elements and proximity fire fighting ensembles and ensemble elements used by a fire department can result in the retirement of elements that have not yet reached the end of their service life. Items of no further use to the organization in front line service might be of use for training or donation to other organizations.

A.10.3.1 When developing these procedures, the organization should coordinate with other agencies such as the medical examiner, law enforcement, or other experts to determine what actions are appropriate. Organizations can find additional guidance related to the processing of structural ensembles and ensemble elements and proximity ensembles and ensemble elements that are directly related to serious fire fighter injuries and fire fighter fatalities in the International Association of Fire Fighters manual, “Line of Duty Notification, Assistance, and Investigation Policy,” available at www.iaff.org/safe/lodd.html, and the International Association of Fire Chiefs guide for investigating a line-of-duty death, “LODD Response Plan,” available at www.iafc.org.

A.11.2.1 The certification organization should have a sufficient breadth of interest and activity so that the loss or award of a specific business contract would not be a determining factor in the financial well-being of the agency.

A.11.2.5 The contractual provisions covering verification programs should contain clauses advising the organization or ISP that, if requirements change, the process should be brought into compliance with the new requirements by a stated effective date through a compliance review program involving all currently verified repairs. Without such clauses, certification organizations would not be able to move quickly to protect their names, marks, or reputations. A verification program would be deficient without these contractual provisions and the administrative means to back them up.

A.11.2.7 Investigative procedures are important elements of an effective and meaningful verification program. A preliminary review should be carried out on processes submitted to the agency before any major testing is undertaken.

A.11.2.12 Such inspections should include witnessing of repairs and review of the quality management system.

A.12.1.1 Interior portions of the liner are difficult to inspect and evaluate because the portions can be hidden from view. From the exterior, a thermal barrier may appear to be acceptable for use, but it might be unsafe due to shifting or migration of the insulating material.

A.12.2.1 It is important to realize that this field evaluation procedure can produce results that are inconsistent with more comprehensive or sophisticated testing and might detect only the worst-case failure areas. To perform more comprehensive or sophisticated testing of the moisture barrier, the garment manufacturer should be contacted for advice.

A.12.2.3.1 If there are questions about using an alcohol–tap water mixture for evaluating the protective garment, the garment manufacturer should be contacted directly for advice.

A.12.3.3.1 An evaluation apparatus meeting these requirements is specified in AATCC 127, *Water Resistance: Hydrostatic Pressure Test.* The method of pressurization can be automatic or manual.

Annex B Informational References

B.1 Referenced Publications.

The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1041, *Standard for Fire Service Instructor Professional Qualifications*, 2007 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 2007 edition.

NFPA 1521, *Standard for Fire Department Safety Officer*, 2008 edition.

NFPA 1581, *Standard on Fire Department Infection Control Program*, 2005 edition.

NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*, 2007 edition.

NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*, 2005 edition.

NFPA 1994, *Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents*, 2007 edition.

NFPA 1999, *Standard on Protective Clothing for Emergency Medical Operations*, 2003 edition.

B.1.2 Other Publications.

B.1.2.1 AATCC Publications.

AATCC 127, *Water Resistance: Hydrostatic Pressure Test*, 2003.

B.1.2.2 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI/ASSE Z87.1, *Occupational and Educational Personal Eye and Face Protection Devices*, 2003.

B.1.2.3 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM F 1731, *Standard Practice for Body Measurements and Sizing of Fire and Rescue Services Uniforms and Other Thermal Hazard Protective Clothing*, 1996 (2002) edition.

ASTM F 1930, *Standard Test Method for Evaluation of Flame Resistant Clothing for Protection Against Flash Fire Simulations Using an Instrumented Manikin*, 2000.

ASTM STP 1237, *Performance of Protective Clothing*, 5th Volume, 1996.

B.1.2.4 EPA Publications. U.S. Environmental Protection Agency publications provided by the U.S. Government Printing Office, Superintendent of Documents, Washington, DC 20402-9325.

EPA SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (The specific methods cited can be downloaded at http://www.epa.gov/epaoswer/hazwaste/test/SW846.htm): Method 3015, "Microwave Assisted Acid Digestion of Aqueous Samples and Extracts," September 1994; Method 3540, "Soxhlet Extraction," Revision 3, December 1996; Method 6010, "Inductively Coupled Plasma-Atomic Emission Spectrometry," Revision 2, December 1996; and Method 8270, "Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS)," Revision 3, December 1996.

B.1.2.5 IAFC Publications. International Association of Fire Chiefs, 4025 Fair Ridge Drive, Suite 300, Fairfax, VA 22033-2868, www.iafc.org.

"LODD Response Plan" (downloadable from IAFC website; click on Resources, Download Documents, Health & Safety, Line of Duty Deaths, Investigation).

B.1.2.6 IAFF Publications. International Association of Fire Fighters, 1750 New York Avenue, N.W., Washington, DC 20006.

"Line of Duty Notification, Assistance, and Investigation Policy," www.iaff.org/safe/lodd.html.

B.1.2.7 ISO Publications. International Organization for Standardization, 1, rue de Varembé, Case postale 56, CH-1211 Geneve 20, Switzerland.

ISO/IEC Guide 65, *General requirements for bodies operating product certification systems*, 1996 edition.

B.1.2.8 USFA Publications. U.S. Fire Administration, 16825 South Seton Avenue, Emmitsburg, MD 21727.

Research, Testing, and Analysis on the Decontamination of Fire Fighting Protective Clothing and Equipment.

B.1.2.9 U.S. Government Publications. U.S. Government Printing Office, Superintendent of Documents, Washington, DC 20402-9325, Phone: 202-512-1800 (www.gpo.gov)

Title 29, Code of Federal Regulations, Part 1910.120, "Hazardous Waste Operations and Emergency Response," August 22, 1994.

B.2 Informational References. (Reserved)

B.3 References for Extracts in Informational Sections. (Reserved)

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NFPA® 1901

Standard for

Automotive Fire Apparatus

2009 Edition

This edition of NFPA 1901, *Standard for Automotive Fire Apparatus*, was prepared by the Technical Committee on Fire Department Apparatus. It was issued by the Standards Council on May 30, 2008, with an effective date of July 18, 2008, and supersedes all previous editions.

This edition of NFPA 1901 was approved as an American National Standard on July 18, 2008.

Origin and Development of NFPA 1901

The 2009 edition of NFPA 1901 is a general update of the 2003 edition. The text has been reorganized to present the requirements better, text has been added to clarify requirements, and the requirements for delivery of documentation and test results with the apparatus have been standardized. Annex material has been added throughout to assist the user in understanding and meeting the requirements.

A new chapter on trailers transporting equipment or other vehicles under emergency response conditions has been added, and changes have been made throughout the document where necessary to address the requirements for the vehicle that is going to tow the trailer. A requirement has been added for a vehicle data recorder to capture data that can be used to promote safe driving and riding practices. The requirements for vehicle stability have been changed to require tilt table testing, a calculated center of gravity no higher than 80 percent of vehicle height, or a vehicle stability system.

This edition introduces the concept of estimated in-service weight as a basis for designing the apparatus and measuring certain stability requirements and links the maximum top speed of the apparatus to the GVWR and agent tank capacity or the tire manufacturer's ratings.

A “Statement of Exceptions” requires the manufacturer to deliver either a certification that the apparatus meets the standard or a statement that describes specifically what is not fully compliant and identifies who is responsible for achieving compliance.

Because diesel particulate filters are being installed on fire apparatus, requirements for operation and performance of those devices have been added.

Requirements for the minimum length of seat belts have been established, together with instruction for how they are measured. A seat belt warning device to indicate when seat belts are not being properly used is required. The new requirements also allow seat belts to be bright orange in addition to red.

The cabs on apparatus with a GVWR over 26,000 lb (11,800 kg) must meet standards on occupant protection during crashes. In addition, the document discourages the wearing of fire helmets in the cab and requires provisions for proper storage of helmets while the vehicle is moving.

More specific requirements for the retroreflective material used for striping apparatus have been added, and striping on the rear of the apparatus has been changed to require retroreflective striping in a chevron pattern sloping downward and away from the centerline of the vehicle at an angle of 45 degrees.

The chapter on industrial supply pumps [rated over 3000 gpm (12,000 L/min)] has been integrated with the chapter on fire pumps [rated 3000 gpm (12,000 L/min) or less], and differences in requirements based on rated capacity are spelled out in the revised fire pump chapter. A requirement has been added for testing the accuracy of the gauges and flowmeters during the pump certification testing.

A change to the aerial ladder and elevating platform requirements allows for electronic envelop control, with electronics and interlocks used to prevent an aerial device from moving into an area where it cannot support its rated capacity.

Foam systems are required to be type tested for accuracy and certified by the system manufacturer and, after installation, to be tested and certified by the final installer for proper operation.

In addition to reorganization of material in the line voltage electrical system chapter for clarification, changes include requiring the protective ground from a shoreline inlet to be bonded to the vehicle frame, requiring the neutral conductor to be switched through the transfer switch if there are multiple power sources, establishing a minimum wire size for cord on permanently mounted reels, requiring fixed scene lighting devices to be tested and listed, and additional testing.

In Chapter 24, Air Systems, requirements for who is to train fire department personnel have been revised. A high-temperature alarm is required in the compressor compartment together with a label cautioning users not to obstruct the airflow. Compressors are required to be equipped with an air quality–monitoring system. If a compressor is driven by an electric motor, a shoreline connection to the electric motor is required. High-pressure air hose and couplings are to have a pressure rating equal to or greater than the highest pressure expected to be encountered, with a safety factor of 4 to 1. Requirements for the testing and certification of breathing air fill stations have been changed to add systems filling SCUBA, the section on system testing is now specific to breathing air systems, and a new section has been added for testing utility air systems.

See Annex E for a complete history of the standard.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the design and performance of fire apparatus for use by the fire service.

NFPA 1901
Standard for
Automotive Fire Apparatus
2009 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex F. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex F.

Chapter 1 Administration

1.1* Scope.

This standard defines the requirements for new automotive fire apparatus and trailers designed to be used under emergency conditions to transport personnel and equipment and to support the suppression of fires and mitigation of other hazardous situations.

1.2 Purpose.

This standard specifies the minimum requirements for new automotive fire apparatus and trailers.

1.3 Application.

1.3.1* This standard shall apply to new fire apparatus that meet the following criteria:

(1) That have 10,000 lb (4500 kg) or greater gross vehicle weight rating (GVWR) or are trailers intended to be towed by fire apparatus under emergency response conditions

(2) That are designed for use under emergency conditions to transport personnel and equipment and to support the suppression of fires and mitigation of other hazardous situations

(3) That are contracted for on or after January 1, 2009

1.3.2 Nothing shall prevent the use of the standard prior to January 1, 2009, if the purchaser and the contractor both agree.

1.3.3 This standard shall not apply to wildland fire apparatus, which are covered by NFPA 1906, *Standard for Wildland Fire Apparatus*.

1.4* Retroactivity.

This standard shall not be applied retroactively.

1.5 Equivalency.

Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.5.1 The technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.6* Units and Formulas.

In this standard, values for measurement in U.S. units are followed by equivalents in SI units. Either set of values can be used, but the same set of values (either U.S. units or SI units) shall be used consistently.

Chapter 2 Referenced Publications

2.1 General.

The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471, www.NFPA.org.

NFPA 70®, *National Electrical Code®*, 2008 edition.

NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus*, 2007 edition.

NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders*, 2004 edition.

NFPA 1961, *Standard on Fire Hose*, 2007 edition.

NFPA 1963, *Standard for Fire Hose Connections*, 2003 edition.

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, 2007 edition.

NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services*, 2006 edition.

NFPA 1989, *Standard on Breathing Air Quality for Emergency Services Respiratory Protection*, 2008 edition.

2.3 Other Publications.

2.3.1 ANSI Publications.

American National Standards Institute, Inc., 25 West 43rd Street, 4th floor, New York, NY 10036.

ANSI A14.2, *Ladders — Portable Metal — Safety Requirements*, 2007.

ANSI A14.5, *Ladders — Portable Reinforced Plastic — Safety Requirements*, 2007.

ANSI Z535.4, *Product Safety Signs and Labels*, 2007.

2.3.2 ASME Publications.

American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990, www.ASME.org/codes.

Boiler and Pressure Vessel Code, Section VIII, Division 1 and Division 2, 2007.

ASME B40.100, *Pressure Gauges and Gauge Attachments*, 2005.

2.3.3 ASNT Publications.

American Society for Nondestructive Testing, Inc., 1711 Arlingate Lane, Columbus, OH 43228-0518, www.ASNT.org.

ASNT CP-189, *Standard for Qualification and Certification of Nondestructive Testing Personnel*, 2006.

2.3.4 ASTM Publications.

ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, www.ASTM.org.

ASTM B 647, *Standard Test Method for Indentation Hardness of Aluminum Alloys by Means of a Webster Hardness Gage*, 1984 (reconfirmed 2006).

ASTM B 648, *Standard Test Method for Indentation Hardness of Aluminum Alloys by Means of a Barcol Impressor*, 1978 (reconfirmed 2006).

ASTM D 4956, *Standard Specification for Retroreflective Sheeting for Traffic Control*, 2007e1.

ASTM E 6, *Standard Terminology Relating to Methods of Mechanical Testing*, 2007a.

ASTM E 10, *Standard Test Method for Brinell Hardness of Metallic Materials*, 2007a.

ASTM E 18, *Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials*, 2007.

ASTM E 92, *Standard Test Method for Vickers Hardness of Metallic Materials*, 1982 (reconfirmed 2003).

ASTM E 114, *Standard Practice for Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method*, 1995 (reconfirmed 2005).

ASTM E 165, *Standard Test Method for Liquid Penetrant Examinations*, 2002.

ASTM E 569, *Standard Practice for Acoustic Emission Monitoring of Structures During Controlled Stimulation*, 2007.

ASTM E 650, *Standard Guide for Mounting Piezoelectric Acoustic Emission Sensors*, 1997 (reconfirmed 2007).

ASTM E 709, *Standard Guide for Magnetic Particle Testing*, 2008.

ASTM E 797, *Standard Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method*, 2005.

ASTM E 1004, *Standard Practice for Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method*, 2002.

2.3.5 AWS Publications.

American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126, www.AWSpubs.org.

AWS B1.10, *Guide for the Nondestructive Examination of Welds*, 1999.

AWS D1.1, *Structural Welding Code — Steel*, 2006.

AWS D1.2, *Structural Welding Code — Aluminum*, 2003.

AWS D1.3, *Structural Welding Code — Sheet Steel*, 2007.

2.3.6 CGA Publications.

Compressed Gas Association, 1725 Jefferson Davis Highway, Suite 1004, Arlington, VA 22202, www.CGAnet.com.

G-7, *Compressed Air for Human Respiration*, 2008.

G-7.1, *Commodity Specification for Air*, 2004.

2.3.7 CSA Publications.

Canadian Standards Association, 5060 Spectrum Way, Mississauga, ON L4W 5N6, Canada, www.CSA.ca.

CSA W47.1, *Certification of Companies for Fusion Welding of Steel*, 2003.

CSA W47.2, *Certification of Companies for Fusion Welding of Aluminum*, 1987 (reconfirmed 2008).

2.3.8 ISEA Publications.

International Safety Equipment Association, 1901 North Moore Street, Arlington, VA 22209-1762, www.safetyequipment.org.

ANSI/ISEA 207, *Standard for High-Visibility Public Safety Vests*, 2006.

2.3.9 ISO Publications.

International Standards Organization, 1 rue de Varembé, Case Postale 56, CH-1211 Genéve 20, Switzerland, www.standardsinfo.net.

ISO/IEC 17020, *General criteria for the operation of various types of bodies performing inspection*, 1998.

ISO/IEC Guide 65, *General requirements for bodies operating product certification systems*, 1996.

2.3.10 Parker Hannifin, Racor Division Publications.

Parker Hannifin, Racor Division, Attn: Dan Haggard, 805 West Street, Holly Springs, MS 38634.

LF 1093-90, *Ember Separation Test Procedure*, January 2003.

2.3.11 SAE Publications.

Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096, www.SAE.org.

SAE J156, *Fusible Links*, 2005.

SAE J541, *Voltage Drop for Starting Motor Circuits*, 1996.

SAE J551/1, *Performance Levels and Methods of Measurement of Electromagnetic Compatibility of Vehicles, Boats (up to 15 m), and Machines (16.6 Hz to 18 GHz)*, 2006.

SAE J553, *Circuit Breakers*, 2004.

SAE J554, *Electric Fuses (Cartridge Type)*, 1987.

SAE J560, *Primary and Auxiliary Seven Conductor Electrical Connector for Truck-Trailer Jumper Cable*, 2004.

SAE J575, *Test Methods and Equipment for Lighting Devices and Components for Use on Vehicles Less Than 2032 mm in Overall Width*, 2007.

SAE J578, *Color Specification*, 2006.

SAE J595, *Directional Flashing Optical Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles*, 2005.

SAE J683, *Tire Chain Clearance — Trucks, Buses (Except Suburban, Intercity, and Transit Buses), and Combinations of Vehicles*, 1985.

SAE J833, *Human Physical Dimensions*, 1989.

SAE J845, *Optical Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles*, 2007.

SAE J994, *Alarm — Backup — Electric, Laboratory Performance Testing*, 2003.

SAE J1127, *Low Voltage Battery Cable*, 2005.

SAE J1128, *Low Voltage Primary Cable*, 2005.

SAE J1292, *Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring*, 1981.

SAE J1318, *Gaseous Discharge Warning Lamp for Authorized Emergency, Maintenance, and Service Vehicles*, 1998.

SAE J1330, *Photometry Laboratory Accuracy Guidelines*, 2007.

SAE J1690, *Flashers*, 1996.

SAE J1849, *Emergency Vehicle Sirens*, 2008.

SAE J1888, *High Current Time Lag Electric Fuses*, 1990.

SAE J1889, *L.E.D. Signal and Marking Lighting Devices*, 2005.

SAE J2077, *Miniature Blade Type Electrical Fuses*, 1990.

SAE J2180, *A Tilt Table Procedure for Measuring the Static Rollover Threshold for Heavy Trucks*, 1998.

SAE J2394, *Seven-Conductor Cable for ABS Power — Truck and Bus*, 2007.

SAE J2420, *COE Frontal Strength Evaluation — Dynamic Loading Heavy Trucks*, 2003.

SAE J2422, *Cab Roof Strength Evaluation — Quasi-Static Loading Heavy Trucks*, 2003.

2.3.12 TRA Publications.

The Tire and Rim Association, Inc., 175 Montrose West Ave., Copley, OH 44321, www.US-TRA.org.

Tire and Rim Association — Year Book, 2008.

2.3.13 UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096, www.UL.com.

ANSI/UL 153, *Standard for Portable Electric Luminaires*, 2005, with revisions through May 10, 2006.

ANSI/UL 498, *Standard for Safety Attachment Plugs and Receptacles*, 2007.

ANSI/UL 969, *Standard for Marking and Labeling Systems*, 2006.

ANSI/UL 1598, *Standard for Luminaires*, 2004, with revisions through May 31, 2006.

2.3.14 UNECE Publications.

UN Economic Commission for Europe, Palais des Nations, CH – 1211, Geneva 10 Switzerland, www.UNECE.org.

ECE Regulation number 29, *Uniform Provisions Concerning the Approval of Vehicles with Regard to the Protection of the Occupants of the Cab of a Commercial Vehicle*, 2007.

2.3.15 U.S. Government Publications.

U.S. Government Printing Office, Washington, DC 20402, www.gpo.gov.

Title 29, Code of Federal Regulations, Part 1910.169, “Air receivers.” 29 CFR 1910.169.

Title 49, Code of Federal Regulations, Part 178.37, “Specification 3AA and 3AAX, seamless steel cylinders.” 49 CFR 178.37.

Title 49, Code of Federal Regulations, Part 393.94, “Interior noise levels in power units, paragraph (c), Test procedure.” 49 CFR 393.94.

Title 49, Code of Federal Regulations, Part 567, “Certification.” 49 CFR 567.

Title 49, Code of Federal Regulations, Part 571, Subpart B, “Federal Motor Vehicle Safety Standards,” No. 108, “Lamps, reflective devices, and associated equipment.” 49 CFR 571.108.

Title 49, Code of Federal Regulations, Part 571, Subpart B, “Federal Motor Vehicle Safety Standards,” No. 209, “Seat belt assemblies.” 49 CFR 571.209.

Title 49, Code of Federal Regulations, Part 571, Subpart B, “Federal Motor Vehicle Safety Standards,” No. 210, “Seat belt assembly anchorages.” 49 CFR 571.210.

Title 49, Code of Federal Regulations, Part 571, Subpart B, “Federal Motor Vehicle Safety Standards,” No. 302, “Flammability of interior materials.” 49 CFR 571.302.

2.3.16 Other Publications.

Merriam-Webster’s Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 70®, National Electrical Code®, 2008 edition.

NFPA 1150, *Standard on Foam Chemicals for Fires in Class A Fuels*, 2004 edition.

NFPA 1451, *Standard for a Fire Service Vehicle Operations Training Program,* 2007 edition.

NFPA 1932, *Standard on Use, Maintenance, and Service Testing of In-Service Fire Department Ground Ladders,* 2004 edition.

NFPA 1989, *Standard on Breathing Air Quality for Emergency Services Respiratory Protection,* 2008 edition.

Chapter 3 Definitions

3.1 General.

The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

3.3.1 Acceptance. An agreement between the purchasing authority and the contractor that the terms and conditions of the contract have been met.

3.3.2 Acceptance Tests. Tests performed on behalf of or by the purchaser at the time of delivery to determine compliance with the specifications for the fire apparatus.

3.3.3 Access Ladder. One or more rungs (of any shape) for climbing that have a degree of inclination between 60 and 90 degrees.

3.3.4 Active Horizontal Angles of Light Emission. The angles, measured in a horizontal plane passing through the optical center of the optical source, as specified by the manufacturer of the optical device, between which the optical source contributes optical power.

3.3.5 Aerial Device. An aerial ladder, elevating platform, or water tower that is designed to position personnel, handle materials, provide continuous egress, or discharge water.

3.3.6 Aerial Fire Apparatus. A vehicle equipped with an aerial ladder, elevating platform, or water tower that is designed and equipped to support fire fighting and rescue operations by positioning personnel, handling materials, providing continuous egress, or discharging water at positions elevated from the ground.

3.3.7 Aerial Ladder. A self-supporting, turntable-mounted, power-operated ladder of two or more sections permanently attached to a self-propelled automotive fire apparatus and designed to provide a continuous egress route from an elevated position to the ground.

3.3.8 Air Control Panel. A consolidated arrangement of valves, regulators, gauges, and air system piping at a location that allows the operator to monitor and control the airflow and pressure within the air system from a centralized location.

3.3.9 Air Quality Monitors. Electronic instruments that monitor the air for such elements as carbon monoxide levels and moisture levels and that are capable of sending a signal to automatically shut down the air system.

3.3.10* Air Tank. A storage vessel meeting the requirements of either U.S. Department of Transportation (DOT) or American Society of Mechanical Engineers (ASME) and used to store an accumulation of air under pressure.

3.3.11 Angle of Approach. The smallest angle made between the road surface and a line drawn from the front point of ground contact of the front tire to any projection of the apparatus in front of the front axle.

3.3.12 Angle of Departure. The smallest angle made between the road surface and a line drawn from the rear point of ground contact of the rear tire to any projection of the apparatus behind the rear axle.

3.3.13 Articulating Boom. An aerial device consisting of two or more folding boom sections whose extension and retraction modes are accomplished by adjusting the angle of the knuckle joints.

3.3.14 ASME Pressure Vessel. A pressure vessel used for the storage or accumulation of air or gas under pressure that is constructed and tested in accordance with the ASME *Boiler and Pressure Vessel Code*.

3.3.15 Authorized Person. A person approved or assigned to perform specific types of duties or to be at a specific location at the job site.

3.3.16 Automatic Electrical Load Management System. A device that continuously monitors the electrical system voltage and automatically sheds predetermined loads in a selected order to prevent overdischarging of the apparatus' batteries.

3.3.17 Auxiliary Braking System. A braking system in addition to the service brakes, such as an engine retarder, transmission retarder, driveline retarder, or exhaust retarder.

3.3.18 Auxiliary Hydraulic Power. A small gasoline engine, diesel engine, or electric motor–driven hydraulic pump used to operate an aerial device in an emergency or in lieu of the main hydraulic system.

3.3.19 Auxiliary Pump. A water pump mounted on the fire apparatus in addition to a fire pump and used for fire fighting either in conjunction with or independent of the fire pump.

3.3.20 Back-Up Alarm. An audible device designed to warn that the fire apparatus is in reverse gear.

3.3.21 Base Rail. The lower chord (rail) of an aerial ladder to which rungs and reinforcements are attached.

3.3.22 Base Section. The first or bottom section of an aerial device.

3.3.23 Bonded (Bonding). Connected to establish electrical continuity and conductivity.

3.3.24 Boom. An assembled section of an aerial device. The boom construction can be of the stressed skin box beam–type, the trussed lattice–type, or the open “U” truss–type design.

3.3.25 Booster Pump. See 3.3.19, *Auxiliary Pump*.

3.3.26 Booster Supplied Air System. A system that is capable of increasing air pressure from an air storage system or a compressor system.

3.3.27 Breathing Air. A respirable gas mixture derived from either normal atmospheric air or from manufactured synthetic air, stored in a compressed state in storage cylinders and respirator breathing air cylinders, and supplied to the user in gaseous form. [**1989,** 2008]

3.3.28 Breathing Air System. The complete assembly of equipment such as compressors, a purification system, pressure regulators, safety devices, manifolds, air tanks or receivers, and interconnected piping required to deliver breathing air.

3.3.29 Bubble (Foam). A thin-walled, roughly spherical film of liquid inflated with air.

3.3.30 Bulk Air System. A method of piping air tanks together to allow air to be supplied to an air system or SCBA fill station, using one or more tanks where all tanks are used simultaneously and are at the same pressure.

3.3.31 Burst Pressure. The pressure at which a hydraulic component fails due to stresses induced as a result of the pressure.

3.3.32 Carbon Monoxide Monitor. A monitoring device that samples a purified air stream for trace elements of carbon monoxide (CO).

3.3.33 Cascade System. A method of piping air tanks together to allow air to be supplied to the SCBA fill station using a progressive selection of tanks each with a higher pressure level.

3.3.34 Center of Gravity. The point at which the entire weight of the fire apparatus is considered to be concentrated so that, if supported at this point, the apparatus would remain in equilibrium in any position.

3.3.35 Chassis. The basic operating motor vehicle including the engine, frame, and other essential structural and mechanical parts, but exclusive of the body and all appurtenances for the accommodation of driver, property, passengers, appliances, or equipment related to other than control. Common usage might, but need not, include a cab (or cowl).

3.3.36 Class A Foam. Foam for use on fires in Class A fuels. [**1150,** 2004]

3.3.37 Class A Fuel. Materials such as vegetation, wood, cloth, paper, rubber, and some plastics in which combustion can occur at or below the surface of the material. [**1150,** 2004]

3.3.38 Class B Fire. A fire in flammable liquids, combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, alcohols, and flammable gases.

3.3.39 Class B Foam. Foam intended for use on Class B fires.

3.3.40 Combination Vehicle. A vehicle consisting of a towing vehicle and one or more towed units.

3.3.41 Command and Communications Apparatus. A fire apparatus used primarily for communications and incident command.

3.3.42* Compound Gauge. A gauge that indicates pressure both above and below atmospheric pressure.

3.3.43* Compressed Air Foam System (CAFS). A foam system that combines air under pressure with foam solution to create foam.

3.3.44 Continuous Duty. Operation at a substantially constant load for an indefinitely long time.

3.3.45 Continuous Egress. A continuous exit or rescue path down an aerial device from an elevated position to the ground.

3.3.46* Contractor. The person or company responsible for fulfilling an agreed upon contract.

3.3.47 Convenient Reach. The ability of the operator to manipulate the controls from a driving/riding position without excessive movement away from the seat back or without excessive loss of eye contact with the roadway.

3.3.48 Dead Load. The weight of the aerial device structure and all materials, components, mechanisms, or equipment permanently fastened thereto.

3.3.49 Defect. A discontinuity in a part or a failure to function that interferes with the service or reliability for which the part was intended.

3.3.50 Discharge Outlet Size. The nominal size of the first fire hose connection from the pump on a discharge.

3.3.51 Documentation. Any data or information supplied by the manufacturer or contractor relative to the apparatus, including information on its operation, service, and maintenance.

3.3.52 DOT Cylinder. A pressure vessel constructed and tested in accordance with Title 49 CFR 178.37 that is used for the storage and transportation of air under pressure.

3.3.53 Drain Time (Foam). The time period it takes for a specified percent of the total solution contained in the foam to revert to liquid and to drain out of the bubble structure.

3.3.54 Dry Location. A location not normally exposed to moisture such as in the interior of the driving or crew compartment, the interior of a fully enclosed walk-in fire apparatus body, or a watertight compartment opened only for maintenance operations.

3.3.55 Dump Valve. A large opening from the water tank of a mobile water supply apparatus for unloading purposes.

3.3.56* Eductor. A device placed in a hose line or a discharge pipe that incorporates a venturi and proportions foam concentrate or other fire fighting agents into the water stream.

3.3.57* Electric Siren (Electromechanical). An audible warning device that produces sound by the use of an electric motor with an attached rotating slotted or perforated disc.

3.3.58 Electrical Equipment. See 3.3.67, Fixed Electrical Equipment, and 3.3.130, Portable Electrical Equipment.

3.3.59* Electronic Siren. An audible warning device that produces sound electronically through the use of amplifiers and electromagnetic speakers.

3.3.60 Elevating Platform. A self-supporting, turntable-mounted device consisting of a personnel-carrying platform attached to the uppermost boom of a series of power-operated booms that articulate, telescope, or both and that are sometimes arranged to provide the continuous egress capabilities of an aerial ladder.

3.3.61 Enclosed Compartment. An area designed to protect stored items from environmental damage (weather resistant) that is confined on six sides and equipped with an access opening(s) that can be closed and latched.

3.3.62 Estimated In-Service Weight. The amount that the fire apparatus manufacturer estimates the apparatus will weigh when it is placed in service with all fixed and portable equipment installed, all tanks full, and all personnel seating positions occupied.

3.3.63 Expansion Ratio. The ratio of the volume of foam in its aerated state to the original volume of nonaerated foam solution.

3.3.64 Exterior. A nonsheltered location exposed to the environment, either continuously or intermittently.

3.3.65 Fire Apparatus. A vehicle designed to be used under emergency conditions to transport personnel and equipment, and to support the suppression of fires and mitigation of other hazardous situations.

3.3.66 Fire Pump. A water pump with a rated capacity of 250 gpm (1000 L/min) through 3000 gpm (12,000 L/min at 150 psi (1000 kPa) net pump pressure, or a water pump with rated capacity over 3000 gpm (12,000 L/min) at 100 psi (700 kPa) net pump pressure, that is mounted on a fire apparatus and used for fire fighting.

3.3.67 Fixed Electrical Equipment. Any electrical equipment that is not removable without the use of tools or is hard wired to the vehicle's electrical system.

3.3.68 Fixed Power Source. Any line voltage power source except a portable generator.

3.3.69 Fly Section. Any section of an aerial telescoping device beyond the base section.

3.3.70 FMVSS. Abbreviation for Federal Motor Vehicle Safety Standards. Regulations promulgated by the National Highway Transportation Safety Administration (NHTSA) of the United States under Public Law 89-563, which are mandatory and must be complied with when motor vehicles or items of motor vehicle equipment are manufactured and certified thereto.

3.3.71 Foam. An aerated fire-extinguishing solution created by mixing air into foam solution to form bubbles.

3.3.72 Foam Concentrate. Foam fire-fighting agent as received from the manufacturer that must be diluted with water to make foam solution.

3.3.73 Foam Proportioner. A device or method to add foam concentrate to water to make foam solution.

3.3.74 Foam Proportioning System. The apparatus and techniques used to mix concentrate with water to make foam solution.

3.3.75 Foam Solution. A homogeneous mixture of water and foam concentrate in the proper proportions.

3.3.76 Fully Enclosed Personnel Area. A driver or passenger compartment on the fire apparatus that provides total enclosure on all sides, top, and bottom and has positive latching on all access doors.

3.3.77 Gallon. United States gallon.

3.3.78 Gauge. A visual device that indicates a measurement.

3.3.79 Gauge Pressure. Pressure measured by an instrument where the pressure indicated is relative to atmospheric pressure.

3.3.80* GAWR (Gross Axle Weight Rating). The final stage manufacturer's specified maximum load-carrying capacity of an axle system, as measured at the tire-ground interfaces.

3.3.81* GCWR (Gross Combination Weight Rating). The final stage manufacturer’s specified maximum loaded weight for a combination (articulated) vehicle consisting of a tow vehicle and one or more towed units.

3.3.82 Generator. An electromechanical device for the production of electricity.

3.3.83* Grade. A measurement of the angle used in road design and expressed as a percentage of elevation change over distance.

3.3.84 Ground Clearance. The clearance under a vehicle at all locations except the axles and driveshaft connections to the axle or items designed to swing clear.

3.3.85* Ground-Fault Circuit Interrupter (GFCI). A device intended for the protection of personnel that functions to deenergize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device. [**70,** 2008]

3.3.86 Grounding Conductor. A non–current-carrying conductor used to connect equipment or the ground circuit of a wiring system to the power source grounding system.

3.3.87* GVWR (Gross Vehicle Weight Rating). The final stage manufacturer's specified maximum load-carrying capacity of a vehicle having two axle systems (a multiaxle axle installation is one system).

3.3.88 Hazardous Material Response Fire Apparatus. An emergency vehicle designed to carry various support equipment and personnel to a scene of a hazardous material incident.

3.3.89 High-Idle Speed Control. A control or switch system that provides a means to increase the engine operating speed from an idle condition to a higher preset operating speed.

3.3.90 Initial Attack Apparatus. Fire apparatus with a fire pump of at least 250 gpm (1000 L/min) capacity, water tank, and hose body whose primary purpose is to initiate a fire suppression attack on structural, vehicular, or vegetation fires, and to support associated fire department operations.

3.3.91 In-Service Weight. The maximum actual vehicle weight under any conditions of mobile operation, sometimes referred to as gross vehicle weight.

3.3.92 Instability. A condition of a mobile unit in which the sum of the moments tending to overturn the unit exceeds the sum of the moments tending to resist overturning.

3.3.93 Instruction Plate. A visual indication whether in pictorial or word format that provides instruction to the operator in the use of a component on the apparatus.

3.3.94 Intake Connection Size. The nominal size of the first fire hose connection from the pump on an intake.

3.3.95 Intake Relief Valve. A relief valve piped to the intake manifold of a pump and designed to automatically relieve excessive pressure from the incoming flow of water by discharging water to the environment.

3.3.96 Interior. A sheltered location not exposed to the environment.

3.3.97 Interlock. A device or arrangement by means of which the functioning of one part is controlled by the functioning of another.

3.3.98 Knuckle. A point of connection between upper and lower booms of an articulating device; the point at which lower and upper booms are hinged together.

3.3.99 Label. A visual indication whether in pictorial or word format that provides for the identification of a control, switch, indicator, or gauge, or the display of information useful to the operator.

3.3.100 Ladder Section. A structural member normally of an open “U” truss-type design that includes the rungs and comprises the base or fly section of an aerial ladder.

3.3.101 Line Voltage Circuit, Equipment, or System. An ac or dc electrical circuit, equipment, or system where the voltage to ground or from line to line is 30 V rms (ac), 42.4 V peak (ac), or 60 V dc; or greater.

3.3.102 Line Voltage Conductor. An ungrounded current-carrying conductor of a line voltage circuit.

3.3.103 Live Load. Forces acting on the aerial device from personnel, portable equipment, water, and nozzle reaction.

3.3.104 Load Limit Indicator. A load indicator or a label, visible at the operator's position, that shows the recommended safe load at any condition of an aerial device's elevation and extension.

3.3.105 Low Voltage Circuit, Equipment, or System. An electrical circuit, equipment, or system where the voltage does not exceed 30 V rms (ac), 42.4 V peak (ac), or 60 V dc; usually 12 V dc in fire apparatus.

3.3.106 Manufacturer. The person or persons, company, firm, corporation, partnership, or other organization responsible for turning raw materials or components into a finished product.

3.3.107* Maximum Pump Close-Off Pressure. The maximum pump discharge pressure obtained with all discharge outlets closed, with the pump primed and running, with the pump drive engine operating at maximum obtainable speed, and with the pump intake pressure at atmospheric pressure or less.

3.3.108 Minimum Continuous Electrical Load. The electrical current required to continuously operate a defined set of electrical devices.

3.3.109 Miscellaneous Equipment. Portable tools and equipment carried on a fire apparatus not including suction hose, fire hose, ground ladders, fixed power sources, hose reels, cord reels, breathing air systems, or other major equipment or components permanently mounted on the apparatus.

3.3.110 Miscellaneous Equipment Allowance. That portion of the GVWR or GCWR allocated for the weight of the miscellaneous equipment and its mounting brackets, boards, or trays.

3.3.111 Mobile Foam Fire Apparatus. Fire apparatus with a permanently mounted fire pump, foam proportioning system, and foam concentrate tank(s) whose primary purpose is for use in the control and extinguishment of flammable and combustible liquid fires in storage tanks and other flammable liquid spills.

3.3.112 Mobile Water Supply Apparatus (Tanker, Tender). A vehicle designed primarily for transporting (pickup, transporting, and delivering) water to fire emergency scenes to be applied by other vehicles or pumping equipment.

3.3.113 Momentary Switch. A switch that returns to the neutral position (off) when released.

3.3.114 Multiple Configuration. Variable configurations or positions of the aerial device (e.g., elevation, extension) in which a manufacturer's different rated load capacities are allowed.

3.3.115 National Hose Thread (NH). A standard screw thread that has dimensions for inside (female) and outside (male) fire hose connections as defined in NFPA 1963, *Standard for Fire Hose Connections*.

3.3.116* Net Pump Pressure. The sum of the discharge pressure and the suction lift converted to psi or kPa when pumping at draft, or the difference between the discharge pressure and the intake pressure when pumping from a hydrant or other source of water under positive pressure.

3.3.117 Neutral Conductor. The conductor connected to the neutral point of a system that is intended to carry current under normal conditions.

3.3.118* Neutral Point. The common point on a wye-connection in a polyphase system or midpoint on a single-phase, 3-wire system, or midpoint of a single-phase portion of a 3-phase delta system, or midpoint of a 3-wire, direct current system.

3.3.119 Nozzle Reaction. Force that occurs when a water stream is discharged from the nozzle.

3.3.120 Operator's Panel. A panel containing gauges, switches, instruments, or controls where an operator can visually monitor the applicable functions.

3.3.121 Optical Center. The point specified by the optical warning device manufacturer of highest intensity when measuring the output of an optical warning device.

3.3.122 Optical Element. Any individual lamp or other light emitter within an optical source.

3.3.123 Optical Power. A unit of measure designated as candela-seconds/minute that combines the flash energy and flash rate of an optical source into one power measurement representing the true visual effectiveness of the emitted light.

3.3.124* Optical Source. Any single, independently mounted, light-emitting component in a lighting system.

3.3.125 Optical Warning Device. A manufactured assembly of one or more optical sources.

3.3.126 Override. A system or device used to neutralize a given action or motion.

3.3.127 Override (Aerial Device). The takeover of all aerial device movement control functions by an operator at a second control station.

3.3.128 Panelboard. A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front. [**70,** 2008]

3.3.129 Personal Gear. The weight of personal clothing and items for personal hygiene carried on the fire apparatus by each crew member when they expect the response to be of long duration.

3.3.130 Portable Electrical Equipment. Any electrical equipment that is not fixed. *(See 3.3.67, Fixed Electrical Equipment.)*

3.3.131* Portable Generator. A mechanically driven power source that can be removed from the fire apparatus and operated at a location that is remote from the fire apparatus.

3.3.132 Power Source. A device that produces line voltage electricity.

3.3.133 Power Supply Assembly. Any cord or distribution assembly that is partly comprised of the neutral conductor, grounding conductor, and line voltage conductors connected from the output terminals of the power source to the first main overcurrent protection device.

3.3.134 Powered Equipment Rack. A power-operated device that is intended to provide storage of suction hoses, ground ladders, or other equipment, generally in a location above apparatus compartments.

3.3.135* Preconnected Hose Line. A hose line that is stored on the apparatus already connected to an outlet on a pump and that can be charged by the activation of one discharge valve.

3.3.136 Proper(ly). In accordance with the manufacturer's specifications or as recommended by the manufacturer.

3.3.137 psi. Pounds per square inch.

3.3.138 PTO. Power takeoff.

3.3.139 Pump Operator's Panel. The area on a fire apparatus that contains the gauges, controls, and other instruments used for operating the pump.

3.3.140 Pump Operator's Position. The location from which the pump operator operates the pump.

3.3.141 Pumper. Fire apparatus with a permanently mounted fire pump of at least 750 gpm (3000 L/min) capacity, water tank, and hose body whose primary purpose is to combat structural and associated fires.

3.3.142 Purchaser. The authority having responsibility for the specification and acceptance of the apparatus.

3.3.143 Purchasing Authority. The agency that has the sole responsibility and authority for negotiating, placing, and, where necessary, modifying each and every solicitation, purchase order, or other award issued by a governing body.

3.3.144 Purification System. A combination of mechanical, chemical, and physical devices such as separators, filters, adsorbents, and catalysts designed to remove or alter contaminants within the compressed air stream to produce effluent air that is breathable.

3.3.145 Qualified Person. A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to deal with problems relating to a particular subject matter, work, or project. [**1451,** 2007]

3.3.146* Quint. Fire apparatus with a permanently mounted fire pump, a water tank, a hose storage area, an aerial ladder or elevating platform with a permanently mounted waterway, and a complement of ground ladders.

3.3.147 Ramp Breakover Angle. The angle measured between two lines tangent to the front and rear tire static loaded radius, and intersecting at a point on the underside of the vehicle that defines the largest ramp over which the vehicle can roll.

3.3.148 Rated Capacity (Aerial Device). The total amount of weight of all personnel and equipment that can be supported at the outermost rung of an aerial ladder or on the platform of an elevating platform with the aerial device placed in the horizontal position at its maximum horizontal extension when the stabilizers are fully deployed.

3.3.149 Rated Capacity (Water Pump). The flow rate to which the pump manufacturer certifies compliance of the pump when it is new.

3.3.150 Readily Accessible. Able to be located, reached, serviced, or removed without removing other components or parts of the apparatus and without the need to use special tools to open enclosures.

3.3.151 Rear Axle Track Width. The lateral distance between the centerlines of the tires at ground; if there are dual rear wheels, the lateral distance from the midway points between the inner and outer tires at ground.

3.3.152 Removable Winch. A winch with quick disconnects for power and controls that can be temporarily mounted on the apparatus at a permanently installed mounting receiver.

3.3.153 Reserve Capacity. The ability of a battery to sustain a minimum electrical load in the event of a charging system failure or a prolonged charging system deficit.

3.3.154 Road Spray Location. Any underbody or underchassis location that is subject to road spray.

3.3.155 SCBA Fill Hose. Flexible hose plumbed to connect SCBA cylinders to the compressed air supply for filling purposes.

3.3.156 SCBA Fill Station. A containment enclosure for refilling self-contained breathing cylinders to guard personnel from fragments due to accidental cylinder rupture.

3.3.157 Sign. A visual indication whether in pictorial or word format that provides a warning to the operator or other persons near the apparatus.

3.3.158 Slow-Operating Valve. A valve that has a mechanism to prevent movement of the flow-regulating element from the fully closed position to the fully opened position or vice versa in less than 3 seconds.

3.3.159* Special Services Fire Apparatus. A multipurpose vehicle that primarily provides support services at emergency scenes.

3.3.160 Split Shaft PTO. A power takeoff (PTO) drive system that is inserted between the chassis transmission and the chassis drive axle and that has the shift mechanism necessary to direct the chassis engine power either to the drive axle or to a fire pump or other accessory.

3.3.161 Stabilizer. A device integral with or separately attached to the chassis of a fire apparatus with an aerial device that is used to increase the moments tending to resist overturning the apparatus.

3.3.162 Stabilizer Pad. A plate inserted beneath a stabilizer shoe to give greater surface bearing area.

3.3.163 Stabilizer Shoe. A permanently mounted shoe on a stabilizer to provide a ground surface area.

3.3.164* Standard Cubic Feet per Minute (SCFM). An expression of airflow rate in which the airflow rate is corrected to standard temperature and pressure.

3.3.165 Suction Lift. The sum of the vertical lift and the friction and entrance loss caused by the flow through the intake strainers and hose expressed in feet of water (meters of water) head.

3.3.166 Sump. A recessed area of a tank assembly designed primarily to entrap sludge or debris for removal and to serve as a central liquid collection point.

3.3.167 Swash Partition. A vertical wall within a tank structure designed to control the unwanted movement of the fluid within that tank.

3.3.168 Switch. Any set of contacts that interrupts or controls current flow through an electrical circuit.

3.3.169 Synthetic Breathing Air. A manufactured breathing air that is produced by blending nitrogen and oxygen. [**1989,** 2008]

3.3.170 Top Rail. The top chord (rail) of an aerial ladder to which reinforcements are attached.

3.3.171 Total Continuous Electrical Load. The total current required to operate all of the devices permanently connected to the apparatus that can be simultaneously energized excluding intermittent-type loads such as primers and booster reel rewind motors.

3.3.172 Tow Vehicle. A motor vehicle used to tow a trailer under emergency response conditions whether the tow vehicle–trailer combination is designed to remain together as a single unit or to be separated at the incident to allow the trailer to be used independently of the tow vehicle.

3.3.173 Trailer. A vehicle designed to be pulled by a tow vehicle and used to transport equipment or other vehicles under emergency response conditions.

3.3.174* Turning Clearance Radius. One-half the larger of the left or right full circle wall-to-wall turning diameter.

3.3.175* Turntable. A structural component that connects the aerial device to the chassis and stabilization system through a rotating bearing that permits 360-degree continuous rotation of the aerial device.

3.3.176 Turntable Alignment Indicator. An indicator that facilitates alignment of the aerial device with the boom support for bedding purposes.

3.3.177* Type 4 Rating. A rating for electrical equipment that is intended for outdoor use because it provides a degree of protection from falling rain, splashing water, and hose-directed water.

3.3.178 Ultimate Strength. The strength of a material in tension, compression, or shear, respectively, that is the maximum tensile, compressive, or shear stress that the material can sustain, calculated on the basis of the ultimate load and the original or unrestrained dimensions.

3.3.179 Unequipped Fire Apparatus. The completed fire apparatus excluding personnel, agent(s), and any equipment removable without the use of tools.

3.3.180 Utility Air. Air used for purposes other than human respiration.

3.3.181 Vibration Isolation. Isolation materials used to prevent structure-borne vibrations from reaching attached surfaces.

3.3.182 Water Tower. An aerial device consisting of permanently mounted power-operated booms that articulate, telescope, or both, and a waterway designed to supply a large capacity mobile elevated water stream.

3.3.183 Wet Location. A nonsheltered location inside a compartment with a door or cover that, while open, exposes the electrical enclosure or panelboard to the same environmental conditions as the exterior of the fire apparatus. A location on a nonenclosed, exterior surface of a fire apparatus body or driving and crew compartment where the enclosure or panel is exposed to the environment. *(See also 3.3.154, Road Spray Location.)*

3.3.184 Yield Strength. The stress at which a material exhibits a specified permanent deformation or set.

Chapter 4 General Requirements

4.1 General.

4.1.1 All fire apparatus shall comply with the following chapters:

(1) Chapter 1, “Administration”

(2) Chapter 2, “Referenced Publications”

(3) Chapter 3, “Definitions”

(4) Chapter 4, “General Requirements”

(5) Chapter 12, “Chassis and Vehicle Components”

(6) Chapter 13, “Low Voltage Electrical Systems and Warning Devices”

(7) Chapter 14, “Driving and Crew Areas”

(8) Chapter 15, “Body, Compartments, and Equipment Mounting”

4.1.2 If a tow vehicle is to respond while calling for right-of way under emergency conditions, it shall meet the requirements of 4.1.1.

4.2 Requirements by Apparatus Type.

4.2.1 In addition to the requirements in Section 4.1, the following also shall apply:

(1) Pumper fire apparatus shall comply with Chapter 5.

(2) Initial attack fire apparatus shall comply with Chapter 6.

(3) Mobile water supply fire apparatus shall comply with Chapter 7.

(4) Aerial fire apparatus shall comply with Chapter 8.

(5) Quint fire apparatus shall comply with Chapter 9.

(6) Special service fire apparatus shall comply with Chapter 10.

(7) Mobile foam fire apparatus shall comply with Chapter 11.

4.2.2 Table 4.2.2 shows the required chapters that shall apply to the construction of the types of fire apparatus in 4.2.1.

Table 4.2.2 Chapter Requirements by Apparatus

Chapter	Pumper Fire Apparatus	Initial Attack Fire Apparatus	Mobile Water Supply Fire Apparatus	Aerial Fire Apparatus	Quint Fire Apparatus	Spe Servi Appa
1. Administration	Required	Required	Required	Required	Required	Req
2. Referenced Publications	Required	Required	Required	Required	Required	Req
3. Definitions	Required	Required	Required	Required	Required	Req
4. General Requirements	Required	Required	Required	Required	Required	Req
5. Pumper Fire Apparatus	Required	N/A	N/A	N/A	N/A	N
6. Initial Attack Fire Apparatus	N/A	Required	N/A	N/A	N/A	N
7. Mobile Water Supply Fire Apparatus	N/A	N/A	Required	N/A	N/A	N

Table 4.2.2 Chapter Requirements by Apparatus

Chapter	Pumper Fire Apparatus	Initial Attack Fire Apparatus	Mobile Water Supply Fire Apparatus	Aerial Fire Apparatus	Quint Fire Apparatus	Spe Servi Appa
8. Aerial Fire Apparatus	N/A	N/A	N/A	Required	N/A	N
9. Quint Fire Apparatus	N/A	N/A	N/A	N/A	Required	N
10. Special Service Fire Apparatus	N/A	N/A	N/A	N/A	N/A	Req
11. Mobile Foam Fire Apparatus	N/A	N/A	N/A	N/A	N/A	N
12. Chassis and Vehicle Components	Required	Required	Required	Required	Required	Req
13. Low Voltage Electrical Systems and Warning Devices	Required	Required	Required	Required	Required	Req
14. Driving and Crew Areas	Required	Required	Required	Required	Required	Req
15. Body, Compartments, and Equipment Mounting	Required	Required	Required	Required	Required	Req
16. Fire Pumps and Associated Equipment	Required	Required	If specified	If specified	Required	If spe
17. Auxiliary Pumps and Associated Equipment	If specified	If specified	If specified	If specified	If specified	If spe
18. Water Tanks	Required	Required	Required	If specified	Required	If spe
19. Aerial Devices	If specified	If specified	N/A	Required	Required	If spe
20. Foam Proportioning Systems	If specified	If specified	If specified	If specified	If specified	If spe
21. Compressed Air Foam Systems	If specified	If specified	If specified	If specified	If specified	If spe
22. Line Voltage Electrical Systems	If specified	If specified	If specified	If specified	If specified	If spe
23. Command and Communications	If specified	If specified	If specified	If specified	If specified	If spe
24. Air Systems	If specified	If specified	If specified	If specified	If specified	If spe
25. Winches	If specified	If specified	If specified	If specified	If specified	If spe

4.2.3 In addition to the types of fire apparatus listed in 4.2.1, other types of fire apparatus shall be permitted by combining the requirements for the components to be used in the apparatus as defined in Section 4.5 with the requirements listed in Section 4.1.

4.3 Responsibility of the Purchaser.

4.3.1* It shall be the responsibility of the purchaser to specify the following details of the apparatus:

(1) Its required performance, including where operations at elevations above 2000 ft (600 m) or on grades greater than 6 percent are required

(2) The maximum number of fire fighters to ride within the apparatus

(3) Specific electrical loads that are to be part of the minimum continuous electrical load defined in 13.3.3

(4) Any hose, ground ladders, or equipment to be carried by the apparatus that exceed the minimum requirements of this standard

(5) If a trailer for the purpose of transporting fire rescue response equipment, whether it is a Type I, Type II, or Type III configuration

4.3.2 After acceptance of the fire apparatus, the purchaser shall be responsible for ongoing training of personnel to develop and maintain proficiency regarding the proper and safe use of the apparatus and the associated equipment.

4.4 Responsibility of the Contractor.

4.4.1 The contractor shall provide a detailed description of the apparatus, a list of equipment to be furnished, and other construction and performance details to which the apparatus shall conform.

4.4.1.1 The detailed description of the apparatus shall include, but shall not be limited to, estimated in-service weight, wheelbase, turning clearance radius, principal dimensions, angle of approach, angle of departure, transmission, axle ratios, and, if applicable, the rated capacity of the aerial device.

4.4.1.2 The contractor's detailed description shall include a statement specifically describing each aspect of the delivered apparatus that will not be fully compliant with the requirements of this standard.

4.4.1.3 The purpose of these contractor specifications shall be to define what the contractor intends to furnish and deliver to the purchaser.

4.4.2 Responsibility for the apparatus and equipment shall remain with the contractor until they are accepted by the purchaser.

4.5 Fire Apparatus Components.

All components shall be installed in accordance with the applicable manufacturer's installation instructions.

4.5.1 If the apparatus is equipped with a fire pump, the pump and its associated equipment shall meet the requirements of Chapter 16.

4.5.2 If the apparatus is equipped with an auxiliary pump, the pump and its associated equipment shall meet the requirements of Chapter 17.

4.5.3 If the apparatus is equipped with a water tank, the water tank shall meet the requirements of Chapter 18.

4.5.4 If the apparatus is equipped with an aerial device (aerial ladder, elevating platform, or water tower), the aerial device shall meet the requirements of Chapter 19.

4.5.5 If the apparatus is equipped with a foam proportioning system, the system shall meet the requirements of Chapter 20.

4.5.6 If the apparatus is equipped with a compressed air foam system (CAFS), the system shall meet the requirements of Chapter 21.

4.5.7 If the apparatus is equipped with a line voltage electrical system, the system shall meet the requirements of Chapter 22.

4.5.8 If the apparatus is equipped with a command and communications area, the area shall meet the requirements of Chapter 23.

4.5.9 If the apparatus is equipped with an air system, the system shall meet the requirements of Chapter 24.

4.5.10 If the apparatus is equipped with a winch system, the system shall meet the requirements of Chapter 25.

4.5.11 If a trailer is towed as a component of an emergency vehicle, the trailer shall meet the requirements of Chapter 26.

4.6 Legal Requirements.

The apparatus shall comply with all applicable federal and state or provincial laws and regulations.

4.7 Third-Party Certification of Test Results.

Where this standard requires the results of tests to be certified by a independent third-party certification organization, that organization shall meet the requirements of this section.

4.7.1 All certification shall be performed by a certification organization that is accredited for inspection and testing systems on fire apparatus in accordance with ISO/IEC 17020, *General criteria for the operation of various types of bodies performing inspection*, or ISO/IEC Guide 65, *General requirements for bodies operating product certification systems*.

4.7.2 The certification organization shall not be owned or controlled by manufacturers or vendors of the product that is being tested.

4.7.3 The certification organization shall be primarily engaged in certification work and shall not have a monetary interest in the product's ultimate profitability.

4.7.4 The certification organization shall witness all tests and shall refuse to certify any test results for a system if all components of that system requiring testing do not pass the testing required by this standard.

4.7.5 There shall be no conditional, temporary, or partial certification of test results.

4.7.6 Appropriate forms or data sheets shall be provided and used during the testing.

4.7.7 Programs shall be in place for training, proficiency testing, and performance verification of any staff involved with certification.

4.7.8 The certification organization's operating procedures shall provide a mechanism for the manufacturer to appeal decisions. The procedures shall include provisions for the presentation of information from representatives of both sides of a controversy to a designated appeals panel.

4.8 Manufacturer Certification of Test Results.

Where this standard requires the results of tests or the performance of a component to be certified by the manufacturer, the manufacturer shall meet the requirements of this section.

4.8.1 A representative of the manufacturer shall witness all tests and shall refuse to certify any test results for a system unless all components of that system requiring testing pass the testing required by this standard.

4.8.2 There shall be no conditional, temporary, or partial certification of test results.

4.8.3 The manufacturer shall have the facilities and equipment necessary to conduct the required testing, a program for the calibration of all instruments, and procedures to ensure the proper control of all testing.

4.8.4 Appropriate forms or data sheets shall be provided and used during the testing.

4.8.5 Programs shall be in place for training, proficiency testing, and performance verification of any personnel involved with certification.

4.8.6 An official of the company that manufactures or installs the product shall designate in writing who is qualified to witness tests and certify results.

4.8.7 Certification documentation shall be delivered with the apparatus, including results of the certification tests.

4.9 Personnel Protection.

4.9.1* Guards, shields, or other protection shall be provided where necessary in order to prevent injury of personnel by hot, moving, or rotating parts during nonmaintenance operations.

4.9.2 Electrical insulation or isolation shall be provided where necessary in order to prevent electrical shock from onboard electrical systems.

4.9.3 Vehicular workmanship shall ensure an operating environment free of accessible sharp projections and edges.

4.9.4 Safety-related (caution, warning, danger) signs shall meet the requirements of ANSI Z535.4, *Product Safety Signs and Labels*.

4.10 Controls and Instructions.

4.10.1 Illumination shall be provided for controls, switches, instruction plates, labels, gauges, and instruments necessary for the operation of the apparatus and the equipment provided on it.

4.10.1.1 If external illumination is provided, it shall be a minimum of 5 fc (50 lx) on the face of the device.

4.10.1.2 If internal illumination is provided, it shall be a minimum of 4 footlamberts (14 cd/m^2).

4.10.2* All required signs, instruction plates, and labels shall be permanent in nature and securely attached and shall meet the requirements of 4.9.4 and UL 969, *Standard for Marking and Labeling Systems*.

4.10.2.1 The signs, instruction plates, and labels shall have resistance to damage from temperatures between –30°F and 176°F (–35°C and 80°C) and exposure to oil, fuel, water, hydraulic fluids, or other fluids used on the apparatus.

4.10.2.2 The exterior mounted labels relating to safety or critical operational instructions shall be reflective or illuminated as required by 4.10.1.

4.10.3 The centerline of any gauge or visual display required by this standard shall be no more than 84 in. (2130 mm) above the level where the operator stands to read the instrument.

4.10.4 The central midpoint or centerline of any control shall be no more than 72 in. (1830 mm) vertically above the ground or platform that is designed to serve as the operator's standing position.

4.11 Vehicle Data Recorder.

4.11.1 All apparatus shall be equipped with an on-board vehicle data recorder (VDR).

4.11.2 The VDR shall be capable of recording the data shown in Table 4.11.2 in that order at least once per second.

Table 4.11.2 VDR Data

Data	Unit of Measure
Vehicle speed	mph
Acceleration (from speedometer)	mph/sec
Deceleration (from speedometer)	mph/sec
Engine speed	rpm
Engine throttle position	% of full throttle

Table 4.11.2 VDR Data

Data	Unit of Measure
Anti-lock braking system event	On/off
Seat occupied status	Occupied: Yes/No by position
Seat belt status	Buckled: Yes/No by position
Master optical warning device switch	On/off
Time	24-hour clock
Date	Year/month/day

4.11.3 Data shall be stored at the sampling rate in a 48-hour loop.

4.11.4 Memory shall be sufficient to record 100 engine hours' worth of minute-by-minute summary showing the data in Table 4.11.4.

Table 4.11.4 VDR Summary Data

Data	Unit of Measure
Maximum vehicle speed	mph
Maximum acceleration (from speedometer)	mph/sec
Maximum deceleration (from speedometer)	mph/sec
Maximum engine speed	rpm
Maximum engine throttle position	% of full throttle
Anti-lock braking system event	On/off
Seat occupied with seat belt unbuckled	Yes/no by position at 30 sec into minute
Master optical warning device switch	On/off at 30 sec into minute
Time	24-hour clock
Date	Year/month/day

4.11.5 When the memory capacity is reached, the system shall erase the oldest data first.

4.11.6 All data stored in the VDR shall be uploadable by the user to a computer and importable into a data management software package.

4.11.7 Data shall be password protected with access controlled by the purchaser.

4.11.8 Software shall be delivered with the apparatus that will run on both Windows® and Apple® operating systems and produce the following formatted reports from the uploaded data:

(1) Raw second-by-second data over a specified data/time range

(2) Daily log for the time the engine is running for a given date (minute-by-minute output of all values)

(3) Weekly summary (maximum values each hour for each day of the week)

(4) Monthly summary (maximum values each day for each day of the month)

4.12 Component Protection.

4.12.1* Hydraulic hose lines, air system tubing, control cords, and electrical harnesses shall be mechanically attached to the frame or body structure of the apparatus.

4.12.2 The types of equipment described in 4.12.1 shall be furnished with protective looms, grommets, or other devices at each point where they pass through body panels or structural members or wherever they lie against a sharp metal edge.

4.12.3 A through-the-frame connector shall be permitted to be used in place of protective looms or grommets.

4.13 Vehicle Stability.

4.13.1* Rollover Stability. The apparatus shall meet the criteria defined in 4.13.1.1, or it shall be equipped with a stability control system in accordance with 4.13.1.2.

4.13.1.1 The apparatus shall meet the criteria defined in either of the following:

(1)* The apparatus shall remain stable to 26.5 degrees in both directions when tested on a tilt table in accordance with SAE J2180, *A Tilt Table Procedure for Measuring the Static Rollover Threshold for Heavy Trucks*.

(2) The calculated or measured center of gravity (CG) shall be no higher than 80 percent of the rear axle track width.

4.13.1.1.1 Compliance shall be certified by testing, calculating, or measuring the apparatus or by comparing the apparatus to a compliant, substantially similar example apparatus, and the certification shall be delivered with the fire apparatus.

4.13.1.1.2 The example apparatus shall be considered substantially similar if it includes a chassis with the same or higher CG height, the same or narrower rear axle track width, the same or greater water tank size and CG height, the same type of front and rear suspension, and the same type and size of aerial device.

4.13.1.1.3 For purposes of 4.13.1.1, the apparatus shall be loaded with fuel, fire-fighting agents, hose, ladders, a weight of 250 lb in each seating position, and weight equivalent to the miscellaneous equipment allowance as defined in Table 12.1.2.

4.13.1.1.3.1 If the apparatus is designed to meet a specified higher equipment loading or larger hose bed capacity or to carry additional ground ladders, these greater loads shall be included in the testing, calculating, or measuring.

4.13.1.1.3.2 The weight added to the fire apparatus for the purpose of test, calculation, or measurement shall be distributed to approximate typical in-service use of the fire apparatus while not exceeding the manufacturer’s published individual compartment weight ratings.

4.13.1.2 If the apparatus is equipped with a stability control system, the system shall have, at a minimum, a steering wheel position sensor, a vehicle yaw sensor, a lateral accelerometer, and individual wheel brake controls.

4.13.2 Weight Distribution.

4.13.2.1* When the fire apparatus is loaded to its estimated in-service weight, the front-to-rear weight distribution shall be within the limits set by the chassis manufacturer.

4.13.2.2 The front axle loads shall not be less than the minimum axle loads specified by the chassis manufacturer under full load and all other loading conditions.

4.13.3 Load Distribution.

4.13.3.1* The apparatus manufacturer shall calculate the load distribution for the apparatus, and that load distribution plan shall be delivered with the fire apparatus.

4.13.3.2 The manufacturer shall engineer the fire apparatus to comply with the gross axle weight ratings (GAWR), the overall gross vehicle weight rating (GVWR), and the chassis manufacturer's load balance guidelines.

4.13.3.3* The fire apparatus, when loaded to its estimated in-service weight, shall have a side-to-side tire load variation of no more than 7 percent of the total tire load for that axle.

4.13.4* Each tire shall be equipped with a visual indicator or monitoring system that indicates tire pressure.

4.14 Fire Apparatus Performance.

4.14.1* The fire apparatus shall meet the requirements of this standard at elevations of 2000 ft (600 m) above sea level.

4.14.2* The fire apparatus shall meet all the requirements of this standard while stationary on a grade of 6 percent in any direction.

4.14.3* The fire apparatus shall meet the requirements of this standard in ambient temperature conditions between 32°F (0°C) and 110°F (43°C).

4.15 Roadability.

4.15.1 The apparatus, when loaded to its estimated in-service weight, shall be capable of the following performance while on dry, paved roads that are in good condition:

(1) From a standing start, the apparatus shall be able to attain a speed of 35 mph (55 km/hr) within 25 seconds on a level road.

(2)* The apparatus shall be able to attain a minimum top speed of 50 mph (80 km/hr) on a level road.

(3)* The apparatus shall be able to maintain a speed of at least 20 mph (32 km/hr) on any grade up to and including 6 percent.

4.15.2* The maximum top speed of fire apparatus with a GVWR over 26,000 lb (11,800 kg) shall not exceed either 68 mph (105 km/hr) or the manufacturer's maximum fire service speed rating for the tires installed on the apparatus, whichever is lower.

4.15.3 If the combined water tank and foam agent tank capacities on the fire apparatus exceed 1250 gal (4732 L), or the GVWR of the vehicle is over 50,000 lb (22,680 kg), the maximum top speed of the apparatus shall not exceed either 60 mph (85 km/hr) or the manufacturer's maximum fire service speed rating for the tires installed on the apparatus, whichever is lower.

4.16 Serviceability.

4.16.1* The fire apparatus shall be designed so that all the manufacturer's recommended routine maintenance checks of lubricant and fluid levels can be performed by the operator without lifting the cab of a tilt-cab apparatus or without the need for hand tools.

4.16.2 Where special tools are required for routine service on any component of the apparatus, such tools shall be provided with the apparatus.

4.16.3 Apparatus components that interfere with repair or removal of other major components shall be attached with fasteners, such as cap screws and nuts, so that the components can be removed and installed with ordinary hand tools. These components shall not be welded or otherwise permanently secured into place.

4.17 Road Tests.

4.17.1 Road tests shall be conducted in accordance with this section to verify that the completed apparatus is capable of compliance with Section 4.15.

4.17.2 The tests shall be conducted at a location and in a manner that does not violate local, state or provincial, or federal traffic laws.

4.17.3 The tests shall be conducted on dry, level, paved roads that are in good condition.

4.17.4 The apparatus shall be loaded to its estimated in-service weight.

4.17.5 The engine shall not operate in excess of the maximum governed speed.

4.17.6 Acceleration tests shall consist of two runs in opposite directions over the same route.

4.17.6.1 The fire apparatus shall attain a speed of 35 mph (55 km/hr) from a standing start within 25 seconds.

4.17.6.2 The fire apparatus shall attain a minimum top speed of 50 mph (80 km/hr).

4.17.7 If the apparatus is equipped with an auxiliary braking system, the manufacturer shall road test the system to confirm that the system is functioning as intended by the auxiliary braking system manufacturer.

4.17.8 If the apparatus is equipped with an air brake system, the service brakes shall bring the apparatus, when loaded to its GVWR, to a complete stop from an initial speed of 20 mph (32.2 km/hr) in a distance not exceeding 35 ft (10.7 m) by actual measurement on a paved, level, dry surface road that is free of loose material, oil, or grease.

4.17.9 If the apparatus is equipped with a hydraulic brake system, the service brakes shall bring the apparatus, when loaded to its GVWR, to a complete stop from an initial speed of 30 mph (48.2 km/hr) in a distance not exceeding 88 ft (26.8 m) by actual measurement on a paved, level, dry surface road that is free of loose material, oil, or grease.

4.18 Tests on Delivery.

4.18.1* If acceptance tests are required at the point of delivery, the purchaser shall specify the details of the tests to be performed, and they shall not be performed in a manner that requires the apparatus or a component to operate outside its designed operating range.

4.18.2 Aerial device stability tests shall not be run other than at the manufacturer's facility.

4.19* Documentation.

Any documentation delivered with the apparatus shall be permitted to be in printed format, electronic format, audiovisual format, or a combination thereof.

4.20 Data Required of the Contractor.

4.20.1 Fire Apparatus Documentation. The contractor shall deliver with the fire apparatus at least one copy of the following documents:

(1) The manufacturer's record of apparatus construction details, including the following information:

   (a) Owner's name and address

   (b) Apparatus manufacturer, model, and serial number

   (c) Chassis make, model, and serial number

   (d) GAWR of front and rear axles and GVWR

   (e) Front tire size and total rated capacity in pounds (kilograms)

   (f) Rear tire size and total rated capacity in pounds (kilograms)

   (g) Chassis weight distribution in pounds (kilograms) with water and manufacturer-mounted equipment (front and rear)

(h) Engine make, model, serial number, rated horsepower and related speed, and governed speed; and if so equipped, engine transmission PTO(s) make, model, and gear ratio

(i) Type of fuel and fuel tank capacity

(j) Electrical system voltage and alternator output in amps

(k) Battery make, model, and capacity in cold cranking amps (CCA)

(l) Chassis transmission make, model, and serial number; and if so equipped, chassis transmission PTO(s) make, model, and gear ratio

(m) Ratios of all driving axles

(n) Maximum governed road speed

(o) Pump make, model, rated capacity in gallons per minute (liters per minute where applicable), and serial number

(p) Pump transmission make, model, serial number, and gear ratio

(q) Auxiliary pump make, model, rated capacity in gallons per minute (liters per minute where applicable), and serial number

(r) Water tank certified capacity in gallons or liters

(s) Aerial device type, rated vertical height in feet (meters), rated horizontal reach in feet (meters), and rated capacity in pounds (kilograms)

(t) Paint manufacturer and paint number(s)

(u) Company name and signature of responsible company representative

(v) Weight documents from a certified scale showing actual loading on the front axle, rear axle(s), and overall fire apparatus (with the water tank full but without personnel, equipment, and hose)

(2) If the apparatus is a mobile foam fire apparatus, the certification of foam tank capacity *(see Section 11.5)*

(3) Certification of compliance of the optical warning system *(see 13.8.16)*

(4) Siren manufacturer’s certification of the siren *(see 13.9.1.1)*

(5) Written load analysis and results of the electrical system performance tests *(see 13.14.1 and Section 13.15)*

(6) Certification of slip resistance of all stepping, standing, and walking surfaces *(see 15.7.4.5)*

(7) If the apparatus has a fire pump, the pump manufacturer's certification of suction

capability *(see 16.2.4.1)*

(8) If the apparatus is equipped with a fire pump and special conditions are specified by the purchaser, the pump manufacturer’s certification of suction capacity under the special conditions *(see 16.2.4.2)*

(9) If the apparatus has a fire pump, a copy of the apparatus manufacturer's approval for stationary pumping applications *(see 16.3.1)*

(10) If the apparatus has a fire pump, the engine manufacturer's certified brake horsepower curve for the engine furnished, showing the maximum governed speed *(see 16.3.2.2)*

(11) If the apparatus has a fire pump, the pump manufacturer's certification of the hydrostatic test *(see 16.5.2.2)*

(12) If the apparatus has a fire pump, the certification of inspection and test for the fire pump *(see 16.13.1.1.5 or 16.13.1.2.4 as applicable)*

(13) If the apparatus is equipped with an auxiliary pump, the apparatus manufacturer’s certification of the hydrostatic test *(see Section 17.12)*

(14) When the apparatus is equipped with a water tank, the certification of water tank capacity *(see Section 18.6)*

(15) If the apparatus has an aerial device, the certification of inspection and test for the aerial device *(see Section 19.24)*

(16) If the apparatus has an aerial device, all the technical information required for inspections to comply with NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus*

(17) If the apparatus has a foam proportioning system, the foam proportioning system manufacturer’s certification of accuracy *(see 20.10.4.2)* and the final installer’s certification the foam proportioning system meets this standard *(see 20.11.2)*

(18) If the system has a CAFS, the documentation of the manufacturer’s predelivery tests *(see Section 21.9)*

(19) If the apparatus has a line voltage power source, the certification of the test for the power source *(see 22.15.7.2)*

(20) If the apparatus is equipped with an air system, air tank certificates *(see 24.5.1.2)*, the SCBA fill station certification *(see 24.9.7)*, and the results of the testing of the air system installation *(see 24.14.5 and 24.15.4)*

(21) Any other required manufacturer test data or reports

4.20.2 Operations and Service Documentation.

4.20.2.1 The contractor shall deliver with the fire apparatus at least two sets of complete operation and service documentation covering the completed apparatus as delivered and accepted.

4.20.2.2 The documentation shall address at least the inspection, service, and operations of the fire apparatus and all major components thereof.

4.20.2.3 The contractor shall also deliver with the fire apparatus the following documentation for the entire apparatus and each major operating system or major component of the apparatus:

(1) Manufacturer's name and address

(2) Country of manufacture

(3) Source for service and technical information

(4) Parts replacement information

(5) Descriptions, specifications, and ratings of the chassis, pump (if applicable), and aerial device (if applicable)

(6) Wiring diagrams for low voltage and line voltage systems to include the following information:

  (a) Pictorial representations of circuit logic for all electrical components and wiring

  (b) Circuit identification

  (c) Connector pin identification

  (d) Zone location of electrical components

  (e) Safety interlocks

  (f) Alternator–battery power distribution circuits

  (g)* Input/output assignment sheets or equivalent circuit logic implemented in multiplexing systems

(7) Lubrication charts

(8) Operating instructions for the chassis, any major components such as a pump or aerial device, and any auxiliary systems

(9) Precautions related to multiple configurations of aerial devices, if applicable

(10) Instructions regarding the frequency and procedure for recommended maintenance

(11) Overall apparatus operating instructions

(12) Safety considerations

(13) Limitations of use

(14) Inspection procedures

(15) Recommended service procedures

(16) Troubleshooting guide

(17) Apparatus body, chassis, and other component manufacturer's warranties

(18) Special data required by this standard

(19) A material safety data sheet (MSDS) for any fluid that is specified for use on the apparatus

4.20.2.4* The contractor shall deliver with the apparatus all manufacturers' operations and service documents supplied with components and equipment that are installed or supplied by the contractor.

4.21 Statement of Exceptions.

The entity responsible for final assembly of the apparatus shall deliver with the fire apparatus either a certification that the apparatus fully complies with all requirements of this standard or, alternatively, a Statement of Exceptions specifically describing each aspect of the completed apparatus that is not fully compliant with the requirements of this standard at the time of delivery.

4.21.1 The Statement of Exceptions shall contain, for each noncompliant aspect of the apparatus or missing required item, the following information:

(1) A separate specification of the section of the applicable standard for which compliance is lacking

(2) A description of the particular aspect of the apparatus that is not in compliance therewith or required equipment that is missing

(3) A description of the further changes or modifications to the delivered apparatus that must be completed to achieve full compliance

(4) Identification of the entity that will be responsible for making the necessary postdelivery changes or modifications or for supplying and installing any missing required equipment to the apparatus to achieve full compliance with this standard

4.21.2 Prior to, or at the time of, delivery of the apparatus, the Statement of Exceptions shall be signed by an authorized agent of the entity responsible for final assembly of the apparatus and by an authorized agent of the purchasing entity, indicating mutual understanding and agreement between the parties regarding the substance thereof.

4.21.3 An apparatus that is delivered subject to a Statement of Exceptions other than a certification of full compliance shall not be placed in emergency service until the apparatus has been modified as necessary to accomplish full compliance with this standard.

Chapter 5 Pumper Fire Apparatus

5.1 General.

If the apparatus is to function as a pumper, it shall meet the requirements of this chapter.

5.2 Fire Pump.

The apparatus shall be equipped with a fire pump that meets the requirements of Chapter 16 and that has a minimum rated capacity of 750 gpm (3000 L/min).

5.3 Aerial Device.

If the pumper is equipped with an aerial device, the requirements of 5.3.1 through 5.3.4 shall apply.

5.3.1 The aerial device shall meet the requirements of Chapter 19.

5.3.2 If the aerial device is equipped with a permanently mounted waterway, the fire pump shall be capable of supplying the flow requirements of 19.6.1, 19.12.1, or 19.16.1 with a maximum intake gauge pressure of 20 psi (138 kPa).

5.3.3 Provisions shall be made to ensure that the pump operator is not in contact with the ground.

5.3.4 Signs shall be placed to warn the pump operator of electrocution hazards.

5.4* Water Tank.

The pumper shall be equipped with a water tank(s) that meets the requirements of Chapter 18 and that has a minimum certified capacity (combined, if applicable) of 300 gal (1100 L).

5.5* Equipment Storage.

A minimum of 40 ft^3 (1.1 m^3) of enclosed weather-resistant compartmentation that meets the requirements of Section 15.1 shall be provided for the storage of equipment.

5.6* Hose Storage.

Hose bed area(s), compartments, or reels that comply with Section 15.10 shall be provided to accommodate the following:

(1) A minimum hose storage area of 30 ft^3 (0.8 m^3) for 2½ in. (65 mm) or larger fire hose

(2) Two areas, each a minimum of 3.5 ft^3 (0.1 m^3), to accommodate 1½ in. (38 mm) or larger preconnected fire hose lines

5.7* Equipment Supplied by the Contractor.

The contractor shall supply the equipment listed in 5.7.1 and 5.7.2 and shall provide and install such brackets or compartments as are necessary to mount the equipment.

5.7.1 Ground Ladders.

5.7.1.1 All fire department ground ladders carried on the apparatus shall meet the requirements of NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders*, except as permitted by 5.7.1.3 and 5.7.1.4.

5.7.1.2* At a minimum, the following fire department ground ladders shall be carried on the apparatus:

(1) One straight ladder equipped with roof hooks

(2) One extension ladder

(3) One folding ladder

5.7.1.3 Stepladders and other types of multipurpose ladders meeting ANSI A14.2, *Ladders — Portable Metal — Safety Requirements,* or ANSI A14.5, *Ladders — Portable Reinforced Plastic — Safety Requirements*, with duty ratings of Type 1A or 1AA shall be permitted to be substituted for the folding ladder required in 5.7.1.2(3).

5.7.1.4 Stepladders and other types of multipurpose ladders shall be permitted to be carried in addition to the minimum fire department ground ladders specified in 5.7.1.2 provided they meet either ANSI A14.2 or ANSI A14.5 with duty ratings of Type 1A or 1AA.

5.7.2 Suction Hose or Supply Hose.

5.7.2.1 A minimum of 20 ft (6 m) of suction hose or 15 ft (4.5 m) of supply hose shall be carried.

5.7.2.1.1 Where suction hose is provided, a suction strainer shall be furnished.

5.7.2.1.2 Where suction hose is provided, the friction and entrance loss of the combination suction hose and strainer shall not exceed the losses listed in Table 16.2.4.1(b) or Table 16.2.4.1(c).

5.7.2.1.3 Where supply hose is provided, it shall have couplings compatible with the local hydrant outlet connection on one end and the pump intake connection on the other end.

5.7.2.2 Suction hose and supply hose shall meet the requirements of NFPA 1961, *Standard on Fire Hose*.

5.7.2.3* The purchaser shall specify whether suction hose or supply hose is to be provided, the length and size of the hose, the type and size of the couplings, the manner in which the hose is to be carried on the apparatus, and the style of brackets desired.

5.8* Minor Equipment.

5.8.1 General. The equipment listed in 5.8.2 and 5.8.3 shall be available on the pumper fire apparatus before the apparatus is placed in service.

5.8.1.1 Brackets or compartments shall be furnished so as to organize and mount the specified equipment.

5.8.1.2 A detailed list of who is to furnish the items and the method for organizing and mounting these items shall be supplied by the purchasing authority.

5.8.2* Fire Hose and Nozzles. The following fire hose and nozzles shall be carried on the apparatus:

(1) 800 ft (240 m) of 2½ in. (65 mm) or larger fire hose

(2) 400 ft (120 m) of 1½ in. (38 mm), 1¾ in. (45 mm), or 2 in. (52 mm) fire hose

(3) One handline nozzle, 200 gpm (750 L/min) minimum

(4) Two handline nozzles, 95 gpm (360 L/min) minimum

(5) One playpipe with shutoff and 1 in. (25 mm), 1⅛ in. (29 mm), and 1¼ in. (32 mm) tips

5.8.3* Miscellaneous Equipment. The following additional equipment shall be carried on the apparatus:

(1) One 6 lb (2.7 kg) flathead axe mounted in a bracket fastened to the apparatus

(2) One 6 lb (2.7 kg) pickhead axe mounted in a bracket fastened to the apparatus

(3) One 6 ft (2 m) pike pole or plaster hook mounted in a bracket fastened to the apparatus

(4) One 8 ft (2.4 m) or longer pike pole mounted in a bracket fastened to the apparatus

(5) Two portable hand lights mounted in brackets fastened to the apparatus

(6) One approved dry chemical portable fire extinguisher with a minimum 80-B:C rating mounted in a bracket fastened to the apparatus

(7) One 2½ gal (9.5 L) or larger water extinguisher mounted in a bracket fastened to the apparatus

(8) One self-contained breathing apparatus (SCBA) complying with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, for each assigned seating position, but not fewer than four, mounted in brackets fastened to the apparatus or stored in containers supplied by the SCBA manufacturer

(9) One spare SCBA cylinder for each SCBA carried, each mounted in a bracket fastened to the apparatus or stored in a specially designed storage space

(10) One first aid kit

(11) Four combination spanner wrenches mounted in brackets fastened to the apparatus

(12) Two hydrant wrenches mounted in brackets fastened to the apparatus

(13) One double female 2½ in. (65 mm) adapter with National Hose (NH) threads, mounted in a bracket fastened to the apparatus

(14) One double male 2½ in. (65 mm) adapter with NH threads, mounted in a bracket fastened to the apparatus

(15) One rubber mallet, suitable for use on suction hose connections, mounted in a bracket fastened to the apparatus

(16) Two salvage covers each a minimum size of 12 ft × 14 ft (3.7 m × 4.3 m)

(17) Two or more wheel chocks, mounted in readily accessible locations, that together will hold the apparatus, when loaded to its GVWR or GCWR, on a hard surface with a 20 percent grade with the transmission in neutral and the parking brake released

(18) One traffic vest for each seating position, each vest to comply with ANSI/ISEA 207, *Standard for High-Visibility Public Safety Vests*, and have a five-point breakaway feature that includes two at the shoulders, two at the sides, and one at the front

(19) Five fluorescent orange traffic cones not less than 28 in. (711 mm) in height, each equipped with a 6 in. (152 mm) retroreflective white band no more than 4 in. (102 mm) from the top of the cone, and an additional 4 in. (102 mm) retroreflective white band 2 in. (51 mm) below the 6 in. (152 mm) band

(20) Five illuminated warning devices such as highway flares, unless the five fluorescent orange traffic cones have illuminating capabilities

(21) One automatic external defibrillator (AED)

5.8.3.1 If the supply hose carried does not use sexless couplings, an additional double female adapter and double male adapter, sized to fit the supply hose carried, shall be carried mounted in brackets fastened to the apparatus.

5.8.3.2 If none of the pump intakes are valved, a hose appliance that is equipped with one or more gated intakes with female swivel connection(s) compatible with the supply hose used on one side and a swivel connection with pump intake threads on the other side shall be carried. Any intake connection larger than 3 in. (75 mm) shall include a pressure relief device that meets the requirements of 16.6.6.

5.8.3.3 If the pumper is equipped with an aerial device with a permanently mounted ladder, four ladder belts meeting the requirements of NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services*, shall be provided.

5.8.3.4 If the apparatus does not have a 2½ in. intake with NH threads, an adapter from 2½ in. NH female to a pump intake shall be carried, mounted in a bracket fastened to the apparatus if not already mounted directly to the intake.

5.8.3.5 If the supply hose carried has other than 2½ in. NH threads, adapters shall be carried to allow feeding the supply hose from a 2½ in. NH thread male discharge and to allow the hose to connect to a 2½ in. NH female intake, mounted in brackets fastened to the apparatus if not already mounted directly to the discharge or intake.

Chapter 6 Initial Attack Fire Apparatus

6.1 General.

If the apparatus is to function as an initial attack fire apparatus, it shall meet the requirements of this chapter.

6.2 Fire Pump.

The apparatus shall be equipped with a fire pump that meets the requirements of Chapter 16 and that has a minimum rated capacity of 250 gpm (1000 L/min).

6.3 Water Tank.

Initial attack apparatus shall be equipped with a water tank(s) that meets the requirements of Chapter 18 and that has a minimum certified capacity (combined, if applicable) of 200 gal (750 L).

6.4* Equipment Storage.

A minimum of 22 ft^3 (0.62 m^3) of enclosed weather-resistant compartmentation that meets the requirements of Section 15.1 shall be provided for the storage of equipment.

6.5* Hose Storage.

Hose bed area(s), compartments, or reels that meet the requirements of Section 15.10 shall be provided to accommodate the following:

(1) A minimum hose storage area of 10 ft^3 (0.3 m^3) for 2½ in. (65 mm) or larger fire hose

(2) Two areas, each a minimum of 3.5 ft^3 (0.1 m^3), to accommodate 1½ in. (38 mm) or larger preconnected fire hose lines

6.6* Equipment Supplied by the Contractor.

The contractor shall supply the equipment listed in 6.6.1 and 6.6.2 and shall provide and install such brackets or compartments as are necessary to mount the equipment.

6.6.1 Ground Ladders.

6.6.1.1 A 12 ft (3.7 m) or longer combination or extension-type fire department ground ladder shall be carried on the apparatus.

6.6.1.2 All fire department ground ladders on the apparatus shall meet the requirements of NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders*, except as permitted by 6.6.1.3.

6.6.1.3 Stepladders and other types of multipurpose ladders shall be permitted to be carried in addition to the minimum fire department ground ladders specified in 6.6.1.1 provided they meet either ANSI A14.2 or ANSI A14.5 with duty ratings of Type 1A or 1AA.

6.6.2 Suction Hose or Supply Hose.

6.6.2.1 A minimum of 20 ft (6 m) of suction hose or 15 ft (4.5 m) of supply hose shall be carried.

6.6.2.1.1 Where suction hose is provided, a suction strainer shall be furnished.

6.6.2.1.2 Where suction hose is provided, the friction and entrance loss of the combination suction hose and strainer shall not exceed the losses listed in Table 16.2.4.1(b) or Table 16.2.4.1(c).

6.6.2.1.3 Where supply hose is provided, it shall have couplings compatible with the local hydrant outlet connection on one end and the pump intake connection on the other end.

6.6.2.2 Suction hose and supply hose shall meet the requirements of NFPA 1961, *Standard on Fire Hose*.

6.6.2.3* The purchaser shall specify whether suction hose or supply hose is to be provided, the length and size of the hose, the type and size of the couplings, the manner in which the hose is to be carried on the apparatus, and the style of brackets desired.

6.7* Minor Equipment.

6.7.1 General. The equipment listed in 6.7.2 and 6.7.3 shall be available on the initial attack fire apparatus before the apparatus is placed in service.

6.7.1.1 Brackets or compartments shall be furnished so as to organize and mount the specified equipment.

6.7.1.2 A detailed list of who is to furnish the items and the method for organizing and mounting these items shall be supplied by the purchasing authority.

6.7.2 Fire Hose and Nozzles. The following fire hose and nozzles shall be carried on the apparatus:

(1) 300 ft (90 m) of 2½ in. (65 mm) or larger fire hose

(2) 400 ft (120 m) of 1½ in. (38 mm), 1¾ in. (45 mm), or 2 in. (52 mm) fire hose

(3) Two handline nozzles, 95 gpm (360 L/min) minimum

6.7.3* **Miscellaneous Equipment.** The following additional equipment shall be carried on the apparatus:

(1) One 6 lb (2.7 kg) pickhead axe mounted in a bracket fastened to the apparatus

(2) One 6 ft (2 m) pike pole or plaster hook mounted in a bracket fastened to the apparatus

(3) Two portable hand lights mounted in brackets fastened to the apparatus

(4) One approved dry chemical portable fire extinguisher with a minimum 80-B:C rating mounted in a bracket fastened to the apparatus

(5) One 2½ gal (9.5 L) or larger water extinguisher mounted in a bracket fastened to the apparatus

(6) One SCBA complying with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, for each assigned seating position, but not fewer than two, mounted in brackets fastened to the apparatus or stored in containers supplied by the SCBA manufacturer

(7) One spare SCBA cylinder for each SCBA carried, each mounted in a bracket fastened to the apparatus or stored in a specially designed storage space(s)

(8) One first aid kit

(9) Two combination spanner wrenches mounted in a bracket(s) fastened to the apparatus

(10) One hydrant wrench mounted in a bracket fastened to the apparatus

(11) One double female adapter, sized to fit 2½ in. (65 mm) or larger fire hose, mounted in a bracket fastened to the apparatus

(12) One double male adapter, sized to fit 2½ in. (65 mm) or larger fire hose, mounted in a bracket fastened to the apparatus

(13) One rubber mallet, for use on suction hose connections, mounted in a bracket fastened to the apparatus

(14) Two or more wheel chocks, mounted in readily accessible locations, that together will hold the apparatus, when loaded to its GVWR or GCWR, on a hard surface with a 20 percent grade with the transmission in neutral and the parking brake released

(15) One traffic vest for each seating position, each vest to comply with ANSI/ISEA 207, *Standard for High-Visibility Public Safety Vests*, and have a five-point breakaway feature that includes two at the shoulders, two at the sides, and one at the front

(16) Five fluorescent orange traffic cones not less than 28 in. (711 mm) in height, each equipped with a 6 in. (152 mm) retroreflective white band no more than 4 in. (102 mm) from the top of the cone, and an additional 4 in. (102 mm) retroreflective white band 2 in. (51 mm) below the 6 in. (152 mm) band

(17) Five illuminated warning devices such as highway flares, unless the five fluorescent orange traffic cones have illuminating capabilities

(18) One automatic external defibrillator (AED)

6.7.3.1 If none of the pump intakes are valved, a hose appliance that is equipped with one or more gated intakes with female swivel connection(s) compatible with the supply hose used on one side and a swivel connection with pump intake threads on the other side shall be carried. Any intake connection larger than 3 in. (75 mm) shall include a pressure relief device that meets the requirements of 16.6.6.

6.7.3.2 If the apparatus does not have a 2½ in. intake with NH threads, an adapter from 2½ in. NH female to a pump intake shall be carried, mounted in a bracket fastened to the apparatus if not already mounted directly to the intake.

6.7.3.3 If the supply hose carried has other than 2½ in. NH threads, adapters shall be carried to allow feeding the supply hose from a 2½ in. NH thread male discharge and to allow the hose to connect to a 2½ in. NH female intake, mounted in brackets fastened to the apparatus if not already mounted directly to the discharge or intake.

Chapter 7 Mobile Water Supply Fire Apparatus

7.1 General.

If the apparatus is to function as a mobile water supply apparatus, it shall meet the requirements of this chapter.

7.2 Pump.

If the apparatus is equipped with a fire pump, the pump shall meet the requirements of Chapter 16.

7.3 Water Tank.

The mobile water supply apparatus shall be equipped with a water tank(s) that meets the requirements of Chapter 18 and that has a minimum certified capacity (combined, if applicable) of 1000 gal (4000 L).

7.4* Equipment Storage.

A minimum of 20 ft^3 (0.57 m^3) of enclosed weather-resistant compartmentation meeting the requirements of Section 15.1 shall be provided for the storage of equipment.

7.5 Hose Storage.

7.5.1* A minimum hose storage area of 6 ft^3 (0.2 m^3) for 2½ in. (65 mm) or larger fire hose that meets the requirements of Section 15.10 shall be provided.

7.5.2 If the apparatus is equipped with a fire pump, two areas, each a minimum of 3.5 ft^3 (0.1 m^3), to accommodate 1½ in. (38 mm) or larger preconnected fire hose lines shall be provided.

7.6* Suction Hose or Supply Hose.

If the mobile water supply fire apparatus is equipped with a pump, the requirements in 7.6.1 through 7.6.3 shall apply.

7.6.1 A minimum of 20 ft (6 m) of suction hose or 15 ft (4.5 m) of supply hose shall be carried.

7.6.1.1 Where suction hose is provided, a suction strainer shall be furnished.

7.6.1.2 Where suction hose is provided, the friction and entrance loss of the combination suction hose and strainer shall not exceed the losses listed in Table 16.2.4.1(b) or Table 16.2.4.1(c).

7.6.1.3 Where supply hose is provided, it shall have couplings compatible with the local hydrant outlet connection on one end and the pump intake connection on the other end.

7.6.2 Suction hose and supply hose shall meet the requirements of NFPA 1961, *Standard on Fire Hose*.

7.6.3* The purchaser shall specify whether suction hose or supply hose is to be provided, the length and size of the hose, the type and size of the couplings, the manner in which the hose is to be carried on the apparatus, and the style of brackets desired.

7.7* Minor Equipment.

7.7.1 The equipment listed in 7.7.2 and 7.7.3 shall be available on the initial attack fire apparatus before the apparatus is placed in service.

7.7.1.1 Brackets or compartments shall be furnished so as to organize and mount the specified equipment.

7.7.1.2 A detailed list of who is to furnish the items and the method for organizing and mounting these items shall be supplied by the purchasing authority.

7.7.2 Fire Hose and Nozzles.

7.7.2.1 The mobile water supply apparatus shall be equipped with at least 200 ft (60 m) of 2½ in. (65 mm) or larger fire hose.

7.7.2.2* If the mobile water supply apparatus is equipped with a fire pump, the following shall be provided:

(1) 400 ft (120 m) of 1½ in. (38 mm), 1¾ in. (45 mm), or 2 in. (52 mm) fire hose

(2) Two handline nozzles, 95 gpm (360 L/min) minimum

7.7.3 Equipment.

7.7.3.1* Mobile water supply fire apparatus shall be equipped with at least the following equipment:

(1) One 6 lb (2.7 kg) flathead or pickhead axe mounted in a bracket fastened to the apparatus

(2) One 6 ft (2 m) or longer pike pole or plaster hook mounted in a bracket fastened to the apparatus

(3) Two portable hand lights mounted in brackets fastened to the apparatus

(4) One approved dry chemical portable fire extinguisher with a minimum 80-B:C rating mounted in a bracket fastened to the apparatus

(5) One 2½ gal (9.5 L) or larger water extinguisher mounted in a bracket fastened to the apparatus

(6) One SCBA complying with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, for each assigned seating position, but not fewer than two, mounted in brackets fastened to the apparatus or stored in containers supplied by the SCBA manufacturer

(7) One spare SCBA cylinder for each SCBA carried, each mounted in a bracket fastened to the apparatus or stored in a specially designed storage space(s)

(8) One first aid kit

(9) Two combination spanner wrenches mounted in a bracket fastened to the apparatus

(10) One hydrant wrench mounted in a bracket fastened to the apparatus

(11) One double female adapter, sized to fit 2½ in. (65 mm) or larger fire hose, mounted in a bracket fastened to the apparatus

(12) One double male adapter, sized to fit 2½ in. (65 mm) or larger fire hose, mounted in a bracket fastened to the apparatus

(13) Two or more wheel chocks, mounted in readily accessible locations, that together will hold the apparatus, when loaded to its GVWR or GCWR, on a hard surface with a 20 percent grade with the transmission in neutral and the parking brake released

(14) One traffic vest for each seating position, each vest to comply with ANSI/ISEA 207, *Standard for High-Visibility Public Safety Vests*, and have a five-point breakaway feature that includes two at the shoulders, two at the sides, and one at the front

(15) Five fluorescent orange traffic cones not less than 28 in. (711 mm) in height, each equipped with a 6 in. (152 mm) retroreflective white band no more than 4 in. (102 mm) from the top of the cone, and an additional 4 in. (102 mm) retroreflective white band 2

in. (51 mm) below the 6 in. (152 mm) band

(16) Five illuminated warning devices such as highway flares, unless the five fluorescent orange traffic cones have illuminating capabilities

(17) One automatic external defibrillator (AED)

7.7.3.2 If the mobile water supply apparatus is equipped with a fire pump and none of the pump intakes are valved, a hose appliance that is equipped with one or more gated intakes with female swivel connection(s) compatible with the supply hose used on one side and a swivel connection with pump intake threads on the other side shall be carried. Any intake connection larger than 3 in. (75 mm) shall include a pressure relief device that meets the requirements of 16.6.6.

7.7.3.3 If the mobile water supply apparatus is equipped with a fire pump, a rubber mallet for use on suction hose connections shall be carried in a bracket fastened to the apparatus.

7.7.3.4 If the apparatus does not have a 2½ in. intake with NH threads, an adapter from 2½ in. NH female to a pump intake shall be carried, mounted in a bracket fastened to the apparatus if not already mounted directly to the intake.

7.7.3.5 If the supply hose carried has other than 2½ in. NH threads, adapters shall be carried to allow feeding the supply hose from a 2½ in. NH thread male discharge and to allow the hose to connect to a 2½ in. NH female intake, mounted in brackets fastened to the apparatus if not already mounted directly to the discharge or intake.

Chapter 8 Aerial Fire Apparatus

8.1 General.

8.1.1 If the apparatus is to function as an aerial fire apparatus, it shall meet the requirements of this chapter.

8.1.2 If the apparatus is to function as a pumper with an aerial device, it shall meet all the requirements of Chapter 5 instead of Chapter 8.

8.2 Aerial Device.

The apparatus shall be equipped with an aerial ladder, elevating platform, or water tower that meets the requirements of Chapter 19.

8.3* Fire Pump.

If the apparatus is equipped with a fire pump, the pump shall meet the requirements of Chapter 16.

8.3.1 Provisions shall be made to ensure that the pump operator is not in contact with the ground.

8.3.2 Signs shall be placed to warn the pump operator of electrocution hazards.

8.3.3 If the aerial fire apparatus is equipped with a fire pump that is intended to supply water to a permanently mounted waterway, the fire pump shall be capable of supplying the flow requirements of 19.6.1, 19.12.1, or 19.16.1 with a maximum intake gauge pressure of 20 psi (138 kPa).

8.4 Water Tank.

If the aerial fire apparatus is equipped with a water tank, it shall meet the requirements of Chapter 18.

8.5* Equipment Storage.

A minimum of 40 ft^3 (1.1 m^3) of enclosed weather-resistant compartmentation meeting the requirements of Section 15.1 shall be provided for the storage of equipment.

8.6 Hose Storage.

8.6.1* Any space on the aerial fire apparatus designed to carry fire hose shall meet the requirements of Section 15.10.

8.6.2 If the apparatus is equipped with a fire pump and a water tank, two areas, each a minimum of 3.5 ft^3 (0.1 m^3), to accommodate 1½ in. (38 mm) or larger preconnected fire hose lines shall be provided.

8.7* Ground Ladders.

8.7.1* A minimum of 115 ft (35 m) of fire department ground ladders shall be supplied and installed by the contractor.

8.7.2* As a minimum, the following types of ladders shall be provided:

(1) One folding ladder

(2) Two straight ladders (with folding roof hooks)

(3) Two extension ladders

8.7.3 The contractor shall provide such brackets or compartments as are necessary to mount the equipment.

8.7.4 The fire department ground ladders shall meet the requirements of NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders*, except as permitted by 8.7.5 and 8.7.6.

8.7.5 Stepladders and other types of multipurpose ladders meeting ANSI A14.2, *Ladders — Portable Metal — Safety Requirements*, or ANSI A14.5, *Ladders — Portable Reinforced*

Plastic — Safety Requirements, with duty ratings of Type 1A or 1AA shall be permitted to be substituted for the folding ladder required in 8.7.2(1).

8.7.6 Stepladders and other types of multipurpose ladders shall be permitted to be carried in addition to the minimum fire department ground ladders specified in 8.7.2 provided they meet either ANSI A14.2 or ANSI A14.5 with duty ratings of Type 1A or 1AA.

8.8* Minor Equipment.

8.8.1 The equipment listed in 8.8.2 and 8.8.3 shall be available on the aerial fire apparatus before the apparatus is placed in service.

8.8.1.1 Brackets or compartments shall be furnished so as to organize and mount the specified equipment.

8.8.1.2 A detailed list of who is to furnish the items and the method for organizing and mounting these items shall be supplied by the purchasing authority.

8.8.2* Aerial fire apparatus shall be equipped with at least the following equipment:

(1) Two 6 lb (2.7 kg) flathead axes mounted in brackets fastened to the apparatus

(2) Three 6 lb (2.7 kg) pickhead axes mounted in brackets fastened to the apparatus

(3) Four pike poles mounted in brackets fastened to the apparatus

(4) Two 3 ft to 4 ft (1 m to 1.2 m) plaster hooks with D handles mounted in brackets fastened to the apparatus

(5) Two crowbars mounted in brackets fastened to the apparatus

(6) Two claw tools mounted in brackets fastened to the apparatus

(7) Two 12 lb (5 kg) sledgehammers mounted in brackets fastened to the apparatus

(8) Four portable hand lights mounted in brackets fastened to the apparatus

(9) One approved dry chemical portable fire extinguisher with a minimum 80-B:C rating mounted in a bracket fastened to the apparatus

(10) One 2½ gal (9.5 L) or larger water extinguisher mounted in a bracket fastened to the apparatus

(11) One SCBA complying with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, for each assigned seating position, but not fewer than four, mounted in brackets fastened to the apparatus or stored in containers supplied by the SCBA manufacturer

(12) One spare SCBA cylinder for each SCBA carried, each mounted in a bracket fastened to the apparatus or stored in a specially designed storage space(s)

(13) One first aid kit

(14) Six salvage covers, each a minimum size of 12 ft × 18 ft (3.6 m × 5.5 m)

(15) Four combination spanner wrenches mounted in brackets fastened to the apparatus

(16) Two scoop shovels mounted in brackets fastened to the apparatus

(17) One pair of bolt cutters, 24 in. (0.6 m) minimum, mounted in a bracket fastened to the apparatus

(18) Four ladder belts meeting the requirements of NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services*

(19) One 150 ft (45 m) light-use life safety rope meeting the requirements of NFPA 1983

(20) One 150 ft (45 m) general-use life safety rope meeting the requirements of NFPA 1983

(21) Two 150 ft (45 m) utility ropes having a breaking strength of at least 5000 lb (2300 kg)

(22) One box of tools to include the following:

- (a) One hacksaw with three blades
- (b) One keyhole saw
- (c) One 12 in. (0.3 m) pipe wrench
- (d) One 24 in. (0.6 m) pipe wrench
- (e) One ballpeen hammer
- (f) One pair of tin snips
- (g) One pair of pliers
- (h) One pair of lineman's pliers
- (i) Assorted types and sizes of screwdrivers
- (j) Assorted adjustable wrenches
- (k) Assorted combination wrenches

(23) Two or more wheel chocks, mounted in readily accessible locations, that together will hold the apparatus, when loaded to its GVWR or GCWR, on a hard surface with a 20 percent grade with the transmission in neutral and the parking brake released

(24) One traffic vest for each seating position, each vest to comply with ANSI/ISEA 207, *Standard for High-Visibility Public Safety Vests*, and have a five-point breakaway feature that includes two at the shoulders, two at the sides, and one at the front

(25) Five fluorescent orange traffic cones not less than 28 in. (711 mm) in height, each equipped with a 6 in. (152 mm) retroreflective white band no more than 4 in. (102 mm) from the top of the cone, and an additional 4 in. (102 mm) retroreflective white band 2

in. (51 mm) below the 6 in. (152 mm) band

(26) Five illuminated warning devices such as highway flares, unless the five fluorescent orange traffic cones have illuminating capabilities

(27) One automatic external defibrillator (AED)

8.8.3 If the aerial fire apparatus is equipped with a fire pump, the requirements of 8.8.3.1 through 8.8.3.3 shall apply.

8.8.3.1 The following equipment shall be provided:

(1) One double female 2½ in. (65 mm) adapter with National Hose (NH) threads, mounted in a bracket fastened to the apparatus

(2) One double male 2½ in. (65 mm) adapter with NH threads, mounted in a bracket fastened to the apparatus

(3) One rubber mallet, for use on suction hose connections, mounted in a bracket fastened to the apparatus

(4) Two hydrant wrenches mounted in brackets fastened to the apparatus

8.8.3.2 If the supply hose carried does not use sexless couplings, an additional double female adapter and double male adapter, sized to fit the supply hose carried, shall be carried mounted in brackets fastened to the apparatus.

8.8.3.3 If none of the pump intakes are valved, a hose appliance that is equipped with one or more gated intakes with female swivel connection(s) compatible with the supply hose used on one side and a swivel connection with pump intake threads on the other side shall be carried. Any intake connection larger than 3 in. (75 mm) shall include a pressure relief device that meets the requirements of 16.6.6.

8.8.3.4 If the apparatus does not have a 2½ in. intake with NH threads, an adapter from 2½ in. NH female to a pump intake shall be carried, mounted in a bracket fastened to the apparatus if not already mounted directly to the intake.

8.8.3.5 If the supply hose carried has other than 2½ in. NH threads, adapters shall be carried to allow feeding the supply hose from a 2½ in. NH thread male discharge and to allow the hose to connect to a 2½ in. NH female intake, mounted in brackets fastened to the apparatus if not already mounted directly to the discharge or intake.

8.8.4* If the aerial fire apparatus does not have a prepiped waterway provided, the following equipment shall be furnished:

(1) Manual ladder pipe with 1¼ in. (32 mm), 1⅜ in. (35 mm), and 1½ in. (38 mm) tips or electric ladder pipe with automatic nozzle that can be attached to the aerial ladder

(2) Sufficient length(s) of 3 in. (75 mm) or larger attack hose complying with the requirements of NFPA 1961, *Standard on Fire Hose*, to reach between the installed

ladder pipe and the ground with at least 10 ft (3 m) of hose available on the ground with the ladder at full extension

(3) One hose strap for each ladder section

(4) Halyards to control the ladder pipe from ground level (for manual ladder pipe only)

8.8.4.1 A bracket for carrying the detachable ladder pipe shall be provided on the apparatus and shall be designed so that the ladder pipe clamps will not have to be readjusted to secure the pipe to the aerial ladder.

8.8.4.2 The horizontal traverse of the detachable ladder pipe shall not exceed the aerial ladder manufacturer's recommendations.

8.8.4.3 The ladder pipe shall be capable of swiveling 135 degrees from a line parallel to the ladder and down.

Chapter 9 Quint Fire Apparatus

9.1 General.

If the apparatus is to function as a quint, it shall meet the requirements of this chapter.

9.2 Fire Pump.

9.2.1 The apparatus shall be equipped with a fire pump that meets the requirements of Chapter 16 and has a minimum rated capacity of 1000 gpm (4000 L/min).

9.2.2 The fire pump shall be capable of supplying the flow requirements of 19.6.1 or 19.12.1 with a maximum intake gauge pressure of 20 psi (138 kPa).

9.2.3 Provisions shall be made to ensure that the pump operator is not in contact with the ground.

9.2.4 Signs shall be placed to warn the pump operator of electrocution hazards.

9.3 Aerial Device.

The apparatus shall be equipped with an aerial ladder or an elevating platform with a permanently installed waterway that meets the requirements of Chapter 19.

9.4 Water Tank.

The apparatus shall be equipped with a water tank(s) that meets the requirements of Chapter 18 and that has a minimum certified capacity (combined, if applicable) of 300 gal (1100 L).

9.5* Equipment Storage.

A minimum of 40 ft^3 (1.1 m^3) of enclosed weather-resistant compartmentation that meets the requirements of Section 15.1 shall be provided for the storage of equipment.

9.6* Hose Storage.

Hose bed area(s), compartments, or reels that comply with Section 15.10 shall be provided to accommodate the following:

(1) A minimum hose storage area of 30 ft^3 (0.8 m^3) for 2½ in. (65 mm) or larger fire hose

(2) Two areas, each a minimum of 3.5 ft^3 (0.1 m^3), to accommodate 1½ in. (38 mm) or larger preconnected fire hose lines

9.7* Equipment Supplied by the Contractor.

The contractor shall supply the equipment listed in 9.7.1 and 9.7.2 and shall provide and install such brackets or compartments as are necessary to mount the equipment.

9.7.1 Ground Ladders.

9.7.1.1 The quint shall carry a minimum of 85 ft (26 m) of fire department ground ladders to include at least one extension ladder, one straight ladder equipped with roof hooks, and one folding ladder.

9.7.1.2 All ground ladders carried on the apparatus shall meet the requirements of NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders*, except as permitted by 9.7.1.3 and 9.7.1.4.

9.7.1.3 Stepladders and other types of multipurpose ladders meeting ANSI A14.2, *Ladders — Portable Metal — Safety Requirements,* or ANSI A14.5, *Ladders — Portable Reinforced Plastic — Safety Requirements,* with duty ratings of Type 1A or 1AA shall be permitted to be substituted for the folding ladder required in 9.7.1.1.

9.7.1.4 Stepladders and other types of multipurpose ladders shall be permitted to be carried in addition to the minimum fire department ground ladders specified in 9.7.1.1 provided they meet either ANSI A14.2 or ANSI A14.5 with duty ratings of Type 1A or 1AA.

9.7.2 Suction Hose or Supply Hose.

9.7.2.1 A minimum of 20 ft (6 m) of suction hose or 15 ft (4.5 m) of supply hose shall be carried.

9.7.2.1.1 Where suction hose is provided, a suction strainer shall be furnished.

9.7.2.1.2 Where suction hose is provided, the friction and entrance loss of the combination suction hose and strainer shall not exceed the losses listed in Table 16.2.4.1(b) or Table 16.2.4.1(c).

9.7.2.1.3 Where supply hose is provided, it shall have couplings compatible with the local hydrant outlet connection on one end and the pump intake connection on the other end.

9.7.2.2 Suction hose and supply hose shall meet the requirements of NFPA 1961, *Standard on Fire Hose*.

9.7.2.3* The purchaser shall specify whether suction hose or supply hose is to be provided, the length and size of the hose, the type and size of the couplings, the manner in which the hose is to be carried on the apparatus, and the style of brackets desired.

9.8* Minor Equipment.

9.8.1 The equipment listed in 9.8.2 and 9.8.3 shall be available on the quint fire apparatus before the apparatus is placed in service.

9.8.1.1 Brackets or compartments shall be furnished so as to organize and mount the specified equipment.

9.8.1.2 A detailed list of who is to furnish the items and the method for organizing and mounting these items shall be supplied by the purchasing authority.

9.8.2* Fire Hose and Nozzles. The following fire hose and nozzles shall be carried on the apparatus:

(1) 800 ft (240 m) of 2½ in. (65 mm) or larger fire hose, in any combination

(2) 400 ft (120 m) of 1½ in. (38 mm), 1¾ in. (45 mm), or 2 in. (52 mm) fire hose, in any combination

(3) One handline nozzle, 200 gpm (750 L/min) minimum

(4) Two handline nozzles, 95 gpm (360 L/min) minimum

(5) One playpipe with shutoff and 1 in. (25 mm), 1⅛ in. (29 mm), and 1¼ in. (32 mm) tips

9.8.3* Miscellaneous Equipment. The following additional equipment shall be carried on the apparatus:

(1) One 6 lb (2.7 kg) flathead axe mounted in a bracket fastened to the apparatus

(2) One 6 lb (2.7 kg) pickhead axe mounted in a bracket fastened to the apparatus

(3) One 6 ft (2 m) pike pole or plaster hook mounted in a bracket fastened to the apparatus

(4) One 8 ft (2.4 m) or longer pike pole mounted in a bracket fastened to the apparatus

(5) Two portable hand lights mounted in brackets fastened to the apparatus

(6) One approved dry chemical portable fire extinguisher with a minimum 80-B:C rating mounted in a bracket fastened to the apparatus

(7) One 2½ gal (9.5 L) or larger water extinguisher mounted in a bracket fastened to the apparatus

(8) One SCBA complying with NFPA 1981, *Standard on Open-Circuit Self-Contained*

Breathing Apparatus (SCBA) for Emergency Services, for each assigned seating position, but not fewer than four, mounted in brackets fastened to the apparatus or stored in containers supplied by the SCBA manufacturer

(9) One spare SCBA cylinder for each SCBA carried, each mounted in a bracket fastened to the apparatus or stored in a specially designed storage space(s)

(10) One spare SCBA cylinder for each SCBA carried

(11) One first aid kit

(12) Four combination spanner wrenches mounted in brackets fastened to the apparatus

(13) Two hydrant wrenches mounted in brackets fastened to the apparatus

(14) One double female 2½ in. (65 mm) adapter with National Hose (NH) threads, mounted in a bracket fastened to the apparatus

(15) One double male 2½ in. (65 mm) adapter with NH threads, mounted in a bracket fastened to the apparatus

(16) One rubber mallet, for use on suction hose connections, mounted in a bracket fastened to the apparatus

(17) Four salvage covers, each a minimum size of 12 ft × 14 ft (3.7 m × 4.3 m)

(18) Four ladder belts meeting the requirements of NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services*

(19) One 150 ft (45 m) light-use life safety rope meeting the requirements of NFPA 1983

(20) One 150 ft (45 m) general-use life safety rope meeting the requirements of NFPA 1983

(21) Two or more wheel chocks, mounted in readily accessible locations, that together will hold the apparatus, when loaded to its GVWR or GCWR, on a hard surface with a 20 percent grade with the transmission in neutral and the parking brake released

(22) One traffic vest for each seating position, each vest to comply with ANSI/ISEA 207, *Standard for High-Visibility Public Safety Vests*, and have a five-point breakaway feature that includes two at the shoulders, two at the sides, and one at the front

(23) Five fluorescent orange traffic cones not less than 28 in. (711 mm) in height, each equipped with a 6 in. (152 mm) retroreflective white band no more than 4 in. (102 mm) from the top of the cone, and an additional 4 in. (102 mm) retroreflective white band 2 in. (51 mm) below the 6 in. (152 mm) band

(24) Five illuminated warning devices such as highway flares, unless the five fluorescent orange traffic cones have illuminating capabilities

(25) One automatic external defibrillator (AED)

9.8.3.1 If the supply hose carried does not use sexless couplings, an additional double female adapter and double male adapter, sized to fit the supply hose carried, shall be carried mounted in brackets fastened to the apparatus.

9.8.3.2 If none of the pump intakes are valved, a hose appliance that is equipped with one or more gated intakes with female swivel connection(s) compatible with the supply hose used on one side and a swivel connection with pump intake threads on the other side shall be carried. Any intake connection larger than 3 in. (75 mm) shall include a pressure relief device that meets the requirements of 16.6.6.

9.8.3.3 If the apparatus does not have a 2½ in. intake with NH threads, an adapter from 2½ in. NH female to a pump intake shall be carried, mounted in a bracket fastened to the apparatus if not already mounted directly to the intake.

9.8.3.4 If the supply hose carried has other than 2½ in. NH threads, adapters shall be carried to allow feeding the supply hose from a 2½ in. NH thread male discharge and to allow the hose to connect to a 2½ in. NH female intake, mounted in brackets fastened to the apparatus if not already mounted directly to the discharge or intake.

Chapter 10 Special Service Fire Apparatus

10.1 General.

If the apparatus is to function as a special service fire apparatus, it shall meet the requirements of this chapter.

10.2 Pump.

If the apparatus is equipped with a fire pump, the pump shall meet the requirements of Chapter 16.

10.3* Equipment Storage.

A minimum of 120 ft^3 (3.4 m^3) of enclosed weather-resistant compartmentation meeting the requirements of Section 15.1 shall be provided for the storage of equipment.

10.4* Equipment Supplied by the Contractor.

If the apparatus is designed to carry ground ladders or has a pump, the contractor shall supply the equipment listed in 10.4.1 and 10.4.2 and shall provide and install such brackets or compartments as are necessary to mount the equipment.

10.4.1 Ground Ladders.

10.4.1.1 If fire department ground ladders are carried on the apparatus, they shall meet the requirements of NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders*, except as permitted by 10.4.1.2.

10.4.1.2 Stepladders and other types of multipurpose ladders shall be permitted to be carried provided they meet either ANSI A14.2, *Ladders — Portable Metal — Safety Requirements*, or ANSI A14.5, *Ladders — Portable Reinforced Plastic — Safety Requirements*, with duty ratings of Type 1A or 1AA.

10.4.2 Suction Hose or Supply Hose. If the special service fire apparatus is equipped with a pump, the requirements in 10.4.2.1 through 10.4.2.3 shall apply.

10.4.2.1 A minimum of 20 ft (6 m) of suction hose or 15 ft (4.5 m) of supply hose shall be carried.

10.4.2.1.1 Where suction hose is provided, a suction strainer shall be furnished.

10.4.2.1.2 Where suction hose is provided, the friction and entrance loss of the combination suction hose and strainer shall not exceed the losses listed in Table 16.2.4.1(b) or Table 16.2.4.1(c).

10.4.2.1.3 Where supply hose is provided, it shall have couplings compatible with the local hydrant outlet connection on one end and the pump intake connection on the other end.

10.4.2.2 Suction and supply hose shall meet the requirements of NFPA 1961, *Standard on Fire Hose*.

10.4.2.3* The purchaser shall specify whether suction hose or supply hose is to be provided, the length and size of the hose, the type and size of the couplings, the manner in which the hose is to be carried on the apparatus, and the style of brackets desired.

10.5* Minor Equipment.

10.5.1 The equipment listed in 10.5.2 shall be available on the special service fire apparatus before the apparatus is placed in service.

10.5.1.1 Brackets or compartments shall be furnished so as to organize and mount the specified equipment.

10.5.1.2 A detailed list of who is to furnish the items and the method for organizing and mounting these items shall be supplied by the purchasing authority.

10.5.2* The following equipment shall be carried on the apparatus:

(1) Two portable hand lights mounted in brackets fastened to the apparatus

(2) One approved dry chemical portable fire extinguisher with a minimum 80-B:C rating mounted in a bracket fastened to the apparatus

(3) One 2½ gal (9.5 L) or larger water extinguisher mounted in a bracket fastened to the apparatus

(4) One SCBA complying with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, for each assigned seating

position, but not fewer than two, mounted in brackets fastened to the apparatus or stored in containers supplied by the SCBA manufacturer

(5) One spare SCBA cylinder for each SCBA carried, each mounted in a bracket fastened to the apparatus or stored in a specially designed storage space(s)

(6) One first aid kit

(7) Two or more wheel chocks, mounted in readily accessible locations, that together will hold the apparatus, when loaded to its GVWR or GCWR, on a hard surface with a 20 percent grade with the transmission in neutral and the parking brake released

(8) One traffic vest for each seating position, each vest to comply with ANSI/ISEA 207, *Standard for High-Visibility Public Safety Vests*, and have a five-point breakaway feature that includes two at the shoulders, two at the sides, and one at the front

(9) Five fluorescent orange traffic cones not less than 28 in. (711 mm) in height, each equipped with a 6 in. (152 mm) retroreflective white band no more than 4 in. (102 mm) from the top of the cone, and an additional 4 in. (102 mm) retroreflective white band 2 in. (51 mm) below the 6 in. (152 mm) band

(10) Five illuminated warning devices such as highway flares, unless the five fluorescent orange traffic cones have illuminating capabilities

(11) One automatic external defibrillator (AED)

Chapter 11 Mobile Foam Fire Apparatus

11.1 General.

If the apparatus is to function as a mobile foam fire apparatus, it shall meet the requirements of this chapter.

11.2 Fire Pump.

The apparatus shall be equipped with a fire pump that has a minimum rated capacity of 750 gpm (3000 L/min) and meets the requirements of Chapter 16.

11.3 Aerial Device.

If the mobile foam fire apparatus is equipped with an aerial device, the requirements of 11.3.1 through 11.3.4 shall apply.

11.3.1 The aerial device shall meet the requirements of Chapter 19.

11.3.2 The aerial device shall be equipped with a permanently mounted waterway, and the fire pump shall be capable of supplying the flow requirements of 19.6.1, 19.12.1, or 19.16.1 with a maximum intake gauge pressure of 20 psi (138 kPa).

11.3.3 Provisions shall be made to ensure that the pump operator is not in contact with the ground.

11.3.4 Signs shall be placed to warn the pump operator of electrocution hazards.

11.4 Foam Proportioning System.

The apparatus shall be equipped with a foam proportioning system that meets the requirements of Chapter 20.

11.5 Foam Tank.

The mobile foam fire apparatus shall be equipped with a foam concentrate tank(s) that meets the requirements of Section 20.6 and that has a minimum certified capacity (combined, if applicable) of 500 gal (2000 L).

11.6* Equipment Storage.

A minimum of 40 ft^3 (1.13 m^3) of enclosed weather-resistant compartmentation that meets the requirements of Section 15.1 shall be provided for the storage of equipment.

11.7* Hose Storage.

Hose bed area(s), compartments, or reels that comply with Section 15.10 shall be provided to accommodate the following:

(1) A minimum hose storage area of 30 ft^3 (0.8 m^3) for 2½ in. (65 mm) or larger fire hose

(2) Two areas, each a minimum of 3.5 ft^3 (0.1 m^3), to accommodate 1½ in. (38 mm) or larger preconnected fire hose lines

11.8* Equipment Supplied by the Contractor.

The contractor shall supply the equipment listed in 11.8.1 and shall provide and install such brackets or compartments as are necessary to mount the equipment.

11.8.1 Suction Hose or Supply Hose.

11.8.1.1 A minimum of 20 ft (6 m) of suction hose or 15 ft (4.5 m) of supply hose shall be carried.

11.8.1.1.1 Where suction hose is provided, a suction strainer shall be furnished.

11.8.1.1.2 Where suction hose is provided, the friction and entrance loss of the combination suction hose and strainer shall not exceed the losses listed in Table 16.2.4.1(b) or Table 16.2.4.1(c).

11.8.1.1.3 Where supply hose is provided, it shall have couplings compatible with the local hydrant outlet connection on one end and the pump intake connection on the other end.

11.8.1.2 Suction hose and supply hose shall meet the requirements of NFPA 1961, *Standard on Fire Hose*.

11.8.1.3* The purchaser shall specify whether suction hose or supply hose is to be provided, the length and size of the hose, the type and size of the couplings, the manner in which the hose is to be carried on the apparatus, and the style of brackets desired.

11.9* Minor Equipment.

11.9.1 General. The equipment listed in 11.9.2 and 11.9.3 shall be available on the mobile foam fire apparatus before the apparatus is placed in service.

11.9.1.1 Brackets or compartments shall be furnished so as to organize and mount the specified equipment.

11.9.1.2 A detailed list of who is to furnish the items and the method for organizing and mounting these items shall be supplied by the purchasing authority.

11.9.2* Fire Hose and Nozzles. The following fire hose and nozzles shall be carried on the apparatus:

(1) 800 ft (240 m) of 2½ in. (65 mm) or larger fire hose, in any combination

(2) 400 ft (120 m) of 1½ in. (38 mm), 1¾ in. (45 mm), or 2 in. (52 mm) fire hose, in any combination

(3) Four foam or water handline nozzles, 200 gpm (750 L/min) minimum

(4) Two foam or water handline nozzles, 95 gpm (360 L/min) minimum

(5) One preconnected monitor, rated to discharge a minimum of 1000 gpm (4000 L/min), mounted on top of the fire apparatus with a spray or foam nozzle rated at a minimum of 1000 gpm (4000 L/min)

11.9.3* Miscellaneous Equipment. The following additional equipment shall be carried on the apparatus:

(1) One 6 lb (2.7 kg) pickhead axe mounted in a bracket fastened to the apparatus

(2) One 6 ft (2 m) pike pole or plaster hook mounted in a bracket fastened to the apparatus

(3) Two portable hand lights mounted in brackets fastened to the apparatus

(4) One approved dry chemical portable fire extinguisher with a minimum 80-B:C rating mounted in a bracket fastened to the apparatus

(5) One SCBA complying with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, for each assigned seating position, but not fewer than four, mounted in brackets fastened to the apparatus or stored in containers supplied by the SCBA manufacturer

(6) One spare SCBA cylinder for each SCBA carried, each mounted in a bracket fastened to the apparatus or stored in a specially designed storage space

(7) One first aid kit

(8) Four combination spanner wrenches mounted in brackets fastened to the apparatus

(9) Two hydrant wrenches mounted in brackets fastened to the apparatus

(10) One double female 2½ in. (65 mm) adapter with National Hose (NH) threads, mounted in a bracket fastened to the apparatus

(11) One double male 2½ in. (65 mm) adapter with NH threads, mounted in a bracket fastened to the apparatus

(12) One rubber mallet, suitable for use on suction hose connections, mounted in a bracket fastened to the apparatus

(13) Two or more wheel chocks, mounted in readily accessible locations, that together will hold the apparatus, when loaded to its GVWR or GCWR, on a hard surface with a 20 percent grade with the transmission in neutral and the parking brake released

(14) One traffic vest for each seating position, each vest to comply with ANSI/ISEA 207, *Standard for High-Visibility Public Safety Vests*, and have a five-point breakaway feature that includes two at the shoulders, two at the sides, and one at the front

(15) Five fluorescent orange traffic cones not less than 28 in. (711 mm) in height, each equipped with a 6 in. (152 mm) retroreflective white band no more than 4 in. (102 mm) from the top of the cone, and an additional 4 in. (102 mm) retroreflective white band 2 in. (51 mm) below the 6 in. (152 mm) band

(16) Five illuminated warning devices such as highway flares, unless the five fluorescent orange traffic cones have illuminating capabilities

(17) One automatic external defibrillator (AED)

11.9.3.1 If the supply hose carried does not use sexless couplings, an additional double female adapter and double male adapter, sized to fit the supply hose carried, shall be carried mounted in brackets fastened to the apparatus.

11.9.3.2 If none of the pump intakes are valved, a hose appliance that is equipped with one or more gated intakes with female swivel connection(s) compatible with the supply hose used on one side and a swivel connection with pump intake threads on the other side shall be carried. Any intake connection larger than 3 in. (75 mm) shall include a pressure relief device that meets the requirements of 16.6.6.

11.9.3.3 If the mobile foam fire apparatus is equipped with an aerial device with a permanently mounted ladder, four ladder belts meeting the requirements of NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services*, shall be provided.

11.9.3.4 If the apparatus does not have a 2½ in. intake with NH threads, an adapter from 2½ in. NH female to a pump intake shall be carried, mounted in a bracket fastened to the apparatus if not already mounted directly to the intake.

11.9.3.5 If the supply hose carried has other than 2½ in. NH threads, adapters shall be carried to allow feeding the supply hose from a 2½ in. NH thread male discharge and to allow the hose to connect to a 2½ in. NH female intake, mounted in brackets fastened to the apparatus if not already mounted directly to the discharge or intake.

Chapter 12 Chassis and Vehicle Components

12.1* Carrying Capacity.

The GAWR and the GCWR or GVWR of the chassis shall be adequate to carry the weight of the fire apparatus when loaded to its estimated in-service weight as defined in 12.1.2.

12.1.1 The manufacturer shall establish the estimated in-service weight during the design of the fire apparatus.

12.1.2 The estimated in-service weight shall include the following:

(1) The chassis, body, and tank(s)

(2) Full fuel, lubricant, and other chassis or component fluid tanks or reservoirs

(3) Full water and other agent tanks

(4)* 250 lb (114 kg) in each seating position

(5) Fixed equipment such as pumps, aerial devices, generators, reels, and air systems as installed

(6) Ground ladders, suction hose, designed hose load in their hose beds and on their reels

(7) An allowance for miscellaneous equipment that is the greatest of the values shown in Table 12.1.2, a purchaser-provided list of equipment to be carried with weights, or a purchaser-specified miscellaneous equipment allowance

Table 12.1.2 Miscellaneous Equipment Allowance

Apparatus Type	Apparatus Size	Equipment Allow	
		lb	k
Pumper fire apparatus	Less than 250 ft^3 (7 m^3) compartment space*	2,000	9
	250 ft^3 (7 m^3) or more of compartment space*	2,500	1,
Initial attack fire apparatus	10,000 lb to 15,000 lb (4,500 kg to 7,000 kg) GVWR	900	4
	15,001 lb to 20,000 lb (7,001 kg to 9,000 kg) GVWR	1,500	6
	20,001 lb (9,000 kg) and up GVWR	2,000	9
Mobile water supply fire apparatus	All	1,000	4

Table 12.1.2 Miscellaneous Equipment Allowance

Apparatus Type	Apparatus Size	Equipment Allowa	
		lb	k
Aerial fire apparatus	All	2,500	1,1
Quint fire apparatus	All	2,500	1,1
Special service fire apparatus	10,000 lb to 15,000 lb (4,500 kg to 7,000 kg) GVWR	2,000	9
	15,001 lb to 20,000 lb (7,001 kg to 9,000 kg) GVWR	2,500	1,1
	20,001 lb to 30,000 lb (9,001 kg to 14,000 kg) GVWR	3,000	1,3
	30,001 lb to 40,000 lb (14,001 kg to 18,000 kg) GVWR	4,000	1,8
	40,001 lb to 50,000 lb (18,001 kg to 23,000 kg) GVWR	6,000	2,7
	50,001 lb to 60,000 lb (23,001 kg to 27,000 kg) GVWR	8,000	3,6
	60,001 lb (27,001 kg) and up GVWR	10,000	4,5
Mobile foam fire apparatus	All	2,000	9

*Compartment space for pumpers is calculated based on the inside dimensions of the enclosed compartment.

12.1.3 The manufacturer shall engineer and design the fire apparatus such that the completed apparatus, when loaded to its estimated in-service weight, with all movable weights distributed as close as is practical to their intended in-service configuration, does not exceed the GVWR.

12.1.4 A final manufacturer's certification of the GVWR or GCWR, along with a certification of each GAWR, shall be supplied on a label affixed to the vehicle.

12.1.5 The fire apparatus manufacturer shall permanently affix a high-visibility label in a location visible to the driver while seated.

12.1.5.1* The label shall show the height of the completed fire apparatus in feet and inches or in meters, the length of the completed fire apparatus in feet and inches or in meters, and the GVWR in tons or metric tons.

12.1.5.2 Wording on the label shall indicate that the information shown was current when the apparatus was manufactured and that, if the overall height changes while the vehicle is in service, the fire department must revise that dimension on the plate.

12.2 Engine and Engine System Design.

12.2.1* Chassis Engine.

12.2.1.1* An engine governor or electronic fuel control system shall be installed that will limit the speed of the engine under all conditions of operation to that speed established by the engine manufacturer, which shall be the maximum governed speed.

12.2.1.2 Audible and visual warning devices that are visible from the driver's position shall be provided to alert the driver to high engine temperature or low oil pressure conditions.

12.2.1.3* Automatic engine shutdown systems shall not be permitted unless they are an integral part of the standard engine management system.

12.2.1.4 Engine derate programming shall be permitted to be used to protect the engine.

12.2.1.5 Engine Speed Auxiliary Control Device.

12.2.1.5.1* An engine speed auxiliary control device (high idle switch or throttle) shall be installed to allow an increase in the engine speed when the apparatus is parked.

12.2.1.5.2* An interlock shall prevent the operation of the engine speed auxiliary control device unless the parking brake is engaged and the transmission is in neutral or park, or the parking brake is engaged and the engine is disengaged from the drive wheels.

12.2.1.5.3 The engine shall be prevented from regulating its own engine speed during times when engine rpm control is critical for consistent apparatus functions such as generator, water pump, or aerial operation.

12.2.1.6 The installation of the engine, transmission, and engine- and transmission-driven accessories [power takeoffs (PTOs), etc.] shall meet the engine and transmission manufacturers' installation recommendations for the service intended.

12.2.1.7 An engine hourmeter shall be provided.

12.2.2 Cooling System.

12.2.2.1* The engine's cooling system shall maintain a temperature in the engine at or below the engine manufacturer's maximum temperature rating under all conditions for which the apparatus is designed.

12.2.2.2 Drain Valves.

12.2.2.2.1 Readily accessible drain valves shall be installed at the lowest point of the cooling system and at such other points as are necessary to permit complete removal of the coolant from the system.

12.2.2.2.2 Drain valves shall be designed such that they will not open accidentally due to vibration.

12.2.2.3 The radiator shall be mounted to prevent the development of leaks caused by twisting or straining where the apparatus operates over uneven ground.

12.2.2.4 Radiator cores shall be compatible with commercial antifreeze solutions.

12.2.3 Lubrication System.

12.2.3.1* The engine shall be provided with an oil filter of the type approved by the engine manufacturer.

12.2.3.2 The engine oil fill pipe shall be large enough and located so as to allow easy filling.

12.2.3.3 A permanent label in the driving compartment shall specify the quantity and type of the following fluids used in the vehicle and tire information:

(1) Engine oil

(2) Engine coolant

(3) Chassis transmission fluid

(4) Pump transmission lubrication fluid

(5) Pump priming system fluid, if applicable

(6) Drive axle(s) lubrication fluid

(7) Air conditioning refrigerant

(8) Air conditioning lubrication oil

(9) Power steering fluid

(10) Cab tilt mechanism fluid

(11) Transfer case fluid

(12) Equipment rack fluid

(13) CAFS air compressor system lubricant

(14) Generator system lubricant

(15) Front tire cold pressure

(16) Rear tire cold pressure

(17) Maximum tire speed ratings

12.2.4* Air Intake System.

12.2.4.1* An air filter shall be provided in the engine's intake air system.

12.2.4.2 Air inlet restrictions shall not exceed the engine manufacturer's recommendations.

12.2.4.3* The air inlet shall be equipped with a means of separating water and burning embers from the air intake system.

12.2.4.4 The requirement in 12.2.4.3 shall be permitted to be achieved by either of the following methods:

(1) Provision of a device such that burning particulate matter larger than 0.039 in. (1.0 mm) in diameter cannot reach the air filter element

(2) Provision of a multiscreen ember separator capable of meeting the test requirements

defined in the Parker Hannafin, Racor Division, publication LF 1093-90, Ember Separation Test Procedure, or an equivalent test

12.2.4.5 An air restriction indicator shall be mounted in the driving compartment and visible to the driver.

12.2.5 Fuel System.

12.2.5.1 Diesel Engines.

12.2.5.1.1* The fuel supply lines and fuel filters shall meet the engine manufacturer's recommendations.

12.2.5.1.2 The filters or strainers shall be of a serviceable type and mounted in an accessible location.

12.2.5.1.3 Where two or more fuel lines are installed, separate fuel pumps operating in parallel with check valves and filtering devices shall be provided.

12.2.5.1.4 The fuel line(s) shall be located or protected so as not to be subjected to excessive heating from any portion of an exhaust system.

12.2.5.1.5 The line(s) shall be protected from mechanical damage.

12.2.5.1.6 Electric Fuel Priming System.

12.2.5.1.6.1* Where an electric fuel priming system is furnished, the valving and piping shall be arranged so that the priming system can be operated only to reprime the fuel system.

12.2.5.1.6.2 When the priming system is not being intentionally operated, it shall be isolated from the fuel system and inoperable.

12.2.5.1.6.3 The priming system shall be marked with a label to indicate proper operation.

12.2.5.2 Gasoline Engines.

12.2.5.2.1 Fuel lines and filters or strainers that meet the engine manufacturer's recommendations shall be provided.

12.2.5.2.2 The filters or strainers shall be of a serviceable type and mounted in an accessible location.

12.2.5.2.3 Where two or more fuel lines are installed, separate fuel pumps operating in parallel with check valves and filtering devices shall be provided.

12.2.5.2.4 The fuel line(s) shall be located or protected so as not to be subjected to excessive heating from any portion of an exhaust system.

12.2.5.2.5 The line(s) shall be protected from mechanical damage.

12.2.5.2.6 A gasoline feed system shall include an electric-powered fuel pump located within or adjacent to the fuel tank.

12.2.6 Exhaust System.

12.2.6.1* The exhaust piping and discharge outlet shall be located or shielded so as not to expose any portion of the apparatus or equipment to excessive heating.

12.2.6.2 Exhaust pipe discharge shall be directed away from any operator's position.

12.2.6.3 If the apparatus is equipped with stabilizers, the exhaust piping discharge shall be directed away from the contact area between the stabilizer and the ground when the stabilizer is deployed.

12.2.6.4 Silencing devices shall be provided.

12.2.6.5 Exhaust backpressure shall not exceed the limits specified by the engine manufacturer.

12.2.6.6 Where parts of the exhaust system are exposed so that they are likely to cause injury to operating personnel, protective guards shall be provided.

12.2.6.7* **Diesel Particulate Filter.** If the apparatus is driven by a diesel engine equipped with a diesel particulate filter (DPF), the requirements of 12.2.6.7.1 through 12.2.6.7.6 shall apply.

12.2.6.7.1 The regeneration process shall be activated by two methods:

(1)* Automatically by the engine system but only when the transmission is in gear and the speedometer indicates a speed above 5 mph (8 km/hr), whether the apparatus is in motion or is operating in stationary pump mode with an engine rpm sufficient to register 5 mph (8 km/hr) on the speedometer

(2) Manually when initiated by activation of a switch located in the driver’s area of the driving compartment

12.2.6.7.2 Instructions for initiating the manual regeneration process shall be explained in the apparatus operator’s manual.

12.2.6.7.3* A switch shall be provided at the driver’s area that will inhibit DPF regeneration until the switch is reset or the engine is shut down and restarted.

12.2.6.7.4 A DPF icon visible to the driver when seated in the driver's seat shall be illuminated to indicate that the DPF requires active regeneration.

12.2.6.7.5 A high exhaust system temperature (HEST) icon visible to the driver when seated in the driver's seat shall be illuminated to indicate that an active regeneration process has been initiated.

12.2.6.7.6* Engine exhaust gas temperature shall not exceed 851°F (455°C) when measured at the exit of the exhaust pipe during normal DPF regeneration.

12.3 Vehicle Components.

12.3.1 Braking System.

12.3.1.1 All brakes shall be readily accessible for adjustment.

12.3.1.2 Where air-actuated braking systems are provided, they shall include the following:

(1) An automatic moisture ejector

(2) An air dryer

(3) A pressure protection valve to prevent all air-operated accessories from drawing air from the air brake system when the air system’s pressure drops below 80 psi (550 kPa)

(4) A quick buildup section in the air reservoir system arranged so that if the apparatus has a completely discharged air system, it is able to move within 60 seconds of startup

12.3.1.2.1 The quick buildup system shall provide sufficient air pressure so that the apparatus has no brake drag and is able to stop under the intended operating conditions following the 60-second buildup time.

12.3.1.2.2* On a chassis that cannot be equipped with a quick buildup air brake system, an onboard automatic electric compressor or a fire station compressed air shoreline hookup shall be permitted in order to maintain full operating air pressure while the vehicle is not running.

12.3.1.3* Parking Brakes.

12.3.1.3.1 Parking brakes shall control the rear wheels, or all wheels, and shall be of the positive, mechanically actuated type.

12.3.1.3.2 A lockup device to retain applied pressure on hydraulically actuated service brake systems or the use of the “park” position on an automatic transmission shall not be substituted for a separate parking brake system.

12.3.1.4* All apparatus with a GVWR of 36,000 lb (16,330 kg) or greater shall be equipped with an auxiliary braking system.

12.3.1.5* Any time a secondary braking device such as transmission retarders or exhaust restriction devices are used, they shall have a switch to turn them off during adverse road conditions.

12.3.2 Suspension and Wheels.

12.3.2.1* Each load-bearing tire and rim of the fire apparatus shall not carry a weight in excess of the recommended load for the operation of truck tires of the size used, as published in *Tire and Rim Association — Year Book* or as recommended by the tire manufacturer, when the apparatus is loaded to its GVWR.

12.3.2.1.1 Where the vehicle tires are utilized as part of an aerial device stability system, the maximum loads imposed on the tires shall not exceed the tire manufacturer's maximum static load rating.

12.3.2.2 Axle housings and any components other than wheels and tires shall clear the road surface by at least 8 in. (203 mm).

12.3.2.3* An angle of approach and an angle of departure of at least 8 degrees shall be maintained at the front and the rear of the vehicle when it is loaded to the estimated in-service weight.

12.3.2.4 Clearance for tire chains shall be provided in accordance with SAE J683, *Tire Chain Clearance — Trucks, Buses (Except Suburban, Intercity, and Transit Buses), and Combinations of Vehicles*.

12.3.2.5 Steering.

12.3.2.5.1 The steering mechanism shall be capable of turning the front wheels to an angle of at least 30 degrees to either the right or the left for nondriving front axles and at least 28 degrees for driving front axles.

12.3.2.5.2 Power steering or power-assisted steering shall be provided.

12.3.2.6 Tractor-Drawn Aerial Fire Apparatus.

12.3.2.6.1 If a tractor-drawn vehicle is provided for an aerial fire apparatus, it shall consist of a tractor with a permanent, nonkingpinned “fifth wheel” mounted on the rear of the chassis to carry the forward end of the aerial ladder trailer unit.

12.3.2.6.2 The fifth wheel and body design shall be of a type that allows full 90-degree jackknifing of the tractor trailer combination with the stabilizers in the stored position.

12.3.2.6.3 A steering wheel shall be provided to steer the rear wheels of the trailer unit.

12.3.2.6.3.1 The steering shall be of the power or power-assisted type.

12.3.2.6.3.2 A minimum wheel cramp angle of 20 degrees right and left shall be provided.

12.3.2.6.4 An audible and visual warning system shall be provided to warn both drivers when the jackknife position approaches the manufacturer's maximum allowable position.

12.3.2.6.5 If the manufacturer's design does not permit the load from the aerial device to be transferred to the rear springs of the tractor, a device shall be installed that will prevent such a weight transfer.

12.3.3* Transmission.

12.3.3.1 The transmission shall be rated for heavy-duty service and shall be designed to match engine torque and speed to the load demand.

12.3.3.2 The transmission shall provide the driver with the selection of individual gears or ranges of gears necessary to meet the performance requirements of this standard.

12.3.4 Fuel Tank.

12.3.4.1* The fuel capacity shall allow the engine to drive the pump for 2½ hours at rated pump capacity at 150 psi (1000 kPa) net pump pressure and at the suction conditions specified in this standard or to operate at 60 percent of gross engine horsepower for 2½ hours, whichever is greater.

12.3.4.2 The tank fill opening shall be marked with a label indicating the type of fuel to be used.

12.3.4.3 If two fuel tanks are furnished, the fuel system shall not require manual intervention to provide fuel to the engine. A single fuel gauge shall indicate the proportional amount of fuel in the fuel system.

12.3.4.4 The tank fill piping shall be placed so it is protected from mechanical damage during the normal use of the fire apparatus.

12.3.4.5 The tank and the fill piping shall be located or shielded so that they are not exposed to heat from an exhaust system or other source of ignition on the apparatus.

12.3.4.6 The tank shall be placed so it is removable for repairs.

12.3.4.7 A means for draining the tank without removing the tank shall be supplied.

12.3.5* Tow Hooks. Front and rear tow hooks or tow eyes shall be attached to the frame structure to allow towing (not lifting) of the apparatus without damage.

12.3.6 Towing Capability. If the apparatus is equipped for towing a trailer, the provisions of 12.3.6.1 through 12.3.6.5 shall apply.

12.3.6.1 For hydraulic brake–equipped or electric brake–equipped trailer towing capability, a primary electrical receptacle shall be provided near the hitch point and shall match the umbilical cable specified in 26.10.4.5.

12.3.6.2 For air brake–equipped trailer towing capability, the following shall apply:

(1) A primary electrical receptacle shall be provided near the hitch point and shall match the umbilical cable specified in 26.10.4.4.

(2) Gladhands shall be provided for air brake connections.

12.3.6.3 An auxiliary electrical receptacle shall be provided near the hitch point and shall match the umbilical cable specified in 26.10.4.6.

12.3.6.4 A label shall be provided in a location in which it is visible to an operator making trailer connections. The label shall state the maximum GVWR and tongue weight of the trailer that can be safely towed with the hitch system.

12.3.6.5 Two safety chain attachment points shall be provided near the hitch point for hitches designed to use safety chains, each designed with an ultimate strength of not less than the maximum GVWR specified on the label required in 12.3.6.4.

Chapter 13 Low Voltage Electrical Systems and Warning Devices

13.1* General.

Any low voltage electrical systems or warning devices installed on the fire apparatus shall be appropriate for the mounting location and intended electrical load and shall meet the specific requirements of Chapter 13.

13.2 Wiring.

All electrical circuit feeder wiring supplied and installed by the fire apparatus manufacturer shall meet the requirements of 13.2.1 through 13.2.8.

13.2.1* The circuit feeder wire shall be stranded copper or copper alloy conductors of a gauge rated to carry 125 percent of the maximum current for which the circuit is protected.

13.2.1.1 Voltage drops in all wiring from the power source to the using device shall not exceed 10 percent.

13.2.1.2 The use of star washers for circuit ground connections shall not be permitted.

13.2.1.3 All circuits shall otherwise be wired in conformance with SAE J1292, *Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring.*

13.2.2 Wiring and Wire Harness Construction.

13.2.2.1 All insulated wire and cable shall conform to SAE J1127, *Low Voltage Battery Cable*, or SAE J1128, *Low Voltage Primary Cable*, type SXL, GXL, or TXL.

13.2.2.1.1 All conductors shall be constructed in accordance with SAE J1127 or SAE J1128, except where good engineering practice dictates special strand construction.

13.2.2.1.2 Conductor materials and stranding, other than copper, shall be permitted if all applicable requirements for physical, electrical, and environmental conditions are met as dictated by the end application.

13.2.2.1.3 Physical and dimensional values of conductor insulation shall be in conformance with the requirements of SAE J1127 or SAE J1128, except where good engineering practice dictates special conductor insulation.

13.2.2.2 The overall covering of conductors shall be moisture-resistant loom or braid that has a minimum continuous rating of 194°F (90°C) except where good engineering practice dictates special consideration for loom installations exposed to higher temperatures.

13.2.3 The overall covering of jacketed cables shall be moisture resistant and have a minimum continuous temperature rating of 194°F (90°C), except where good engineering practice dictates special consideration for cable installations exposed to higher temperatures.

13.2.4 All wiring connections and terminations shall use a method that provides a positive mechanical and electrical connection.

13.2.4.1 The wiring connections and terminations shall be installed in accordance with the device manufacturer's instructions.

13.2.4.2 All ungrounded electrical terminals shall have protective covers or be in enclosures.

13.2.4.3 Wire nut, insulation displacement, and insulation piercing connections shall not be used.

13.2.5 Wiring shall be restrained to prevent damage caused by chafing or ice buildup and protected against heat, liquid contaminants, or other environmental factors.

13.2.6* Wiring shall be uniquely identified at least every 2 ft (0.6 m) by color coding or permanent marking with a circuit function code. The identification shall reference a wiring diagram. *[See 4.20.2.3(6).]*

13.2.7 Circuits shall be provided with properly rated low voltage overcurrent protective devices.

13.2.7.1 Such devices shall be readily accessible and protected against heat in excess of the overcurrent device's design range, mechanical damage, and water spray.

13.2.7.2 Circuit protection shall be accomplished by utilizing fuses, circuit breakers, fusible links, or solid state equivalent devices.

13.2.7.3 If a mechanical-type device is used, it shall conform to one of the following SAE standards:

(1) SAE J156, *Fusible Links*

(2) SAE J553, *Circuit Breakers*

(3) SAE J554, *Electric Fuses (Cartridge Type)*

(4) SAE J1888, *High Current Time Lag Electric Fuses*

(5) SAE J2077, *Miniature Blade Type Electrical Fuses*

13.2.8 Switches, relays, terminals, and connectors shall have a direct current (dc) rating of 125 percent of maximum current for which the circuit is protected.

13.3 Power Supply.

13.3.1 A 12 V or greater electrical alternator shall be provided.

13.3.2* The alternator shall have a minimum output at idle to meet the minimum continuous electrical load of the fire apparatus as defined in 13.3.3, at 200°F (93°C) ambient temperature within the engine compartment, and shall be provided with full automatic regulation.

13.3.3 Minimum Continuous Electrical Load.

13.3.3.1 The minimum continuous electrical load shall consist of the total amperage required to simultaneously operate the following in a stationary mode during emergency operations:

(1) The propulsion engine and transmission

(2) All legally required clearance and marker lights, headlights, and other electrical devices except windshield wipers and four-way hazard flashers

(3) The radio(s) at a duty cycle of 10 percent transmit and 90 percent receive (for calculation and testing purposes, a default value of 5 A continuous)

(4) The lighting necessary to produce 2 fc (20 lx) of illumination on all walking surfaces on the apparatus and on the ground at all egress points onto and off the apparatus, 5 fc (50 lx) of illumination on all control and instrument panels, and 50 percent of the total compartment lighting loads

(5) The minimum optical warning system required in Section 13.8, where the apparatus is blocking the right-of-way

(6) The continuous electrical current required to simultaneously operate any fire pumps, aerial devices, and hydraulic pumps

(7)* Other warning devices and electrical loads defined by the purchaser as critical to the mission of the apparatus

13.3.3.2 If the apparatus is equipped to tow a trailer, an additional 45 A shall be added to the minimum continuous electrical load to provide electrical power for the federally required clearance and marker lighting and the optical warning devices mounted on the trailer.

13.3.4* The condition of the low voltage electrical system shall be monitored by a warning system that provides both an audible and a visual signal to persons on, in, or near the apparatus of an impending electrical system failure caused by the excessive discharge of the battery set.

13.3.4.1 The charge status of the battery shall be determined either by direct measurement of the battery charge or indirectly by monitoring the electrical system voltage.

13.3.4.2 If electrical system voltage is monitored, the alarm shall sound if the system voltage at the battery or at the master load disconnect switch drops below 11.8 V for 12 V nominal systems, 23.6 V for 24 V nominal systems, or 35.4 V for 42 V nominal systems for more than 120 seconds.

13.3.5 A voltmeter shall be mounted on the driver's instrument panel to allow direct observation of the system voltage.

13.3.6 Load Management.

13.3.6.1* If the total continuous electrical load exceeds the minimum continuous electrical output rating of the installed alternator(s) operating under the conditions specified in 13.3.2, an automatic electrical load management system shall be required.

13.3.6.2 The minimum continuous electrical loads defined in 13.3.3 shall not be subject to automatic load management.

13.4* Batteries.

13.4.1 Batteries shall be of the high-cycle type.

13.4.2 With the engine off, the battery system shall be able to provide the minimum continuous electrical load for 10 minutes without discharging more than 50 percent of the reserve capacity and then to restart the engine.

13.4.3 The battery system cold cranking amps (CCA) rating shall meet or exceed the minimum CCA recommendations of the engine manufacturer.

13.4.4 The batteries shall be mounted to prevent movement during fire apparatus operation and shall be protected against accumulations of road spray, snow, and road debris.

13.4.4.1 The batteries shall be readily accessible for examination, testing, and maintenance.

13.4.4.2 A means shall be provided for jump-starting the engine if the batteries are not accessible without lifting the cab of a tilt-cab apparatus.

13.4.4.3 Where an enclosed battery compartment is provided, it shall be ventilated to the exterior to prevent the buildup of heat and explosive fumes.

13.4.4.4* The batteries shall be protected against vibration and temperatures that exceed the battery manufacturer’s recommendation.

13.4.5* An onboard battery conditioner or charger or a polarized inlet shall be provided for charging all batteries. Where an onboard conditioner or charger is supplied, the associated line voltage electrical power system shall be installed in accordance with Chapter 22.

13.4.6 A master load disconnect switch shall be provided between the starter solenoid(s) and the remainder of the electrical loads on the apparatus.

13.4.6.1 The starter solenoids shall be connected directly to the batteries.

13.4.6.2 Electronic control systems and similar devices shall be permitted to be otherwise connected if so specified by their manufacturer.

13.4.6.3 The alternator shall be wired directly to the batteries through the ammeter shunt(s), if one is provided, and not through the master load disconnect switch.

13.4.6.4* A green “battery on” pilot light that is visible from the driver's position shall be provided.

13.4.7* A sequential switching device shall be permitted to energize the optical warning devices required in 13.3.3 and other high current devices, provided the switching device shall first energize the electrical devices required in 13.3.3 within 5 seconds.

13.5 Starting Device.

13.5.1 An electrical starting device shall be provided for the engine.

13.5.2 Where the electrical starting device is operating under maximum load, the voltage drop of the conductors between the battery and the starting device shall be in accordance with SAE J541, *Voltage Drop for Starting Motor Circuits.*

13.6 Temperature Exposure.

Any alternator, electrical starting device, ignition wiring, distributor, or ignition coil shall be moisture resistant and protected such that it is not exposed to a temperature that exceeds the component manufacturer's recommendations.

13.7* Electromagnetic Interference.

Electromagnetic interference suppression shall be provided, as required, to satisfy the radiation limits specified in SAE J551/1, *Performance Levels and Methods of Measurement of Electromagnetic Compatibility of Vehicles, Boats (up to 15 m), and Machines (16.6 Hz to 18 GHz).*

13.8 Optical Warning Devices.

Each apparatus shall have a system of optical warning devices that meets or exceeds the requirements of this section.

13.8.1* The optical warning system shall consist of an upper and a lower warning level.

13.8.2 The requirements for each level shall be met by the warning devices in that particular level without consideration of the warning devices in the other level.

13.8.3 For the purposes of defining and measuring the required optical performance, the upper and lower warning levels shall be divided into four warning zones.

13.8.3.1 The four zones shall be determined by lines drawn through the geometric center of the apparatus at 45 degrees to a line drawn lengthwise through the geometric center of the apparatus.

13.8.3.2 The four zones shall be designated A, B, C, and D in a clockwise direction, with zone A to the front of the apparatus. *(See Figure 13.8.3.2.)*

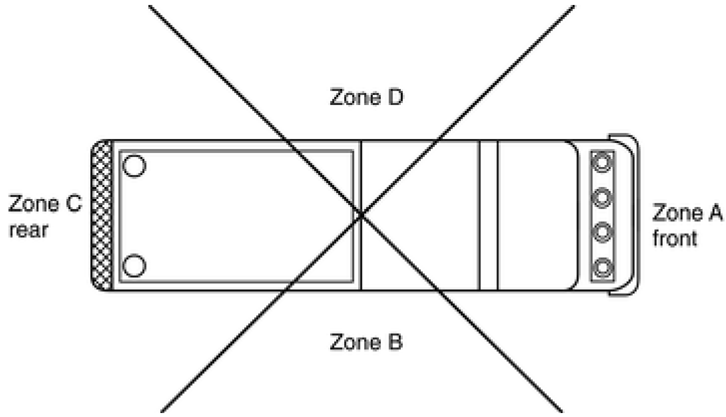


FIGURE 13.8.3.2 Warning Zones for Optical Warning Devices.

13.8.4 Each optical warning device shall be installed on the apparatus and connected to the apparatus's electrical system in accordance with the requirements of this standard and the requirements of the manufacturer of the device.

13.8.5 A master optical warning system switch that energizes all the optical warning devices shall be provided.

13.8.6 The optical warning system on the fire apparatus shall be capable of two separate signaling modes during emergency operations.

13.8.6.1 One mode shall signal to drivers and pedestrians that the apparatus is responding to an emergency and is calling for the right-of-way.

13.8.6.2 One mode shall signal that the apparatus is stopped and is blocking the right-of-way.

13.8.6.3 The use of some or all of the same warning lights shall be permitted for both modes provided the other requirements of this chapter are met.

13.8.7 A switching system shall be provided that senses the position of the parking brake or the park position of an automatic transmission.

13.8.7.1 When the master optical warning system switch is closed and the parking brake is released or the automatic transmission is not in park, the warning devices signaling the call for the right-of-way shall be energized.

13.8.7.2 When the master optical warning system switch is closed and the parking brake is on or the automatic transmission is in park, the warning devices signaling the blockage of the right-of-way shall be energized.

13.8.7.3* The system shall be permitted to have a method of modifying the two signaling modes.

13.8.8 The optical warning devices shall be constructed or arranged so as to avoid the projection of light, either directly or through mirrors, into any driving or crew compartment(s).

13.8.9 The front optical warning devices shall be placed so as to maintain the maximum possible separation from the headlights.

13.8.10* The optical sources on each level shall be of sufficient number and arranged so that failure of a single optical source does not create a measurement point in any zone on the same level as the failed optical source without a warning signal at a distance of 100 ft (30 m) from the geometric center of the apparatus.

13.8.11 Flash Rate.

13.8.11.1 The minimum flash rate of any optical source shall be 75 flashes per minute, and the minimum number of flashes at any measurement point shall be 150 flashes per minute.

13.8.11.1.1 Steadily burning, nonflashing optical sources shall be permitted to be used.

13.8.11.1.2 The optical energy provided by nonflashing optical sources shall not be included in the calculations of the zone's total optical power.

13.8.11.2 The flasher of any current-interrupted flashing device shall otherwise meet the requirements of SAE J1690, *Flashers.*

13.8.12* Color of Warning Lights.

13.8.12.1 Permissible colors or combinations of colors in each zone, within the constraints imposed by applicable laws and regulations, shall be as shown in Table 13.8.12.1.

Table 13.8.12.1 Zone Colors

Color	Calling for Right-of-Way	Blocking Right-of-Way
Red	Any zone	Any zone
Blue	Any zone	Any zone
Yellow	Any zone except A	Any zone
White	Any zone except C	Not permitted

13.8.12.2 All colors shall be as specified in SAE J578, *Color Specification*, for red, blue, yellow, or white.

13.8.13* Requirements for Large Apparatus.

13.8.13.1 If the apparatus has a bumper-to-bumper length of 25 ft (7.6 m) or more or has an optical center on any optical warning device greater than 8 ft (2.4 m) above level ground, the requirements of 13.8.13.2 through 13.8.13.6 shall apply.

13.8.13.2 Upper-Level Optical Warning Devices.

13.8.13.2.1 The upper-level optical warning devices shall be mounted as high and as close to the corner points of the apparatus as is practical to define the clearance lines of the apparatus.

13.8.13.2.2 The upper-level optical warning devices shall not be mounted above the maximum height, specified by the device manufacturer, that gives an intensity value at 4 ft (1.2 m) above level ground and at 100 ft (30.5 m) from the optical warning device of less than 50 percent of that required at the optical center.

13.8.13.3 Lower-Level Optical Warning Devices.

13.8.13.3.1 To define the clearance lines of the apparatus, the optical center of the lower-level optical warning devices in the front of the vehicle shall be mounted on or forward of the front axle centerline and as close to the front corner points of the apparatus as is practical.

13.8.13.3.2 The optical center of the lower-level optical warning devices at the rear of the vehicle shall be mounted on or behind the rear axle centerline and as close to the rear corners of the apparatus as is practical.

13.8.13.3.3 The optical center of any lower-level device shall be between 18 in. and 62 in. (460 mm and 1600 mm) above level ground.

13.8.13.4 Midship Optical Warning Devices.

13.8.13.4.1 A midship optical warning device shall be mounted on both the right and the left sides of the apparatus if the distance between the front and rear lower-level optical devices exceeds 25 ft (7.6 m) at the optical center.

13.8.13.4.2 Additional midship optical warning devices shall be required, where necessary, to maintain a horizontal distance between the centers of adjacent lower-level optical warning devices of 25 ft (7.6 m) or less.

13.8.13.4.3 The optical center of any midship mounted optical warning device shall be between 18 in. and 62 in. (460 mm and 1600 mm) above level ground.

13.8.13.5* For each operating mode, the combined optical power of all the optical sources shall meet or exceed the zone total optical power requirements shown in Table 13.8.13.5.

Table 13.8.13.5 Minimum Optical Power Requirements for Large Apparatus

		Mode of Operation					
		Calling for Right-of-Way			Blocking Right-of-Way		
Zone	**Level**	***H* Total**	**At Any *H* Point**	**At Any Point 5 Degrees Up or 5 Degrees Down from *H***	***H* Total**	**At Any *H* Point**	**At Any Poin 5 Degrees Up 5 Degrees Dov from *H***
A	Upper	1,000,000	10,000	3,500	400,000	10,000	3,500
B	Upper	400,000	10,000	3,500	400,000	10,000	3,500
C	Upper	400,000	10,000	3,500	800,000	10,000	3,500
D	Upper	400,000	10,000	3,500	400,000	10,000	3,500
A	Lower	150,000	3,750	1,300	150,000	3,750	1,300
B	Lower	150,000	3,750	1,300	150,000	3,750	1,300

Table 13.8.13.5 Minimum Optical Power Requirements for Large Apparatus

		Mode of Operation					
		Calling for Right-of-Way			Blocking Right-of-Way		
Zone	Level	*H* Total	At Any *H* Point	At Any Point 5 Degrees Up or 5 Degrees Down from *H*	*H* Total	At Any *H* Point	At Any Poin 5 Degrees Up 5 Degrees Dov from *H*
C	Lower	150,000	3,750	1,300	150,000	3,750	1,300
D	Lower	150,000	3,750	1,300	150,000	3,750	1,300

Notes:
1. All values are in candela-seconds/minute.
2. *H* = Horizontal plane passing through the optical center.
3. The values in the *H* Total columns are the total of 19 data point values for each light, with data points on the boundary between zones counted in both zones.

13.8.13.6 No individual measurement point shall be less than that shown in Table 13.8.13.5.

13.8.14* Requirements for Small Apparatus.

13.8.14.1 If the apparatus has a bumper-to-bumper length of less than 25 ft (7.6 m) and has the optical center of all optical warning devices at 8 ft (2.4 m) or less above level ground, the requirements of 13.8.14.2 through 13.8.14.5 shall apply.

13.8.14.2 Upper-Level Optical Warning Devices.

13.8.14.2.1 The upper-level optical warning devices shall be mounted as high as practical, but not over 8 ft (2.4 m), at the optical center.

13.8.14.2.2 The upper-level optical warning devices shall be permitted to be combined in one or more enclosures and shall be permitted to be mounted on the cab roof or any other convenient point.

13.8.14.3 Lower-Level Optical Warning Devices.

13.8.14.3.1 One or more lower-level optical warning devices shall be visible from the front and the side of the apparatus.

13.8.14.3.2 The optical center of the lower-level optical warning devices in the front of the vehicle shall be mounted on or forward of the front wheel centerline and as close to the front corner points of the apparatus as is practical.

13.8.14.3.3 The optical center of the device(s) shall be between 18 in. and 48 in. (460 mm and 1220 mm) above level ground.

13.8.14.4 For each operating mode, the combined optical power of all the optical sources mounted on both the upper and lower levels shall meet or exceed the zone's total optical power requirements shown in Table 13.8.14.4.

Table 13.8.14.4 Minimum Optical Power Requirements for Small Apparatus

	Mode of Operation					
	Calling for Right-of-Way			**Blocking Right-of-Way**		
Zone	***H* Total**	**At Any *H* Point**	**At Any Point 5 Degrees Up or 5 Degrees Down from *H***	***H* Total**	**At Any *H* Point**	**At Any Point 5 Degrees Up or 5 Degrees Down from *H***
A	1,000,000	10,000	3,500	400,000	10,000	3,500
B	200,000	8,000	3,500	200,000	8,000	3,500
C	400,000	10,000	3,500	800,000	10,000	3,500
D	200,000	8,000	3,500	200,000	8,000	3,500

Notes:
1. All values are in candela-seconds/minute.
2. *H* = Horizontal plane passing through the optical center.
3. The values in the *H* Total columns are the total of 19 data point values for each light, with data points on the boundary between zones counted in both zones.

13.8.14.5 No individual measurement point shall be less than that shown in Table 13.8.14.4.

13.8.15 Tests of Optical Warning Devices.

13.8.15.1 Mechanical and Environmental Test.

13.8.15.1.1 All optical warning devices shall be tested to the requirements of SAE J595, *Directional Flashing Optical Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles*; SAE J845, *Optical Warning Devices for Authorized Emergency, Maintenance, and Service Vehicles*; SAE J1318, *Gaseous Discharge Warning Lamp for Authorized Emergency, Maintenance, and Service Vehicles*; or SAE J1889, *L.E.D. Signal and Marking Lighting Devices*.

13.8.15.1.2 Optical devices and components designed for mounting only in weatherproof, interior spaces shall be tested in conformance with the applicable SAE standard listed in 13.8.15.1.1 and shall comply with the vibration test and the warpage test for plastic components.

13.8.15.1.3 Optical devices and components designed for mounting on the exterior of the apparatus or in nonweatherproof interior spaces shall be tested in conformance with SAE J845 and shall comply with the following performance requirements of that standard:

(1) Vibration

(2) Moisture

(3) Dust

(4) Corrosion

(5) High temperature

(6) Low temperature

(7) Durability

(8) Warpage

13.8.15.2 Photometric Test Procedures for Optical Devices.

13.8.15.2.1 Testing shall be performed by, or on behalf of, the device manufacturer to ensure compliance with the requirements of 13.8.15.2.2 through 13.8.15.2.5.2.

13.8.15.2.1.1 The results of the testing shall be used to determine compliance with this standard, and all required photometric data shall be available, upon request, from the optical warning device manufacturer.

13.8.15.2.1.2 The goniometer, integrating photometer, and other equipment used to take the test measurements shall meet the requirements of SAE J1330, *Photometry Laboratory Accuracy Guidelines*.

13.8.15.2.2 The optical source shall be mounted in a goniometer and operated as it would be in a normal system application.

13.8.15.2.2.1 The minimum distance between the light-emitting surface of the source being tested and the front face of the photometer detector shall be 59 ft (18 m).

13.8.15.2.2.2 The goniometer shall be oriented and the integrating photometer shall be set to integrate light pulses from the source for 20 seconds.

13.8.15.2.3 For all tests performed with the power applied, the lighting system, or component thereof, shall be operated at 12.8 V ±0.1 V for 12 V nominal equipment, 25.6 V ±0.2 V for 24 V nominal equipment, and 38.4 V ±0.3 V for 42 V nominal equipment.

13.8.15.2.3.1 If the equipment is rated for operation on multiple voltages, the tests shall be performed at each of the rated voltages used by the equipment.

13.8.15.2.3.2 Voltage shall be measured at a point 12 in. ± 1 in. (300 mm ± 25 mm) from the entry into the component.

13.8.15.2.4 The technique described in 13.8.15.2.2 through 13.8.15.2.2.2 shall be performed along the horizontal plane that passes through the optical center, beginning at the optical center and repeated at 5-degree intervals to the left and to the right of the optical center throughout the active horizontal angle of light emission of the optical source.

13.8.15.2.5 Measurements shall be repeated at 5 degrees up and 5 degrees down from the horizontal plane that passes through the optical center, beginning at a point on the vertical plane passing through the optical center.

13.8.15.2.5.1 The measurements shall be repeated at 5 degree intervals to the left and to the right of this vertical plane throughout the active horizontal angle of light emission of the optical source.

13.8.15.2.5.2 If the optical warning device contains more than one optical source, the test shall be repeated for each optical source.

13.8.16* Compliance Documentation. The apparatus manufacturer shall demonstrate compliance of the warning system by one of the following methods:

(1) Certification that the system was installed within the geometric parameters specified by the manufacturer of the system referencing the optical source test reports provided by the manufacturer of the system

(2) Certification that a mathematical calculation based on test reports for individual optical sources provided by the manufacturer of the devices and performed by a qualified person demonstrates that the combination of individual devices as installed meets the requirements of this standard

(3) Actual measurement of the lighting system after installation on the apparatus

13.9 Audible Warning Devices.

13.9.1 Audible warning equipment in the form of at least one automotive traffic horn and one electric or electronic siren shall be provided.

13.9.1.1 The siren manufacturer shall certify the siren as meeting the requirements of SAE J1849, *Emergency Vehicle Sirens.*

13.9.1.2* A means shall be provided to allow the activation of the siren within convenient reach of the driver.

13.9.2 Where furnished, air horns, electric siren(s), and electronic siren speaker(s) shall be mounted as low and as far forward on the apparatus as is practical.

13.9.3 Audible warning equipment shall not be mounted on the roof of the apparatus.

13.10 Work Lighting.

All light level measurements shall be made with a light meter with a hemispherical light sensor held against the surface, facing perpendicular to the surface, and not deliberately pointed toward the light source.

13.10.1 Ground Lighting.

13.10.1.1* The work area immediately behind the vehicle shall be illuminated to a level of at least 3 fc (30 lx) within a 10 ft × 10 ft (3 m × 3 m) square to the rear of the vehicle.

13.10.1.2 The fire apparatus shall be equipped with lighting that is capable of providing illumination at a minimum level of 2 fc (20 lx) on ground areas within 30 in. (800 mm) of the edge of the apparatus in areas designed for personnel to climb onto the apparatus or descend from the apparatus to the ground level.

13.10.1.3 Lighting designed to provide illumination on areas under the driver and crew riding area exits shall be switchable but activated automatically when the exit doors are opened.

13.10.1.4 All other ground area lighting shall be switchable.

13.10.2* Hose Bed Lighting.

13.10.2.1 If a hose bed is provided, lighting on the hose bed shall be at a level of 3 fc (30 lx) or higher.

13.10.2.2 Lateral hose beds (crosslays) that are permanently covered shall not be required to be illuminated.

13.10.3 Surface Lighting. The apparatus shall have sufficient lighting to provide a minimum level of 2 fc (20 lx) on all work surfaces, steps, and walkways.

13.10.4* Interior Lighting. The apparatus shall have sufficient lighting to provide an average level of 2 fc (20 lx) at each seating surface in the driving and crew compartments.

13.10.5 Compartment Lighting.

13.10.5.1 Each engine compartment and pump compartment shall have a light of at least 20 candlepower (250 lumens).

13.10.5.2 The priming lubricant reservoir, if applicable, shall be illuminated.

13.10.5.3 Each enclosed tool and equipment compartment greater than 4 ft^3 (0.1 m^3) in volume and having an opening greater than 144 $in.^2$ (92,900 mm^2) shall have sufficient compartment lighting to provide a minimum of 2 fc (20 lx) at any location on the floor of the compartment without any shelves, dividers, or equipment in the compartment.

13.10.5.4 Compartments such as ladder tunnels, pikepole storage tubes, or underbody compartments designed around the volumetric requirements of specific equipment that can be removed without the use of article illumination shall not be required to have compartment lighting.

13.10.6 Switching. Switches for all work lighting shall be readily accessible.

13.10.7 Protection. The lights shall be arranged or protected to minimize accidental breakage.

13.10.8 Testing. All work lights mounted in wet locations shall be tested in conformance with SAE J575, *Test Methods and Equipment for Lighting Devices and Components for Use on Vehicles Less Than 2032 mm in Overall Width,* and shall comply with the following performance requirements of that standard:

(1) Vibration

(2) Moisture

(3) Dust

(4) Corrosion

(5) High temperature

(6) Low temperature

(7) Durability

(8) Warpage

13.11 Hazard Light.

13.11.1 A red flashing or rotating light, located in the driving compartment, shall be illuminated automatically whenever the apparatus's parking brake is not fully engaged and any of the following conditions exist:

(1) Any passenger or equipment compartment door is not closed.

(2) Any ladder or equipment rack is not in the stowed position.

(3) Stabilizer system is not in its stowed position.

(4) Powered light tower is not stowed.

(5) Any other device permanently attached to the apparatus is open, extended, or deployed in a manner that is likely to cause damage to the apparatus if the apparatus is moved.

13.11.2 Compartments meeting all of the following conditions shall be permitted to be exempt from the requirements of 13.11.1.

(1) The volume is less than or equal to 4 ft^3 (0.1 m^3).

(2) The compartment has an opening less than or equal to 144 $in.^2$ (92,900 mm^2).

(3) The open door does not extend sideways beyond the mirrors or up above the top of the fire apparatus.

(4) All equipment in the compartment is restrained so that nothing can fall out if the door is open while the apparatus is moving.

13.11.3* Paragraph 13.11.1 shall not apply to manually raised pole lights with an extension of less than 5 ft (1.5 m).

13.11.4 The hazard light shall be marked with a sign that reads “Do Not Move Apparatus When Light Is On.”

13.12* Backup Alarm.

An electric or electronic backup alarm shall be provided that meets the Type D (87 dBA) requirements of SAE J994, *Alarm — Backup — Electric, Laboratory Performance Testing.*

13.13 Stop, Tail, and Directional Lights.

13.13.1 The apparatus shall be equipped with all legally required stop, tail, and directional lights.

13.13.2 Directional lights shall be visible from the front, sides, and rear of the apparatus.

13.13.3 On apparatus 30 ft (10 m) or longer in length, a turn signal shall be mounted approximately midway along the apparatus at approximately running board height.

13.13.4 Equipment shall not be mounted in a manner that obscures the stop, tail, or directional lights.

13.14 Electrical System Performance Tests.

13.14.1* The fire apparatus low voltage electrical system shall be tested as required by this section, the test results shall be certified by the apparatus manufacturer, and the certified test results shall be delivered with the fire apparatus.

13.14.2 Tests shall be performed when the air temperature is between 0°F and 110°F (–18°C and 43°C).

13.14.3 Test Sequence.

13.14.3.1 The three tests defined in 13.14.3.2 through 13.14.3.4.4 shall be performed in the order in which they appear.

13.14.3.1.1 Before each test, the batteries shall be fully charged until the voltage stabilizes at the voltage regulator set point and the lowest charge current is maintained for 10 minutes.

13.14.3.1.2 Failure of any of these tests shall require a repeat of the sequence.

13.14.3.2 Reserve Capacity Test.

13.14.3.2.1 The engine shall be started and kept running until the engine and engine compartment temperatures are stabilized at normal operating temperatures and the battery system is fully charged.

13.14.3.2.2 The engine shall be shut off, and the minimum continuous electrical load shall be activated for 10 minutes.

13.14.3.2.3 All electrical loads shall be turned off prior to attempting to restart the engine.

13.14.3.2.4 The battery system shall then be capable of restarting the engine.

13.14.3.2.5 Failure to restart the engine shall be considered a test failure of the battery system.

13.14.3.3 Alternator Performance Test at Idle.

13.14.3.3.1 The minimum continuous electrical load shall be activated with the engine running at idle speed.

13.14.3.3.2 The engine temperature shall be stabilized at normal operating temperature.

13.14.3.3.3 The battery system shall be tested to detect the presence of battery discharge current.

13.14.3.3.4 The detection of battery discharge current shall be considered a test failure.

13.14.3.4 Alternator Performance Test at Full Load.

13.14.3.4.1 The total continuous electrical load shall be activated with the engine running up to the engine manufacturer's governed speed.

13.14.3.4.2 The test duration shall be a minimum of 2 hours.

13.14.3.4.3 Activation of the load management system shall be permitted during this test.

13.14.3.4.4 An alarm sounded by excessive battery discharge, as detected by the warning system required in 13.3.4, or a system voltage of less than 11.8 V dc for a 12 V nominal system, 23.6 V dc for a 24 V nominal system, or 35.4 V dc for a 42 V nominal system for more than 120 seconds shall be considered a test failure.

13.14.4 Low Voltage Alarm Test.

13.14.4.1 The following test shall be started with the engine off and the battery voltage at or above 12 V for a 12 V nominal system, 24 V for a 24 V nominal system, or 36 V for a 42 V nominal system.

13.14.4.2 With the engine shut off, the total continuous electrical load shall be activated and shall continue to be applied until the excessive battery discharge alarm activates.

13.14.4.3 The battery voltage shall be measured at the battery terminals.

13.14.4.4 The test shall be considered a failure if the alarm does not sound in less than 140 seconds after the voltage drops to 11.70 V for a 12 V nominal system, 23.4 V dc for a 24 V nominal system, or 35.1 V for a 42 V nominal system.

13.14.4.5 The battery system shall then be able to restart the engine.

13.14.4.6 Failure to restart the engine shall be considered a test failure.

13.15 Documentation.

The manufacturer shall deliver the following with the fire apparatus:

(1) Documentation of the electrical system performance tests

(2) A written electrical load analysis, including the following:

  (a) The nameplate rating of the alternator

  (b) The alternator rating under the conditions specified in 13.3.2

(c) Each of the component loads specified in 13.3.3 that make up the minimum continuous electrical load

(d) Additional electrical loads that, when added to the minimum continuous electrical load, determine the total continuous electrical load

(e) Each individual intermittent electrical load

Chapter 14 Driving and Crew Areas

14.1 General.

14.1.1 Each crew riding position shall be within a fully enclosed personnel area.

14.1.2 A label that states the number of personnel the vehicle is designed to carry shall be located in an area visible to the driver.

14.1.3* Each crew riding position shall be provided with a seat and an approved seat belt designed to accommodate a person with and without heavy clothing.

14.1.3.1 Seat belt assemblies shall conform to the Federal Motor Vehicle Safety Standard (FMVSS) No. 209, "Seat belt assemblies."

14.1.3.2* The effective seat belt web length for a Type 1 lap belt for pelvic restraint shall be a minimum of 60 in. (1525 mm) with the seat adjusted all the way back and down when measured using the following procedure:

(1) Locate an imaginary line where the plane of the center of the seat back surface intersects the plane of the center of the seat cushion surface (line 1 in Figure 14.1.3.2). For seats with an SCBA seat back, use a plane that simulates the position of an SCBA back pad installed in the SCBA holder.

(2) Locate point A on line 1 at the outside of the seat on the retractor side of the seat.

(3) Locate point C on line 1 at the outside of the seat on the receiver side of the seat.

(4) Locate point D at the tip of the receiver.

(5) Pull the seat belt webbing entirely out of the retractor and measure along the webbing between point A and the male seat belt buckle. Record this length as AD.

(6) Measure from point C to point D and record this length as CD.

(7) The effective seat belt web length equals AD + CD.

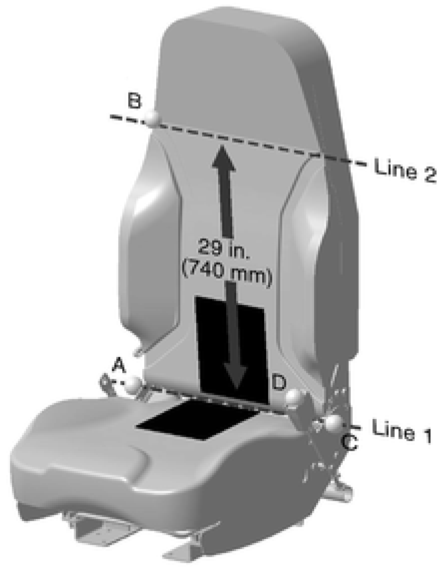


FIGURE 14.1.3.2 Dimension Lines for Measuring Seat Belt Effective Length.

14.1.3.3* The effective seat belt web length for a Type 2 pelvic and upper torso restraint-style seat belt assembly shall be a minimum of 110 in. (2800 mm) with the seat adjusted all the way back and down when measured using the following procedure:

(1) Locate an imaginary line where the plane of the center of the seat back surface intersects the plane of the center of the seat cushion surface (line 1 in Figure 14.1.3.2). For seats with an SCBA seat back, use a plane that simulates the position of an SCBA back pad installed in the SCBA holder.

(2) Locate an imaginary line parallel with line 1 and lying on the center of the seat back surface 29 in. (740 mm) from line 1 (line 2 in Figure 14.1.3.2).

(3) Locate point A on line 1 at the outside of the seat on the retractor side of the seat.

(4) Locate point B on line 2 at the shoulder strap edge of the seat back.

(5) Locate point C on line 1 at the outside of the seat on the receiver side of the seat.

(6) Locate point D at the tip of the receiver.

(7) Pull the seat belt webbing entirely out of the retractor and measure along the webbing between points A and B. Record this length as AB.

(8) Measure from point C to point D and record this length as CD.

(9) The effective seat belt web length equals AB + 2CD.

14.1.3.4 The seat belt webbing shall be bright red or bright orange in color, and the buckle portion of the seat belt shall be mounted on a rigid or semirigid stalk such that the buckle remains positioned in an accessible location.

14.1.3.5 All forward-facing seats adjacent to a side wall shall be provided with a Type 2 pelvic and upper torso restraint-style seat belt assembly.

14.1.3.6 All seat belt assembly anchorages shall conform to the Federal Motor Vehicle Safety Standard (FMVSS) No. 210, “Seat belt assembly anchorages.”

14.1.3.7 Tiller seats shall have a lap belt.

14.1.3.8 Signs that read “Occupants Must be Seated and Belted When Apparatus Is in Motion” shall be visible from each seated position.

14.1.3.9 Each seating position that is not intended to be used during transit shall be individually labeled as follows:

WARNING: *THIS SEAT IS NOT TO BE OCCUPIED WHILE VEHICLE IS IN MOTION.*

14.1.3.10 A seat belt warning system shall be provided.

14.1.3.10.1 The warning system shall consist of an audible warning device that can be heard at all seating positions designed to be occupied while the vehicle is in motion and a visual display visible to the driver or the officer showing the condition of each seating position.

14.1.3.10.2 The warning shall be activated anytime the parking brake is released or the automatic transmission is not in park.

14.1.3.10.3 The seat position display shall indicate conditions in accordance with Table 14.1.3.10.3.

Table 14.1.3.10.3 Display for Seating System

Display Indication	Seat Belt	Seat Sensor
Affirmative indication	Buckled	Senses occupant
Negative indication	Buckled	No occupant
Negative indication	Unbuckled	Senses occupant
Dark	Unbuckled	No occupant

14.1.3.10.4 The display indication shall be permitted to consist of lights, text, graphical indicators, digital displays, or other methods.

14.1.3.10.5 The warning system shall not show an affirmative indication unless it has determined that the seat was occupied before the seat belt was buckled.

14.1.4 Materials used within the driving and crew compartment shall comply with Federal Motor Vehicle Safety Standard (FMVSS) No. 302, “Flammability of interior materials.”

14.1.5 All interior crew and driving compartment door handles shall be designed and installed to protect against accidental or inadvertent opening.

14.1.6 Any door of the apparatus designed to allow persons to enter or exit the apparatus shall have at least 96 in.^{2} (62,000 mm^2) of retroreflective material affixed to the inside of the door.

14.1.7 At any seat location, the maximum noise level shall be 90 dBA without any warning devices in operation, as measured by the test procedure defined in 49 CFR 393.94(c), "Vehicular interior noise levels test procedure," except that the test shall be performed with the vehicle traveling at a steady speed of 45 mph (72 km/hr) on a level, paved, smooth-surface road.

14.1.8 Seat Head Height.

14.1.8.1* The minimum vertical dimension from the seat H point to the ceiling for each belted seating position shall be as follows:

(1) For suspension-style seats with independent height adjustment, the minimum vertical dimension shall be 37 in. (940 mm) measured with the height adjustment in its lowest position and the suspension inflated and/or raised to the upper limit of its travel.

(2) For suspension-style seats without independent height adjustment, the minimum vertical dimension shall be 37 in. (940 mm) measured with the suspension inflated and/or raised to the upper limit of its travel.

(3) For nonsuspension-style seats, the minimum vertical dimension shall be 35 in. (889 mm) measured with the seat adjusted to its lowest position.

14.1.8.2 When independent vertical and/or horizontal seat adjustment is provided, it shall be fully adjustable within 10 seconds.

14.1.8.3 The seat-to-ceiling height shall be measured at the lowest surface in the area immediately above the projected area of the seat as it moves through its horizontal travel with any soft headliner material depressed by hand.

14.1.8.4* The following statement shall be included in the operator's manual: "Fire helmets shall not be worn by persons riding in enclosed driving and crew areas. Fire helmets are not designed for crash protection and they will interfere with the protection provided by head rests. The use of seat belts is essential to protecting fire fighters during driving."

14.1.8.4.1 A location for helmet storage shall be provided.

14.1.8.4.2 If helmets are to be stored in the driving or crew compartment, the helmets shall be secured in compliance with 14.1.11.2.

14.1.8.4.3 A label stating "DO NOT WEAR HELMET WHILE SEATED" shall be visible from each seating location.

14.1.9 Seat Arrangement.

14.1.9.1 Each seating space shall have a minimum width of 22 in. (560 mm) at the shoulder level.

14.1.9.2 Seat cushions shall be a minimum of 18 in. (460 mm) in width and 15 in. (380 mm) from the front of the cushion to the face of the seat back.

14.1.9.3 A back cushion that extends from the face of the seat vertically at least 18 in. (460 mm) and that is a minimum of 18 in. (460 mm) wide at the base shall be provided.

14.1.9.3.1 The back cushion shall be permitted to be split to accommodate a fully recessed SCBA and bracket.

14.1.9.3.2 Where the back cushion is split to accommodate a SCBA, a headrest shall be supplied.

14.1.10 SCBA Mounting.

14.1.10.1* Where SCBA units are mounted within a driving or crew compartment, a positive latching mechanical means of holding the SCBA device in its stowed position shall be provided such that the SCBA unit cannot be retained in the mount unless the positive latch is engaged.

14.1.10.2 The bracket holding device and its mounting shall retain the SCBA unit when subjected to a 9 G force and shall be installed in accordance with the bracket manufacturer's requirements.

14.1.10.3 If the SCBA unit is mounted in a seatback, the release mechanism shall be accessible to the user while seated.

14.1.11 Equipment Mounting.

14.1.11.1 All equipment required to be used during an emergency response shall be securely fastened.

14.1.11.2 All equipment not required to be used during an emergency response, with the exception of SCBA units, shall not be mounted in a driving or crew area unless it is contained in a fully enclosed and latched compartment capable of containing the contents when a 9 G force is applied in the longitudinal axis of the vehicle or a 3 G force is applied in any other direction, or the equipment is mounted in a bracket(s) that can contain the equipment when the equipment is subjected to those same forces.

14.1.12 Steps and access handrails that comply with 15.7.1 through 15.7.4.6 and Section 15.8 shall be provided as necessary for access to all driving and crew compartments.

14.1.13 Where the crew compartment and the driving compartment are separated, prohibiting direct voice communication, a two-way buzzer or two-way voice intercom system shall be provided.

14.1.14 Means of Escape.

14.1.14.1 Any interior area to be occupied by personnel shall have a minimum of two means of escape.

14.1.14.2 Each opening shall be a minimum of 24 in. × 24 in. (610 mm × 610 mm).

14.2 Cab Tilt Systems.

If the fire apparatus has a cab tilt system, the system shall meet the requirements of 14.2.1 through 14.2.3.2.

14.2.1 If the operation of the cab tilt system is accomplished by hydraulic means, the system shall be equipped with devices to prevent the motion of the cab in the event of any hydraulic hose failure.

14.2.2 If the cab has a powered tilting system, the system shall be interlocked to operate only when the parking brake is engaged and shall be configured so that the failure of a single component will not result in unintentional tilting of the cab.

14.2.3 The control of the cab tilt mechanism shall be accomplished clear of the cab travel area while still having the travel area in clear view.

14.2.3.1 A mechanical means shall be provided to hold the cab in a fully raised position.

14.2.3.2 If the cab is able to be raised to a defined intermediate position, a mechanical means shall also be provided to hold the cab in that intermediate position.

14.3 Driving Compartment.

14.3.1* A fully enclosed driving compartment with seating capacity for not fewer than two persons shall be provided except at a tiller operator's driving position. *(See 14.4.1.)*

14.3.2* Cabs on apparatus with a GVWR greater than 26,000 lb (11,800 kg) shall meet the requirements of one of the following sets of standards:

(1) SAE J2420, *COE Frontal Strength Evaluation —– Dynamic Loading Heavy Trucks*, and SAE J2422, *Cab Roof Strength Evaluation —– Quasi-Static Loading Heavy Trucks*

(2) ECE Regulation number 29, *Uniform Provisions Concerning the Approval of Vehicles with Regard to the Protection of the Occupants of the Cab of a Commercial Vehicle*

14.3.3 Driver's Seat.

14.3.3.1 The driver's seat shall be readily adjustable by the driver.

14.3.3.2 The seat shall be arranged to accommodate a person conforming to at least the fifth percentile female through 95th percentile male as defined in SAE J833, *Human Physical Dimensions.*

14.3.4* The passenger side mirror shall be so mounted that the driver has a clear view of the mirror when the passengers are in their normal seated positions.

14.3.5 All primary rear view mirrors used by the driver shall be adjustable from the driver’s position.

14.3.6 Instrumentation and Controls.

14.3.6.1 The following instrumentation and controls shall be mounted in the driving compartment and shall be identified and visible to the driver while seated:

(1) Speedometer

(2) Tachometer

(3) Odometer

(4) Oil pressure indicator or gauge

(5) Coolant temperature indicator or gauge

(6) Automatic transmission temperature indicator or gauge, if applicable

(7) Voltmeter

(8) Hazard indicator light *(see Section 13.11)*

(9) Air pressure gauge(s), if applicable

(10) Turn signal control and indicator lights

(11) Headlight/DOT light switch

(12) High-beam headlight switch and indicator

(13) Fuel level gauge(s)

(14) Master ignition switch (if a key is provided, it shall be unable to be removed from the driving compartment interior)

(15) Heater/defroster controls

(16) Warning lights and siren switches

(17) Master electrical load switch

(18) “Battery on” indicator light

(19) Windshield wipers and windshield washer control

(20) PTO-engaged indicator, if applicable

(21) Pump engagement controls, if applicable

14.3.6.2 Controls and switches that are expected to be operated by the driver while the apparatus is in motion shall be within convenient reach for the driver.

14.4 Tractor-Drawn Vehicles.

Where a tractor-drawn vehicle with tillered steering is provided, the requirements of this section also shall apply.

14.4.1 A fully enclosed tiller operator's compartment with seating for one person shall be provided at the rear wheel's steering position.

14.4.2 No side compartmentation shall be installed that obscures the ability of the tiller operator to see the tiller axle fender area.

14.4.3* Seat Arrangement.

14.4.3.1 The manufacturer shall provide a seat with an approved seat belt within the enclosure.

14.4.3.2 The seating space shall be a minimum of 22 in. (560 mm) in width at the shoulder level.

14.4.3.3 The seat cushion shall be a minimum of 18 in. (460 mm) in width and 15 in. (380 mm) from the front of the cushion to the face of the seat back.

14.4.3.4 A back cushion shall be provided.

14.4.3.5 The seat shall have an adjustment range of at least 3 in. (76 mm) from front to rear and be adjustable by the tiller operator.

14.4.4 A warning indicator in the driving compartment shall activate if the parking brake is released and the tiller operator is not signaling his/her presence.

14.4.5 Communications.

14.4.5.1 A two-way buzzer system or a two-way voice intercom shall be provided for communication between the driver and the tiller operator.

14.4.5.2 The communication system shall be operable without the tiller operator having to take his/her hands off the steering wheel.

14.4.6 A heater or ventilation system and defroster shall be provided.

14.4.7 A windshield wiper and washer fluid system shall be provided.

14.4.8 The following instrumentation and controls shall be mounted in the tiller operator's compartment and shall be identified and visible to the tiller operator while seated:

(1) Heater/defroster controls

(2) Turn signal indicator lights

(3) Two-way buzzer signal switch

(4) Windshield wiper and washer fluid control

14.4.9 Controls and switches that are expected to be operated by the tiller operator while the apparatus is in motion shall be within convenient reach of that operator.

14.4.10 Exterior rearview mirrors shall be provided at the tiller position.

Chapter 15 Body, Compartments, and Equipment Mounting

15.1* Compartmentation.

15.1.1* Any enclosed external compartments shall be weather resistant and ventilated and have provisions for drainage of moisture.

15.1.2 All electrical junctions or wiring within compartments shall be protected from mechanical damage resulting from equipment stored in the compartment.

15.2* Radio Space.

A protected space or compartment shall be provided for the installation of radio equipment.

15.3 Equipment Containment.

15.3.1* Equipment holders or compartments shall be provided for all tools, equipment, and other items that are on the fire apparatus.

15.3.2* Equipment holders shall be attached and shall be designed so that equipment remains in place under all vehicle operating conditions.

15.3.3 All tools and equipment shall be readily accessible.

15.4 Powered Equipment Racks.

When a powered equipment rack is provided, it shall meet the requirements of this section.

15.4.1 The equipment rack shall be constructed of materials that are capable of carrying the equipment that is intended to be mounted on the equipment rack.

15.4.2 A lock shall be provided that will retain the equipment rack in the road travel position when the vehicle is in motion.

15.4.3 An interlock shall be provided to prevent operation of the equipment rack unless the apparatus parking brake has been activated.

15.4.4 Controls shall be provided in a position where the operator can visually follow the travel of the equipment rack.

15.4.5 A visual signal shall be provided at the driver's position to indicate that the equipment rack is in motion, or in the down position, and that the parking brake is not engaged.

15.4.6 Flashing lights facing the front and rear of the apparatus shall be provided on the equipment rack and shall be illuminated whenever the equipment rack is in the down position.

15.4.7 The outward ends of the equipment rack that protrude beyond the body of the apparatus shall have retroreflective material to indicate a hazard or an obstruction.

15.5* SCBA Storage.

Storage of complete SCBA units or SCBA cylinders shall be arranged so as to prevent damage, injury, or abrasion to the SCBA from other equipment stored in the general area.

15.5.1 If an SCBA unit or cylinder is stored within a driving or crew compartment, the mounting shall comply with the requirements of Section 15.5 and 14.1.10.

15.5.2 If an SCBA cylinder is mounted in a vertical position with the valve down, it shall be supported with a brace or yoke under the cylinder or valve area to prevent downward movement.

15.5.3 The holding or clamping device shall not injure, wear, scrape, or otherwise affect the SCBA unit or cylinder, including damage to the paint or reflective finish, while the cylinder is being placed in, stored in, or removed from the holder.

15.5.4 The SCBA storage area shall be a ventilated, dry area away from all heat sources that could damage the SCBA (e.g., mufflers, engines).

15.5.5* Vertical Storage of SCBA Cylinders in Tubes.

15.5.5.1 The base of the storage tube shall have a rubber, plastic, or similar device to prevent wear on the cylinder and to prevent damage if the cylinder is accidentally dropped into the storage position.

15.5.5.2 Each storage tube shall have a drain to prevent accumulation of moisture.

15.5.6* Horizontal Storage of SCBA Cylinders.

15.5.6.1 The storage rack or tube assembly shall be designed to prevent the cylinder from accidentally sliding out from the storage rack or tube and shall be installed so as to keep the cylinder from hitting or rubbing on compartment doors by preventing movement or shifting when in transit.

15.5.6.2 The rear wall of each SCBA storage area or tube shall be covered with a rubber, plastic, or similar material to prevent wear on cylinders.

15.6 Pump and Plumbing Access.

15.6.1 One or more doors or panels that open or are removable without the use of tools shall be provided to allow visual inspection or access for checking the fire pump and plumbing area.

15.6.2 The clear opening shall have no one dimension measure less than 18 in. (460 mm).

15.6.3 Additional door(s) or panel(s) that require no more than standard tools to be opened or removed shall be provided for access to the pump and plumbing area.

15.6.4 All valves, gauges, controls, and other plumbing equipment shall be accessible for service and replacement.

15.6.5* The clear space required by the pump manufacturer to perform in-truck overhaul and maintenance shall be provided.

15.7 Stepping, Standing, and Walking Surfaces.

15.7.1* Steps, platforms, or permanently attached access ladders shall be provided so that fire fighters have access to all working and storage areas of the fire apparatus.

15.7.1.1 The maximum stepping height shall not exceed 18 in. (460 mm), with the exception of the ground to first step, which shall not exceed 24 in. (610 mm) when the vehicle is loaded to its estimated in-service weight.

15.7.1.1.1 A permanently attached supplemental access/egress means from the ground to these steps, platforms, or permanently attached access ladders shall be provided where the ground to the first step, platform, or ladder exceeds 24 in. (610 mm).

15.7.1.1.2 The supplemental access means shall consist of a step(s), platform(s), or access ladder(s).

15.7.1.1.3 The ground-to-first-step height shall be determined with the apparatus on level ground.

15.7.1.1.4 Where the apparatus is supplied with stabilizers, the ground-to-first-step height shall be determined with the apparatus on level ground and the stabilizers deployed in accordance with the manufacturer's instructions so that the aerial device meets the stability requirements of Section 19.21.

15.7.1.2* All steps shall have a minimum area of 35 in.^{2} (22,580 mm^2), shall be of such a shape that a 5 in. (125 mm) diameter disk does not overlap any side when placed on the step, and shall be arranged to provide at least 8 in. (200 mm) of clearance between the leading edge of the step and any obstruction.

15.7.1.3 All platforms shall have a minimum depth of 8 in. (200 mm) from the leading edge of the platform to any obstruction.

15.7.1.4 All access ladders shall have at least 8 in. (200 mm) clearance between the leading edge of any rung and the body of the fire apparatus or other obstruction.

15.7.2 All steps, platforms, or access ladders shall be designed and installed to sustain a minimum static load of 500 lb (227 kg) without deformation.

15.7.3 Ladder rungs on access ladders shall have a skid resistant surface or covering, but that surface or covering shall not be required to meet the slip resistance performance requirements of 15.7.4.

15.7.4* **Slip Resistance.**

15.7.4.1 All materials used for exterior surfaces designated as stepping, standing, and walking areas and all interior steps shall have a minimum slip resistance in any orientation of 0.68 when tested wet using the English XL tester in accordance with the manufacturer's instructions or 0.52 when tested wet using the Brungraber Mark II tester in accordance with the manufacturer's instructions.

15.7.4.2 All materials used for interior floors shall have a minimum slip resistance in any orientation of 0.58 when tested dry using the English XL tester in accordance with the manufacturer's instructions or 0.47 when tested dry using the Brungraber Mark II tester in accordance with the manufacturer's instructions.

15.7.4.3 A standard Neolite® test sensor shall be used with both the English XL tester and the Brungraber Mark II tester.

15.7.4.4 Sampling Strategy.

15.7.4.4.1 For uniformly patterned materials, at least 16 readings shall be taken on each sample.

15.7.4.4.1.1 Each reading shall be taken 90 degrees clockwise from the previous orientation, resulting in at least four readings in each orientation.

15.7.4.4.1.2 The readings shall be averaged and reported as the slip resistance for the material.

15.7.4.4.2 For directionally patterned materials, at least 32 readings shall be taken on each sample.

15.7.4.4.2.1 Each reading shall be taken 45 degrees clockwise from the previous orientation, resulting in at least four readings in each orientation.

15.7.4.4.2.2 The four readings in each direction shall be averaged and reported as the slip resistance for the material in that orientation.

15.7.4.5 The contractor shall deliver with the fire apparatus a certification that all materials used for exterior surfaces designated as stepping, standing, and walking areas, all interior steps, and all interior floors meet the requirements of 15.7.4.

15.7.4.6 Where the fuel fill is located at or near a stepping surface, the surface shall be constructed of an open grate–type material to facilitate draining of accidentally spilled fuel to lessen any slipping hazard.

15.7.5 A sign shall be located on the vehicle at the rear step areas and at any cross walkways to warn personnel that riding in or on these areas while the vehicle is in motion is prohibited.

15.8 Access Handrails or Handholds.

15.8.1 Access handrails or handholds shall be provided at each entrance to a driving or crew compartment and at each position where steps or ladders for climbing are located.

15.8.2 Exterior access handrails shall be constructed of or covered with a slip-resistant, noncorrosive material.

15.8.3 Exterior access handrails shall be between 1 in. and 1⅝ in. (25 mm and 42 mm) in diameter and have a minimum clearance between the handrails and any surface of at least 2 in. (50 mm).

15.8.4* All exterior access handrails shall be designed and mounted to reduce the possibility of hand slippage and to avoid snagging of hose, equipment, or clothing.

15.8.5 Handrails and handholds shall be constructed so that three points of contact (two hands and one foot, or one hand and two feet) can be maintained at all times while ascending and descending.

15.8.6* Access handrails supplied by the chassis manufacturer on a commercial chassis shall be permitted to be used to meet the requirements of this section.

15.9 Metal Finish.

15.9.1 Where dissimilar metals that pose a galvanic corrosion or reactive threat are to be mounted together, the mounting base material shall have an isolation barrier prior to assembly to prevent dissimilar metal reaction.

15.9.2* Painting.

15.9.2.1* All exposed ferrous metal surfaces that are not plated or stainless steel shall be cleaned and prepared and shall be painted or coated.

15.9.2.2 The paint or coating, including any primer, shall be applied in accordance with the paint or coating manufacturer's recommendation.

15.9.3* Reflective Striping.

15.9.3.1* A retroreflective stripe(s) shall be affixed to at least 50 percent of the cab and body length on each side, excluding the pump panel areas, and at least 25 percent of the width of the front of the apparatus.

15.9.3.1.1 The stripe or combination of stripes shall be a minimum of 4 in. (100 mm) in total width.

15.9.3.1.2 The 4 in. (100 mm) wide stripe or combination of stripes shall be permitted to be interrupted by objects (i.e., receptacles, cracks between slats in roll up doors) provided the full stripe is seen as conspicuous when approaching the apparatus.

15.9.3.1.3 A graphic design shall be permitted to replace all or part of the required striping material if the design or combination thereof covers at least the same perimeter length(s) required by 15.9.3.1.

15.9.3.2 At least 50 percent of the rear-facing vertical surfaces, visible from the rear of the apparatus, excluding any pump panel areas not covered by a door, shall be equipped with retroreflective striping in a chevron pattern sloping downward and away from the centerline of the vehicle at an angle of 45 degrees.

15.9.3.2.1 Each stripe in the chevron shall be a single color alternating between red and either yellow, fluorescent yellow, or fluorescent yellow-green.

15.9.3.2.2 Each stripe shall be 6 in. (150 mm) in width.

15.9.3.3 All retroreflective materials required by 15.9.3.1 and 15.9.3.2 shall conform to the requirements of ASTM D 4956, *Standard Specification for Retroreflective Sheeting for Traffic Control*, Section 6.1.1 for Type I Sheeting.

15.9.3.3.1 All retroreflective materials used to satisfy the requirements of 15.9.3.1 that are colors not listed in ASTM D 4956, Section 6.1.1, shall have a minimum coefficient of retroreflection of 10 with observation angle of 0.2 degrees and entrance angle of -4 degrees.

15.9.3.3.2 Fluorescent yellow and fluorescent yellow-green retroreflective materials used to meet the requirements of 15.9.3.2 shall conform to the minimum requirements specified for yellow Type I Sheeting in ASTM D 4956, Section 6.1.1.

15.9.3.3.3 Any printed or processed retroreflective film construction used to meet the requirements of 15.9.3.1 and 15.9.3.2 shall conform to the standards required of an integral colored film as specified in ASTM D 4956, Section 6.1.1.

15.10* Hose Storage.

If a hose storage area(s) is provided, it shall comply with this section.

15.10.1* The hose storage area(s) shall be reinforced at the corners.

15.10.2 The bottom shall be made of removable sections fabricated from noncorrosive materials.

15.10.3* The bottom shall be constructed to prevent the accumulation of water and allow ventilation to aid in drying hose.

15.10.4 The interior shall be smooth and free from all projections, such as nuts, sharp angles, or brackets, that might cause damage to the hose.

15.10.5 The interior of a hose storage area shall not be required to meet the slip resistance requirements given in 15.7.4.

15.10.6 Reels, handrails, ladders, and equipment holders shall be placed so as not to obstruct the laying or removal of hose from the storage area.

15.10.7* Any hose storage area shall be equipped with a positive means to prevent unintentional deployment of the hose from the top, sides, front, and rear of the hose storage area while the apparatus is underway in normal operations.

15.11 Requirements for Mounting of Ground Ladders.

15.11.1 Ground ladders shall be mounted and protected to prevent movement, abrasion, or other damage to the ground ladder while they are on the fire apparatus. [**1932:**4.1.2]

15.11.2 When mounted on the apparatus, ground ladders shall not be subject to exposure to heat sources (such as engine heat) of 212°F (100°C) or greater. [**1932:**4.1.3]

15.11.3 Ground ladders shall be supported to prevent any sagging or distortion while they are mounted on the fire apparatus. [**1932:**4.1.4]

15.11.4 The rollers and other moving parts of the frame holding the ground ladders on the apparatus shall be readily accessible to permit lubrication.

15.12* Receivers and Anchors for Rope and Removable Winches.

15.12.1 Receivers or anchors installed at any location on the apparatus for use as removable winch anchors shall be designed and affixed to provide at least a 2.0 to 1 straight line pull no-yield safety factor over the load rating of the removable winch.

15.12.2 Receivers or anchors installed at any location on the apparatus for use with rope operations shall be designed and affixed to the apparatus to provide at least a 9000 lbf (40,000 N) no-yield condition with a straight line pull.

15.12.3 A label shall be placed on or near each receiver or anchor that states the maximum straight line pull rating of the anchor.

15.13 Slip-On Fire-Fighting Module.

If the pump, piping, and tank are built as a slip-on, self-contained unit, it shall meet the requirements of 15.13.1 through 15.13.3 and shall be mounted on the fire apparatus in accordance with 15.13.4.

15.13.1 The major components of the slip-on module, including the pump, pumping engine, water and agent tank(s), plumbing system, and electrical system shall meet the requirements of the applicable chapters of this standard covering those components.

15.13.2 Intake and discharge piping shall not interfere with the routine maintenance of the pump, engine, or auxiliary systems and shall not unduly restrict the servicing of these components.

15.13.3 The manufacturer of a slip-on fire-fighting module shall provide the following data with the module:

(1) Weight without water but with all other tanks or reservoirs for liquids full

(2) Weight full with water and other liquids, including foam concentrate, fuel, and lubricants

(3) Horizontal center of gravity when full with water and other liquids

(4) Overall dimensions

15.13.4 Mounting.

15.13.4.1 The slip-on module shall be mounted in a manner that allows access to the engine, pump, and auxiliary systems for routine maintenance.

15.13.4.2 The slip-on module shall be removable using common hand tools.

15.13.4.3 The slip-on module shall be mounted in a manner that prevents damage by vibration.

15.13.4.4* Special anchorage shall be provided on the vehicle chassis and on the slip-on fire-fighting module to secure the fire-fighting module to the vehicle chassis.

15.13.4.5 The anchorage described in 15.13.4.4 shall be designed to prevent movement of the slip-on module during rapid acceleration or deceleration.

15.13.4.6 Drilling on chassis frame flanges or welding to chassis frame shall not be permitted.

Chapter 16 Fire Pumps and Associated Equipment

16.1 Application.

If the apparatus is equipped with a fire pump, the provisions of this chapter shall apply.

16.2 Design and Performance Requirements.

16.2.1 Fire Pump Rated Capacity.

16.2.1.1 The fire pump shall be mounted on the apparatus and shall have a minimum rated capacity of 250 gpm (1000 L/min) at 150 psi (1000 kPa) net pump pressure.

16.2.1.2 Pumps of higher capacity shall be rated at one of the capacities specified in Table 16.2.4.1(a).

16.2.2* Where the apparatus is designed for "pump-and-roll" operations, the vehicle drive engine and drive train shall be arranged so that the pump can deliver at least 20 gpm (76 L/min) at a gauge pressure of 80 psi (550 kPa) while the fire apparatus is moving at 2 mph (3.2 kmph) or less.

16.2.3 Pumping System Capability.

16.2.3.1 If the pumping system is rated at 3000 gpm (12,000 L/min) or less, it shall be capable of delivering the following:

(1) One hundred percent of rated capacity at 150 psi (1000 kPa) net pump pressure

(2) Seventy percent of rated capacity at 200 psi (1400 kPa) net pump pressure

(3) Fifty percent of rated capacity at 250 psi (1700 kPa) net pump pressure

16.2.3.2* If the pumping system is rated at over 3000 gpm (12,000 L/min), it shall be capable of delivering the following:

(1) One hundred percent of rated capacity at 100 psi (700 kPa) net pump pressure

(2) Seventy percent of rated capacity at 150 psi (1000 kPa) net pump pressure

(3) Fifty percent of rated capacity at 200 psi (1400 kPa) net pump pressure

16.2.3.3 When dry, the pump system shall be capable of meeting the requirements of 16.2.3.3.1 through 16.2.3.3.4.

16.2.3.3.1 Where pumps are rated at less than 1500 gpm (6000 L/min), they shall be capable of taking suction through 20 ft (6 m) of suction hose under the conditions specified in Table 16.2.4.1(a) for the rated capacity of the pump and discharging water in not more than 30 seconds.

16.2.3.3.2 Where pumps are of 1500 gpm (6000 L/min) or larger capacity, they shall be capable of taking suction through 20 ft (6 m) of suction hose under the conditions specified in Table 16.2.4.1(a) for the rated capacity of the pump and discharging water in not more than 45 seconds.

16.2.3.3.3 Where the pump system includes an auxiliary 4 in. (100 mm) or larger intake pipe having a volume of 1 ft^3 (0.03 m^3) or more, an additional 15 seconds beyond that allowed in 16.2.3.3.1 and 16.2.3.3.2 shall be permitted.

16.2.3.3.4* Where pumps are of the parallel/series type, they shall complete the requirements of 16.2.3.3.1 through 16.2.3.3.3 in both parallel and series operation.

16.2.3.4 Vacuum.

16.2.3.4.1 The completed pumping system shall be capable of developing a vacuum of 22 in. Hg (75 kPa) at altitudes up to 2000 ft (600 m) by means of the pump priming system and sustaining the vacuum for at least 5 minutes with a loss not to exceed 10 in. Hg (34 kPa).

16.2.3.4.2 The requirement in 16.2.3.4.1 shall be met with all intake valves open, with all intakes capped or plugged, with all discharge caps removed, and without the use of the pump primer during the 5-minute period.

16.2.4 Pump Suction Capability.

16.2.4.1* The pump manufacturer shall certify that the fire pump is capable of pumping 100 percent of rated capacity at 150 psi (1000 kPa) net pump pressure for pumps rated 3000 gpm (12,000 L/min) or less or at 100 psi (700 kPa) for pumps rated greater than 3000 gpm (12,000 L/min) from draft through 20 ft (6 m) of suction hose with a strainer attached under the following conditions:

(1) An altitude of 2000 ft (600 m) above sea level

(2) Atmospheric pressure of 29.9 in. Hg (101 kPa) (corrected to sea level)

(3) Water temperature of 60°F (15.6°C)

(4) Suction hose size and number of hose not to exceed those indicated in Table 16.2.4.1(a)

(5) Lift as indicated in Table 16.2.4.1(a)

(6) Friction and entrance loss in suction hose, including strainer, as given in Table 16.2.4.1(b) or Table 16.2.4.1(c)

Table 16.2.4.1(a) Suction Hose Size, Number of Suction Lines, and Lift for Pump Manufacturer's Suction Capability Certification

Rated Capacity		Suction Hose Size		Number of Suction Lines	Lift	
gpm	L/min	in.	mm		ft	m
250	1,000	3	75	1	10	3
300	1,100	3	75	1	10	3
350	1,300	4	100	1	10	3
500	2,000	4½	100	1	10	3
750	3,000	4½	110	1	10	3
1000	4,000	6	150	1	10	3
1250	5,000	6	150	1	10	3
1500	6,000	6	150	2	10	3
1750	7,000	6	150	2	8	2.4
2000	8,000	6	150	2	6	1.8
2000	8,000	8	200	1	6	1.8
2250	9,000	6	150	3	6	1.8
2250	9,000	8	200	1	6	1.8
2500	10,000	6	150	3	6	1.8
2500	10,000	8	200	1	6	1.8
3000	12,000	6	150	4	6	1.8
3000	12,000	8	200	2	6	1.8
3500	14,000	6	150	4	6	1.8
3500	14,000	8	200	2	6	1.8
4000	16,000	6	150	4	6	1.8
4000	16,000	8	200	2	6	1.8

Table 16.2.4.1(b) Friction and Entrance Loss in 20 ft of Suction Hose, Including Strai

Flow Rate (gpm)	Number of Suction Hose and Size (inside diameter)							
	One 3 in.		One 4 in.		One 4½ in.		One 5 in.	
	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. H
250	5.2 (1.2)	4.6						
175	2.6 (0.6)	2.3						
125	1.4 (0.3)	1.2						

Table 16.2.4.1(b) Friction and Entrance Loss in 20 ft of Suction Hose, Including Strai

Flow Rate (gpm)	Number of Suction Hose and Size (inside diameter)							
	One 3 in.		One 4 in.		One 4½ in.		One 5 in.	
	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. H
300	7.5 (1.7)	6.6						
210	3.8 (0.8)	3.4						
150	1.9 (0.4)	1.7						
350			2.5 (0.7)	2.1				
245			1.2 (0.3)	1.1				
175			0.7 (0.1)	0.6				
500			5.0 (1.3)	4.4	3.6 (0.8)	3.2		
350			2.5 (0.7)	2.1	1.8 (0.4)	1.6		
250			1.3 (0.4)	1.1	0.9 (0.3)	0.8		
750			11.4 (2.9)	9.8	8.0 (1.6)	7.1	4.7 (0.9)	4.2
525			5.5 (1.5)	4.9	3.9 (0.8)	3.4	2.3 (0.5)	2.0
375			2.8 (0.7)	2.5	2.0 (0.4)	1.8	1.2 (0.2)	1.1
1000					14.5 (2.8)	12.5	8.4 (1.6)	7.4
700					7.0 (1.4)	6.2	4.1 (0.8)	3.7
500					3.6 (0.8)	3.2	2.1 (0.4)	1.9
	One 5 in.		One 6 in.		Two 4½ in.		Two 5 in.	
	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. H
1250	13.0 (2.4)	11.5	5.2 (0.9)	4.7	5.5 (1.2)	4.9		
875	6.5 (1.2)	5.7	2.6 (0.5)	2.3	2.8 (0.7)	2.5		
625	3.3 (0.7)	2.9	1.3 (0.3)	1.1	1.4 (0.3)	1.2		
1500			7.6 (1.4)	6.7	8.0 (1.6)	7.1	4.7 (0.9)	4.2
1050			3.7 (0.7)	3.3	3.9 (0.8)	3.4	2.3 (0.5)	2.0
750			1.9 (0.4)	1.7	2.0 (0.4)	1.8	1.2 (0.2)	1.1
1750			10.4 (1.8)	9.3	11.0 (2.2)	9.7	6.5 (1.2)	5.7
1225			5.0 (0.9)	4.6	5.3 (1.1)	4.7	3.1 (0.7)	2.7
875			2.6 (0.5)	2.3	2.8 (0.6)	2.5	1.6 (0.3)	1.4
2000					14.5 (2.8)	12.5	8.4 (1.6)	7.4
1400					7.0 (1.4)	6.2	4.1 (0.8)	3.7
1000					3.6 (0.8)	3.2	2.1 (0.4)	1.9
2250							10.8 (2.2)	9.5

	One 5 in.		One 6 in.		Two 4½ in.		Two 5 in.	
	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. H
1575							5.3 (1.1)	4.7
1125							2.8 (0.5)	2.5
2500							13.0 (2.4)	11.5
1750							6.5 (1.2)	5.7
1250							3.3 (0.7)	2.9

	Two 6 in.		Three 6 in.		Four 6 in.		One 8 in.	
	ft water	in. Hg	ft water	in. Hg	ft water	in. Hg	ft water	in. H
2000	3.4 (0.6)	3.0					4.3 (1.1)	3.8
1400	1.7 (0.3)	1.5					2.0 (0.6)	1.8
1000	0.9 (0.2)	0.8					1.0 (0.3)	0.9
2250	4.3 (0.8)	3.8	2.0 (0.5)	1.8			5.6 (1.4)	5.0
1575	2.2 (0.4)	1.9	1.0 (0.2)	0.9			2.5 (0.9)	2.2
1125	1.1 (0.2)	1.0	0.5 (0.1)	0.5			1.2 (0.4)	1.1
2500	5.2 (0.9)	4.7	2.3 (0.6)	2.0			7.0 (1.7)	6.2
1750	2.6 (0.5)	2.3	1.2 (0.2)	1.1			3.2 (1.0)	2.8
1250	1.3 (0.3)	1.1	0.6 (0.1)	0.5			1.5 (0.4)	1.3
3000	7.6 (1.4)	6.9	3.4 (0.6)	3.0			10.1 (3.0)	9.0
2100	3.7 (0.7)	3.4	1.7 (0.3)	1.5			4.7 (1.3)	4.2
3500	10.4 (1.8)	9.3			2.6 (0.5)	2.3		
2450	5.0 (0.9)	4.6			1.2 (0.3)	1.1		
4000			4.8 (0.9)	4.3	3.4 (0.6)	3.0		
2800			2.8 (0.5)	2.5	1.7 (0.3)	1.5		

Note: Figures in parentheses indicate increment to be added or subtracted for each 10 ft of hose greater than or less

Table 16.2.4.1(c) Friction and Entrance Loss in 6 m of Suction Hose, Including S

Flow Rate (L/min)	Number of Suction Hose and Size (inside diameter)							
	One 75 mm		One 100 mm		One 110 mm		One 125 mm	
	m water	kPa	m water	kPa	m water	kPa	m water	kPa
1,000	1.6 (0.04)	16						
700	0.8 (0.02)	8						
500	0.4 (0.01)	4						
1,100	2.2 (0.05)	22						
770	1.1 (0.02)	12						

Table 16.2.4.1(c) Friction and Entrance Loss in 6 m of Suction Hose, Including S

Flow Rate (L/min)	Number of Suction Hose and Size (inside diameter)							
	One 75 mm		One 100 mm		One 110 mm		One 125 mm	
	m water	kPa	m water	kPa	m water	kPa	m water	kPa
550	0.6 (0.01)	6						
1,300			0.7 (0.02)	7				
910			0.4 (0.01)	4				
650			0.2 (0.01)	2				
2,000			1.5 (0.04)	15	1.1 (0.02)	11		
1,400			0.7 (0.02)	7	0.5 (0.01)	5		
1,000			0.4 (0.01)	4	0.3 (0.01)	3		
3,000			3.5 (0.09)	33	2.4 (0.05)	24	1.4 (0.03)	14
2,100			1.7 (0.05)	17	1.2 (0.02)	11	0.7 (0.01)	7
1,500			0.9 (0.02)	8	0.6 (0.01)	6	0.4 (0.01)	4
4,000					4.4 (0.08)	42	2.6 (0.05)	25
2,800					2.1 (0.04)	21	1.2 (0.02)	13
2,000					1.1 (0.02)	11	0.6 (0.01)	6

Flow Rate (L/min)	One 125 mm		One 150 mm		Two 110 mm		Two 125 mm	
	m water	kPa	m water	kPa	m water	kPa	m water	kPa
5,000	4.0 (0.07)	39	1.6 (0.03)	16	1.7 (0.04)	17		
3,500	2.0 (0.04)	19	0.8 (0.02)	8	0.9 (0.02)	8		
2,500	1.0 (0.02)	10	0.4 (0.01)	4	0.4 (0.01)	4		
6,000			2.3 (0.04)	23	2.4 (0.05)	24	1.4 (0.03)	14
4,200			1.1 (0.02)	11	1.2 (0.02)	12	0.7 (0.02)	7
3,000			0.6 (0.01)	6	0.6 (0.01)	6	0.4 (0.01)	4
7,000			3.2 (0.05)	31	3.6 (0.07)	33	2.0 (0.04)	19
4,900			1.5 (0.03)	16	1.6 (0.03)	16	0.9 (0.02)	9
3,500			0.8 (0.02)	8	0.9 (0.02)	8	0.5 (0.01)	5
8,000					4.4 (0.08)	42	2.6 (0.05)	25
5,600					2.1 (0.04)	21	1.2 (0.02)	13
4,000					1.1 (0.02)	11	0.6 (0.01)	6
9,000							3.3 (0.07)	32
6,300							1.6 (0.03)	16

Flow Rate (L/min)	One 125 mm		One 150 mm		Two 110 mm		Two 125 mm	
	m water	kPa	m water	kPa	m water	kPa	m water	kPa
4,500							0.9 (0.02)	8
10,000							4.0 (0.07)	39
7,000							2.0 (0.04)	19
5,000							1.0 (0.02)	10

Flow Rate (L/min)	Two 150 mm		Three 150 mm		Four 150 mm		One 200 mm	
	m water	kPa	m water	kPa	m water	kPa	m water	kPa
8,000	1.0 (0.02)	10					1.3 (0.03)	13
5,600	0.5 (0.01)	5					0.6 (0.02)	6
4,000	0.3 (0.01)	3					0.3 (0.01)	3
9,000	1.3 (0.02)	13	0.6 (0.01)	6			1.7 (0.05)	17
6,300	0.7 (0.01)	6	0.3 (0.01)	3			0.7 (0.03)	7
4,500	0.3 (0.01)	3	0.2 (0.01)	2			0.4 (0.01)	4
10,000	1.6 (0.03)	16	0.7 (0.02)	7			2.1 (0.05)	21
7,000	0.8 (0.02)	8	0.4 (0.01)	4			1.0 (0.03)	9
5,000	0.4 (0.01)	4	0.2 (0.01)	2			0.5 (0.01)	4
12,000	2.3 (0.04)	23	1.0 (0.02)	10			3.0 (0.09)	30
8,400	1.1 (0.02)	12	0.5 (0.01)	5			1.4 (0.04)	14
14,000	3.2 (0.05)	31			0.8 (0.2)	8		
9,800	1.5 (0.03)	16			0.4 (0.1)	4		
16,000			1.5 (0.3)	15	1.0 (0.2)	10		
11,200			0.9 (0.2)	8	0.5 (0.1)	5		

Note: Figures in parentheses indicate increment to be added or subtracted for each 3 m of hose greater than or less t

16.2.4.2* The pump manufacturer shall certify that the pump is capable of pumping rated capacity at 150 psi (1000 kPa) net pump pressure for pumps rated 3000 gpm (12,000 L/min) or less or at 100 psi (700 kPa) for pumps rated greater than 3000 gpm (12,000 L/min) at any of the following special conditions when these conditions are specified by the purchaser:

(1) At an elevation above 2000 ft (600 m)

(2) At lifts higher than those listed in Table 16.2.4.1(a), through more than 20 ft (6 m) of suction hose, or both

(3) For pumps having a rated capacity of 1500 gpm (6000 L/min) or larger, through a single

suction hose only, or through the number of hose listed in Table 16.2.4.1(a) attached to one side of the apparatus only

16.3 Pumping Engine Requirements.

16.3.1 The apparatus manufacturer shall approve the use of the pumping engine for stationary pumping applications based on the size of the fire apparatus and the rating of the pump being furnished.

16.3.2 Engine Speed.

16.3.2.1 The engine shall be capable of performing the pumping tests herein specified without exceeding the maximum governed speed of the engine as shown on a certified brake horsepower curve of the type of engine used without accessories.

16.3.2.2 The brake horsepower curve certification shall be signed by a responsible official of the engine manufacturer.

16.3.3 If the fire pump is rated at 750 gpm (3000 L/min) or greater but not greater than 3000 gpm (12,000 L/min), the engine/pump combination shall be capable of delivering the rated pump capacity at 165 psi (1100 kPa) net pump pressure.

16.3.4* If a separate pumping engine is provided, it shall meet the requirements of 12.2.1.1, 12.2.1.2, 12.2.1.7, 12.2.2, 12.2.3.1, 12.2.3.2, 12.2.4 through 12.2.6, Section 13.2, 13.4.3, 13.4.4, 13.4.4.1, 13.4.4.3, 13.4.4.4, 13.4.5, Section 13.5, and Section 13.6.

16.3.5 A supplementary heat exchanger cooling system shall be provided for the pump drive engine.

16.3.5.1 Valving shall be installed to permit water from the discharge side of the pump to cool the coolant circulating through the engine cooling system without intermixing.

16.3.5.2 The heat exchanger shall maintain the temperature of the coolant in the pump drive engine not in excess of the engine manufacturer's temperature rating under all pumping conditions.

16.3.5.3 A drain(s) shall be provided to allow draining of the heat exchanger so as to prevent damage from freezing.

16.3.6 Indicator or Light.

16.3.6.1 Where a separate engine is used to drive the pump, an indicator or light that is energized when the pump engine is running shall be provided in the driving compartment.

16.3.6.2 The indicator or light shall be marked with a label that reads “Pump Engine Running.”

16.4 Power Train Capability.

16.4.1 All components in the power train from the engine to the fire pump shall be capable of transmitting the torque necessary to power the pump, as installed in the apparatus, for the pump performance points specified in 16.2.3.1 and 16.2.3.2, if applicable, without exceeding the component manufacturer's continuous duty torque rating.

16.4.2 When pumping continuously at each of the pump performance points specified in 16.2.3.1 and 16.2.3.2, if applicable, lubricant temperatures in any power train component installed in the apparatus from the engine to the pump shall not exceed the component manufacturer's recommendation for maximum temperature.

16.4.3* A means shall be provided to limit the nominal net engine output during pumping operation to a torque level equal to the nominal continuous duty torque rating of the weakest component or, if there are multiple devices to be driven simultaneously, to a level equal to the sum of the nominal continuous duty torque ratings of multiple components.

16.5 Construction Requirements.

16.5.1* Wetted moving parts shall be constructed of a corrosion-resistant material.

16.5.2 Hydrostatic Test.

16.5.2.1 The pump body shall be subjected to a hydrostatic test to a gauge pressure of 500 psi (3400 kPa) for a minimum of 10 minutes.

16.5.2.2 The pump manufacturer shall provide a certificate of completion for the hydrostatic test.

16.5.3 The entire discharge and intake piping system, valves, drain cocks and lines, and intake and outlet closures, excluding the tank fill and tank-to-pump lines on the tank side of the valves in those lines, shall be capable of withstanding a hydrostatic gauge pressure of 500 psi (3400 kPa).

16.5.4 Pulsation-Free Fire Streams.

16.5.4.1 The pump shall be capable of producing fire streams that are free from pulsations.

16.5.4.2 When an accumulator is used to provide pulsation-free fire streams, the accumulator shall be constructed and tested in accordance with the ASME *Boiler and Pressure Vessel Code,* Section VIII, Division 2.

16.5.5 The pump shall allow a positive pressure water source to directly add to the pump's discharge pressure.

16.6 Pump Intake Connections.

16.6.1* The pump shall have a sufficient number and size of intakes to perform the apparatus pump system certification test.

16.6.1.1 The intakes specified in 16.6.1 shall have male National Hose threads if the apparatus is to be used in the United States.

16.6.1.2 If the couplings on the suction hose carried on the apparatus are of a different size from that of the pump intake(s) or have means of hose attachment other than that provided on the intake(s), an adapter(s) shall be provided to allow connection of the suction hose to the pump intake(s).

16.6.1.3* A sign shall be provided on the pump operator's panel that states the following:

> ***WARNING:*** *Death or serious injury might occur if proper operating procedures are not followed. The pump operator as well as individuals connecting supply or discharge hoses to the apparatus must be familiar with water hydraulics hazards and component limitations.*

16.6.2 Intake Strainer.

16.6.2.1 Each intake shall have a removable or accessible strainer inside the connection.

16.6.2.2* The strainer(s) shall restrict spherical debris that is too large to pass through the pump.

16.6.3 At least one valved intake shall be provided that can be controlled from the pump operator's position.

16.6.3.1 The valve and piping shall be a minimum 2½ in. (65 mm) nominal size.

16.6.3.2 If the intake is 2½ in. (65 mm) nominal size, the intake shall be equipped with a female swivel coupling with NH threads.

16.6.4 Any 3 in. (75 mm) or larger intake valve except the tank-to-pump intake valve shall be a slow-operating valve.

16.6.5* Each valved intake shall be equipped with a bleeder valve having a minimum ¾ in. (19 mm) pipe thread connection to bleed off air or water.

16.6.5.1 The bleeder valve shall be operational without the operator having to get under the apparatus.

16.6.5.2 If a valved appliance is attached to an intake, it shall be equipped with a ¾ in. (19 mm) bleeder valve on each intake.

16.6.5.3 Bleeder valves for valved intakes 4 in. (100 mm) and larger not located at the pump operator's panel shall be located where the bleeder valve controls are visible and operationally functional while the operator remains stationary at the valved intake position.

16.6.6 Each valved intake having a connection size larger than 3 in. (75 mm) shall be equipped with an adjustable automatic pressure relief device installed on the supply side of the valve to bleed off pressure from a hose connected to the valved intake.

16.6.6.1 The pressure relief device shall discharge to atmosphere, and the discharge shall be piped or directed away from the pump operator's position.

16.6.6.2 The automatic pressure relief device shall be adjustable from a minimum of 90 psi (620 kPa) to at least 185 psi (1275 kPa).

16.6.6.3 The pressure relief device, when preset at 125 psi (860 kPa), shall not allow a pressure rise greater than 60 psi (400 kPa) at the device inlet while flowing a minimum of 150 gpm (570 L/min).

16.6.7 If the pump is equipped with one or more intakes larger than 3 in. (75 mm) that are not valved, an adjustable automatic pressure relief device shall be installed on the pump system to bleed off excess pressure from a hose connected to the pump intake.

16.6.7.1 The automatic pressure relief device shall be adjustable from a minimum of 90 psi (620 kPa) to at least 185 psi (1275 kPa).

16.6.7.2 The pressure relief device, when preset at 125 psi (860 kPa), shall not allow a pressure rise greater than 60 psi (400 kPa) at the device inlet while flowing a minimum of 150 gpm (570 L/min).

16.6.7.3 The pressure relief device shall discharge to atmosphere.

16.6.8 All intakes shall be provided with caps or closures capable of withstanding a hydrostatic gauge pressure of 500 psi (3400 kPa).

16.6.8.1 Intakes having male threads shall be equipped with caps; intakes having female threads shall be equipped with plugs.

16.6.8.2 Where adapters for special threads or other means for hose attachment are provided on the intakes, closures shall be provided for the adapters in lieu of caps or plugs.

16.6.9 Caps or closures for intake connections smaller than 4 in. (100 mm) shall remain secured to the apparatus when removed from the connection.

16.6.10 If the suction inlets are to be equipped with a valve, siamese, or adapter that will remain in place while the apparatus is in motion, that valve, siamese, or adapter shall not project beyond the apparatus running board.

16.6.11 The purchaser shall specify if any valve, siamese, or adapter is to be permanently installed on an intake and identify the brand and model of such item.

16.7* Pump Discharge Outlets.

16.7.1* Discharge outlets of 2½ in. (65 mm) or larger shall be provided to discharge the rated capacity of the pump at the flow rates shown in Table 16.7.1.

Table 16.7.1 Discharge Rates by Outlet Size

Outlet Size		Flow Rates	
in.	**mm**	**gpm**	**L/min**
2½	65	250	1000
3	75	375	1400
4	100	625	2400
5	125	1000	4000

Table 16.7.1 Discharge Rates by Outlet Size

Outlet Size		Flow Rates	
in.	**mm**	**gpm**	**L/min**
6	150	1440	5500

16.7.1.1 If the apparatus is equipped with an aerial device with a waterway that is permanently connected to the pump, the discharge from that waterway shall be permitted to be credited as a 1000 gpm (4000 L/min) outlet.

16.7.1.2 A minimum of two 2½ in. (65 mm) outlets shall be provided on any pump rated at 750 gpm (3000 L/min) or greater, and a minimum of one 2½ in. (65 mm) outlet shall be provided on any pump rated at less than 750 gpm (3000 L/min).

16.7.2 Discharge Outlet Connections.

16.7.2.1 All 2½ in. (65 mm) or larger discharge outlet connections shall be equipped with male National Hose threads.

16.7.2.2* Adapters with special threads or other means for hose attachment shall be permitted to be attached to any outlets.

16.7.3* The piping and valves supplying any preconnected 1½ in. (38 mm), 1¾ in. (45 mm), or 2 in. (52 mm) hose line, including the piping to the preconnected hose storage areas specified in Section 5.6(2), Section 6.5(2), 7.5.2, 8.6.2, Section 9.6(2), or Section 11.7(2), as applicable, shall be at least 2 in. (52 mm) in size.

16.7.4 All discharge outlet connections, except connections to which a hose will be preconnected, shall be equipped with caps or closures capable of withstanding a hydrostatic gauge pressure of 100 psi (700 kPa) over the maximum pump close-off pressure or 500 psi (3400 kPa), whichever is greater.

16.7.4.1 Where adapters are provided on the discharge outlet connections, the closures shall fit on the adapters.

16.7.4.2 Caps or closures for outlet connections smaller than 4 in. (100 mm) shall remain secured to the apparatus when removed from the connection.

16.7.5 Each discharge outlet shall be equipped with a valve that can be opened and closed smoothly at the flows shown in Table 16.7.1 at pump discharge gauge pressures of 250 psi (1700 kPa).

16.7.5.1 The flow-regulating element of each valve shall not change its position under any condition of operation that involves discharge pressures to the maximum pressure of the pump; the means to prevent a change in position shall be incorporated in the operating mechanism and shall be permitted to be manually or automatically controlled.

16.7.5.2* Any 3 in. (75 mm) or larger discharge valve shall be a slow-operating valve.

16.7.6 All 1½ in. (38 mm) or larger discharge outlets shall be equipped with a drain or bleeder valve having a minimum ¾ in. (19 mm) pipe thread connection for draining or bleeding off pressure from a hose connected to the outlet.

16.7.7 Any 2 in. (52 mm) or larger discharge outlet that is located more than 42 in. (1070 mm) off the ground to which hose is to be connected and that is not in a hose storage area shall be supplied with a sweep elbow of at least 30 degrees downward.

16.7.8 Valves.

16.7.8.1 Each pump discharge shall have a valve that can be controlled from the pump operator's position.

16.7.8.2 A secondary valve shall be permitted to be provided at a discharge outlet if required for special applications.

16.7.9* Location of Discharge Outlets.

16.7.9.1 No discharge outlet larger than 2½ in. (65 mm) shall be located at the pump operator's panel.

16.7.9.2 If the apparatus has a top console–type pump operator's panel, vertical discharge outlets larger than 2½ in. (65 mm) shall be permitted at the top midship position of apparatus where the outlets are used for directly connected deck guns or monitors and no fire hose is used for coupling the components.

16.7.10 Where the valve-operating mechanism does not indicate the position of the valve, an indicator shall be provided to show when the valve is closed.

16.8 Pump Drains.

16.8.1 A readily accessible drain valve(s) that is marked with a label as to its function shall be provided to allow for draining of the pump and all water-carrying lines and accessories.

16.8.2 The drain valve(s) shall be operational without the operator having to get under the apparatus.

16.9 Pump Operator's Panel.

16.9.1* Each pump control, gauge, and other instrument necessary to operate the pump shall be located on a panel known as the pump operator's panel and shall be marked with a label as to its function.

16.9.2 All gauges, discharge outlets, pump intakes, and controls shall be illuminated in compliance with 4.10.1.

16.10* Pump Controls.

16.10.1 General Provisions. Provisions shall be made for placing the pump drive system in operation using controls and switches that are identified and within convenient reach of the operator.

16.10.1.1 Where the pump is driven by the chassis engine and engine compression brakes or engine exhaust brakes are furnished, these engine brakes shall be automatically disengaged for pumping operations.

16.10.1.2* Any control device used in the pumping system power train between the engine and the pump, except a manual pump shift override device if provided, shall be equipped with a means to prevent unintentional movement of the control device from its set position in the pumping mode.

16.10.1.3 A label indicating the chassis transmission shift selector position to be used for pumping shall be provided in the driving compartment and located so that it can be read from the driver's position.

16.10.1.4 Where the pump is driven by the chassis engine and transmission through a split shaft PTO, the driving compartment speedometer shall register when the pump drive system is engaged.

16.10.1.5 Where chassis transmission retarders are furnished, they shall be automatically disengaged for pumping operations.

16.10.1.6 Where the pump is driven by the chassis engine and an automatic chassis transmission through a split-shaft PTO, the chassis transmission shall shift to neutral upon engagement of the parking brake.

16.10.2 Stationary Pump Driven Through Split-Shaft PTO — Automatic Chassis Transmission. Where the apparatus is equipped with an automatic chassis transmission, the water pump is driven by the chassis engine through the transmission's main driveline, and the apparatus is to be used for stationary pumping only, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pumping system can be operated from the pump operator's position.

16.10.2.1* A "Pump Engaged" indicator shall be provided in the driving compartment to indicate that the pump shift process has been successfully completed.

16.10.2.2 An "OK to Pump" indicator shall be provided in the driving compartment to indicate that the pump is engaged, the chassis transmission is in pump gear, and the parking brake is engaged.

16.10.3 Stationary Pump Driven Through Split-Shaft PTO — Manual Chassis Transmission. Where the apparatus is equipped with a manual chassis transmission, the water pump is driven by the chassis engine through the transmission's main driveline, and the apparatus is to be used for stationary pumping only, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pumping system can be operated from the pump operator's position.

16.10.3.1* A "Pump Engaged" indicator shall be provided in the driving compartment to indicate that the pump shift has been successfully completed.

16.10.3.2 An "OK to Pump" indicator shall be provided in the driving compartment to indicate that the pump is engaged and the parking brake is engaged.

16.10.4 Stationary Pump Driven Through Transmission-Mounted PTO, Front-of-Engine Crankshaft PTO, or Engine Flywheel PTO — Automatic Chassis Transmission. Where the apparatus is equipped with an automatic chassis transmission, the water pump is driven by a transmission-mounted (SAE) PTO, front-of-engine crankshaft PTO, or engine flywheel PTO, and the apparatus is to be used for stationary pumping only with the chassis transmission in neutral, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pump system can be operated from the pump operator's position.

16.10.4.1 A "Pump Engaged" indicator shall be provided both in the driving compartment and on the pump operator's panel to indicate that the pump shift has been successfully completed.

16.10.4.2 An "OK to Pump" indicator shall be provided in the driving compartment to indicate that the pump is engaged, the chassis transmission is in neutral, and the parking brake is engaged.

16.10.5 Stationary Pump Driven Through Transmission-Mounted PTO, Front-of-Engine Crankshaft PTO, or Engine Flywheel PTO — Manual Chassis Transmissions. Where the apparatus is equipped with a manual chassis transmission, the water pump is driven by a transmission-mounted (SAE) PTO, front-of-engine crankshaft PTO, or engine flywheel PTO, and the apparatus is to be used for stationary pumping only with the chassis transmission in neutral, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pump system can be operated from the pump operator's position.

16.10.5.1 A "Pump Engaged" indicator shall be provided both in the driving compartment and on the pump operator's panel to indicate that the pump shift has been successfully completed.

16.10.5.2 An "OK to Pump" indicator shall be provided in the driving compartment to indicate that the pump is engaged and the parking brake is engaged.

16.10.6 Stationary and "Pump-and-Roll" Pump —– Automatic Chassis Transmissions. Where the water pump is driven by a transmission-mounted (SAE) PTO, front-of-engine crankshaft PTO, or engine flywheel PTO, and the apparatus is designed to be used in both the stationary pumping mode and the "pump-and-roll" pumping mode with the automatic chassis transmission in neutral for stationary pumping and in a road gear for pump-and-roll pumping, an interlock system shall be provided to ensure that the pump drive system components are properly engaged in the pumping mode of operation so that the apparatus can be operated in either stationary or pump-and-roll pumping mode.

16.10.6.1 A “Pump Engaged” indicator shall be provided both in the driving compartment and on the pump operator's panel to indicate that the pump shift has been successfully completed.

16.10.6.2 An “OK to Pump” indicator shall be provided in the driving compartment to indicate that the pump is engaged, the chassis transmission is in neutral, and the parking brake is engaged.

16.10.6.3 An “OK to Pump and Roll” indicator shall be provided in the driving compartment and shall be energized when the pump is engaged, the chassis transmission is in road gear, and the parking brake is released.

16.10.6.4 When the “OK to Pump and Roll” indicator is energized, the “OK to Pump” indicator shall not be energized.

16.10.7 Stationary and “Pump-and-Roll” Pumps — Manual Chassis Transmissions. Where the water pump is driven by a transmission-mounted (SAE) PTO, front-of-engine crankshaft PTO, or engine flywheel PTO, and the apparatus is designed to be used in both the stationary pumping mode and the pump-and-roll pumping mode with the chassis transmission in neutral for stationary pumping or in a road gear for pump-and-roll pumping, an interlock system shall be provided to ensure that the pump drive system components are properly engaged in the pumping mode of operation so that the apparatus can be operated in either stationary or pump-and-roll pumping mode.

16.10.7.1 A “Pump Engaged” indicator shall be provided both in the driving compartment and on the pump operator's panel to indicate that the pump shift has been successfully completed.

16.10.7.2 An “OK to Pump” indicator shall be provided in the driving compartment to indicate that the pump is engaged and the parking brake is engaged.

16.10.7.3 An “OK to Pump and Roll” indicator shall be provided in the driving compartment and shall be energized when the pump is engaged and the parking brake is released.

16.10.7.4 When the “OK to Pump and Roll” indicator is energized, the “OK to Pump” indicator shall not be energized.

16.10.8 Stationary Pumps Driven Through Transfer Case PTOs — Automatic Chassis Transmissions. Where the apparatus is equipped with an automatic chassis transmission, the water pump is driven by the chassis engine through the transmission's main driveline and through a transfer case, and the apparatus is to be used for stationary pumping only, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pumping system can be operated from the pump operator's position.

16.10.8.1 A “Pump Engaged” indicator shall be provided in the driving compartment to indicate that the pump shift has been successfully completed.

16.10.8.2 An “OK to Pump” indicator shall be provided in the driving compartment to indicate that the pump is engaged, the chassis transmission is in pump gear, the transfer case drive to the chassis wheels is in neutral, and the parking brake is engaged.

16.10.9 Stationary Pumps Driven Through Transfer Case PTOs — Manual Chassis Transmissions. Where the apparatus is equipped with a manual chassis transmission, the water pump is driven by the chassis engine through the transmission's main driveline and through a transfer case, and the apparatus is to be used for stationary pumping only, an interlock system shall be provided to ensure that the pump drive system components are engaged in the pumping mode of operation so that the pumping system can be operated from the pump operator's position.

16.10.9.1 A “Pump Engaged” indicator shall be provided in the driving compartment to indicate that the pump shift has been successfully completed.

16.10.9.2 An “OK to Pump” indicator shall be provided in the driving compartment to indicate that the pump is engaged, the transfer case drive to the chassis wheels is in neutral, and the parking brake is engaged.

16.10.10 Pump Operator’s Panel Engine Speed Advancement — Automatic Chassis Transmission.

16.10.10.1 An engine speed control shall be provided at the pump operator’s panel.

16.10.10.2 A “Throttle Ready” indicator that lights when the pump is in the “OK to Pump” mode shall be provided on the pump operator’s panel.

16.10.10.3* The “Throttle Ready” indicator at the pump operator’s panel shall be permitted to light when the chassis transmission is in neutral and the parking brake is engaged.

16.10.10.4 An interlock system shall be provided to prevent advancement of the engine speed at the pump operator's panel unless the apparatus has “Throttle Ready” indication.

16.10.10.5 Loss of power to the interlock system in 16.10.10.4 shall return the engine speed to idle and prevent advancement from the pump operator’s panel.

16.10.11 Pump Operator’s Panel Engine Speed Advancement — Manual Chassis Transmission.

16.10.11.1 An engine speed control shall be provided on the pump operator’s panel.

16.10.11.2 A “Throttle Ready” indicator that lights when the pump is in the “OK to Pump” mode shall be provided on the pump operator’s panel.

16.10.11.3* The “Throttle Ready” indicator on the pump operator’s panel shall be permitted to light when the parking brake is engaged.

16.10.11.4 Loss of power to the interlock system in 16.10.11.3 shall return the engine speed to idle and prevent advancement from the pump operator’s panel.

16.10.12 If a pump shift manual override device is provided, the “Pump Engaged,” “OK to Pump,” and “Throttle Ready” indicators and the pump operator’s panel engine speed advancement interlock system shall be operationally functional when the manual override device is used to shift the pump.

16.10.13 Parallel/Series Control.

16.10.13.1 With parallel/series centrifugal pumps, the control positions for parallel operation (volume) and series operation (pressure) shall be indicated.

16.10.13.2 The control for changing the pump from series to parallel, and vice versa, shall be operable at the pump operator's position.

16.10.14* Pressure Control System.

16.10.14.1* A system shall be provided that, when set in accordance with the manufacturer's instructions, will automatically control the increase in net pump pressure to a maximum of 30 psi (200 kPa) pressure rise when all discharge valves are closed not more rapidly than in 3 seconds and not more slowly than in 10 seconds during the following conditions:

(1) Over a range of pressures from 70 psi to 300 psi (500 kPa to 2000 kPa) net pump pressure with intake gauge pressure between -10 psi and 185 psi (-70 kPa and 1300 kPa) and discharge gauge pressure between 90 psi and 300 psi (620 kPa and 2000 kPa)

(2) With initial engine and pump controls set to produce a range of flows from 150 gpm (550 L/min) to the rated capacity of the pump

16.10.14.2 If the pump is equipped with a relief valve system where the system does not control engine speed, the system shall be equipped with a means to indicate when the system is in control of the pressure.

16.10.14.2.1 If the pump is equipped with a governor system that controls engine speed, an indicator shall show when the system is turned on and whether it is controlling the engine speed or pump pressure.

16.10.14.2.2 Either system shall be controllable by one person at the pump operator position.

16.10.14.3 If the system discharges water to the atmosphere, the discharge shall be in a manner that will not expose personnel to high pressure water streams.

16.10.15* Priming System. A priming system shall be provided and controlled from the pump operator's position.

16.10.15.1 The priming system shall be capable of meeting the requirements of 16.2.3.3 and 16.2.4.

16.10.15.2 The priming system shall be capable of operating with no lubricant or with a biodegradable nontoxic lubricant.

16.10.16 Protection of Pump Controls. All pump controls and devices shall be installed so as to be protected against mechanical damage and the effects of adverse weather conditions on their operation.

16.11 Pump Engine Controls.

16.11.1* A throttle control that holds its set position shall be provided to control the pump engine speed.

16.11.2 The throttle control on vertically (greater than 45 degrees) arranged pump panels shall be located not higher than 72 in. (1830 mm) nor lower than 42 in. (1070 mm) from the operator’s standing position with all instruments in full view.

16.11.3 The throttle control on horizontally (less than 45 degrees) arranged pump panels shall be located not higher than 50 in. (1270 mm) nor lower than 32 in. (810 mm) from the operator’s standing position with all instruments in full view.

16.12 Instrumentation.

16.12.1 Pump Operator's Panel.

16.12.1.1* The following controls and instruments shall be provided and installed as a group on the pump operator's panel:

(1) Master pump intake pressure gauge

(2) Master pump discharge pressure gauge

(3) Pumping engine tachometer

(4) Pumping engine coolant temperature gauge

(5) Pumping engine oil pressure gauge

(6) Voltmeter

(7) Pump pressure control(s)

(8) Pumping engine throttle

(9) Primer control

(10) Water tank–to–pump valve control

(11) Water tank fill valve control

(12) Water tank level gauge

16.12.1.2 The instruments and controls required by 16.12.1.1 shall be placed so as to keep the pump operator as far as practicable from all discharge and intake connections and in a location where the instruments and controls are visible and operationally functional while the operator remains stationary.

16.12.1.3 Any instrumentation exposed to the elements shall be weatherproof.

16.12.1.4 The pumping engine oil pressure and engine coolant temperature gauges shall be equipped with audible and visual warnings.

16.12.1.5 All engine operation gauges on the pump operator's panel shall be in addition to those on the vehicle's instrument panel.

16.12.2 Master Pump Intake and Discharge Pressure Gauges.

16.12.2.1 Master pump intake and pump discharge pressure gauges shall be located within 8 in. (200 mm) of each other, edge to edge, with the intake pressure gauge to the left of or below the pump discharge pressure gauge.

16.12.2.1.1 The intake pressure gauge shall read from 30 in. Hg (100 kPa) vacuum to at least a gauge pressure of 300 psi (2000 kPa).

16.12.2.1.2 The discharge pressure gauge shall read from a gauge pressure of 0 psi or lower to a gauge pressure of at least 300 psi (2000 kPa).

16.12.2.1.3 Pressure gauges shall not be damaged by a 30 in. Hg (100 kPa) vacuum.

16.12.2.1.4 Pressure gauges shall be marked with labels that read “Pump Intake” for the intake pressure gauge and “Pump Discharge” for the discharge pressure gauge.

16.12.2.2 If analog gauges are used, they shall meet the requirements of 16.12.2.2.1 through 16.12.2.2.7.

16.12.2.2.1 There shall be at least a 1 in. (25 mm) diameter differential in viewing area between the master gauges and the individual discharge gauges, with the master gauges being the larger.

16.12.2.2.2 Analog gauges displaying the vacuum portion in 45 degrees of arc or less shall have an accuracy complying with Grade 1A as defined by ASME B40.100, *Pressure Gauges and Gauge Attachments*.

16.12.2.2.3 Analog gauges displaying the vacuum portion in greater than 120 degrees of arc shall have an accuracy of 3½ percent or better on vacuum and 3½ percent or better on pressure over their entire respective scale.

16.12.2.2.4 Analog gauges displaying the vacuum portion in greater than 120 degrees of arc shall have graduation lines on the vacuum side every 1 in. Hg (5 kPa) with major and immediate graduation lines emphasized and figures at least every 10 in. Hg (50 kPa).

16.12.2.2.5 Numerals for master gauges shall be a minimum of 0.25 in. (6.4 mm) high.

16.12.2.2.6 There shall be graduation lines showing at least every 10 psi (50 kPa), with major and intermediate graduation lines emphasized, and figures at least every 100 psi (500 kPa).

16.12.2.2.7 Analog pressure gauges shall be vibration and pressure pulsation dampened; be resistant to corrosion, condensation, and shock; and have internal mechanisms that are factory lubricated for the life of the gauge.

16.12.2.3 If digital master pressure gauges are used, they shall meet the requirements of

16.12.2.3.1 through 16.12.2.3.3.

16.12.2.3.1 The digits shall be at least 0.5 in. (12.7 mm) high.

16.12.2.3.2 Digital pressure gauges shall display pressure in increments of not more than 10 psi (50 kPa).

16.12.2.3.3 Digital master pressure gauges shall have an accuracy of ±3 percent over the full scale.

16.12.3 Discharge Outlet Instrumentation.

16.12.3.1 A pressure gauge shall be provided for each discharge outlet 1½ in. (38 mm) or larger in size and shall be marked with a label to indicate the outlet to which it is connected.

16.12.3.2* Any discharge outlet that is equipped with a flowmeter shall also be provided with a pressure gauge.

16.12.3.3 The pressure gauge or flowmeter display shall be located adjacent to the corresponding valve control with no more than 6 in. (150 mm) separating the pressure gauge or flowmeter bezel and the valve control midpoint or centerline.

16.12.3.4 If both a flowmeter and a pressure gauge are provided for an individual discharge outlet, the pressure gauges shall be located within 6 in. (150 mm) of the valve control midpoint or centerline, and the flowmeter display shall be adjacent to and within 2 in. (51 mm) of the pressure gauge bezel.

16.12.3.5 Pressure gauges shall be connected to the outlet side of the valve.

16.12.3.6 Flowmeters shall display flow in increments no greater than 10 gpm (50 L/min).

16.12.3.7 Where analog pressure gauges are used, they shall have a minimum accuracy of Grade B as defined in ASME B40.100.

16.12.3.7.1 Numerals for gauges shall be a minimum $\frac{5}{32}$ in. (4 mm) high.

16.12.3.7.2 There shall be graduation lines showing at least every 10 psi (50 kPa), with major and intermediate graduation lines emphasized, and figures at least every 100 psi (500 kPa).

16.12.3.7.3 Analog pressure gauges shall be vibration and pressure pulsation dampened; be resistant to corrosion, condensation, and shock; and have internal mechanisms that are factory lubricated for the life of the gauge.

16.12.3.8 If digital pressure gauges are used, they shall meet the requirements of 16.12.3.8.1 through 16.12.3.8.3.

16.12.3.8.1 The digits shall be at least ¼ in. (6.4 mm) high.

16.12.3.8.2 Digital pressure gauges shall display pressure in increments of not more than 10 psi (50 kPa).

16.12.3.8.3 Digital pressure gauges shall have an accuracy of ±3 percent over the full scale.

16.12.3.9 Each flowmeter shall be calibrated to an accuracy of ±5 percent when flowing the amount of water shown in Table 16.12.3.9 for the pipe size in which it is mounted.

Table 16.12.3.9 Flowmeter Calibration Flow for Each Pipe Size

Pipe Size		Flow	
in.	mm	gpm	L/min
1	25	40	150
1½	38	90	340
2	52	160	600
2½	65	250	950
3	75	375	1400
4	100	625	2400
5	125	1000	4000
6	150	1440	5500

16.12.4 Each pressure gauge or flowmeter and its display shall be mounted and attached so it is protected from accidental damage and excessive vibration.

16.12.5 Connections for test gauges shall be provided at the pump operator's panel.

16.12.5.1 One test gauge connection shall be connected to the intake side of the pump, and the other shall be connected to the discharge manifold of the pump.

16.12.5.2 The test gauge connections shall have a 0.25 in. (6.4 mm) standard pipe thread, shall be plugged, and shall be marked with a label.

16.13 Required Testing.

16.13.1 Apparatus Pump System Certification.

16.13.1.1 If the fire pump has a rated capacity of 750 gpm (3000 L/min) or greater, the pump shall be tested after the pump and all its associated piping and equipment have been installed on the apparatus.

16.13.1.1.1 The tests shall include at least the pumping test *(see 16.13.2)*, the pressure control system test *(see 16.13.4)*, the priming system tests *(see 16.13.5)*, the vacuum test *(see 16.13.6)*, and the gauge and flowmeter test *(see 16.13.9)*.

16.13.1.1.2 If the fire pump is rated at 750 gpm (3000 L/min) or greater but not greater than 3000 gpm (12,000 L/min), the pumping engine overload test *(see 16.13.3)* shall be included.

16.13.1.1.3 If the fire pump is driven by the chassis engine, the engine speed advancement interlock test *(see 16.13.8)* shall be included.

16.13.1.1.4 If the apparatus is equipped with a water tank, the water tank–to–pump flow test *(see 16.13.7)* shall be included.

16.13.1.1.5 An independent third-party certification organization shall witness the tests and certify the test results.

16.13.1.2 If the fire pump has a rated capacity of less than 750 gpm (3000 L/min), the pump shall be tested after the pump and all its associated piping and equipment have been installed on the apparatus.

16.13.1.2.1 The tests shall include at least the pumping test *(see 16.13.2)*, the pressure control system test *(see 16.13.4)*, the priming system tests *(see 16.13.5)*, the vacuum test *(see 16.13.6)*, and the gauge and flowmeter test *(see 16.13.9).*

16.13.1.2.2 If the apparatus is equipped with a water tank, the water tank–to–pump flow test *(see 16.13.7)* shall be included.

16.13.1.2.3 If the fire pump is driven by the chassis engine, the engine speed advancement interlock test *(see 16.13.8)* shall be included.

16.13.1.2.4* The test results shall be certified by the apparatus manufacturer.

16.13.1.3 Test Label.

16.13.1.3.1 A test label shall be provided at the pump operator's panel that gives the rated discharges and pressures together with the speed of the engine as determined by the certification test for each unit, the position of the parallel/series pump as used, and the governed speed of the engine as stated by the engine manufacturer on a certified brake horsepower curve.

16.13.1.3.2 The label shall be completely stamped with all information at the factory and attached to the vehicle prior to shipping.

16.13.2 Pumping Test.

16.13.2.1 Conditions for Test.

16.13.2.1.1 The test site shall be adjacent to a supply of clear water at least 4 ft (1.2 m) deep and close enough to allow the suction strainer to be submerged at least 2 ft (0.6 m) below the surface of the water when connected to the pump by 20 ft (6 m) of suction hose.

16.13.2.1.2* Tests shall be performed when conditions are as follows:

(1) Air temperature: 0°F to 110°F (-18°C to 43°C)

(2) Water temperature: 35°F to 90°F (2°C to 32°C)

(3) Barometric pressure: 29 in. Hg (98.2 kPa), minimum (corrected to sea level)

(4)* Minimum lift: 3 ft (1 m) from center of pump intake to the surface of the water

16.13.2.1.3 If it is necessary to perform the test outside the air or water temperature ranges stated in 16.13.2.1.2 and the pump passes the certification test, the test results shall be acceptable.

16.13.2.1.4 Engine-driven accessories shall not be functionally disconnected or otherwise rendered inoperative during the tests.

16.13.2.1.4.1 If the chassis engine drives the pump, the total continuous electrical loads, excluding those loads associated with the equipment defined in 16.13.2.1.4.3, shall be applied for the entire pumping portion of this test.

16.13.2.1.4.2 If the vehicle is equipped with a fixed power source driven by the same engine that drives the fire pump, it shall be running at a minimum of 50 percent of its rated capacity throughout the pumping portion of the pump test.

16.13.2.1.4.3 The following devices shall be permitted to be turned off or not operating during the pump test:

(1) Aerial hydraulic pump

(2) Foam pump

(3) Hydraulically driven equipment (other than hydraulically driven line voltage generator)

(4) Winch

(5) Windshield wipers

(6) Four-way hazard flashers

(7) Compressed air foam system (CAFS) compressor

16.13.2.1.5 All structural enclosures, such as floorboards, gratings, grilles, and heat shields, not furnished with a means for opening them in service shall be kept in place during the tests.

16.13.2.2 Equipment.

16.13.2.2.1 Suction Hose.

16.13.2.2.1.1 The suction hose size and maximum number of lines during the apparatus pump system certification testing shall be as defined in Table 16.13.2.2.1.1.

Table 16.13.2.2.1.1 Suction Hose Size and Number of Suction Lines for Fire Pumps

Rated Capacity		Maximum Suction Hose Size		
gpm	L/min	in.	mm	Maximum Number of Suction Lines*
250	1,000	3	75	1
300	1,100	3	75	1
350	1,300	4	100	1

Table 16.13.2.2.1.1 Suction Hose Size and Number of Suction Lines for Fire Pumps

Rated Capacity		Maximum Suction Hose Size		
gpm	L/min	in.	mm	Maximum Number of Suction Lines*
500	2,000	4	100	1
750	3,000	4½	110	1
1,000	4,000	6	150	1
1,250	5,000	6	150	1
1,500	6,000	6	150	2
1,750	7,000	6	150	2
2,000	8,000	6	150	2
2,000	8,000	8	200	1
2,250	9,000	6	150	3
2,250	9,000	8	200	1
2,500	10,000	6	150	3
2,500	10,000	8	200	1
3,000	12,000	6	150	4
3,000	12,000	8	200	2
3,500	14,000	6	150	4
3,500	14,000	8	200	2
4,000	16,000	6	150	4
4,000	16,000	8	200	2

*Where more than one suction line is used, all suction lines do not have to be the same hose size.

16.13.2.2.1.2 A suction strainer and hose that will allow flow with total friction and entrance loss not greater than that specified in Table 16.2.4.1(b) or Table 16.2.4.1(c) shall be used.

16.13.2.2.2 Sufficient fire hose shall be provided to discharge the rated capacity of the pump to the nozzles or other flow measuring equipment without exceeding a flow velocity of 35 ft/sec (10 m/sec) [approximately 500 gpm (2000 L/min) for 2½ in. (65 mm) hose].

16.13.2.2.3 Where nozzles are used, they shall be smoothbore, and the inside diameters shall be from ¾ in. to 2½ in. (19 mm to 63.5 mm).

16.13.2.2.4 Test Gauges.

16.13.2.2.4.1 All test gauges shall meet the requirements for Grade A gauges as defined in ASME B40.100 and shall be at least size 3½ per ASME B40.100.

16.13.2.2.4.2 A mercury manometer shall be permitted to be used in lieu of a pump intake gauge.

16.13.2.2.4.3 The pump intake gauge shall have a range of 30 in. Hg (100 kPa) vacuum to zero for a vacuum gauge or 30 in. Hg (100 kPa) vacuum to a gauge pressure of 150 psi (1000 kPa) for a compound gauge.

16.13.2.2.4.4 The discharge pressure gauge shall have a gauge pressure range of 0 psi to 400 psi (0 kPa to 2800 kPa).

16.13.2.2.4.5 Pitot gauges shall have a gauge pressure range of at least 0 psi to 160 psi (0 kPa to 1100 kPa).

16.13.2.2.4.6 All gauges shall be calibrated in the month preceding the tests using a dead-weight gauge tester or a master gauge meeting the requirements for Grade 3A or 4A gauges, as defined in ASME B40.100, that has been calibrated within the preceding year.

16.13.2.2.5 Each test gauge connection shall include a means for "snubbing," such as a needle valve to damp out rapid needle movements.

16.13.2.2.6* The engine speed–measuring equipment shall consist of a nonadjustable tachometer supplied from the engine or transmission electronics, a revolution counter on a checking shaft outlet and a stop watch, or other engine speed–measuring means that is accurate to within ±50 rpm of actual speed.

16.13.2.3 Procedure.

16.13.2.3.1* The ambient air temperature, water temperature, vertical lift, elevation of test site, and atmospheric pressure (corrected to sea level) shall be determined and recorded prior to and after each pump test.

16.13.2.3.2* The engine, pump, transmission, and all parts of the apparatus shall exhibit no undue heating, loss of power, or other defect during the entire test.

16.13.2.3.3 Engine Speed Check.

16.13.2.3.3.1 A check of the no-load governed speed of the engine shall be made and recorded.

16.13.2.3.3.2 If the engine speed is not within 2 percent of the rated no-load governed speed as recorded on the manufacturer engine curve, the manufacturer shall adjust the engine speed to within acceptable limits.

16.13.2.3.4 If the apparatus is equipped with a fire pump rated at 750 gpm (3000 L/min) or greater but not greater than 3000 gpm (12,000 L/min), the pump shall be subjected to a 3-hour pumping test from draft consisting of 2 hours of continuous pumping at rated capacity at a minimum of 150 psi (1000 kPa) net pump pressure, followed by ½ hour of continuous pumping at 70 percent of rated capacity at a minimum of 200 psi (1400 kPa) net pump pressure and ½ hour of continuous pumping at 50 percent of rated capacity at a minimum of 250 psi (1700 kPa) net pump pressure.

16.13.2.3.4.1 The pump shall not be stopped until after the 2-hour test at rated capacity, unless it becomes necessary to clean the suction strainer.

16.13.2.3.4.2 The pump shall be permitted to be stopped between tests in order to change the hose or nozzles, clean the strainer, or add fuel for the pump drive engine.

16.13.2.3.4.3 The capacity, discharge pressure, intake pressure, and engine speed shall be recorded at least every 15 minutes but not fewer than three times for each test sequence.

16.13.2.3.4.4 The average net pump pressure shall be calculated and recorded based on the average values for discharge and intake pressure.

16.13.2.3.5 If the apparatus is equipped with a fire pump rated at greater than 3000 gpm (12,000 L/min), the pump shall be subjected to a 3-hour pumping test from draft consisting of 2 hours of continuous pumping at rated capacity at a minimum of 100 psi (700 kPa) net pump pressure, followed by ½ hour of continuous pumping at 70 percent of rated capacity at a minimum of 150 psi (1000 kPa) net pump pressure and ½ hour of continuous pumping at 50 percent of rated capacity at a minimum of 200 psi (1400 kPa) net pump pressure.

16.13.2.3.5.1 The pump shall not be stopped until after the 2-hour test at rated capacity, unless it becomes necessary to clean the suction strainer.

16.13.2.3.5.2 The pump shall be permitted to be stopped between tests in order to change the hose or nozzles, clean the strainer, or add fuel for the pump drive engine.

16.13.2.3.5.3 The capacity, discharge pressure, intake pressure, and engine speed shall be recorded at least every 15 minutes but not fewer than three times for each test sequence.

16.13.2.3.5.4 The average net pump pressure shall be calculated and recorded based on the average values for discharge and intake pressure.

16.13.2.3.6 If the apparatus is equipped with a fire pump rated at less than 750 gpm (3000 L/min), the pump shall be subjected to a 50-minute pumping test from draft consisting of 30 minutes of continuous pumping at rated capacity at a minimum of 150 psi (1000 kPa) net pump pressure, followed by 10 minutes of continuous pumping at 70 percent of rated capacity at a minimum of 200 psi (1400 kPa) net pump pressure, and 10 minutes of continuous pumping at 50 percent of rated capacity at a minimum of 250 psi (1700 kPa) net pump pressure.

16.13.2.3.6.1 The pump shall not be stopped until after the 30-minute test at rated capacity, unless it becomes necessary to clean the suction strainer.

16.13.2.3.6.2 The pump shall be permitted to be stopped between tests in order to change the hose or nozzles or clean the strainer.

16.13.2.3.6.3 The capacity, discharge pressure, intake pressure, and engine speed shall be recorded at least every 10 minutes but not fewer than three times for each test sequence.

16.13.2.3.6.4 The average net pump pressure shall be calculated and recorded based on the average values for discharge and intake pressure.

16.13.3 Pumping Engine Overload Test. If the pump has a rated capacity of 750 gpm (3000 L/min) or greater but not greater than 3000 gpm (12,000 L/min), the apparatus shall be subjected to an overload test consisting of pumping rated capacity at 165 psi (1100 kPa) net pump pressure for at least 10 minutes.

16.13.3.1 This test shall be performed immediately following the pumping test of rated capacity at 150 psi (1000 kPa).

16.13.3.2 The capacity, discharge pressure, intake pressure, and engine speed shall be recorded at least three times during the overload test.

16.13.4 Pressure Control System Test.

16.13.4.1 If the pump is rated at 3000 gpm (12,000 L/min) or less, the pressure control system on the pump shall be tested as follows:

(1) The pump shall be operated at draft, delivering rated capacity at a discharge gauge pressure of 150 psi (1000 kPa).

(2) The pressure control system shall be set in accordance with the manufacturer's instructions to maintain the discharge gauge pressure at 150 psi (1000 kPa) ± 5 percent.

(3) All discharge valves shall be closed not more rapidly than in 3 seconds and not more slowly than in 10 seconds.

(4) The rise in discharge pressure shall not exceed 30 psi (200 kPa) and shall be recorded.

(5) The original conditions of pumping rated capacity at a discharge gauge pressure of 150 psi (1000 kPa) shall be re-established.

(6) The discharge pressure gauge shall be reduced to 90 psi (620 kPa) by throttling the engine fuel supply, with no change to the discharge valve settings, hose, or nozzles.

(7) The pressure control system shall be set according to the manufacturer's instructions to maintain the discharge gauge pressure at 90 psi (620 kPa) ± 5 percent.

(8) All discharge valves shall be closed not more rapidly than in 3 seconds and not more slowly than in 10 seconds.

(9) The rise in discharge pressure shall not exceed 30 psi (200 kPa) and shall be recorded.

(10) The pump shall be operated at draft, pumping 50 percent of rated capacity at a discharge gauge pressure of 250 psi (1700 kPa).

(11) The pressure control system shall be set in accordance with the manufacturer's instructions to maintain the discharge gauge pressure at 250 psi (1700 kPa) ± 5 percent.

(12) All discharge valves shall be closed not more rapidly than in 3 seconds and not more slowly than in 10 seconds.

(13) The rise in discharge pressure shall not exceed 30 psi (200 kPa) and shall be recorded.

16.13.4.2 If the pumping system is rated at greater than 3000 gpm (12,000 L/min), the pressure control system on the pump shall be tested as follows:

(1) The pump shall be operated at draft, delivering rated capacity at a discharge gauge pressure of 100 psi (700 kPa).

(2) The pressure control system shall be set in accordance with the manufacturer's instructions to maintain the discharge gauge pressure at 100 psi (700 kPa) ± 5 percent.

(3) All discharge valves shall be closed not more rapidly than in 3 seconds and not more slowly than in 10 seconds.

(4) The rise in discharge pressure shall not exceed 30 psi (200 kPa) and shall be recorded.

(5) The original conditions of pumping rated capacity at a discharge gauge pressure of 150 psi (1000 kPa) shall be re-established.

(6) The pump shall be operated at draft, pumping 50 percent of rated capacity at a discharge gauge pressure of 200 psi (1400 kPa).

(7) The pressure control system shall be set in accordance with the manufacturer's instructions to maintain the discharge gauge pressure at 200 psi (1400 kPa) ± 5 percent.

(8) All discharge valves shall be closed not more rapidly than in 3 seconds and not more slowly than in 10 seconds.

(9) The rise in discharge pressure shall not exceed 30 psi (200 kPa) and shall be recorded.

16.13.5 Priming System Tests. With the apparatus set up for the pumping test, the primer shall be operated in accordance with the manufacturer's instructions until the pump has been primed and is discharging water.

16.13.5.1 This test shall be permitted to be performed in connection with priming the pump for the pumping test.

16.13.5.2 The interval from the time the primer is started until the time the pump is discharging water shall be noted.

16.13.5.3 The time required to prime the pump shall not exceed 30 seconds if the rated capacity is 1250 gpm (5000 L/min) or less.

16.13.5.4 The time required to prime the pump shall not exceed 45 seconds if the rated capacity is 1500 gpm (6000 L/min) or more.

16.13.5.5 An additional 15 seconds shall be permitted in order to meet the requirements of 16.13.5.3 and 16.13.5.4 when the pump system includes an auxiliary 4 in. (100 mm) or larger intake pipe having a volume of 1 ft^3 (0.03 m^3) or more.

16.13.5.5.1 The additional 15 seconds shall not apply to valved intake pipes such that when the valve is closed, the pipe volume between the fire pump and the valve is reduced to less than 1 ft^3 (0.03 m^3).

16.13.6 Vacuum Test. The vacuum test shall consist of subjecting the interior of the pump, with all intake valves open, all intakes capped or plugged, and all discharge caps removed, to a vacuum of 22 in. Hg (75 kPa) by means of the pump priming system.

16.13.6.1 At altitudes above 2000 ft (600 m), the vacuum attained shall be permitted to be less than 22 in. Hg (75 kPa) by 1 in. Hg (3.4 kPa) for each 1000 ft (300 m) of altitude above 2000 ft (600 m).

16.13.6.2 The primer shall not be used after the 5-minute test period has begun.

16.13.6.3 The engine shall not be operated at any speed greater than the governed speed during this test.

16.13.6.4 The vacuum shall not drop more than 10 in. Hg (34 kPa) in 5 minutes.

16.13.6.5* The vacuum test shall then be repeated with all intake valves closed and the caps or plugs on all gated intakes removed.

16.13.7 Water Tank–to–Pump Flow Test.

16.13.7.1 A water tank–to–pump flow test shall be conducted as follows:

(1) The water tank shall be filled until it overflows.

(2) All intakes to the pump shall be closed.

(3) The tank fill line and bypass cooling line shall be closed.

(4) A hose line(s) and nozzle(s) for discharging water at the rated tank-to-pump flow rate shall be connected to one or more discharge outlets.

(5) The tank-to-pump valve(s) and the discharge valve(s) leading to the hose line(s) and nozzle(s) shall be fully opened.

(6) The engine throttle shall be adjusted until the required flow rate -0/+5 percent is established *(see 18.3.2)*.

(7) The discharge pressure shall be recorded.

(8) The discharge valves shall be closed and the water tank refilled.

(9) The bypass cooling line shall be permitted to be opened temporarily, if needed, to keep the water temperature in the pump within acceptable limits.

(10) The discharge valves shall be fully reopened and the time noted.

(11) If necessary, the engine throttle shall be adjusted to maintain the discharge pressure recorded as noted in 16.13.7.1(7).

(12) When the discharge pressure drops by 10 psi (70 kPa) or more, the time shall be noted and the elapsed time from the opening of the discharge valves shall be calculated and recorded.

16.13.7.2 Volume Discharge Calculation.

16.13.7.2.1 The volume discharged shall be calculated by multiplying the rate of discharge in gallons per minute (liters per minute) by the time in minutes elapsed from the opening of the discharge valves until the discharge pressure drops by at least 10 psi (70 kPa).

16.13.7.2.2 Other means shall be permitted to be used to determine the volume of water pumped from the tank, such as a totalizing flowmeter, weighing the fire apparatus before and after, or refilling the tank using a totalizing flowmeter.

16.13.7.3 The rated tank-to-pump flow rate shall be maintained until 80 percent of the rated capacity of the tank has been discharged.

16.13.8* Engine Speed Advancement Interlock Test. The engine speed advancement interlock system shall be tested to verify that engine speed cannot be increased at the pump operator's panel unless there is throttle-ready indication.

16.13.8.1 If the apparatus is equipped with a stationary pump driven through split-shaft PTO, the test shall verify that the engine speed control at pump operator's panel cannot be advanced when either of the following conditions exists:

(1) The chassis transmission is in neutral, the parking brake is off, and the pump shift in the driving compartment is in the road position.

(2) The chassis transmission has been placed in the position for pumping as indicated on the label provided in the driving compartment, the parking brake is on, and the pump shift in the driving compartment is in the road position.

16.13.8.2 If the apparatus is equipped with a stationary pump driven through a transmission mounted PTO, front-of-engine crankshaft PTO, or engine flywheel PTO, the test shall verify that the engine speed control on the pump operator's panel cannot be advanced when either of the following conditions exists:

(1) The chassis transmission is in neutral, the parking brake is off, and the pump shift status in the driving compartment is disengaged.

(2) The chassis transmission is in any gear other than neutral, the parking brake is on, and the pump shift in the driving compartment is in the "Pump Engaged" position.

16.13.8.3 If the apparatus is equipped with a pump driven by the chassis engine designed for both stationary pumping and pump-and-roll, the test shall verify that the engine speed control at pump operator's panel cannot be advanced when either of the following conditions exists:

(1) The chassis transmission is in neutral, the parking brake is on, and the pump shift status in the driving compartment is disengaged.

(2) The chassis transmission is in any gear other than neutral, the parking brake is on, and the pump shift in the driving compartment is in the "Pump Engaged" or the "OK to Pump & Roll" position.

16.13.8.4 If the apparatus is equipped with a stationary pump driven through transfer case PTO, the test shall verify that the engine speed control on the pump operator's panel cannot be advanced when one of the following conditions exists:

(1) The chassis transmission is in neutral, the transfer case is in neutral, the parking brake is off, and the pump shift in the driving compartment is in the road position.

(2) The chassis transmission is in neutral, the transfer case is engaged, the parking brake is off, and the pump shift in the driving compartment is in the road position.

(3) The chassis transmission has been placed in the position for pumping as indicated on the label provided in the driving compartment, the parking brake is on, and the pump shift in the driving compartment is in the road position.

16.13.9 Gauge and Flowmeter Test.

16.13.9.1 Pump intake and discharge pressure gauges shall be checked for accuracy while pumping at rated capacity at 150 psi (1000 kPa).

16.13.9.2 Any gauge that is off by more than 10 psi (70 kPa) from the calibrated test gauge shall be recalibrated, repaired, or replaced.

16.13.9.3 Each flowmeter shall be checked for accuracy while pumping water at rated capacity at 100 psi (700 kPa).

16.13.9.4 Any flowmeter that is off by more than 10 percent shall be recalibrated, repaired, or replaced.

16.13.10* Manufacturer's Predelivery Test.

16.13.10.1 The manufacturer shall conduct a piping hydrostatic test prior to delivery of the apparatus.

16.13.10.2 The test shall be conducted as follows:

(1) The pump and its connected piping system shall be hydrostatically tested to a gauge pressure of 250 psi (1700 kPa).

(2) The hydrostatic test shall be conducted with the tank fill line valve, the bypass line valve if so equipped, and the tank-to-pump valve closed.

(3) All discharge valves shall be open and the outlets capped.

(4) All intake valves shall be closed, and nonvalved intakes shall be capped.

(5) This pressure shall be maintained for 3 minutes.

Chapter 17 Auxiliary Pumps and Associated Equipment

17.1* Application.

If the apparatus is equipped with an auxiliary pump, the provisions of this chapter shall apply.

17.2 Pump Performance.

17.2.1 Auxiliary pumps shall be rated as either high pressure or medium pressure.

17.2.2 The performance of a high pressure auxiliary pump shall be a minimum of 66 gpm (250 L/min) at 600 psi (4000 kPa) discharge pressure for each high pressure hose reel connected to it that can be operated simultaneously with other high pressure hose reels.

17.2.3 Medium Pressure Auxiliary Pumps.

17.2.3.1 The pump shall have one of the following rated capacities: 30 gpm (115 L/min), 60 gpm (230 L/min), 90 gpm (345 L/min), 120 gpm (460 L/min), 250 gpm (1000 L/min), or 350 gpm (1300 L/min).

17.2.3.2 The pump shall be capable of pumping 100 percent of its rated capacity at 150 psi (1000 kPa) discharge pressure, 70 percent of its rated capacity at 200 psi (1400 kPa) discharge pressure, and 50 percent of its rated capacity at 250 psi (1700 kPa) discharge pressure.

17.2.4 The rating for auxiliary pumps shall be based on the pump taking water from the apparatus water tank.

17.2.5 Where an auxiliary pump is provided in combination with a fire pump and the pumps are interconnected so that pressure from one pump can be transmitted to the other pump, check valves, intake or discharge relief valves, pump drive gear ratios, or other automatic means shall be provided to avoid pressurizing either pump beyond its maximum hydrostatic test pressure.

17.3* Power Train Capability.

17.3.1* All components in the power train from the engine to the pump shall be capable of transmitting the continuous duty power required by the pump for at least 50 minutes at the pump's rated capacity and pressure.

17.3.2* When pumping rated capacity and pressure, lubricant temperatures in any power train component shall not exceed the component manufacturer's recommendation for maximum temperature.

17.4 Construction Requirements.

The pump, piping, and valves shall be capable of withstanding a minimum hydrostatic pressure of 100 psi (700 kPa) above the maximum pump close off pressure.

17.5 Pump Intakes.

17.5.1* Each pump intake shall be sized to permit the full rated performance of the pump and shall be equipped with a valve that can be controlled from the pump operator's position.

17.5.2 Each external intake shall be equipped with National Hose threads on the connection, a removable or accessible strainer, and a bleeder valve to bleed off air or water from a hose connected to the intake.

17.5.2.1 Adapters with special threads or other means for hose attachment shall be permitted on any intake connection.

17.5.2.2 All intake connections shall be provided with closures capable of withstanding a hydrostatic gauge pressure of 500 psi (3400 kPa).

17.5.2.2.1 Intake connections having male threads shall be equipped with caps; intake connections having female threads shall be equipped with plugs.

17.5.2.2.2 Where adapters for special threads or other means for hose attachment are provided on the intake connections, closures shall be provided for the adapters in lieu of caps or plugs.

17.5.2.3 Caps or closures for intake connections smaller than 4 in. (100 mm) shall remain secured to the apparatus when removed from the connection.

17.6* Pump Discharges.

17.6.1 Each pump discharge shall be equipped with a valve that can be controlled from the pump operator's position.

17.6.2 Any discharge that can be supplied from both the auxiliary pump and the fire pump shall have check valves in both supply lines to prevent backflow into the other pump.

17.6.3 Discharge Outlet Connections.

17.6.3.1* All discharge outlet connections shall be equipped with male National Hose threads.

17.6.3.2 Adapters with special threads or other means for hose attachment shall be permitted to be attached to any discharge outlet connection.

17.6.4 All discharge outlet connections, except connections to which a hose will be preconnected, shall be equipped with caps or closures capable of withstanding a hydrostatic gauge pressure of 100 psi (700 kPa) over the maximum pump close-off pressure or 500 psi (3400 kPa), whichever is greater.

17.6.4.1 Where adapters are provided on the discharge outlet connection, the closures shall fit on the adapters.

17.6.4.2 Caps or closures for outlet connections smaller than 4 in. (100 mm) shall remain secured to the apparatus when removed from the connection.

17.6.5 If a water tank fill line is provided, the line shall be connected from the pump discharge manifold directly to the water tank and shall include a valve that can be controlled from the pump operator's position.

17.7 Pump Operator's Panel.

17.7.1 Each pump control, gauge, and other instrument necessary to operate the auxiliary pump shall be located on a panel known as the pump operator’s panel and shall be marked with a label as to its function.

17.7.2 All gauges, instruments, discharge outlets, pump intakes, and controls located on the auxiliary pump operator's panel shall be illuminated in compliance with 4.10.1.

17.8 Pump Controls.

17.8.1 Controls shall be provided for placing the pump in operation.

17.8.2 The control for the pump engagement mechanism shall be marked with a label to indicate when the pump is properly engaged in pumping position.

17.8.3 Parallel/Series Control.

17.8.3.1 With parallel/series centrifugal pumps, the positions for parallel operation (volume) and series operation (pressure) shall be indicated.

17.8.3.2 The control for changing the pump from series to parallel, and vice versa, shall be located on the pump operator's panel.

17.8.4 If more than one discharge outlet is provided, a relief valve or other pressure control device shall be provided that is capable of limiting the pump discharge pressure.

17.8.5 All pump controls and devices shall be installed so as to be protected against mechanical damage or the effects of adverse weather conditions on their operation.

17.8.6 Drain Valve(s).

17.8.6.1 A readily accessible drain valve(s) that is marked with a label as to its function shall be provided to allow the pump and all water-carrying lines and accessories to be drained.

17.8.6.2 The drain valve(s) shall be operational without the operator having to get under the apparatus.

17.8.7 A bypass line of not less than ¼ in. (6.4 mm) diameter that has a valve that can be controlled from the pump operator's position or an automatic-type control shall be installed from the discharge manifold directly to the water tank or ground.

17.9 Pump Drive Systems.

17.9.1 Where the pump is driven by a transmission-mounted (SAE) PTO, front-of-engine crankshaft PTO, or flywheel PTO, the provisions of 16.10.4 through 16.10.7 shall apply as applicable.

17.9.2 Where the pump is driven by a chassis transmission-mounted (SAE) PTO and the pump system does not conform to 16.4.2, a visible or audible warning device shall be provided on the pump operator's panel that is actuated if the temperature of the lubricant in the chassis transmission exceeds the transmission manufacturer's recommended maximum temperature.

17.9.3* If a separate pumping engine is provided, it shall meet the requirements of 12.2.1.1, 12.2.1.2, 12.2.1.7, 12.2.2, 12.2.3.1, 12.2.3.2, 12.2.4 through 12.2.6, Section 13.2, 13.4.3, 13.4.4, 13.4.4.1, 13.4.4.3, 13.4.4.4, 13.4.5, Section 13.5, and Section 13.6.

17.9.4 Where a separate engine is used to drive the auxiliary pump, an amber indicator light marked with a label that reads “Pump Engine Running” shall be provided in the driving compartment and shall be energized when the pump engine is running.

17.10 Engine Controls.

17.10.1 A throttle control that holds its set position shall be provided to control the engine speed. It shall be located so that it can be manipulated from the pump operator's position with all instrumentation in full view.

17.10.2 This throttle control shall be permitted to be the same throttle control that is used for the main fire pump.

17.11 Gauges and Instruments.

17.11.1 Master Pump Discharge Pressure Gauge. A master discharge pressure gauge shall be provided.

17.11.1.1 It shall read from a gauge pressure of 0 to at least 300 psi (2100 kPa) but not less than 100 psi (700 kPa) higher than the maximum pressure that can be developed by the pump when it is operating with zero intake pressure.

17.11.1.2 Where an analog pressure gauge is used, it shall have a minimum accuracy of Grade 1A as defined in ASME B40.100, *Pressure Gauges and Gauge Attachments*.

17.11.1.2.1 Numerals for master gauges shall be a minimum 0.25 in. (6.4 mm) high.

17.11.1.2.2 There shall be graduation lines showing at least every 10 psi (50 kPa), with major and intermediate graduation lines emphasized and figures at least every 100 psi (500 kPa).

17.11.1.2.3 Analog pressure gauges shall be vibration and pressure pulsation dampened; be resistant to corrosion, condensation, and shock; and have internal mechanisms that are factory lubricated for the life of the gauge.

17.11.1.3 If a digital pressure gauge is used, the digits shall be at least 0.25 in. (6.4 mm) high.

17.11.1.3.1 Digital pressure gauges shall display pressure in increments of not more than 10 psi (50 kPa).

17.11.1.3.2 Digital master pressure gauges shall have an accuracy of ±3 percent over the full scale.

17.11.1.4 Master discharge pressure gauges shall be checked for accuracy while pumping at rated capacity. Any gauge that is off by more than 10 psi (70 kPa) from the calibrated test gauge shall be recalibrated, repaired, or replaced.

17.11.2 Discharge Outlet Instrumentation. If the apparatus is equipped with 1½ in. (38 mm) or larger discharge outlets that can be supplied only by the auxiliary pump, these discharge outlets shall be equipped with pressure gauges or flowmeters.

17.11.2.1 The pressure gauge or flowmeter display shall be located adjacent to the corresponding valve control with no more than 6 in. (150 mm) separating the pressure gauge or flowmeter bezel and the valve control centerline.

17.11.2.2 Pressure gauges shall be connected to the outlet side of the valve.

17.11.2.3 Flowmeters shall display flow in increments not greater than 10 gpm (50 L/min).

17.11.2.4 Where an analog pressure gauge is used, the gauge shall have a minimum accuracy of Grade B as defined in ASME B40.100, *Pressure Gauges and Gauge Attachments*.

17.11.2.4.1 Numerals for gauges shall be a minimum $\frac{5}{32}$ in. (4 mm) high.

17.11.2.4.2 There shall be graduation lines showing at least every 10 psi (50 kPa), with major and intermediate graduation lines emphasized and figures at least every 100 psi (500 kPa).

17.11.2.4.3 Analog pressure gauges shall be vibration and pressure pulsation dampened; be resistant to corrosion, condensation, and shock; and have internal mechanisms that are factory lubricated for the life of the gauge.

17.11.2.5 If a digital pressure gauge is used, the digits shall be at least 0.25 in. (6.4 mm) high.

17.11.2.5.1 Digital pressure gauges shall display pressure in increments of not more than 10 psi (50 kPa).

17.11.2.5.2 Digital pressure gauges shall have an accuracy of ±3 percent over the full scale.

17.11.2.6 Discharge outlet pressure gauges shall be checked for accuracy while pumping at rated capacity. Any gauge that is off by more than 10 psi (70 kPa) from the calibrated test gauge shall be recalibrated, repaired, or replaced.

17.11.2.6.1 Each flowmeter shall be checked for accuracy while pumping water at rated capacity. Any flowmeter that is off by more than 10 percent shall be recalibrated, repaired, or replaced.

17.11.3 Protection of Gauges and Instruments. Each pressure gauge or flowmeter and its display shall be mounted and attached so they are protected from accidental damage and excessive vibration.

17.12 Testing.

The pump, piping, valves, and caps or plugs shall be hydrostatically tested to 100 psi (700 kPa) above the maximum pump close-off pressure, and the apparatus manufacturer shall certify the test results in writing.

Chapter 18 Water Tanks

18.1 Application.

If the fire apparatus is equipped with a water tank, the provisions of this chapter shall apply.

18.2 Tank Construction.

18.2.1 All water tanks shall be constructed of noncorrosive material or other materials that are protected against corrosion and deterioration.

18.2.2* The water tanks shall have a means to permit flushing of the tank.

18.2.3* If the water tank is independent of the body and compartments, it shall be equipped with a method for lifting the tank(s) off the chassis.

18.2.4 Tanks shall be cradled, cushioned, spring-mounted, or otherwise protected from undue stress resulting from travel on uneven terrain, in accordance with the tank manufacturer's requirements.

18.2.5* All water tanks shall be provided with baffles or swash partitions to form containment cells or dynamic water movement control.

18.2.5.1 If a containment method of baffling is used, the baffles shall meet the requirements of 18.2.5.1.1 through 18.2.5.1.4.

18.2.5.1.1 At least one baffle running longitudinal to the axis of the apparatus shall be provided in all water tanks.

18.2.5.1.2 At least one transverse baffle shall be provided in tanks of 100 gal (380 L) or more.

18.2.5.1.3 There shall be a maximum distance of 48 in. (1220 mm) between any combination of tank vertical walls and baffles or between parallel baffles.

18.2.5.1.4 Each baffle shall cover at least 75 percent of the area of the plane that contains the baffle.

18.2.5.2 If a dynamic method of partitioning is used, the baffles shall meet the requirements of 18.2.5.2.1 through 18.2.5.2.4.

18.2.5.2.1 The tank shall contain vertical transverse and longitudinal partitions.

18.2.5.2.2 The vertical partitions shall be secured to the top and bottom of the tank.

18.2.5.2.3 The longitudinal partitions shall extend a minimum of 75 percent of the tank length.

18.2.5.2.4 The partitions shall be arranged in such a manner that the vertical plane of each partition shall create cells no dimension of which shall exceed 48 in. (1220 mm).

18.2.6 Cleanout Sumps.

18.2.6.1 One or more cleanout sumps shall be provided.

18.2.6.2 A 3 in. (75 mm) or larger removable pipe plug shall be furnished in each sump.

18.2.6.3 If the sump is used for the tank-to-pump line connection, the design shall prevent sludge or debris in the sump from entering the pump.

18.2.7 Water Level Indicator.

18.2.7.1 An indicator shall be provided that shows the level or amount of water in the tank(s).

18.2.7.2 If the apparatus is not equipped with a pump, the indicator shall be visible at the inlet valve position.

18.3 Tank-to-Pump Intake Line.

18.3.1 If the apparatus is equipped with a pump, the water tank shall be connected to the intake side of the pump with a valve controlled at the pump operator's position.

18.3.2 Tank-to-Pump Flow Rate.

18.3.2.1 If the water tank has a certified capacity of less than 500 gal (2000 L), the piping and valve arrangement shall be capable of delivering water to the pump at a minimum rate of 250 gpm (1000 L/min).

18.3.2.2 If the water tank has a certified capacity of 500 gal (2000 L) or greater, the piping and valve arrangement shall be capable of delivering water to the pump at a minimum rate of 500 gpm (2000 L/min) or the rated capacity of the pump, whichever is less.

18.3.2.3 The flow required by 18.3.2.1 and 18.3.2.2 shall be sustainable while pumping a minimum of 80 percent of the certified tank capacity with the apparatus on level ground.

18.3.3* An automatic means shall be provided in the tank-to-pump line that prevents unintentional backfilling of the water tank through that line.

18.3.4 Connections or outlets from the tank(s) to the pump shall be designed to prevent air from being entrained while pumping water from the tank.

18.4 Filling and Venting.

18.4.1* Fill Opening. A readily accessible, covered fill opening designed to prevent spillage shall be provided.

18.4.1.1* The fill opening shall have a minimum inside diameter of 3¼ in. (83 mm).

18.4.1.2 The cover shall be marked with a label that reads “Water Fill.”

18.4.1.3 A screen that is easily removed and cleaned shall be installed in the opening.

18.4.1.4* The cover or another device shall open as a vent to release pressure buildup in the tank.

18.4.2 Vent/Overflow Outlet.

18.4.2.1 A vent/overflow outlet that is sized to allow water to be drawn from the tank at a rate at least equal to that required in 18.3.2 shall be provided.

18.4.2.2* The vent/overflow outlet shall be designed to direct any water to behind the rear axle so as not to interfere with rear tire traction.

18.4.3 Tank Fill Line. If the apparatus is equipped with a pump, a valved tank fill line shall be provided.

18.4.3.1* Where the water tank has a capacity of 1000 gal (4000 L) or less, the tank fill line shall be at least 1 in. (25 mm) nominal inside diameter.

18.4.3.2* Where the water tank has a capacity greater than 1000 gal (4000 L), the fill line shall be at least 2 in. (52 mm) nominal inside diameter.

18.4.3.3* The valve shall be capable of regulating flow and shall be controllable from the pump operator's position.

18.5 Mobile Water Supply Apparatus.

If the apparatus is designed to be a mobile water supply apparatus, the requirements of this section shall apply.

18.5.1 External Fill. An external fill connection leading directly to the tank shall be provided.

18.5.1.1* The external fill connection shall permit a minimum filling rate of 1000 gpm (4000 L/min) from sources external to the unit.

18.5.1.2 The external fill connection shall be provided with a removable or accessible strainer, a shutoff valve capable of being throttled, a minimum 30-degree sweep elbow positioned downward, and a closure cap or plug.

18.5.1.3 Any 3 in. (75 mm) or larger valve shall be a slow-operating valve.

18.5.1.4 A check-type device shall be permitted to be substituted for the modulating and slow-operating valve in those operations where the flow rate is to be controlled at the source.

18.5.2* Water Transfer. Single or multiple tank connections that meet the requirements of 18.5.2.1 and 18.5.2.2 shall be provided.

18.5.2.1 The tank connection(s) shall be capable of allowing water to be transferred from the tank to an external use to the right, left, and rear of the fire apparatus.

18.5.2.2* Each tank connection shall be capable of emptying 90 percent of the tank capacity at a minimum average rate of 1000 gpm (4000 L/min) with the apparatus on level ground.

18.6 Water Tank Capacity Certification.

18.6.1* The manufacturer shall certify the capacity of the water tank prior to delivery of the apparatus.

18.6.2 The certified capacity shall be recorded on the manufacturer's record of construction *(see 4.20.1)*, and the certification shall be delivered with the fire apparatus.

Chapter 19 Aerial Devices

19.1* General Requirements.

19.1.1 If the apparatus is equipped with an aerial ladder, the aerial device and apparatus shall meet the requirements of Sections 19.2 through 19.6 and Sections 19.17 through 19.25.

19.1.2 If the apparatus is equipped with an elevating platform, the aerial device and apparatus shall meet the requirements of Sections 19.7 through 19.12 and Sections 19.17 through 19.25.

19.1.3 If the apparatus is equipped with a water tower, the aerial device and apparatus shall meet the requirements of Sections 19.13 through 19.25.

19.2 Aerial Ladder Requirements.

19.2.1 The aerial ladder shall consist of two or more ladder sections that, together with the steps and platforms on the apparatus body, provide continuous egress for fire fighters and civilians from an elevated position to the ground.

19.2.2 The rated vertical height of an aerial ladder shall be at least 50 ft (15 m) and shall be measured vertically with the ladder at maximum elevation and extension from the outermost rung of the outermost fly section to the ground.

19.2.3* The rated horizontal reach of an aerial ladder shall be measured in a horizontal plane from the centerline of the turntable rotation to the outermost rung on the outermost fly section with the aerial ladder extended to its maximum horizontal reach.

19.2.4 Height and reach dimensions shall be taken with the aerial ladder mounted on a chassis meeting the aerial manufacturer's minimum recommended fire apparatus specifications, with the fire apparatus on level ground, and with the stabilizers fully deployed.

19.2.5 The ladder rungs shall be equally spaced on a maximum 14 in. (350 mm) centers and minimum 11¾ in. (300 mm) centers and shall have a skid-resistant surface or covering.

19.2.5.1 Where covering is provided, it shall not twist and shall cover at least 60 percent of the length of each rung.

19.2.5.2 Where round rungs are furnished, the rungs shall have a minimum outside diameter of 1¼ in. (32 mm), including the skid-resistant surface or covering.

19.2.5.3 Where rungs other than round are furnished, they shall have a cross-sectional area not less than 1.2 in.^{2} (775 mm^2); a maximum outside dimension of the cross-sectional area (height or width) of 3.2 in. (81 mm), including the skid-resistant surface or covering; and a minimum outside dimension of ¾ in. (19 mm), including the skid-resistant surface or covering.

19.2.5.4 The minimum design load for each rung shall be 500 lb (227 kg) distributed over a 3½ in. (89 mm) wide area at the center of the length of the rung with the rung oriented in its weakest position.

19.2.6 There shall be a minimum of 18 in. (460 mm) in width inside the aerial ladder between the rails measured at the narrowest point, excluding any mounted equipment.

19.2.7 Obstructions Below the Ladder.

19.2.7.1 Where a solid obstruction below the ladder is wider than 12 in. (300 mm), a minimum clearance of 7 in. (180 mm) between the centerline of the rung and the obstruction shall be provided.

19.2.7.2 Where the solid obstruction below the centerline of the ladder is 12 in. (300 mm) or less in width, the standoff between the centerline of the rung and the obstruction shall be permitted to be less than 7 in. (180 mm), provided there is at least 6 in. (150 mm) of rung width and 7 in. (180 mm) of depth below the centerline of the rung on each side of the obstruction.

19.2.8 Top rails shall be provided on the ladder, shall have a minimum width of 1 in. (25 mm), and shall be at a minimum height of 12 in. (300 mm) above the centerline of the rungs, excluding the outermost two rungs of the outermost fly section.

19.2.9 Two folding steps with surfaces that meet the skid-resistant requirements of 15.7.4 shall be provided on the ladder for use by the ladder pipe–monitor operator.

19.2.9.1 Each folding step shall have a minimum design load of 500 lb (227 kg) and shall be a minimum of 35 in.^{2} (22,500 mm^2) in area.

19.2.9.2 A single step that has a minimum design load of 500 lb (227 kg) and a minimum area of 100 in.^{2} (65,000 mm^2) shall be permitted to be used in place of the two steps.

19.2.10 Provisions shall be made so that personnel working on the ladder can attach fall protection harnesses.

19.2.11 The apparatus shall be equipped with steps that meet the skid resistance requirements of 15.7.4 or with rungs that provide a path at any degree of elevation from the bottom rung of the aerial ladder to the ground.

19.2.11.1 Steps, with the exception of the ground to the first step, shall be spaced on no more than 18 in. (460 mm) centers.

19.2.11.2 Handrails shall be provided within reach at each step location.

19.2.12 With the stabilizers set, the aerial ladder shall be capable of being raised from the bedded position to maximum elevation and extension and rotated 90 degrees.

19.2.12.1 Two or more of these functions shall be permitted to be performed simultaneously.

19.2.12.2 The functions described in 19.2.12 shall be accomplished within 120 seconds if the aerial ladder has a rated vertical height of 110 ft (34 m) or less.

19.2.12.3 The functions described in 19.2.12 shall be accomplished within 180 seconds if the aerial ladder has a rated vertical height over 110 ft (34 m).

19.2.13* Where a breathing air system is provided, it shall meet the requirements of 19.2.13.1 through 19.2.13.8.

19.2.13.1 If a secondary operator's position is provided, the breathing air system shall provide air for a minimum of one person at the secondary operator's position.

19.2.13.2 The system shall include storage for at least 200 ft^3 (5660 L) of breathing air and shall meet the requirements of Section 24.5.

19.2.13.3 Piping System.

19.2.13.3.1 All components of the piping system shall be designed for a pressure rating of three times the working pressure that they are expected to carry.

19.2.13.3.2 The piping system shall be arranged with a high pressure regulator at the air supply that shall limit the air pressure in the piping up the aerial device to the pressure required to supply 125 psi (862 kPa) at the outlet point.

19.2.13.3.3 All piping, valves, and components shall be fabricated of corrosion-resistant materials and shall be sized for the number of outlets provided at the secondary aerial ladder operator's position.

19.2.13.3.4 A pressure relief valve set to relieve the pressure at 1½ times the working pressure of the piping system in the event of regulator failure shall be provided on the downstream side of the high pressure regulator.

19.2.13.4 Damage Prevention.

19.2.13.4.1 All valves, pressure regulators, and gauges shall be protected from accidental damage.

19.2.13.4.2 The piping or hose system between the air cylinder(s) and the secondary aerial ladder operator's position shall be installed so as to prevent damage due to abrasion, bending, pinching, or exposure to excessive heat.

19.2.13.5 Holders shall be provided for the storage of the breathing air equipment when it is not in use.

19.2.13.6 A low air warning system shall be provided that will monitor the air volume and provide an audible and visual warning at both the upper and lower control stations when the air volume is at or below 20 percent.

19.2.13.7 The quality of the breathing air shall meet the requirements of NFPA 1989, *Standard on Breathing Air Quality for Emergency Services Respiratory Protection*.

19.2.13.8 All components of the system that the breathing air will be in contact with shall be cleaned of oil, grease, contaminants, and foreign material.

19.3 Aerial Ladder Rated Capacity.

19.3.1 The rated capacity of the aerial ladder shall be a minimum load of 250 lb (114 kg) carried on the outermost rung of the outermost fly section with the aerial ladder placed in the horizontal position at maximum horizontal extension and with the stabilizers fully deployed.

19.3.1.1 The minimum rated capacity shall remain constant throughout the entire operating envelope of the aerial ladder.

19.3.1.2 The aerial ladder shall be capable of operating in any position while carrying its rated capacity on the outermost rung of the outermost fly section.

19.3.1.3 If the aerial ladder has a permanently mounted water delivery system, the 250 lb (114 kg) rated capacity shall be determined without water in the system.

19.3.2 The rated capacity of the aerial ladder shall be a minimum load of 250 lb (114 kg) carried on the outermost rung of the outermost fly section with the aerial ladder at 45 degrees to the horizontal and at maximum extension while discharging water at rated capacity through the full range of monitor or nozzle movements as permitted by the aerial manufacturer.

19.3.3 Rated capacities in excess of 250 lb (114 kg) shall be stated in increments of 250 lb (114 kg) and shall be in addition to any fire-fighting equipment installed on the aerial ladder by the manufacturer.

19.3.4* If the aerial ladder is rated in multiple configurations, the manufacturer shall describe these configurations, including the rated capacity of each, in both the operations manual and on a label at the operator's control station.

19.4 Aerial Ladder Operating Position.

19.4.1 Indicating devices that are lighted and marked with a label shall be visible from the operator's position and shall indicate the following:

(1) That the rungs are aligned for climbing

(2) That the aerial ladder is aligned with the travel bed

19.4.2 A system that is lighted and marked with labels shall be visible from the operator's position to indicate the elevation, extension, and rated capacities.

19.4.3 Voice Communication System.

19.4.3.1* A weather-resistant two-way voice communication system shall be provided between the aerial ladder operator's position and the tip of the ladder.

19.4.3.2 The speaker/microphone at the tip shall allow for hands-free operation.

19.5 Aerial Ladder Operating Mechanisms.

19.5.1 Elevation. A power-operated system for elevating and lowering the aerial ladder under all the rated conditions of loading shall be provided.

19.5.1.1 Where hydraulic components are utilized, they shall meet the requirements of Section 19.19 and shall be designed to prevent damage at the top and bottom limits.

19.5.1.2 An automatic locking device(s) shall be provided so that the desired elevated position can be maintained.

19.5.1.3 A locking device shall be provided that will retain the aerial ladder in the bed when the fire apparatus is in motion.

19.5.2 Rotation. A power-operated turntable shall be provided that will allow continuous rotation in either direction under all the rated conditions of loading.

19.5.2.1* The turntable rotation bearing shall be accessible for lubrication and retorquing of bolts.

19.5.2.2 The turntable rotation mechanism shall be equipped with an automatically applied brake or self-locking drive that provides sufficient braking capacity when all power systems are nonfunctioning, to prevent turntable rotation under all rated conditions of loading.

19.5.3 Extension. A power-operated system for extending and retracting the fly section(s) under all rated conditions of loading shall be provided.

19.5.3.1 Where hydraulic components are utilized, they shall meet the requirements of Section 19.19.

19.5.3.2 An automatic locking device shall be provided so that the desired position of extension can be maintained.

19.5.3.3 Rollers, pulleys, and roller guides shall be equipped with self-lubricating bearings or readily accessible grease fittings.

19.5.3.4 Slide pads, rollers, and bearings, when used, shall be readily accessible for replacement.

19.5.3.5 When wire ropes or chains are used to extend the ladder sections, the system shall be redundant with a minimum of two wire ropes or chains used per ladder section.

19.5.3.6 A means shall be provided to prevent damage to the extension system at full retraction or full extension.

19.5.4* Secondary Operator's Position. If a secondary aerial ladder operator's position is located at the tip of the outermost fly section, the following shall apply:

(1) The lower control shall override the aerial tip control station.

(2) The lower control station shall have a momentary switch that enables the tip controls when closed and disables the tip controls when opened or released.

(3) The maximum speed of the ladder functions measured at the tip shall be as follows when operated from the tip control station:

 (a) Rotation at 2 ft/sec (0.6 m/sec), when fully extended at 0 degrees elevation

 (b) Elevation and lowering at 1 ft/sec (0.3 m/sec)

 (c) Extension and retraction at 0.5 ft/sec (0.15 m/sec)

(4) The step(s) for the tip operator shall be designed to keep the operator's feet from protruding through the outermost fly section.

19.6* Aerial Ladder Water Delivery System.

Where a prepiped waterway is provided, 19.6.1 through 19.6.10 shall apply.

19.6.1 The waterway system shall be capable of flowing 1000 gpm (4000 L/min) at 100 psi (700 kPa) nozzle pressure at full elevation and extension.

19.6.2 For ladders with a rated vertical height of 110 ft (34 m) or less, the friction loss (total system loss less head loss) between the monitor outlet and a point below the waterway swivel shall not exceed 100 psi (700 kPa) at 1000 gpm (4000 L/min) flow with the ladder at full horizontal extension.

19.6.3 A preset relief valve that is capable of protecting the waterway system by relieving pressure through the dumping of water to the environment shall be provided.

19.6.3.1 Such dumping shall be through a system of piping terminating in an area away from the operator's position.

19.6.3.2 The discharge end of the piping shall not have a threaded connection.

19.6.4 A permanently attached monitor shall be provided.

19.6.4.1 The monitor shall be capable of swiveling at least 135 degrees from a line parallel to the ladder and down.

19.6.4.2 The monitor shall be capable of horizontal traverse at least 45 degrees from each side of center.

19.6.4.3 Positive stops shall be provided to prevent the swivel or traverse of the monitor from exceeding the aerial ladder manufacturer's recommendation.

19.6.4.4 If a power-operated monitor is provided, the primary controls shall be at the aerial operator's position, and those controls shall be capable of overriding all other monitor controls.

19.6.4.5* A permanently installed monitor/nozzle shall not obstruct access to or from the tip of the ladder.

19.6.5 A 1000 gpm (4000 L/min) nozzle shall be furnished.

19.6.6* The water system shall be arranged so it can be supplied at ground level through an external inlet that is a minimum of 4 in. (100 mm) in size.

19.6.7 If the apparatus is equipped with a fire pump capable of supplying the required flow and pressure, a permanent valved connection shall be provided between the pump and the waterway system.

19.6.8 A flowmeter shall be installed in the waterway, with a display on either the pump operator's panel or the aerial ladder operator's control panel.

19.6.9* A 1½ in. (38 mm) minimum drain valve shall be provided at the low point of the waterway inlet system.

19.6.10 If the apparatus has a fire pump and normal operations are to supply the waterway through the pump, a cap meeting the requirements of 16.7.4 shall be provided on the external inlet.

19.7 Elevating Platform Requirements.

19.7.1 The elevating platform shall consist of an elevated tower of two or more booms or sections equipped with a passenger-carrying platform(s) assembly.

19.7.2 The rated vertical height of the elevating platform shall be measured vertically from the top surface of the platform handrail to the ground, with the platform raised to its position of maximum elevation.

19.7.3* The rated horizontal reach of the elevating platform shall be measured in a horizontal plane from the centerline of the turntable rotation to the outer edge of the platform handrail, with the elevating platform extended to its maximum horizontal reach.

19.7.4 Height and reach dimensions shall be measured with the elevating platforms mounted on a chassis meeting the elevating platform manufacturer's minimum recommended fire apparatus specifications, with the fire apparatus on level ground, and with the stabilizers fully deployed.

19.7.5 Where the rated vertical height of the elevated platform is 110 ft (34 m) or less, the elevating platform, with stabilizers set, shall be capable of being raised from the bedded position to maximum elevation and extension and rotated 90 degrees within 150 seconds. Two or more of these functions shall be permitted to be performed simultaneously.

19.7.6 Platform Construction.

19.7.6.1 The platform shall have a minimum floor area of 14 ft^2 (1.3 m^2).

19.7.6.2 A continuous guard railing, a minimum of 42 in. (1070 mm) high, shall be provided on all sides.

19.7.6.2.1 The railing shall be constructed so there are no horizontal or vertical openings below it greater than 24 in. (610 mm) in either dimension.

19.7.6.2.2 There shall be a minimum of two gates providing access to the platform.

19.7.6.2.3 Each gate shall be provided with a self-engaging latch.

19.7.6.2.4 The use of a vertical opening or inward opening, self-closing gate or door for access to and from the platform shall be permitted to meet the continuous railing requirement.

19.7.6.3 A kick plate of not less than 4 in. (100 mm) high shall be provided around the floor and shall be permitted to swing with the gate.

19.7.6.4 The steps and the floor of the platform shall be provided with skid-resistant surfaces that meet the requirements of 15.7.4.

19.7.6.5 Drain openings shall be provided to prevent water accumulation on the platform floor.

19.7.6.6 Heat Shield.

19.7.6.6.1 A heat-reflective shield shall be provided on the front, sides, and bottom of the platform.

19.7.6.6.2 If necessary, openings for the movement and operation of the water monitor shall be permitted in the front heat shield.

19.7.6.7 Water Curtain System.

19.7.6.7.1 A water curtain system capable of providing a cooling spray under the entire floor of the platform and flowing a minimum of 75 gpm (284 L/min) shall be provided.

19.7.6.7.2 The system shall be controlled by a single, quick-acting valve with an actuator accessible from the platform.

19.7.6.8 Provisions shall be made so that personnel working on the platform can attach fall protection harnesses.

19.7.7 Where a breathing air system is provided, it shall supply breathing air for a minimum of two persons on the platform and shall meet the requirements of 19.7.7.1 through 19.7.7.7.

19.7.7.1 The system shall include storage for at least 400 ft^3 (11,320 L) of breathing air and shall meet the requirements of Section 24.5.

19.7.7.2 Piping System.

19.7.7.2.1 All components of the piping system shall be designed for a pressure rating of three times the working pressure that they are expected to carry.

19.7.7.2.2 The piping system shall be arranged with a high pressure regulator at the air supply that shall limit the air pressure in the piping up the aerial device to the pressure required to supply 125 psi (862 kPa) at the outlet point.

19.7.7.2.3 All piping, valves, and components shall be fabricated of corrosion-resistant materials and shall be sized for the number of outlets provided in the platform.

19.7.7.2.4 A pressure relief valve set to relieve the pressure at 1½ times the working pressure of the piping system in the event of regulator failure shall be provided on the downstream side of the high pressure regulator.

19.7.7.3 Damage Prevention.

19.7.7.3.1 All valves, pressure regulators, and gauges shall be protected from accidental damage.

19.7.7.3.2 The piping or hose system between the air cylinder(s) and the platform shall be installed so as to prevent damage due to abrasion, bending, pinching, or exposure to excessive heat.

19.7.7.4 Holders shall be provided for the storage of the breathing air equipment when it is not in use.

19.7.7.5 A low air warning system shall be provided that monitors the air volume and provides an audible and visual warning at both the upper and lower control stations when the air volume is at or below 20 percent.

19.7.7.6 The quality of the breathing air shall meet the requirements of NFPA 1989, *Standard on Breathing Air Quality for Emergency Services Respiratory Protection*.

19.7.7.7 All components of the system that the breathing air will be in contact with shall be cleaned of oil, grease, contaminants, and foreign material.

19.8 Elevating Platform Rated Capacity.

19.8.1 The rated capacity of the elevating platform shall be a minimum of 750 lb (340 kg), with no water in the water delivery system, with the elevating platform placed in the horizontal position at maximum horizontal extension, and with the stabilizers fully deployed.

19.8.2 The rated capacity of the elevating platform shall be a minimum of 500 lb (227 kg) with the water delivery system full of water but not discharging, with the elevating platform placed in the horizontal position at maximum horizontal extension, and with the stabilizers fully deployed.

19.8.3 The elevating platform shall be capable of operating in any position while carrying its rated capacity.

19.8.4 The elevating platform shall be capable of delivering a minimum of 1000 gpm (4000

L/min) from the platform with the booms or sections and the monitors and nozzles positioned in any configuration allowed by the manufacturer while carrying a minimum load of 500 lb (227 kg) on the platform.

19.8.5 All rated capacities shall be stated in increments of 250 lb (114 kg) and shall be in addition to any fire-fighting equipment installed on the elevating platform by the manufacturer.

19.8.6 If the elevating platform is rated in multiple configurations, the manufacturer shall describe these configurations, including the rated capacity of each, in the operations manual and on the labels at the operator's control stations.

19.9 Elevating Platform Operating Positions.

19.9.1 There shall be two control stations, one to be known as the platform control station and the other as the lower control station.

19.9.1.1 All operational controls shall be operable from both of these positions.

19.9.1.2 The lower control station shall be located so as to facilitate the operator's observation of the platform while at the controls.

19.9.1.3 The lower station controls shall be capable of overriding the platform station controls.

19.9.2 Voice Communication System.

19.9.2.1* A weather-resistant two-way voice communication system shall be provided between the platform control station and the lower control station.

19.9.2.2 The speaker/microphone at the platform control station shall allow for hands-free operation.

19.10 Elevating Platform Operating Mechanisms.

19.10.1* Power-operated elevating and extending devices designed and powered to allow multiple movements of the elevating platform booms or sections simultaneously under all rated conditions of loading shall be provided.

19.10.1.1 Where hydraulic components are utilized, they shall meet the requirements of Section 19.19.

19.10.1.2 An automatic locking device(s) shall be provided so that the desired elevated position can be maintained.

19.10.1.3 Provisions shall be made to prevent damage at the top and bottom limits of elevation and extension.

19.10.2 An automatic platform-leveling system shall be provided so that the platform, together with its rated load, is supported and maintained level in relation to the turntable or horizontal regardless of the positions of the booms or sections.

19.10.3 A power-operated turntable shall be provided that allows continuous rotation in either direction under all the rated conditions of loading.

19.10.3.1* The turntable rotation bearing shall be accessible for lubrication and retorquing of bolts.

19.10.3.2 The turntable rotation mechanism shall be equipped with an automatically applied brake or self-locking drive that provides sufficient braking capacity when all power systems are nonfunctioning, to prevent turntable rotation under all rated conditions of loading.

19.10.4 A locking device shall be provided that will retain the elevating platform booms or sections in the bed when the fire apparatus is in motion.

19.11 Ladders on the Elevating Platform.

19.11.1 If the raising and extending booms or sections incorporate a ladder or ladder sections, the ladder shall meet the requirements of 19.2.1, 19.2.5 through 19.2.8, 19.2.10, 19.2.11, and Section 19.4.

19.11.2 The transition step between the top rung of the ladder and the platform shall not be greater than 18 in. (457 mm).

19.12 Elevating Platform Water Delivery System.

On elevating platforms of 110 ft (34 m) or less rated vertical height, a permanent water delivery system shall be installed.

19.12.1 The water delivery system shall be capable of delivering 1000 gpm (4000 L/min) at 100 psi (700 kPa) nozzle pressure with the elevating platform at its rated vertical height.

19.12.2 Friction loss (total system loss less head loss) between the monitor outlet and a point below the waterway swivel shall not exceed 100 psi (700 kPa) at a flow of 1000 gpm (4000 L/min).

19.12.3 One or more permanently installed monitors with nozzles capable of discharging 1000 gpm (4000 L/min) shall be provided on the platform.

19.12.3.1 The monitor(s) shall be supplied by the permanent water system.

19.12.3.2 The monitor(s) shall allow the operator to control the aimed direction of the nozzle through a rotation of at least 45 degrees on either side of center and at least 45 degrees above and below horizontal.

19.12.3.3 The horizontal and vertical traverse of the monitors shall not exceed the elevating platform manufacturer's recommendation.

19.12.3.4* A slow-operating valve shall be provided at the base of any monitor.

19.12.4 If a hose connection is provided, it shall be a minimum 2½ in. (65 mm) nominal diameter valved connection.

19.12.5* The water system shall be arranged so it can be supplied at ground level through an external inlet that is a minimum of 4 in. (100 mm) in size.

19.12.6 If the apparatus is equipped with a fire pump capable of supplying the required flow and pressure, a permanent valved connection shall be provided between the pump and the waterway system.

19.12.7 A flowmeter shall be installed in the waterway with at least one display on the pump operator's panel or at the elevating platform operator's position.

19.12.8 A preset relief valve capable of protecting the waterway system by relieving pressure through the dumping of water to the environment shall be provided.

19.12.8.1 Such dumping shall be through a system of piping terminating in an area away from the operator's position.

19.12.8.2 The discharge end of the piping shall not have a threaded connection.

19.12.9 Waterway Drains.

19.12.9.1* A 1½ in. (38 mm) minimum drain valve shall be provided at the low point of the waterway system.

19.12.9.2 Additional drains shall be provided to drain any portions of the waterway that do not drain to the low point of the system.

19.12.10 If the apparatus has a pump and normal operations are to supply the waterway through the pump, a cap meeting the requirements of 16.7.4 shall be provided on the external inlet.

19.13 Water Tower Requirements.

19.13.1 The water tower shall consist of two or more booms designed to telescope, articulate, or both and a waterway designed to supply a large capacity elevated water stream.

19.13.2 The rated vertical height of the water tower shall be measured vertically from the discharge end of the nozzle to the ground, with the nozzle raised to its position of maximum elevation.

19.13.3* The rated horizontal reach of the water tower shall be measured in a horizontal plane from the centerline of the turntable rotation to the end of the nozzle, with the water tower extended to its maximum horizontal reach.

19.13.4 Height and reach dimensions shall be taken with the water tower mounted on a chassis meeting the water tower manufacturer's minimum recommended fire apparatus specifications, the fire apparatus on level ground, and stabilizers deployed in accordance with the manufacturer's instructions.

19.13.5 The water tower, with stabilizers set if required, shall be capable of being raised from the bedded position to maximum elevation and extension and rotated 90 degrees within 105 seconds. Two or more of these functions shall be permitted to be performed simultaneously.

19.14 Water Tower Rated Capacity.

19.14.1 The water tower shall be capable of delivering a minimum water stream of 1000 gpm (4000 L/min) at 100 psi (700 kPa) from the water tower nozzle with the booms or sections and nozzle positioned in any configuration permitted by the manufacturer.

19.14.2 The rated capacity shall include the weight of the charged waterway and the maximum nozzle reaction force.

19.14.3 If the water tower is rated in multiple configurations, the manufacturer shall describe these configurations, including the rated capacity of each, in the operations manual and on the label at the operator's control station.

19.15 Water Tower Operating Mechanisms.

19.15.1 Power-operated elevating and extending devices shall be provided.

19.15.1.1 They shall be so designed and powered to allow multiple movements of the water tower booms or sections simultaneously under all rated conditions of loading.

19.15.1.2 Where hydraulic components are utilized, they shall meet the requirements of Section 19.19.

19.15.1.3 An automatic locking device(s) shall be provided so that the desired elevated position can be maintained.

19.15.1.4 Provisions shall be made to prevent damage at the top and bottom limits of elevation and extension.

19.15.2 A lock shall be provided that will retain the water tower booms or sections in the bed when the fire apparatus is in motion.

19.15.3 If the water tower has a rated water delivery capacity of 3500 gpm (14,000 L/min) or less, a power-operated turntable shall be provided that will allow continuous rotation in either direction under all rated conditions of loading.

19.15.3.1* The turntable rotation bearing shall be accessible for lubrication and retorquing of bolts.

19.15.3.2 The turntable rotation mechanism shall be provided with an automatically applied brake or self-locking drive that is capable of preventing turntable rotation under all rated conditions of loading when all power systems are nonfunctioning.

19.16 Water Tower Water Delivery System.

19.16.1 A permanent water system shall be installed capable of delivering 1000 gpm (4000 L/min) at 100 psi (700 kPa) nozzle pressure with the water tower and nozzle positioned in any configuration permitted by the manufacturer.

19.16.2 For water towers with a rated vertical height of 110 ft (34 m) or less, the friction loss (total system loss less head loss) between the monitor outlet and a point below the waterway swivel shall not exceed 100 psi (700 kPa) at a flow of 1000 gpm (4000 L/min).

19.16.3 A permanently installed monitor with a nozzle(s) capable of a discharge rate of at least 1000 gpm (4000 L/min) shall be provided at the top of the water tower and supplied by the permanent water system.

19.16.3.1 The monitor shall be powered so as to allow the operator(s) to control its aimed direction.

19.16.3.2 If the water tower has a rated water delivery capacity of 3500 gpm (14,000 L/min) or less, the monitor, as distinct from the supporting boom, shall allow the operator to control the aimed direction of the nozzle through a rotation of at least 45 degrees either side of center and at least 30 degrees above and 135 degrees below the centerline of the boom.

19.16.3.3 The horizontal and vertical traverse of the monitor shall not exceed the water tower manufacturer's recommendation.

19.16.4 If a variable pattern spray nozzle is provided, a control shall be provided at the operator's position to select the desired stream pattern.

19.16.5* The water system shall be arranged so it can be supplied at ground level through an external inlet that is a minimum of 4 in. (100 mm) in size.

19.16.6 If the apparatus is equipped with a fire pump capable of supplying the required flow and pressure, a permanent valved connection shall be provided between the pump and the waterway system.

19.16.7 A flowmeter shall be installed in the water delivery system with the display on either the pump operator's panel or the water tower operator's control panel.

19.16.8 A preset relief valve capable of protecting the waterway system by relieving pressure through the dumping of water to the environment shall be provided.

19.16.8.1 Such dumping shall be through a system of piping terminating in an area away from the operator's position.

19.16.8.2 The discharge end of the piping shall not have a threaded connection.

19.16.9* A 1½ in. (38 mm) minimum drain valve shall be provided at the low point of the waterway system.

19.16.10 If the apparatus has a pump and normal operations are to supply the waterway through the pump, a cap meeting the requirements of 16.7.4 shall be provided on the external inlet.

19.17 Control Devices.

19.17.1 Controls shall be provided at the driver's position to transfer power to the aerial device.

19.17.2 A visual signal shall be provided at the driver's position to indicate when the operating mechanisms are engaged.

19.17.3 An interlock shall be provided that prevents operation of the aerial device until the parking brakes have been set and the transmission has been placed in neutral or the transmission is in the drive position with the driveline to the rear axle disengaged.

19.17.4 A power-operated governed engine speed control shall be provided to limit the operating speed of the aerial device apparatus engine to within the operating parameters as determined by the manufacturer and this standard.

19.17.4.1 An interlock shall be provided that allows operation of the engine speed control only after the parking brakes have been set and the transmission is in neutral.

19.17.4.2 Where the apparatus is equipped with a fire pump, any high idle speed control shall be automatically disengaged when the fire pump is operating.

19.17.5 An interlock system shall be provided to prevent the following:

(1) Rotation of the aerial device before the stabilizer(s) is in a configuration to meet the stability requirements of Section 19.21

(2) Movement of the stabilizers unless the aerial device is in the travel position

(3) Operation of the aerial device into an unstable position when the aerial device can be operated with the stabilizers not fully deployed on at least one side of the vehicle

19.17.6 Controls at the operator's position shall be lighted, marked with a label, and conveniently arranged.

19.17.6.1 These controls shall allow the operator to perform the following:

(1) Elevate and lower the aerial device

(2) Extend and retract the aerial device, if applicable

(3) Rotate the aerial device in either direction, if applicable

(4) Operate the intercom, if applicable

19.17.6.2 A method shall be provided to prevent unintentional movement of the aerial device.

19.17.6.3 Each control shall allow the operator to regulate the speed of elevation, extension, and rotation of the aerial device within the limits determined by the manufacturer and this standard.

19.17.6.4 Each control shall be arranged so it can be operated by an operator with a gloved hand without disturbing any other control(s).

19.17.6.5 For aerial devices that can be operated over the side with the stabilizers not fully deployed, an indicator shall be located at the operator's position to allow the operator to determine the maximum extension in relation to the angle of elevation and the extended length of the stabilizers.

19.17.7 Where a three-lever system is used to control the basic functions of the aerial device, the levers shall be distinctively different from the other controls on the panel and arranged adjacent to each other, with the extension control being the left lever, the rotation control being the center lever, and the elevation control being the right lever, as shown in Figure 19.17.7.

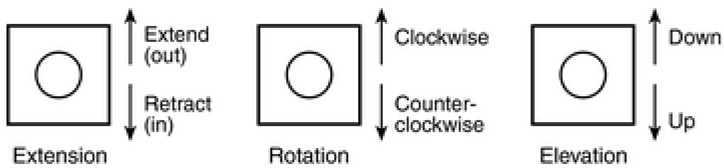


FIGURE 19.17.7 Control Lever Arrangement.

19.17.7.1 The aerial device shall extend when the extension control is pushed up or forward (away from the operator).

19.17.7.2 If the rotation control has a forward/backward orientation or an up/down orientation, the turntable shall rotate clockwise when the rotation control is pushed up or forward (away from the operator). Otherwise, the rotational control handle shall move in the direction of rotation.

19.17.7.3 The aerial device shall lower when the elevation control is pushed up or forward (away from the operator).

19.17.8 Where a multifunction control lever is furnished, it shall move in the direction of the function it controls, where possible.

19.17.9 Where a two-lever system is used, the extension control shall be to the left, and a combination lever for rotation and elevation shall be to the right.

19.17.10 All controls regulating the movement of the aerial device shall automatically return to the neutral position upon release by the operator.

19.17.11 When electric over hydraulic aerial device controls are incorporated, a readily accessible, manual means of overriding the electric controls shall be provided.

19.18 Safety.

19.18.1* If the operator's position is on the turntable, the turntable platform shall be provided with a railing at least 42 in. (1070 mm) high.

19.18.1.1 The railing design shall be capable of withstanding a force of 225 lbf (1000 N) applied at any point from any direction without permanent deformation.

19.18.1.2 Where the operator's position is equipped with an operator's seat, the seat shall be provided with a railing or an armrest capable of withstanding a force of 225 lbf (1000 N) applied at any point from the inside of the seat.

19.18.2* Any aerial device operator's position at ground level shall be arranged so that the operator is not in contact with the ground.

19.18.3 A sign(s) shall be placed at any ground level operator's position to warn the operator(s) of electrocution hazards.

19.18.4 Where the aerial device includes moving cylinders or other moving parts, these shall be arranged so as to provide hand clearance, or hand guards shall be provided to prevent injury to the operator.

19.18.5 Lighting shall be provided at the base of the aerial device and shall be arranged to illuminate the aerial device in any position of operation.

19.18.6 A spotlight of not less than 75,000 beam cp (75,000 lumens per steradian) or a floodlight of not less than 10,500 lumens shall be provided on the apparatus by which the operator shall be able to observe the effect of the stream from the ladder pipe or monitor nozzle.

19.18.7 Provisions shall be made so that in the event of failure of the primary operating power source, an auxiliary source of power shall be readily available that is capable of returning the aerial device to the road travel position.

19.18.8 Where the operation of the aerial device is accomplished by hydraulic means, the system shall prevent motion of the aerial device in the event of any hydraulic hose failure.

19.18.9 Where the operation of the aerial device is accomplished by means other than hydraulic, the system shall be designed to prevent motion of the aerial device in the event of a power failure.

19.18.10 All components used to stabilize the apparatus on which the aerial device is mounted shall be designed to prevent instability in the event of a hydraulic hose failure or a power failure.

19.18.11 Where the design of the aerial device incorporates a knuckle, the knuckle shall be as follows:

(1) Equipped with position lights or continuously illuminated by boom lights

(2) Painted with reflective paint or provided with retroreflective striping

19.19 Hydraulic System.

19.19.1 The nonsealing moving parts of all hydraulic components whose failure results in motion of the aerial device shall have a minimum bursting strength of four times the maximum operating pressure to which the component is subjected.

19.19.1.1 Dynamic sealing parts of all hydraulic components whose failure results in motion of the aerial device shall not begin to extrude or otherwise fail at pressures at or below two times the maximum operating pressure to which the component is subjected.

19.19.1.2 Static sealing parts of all hydraulic components whose failure results in motion of the aerial device shall have a minimum bursting strength of four times the maximum operating pressure to which the component is subjected.

19.19.2 All hydraulic hose, tubing, and fittings shall have a minimum bursting strength of at least three times the maximum operating pressure to which the components are subjected.

19.19.3 All other hydraulic components shall have a minimum bursting strength of at least two times the maximum operating pressure to which the components are subjected.

19.19.4 The hydraulic system shall be provided with an oil pressure gauge at the lower operating position.

19.19.5 Hydraulic Reservoir.

19.19.5.1 A means for checking and filling the hydraulic reservoir shall be readily accessible.

19.19.5.2 The fill location shall be conspicuously marked with a label that reads “Hydraulic Oil Only.”

19.19.5.3 The manufacturer shall provide instructions for checking and filling the hydraulic reservoir.

19.19.6 The hydraulic system components shall be capable of maintaining, under all operating conditions, oil cleanliness and temperature that comply with the component manufacturer's recommendations.

19.19.7* The hydraulic system shall have adequate cooling for continuous operation of not less than 2½ hours.

19.19.8 An hourmeter shall be provided that records any time the aerial device hydraulic system is engaged.

19.20 Structure.

19.20.1* All structural load–supporting elements of the aerial device that are made of a ductile material shall have a design stress of not more than 50 percent of the minimum yield strength of the material based on the combination of the rated capacity and the dead load, which is equivalent to a 2:1 safety factor.

19.20.2 All structural load–supporting elements of the aerial device that are made of a nonductile material shall have a design stress of not more than 20 percent of the minimum ultimate strength of the material, based on the combination of the rated capacity and the dead load, which is equivalent to a 5:1 safety factor.

19.20.3 Wire ropes, chains, and attaching systems used to extend and retract the fly sections or booms shall have a 5:1 safety factor based on ultimate strength under all operating conditions allowed by the manufacturer.

19.20.3.1 The factor of safety for the wire rope shall remain above 2:1 during any extension or retraction system stall.

19.20.3.2 The minimum ratio of the diameter of wire rope used to the diameter of the sheave used shall be 1:12.

19.21 Stabilization.

19.21.1* The stability requirements defined in 19.21.2 and 19.21.3 shall be met by the apparatus on which the aerial device is mounted when that apparatus is in a service-ready condition but with all normally removable items, such as water, hose, ground ladders, and loose equipment, removed.

19.21.1.1 Items mounted on the aerial device by the manufacturer shall remain mounted.

19.21.1.2 Stabilizers shall be provided, if required, to meet the stability requirements of 19.21.2 and 19.21.3.

19.21.2 The aerial device shall be capable of sustaining a static load 1½ times its rated capacity in every position in which the aerial device can be placed when the apparatus is on a firm and level surface.

19.21.3 Sloping Surface.

19.21.3.1 The aerial device shall be capable of sustaining a static load 1⅓ times its rated capacity in every position in which the aerial device can be placed when the apparatus is on a slope of 5 degrees (8.7 percent) downward in the direction most likely to cause overturning.

19.21.3.2 If other capabilities, such as a means of turntable leveling, are provided to minimize the effect of the sloping surface, those capabilities shall be permitted to be utilized for the purpose of determining whether the apparatus meets this stability requirement.

19.21.4 If a stabilizer system is provided, it shall meet the requirements of 19.21.4.1 through 19.21.4.4.

19.21.4.1 If the stabilizer system is power operated, the controls shall be arranged so that the operator can view the stabilizers in motion.

19.21.4.1.1 An audible alarm, of not less than 87 dBA measured at any position the stabilizer can be in, shall sound when a stabilizer is moving.

19.21.4.1.2 An indicator(s) shall be provided to denote when the apparatus is operable within the manufacturer's range of level conditions.

19.21.4.1.3 Where the rated vertical height of the aerial device is 110 ft (34 m) or less, all stabilizers shall be deployed from the stored position to the operating position within 90 seconds.

19.21.4.2 The ground contact area for each stabilizer shall be such that a unit pressure of not greater than 75 psi (500 kPa) will be exerted over the ground contact area when the apparatus is loaded to its maximum in-service weight and the aerial device is carrying its rated capacity in every position permitted by the manufacturer.

19.21.4.2.1 The requirement defined in 19.21.4.2 shall be permitted to be accomplished with stabilizer pads in conjunction with the permanently mounted stabilizer shoes to meet the loading requirement of 75 psi (500 kPa) or less.

19.21.4.2.2 At a minimum, the stabilizer shoe shall be capable of swiveling on an axis parallel to the longitudinal axis of the apparatus.

19.21.4.3 All stabilizers that protrude beyond the body of the apparatus shall be striped or painted with retroreflective material so as to indicate a hazard or obstruction.

19.21.4.4 All stabilizers that protrude beyond the body of the apparatus shall be provided with one or more red warning lights located either on the stabilizer or in the body panel above the stabilizer visible on the side of the apparatus where the stabilizer is located.

19.22 Quality Control.

19.22.1 The manufacturer and installer shall have in effect a complete and documented quality control program that will ensure complete compliance with the requirements of this standard.

19.22.2 The quality control program shall include 100 percent nondestructive testing (NDT) of all critical structural components of the aerial device.

19.22.2.1 The manufacturer shall determine the types of NDT to be conducted.

19.22.2.2 The procedures used for NDT shall comply with the applicable standards defined in 19.22.5.

19.22.2.3 All NDT procedures shall be fully documented with respect to the extent of the examination, the method of testing, and the inspection techniques.

19.22.2.4 All testing shall be performed by Level II or Level III NDT technicians or by Level 1 NDT technicians or trainees under the direct supervision of an onsite Level II or Level III NDT technician, all of whom have been certified in the test methods used in accordance with ASNT CP-189, *Standard for Qualification and Certification of Nondestructive Testing Personnel*.

19.22.2.5 Personnel certified under ASNT CP-189 shall be permitted to conduct NDT with limited certifications, so long as the certifications meet the training and experience requirements listed in Table 19.22.2.5 and any applicable requirements in Appendix B of ASNT CP-189. The personnel shall be certified as Limited Level II, and the certification card shall indicate that a limited certification has been issued in the given technique.

Table 19.22.2.5 Training and Experience Hours for Conducting Limited Level II Inspections

Evaluation Technique	Required Training (hr)	Minimum Required Experience in Method (hr)
Magnetic particle — ac yoke, visible dry powder	8	120
Liquid penetrant — water washable or solvent removable, visible dye, penetrant	8	100
Visual inspection — eye, aided by magnifiers and measuring tools	8	100
Ultrasonic straight beam (A-scan) flaw detection	40	60

19.22.3 Welder Certification.

19.22.3.1 Welds for all structural load–supporting elements shall be performed by certified welders under the guidelines of AWS D1.1, *Structural Welding Code — Steel*; AWS D1.2, *Structural Welding Code — Aluminum*; and AWS D1.3, *Structural Welding Code — Sheet Steel*.

19.22.3.2 Welding performed by fabricators and welders approved by the Canadian Welding Bureau to Canadian Standards Association (CSA) W47.1, *Certification of Companies for Fusion Welding of Steel*, or CSA W47.2, *Certification of Companies for Fusion Welding of Aluminum*, shall be considered equivalent to welding performed according to 19.22.3.1.

19.22.3.3 Welding performed by machines shall be considered equivalent to welding performed by certified welders.

19.22.4 The manufacturer and the installer shall establish applicable welding quality assurance procedures for all weldments.

19.22.4.1 Methods of NDT shall be described in the manufacturer's quality assurance procedures and shall be as recommended by AWS B1.10, *Guide for the Nondestructive Examination of Welds*.

19.22.4.2 The manufacturer shall designate the welds to be examined, the extent of examination, and the type of testing.

19.22.5 Nondestructive Testing Procedure.

19.22.5.1 All ultrasonic inspections shall be conducted in accordance with the following ASTM standards:

(1) ASTM E 114, *Standard Practice for Ultrasonic Pulse-Echo Straight-Beam Examination by the Contact Method*

(2) ASTM E 797, *Standard Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method*

19.22.5.2 All magnetic particle inspections shall be conducted in accordance with ASTM E 709, *Standard Guide for Magnetic Particle Testing.*

19.22.5.3 All liquid penetrant inspections shall be conducted in accordance with ASTM E 165, *Standard Test Method for Liquid Penetrant Examinations.*

19.22.5.4 All electrical conductivity measurements shall be conducted in accordance with ASTM E 1004, *Standard Practice for Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method*.

19.22.5.5 All hardness readings shall be conducted in accordance with the following ASTM standards:

(1) ASTM E 6, *Standard Terminology Relating to Methods of Mechanical Testing*

(2) ASTM E 10, *Standard Test Method for Brinell Hardness of Metallic Materials*

(3) ASTM E 18, *Standard Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials*

(4) ASTM E 92, *Standard Test Method for Vickers Hardness of Metallic Materials*

(5) ASTM B 647, *Standard Test Method for Indentation Hardness of Aluminum Alloys by Means of a Webster Hardness Gage*

(6) ASTM B 648, *Standard Test Method for Indentation Hardness of Aluminum Alloys by Means of a Barcol Impressor*

19.22.5.6 All acoustic emission inspections shall be conducted in accordance with the following ASTM standards:

(1) ASTM E 569, *Standard Practice for Acoustic Emission Monitoring of Structures During Controlled Stimulation*

(2) ASTM E 650, *Standard Guide for Mounting Piezoelectric Acoustic Emission Sensors*

19.23 Instruction Plates and Signs.

19.23.1 Instruction plates and signs that provide operational directions, warnings, and cautions shall be installed in positions visible to the operator(s).

19.23.1.1 Instruction plates shall describe the function and operation of each control.

19.23.1.2 Warning and caution signs shall indicate hazards inherent in the operation of the aerial device, including, but not limited to, the following:

(1) Electrical hazards where the aerial device does not provide protection to the personnel from contact with or proximity to an electrically charged conductor

(2) Electrical hazards where the aerial device does not provide protection to ground personnel who contact the apparatus when it is in contact with energized electrical conductors

(3) Hazards from stabilizer motion

(4) Hazards that can result from failure to follow manufacturer's operating instructions

19.23.2 Labels shall disclose the following information relative to the aerial device:

(1) Make

(2) Model

(3) Insulated or noninsulated

(4) Serial number

(5) Date of manufacture

(6) Rated capacity

(7) Rated vertical height

(8) Rated horizontal reach

(9) Maximum hydraulic system pressure, if applicable

(10) Hydraulic oil requirements (change quantity and type), if applicable

19.24 Certification Tests.

The completed apparatus with the aerial device shall be tested to the criteria defined in this section and the test results certified by an independent third-party certification organization. The certified test results shall be delivered with the fire apparatus.

19.24.1 The aerial device shall be inspected and tested in accordance with the requirements of Chapter 19, Performance Testing of Aerial Devices, of NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus*, including all NDT, prior to being subjected to the tests defined in 19.24.2 through 19.24.4.

19.24.2 Stability Test.

19.24.2.1 The apparatus on which the aerial device is mounted shall be in a service-ready condition and shall be placed on a firm, level surface.

19.24.2.2 All normally removable items, such as water, hose, ground ladders, and loose equipment, shall be removed, but items mounted on the aerial device by the manufacturer shall remain mounted.

19.24.2.3 If having the stabilizers extended is part of the configuration, the stabilizers shall be deployed to the point where the interlock system allows operation of the aerial device.

19.24.2.4 Systems that allow the aerial device to be operated over the side with the stabilizers not fully deployed shall be tested in three positions:

(1) Stabilizers at the minimum extension as defined by the manufacturer

(2) Stabilizers extended to midpoint of the minimum extension and full extension

(3) Stabilizers fully deployed

19.24.2.5 A load of 1½ times the rated capacity as specified by the manufacturer shall be suspended from the tip of the aerial ladder or from the platform of the elevating platform when it is in the position of least stability.

19.24.2.6 If the manufacturer specifies a rated capacity while water is flowing, then one times the water load and the worst-case nozzle reaction shall be added to the stability test weights.

19.24.2.7 For a water tower, the stability test shall include the weight of the water in the system and 1½ times the maximum nozzle reaction force when the aerial device is in the position of least stability.

19.24.2.8* The apparatus shall show no signs of instability, and the test shall not cause permanent deformation of any components.

19.24.2.9 The stability shall be further tested as defined in 19.24.2.9.1 through 19.24.2.9.6.

19.24.2.9.1 The apparatus that the aerial device is mounted on shall be placed on a firm surface sloping downward at 5 degrees (8.7 percent grade) in the direction most likely to cause overturning and shall be configured as defined in 19.24.2.2.

19.24.2.9.2 If having the stabilizers extended is part of the configuration, the stabilizers shall be deployed in accordance with the manufacturer's recommendations.

19.24.2.9.3 Systems that allow the aerial device to be operated over the side with the stabilizers not fully deployed shall be tested in three positions:

(1) Stabilizers at the minimum extension as defined by the manufacturer

(2) Stabilizers extended to midpoint of the minimum extension and full extension

(3) Stabilizers fully deployed

19.24.2.9.4 A load of 1⅓ times the rated capacity shall be suspended from the tip of the aerial ladder or the platform of the elevating platform when it is in the position of least stability.

19.24.2.9.5 For a water tower, the stability test shall include the weight of the water in the system and 1⅓ times the maximum nozzle reaction when it is in the position of least stability.

19.24.2.9.6 The apparatus shall show no signs of instability, and the test shall not cause permanent deformation of any components.

19.24.3 Horizontal Load Test.

19.24.3.1 With the aerial device out of the cradle in the fully extended position at zero degrees elevation, a test load shall be applied in a horizontal direction normal to the centerline of the ladder or boom.

19.24.3.1.1 For aerial devices with a prepiped waterway, a 350 lb (160 kg) test load shall be applied at the tip of the ladder or boom.

19.24.3.1.2 For aerial ladders without a prepiped waterway, a 220 lb (100 kg) test load shall be applied at the tip of the ladder or boom.

19.24.3.2 The turntable shall not rotate, and the ladder or boom shall not deflect beyond what the manufacturer's specification allows.

19.24.4 Aerial Device Water System Test.

19.24.4.1 If the aerial device is equipped with a permanent water system and has a rated vertical height of 110 ft (34 m) or less, standard model flow test data shall be delivered with the fire apparatus.

19.24.4.2 If the water system has been modified from the standard model configuration, a new flow test shall be conducted to determine that the friction loss in the water system between the base of the swivel and the monitor outlet does not exceed 100 psi (700 kPa) with 1000 gpm (4000 L/min) flowing and with the water system at full extension.

19.24.4.3 A flow test shall be conducted on each vehicle to determine that the water system is capable of flowing 1000 gpm (4000 L/min) at 100 psi (700 kPa) nozzle pressure with the aerial device at full elevation and extension.

19.24.4.3.1 Where the apparatus is equipped with a fire pump designed to supply the water system, the test shall be conducted using the onboard fire pump.

19.24.4.3.2 The intake pressure to the fire pump shall not exceed 20 psi (138 kPa).

19.25* Manufacturer's Predelivery Test.

If the aerial device is equipped with a permanent water delivery system, the manufacturer shall, prior to delivery of the apparatus, hydrostatically test the piping for the waterway system, including the monitor, at the maximum operating pressure required to flow 1000 gpm (4000 L/min) at 100 psi (700 kPa) nozzle pressure at maximum elevation and extension.

Chapter 20 Foam Proportioning Systems

20.1 Application.

20.1.1* If the fire apparatus is equipped with a proportioning system for foam or other water additives, it shall comply with the applicable sections of this chapter.

20.1.2 References in this chapter to foam proportioning systems shall include systems to proportion all water additives.

20.2* Requirements by Type of Foam Proportioning System.

20.2.1* Eductor System. An eductor foam proportioning system shall meet the requirements of 20.3.1 through 20.3.7, 20.3.9, and Sections 20.4 through 20.6 and 20.9 through 20.11.

20.2.2* Self-Educting Master Stream Nozzle. A self-educting master stream nozzle shall meet the requirements of Sections 20.3, 20.4, 20.6, and 20.9 through 20.11.

20.2.3* Intake-Side System. An intake-side foam proportioning system shall meet the requirements of Sections 20.3 through 20.6 and 20.9 through 20.11.

20.2.4* Around-the-Pump System. An around-the-pump foam proportioning system shall meet the requirements of Sections 20.3 through 20.6 and 20.9 through 20.11.

20.2.5* Balanced Pressure System. A balanced pressure foam proportioning system shall meet the requirements of Sections 20.3 through 20.11.

20.2.6* Direct Injection System. A direct injection foam proportioning system shall meet the requirements of Sections 20.3 through 20.7 and 20.9 through 20.11.

20.2.7* Water-Powered Direct Injection Foam Proportioning System. A water motor or water turbine foam proportioning system shall meet the requirements of Sections 20.3 through 20.7 and 20.9 through 20.11.

20.3 Design and Performance Requirements of a Foam Proportioning System.

20.3.1* The foam proportioning system shall be capable of proportioning foam concentrate(s) in accordance with the foam concentrate manufacturer's recommendations for the type of foam concentrate used in the system over the system's design range of flow and pressures.

20.3.2 The purchaser shall specify the following:

(1) Range of waterflows and pressures

(2) Proportioning rates

(3) Types of concentrate(s) (Class A, Class B, etc.)

(4) Brand and viscosity of concentrate

20.3.3 The fire apparatus shall be capable of supplying the power required by the foam proportioning system in addition to the requirements of the other power-dependent systems installed on the apparatus.

20.3.4* Components of the foam proportioning system that are continuously wetted with foam concentrate shall be constructed of materials that will not be damaged in form, fit, or function when exposed to foam concentrates, including the adverse effects of corrosion, formation of harmful solids, deterioration of gaskets and seals, binding of moving parts, and deterioration of the foam concentrate caused by contact with incompatible materials.

20.3.5 The foam proportioning system components that can be flushed with water after use shall be constructed of materials that do not corrode after being flushed with water and allowed to dry. These components shall also be constructed of materials resistant to deterioration by foam concentrates.

20.3.6 The foam concentrate supply line shall not collapse under any operating conditions specified by the manufacturer of the foam proportioning system.

20.3.7 A means shall be provided to prevent water backflow into the foam proportioning system and the foam concentrate storage tank.

20.3.8 A device that consists of a removable element that does not restrict the full flow capacity of the foam concentrate supply line shall be provided on the foam concentrate supply side of the foam proportioning system to prevent any debris that might affect the operation of the foam proportioning system from entering the system.

20.3.9 Flush Lines.

20.3.9.1 A flush line(s) shall be provided as required by the foam proportioning system manufacturer to flush foam concentrate from the system.

20.3.9.2 A means shall be provided in the flush line(s) to prevent water backflow into the foam concentrate tank or water tank during the flushing operation.

20.3.9.3 Where the foam proportioning system is connected to more than one foam concentrate storage tank, provisions shall be made to flush all common lines to avoid contamination of dissimilar foam concentrates.

20.4 Controls for Foam Proportioning Systems.

20.4.1* The foam proportioning system operating controls shall be located at the pump operator's position and shall be identified as required by 20.9.2.

20.4.2 Foam proportioning systems that require flushing after use shall be provided with controls accessible to the operator to completely flush the system with water according to the manufacturer's instructions.

20.4.3 Foam proportioning systems that incorporate foam concentrate metering valves shall have each metering valve calibrated and marked with a label to indicate the rate(s) of the foam concentrate proportioning available as determined by the design of the system.

20.4.4 Foam proportioning systems that incorporate automatic proportioning features shall be equipped with controls that enable the operator to isolate the automatic feature and operate the system.

20.5 Foam Proportioning System Pressure Gauges, Flowmeters, and Indicators.

20.5.1 The displays of all pressure gauges or flowmeters and other indicators (e.g., fluid-level indicators) shall be located so that they are visible from the pump operator's position and shall meet the requirements of 4.10.3.

20.5.2 If an analog pressure gauge is used, it shall meet the requirements of 20.5.2.1 through 20.5.2.4.

20.5.2.1 The gauge shall have a minimum accuracy of Grade B as defined in ASME B40.100, *Pressure Gauges and Gauge Attachments.*

20.5.2.2 Numerals for master gauges shall be a minimum of $\frac{5}{32}$ in. (4 mm) high.

20.5.2.3 There shall be graduation lines showing at least every 10 psi (50 kPa), with major and intermediate graduation lines emphasized and figures at least every 100 psi (500 kPa).

20.5.2.4 Analog pressure gauges shall be vibration and pressure pulsation dampened; be resistant to corrosion, condensation, and shock; and have internal mechanisms that are factory lubricated for the life of the gauge.

20.5.3 If digital pressure gauges are used, they shall meet the requirements of 20.5.3.1 through 20.5.3.3.

20.5.3.1 The digits shall be at least 0.25 in. (6.4 mm) high.

20.5.3.2 Digital pressure gauges shall display pressure in increments of not more than 10 psi (50 kPa).

20.5.3.3 Digital pressure gauges shall have an accuracy of ±3 percent over the full scale.

20.5.4 Each pressure gauge or flowmeter and its respective display shall be mounted and attached so it is protected from accidental damage and excessive vibration.

20.5.5 A gauge(s) shall be provided for balanced pressure foam proportioning systems that simultaneously indicates water pressure and foam concentrate pressure.

20.6 Atmospheric Foam Concentrate Tank.

If the foam proportioning system incorporates an atmospheric foam concentrate tank, the requirements of 20.6.1 through 20.6.12 shall apply.

20.6.1 The foam concentrate tank(s) shall be constructed of noncorrosive materials or other materials that are protected against corrosion or deterioration and that will not be adversely affected by the foam concentrate to be stored in the tank.

20.6.2 Swash Partitions.

20.6.2.1 All foam concentrate tanks shall be provided with swash partitions arranged such that the maximum dimension perpendicular to the plane of any partition shall not exceed 36 in. (900 mm).

20.6.2.2 The swash partition(s) shall extend from wall to wall and cover at least 75 percent of the area of the plane of the partition.

20.6.3 The foam concentrate tank shall be provided with a fill tower or expansion compartment having a minimum area of 12 in.^{2} (7500 mm^2) and having a volume of not less than 1 percent of the total tank volume.

20.6.3.1 The fill tower opening shall be protected by a completely sealed airtight cover.

20.6.3.2* The cover shall be attached to the fill tower by mechanical means.

20.6.3.3 The fill opening shall incorporate a removable screen with a mesh not to exceed 0.25 in. (6 mm) and shall be arranged so that foam concentrate from a 5 gal (19 L) container can be dumped directly to the bottom of the tank to minimize aeration without the use of funnels or other special devices.

20.6.4 The fill tower shall be equipped with a pressure/vacuum vent that enables the tank to compensate for changes in pressure or vacuum when filling or withdrawing foam concentrate from the tank.

20.6.4.1 The pressure/vacuum vent shall not allow atmospheric air to enter the foam tank except during operation or to compensate for thermal fluctuations.

20.6.4.2 The vent shall be protected to prevent foam concentrate from escaping or directly contacting the vent at any time.

20.6.4.3 The vent shall be of sufficient size to prevent tank damage during filling or foam withdrawal.

20.6.5 The foam concentrate tank shall not be equipped with an overflow pipe or any direct opening to the atmosphere.

20.6.6* The foam concentrate tank(s) shall be designed and constructed to facilitate complete interior flushing and cleaning as required.

20.6.7 Tank Drain.

20.6.7.1 A minimum 1 in. (25 mm) inside diameter full flow drain valve and piping shall be provided at the lowest point of any foam concentrate tank.

20.6.7.2 The drain shall be piped to drain directly to the surface beneath the apparatus without contacting other body or chassis components.

20.6.8* The foam concentrate tank shall be constructed and installed to be independent of the apparatus body.

20.6.9 The foam concentrate discharge system design shall prevent the siphoning of foam concentrate.

20.6.10 Labels.

20.6.10.1 A label that reads “Foam Tank Fill” shall be placed at or near any foam concentrate tank fill opening.

20.6.10.2* A label that specifies the following shall be placed at or near any foam concentrate tank fill opening:

(1) Type(s) of foam concentrate the system is designed to use

(2) Any restrictions on the type of foam concentrate that can be used with the system

(3) A warning message that reads “Warning: Do Not Mix Brands and Types of Foam”

20.6.11 The foam concentrate tank outlet connection shall be designed and located to prevent aeration of the foam concentrate and shall allow withdrawal of 80 percent of the foam concentrate tank storage capacity under all operating conditions with the fire apparatus on level ground.

20.6.12 The foam concentrate tank inlet connection, if provided, shall prevent aeration of the foam concentrate under all operating conditions.

20.7* Foam Concentrate Pump.

If the foam proportioning system is equipped with a foam concentrate pump, the requirements of 20.7.1 through 20.7.5 shall apply.

20.7.1 The foam concentrate pump shall operate without cavitation when delivering maximum rated flow.

20.7.2* The materials of construction for the foam concentrate pump shall be corrosion resistant and compatible with the type of foam concentrate(s) listed on the label required in 20.9.3.

20.7.3 Drivetrain components that transmit power to the foam concentrate pump shall be in accordance with the fire apparatus manufacturer’s design performance provided on the label required in 20.9.3.

20.7.4 A means to relieve excess pressure in the foam concentrate pumping system shall be provided to protect the foam concentrate pump from damage.

20.7.5* Foam concentrate pumps that are intended to be supplied from an external source of foam concentrate shall be provided with an external valved intake connection.

20.8 Pressure Vessel Foam Concentrate or Foam Solution Tanks.

If the foam proportioning system incorporates a pressure vessel foam concentrate tank, or the foam solution is contained in a pressure vessel, the requirements of 20.8.1 through 20.8.8 shall apply.

20.8.1 If the tank is charged with a compressed gas or a pressurized liquid, and it falls within the scope of the ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1, it shall be designed, fabricated, and stamped in accordance with the requirements of the ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1, for the rated pressure.

20.8.2 Foam proportioning system piping and components shall be designed to withstand a minimum of 1½ times the maximum working pressure of the pressure vessel and shall be tested to the working pressure of the pressure vessel after installation.

20.8.3 The pressure vessel tank shall be protected against corrosion from the foam concentrate or water stored in the tank.

20.8.4 If the tank is equipped with a gravity fill (i.e., has a fill cap), the fill opening shall be a minimum of 2 in. (51 mm) inside diameter.

20.8.4.1 The fill cap shall be equipped with nontapered threads and a compressible gasket.

20.8.4.2 Special wrenches or tools required to tighten the fill cap shall be supplied by the manufacturer and shall be mounted adjacent to the fill cap.

20.8.4.3 A safety vent hole shall be located in the fill cap so that it vents the tank pressure while at least 3½ threads remain engaged.

20.8.5 A minimum ½ in. (13 mm) manually operated valved vent shall be provided on all pressure vessel tanks.

20.8.6 If the pressure vessel is charged with a compressed gas or a pressurized liquid, a relief valve that meets the applicable requirements of the ASME *Boiler and Pressure Vessel Code*, Section VIII, Division 1, shall be installed on the pressure vessel and set to prevent the vessel pressure from exceeding 110 percent of the maximum allowable working pressure.

20.8.7 A minimum 1 in. (25 mm) inside diameter full flow drain valve and piping shall be provided on all pressure vessel tanks.

20.8.8 A device indicating the internal pressure of the pressure vessel shall be located at the operator’s position.

20.9 Labels and Instruction Plates.

20.9.1 An instruction plate shall be provided for the foam proportioning system that includes, at a minimum, a piping schematic of the system and basic operating instructions.

20.9.2 Each control, gauge, and indicator necessary to operate the foam proportioning system shall be marked with a label as to its function.

20.9.3 A label located at the operator's position shall provide the following information pertaining to the performance operating specifications of the foam proportioning system:

(1) Foam classification type

(2) Maximum and minimum proportioning rates (percent)

(3) Maximum and minimum waterflow [gpm (L/min)]

(4) Maximum and minimum operating pressures

(5)* The statement "Use only concentrates that are compatible with this foam proportioning system. Refer to the foam proportioning system manufacturer's operating manual."

20.9.3.1 If an in-line eductor system is provided on the apparatus, the following information shall also be provided on the plate:

(1) Maximum hose length using 1½ in., 1¾ in., and 2 in. (38 mm, 45 mm, and 52 mm) hose

(2) Allowable elevation changes

(3) The statement "The flow rate of the nozzle must match the flow rate of the system."

20.9.3.2 If an around-the-pump system is provided on the apparatus, the following information shall also be provided on the plate:

(1) Maximum intake pressure or required intake to discharge pressure differential

(2) A table to indicate flow rate and the corresponding metering valve setting

20.9.4 Operations and Maintenance Manual.

20.9.4.1 Two copies of an operations and maintenance manual shall be provided.

20.9.4.2 The manual shall include a complete diagram of the system, operating instructions, system foam concentrate capabilities, original system calibration, and details outlining all recommended maintenance procedures.

20.10* Foam Proportioning System Accuracy.

20.10.1* The foam proportioning system shall be type tested and certified by the foam proportioning system manufacturer to be accurate throughout the foam proportioning system's declared range of waterflow, water pressure, foam percentage (or foam proportioning system capacity), and concentrate viscosity.

20.10.1.1 At a minimum, this declaration shall include the test points listed in Table 20.10.1.1.

Table 20.10.1.1 Test Points for Certification of Foam Proportioning System Performance

Waterflow	Water Pressure	Foam Percentage or Foam Proportioning System Capacity
Minimum	Minimum	Minimum

Table 20.10.1.1 Test Points for Certification of Foam Proportioning System Performance

Waterflow	Water Pressure	Foam Percentage or Foam Proportioning System Capacity
Maximum	Maximum	Maximum*
Minimum	Maximum	Minimum
Maximum	Minimum	Maximum
Midrange	Midrange	Midrange†

* See 20.10.1.3.

† See 20.10.1.2.

20.10.1.2* Calibration at midrange shall be established by the foam proportioning system manufacturer.

20.10.1.3 When testing to the maximum for waterflow and foam percentage or foam proportioning system capacity, the test shall be at the limits of the foam proportioning system or the water pump, whichever is more restrictive.

20.10.2 Systems designed to produce foam solution at ratios of less than 1 percent shall proportion foam concentrate to an accuracy of -0/+40 percent.

20.10.3 Systems designed to produce foam solution at ratios of 1 percent or greater shall proportion foam concentrate to an accuracy of -0/+30 percent or 1 percentage point, whichever is less.

20.10.4 The foam proportioning system manufacturer shall provide the certification required by Section 20.10 to the final-stage apparatus manufacturer.

20.10.4.1 The certification shall include the foam proportioning system manufacturer’s viscosity performance specifications.

20.10.4.2 The final-stage apparatus manufacturer shall deliver a copy of the certification with the fire apparatus.

20.11 Testing and Documentation.

20.11.1 The final installer shall test and certify the following:

(1) The foam proportioning system, as installed, complies with the foam equipment manufacturer's installation recommendations.

(2)* The foam proportioning system has been calibrated and tested to meet the foam equipment manufacturer’s and the purchaser's performance specifications.

(3)* At a minimum, the foam proportioning system has been tested at the points defined in

Table 20.11.1 for each foam system injection point.

Table 20.11.1 Test Points for Installation Testing of Foam Proportioning System Performance

Waterflow	Water Pressure	Foam Percentage or Foam Proportioning System Capacity
Minimum	Minimum	Minimum
Maximum	Maximum	Maximum*
Midrange	Midrange	Midrange†

* See 20.10.1.3.

† See 20.10.1.2.

20.11.2 The final installer shall deliver documentation with the fire apparatus declaring the foam proportioning system as installed meets the requirements of 20.10.2 or 20.10.3 across the foam proportioning system manufacturer's declared range of waterflow, water pressure, foam percentage (or foam proportioning system capacity), and concentrate viscosity at the test points defined in Table 20.11.1.

Chapter 21 Compressed Air Foam Systems (CAFS)

21.1* Application.

If the fire apparatus is equipped with a compressed air foam system (CAFS), it shall comply with the applicable sections of this chapter.

21.2 General Requirements.

21.2.1 An automatic regulating foam proportioning system shall be used and shall comply with the applicable requirements of Chapter 20.

21.2.2 The total CAFS rating shall be expressed in terms of airflow and waterflow.

21.2.2.1 The airflow shall be expressed in standard cubic feet per minute (SCFM) [L/min at standard temperature and pressure] and shall be based on the continuous flow capacity of the compressed air source(s) at a minimum gauge pressure of 125 psi (862 kPa).

21.2.2.2 The waterflow shall be expressed in gallons per minute (gpm) [liters per minute (L/min)] at a gauge pressure of 125 psi (862 kPa).

21.2.3 The fire apparatus shall be capable of supplying power for operating the CAFS at its rated capacity while simultaneously providing power to all other power-dependent systems installed on the apparatus.

21.2.4* On a CAFS, the air pressures shall be automatically balanced to the water pressure to within -0/+10 percent throughout the operational range of the CAFS.

21.2.5* A means shall be provided on the CAFS for the operator to relieve all pressure from the system after the system has been deactivated.

21.3 Compressed Air System.

21.3.1 The compressed air system operating in clean environmental conditions shall be designed to provide a continuous rated air supply for a duration of 6 hours without needing adjustment, additional lubrication, or air filters changed.

21.3.2 Relief Valve.

21.3.2.1 The compressed air system shall be equipped with a relief valve that is set to prevent the compressed air system from exceeding 110 percent of the maximum allowable working pressure of the system.

21.3.2.2 The outlet of the relief valve shall be routed to an area that does not expose personnel to air blasts or cause the creation of dust.

21.3.3 If the possibility exists for moisture to build up in the compressed air system, the system shall be equipped with moisture traps and drains.

21.3.4 If a holding, surge, or separator tank (DOT tank or ASME pressure vessel) is provided, it shall comply with 29 CFR 1910.169, “Air receivers,” or equal for the rated pressure.

21.3.4.1 Transportable air tanks shall comply with 49 CFR 178.37, “Specification 3AA and 3AAX seamless steel cylinders,” or 29 CFR 1910.169.

21.3.4.2 Relief valves on transportable air tanks shall be of the ASME type on ASME cylinders and of the DOT type on DOT cylinders or equal for the rated pressure.

21.3.4.3 Valves installed on air tanks shall meet the requirements of the Compressed Gas Association or equivalent standards regarding pressure and usage with compressed air.

21.3.4.4 If the installation utilizes cylinders that require periodic testing, a label shall be placed on the operator’s panel indicating the test date stamped on the cylinders and the date the cylinders will next require testing.

21.4* Air Mixing.

21.4.1 An automatic means shall be provided to prevent the backflow of water or foam solution into the compressed air system or of air into the water pump or the foam proportioning equipment.

21.4.2 A means of mixing air and foam solution that provides for a homogeneous mixture of compressed air and foam solution shall be provided on CAFS.

21.5* Compressed Air System Piping.

The discharge plumbing shall be configured to minimize the use of elbows or abrupt turns.

21.6 Air System Controls.

21.6.1 All compressed air system controls shall be located on the pump operator's panel and shall be identified with an instruction plate in accordance with the requirements of 21.8.1.

21.6.2 Compressed air systems that require flushing after use shall be provided with controls that are accessible to the operator and enable the operator to completely flush the system with water according to the manufacturer's instructions.

21.7 Foam System Pressure Gauges, Flowmeters, and Indicators.

21.7.1 The displays of all pressure gauges, flowmeters, and indicators (e.g., fluid level indicators) shall be located so they are visible from the pump operator's position and shall meet the requirements of 4.10.3.

21.7.2 Where analog pressure gauges are used, they shall meet the requirements of 21.7.2.1 through 21.7.2.4.

21.7.2.1 Analog pressure gauges shall have a minimum accuracy of Grade B as defined in ASME B40.100, *Pressure Gauges and Gauge Attachments*.

21.7.2.2 Numerals for master gauges shall be a minimum of $\frac{5}{32}$ in. (4 mm) high.

21.7.2.3 There shall be graduation lines showing at least every 10 psi (50 kPa), with major and intermediate graduation lines emphasized and figures at least every 100 psi (500 kPa).

21.7.2.4 Analog pressure gauges shall be vibration and pressure pulsation dampened; be resistant to corrosion, condensation, and shock; and have internal mechanisms that are factory lubricated for the life of the gauge.

21.7.3 If digital pressure gauges are used, they shall meet the requirements of 21.7.3.1 through 21.7.3.3.

21.7.3.1 The digits shall be at least 0.25 in. (6.4 mm) high.

21.7.3.2 Digital pressure gauges shall display pressure in increments of not more than 10 psi (50 kPa).

21.7.3.3 Digital pressure gauges shall have an accuracy of ±3 percent over the full scale.

21.7.4 Each pressure gauge and flowmeter and its display shall be mounted and attached so it is protected from accidental damage and excessive vibration.

21.7.5 If flowmeters are provided, they shall meet the requirements of 21.7.5.1 and 21.7.5.2.

21.7.5.1 Flowmeter displays shall be located at the pump operator's panel and shall indicate the airflow in standard cubic feet per minute (SCFM) [L/min at standard temperature and pressure] and indicate the waterflow in gallons per minute (gpm) [liters per minute (L/min)].

21.7.5.2 Flowmeters shall be rated to a hydrostatic burst gauge pressure of 500 psi (3400 kPa) if located on the pressure side of the system.

21.7.6* A pressure gauge shall be provided for the compressed air system.

21.8 Labels and Instruction Plates.

21.8.1 An instruction plate indicating the identification, function, and operation shall be provided for each control, gauge, and indicator required to operate the CAFS.

21.8.2 A label shall be provided that is visible from the pump operator's position that gives the rated continuous flow capacity of the compressed air system at a gauge pressure of 125 psi (862 kPa).

21.8.3 An instruction plate shall be provided that is visible from the pump operator's position and states the following:

(1) Open and close valves slowly.

(2) Do not run with just air and water.

(3) Shut off air when foam tank is empty.

(4) Be prepared for high nozzle reactions — open nozzle slowly.

21.8.4 Operations and Maintenance Manual.

21.8.4.1 Two copies of an operations and maintenance manual shall be provided.

21.8.4.2 The manual shall include a complete diagram of CAFS, operating instructions, the system rating, and details outlining all recommended maintenance procedures.

21.9* Manufacturer's Predelivery Tests.

The manufacturer shall conduct the tests in 21.9.1 and 21.9.2 prior to delivery of the fire apparatus and deliver documentation of the test results with the fire apparatus.

21.9.1 CAFS Capacity Rating Test.

21.9.1.1 The operation of the water pump and the compressed air source shall be tested simultaneously to determine the integrity of the system and to ensure that the power available is capable of operating these components of CAFS simultaneously.

21.9.1.1.1 The compressed air system shall be operated at its flow capacity at a minimum gauge pressure of 125 psi (862 kPa), and the water pump shall discharge a minimum of 2 gpm (7.6 L/min) of water at 125 psi (862 kPa) net pump pressure for every 1 SCFM [28.3 L/min at standard temperature and pressure] of compressed air discharge.

21.9.1.1.2 The discharge shall be through at least two separate discharge openings, one discharging air only and the other discharging water only.

21.9.1.2 One or more lines of fire hose of sufficient diameter shall be provided to allow discharge of the required amount of water from the pump to a nozzle or other flow-measuring equipment without exceeding a flow velocity of 35 ft/sec (10.7 m/sec) [approximately 500 gpm (2000 L/min) for 2½ in. (65 mm) hose].

21.9.1.2.1 The discharge shall be measured using a smoothbore nozzle and pitot tube or other equipment such as flowmeters, volumetric tanks, or weigh tanks.

21.9.1.2.2 Test gauges shall meet the requirements of 16.13.2.2.4 and 16.13.2.2.5.

21.9.1.3 The airflow rate shall be measured using a pressure and temperature compensated flow-measuring device.

21.9.1.3.1 The airflow shall be measured in SCFM [L/min at standard temperature and pressure] at a minimum gauge pressure of 125 psi (862 kPa).

21.9.1.3.2 The airflow-measuring device shall have been calibrated for accuracy within the previous 3 months.

21.9.1.3.3* The air discharge outlet shall have nothing attached directly to it except the test device(s).

21.9.1.4 The water pump and the compressed air system shall be started, and the rated flows and pressures as specified in 21.9.1.1.1 shall be established and maintained.

21.9.1.4.1 The system shall be run for 1 hour.

21.9.1.4.2 Readings of the airflow rate and pressure and the water pump pressure and discharge rate shall be taken at least every 10 minutes.

21.9.1.5 Failure of any component of the CAFS to maintain air and water pressures and discharge volumes at or above the system rating shall constitute failure of the test.

21.9.2 Standby Run Test.

21.9.2.1 One 200 ft (60 m) line of 1½ in. (38 mm) hose shall be connected to the discharge of the CAFS and shall be stretched out on level ground.

21.9.2.2 A quarter-turn valve of the same nominal size as the hose shall be installed at the discharge end.

21.9.2.3 The hose shall be restrained immediately behind the valve at the discharge end to prevent uncontrolled movement when the valve is opened.

21.9.2.4 Operating as a CAFS, with a gauge pressure air output at 125 psi (862 kPa), a foam flow shall be established in the hose line.

21.9.2.5 With the water tank at the half-full level, the valve at the discharge end of the hose shall be shut no faster than in 3 seconds and no slower than in 10 seconds.

21.9.2.6 The engine's speed shall be maintained for 10 minutes without discharging water, air, or foam solution from the CAFS and without operator intervention.

21.9.2.7 A bypass line shall be permitted to be opened temporarily, if needed, to keep the water temperature in the pump within acceptable limits.

21.9.2.8 At the end of 10 minutes, the valve shall be reopened no faster than in 3 seconds and no slower than in 10 seconds.

21.9.2.9 Damage to the CAFS that affects its rated performance characteristics or the lack of a fire stream immediately upon opening the hose line shall constitute failure of this test.

Chapter 22 Line Voltage Electrical Systems

22.1* Application.

Where any part of a line voltage electrical system is provided as a fixed installation, the applicable requirements of this chapter shall apply.

22.2 General Requirements.

22.2.1 Stability.

22.2.1.1 Any fixed line voltage power source producing alternating current (ac) shall produce electric power at 60 Hz ±3 Hz when producing power at all levels between no load and full rated power.

22.2.1.2 Any fixed line voltage power source shall produce electric power at the rated voltage ±10 percent when producing power at all levels between no load and full rated power.

22.2.2 The maximum voltage supplied to portable equipment shall not exceed 275 volts to ground. Higher voltage shall be permitted only when used to operate fixed wired, permanently mounted equipment on the apparatus.

22.2.3 Conformance with *National Electrical Code*.

22.2.3.1 All components, equipment, and installation procedures shall conform to *NFPA 70*, *National Electrical Code*, except where superseded by the requirements of this chapter.

22.2.3.2 Where the requirements of this chapter differ from those in *NFPA 70*, the requirements in this chapter shall apply.

22.2.4* Where available, line voltage electrical system equipment and materials included on the apparatus shall be listed and used only in the manner for which they have been listed.

22.2.5 All equipment and materials shall be installed in accordance with the manufacturer's instructions.

22.2.6 Location Ratings.

22.2.6.1 Any equipment used in a dry location shall be listed for dry locations.

22.2.6.2 Any equipment used in a wet location shall be listed for wet locations.

22.2.6.3 Any equipment, except a PTO-driven generator, used in an underbody or underchassis location that is subject to road spray shall be either listed as Type 4 or mounted in an enclosure that is listed as Type 4.

22.2.6.4* If a PTO-driven generator is located in an underbody or underchassis location, the installation shall include a shield to prevent road spray from splashing directly on the generator.

22.3 Grounding and Bonding.

22.3.1* Grounding. Grounding shall be in accordance with 250.34(A) and 250.34(B) of *NFPA 70*.

22.3.1.1* Ungrounded systems shall not be used.

22.3.1.2 Only stranded or braided copper conductors shall be used for grounding and bonding.

22.3.1.3 The grounded current-carrying conductor (neutral) shall be insulated from the equipment-grounding conductors and from the equipment enclosures and other grounded parts.

22.3.1.4 The neutral conductor shall be colored white or gray in accordance with 200.6, “Means of Identifying Grounded Conductors,” of *NFPA 70*.

22.3.1.5 Any bonding screws, straps, or buses in the distribution panelboard or in other system components between the neutral and equipment-grounding conductor shall be removed and discarded.

22.3.2 Bonding.

22.3.2.1 The neutral conductor of the power source shall be bonded to the vehicle frame.

22.3.2.2 The neutral bonding connection shall occur only at the power source.

22.3.2.3 In addition to the bonding required for the low voltage return current, each body and each driving or crew compartment enclosure shall be bonded to the vehicle frame by a copper conductor.

22.3.2.3.1 The conductor shall have a minimum amperage rating, as defined in 310.15, “Ampacities for Conductors Rated 0–2000 Volts,” of *NFPA 70*, of 115 percent of the rated amperage on the power source specification label.

22.3.2.3.2 A single conductor that is sized to meet the low voltage and line voltage requirements shall be permitted to be used.

22.3.3* Ground Fault Circuit Interrupters.

22.3.3.1 In special service vehicles incorporating a lavatory, sink, toilet, shower, or tub, 120 V, 15 or 20 A receptacles within 6 ft (1.8 m) of these fixtures shall have ground fault circuit interrupter (GFCI) protection.

22.3.3.2 GFCIs integrated into outlets or circuit breakers or as stand-alone devices shall be permitted to be used in situations other than those described in 22.3.3.1.

22.4 Power Source General Requirements.

The requirements in 22.4.1 through 22.4.10 shall apply to all line voltage power sources.

22.4.1 All power source system mechanical and electrical components shall be sized to support the continuous duty nameplate rating of the power source.

22.4.2 The power source shall be shielded from contamination that would prevent the power source from operating within its design specifications.

22.4.3 Power Source Rating.

22.4.3.1* For power sources of 8 kW or larger, the power source manufacturer shall declare the continuous duty rating that the power source can provide when installed on fire apparatus according to the manufacturer's instructions and run at 120°F (49°C) air intake temperature at 2000 ft (600 m) above sea level.

22.4.3.2 The rating on the power source specification label shall not exceed the declared rating from the power source manufacturer.

22.4.4 Access shall be provided to permit both routine maintenance and removal of the power source for major servicing.

22.4.5 The power source shall be located such that neither it nor its mounting brackets interfere with the routine maintenance of the fire apparatus.

22.4.6 Instrumentation.

22.4.6.1 If the power source is rated at less than 3 kW, a “Power On” indicator shall be provided.

22.4.6.2 If the power source is rated at 3 kW or more but less than 8 kW, a voltmeter shall be provided.

22.4.6.3* If the power source is rated at 8 kW or more, the following instrumentation shall be provided at an operator's panel:

(1) Voltmeter

(2) Current meters for each ungrounded leg

(3) Frequency (Hz) meter

(4) Power source hourmeter

22.4.6.4 The instrumentation shall be permanently mounted at an operator's panel.

22.4.6.4.1 The instruments shall be located in a plane facing the operator.

22.4.6.4.2 Gauges, switches, or other instruments on this panel shall each have a label to indicate their function.

22.4.6.4.3 The instruments and other line voltage equipment and controls shall be protected from mechanical damage and not obstructed by tool mounting or equipment storage.

22.4.7 An instruction plate(s) that provides the operator with the essential power source operating instructions, including the power-up and power-down sequence, shall be permanently attached to the apparatus at any point where such operations can take place.

22.4.8* Operation.

22.4.8.1 Provisions shall be made for placing the generator drive system in operation using controls and switches that are identified and within convenient reach of the operator.

22.4.8.2 Where the generator is driven by the chassis engine and engine compression brakes or engine exhaust brakes are furnished, they shall be automatically disengaged for generator operations.

22.4.8.3* Any control device used in the generator system power train between the engine and the generator shall be equipped with a means to prevent unintentional movement of the control device from its set position in the power generation mode.

22.4.9 If there is permanent wiring on the apparatus that is designed to be connected to the power source, a power source specification label that is permanently attached to the apparatus at the operator's control station shall provide the operator with the information detailed in Figure 22.4.9.

Power Source Specifications

Operational Category	**Continuous Duty Rating**
Rated voltage(s) and type (ac or dc)	
Phase	
Rated frequency	
Rated amperage	
Continuous rated watts	
Power source engine speed	

FIGURE 22.4.9 Power Source Specifications Label.

22.4.10 The power source, at any load, shall not produce a noise level that exceeds 90 dBA in any driving compartment, crew compartment, or onboard command area with windows and doors closed or at any operator's station on the apparatus.

22.5 Power Source Type Specific Requirements.

22.5.1* **Direct Drive (PTO) Generators.** If the generator is driven by any type of PTO, it shall meet the requirements of 22.5.1.1 through 22.5.1.5.

22.5.1.1 The transmission's PTO port and PTO, or the split shaft PTO, and all associated drive shaft components shall be rated to support the continuous duty torque requirements of the generator's continuous duty rating as stated on the power source nameplate.

22.5.1.2 Where the generator is driven by the chassis engine and transmission through a split shaft PTO, the driving compartment speedometer shall register when the generator drive system is engaged.

22.5.1.3 Where the generator is driven by the chassis engine and transmission through a split shaft PTO and a chassis transmission retarder is furnished, it shall be automatically disengaged for generator operations.

22.5.1.4 The direct drive generator shall be mounted so that it does not change the ramp breakover angle, angle of departure, or angle of approach as defined by other components, and it shall not extend into the ground clearance area.

22.5.1.5 The direct drive generator shall be mounted away from exhaust and muffler areas or provided with a heat shield to reduce operating temperatures in the generator area.

22.5.2* **Hydraulically Driven Generators.** If the generator is driven using hydraulic components, it shall meet the requirements of 22.5.2.1 through 22.5.2.5.

22.5.2.1* A means shall be provided to activate the hydraulic generator system.

22.5.2.2 If the hydraulic generator system is not capable of output as stated on the power source specification label at all engine speeds, an automatic engine speed control system shall be provided.

22.5.2.3 If the apparatus is equipped with a fire pump driven by the chassis engine, the generator shall be capable of output as stated on the power source specification label with the engine at idle.

22.5.2.4 Hydraulic Components.

22.5.2.4.1 A hydraulic system filter and strainer shall be provided and shall be located in a readily accessible area.

22.5.2.4.2 Hydraulic hose shall meet the hydraulic pump manufacturer's recommendations for pressure, size, vacuum, and abrasion resistance.

22.5.2.4.3* Hydraulic fittings shall meet the hydraulic pump manufacturer's recommendations for pressure, size, and the type of hose used.

22.5.2.5* Where the hydraulic hose comes into contact with other surfaces, the hose shall be protected from chafing.

22.5.3* **Fixed Auxiliary Engine–Driven Generators.** If the generator is driven by a fixed auxiliary engine, it shall meet the requirements of 22.5.3.1 through 22.5.3.9.4.

22.5.3.1 The generator shall be installed so that fumes, vapors, heat, and vibrations do not enter the driving or crew compartment.

22.5.3.2* Generators rated at 8 kW or more shall be equipped with a high temperature automatic shutdown system and a low oil (pressure or level) automatic shutdown system.

22.5.3.3 The generator shall be installed in accordance with the generator manufacturer's requirements for ventilation and service accessibility.

22.5.3.4 If the generator is installed in a compartment and the compartment doors must be open during its operation, the generator shall be equipped with an interlock system to prevent its operation if the doors are not open, or the compartment shall be equipped with a high temperature alarm.

22.5.3.5 If the generator is installed in a compartment on a slide tray and the slide tray must be in the extended or out position during operation, an interlock shall be provided to prevent operation unless the tray is in the correct position, or the compartment shall be equipped with a high temperature alarm.

22.5.3.6 Permanently installed generators shall have readily accessible engine oil drain provisions or piping to a remote location for oil changing.

22.5.3.7* If the generator is located in a position on the apparatus where the operator cannot see the instrumentation and operate the controls while standing at ground level or positioned at a specifically designated operator station, an operating panel with the required instrumentation, start and stop controls, and other controls necessary for safe operation shall be provided at a remote operator’s panel.

22.5.3.8 Fuel System.

22.5.3.8.1 Fuel lines shall be protected from chafing at all wear points.

22.5.3.8.2 If the fuel source is shared with the apparatus engine, a separate fuel pickup system shall be provided that is arranged to ensure that the generator cannot utilize more than 75 percent of the fuel tank's capacity.

22.5.3.9 Exhaust System.

22.5.3.9.1* The exhaust piping and discharge shall be located or shielded to prevent thermal damage to the apparatus or equipment.

22.5.3.9.2 The exhaust shall be piped to the exterior of the vehicle and discharged at a location away from any operator's position.

22.5.3.9.3 Where parts of the exhaust system are exposed so that they can cause injury to operating personnel, protective guards shall be provided.

22.5.3.9.4 Silencing devices shall be provided and shall not create exhaust backpressure that exceeds the limits specified by the engine manufacturer.

22.5.4* Belt-Driven Power Sources. If the power source is belt driven, it shall meet the requirements of 22.5.4.1 through 22.5.4.3.

22.5.4.1 A means shall be provided to mechanically engage and disengage the generator or alternator rotation or to electronically stop the production of electricity from the generator or alternator.

22.5.4.2 A voltmeter shall be provided at an operator's panel for any system of this type.

22.5.4.3 The belt drive system shall be rated to drive the generator or alternator at the nameplate rating.

22.5.5* Line Voltage Power Derived from the Apparatus Low Voltage Power Supply Systems. If the power source derives its input energy from the apparatus low voltage electrical system, it shall meet the requirements of 22.5.5.1 and 22.5.5.2.

22.5.5.1 The low voltage power supply system shall be installed in compliance with the requirements of Chapter 13.

22.5.5.2* The alternator and/or battery system shall be adequate to provide power for continuous operation for a minimum of 2 hours at full output.

22.5.6 Power Sources Requiring Elevated Engine Speed. If the power source requires the chassis engine to be operating at a specific fixed speed or a specific speed range, it shall meet the requirements of 22.5.6.1 through 22.5.6.3.

22.5.6.1 The main propulsion engine shall have a governor capable of maintaining the engine speed within the limits required by the power source to meet the frequency control, voltage control, and power output specifications.

22.5.6.2 An interlock shall prevent engagement of the generator unless the parking brake is engaged and the transmission is in neutral or not connected to the drive wheels.

22.5.6.3* Where the chassis engine drives the generator and electronic engine throttle controls are provided, an interlock shall prevent engine speed control from any other source that would interfere with the generator while the generator is operating.

22.5.7 Power Sources Requiring the Chassis Transmission to Be in a Specific Gear. If the power source requires the chassis transmission be in a specific gear when producing line voltage power, it shall meet the requirements of 22.5.7.1 and 22.5.7.2.

22.5.7.1 A label indicating the chassis transmission shift selector position to be used for generator operation shall be provided in the driving compartment and located so that it can be read from the driver's position.

22.5.7.2 Interlocks shall be provided that prevent advancement of the engine throttle for generator operation unless the transmission is in the correct gear.

22.5.8 Generators. If the power source is mechanically driven, it shall comply with Article 445, "Generators," of *NFPA 70*.

22.5.9 Chassis Engine–Driven Generators. Where the generator is driven by the chassis engine, the requirements in 22.5.9.1 through 22.5.9.3 shall apply.

22.5.9.1* Unless the generator is always engaged, a "Generator Engaged" indicator shall be provided in the driving compartment to indicate that the generator shift has been successfully completed.

22.5.9.2 Unless the generator is always engaged and operating, an "OK to Operate Generator" indicator shall be provided in the driving compartment to indicate that the generator is engaged (if not always engaged), the transmission is in the proper gear (if required, automatic transmissions only), and the parking brake is engaged (if applicable).

22.5.9.3 An interlock system shall be provided to prevent advancement of the engine speed in the driving compartment or at any operator's panel unless the parking brake is engaged, and the transmission is in neutral or the output of the transmission is correctly connected to a pump or generator instead of the drive wheels.

22.5.10* Waveform Created Electronically. If the power output waveform is electronically created, the purchaser shall specify whether modified sine wave or pure sine wave output is required.

22.6* Portable Generator Installations.

The generator shall comply with Article 445, "Generators," of *NFPA 70*.

22.6.1 Any portable generator that can be operated while mounted on the apparatus shall be as follows:

(1) Installed so that fumes, vapors, heat, excessive noise, and vibrations do not enter interior driving or crew compartments or damage the generator during operation

(2) Have the exhaust outlet located so that exhaust is directed away from any operator station located on the apparatus and guarded to protect the operator

22.6.2 If the portable generator is remotely mounted, it shall have a remote operator's control station that shall provide a means for starting and stopping the generator and monitoring the same instrumentation as is required for fixed power sources.

22.6.3 Wiring for Portable Generator Installations. Wiring installed for the purpose of facilitating the distribution of power from a portable generator installation to fixed wiring on the apparatus shall conform to the additional requirements of 22.6.3.1 through 22.6.3.5.

22.6.3.1 Circuit conductors shall be sized in relation to the power source specification label rating and shall be protected by an overcurrent device commensurate with their amperage capacities.

22.6.3.2 There shall be a single output connector cord with all of the conductors in the cord sized to carry a minimum of 115 percent of the nameplate amperage.

22.6.3.3 If there is not an overcurrent protection device at the power source, the output connector cord shall not exceed 72 in. (1830 mm) in length and shall be connected to an overcurrent protection device.

22.6.3.4 The rating of an external main overcurrent protection device shall equal the rated amperage on the power source specification label or the next larger available size overcurrent protection device where so recommended by the power source manufacturer.

22.6.3.5 If a connecting plug is required, it shall be sized in relation to the system and conform to NEMA configurations for plugs.

22.7 Line Voltage Supplied from an External Source.

22.7.1* If the apparatus is equipped with a fixed power inlet (shoreline inlet), it shall be a permanently mounted inlet (male-recessed type with cover), sized in accordance with the anticipated load, and wired directly to the system or device to be powered or wired to a transfer switch where required by 22.7.2.

22.7.1.1 The protective ground from the shoreline inlet shall be bonded to the vehicle frame.

22.7.2 Transfer Switch Applications.

22.7.2.1 A transfer switch shall be required to isolate one power source from the other where a circuit(s) is intended to be supplied from more than one power source.

22.7.2.2 Transfer equipment, including transfer switches, shall operate such that all ungrounded conductors of one power source are disconnected before any ungrounded conductors of the second power source are connected.

22.7.2.3 The neutral conductor shall be switched through the transfer switch.

22.7.3 The apparatus shall have a label permanently affixed at the power inlet that indicates the information shown in Figure 22.7.3.

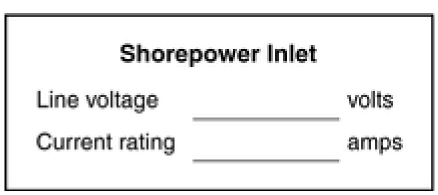


FIGURE 22.7.3 Shorepower Inlet Label.

22.8 Power Supply Assembly.

22.8.1 The conductors used in the power supply assembly between the output terminals of the power source and the main overcurrent protection device shall not exceed 12 ft (4 m) in length.

22.8.2 All power supply assembly conductors, including neutral and grounding conductors, shall have an equivalent amperage rating and shall be sized to carry not less than 115 percent of the amperage of the nameplate current rating of the power source.

22.8.3* If the power supply assembly connects to the vibrating part of a generator (not a connection on the base), the conductors shall be flexible cord or other fine-stranded conductors enclosed in metallic or nonmetallic liquidtight flexible conduit rated for wet locations and temperatures not less than 194°F (90°C).

22.9 Overcurrent Protection.

Manually resettable overcurrent devices shall be installed to protect the line voltage electrical system components.

22.9.1 Power Source Protection. A main overcurrent protection device shall be provided that is either incorporated in the power source or connected to the power source by a power supply assembly.

22.9.1.1 The size of the main overcurrent protection device shall not exceed 100 percent of the rated amperage stated on the power source specification label or the rating of the next larger available size overcurrent protection device, where so recommended by the power source manufacturer.

22.9.1.2 If the main overcurrent protection device is subject to road spray, the unit shall be housed in a Type 4–rated enclosure.

22.9.2 Branch Circuit Overcurrent Protection. Overcurrent protection devices shall be provided for each individual circuit and shall be sized at not less than 15 amps in accordance with 240.4, “Protection of Conductors,” of *NFPA 70*.

22.9.2.1 Any panelboard shall have a main breaker where the panel has six or more individual branch circuits or the power source is rated 8 kW or larger.

22.9.2.2 Each overcurrent protection device shall be marked with a label to identify the function of the circuit it protects.

22.9.2.3 Dedicated circuits shall be provided for any large appliance or device (air conditioning units, large motors, etc.) that requires 60 percent or more of the rated capacity of the circuit to which it is connected, and that circuit shall serve no other purpose.

22.9.3 Panelboards. All fixed power sources shall be hardwired to a permanently mounted panelboard unless one of the following conditions exists:

(1) All line voltage power connections are made through receptacles on the power source and the receptacles are protected by integrated overcurrent devices.

(2) Only one circuit is hardwired to the power source, which is protected by an integrated overcurrent device.

22.9.3.1 The panel shall be visible and located so that there is unimpeded access to the panelboard controls.

22.9.3.2 All panelboards shall be designed for use in their intended location.

22.9.3.3 The panel(s) shall be protected from mechanical damage, tool mounting, and equipment storage.

22.9.3.4* Where the power source is 120/240 V and 120 V loads are connected, the apparatus manufacturer or line voltage system installer shall consider load balancing to the extent that it is possible.

22.10* Wiring Methods.

Fixed wiring systems shall be limited to the following:

(1) Metallic or nonmetallic liquidtight flexible conduit rated at temperatures not less than 194°F (90°C) with stranded copper wire rated for wet locations and temperatures not less than 194°F (90°C)

(2) Type SOW, SOOW, SEOW, or SEOOW flexible cord rated at 600 V and at temperatures not less than 194°F (90°C)

22.10.1 Electrical cord or conduit shall not be attached to chassis suspension components, water or fuel lines, air or air brake lines, fire pump piping, hydraulic lines, exhaust system components, or low voltage wiring and shall be arranged as follows:

(1) Separated by a minimum distance of 12 in. (300 mm) from exhaust piping or shielded from such piping

(2) Separated from fuel lines by a minimum distance of 6 in. (150 mm)

22.10.2 A means shall be provided to allow “flexing” between the driving and crew compartment, the body, and other areas or equipment whose movement would stress the wiring.

22.10.3 Electrical cord or conduit shall be supported within 6 in. (150 mm) of any junction box and at a minimum of every 24 in. (600 mm) of run.

22.10.3.1 Supports shall be made of nonmetallic materials or of corrosion-resistant or corrosion-protected metal.

22.10.3.2 All supports shall be of a design that does not cut or abrade the conduit or cord and shall be mechanically fastened to the apparatus.

22.10.4 Only fittings and components listed for the type of cord or conduit being installed shall be used.

22.10.5 Splices shall be made only in a listed junction box.

22.10.6 Additional Requirements for Flexible Cord Installations.

22.10.6.1* Where flexible cord is used in any location where it could be damaged, it shall be protected by installation in conduit, enclosures, or guards.

22.10.6.2 Where flexible cord penetrates a metal surface, rubber or plastic grommets or bushings shall be installed.

22.10.7 Wiring Identification.

22.10.7.1 Each line voltage circuit originating from the main panelboard shall be identified.

22.10.7.2 The wire or circuit identification either shall reference a wiring diagram or wire list or shall indicate the final termination point of the circuit.

22.10.7.3 Where prewiring for future power sources or devices exists, the unterminated ends shall be marked with a label showing their wire size and intended function.

22.11 Wiring System Components.

22.11.1 Only stranded copper conductors with an insulation rated for temperatures of at least 194°F (90°C) and wet locations shall be used.

22.11.1.1 Conductors in flexible cord shall be sized in accordance with Table 400.5(A) of *NFPA 70*.

22.11.1.2 Conductors used in conduit shall be sized in accordance with 310.15, “Ampacities for Conductors Rated 0–2000 Volts,” of *NFPA 70*.

22.11.1.3 Aluminum or copper-clad aluminum conductors shall not be used.

22.11.2 All boxes shall conform to and be mounted in accordance with Article 314, “Outlet, Device, Pull, and Junction Boxes; Conduit Bodies; Fittings; and Manholes,” of *NFPA 70*.

22.11.2.1 All boxes shall be accessible using ordinary hand tools.

22.11.2.2 Boxes shall not be permitted behind welded or pop-riveted panels.

22.11.2.3 The maximum number of conductors permitted in any box shall be in accordance with 314.16, “Number of Conductors in Outlet, Device, and Junction Boxes, and Conduit Bodies,” of *NFPA 70*.

22.11.3* All wiring connections and terminations shall provide a positive mechanical and electrical connection.

22.11.3.1 Connectors shall be installed in accordance with the manufacturer's instructions.

22.11.3.2 Wire nuts or insulation displacement and insulation-piercing connectors shall not be used.

22.11.4* Each switch shall indicate the position of its contact points (i.e., open or closed) and shall be rated for the continuous operation of the load being controlled.

22.11.4.1 All switches shall be marked with a label indicating the function of the switch.

22.11.4.2* Circuit breakers used as switches shall be “switch rated” (SWD) or better.

22.11.4.3 Switches shall simultaneously open all associated line voltage conductors.

22.11.4.4 Switching of the neutral conductor alone shall not be permitted.

22.11.4.5 Line voltage circuits controlled by low voltage circuits shall be wired through properly rated relays in listed enclosures that control all nongrounded current-carrying conductors.

22.11.5* Receptacles and Inlet Devices.

22.11.5.1 Wet and Dry Locations.

22.11.5.1.1 All wet location receptacle outlets and inlet devices, including those on hardwired, remote power distribution boxes, shall be of the grounding type, provided with a wet location cover, and installed in accordance with Section 406.8, “Receptacles in Damp or Wet Locations,” of *NFPA 70*.

22.11.5.1.2 All receptacles located in a wet location shall be not less than 24 in. (600 mm) from the ground.

22.11.5.1.3* Receptacles on offroad fire apparatus shall be a minimum of 30 in. (750 mm) from the ground.

22.11.5.2 All receptacles located in a dry location shall be of the grounding type and shall be at least 12 in. (300 mm) above the interior floor height.

22.11.5.3 No receptacle shall be installed in a face-up position.

22.11.5.4 The face of any wet location receptacle shall be installed in a plane from vertical to not more than 45 degrees off vertical.

22.11.5.5 Receptacle Label.

22.11.5.5.1 Each receptacle shall be marked with a label indicating the nominal line voltage (120 volts or 240 volts) and the current rating in amps of the circuit.

22.11.5.5.2 If the receptacle is dc or other than single phase, that information shall also be marked on the label.

22.11.5.6* All receptacles and electrical inlet devices shall be listed to UL 498, *Standard for Safety Attachment Plugs and Receptacles*, or other recognized performance standards.

22.11.5.7 Receptacles used for dc voltages shall be rated for dc service.

22.12 Cord Reels.

All permanently mounted cord reels shall be rated for continuous duty and installed to be accessible for removal, cord access, maintenance, and servicing.

22.12.1 The power rewind cord reel spool area shall be visible to the operator during the rewind operation, or the reel spool shall be encapsulated to prevent cord from spooling off the reel.

22.12.2 Rollers or guides shall be provided, where required, to prevent damage to the cord at reel spools or compartment openings.

22.12.3 Rewind Provision.

22.12.3.1 Manually operated reels shall have a hand crank.

22.12.3.2 Power rewind–type reels shall have the control in a position where the operator can observe the rewinding operation. If a reel is in an enclosure or out of direct view, the cord entry point to the enclosure shall be visible to the operator of the reel control.

22.12.3.3 The rewind control or crank shall not be more than 72 in. (1830 mm) above the operator's standing position.

22.12.3.4 The rewind control shall be marked with a label indicating its function and shall be guarded to prevent accidental operation.

22.12.4* The reel shall be designed to hold 110 percent of the capacity needed for the intended cord length.

22.12.5* The wire size shall be in accordance with *NFPA 70*, Table 400.5(A), but in no case shall it be smaller than 12 AWG.

22.12.6* Electrical cord shall be Type SEOOW, Type SOOW, or Type STOOW.

22.12.7* A label that indicates the following information shall be provided in a visible location adjacent to any permanently connected reel:

(1) Current rating

(2) Current type

(3) Phase

(4) Voltage

(5) Total cord length

22.12.8 Where a power distribution box is hardwired to the end of a cord that is stored on a fixed cord reel or other fixed storage means, the requirements in 22.12.8.1 through 22.12.8.6 shall apply.

22.12.8.1 The remote power distribution box shall be listed for use in a wet location.

22.12.8.2* The distribution box shall be as follows:

(1) Protected from corrosion

(2) Capable of being carried with a gloved hand

(3) Designed to keep the exterior electrical components above 2 in. (51 mm) of standing water

22.12.8.3 Inlets, receptacles, circuit breakers, or GFCI devices shall not be mounted on the top surface of the horizontal plane.

22.12.8.4 Branch circuit breakers shall be installed in the remote power distribution box if the overcurrent device protecting the feed cord to the box is too large to protect the wiring supplying the devices plugged onto the distribution box.

22.12.8.5* Remote power distribution boxes shall have a light on the box to indicate the power is on.

22.12.8.5.1* The light shall be visible in a 360 degree plane from a minimum of 200 ft (60 m) in complete darkness.

22.12.8.5.2 The light shall be mechanically protected to prevent damage.

22.12.8.6 The hardwired portable cord connection to the box shall have strain relief and meet the intended usage requirements.

22.13 Scene Lighting Systems.

Where fixed scene lights are supplied, the requirements in 22.13.1 through 22.13.4 shall apply.

22.13.1 All scene lights shall be provided with a lens or a means for preventing damage from water spray and shall be listed for wet location usage.

22.13.2 Handle on Lights.

22.13.2.1 If the light is adjustable, a handle shall be provided.

22.13.2.2 The design of the light shall not allow the temperature of the handle to exceed 131°F (55°C).

22.13.3 The manufacturer of the device shall have the scene light tested by a nationally recognized testing laboratory and listed to UL 153, *Standard for Portable Electric Luminaires*, or UL 1598, *Luminaires*.

22.13.4 If manually operated floodlights are not operable from the ground, access steps that meet the requirements of Section 15.7 and handrails that meet the requirements of Section 15.8 shall be provided to allow the user to reach the floodlights.

22.14 Power-Operated Light Mast.

22.14.1* General.

22.14.1.1 The mast shall be designed to sustain the intended tip load with at least a 125 percent safety factor.

22.14.1.2 The mast shall withstand a minimum of a 50 mph (80 kph) wind in a raised, unguyed position.

22.14.2* Installation and Operational Requirements.

22.14.2.1 The mast shall be capable of being raised within 2 minutes.

22.14.2.2 Where the installation precludes the operator from seeing the light in its nested position, a means shall be provided to allow the operator to align the light for nesting when the operator is at the operator's position.

22.14.2.3* Appropriate warning labels on the hazards of electrocution shall be installed.

22.14.2.4 A means shall be provided to prevent operations that could cause damage to the power supply conductors.

22.14.2.5 In the event of a failure of the light tower's raising system while the tower is deployed or being deployed, a means shall be provided to limit the rate of descent in order to prevent injury to equipment or personnel.

22.14.2.6 A secondary means of control shall be provided to allow for emergency lowering of the mast.

22.14.2.7 Where the tower is powered by the chassis air brake system, the air supply shall be from an auxiliary air circuit that is equipped with a pressure protection valve and an auxiliary air tank(s).

22.14.2.8* An automatic de-energizing means shall be provided so there is no electrical power to the mast or to the light wiring when the mast is in a stowed position.

22.14.2.9 The hazard warning light required in Section 13.11 shall be illuminated whenever the light tower is not in the stowed position.

22.14.2.10 The operational envelope of the mast shall be automatically illuminated whenever the mast assembly is being raised, lowered, or rotated.

22.14.3 Labeling.

22.14.3.1 An instruction plate showing the operation of the mast and operational warning signs shall be provided at the operator's position.

22.14.3.2 A label shall be provided at the operator's position to indicate the following:

(1) Extended tower height from the ground

(2) Bulb replacement data

22.15* Electrical System Testing.

22.15.1 The wiring and associated equipment shall be tested by the apparatus manufacturer or the installer of the line voltage system.

22.15.2 Dielectric Voltage Withstand Test.

22.15.2.1 The wiring and permanently connected devices and equipment shall be subjected to a dielectric voltage withstand test of 900 volts for 1 minute.

22.15.2.2 The testing shall be performed after all body work has been completed.

22.15.2.3* The test shall be conducted as follows:

(1) Isolate the power source from the panel board and disconnect any solid state low voltage components.

(2) Connect one lead of the dielectric tester to all the hot and neutral buses tied together.

(3) Connect the other lead to the fire apparatus frame or body.

(4) Close any switches and circuit breakers in the circuit(s).

(5) Apply the dielectric voltage for 1 minute in accordance with the testing equipment manufacturer's instructions.

22.15.3* The electrical polarity of all permanently wired equipment, cord reels, and receptacles shall be tested to verify that wiring connections have been properly made.

22.15.4 Electrical continuity shall be verified from the chassis or body to all line voltage electrical enclosures, light housings, motor housings, light poles, switch boxes, and receptacle ground connections that are accessible to fire fighters in normal operations.

22.15.5 If the apparatus is equipped with a transfer switch, it shall be tested to verify operation and that all nongrounded conductors are switched.

22.15.6 Electrical light towers, floodlights, motors, fixed appliances, and portable generators shall be operated at their full rating or capacity for 30 minutes to ensure proper operation.

22.15.7* Certification Test of Power Source.

22.15.7.1 The apparatus manufacturer or installer of the power source shall perform a certification test on the power source.

22.15.7.2 The testing of the power source shall be witnessed, and the results of the tests of the power source shall be certified by an independent third-party certification organization.

22.15.7.3 Test Procedure.

22.15.7.3.1 The prime mover shall be started from a cold start condition, and the unloaded voltage and frequency shall be recorded.

22.15.7.3.2 The line voltage electrical system shall be loaded to at least 100 percent of the continuous rated wattage stated on the power source specification label. Testing with a resistive load bank shall be permitted.

22.15.7.3.3 The power source shall be operated in the manner specified by the apparatus manufacturer as documented on instruction plates or in operation manuals.

22.15.7.3.4 The power source shall be operated at a minimum of 100 percent of the continuous rated wattage as stated on the power source specification label for a minimum of 2 hours.

22.15.7.3.4.1 The load shall be adjusted to maintain the output wattage at or above the continuous rated wattage during the entire 2-hour test.

22.15.7.3.4.2 The following conditions shall be recorded at least every ½ hour during the test:

(1) The power source output voltage, frequency, and amperes

(2) The prime mover's oil pressure, water temperature, and transmission temperature, if applicable

(3) The power source hydraulic fluid temperature, if applicable

(4) The ambient temperature and power source air inlet temperature

22.15.7.3.4.3 The following conditions shall be recorded once during the test for power sources driven by dedicated auxiliary internal combustion engines:

(1) Altitude

(2) Barometric pressure

(3) Relative humidity

22.15.7.3.5 If the generator is driven by the chassis engine and the generator allows for operation at variable speeds, the chassis engine speed shall be reduced to the lowest rpm allowed for generator operation and the voltage and frequency shall be recorded.

22.15.7.3.6 The load shall be removed, and the unloaded voltage and frequency shall be recorded.

22.15.7.3.7 Voltage shall be maintained within ±10 percent of the voltage stated on the power source specification label during the entire test.

22.15.7.3.8 Frequency shall be maintained within ±3 Hz of the frequency stated on the power source specification label during the entire test.

22.15.7.3.9 The total continuous electrical loads, excluding those loads associated with the equipment defined in 22.15.7.3.11.2, shall be applied during the testing unless an auxiliary engine drives the power source.

22.15.7.3.10 Concurrent Pumping.

22.15.7.3.10.1* If the apparatus is equipped with a fire pump, the 2-hour certification test of the power source shall be completed with the fire pump pumping at 100 percent capacity at 150 psi (1000 kPa) net pump pressure.

22.15.7.3.10.2 The test shall be permitted to be run concurrently with the pump certification test required in 16.13.1.

22.15.7.3.10.3 Running the pump during testing of portable generators connected to fixed wiring on the apparatus shall not be required unless the generator is mounted in an area subjected to a rise in ambient temperature greater than 30°F (17°C) from the vehicle engine, pump, or other heat source.

22.15.7.3.11 Prime Mover–Driven Accessories.

22.15.7.3.11.1 Accessories driven by the power source prime mover shall not be functionally disconnected or otherwise rendered inoperative during the line voltage electrical tests.

22.15.7.3.11.2 The following devices shall be permitted to be turned off or not operating during the fixed power source test:

(1) Aerial hydraulic pump

(2) Foam pump

(3) Hydraulically driven equipment other than a hydraulically driven line voltage generator

(4) Winch

(5) Windshield wipers

(6) Four-way hazard flashers

(7) Compressed air foam system (CAFS) compressor

22.15.7.3.12 If the line voltage power is derived from the fire apparatus's low voltage system and is the primary source for line voltage, the power source shall not be shed by a load management system during the 2-hour test.

22.15.8 The results of each test shall be recorded on an appropriate form and provided with the delivery of the fire apparatus.

Chapter 23 Command and Communications

23.1 General.

If the fire apparatus is equipped with a separate communications area or if it is used as a totally dedicated command apparatus, it shall meet the requirements of this chapter.

23.2* Location.

The command center shall be enclosed within a vehicle crew area or body.

23.3* Climate Control.

23.3.1 The command area shall be provided with a heater capable of maintaining the temperature at a minimum of 60°F (16°C) with the fire apparatus's doors closed.

23.3.2 If an air conditioner is provided, it shall be capable of maintaining a minimum temperature of 20°F (11°C) below ambient down to 72°F (22°C) with the fire apparatus's doors closed.

23.4* Noise Levels.

When the fire apparatus is stopped with all components on the apparatus required for continuous operation at an incident in operation, the noise levels in the command area shall not exceed 80 dBA.

23.5 Lighting Levels.

23.5.1 The command area shall have a switch control at the door entry area for general entry lighting or automatic dome lighting.

23.5.2* Lighting levels during command operations shall provide a continuous 100 fc (1000 lx) in the command area.

23.6 Command Working Surfaces and Countertop.

23.6.1* Horizontal working surfaces shall be smooth and shall have corners and edges that will not cause injury or damage when rubbed up against.

23.6.2 Chair-level work surfaces shall be 28 in. to 30 in. (710 mm to 760 mm) above the floor.

23.6.3 Standup work surfaces shall be 36 in. to 40 in. (900 mm to 1000 mm) above the floor.

23.7 Seating in Command Center.

23.7.1* If seating is provided in the command center and that same seating is used during mobile operations (moving over the highway), the seat(s) and crew area(s) shall comply with Section 14.1.

23.7.2 Storage shall be provided for all seating that is not permanently mounted in the fire apparatus so that the seating can be stored in such a way as to protect all passengers while the fire apparatus is in motion.

23.7.3 A visible label shall be attached to each nonpermanently mounted seat indicating that the seat is not to be used while the fire apparatus is in transit and is to be stored during that time.

23.8* Cabinets and Equipment Storage.

Cabinets for the storage of equipment shall be designed and engineered to contain the equipment during periods of transit.

23.9 Wall, Ceiling, and Floor Surfaces.

23.9.1* The interior surfaces of command areas shall be free of sharp corners, projections, and edges.

23.9.2 Floor surfaces shall be capable of being routinely cleaned.

23.9.2.1 Floor mats or coverings shall be durable and removable for cleaning.

23.9.2.2 Floor surfaces, walking surfaces, and access steps shall comply with Section 15.7.

23.9.2.3 Access handrails shall comply with Section 15.8.

23.9.3 Dry-type greaseboards, corkboards, chalk-type boards, or similar bulletin- or command-type wall surfaces shall be fastened in place and shall be replaceable.

23.10 Communications and Electrical Consoles.

23.10.1* The communications equipment shall be installed in accordance with the component manufacturer's instructions and manuals.

23.10.2 If a radio or electrical console is provided, it shall be enclosed on all sides to afford protection to equipment mounted in the console.

23.10.2.1 The front surface shall be hinged or bolted in place.

23.10.2.2 Additional hinged or removable panels shall be provided, as required, for access to equipment.

23.11* Computer Equipment and Installation.

23.11.1 All computer equipment shall be installed in a manner to reduce shock, vibration, and mechanical injury.

23.11.2 All equipment not used during transit, such as computer equipment, shall be stored in cabinets or mounted to comply with 14.1.11.

23.11.3 Computer Electrical Outlets.

23.11.3.1 Electrical outlets specifically for computer use, whether low voltage or line voltage, shall be marked with a label for their intended usage and power output.

23.11.3.2 The outlets shall be tested by the apparatus builder to ensure that they meet the voltage and amperage specified on the label.

23.12 Video Equipment and Installation.

23.12.1 The purchaser shall detail the exact video equipment that is to be mounted on and used with the apparatus.

23.12.2 The storage of video equipment shall be in enclosed cabinets, with padding to prevent mechanical injury and quick release straps to hold the equipment in its designated storage area.

23.12.3 If a video monitor is provided, it shall be mounted so as to prevent it from being damaged during transit.

23.12.4 If the equipment is to be externally mounted, mounting brackets and outlet plugs shall be installed as necessary to accommodate the outside mounting of video equipment.

23.12.5 Roof access ladders, steps, and safety railings shall meet the requirements of and be installed as required by Chapter 15.

Chapter 24 Air Systems

24.1 Application.

24.1.1 Where a breathing air system or a utility air system is mounted on fire apparatus, the requirements of this chapter shall apply.

24.1.2 This chapter shall not apply to a compressed air foam system (CAFS).

24.2* Provisions Applying to All Air Systems.

24.2.1* Compressor and booster supplied systems shall be capable of storage and operation in any ambient temperature between 32°F and 110°F (0°C and 43°C).

24.2.2 Cascade and bulk air systems shall be capable of storage and operation in any ambient temperature between 0°F and 110°F (–18°C and 43°C).

24.2.3 The air system shall be designed so that it can be stored and operated in environments with relative humidity up to and including 100 percent.

24.2.4 All materials used in the air system shall be corrosion resistant or treated to resist corrosion unless the finished product will be in continual contact with a noncorrosive lubricant.

24.2.5 Assembly and Installation Practices.

24.2.5.1 Installation of low voltage electrical components shall meet the requirements of Chapter 13, and installation of line voltage electrical components shall meet the requirements of Chapter 22.

24.2.5.2 Hot Surfaces.

24.2.5.2.1 Surfaces over 142°F (61°C) shall be covered with a thermal insulating material or shall be mechanically guarded to protect the operator.

24.2.5.2.2 If covering or guarding the surface affects the operation of the component, a label shall be provided that states “Caution: Hot Surfaces When Operating.”

24.2.5.3 The air system shall be designed and constructed to withstand the stresses, vibrations, and other conditions incident to being mounted on a fire apparatus and being used in mobile service.

24.2.5.4 Locking Devices.

24.2.5.4.1 All screws, pins, bolts, and other fasteners whose failure would create a hazardous condition for personnel or equipment shall be equipped with locking devices.

24.2.5.4.2 Safety wire, self-locking nuts, cotter pins, lock washers, and liquid-locking compounds shall be acceptable.

24.2.6 Breathing Air Systems.

24.2.6.1 Each part utilized in the fabrication of the air system and its components shall be designed for use in compressed breathing air service at pressures, temperatures, and flow rates that will be encountered during actual air system operation.

24.2.6.2 Discharge air from a compressor shall pass through a purification system prior to distribution.

24.2.6.3 Prior to the initial air quality test and commissioning, the breathing air system shall be purged with pure air until moisture and other contaminants have been removed.

24.2.7 General Piping and Installation.

24.2.7.1 All pneumatic fittings, tubing, and hose shall be rated for the maximum allowable working pressure that could be encountered, with a test safety factor of not less than 4:1.

24.2.7.2 All pneumatic fittings, tubing, and hose shall be corrosion resistant or treated to resist corrosion.

24.2.7.3 No threaded close nipples shall be used.

24.2.7.4 Plugs shall be bar stock type with Allen head or hex heads.

24.2.7.5 All piping and tubing shall be blown clean with clean, dry air before being installed.

24.2.7.6 When making up threaded piping joints, the sealant shall be applied to the thread in a manner that will prohibit entry of the sealant into the piping system.

24.2.7.7 Pipes or tubes installed but not connected shall have the ends closed with threaded caps or plugs to prevent the entry of foreign material.

24.2.7.8 Air connections on equipment or panels shall be provided with a threaded dust cap on a safety chain or shall be a quick disconnect–type fitting.

24.2.7.9 All rigid piping compressed air lines shall be clamped to a rigid body or chassis component at a minimum of every 16 in. (400 mm) and within 4 in. (100 mm) on each side of a coupling or elbow.

24.2.7.9.1 Rigid piping shall run in an orderly manner with a minimum of bends and elbows.

24.2.7.9.2 The piping installation shall provide room for maintenance and repairs with access panels provided where applicable.

24.2.7.10 Any rigid piping or flexible lines that run through a compartment shall be protected with removable mechanical protection to prevent wear and damage from equipment stored in the compartment.

24.2.8 Flexible Hose.

24.2.8.1 Flexible hose shall be installed in such a manner as to prevent cuts, abrasions, exposure to damage, excessive temperatures, damage from loose equipment, and excessive bending.

24.2.8.2 The hose shall be installed in a manner that permits removal of the hose without removal of major vehicle components or vehicle-mounted equipment.

24.2.9 Operator's Panel and Controls.

24.2.9.1 The air operator's panel containing gauges, instruments, and valves shall face the operator's position and shall be lighted in compliance with 4.10.1.

24.2.9.2 Any instrument that is to be used as a basis for manual control shall be visible and controlled from the operator's position.

24.2.9.3 Accessory gauges or controls that are not critical to the mission of the air system shall be permitted to be mounted remotely from the operator's panel or at another location where they can be monitored.

24.2.9.4 Pressure gauges or other devices shall not be mounted directly on lines where excessive vibration is likely to occur.

24.2.9.5 With the exception of direct connected process instruments (e.g., pressure gauges), instruments shall not use instrument piping or electrical conduit for support.

24.2.9.6 Any gauge shall be capable of reading at least 110 percent but not greater than 200 percent of maximum working air pressure.

24.2.10 Maintainability.

24.2.10.1 The design of the air system shall provide for maintainability by including, but not necessarily being limited to, the following maintainability objectives and technical and operational constraints:

(1) The design shall be such that faults can be isolated to allow access to removable

assemblies or components.

(2) Electrical panels, junction boxes, circuit breakers, and fuses shall be readily accessible.

(3) The physical arrangement of components shall be such that they can be inspected, serviced, calibrated, and, if necessary, adjusted without being removed and with minimum disturbance to other parts.

(4) The design shall be such that inspection, service, and replacement can be accomplished using a minimum of special tools and support equipment.

(5) Test points shall be provided to facilitate malfunction isolation and the connection of calibration instrumentation.

(6) If equipment requires oil or other liquid drainage, it shall be provided with a remote drainage system that is equipped with a control valve, threaded plug or cap, and a label to note usage.

24.2.10.2 If special tools are required to service or maintain the air system, those tools shall be supplied by the manufacturer.

24.2.11 Labels and Plates.

24.2.11.1 All major components and accessories shall be identified with a label.

24.2.11.2 Caution and warning signs shall be affixed where necessary.

24.2.11.3 Instruction plate(s) shall be installed, as applicable, to advise the operator on the proper adjustment or setting of controls for safe operation.

24.2.11.4 Controls, gauges, valves, and other equipment shall be marked with a label indicating their function.

24.2.11.5 All controls and valves shall have a label to indicate movement direction.

24.2.11.6* The major component manufacturers and installers of the air system shall provide electrical diagrams and air piping drawings that document the system and its operation.

24.2.11.6.1 All symbols used shall be described in key charts on the drawings.

24.2.11.6.2 All diagrams and drawings shall be delivered with the fire apparatus.

24.2.11.6.3 The following information shall be shown:

(1) The general arrangement of the air system, including air storage, air compressor (if provided), air panel, SCBA fill station (if provided), and air inlets and outlets

(2) The electrical wiring arrangement and controls, denoting shorepower equipment, low voltage equipment, and line voltage equipment

(3) The air operator's control panel surface showing all controls, gauges, valves, outlets, and other specified equipment, including the labeling on the panel and controls

(4) The air piping arrangement with airflow direction indicated and showing all valves, gauges, controls, air tanks, and furnished equipment

24.2.12 Documentation.

24.2.12.1 Two complete sets of documentation that cover the operation and maintenance of the system shall be delivered with the fire apparatus.

24.2.12.2 The documentation shall be permitted to be in printed format, electronic format, audiovisual format, or a combination thereof.

24.2.12.3 Nomenclature for switches, controls, and indicators shall be consistent with that used on the diagrams required in 24.2.11.6 and on equipment nameplates.

24.2.12.4 The manuals shall include, but not necessarily be limited to, the following:

(1) An illustrated parts lists

(2) A schedule of maintenance and adjustment checks

(3) A lubrication schedule

(4) Troubleshooting information to enable a technician to locate trouble and to make repairs or adjustments to the equipment

(5) Step-by-step procedures for starting, operating, and stopping the equipment

24.2.13 Training and Instruction.

24.2.13.1* If a breathing air system without a compressor/purification system is provided, the final installer of the air system shall supply a qualified person to provide operational training to fire department personnel that includes the following:

(1) A complete system component familiarization/walkaround

(2) A complete review of the system and its safety features

(3) A review of all operation, service, and maintenance documentation

(4) Hands-on familiarization of the safe operation of the fill station and air management panel, including actual SCBA filling, air reel operations, and other pertinent operations of the system

24.2.13.2* If a breathing air system that includes a compressor/purification system is provided, a person certified by the breathing air compressor manufacturer in the operation of the specified air compressor system shall provide training to fire department personnel.

24.2.13.2.1 The training shall include the items listed in 24.2.13.1.

24.2.13.2.2 The training shall also include the following:

(1) A review of the compressor/purification system operations and maintenance, including

the operations and maintenance documentation and the name, address, and phone number of the local distributor

(2) Procedures to change purification cartridges

(3) Hands-on familiarization of the safe operation of the compressor and purification system

24.2.13.3 The fire department shall designate one or two individuals to be the resource persons for all the breathing air system training and equipment indoctrination.

24.2.13.4 The fire department shall designate where the training is to take place.

24.3* Breathing Air Compressor.

24.3.1 The purchaser shall determine the working pressure and capacity required from the compressor and state those requirements in the purchase specifications.

24.3.2 Compressor Intake.

24.3.2.1* The air intake shall be located where it will not be contaminated by the exhaust of the fire apparatus or the exhaust of the gasoline or diesel engines used to power the compressor or other components on the apparatus.

24.3.2.2 If an extended air intake pipe is used, it shall be installed in accordance with the compressor manufacturer's specifications.

24.3.3 Cooling.

24.3.3.1 The final installer shall assemble and install all components in accordance with the component manufacturers' instructions and shall test the final assembled system in accordance with this standard and the operating parameters of the component manufacturers.

24.3.3.2* Provisions shall be made by the final installer to ensure there is adequate cooling to keep the air compressor within the compressor manufacturer's operating temperature range while it is operating in an ambient temperature range between 32°F and 110°F (0°C and 43°C).

24.3.3.2.1 The final stage installer of the air compressor shall submit air system arrangement drawings, airflow schematic drawings, body drawings, and other pertinent data to the air compressor assembler for written approval.

24.3.3.2.2 A copy of this approval shall be retained by the final assembler in apparatus documentation.

24.3.3.3 The temperature of the compressed air shall not exceed 20°F (11°C) above ambient when measured at the discharge nozzle of the compressor aftercooler.

24.3.3.4 The air compressor compartment shall be equipped with a temperature sensing device that will actuate an audible and visual alarm at the fill station operator’s panel when the ambient temperature in the compartment exceeds 140°F (60°C).

24.3.3.5* The final stage installer shall provide a warning label(s) cautioning: “Do not obstruct airflow path with equipment mounting.”

24.3.4 A relief valve shall be provided after each stage of compression.

24.3.5 If interstage condensate traps are provided by the compressor manufacturer, they shall be plumbed with the final separator and to an automatic condensate drain system, which shall be plumbed to a reservoir to collect the discharged liquids.

24.3.6 Compressor Drive System, Controls, and Air Quality Monitoring.

24.3.6.1 All compressors shall have automatic audible and visual alarms and controls at the main operator's panel that shut down the compressor and prevent automatic restart when any of the following conditions occurs:

(1) Oil level or oil pressure is low.

(2) Discharge air temperature is higher than recommended by the manufacturer.

(3) Moisture in the compressed air at the purification system outlet exceeds 24 ppm.

(4) Carbon monoxide level within the processed air exceeds 10 ppm.

24.3.6.2* All compressors shall be equipped with the following:

(1) An air pressure switch that controls the maximum operating pressure

(2) Interstage pressure gauges after each compression stage

(3) Final stage pressure gauge

(4) Oil pressure gauge on pressure lubricated compressors or an oil level indicator or device on nonpressure oil-type compressors

(5) Electric, nonresettable hourmeter(s)

(6) Air quality monitoring system

24.3.6.3* Compressors with electric motors shall be equipped with the following:

(1) Magnetic motor starter with motor overload protection

(2) Protective control to prevent automatic restart after power loss has been restored

(3) A shorepower connection to permit external electric power to supply the air compressor’s electric motor when the vehicle is in a fire station

24.3.6.4 Compressors with gasoline and diesel engines shall be equipped with the following:

(1) Means to allow the engine to be started, idled, and run with the compressor disengaged or unloaded

(2) Electric, nonresettable hourmeter to record engine operating hours

24.3.7 The compressor and driver assembly shall be mounted to a subassembly with shock mounts to provide vibration dampening.

24.3.7.1 The compressor frame shall have provision for safe handling or lifting.

24.3.7.2 Frames for compressors with V-belt drives shall include a means to adjust the V-belt tension.

24.3.8 The air compressor shall have a label affixed in a conspicuous location showing the name and address of the manufacturer, the serial number and model number, the date of manufacture, and the rated capacity.

24.4 Purification System.

If the compressed air system is to supply breathing air, a purification system that meets the requirements of 24.4.1 through 24.4.8 shall be installed.

24.4.1* If the processed air is to be used as breathing air, the purification system shall produce breathing air that meets the requirements of NFPA 1989, *Standard on Breathing Air Quality for Emergency Services Respiratory Protection*.

24.4.2 If the processed air is to be used for underwater diving, the purification system shall produce breathing air that meets the requirements of Grade E breathing air as specified by CGA G-7.1, *Commodity Specification for Air*.

24.4.3 The purification system shall be capable of producing the required air quality at full capacity of the compressor for a minimum of 50 hours with inlet air of 80°F (27°C) at saturation.

24.4.3.1 The purification system shall be equipped with purifier cartridges and filter elements.

24.4.3.2* The design of the purification system shall permit replacement of the purifier cartridges without disconnecting piping or other components.

24.4.3.3 The purifier system shall be protected from mechanical damage caused by loose equipment stored on the apparatus.

24.4.4 A relief valve shall be provided in the purification system, set no higher than 10 percent above the maximum allowable working pressure.

24.4.5 A mechanical separator shall be provided and shall be piped to the automatic drain system.

24.4.5.1 A check valve shall be installed between the mechanical separator and the remainder of the purification system.

24.4.5.2 The mechanical separator and the purifier housings shall be designed for a 4:1 safety factor at their maximum allowable working pressure.

24.4.5.3 The mechanical separator and the purifier housings shall be corrosion resistant or treated to resist corrosion.

24.4.6 A pressure gauge shall be installed ahead of the purifier to monitor depressurization before service, maintenance, or repairs of the compressor or purifier.

24.4.7 A pressure regulator valve (back pressure regulator or minimum pressure valve) with a minimum setting of 2000 psi (14,000 kPa) shall be installed in the purification system downstream of the mechanical separator and purifier housings.

24.4.7.1 A piping connection shall be provided downstream of the pressure regulator valve to provide an air sample for the air quality testing.

24.4.7.2 A line valve shall be installed on the purifier outlet to allow the purifier to be isolated from the downstream air system during inspection, maintenance, and repairs.

24.4.8 A warning label shall be installed at the purifier chambers as follows:

> ***WARNING:*** *Prior to changing purifier cartridges, or performing service or maintenance on the purifier system, release all air pressure in the air compressor system.*

24.5* Air Storage Systems.

24.5.1 Transportable Air Tanks.

24.5.1.1 Transportable air tanks shall comply with 49 CFR 178.37, “Specification 3AA and 3AAX seamless steel cylinders,” or 29 CFR 1910.169, “Air receivers.”

24.5.1.2 The air tank manufacturer shall provide a copy of either the U.S. Department of Transportation (DOT) certificate Report of Inspection of Gas Cylinders or the ASME certificate Manufacturers Data Report for Pressure Vessels, and the certificate shall be delivered with the fire apparatus.

24.5.1.3 Relief valves on transportable air tanks shall be of the ASME type on ASME cylinders and of the DOT type on DOT cylinders or equal for the rated pressure.

24.5.2 Valves installed on air tanks shall meet the requirements of the Compressed Gas Association regarding pressure and usage with compressed air.

24.5.3 Air tanks shall be permanently stamped or identified in accordance with DOT or ASME regulations.

24.5.4 If the installation utilizes cylinders that require periodic testing, a label shall be placed on or near the operator's panel that provides the following:

(1) The original cylinder test date stamped on the cylinders

(2) The recommended testing interval

(3) Five additional open spaces, appropriately labeled, for the user to enter actual retesting dates

24.5.5 The manufacturer's test date (month and year) on each air tank shall be current within

12 months of the apparatus delivery date.

24.5.6 Air tanks shall be marked with a label that reads “High Pressure ____ psi Breathing Air” or “High Pressure _____ kPa Breathing Air.”

24.5.7 Air Tank Mounting.

24.5.7.1* Air tanks shall be mounted in an arrangement that will hold the tanks in all types of mobile use.

24.5.7.1.1 A protective device(s) shall be provided to protect the air tank valve(s) and associated piping from damage as a result of accidental impact.

24.5.7.1.2 The protective device(s) shall not prevent access for operation and inspection.

24.5.7.2 The air tank mounting shall facilitate removal of air tanks for inspection, testing, or service.

24.5.7.2.1 Air tanks shall be installed so that all air tanks, control valves, and associated piping are readily accessible.

24.5.7.2.2 Air tanks shall be mounted in such a fashion to permit visual inspection of external surfaces and emergency access to shutoff of tank valves.

24.5.7.2.3 The air tank location shall be away from any heat-producing devices such as the generator engine or exhaust.

24.5.8 Air Tank Valve Control and Monitoring.

24.5.8.1 A slow-operating valve(s) shall be provided to control airflow into and out of the storage system (if applicable).

24.5.8.2 A separate inlet connection shall be provided so that the storage system can be refilled from a remote source.

24.5.8.2.1 The inlet connection fitting shall be compatible with the rated pressure of the storage system as specified by CGA G-7, *Compressed Air for Human Respiration*, and shall be equipped with a dust cap with a chain and “pin hole” to release leaking pressure when not in use.

24.5.8.2.2 A check valve or a line valve shall be provided on the inlet connection.

24.5.8.3 Gauges shall be provided to allow for monitoring pressures from the air storage system or individual air tanks.

24.5.8.3.1 For systems that are capable only of bulk filling, a minimum of a single gauge shall be provided.

24.5.8.3.2 For systems capable of cascade filling, gauges shall be provided for each individually controlled tank or set of tanks.

24.6* Air Booster Systems.

24.6.1 Line valves shall be provided at the air control panel or on the air booster to control the booster inlet air supply line and the booster discharge airflow.

24.6.2 A pressure gauge shall be provided on the supply line and the discharge line from the booster.

24.6.3 A safety valve or high pressure switch shall be installed on the discharge side of the air booster.

24.6.4 The pressure setting on the safety valve or high pressure switch shall not exceed the maximum allowable working pressure of the booster, the booster's distribution piping, or the air system components.

24.7 Air Supply Regulation.

Air supply regulation shall include the following provisions on an operator's air control panel:

(1) One air pressure gauge marked with a label that reads "Supply Pressure" between the air supply line valve and the pressure self-relieving regulator

(2) One slow-operating air supply valve on the intake supply line

(3) One self-relieving adjustable pressure regulator equipped with a device to prevent unintentional adjustment

(4) One air pressure gauge downstream of the pressure regulator

(5) One pressure relief valve preset at not over 10 percent above the pressure regulator output setting

(6) A warning label installed next to the pressure regulator to indicate working pressure setting and that a relief valve will release at 10 percent higher than the working pressure

24.8 Air Control Panel.

24.8.1 The air control panel and system piping arrangement for a compressor-supplied breathing air system shall allow the operator to perform the following functions:

(1) Fill the storage system directly from the compressor/purification system

(2) Fill SCBA cylinders directly from the compressor/purification system

(3) Fill SCBA cylinders directly from the storage system/air booster

(4) Utilize the cascade method or bulk fill method of filling SCBA cylinders, as desired

(5) Bypass filling of the storage system to top off SCBA directly from the compressor/purification system

(6) Regulate the maximum SCBA fill pressure

(7) Meter airflow to control the SCBA fill rate with a slow-operating valve

(8) Take an air sample to check air quality (at panel or at end of air reel hose, if applicable)

24.8.2 When a cascade system is installed without a compressor, an air control panel and the system piping arrangement shall allow the operator to perform the following functions:

(1) Fill the storage system directly from a remote air compressor

(2) Fill SCBA cylinders directly from a remote air compressor

(3) Fill SCBA cylinders directly from the storage system

(4) Fill SCBA cylinders directly from a booster pump that is supplied by the storage system, if provided

(5) Utilize the cascade method, the bulk fill method, or both for filling SCBA cylinders, as appropriate to the design of the system

(6) Regulate the maximum SCBA fill pressure

(7) Meter airflow to control the SCBA fill rate with a slow-operating valve

(8) Take an air sample to check air quality (at the panel or at the end of an air reel hose, if applicable)

24.9 SCBA or SCUBA Air Cylinder Fill Station.

24.9.1 If SCBA and/or SCUBA air cylinders are to be filled from a fire apparatus–mounted air system, the fill station shall meet the requirements of 24.9.1.1 through 24.9.1.6.

24.9.1.1 The fill station shall fully enclose the cylinder during filling to contain the fragments if a cylinder ruptures.

24.9.1.2 The fill station shall fully enclose the refill lines to the cylinders.

24.9.1.3 The fill station shall direct the concussive air blast away from the operator and bystanders.

24.9.1.4 A fill station within an enclosed crew area shall have provisions to vent the concussive air blast to the exterior of the fire apparatus.

24.9.1.5 A means shall be provided to prevent SCBA or SCUBA cylinders from being refilled unless the fill station is in the “cylinder fill operation position.”

24.9.1.6 A warning sign shall indicate the hazards inherent in the operation of filling SCBA or SCUBA cylinders.

24.9.2 Pressure gauges, pressure-regulating devices, and controls shall be provided to allow the operator to control the SCBA cylinder fill pressure and fill rate on each SCBA fill hose.

24.9.3 A valve(s) on a fill line(s) shall be a slow-operating valve.

24.9.4 A separate flow restriction device shall be provided on each SCBA fill hose.

24.9.5 A method of bleeding each air cylinder fill hose shall be provided.

24.9.6 The SCBA or SCUBA fill enclosure shall be installed in accordance with requirements of the fill enclosure manufacturer.

24.9.7 Testing and Certification.

24.9.7.1 The manufacturer of the enclosed air refill station shall type test a standard production model to validate the design.

24.9.7.1.1 If the enclosed air fill station is for SCBA cylinders, the test shall include pressurizing an SCBA cylinder that is capable of holding at least 88 ft^3 (2492 L) of air at 4500 psi (31,025 kPa) to failure. The failure shall occur when the pressure in the cylinder is not less than 4500 psi (31,025 kPa).

24.9.7.1.2 If the enclosed air fill station is for SCUBA cylinders, the test shall include pressurizing an SCUBA cylinder that is capable of holding 80 ft^3 (2265 L) of air at 3000 psi (20,685 kPa) to failure. The failure shall occur when the pressure in the cylinder is not less than 3000 psi (20,685 kPa).

24.9.7.1.3 If the enclosed air fill station is designed for both SCBA and SCUBA cylinders, the refill station shall be tested in accordance with 24.9.7.1.1.

24.9.7.1.4 If the system provides for simultaneously refilling of multiple cylinders, the other chambers shall contain air cylinders equal in capacity and pressure to the cylinder in the chamber being tested.

24.9.7.1.5 The test pressure shall be measured at the SCBA or SCUBA fill enclosure.

24.9.7.1.6 The SCBA or SCUBA fill station shall be tested in a configuration that meets the fill station manufacturer's standard installation requirements.

24.9.7.2 The testing shall prove the following:

(1) The air refill station is capable of containing all fragments of a failed cylinder.

(2) The cylinders in adjacent chambers do not rupture.

(3) The venting provisions direct the air-concussive release away from the operator.

24.9.7.3 All tests shall be witnessed and the test results certified by an independent third-party certification organization.

24.10* Air Hose Reels.

24.10.1* Any permanently mounted air hose reel shall be certified by the reel manufacturer for use at the maximum expected working pressure with a safety factor of at least 4:1.

24.10.2 The air hose reel swivel joint, connecting feed hose, check valve, and air supply equipment shall be rated for the maximum working pressure with a safety factor of at least 4:1.

24.10.3 The air hose reel shall be designed to hold at least 110 percent of the intended hose length with a minimum capacity of 100 ft (30 m).

24.10.4 Size of Fluid Path.

24.10.4.1 The air hose reel shall have a full flow–style swivel joint and a hose connection designed and sized to match the hose intended to be used.

24.10.4.2 The air hose reel shall have a fluid path sized for its intended flow and working pressure.

24.10.5 The reel shall be marked with a label to indicate its intended use and the following:

(1) Utility air or breathing air

(2) Operating pressure

(3) Total hose length

(4) Hose size (ID)

24.10.6 Air Supply to Air Reel.

24.10.6.1 The following equipment shall be provided on the intake air supply line to the reel where the air supply gauge pressure is up to 150 psi (1000 kPa):

(1) One air pressure gauge

(2) One slow-operating air supply valve

(3) One check valve

24.10.6.2 The following equipment shall be provided on the intake air supply line to the reel where the air supply gauge pressure is between 151 psi (1000 kPa) and 300 psi (2000 kPa):

(1) One air pressure gauge upstream of the air pressure–regulating device

(2) One slow-operating air supply valve

(3) One adjustable pressure regulator equipped with a device to prevent inadvertent or accidental adjustment

(4) One downstream pressure gauge [0 psi to 500 psi (0 kPa and 3400 kPa) range]

24.10.6.3 The following equipment shall be provided on the intake air supply line to the reel where the air supply gauge pressure is over 300 psi (2000 kPa):

(1) One air pressure gauge upstream of the air pressure–regulating device

(2) One slow-operating air supply valve

(3) One adjustable pressure regulator equipped with a device to prevent inadvertent or accidental adjustment

(4) One downstream pressure gauge

(5) One preset pressure relief valve set at not over 10 percent above maximum working pressure

24.10.7 The inlet to an air hose reel with an operating gauge pressure of over 300 psi (2000 kPa) shall have a flow-limiting device, such as a velocity-type valve, or a manually adjustable orifice-type valve.

24.10.7.1 The device shall be adjusted to restrict excessive flow and shall be located or covered to prevent readjustment.

24.10.7.2 The metering device shall not be used for normal shutoff valve purposes.

24.10.8 The final assembler of the air hose reel, piping, and valve system shall test the system at the maximum operating pressure of the system for 10 minutes with no pressure loss.

24.10.8.1 This test shall include the hose, if supplied, on the reel.

24.10.8.2 A permanent label shall be installed adjacent to the air reel controls to indicate the operating pressure range and the type of air provided, low pressure utility air [gauge pressure under 300 psi (2000 kPa)], low pressure breathing air [gauge pressure under 125 psi (800 kPa)], or high pressure breathing air [gauge pressure over 300 psi (2000 kPa)].

24.10.9 Air Reel Installation.

24.10.9.1 Reels installed in concealed locations shall be accessible for maintenance and servicing, hose access, and reel removal.

24.10.9.2 Rollers and guides shall be installed, where necessary, to prevent damage to the hose at the reel spool or compartment openings and to allow deployment and rewinding of the hose.

24.10.9.3 Reels shall be installed in such a manner so as not to expose the operator to the rewind components.

24.10.9.4 Manually operated reels shall have an operable hand crank with its central midpoint or centerline located not over 72 in. (1830 mm) above the ground or platform that is designed to serve as the operator's standing position.

24.10.9.5 Switches for power rewind–type reels shall be located in a position that allows the operator to safely rewind the hose.

24.10.9.5.1 The rewind control shall not be more than 72 in. (1830 mm) above the operator's standing position.

24.10.9.5.2 The rewind control shall be marked with a label indicating its function and shall be guarded to prevent accidental activation.

24.10.10* **Low Pressure Breathing Air Reel.**

24.10.10.1 The regulation of the output pressure from the breathing air reel shall be at the reel or at an air control panel.

24.10.10.2 No shutoff valves or flow control valves shall be installed downstream of the pressure regulator except at the end of the hose.

24.10.10.3 The low pressure breathing air supply shall be equipped with a low air pressure audible warning device on the air supply.

24.11 Air Hose.

24.11.1* All low pressure [gauge pressure not over 300 psi (2000 kPa)] air hose and couplings supplied shall comply with their intended application and shall have a pressure rating equal to or greater than the highest pressure expected to be encountered as input to the hose with a test safety factor of at least 3:1.

24.11.2 All high pressure [gauge pressure over 300 psi (2000 kPa)] air hose and couplings supplied shall comply with their intended application and shall have a pressure rating equal to or greater than the highest pressure expected to be encountered as input to the hose with a test safety factor of at least 4:1.

24.11.3 Where the hose is attached to an air reel, it shall be done in a manner that allows for its removal.

24.11.4 Discharge Ends.

24.11.4.1* The discharge end of any breathing air hose shall have a threaded connection.

24.11.4.1.1 If no other fittings are installed at the end of the hose, a temporary protective cap shall be installed to prevent internal contamination of the hose during shipping.

24.11.4.1.2 If the discharge end of hose will terminate with a threaded connection when in use, it shall be equipped with a slow-operating valve.

24.11.4.1.3 If the threaded end of the hose terminates in a quick-connection fitting, a slow operating valve and protective cap shall not be required.

24.11.4.1.4 Connections to hose shall comply with 24.2.7.

24.11.4.2 The discharge end of utility air hose shall have either a threaded connection and slow-operating valve or a quick-connection fitting.

24.11.5 Color Coding.

24.11.5.1 The ends of the hose shall be color coded or marked with a label to designate the operating pressure of the hose.

24.11.5.2 If color coding is used, it shall be as follows:

(1) Blue for utility air hose up to a gauge pressure of 300 psi (2000 kPa)

(2) White for breathing air hose up to a gauge pressure of 300 psi (2000 kPa)

(3) Yellow for breathing air hose from a gauge pressure of 301 psi to 3000 psi (2001 kPa to 20,000 kPa)

(4) Red for breathing air hose over a gauge pressure of 3000 psi (20,000 kPa)

24.11.6* Low pressure breathing air hose shall be a minimum ⅜ in. (10 mm) ID with a maximum hose length of not more than 300 ft (90 m).

24.11.7 Utility air hose shall be of a flexible type, with a scuff abrasion–resistant outer covering.

24.11.8 The hose shall be oil resistant and shall be compatible with oil, alkalis, kerosene, paraffin, grease, and salt solutions.

24.11.9 The hose connections for utility air hose shall not be the same as for low pressure breathing air hose or high pressure air hose.

24.12* Low Pressure Utility Air Supply.

24.12.1* The chassis air brake system shall not be used for emergency use applications such as airbags, tools, air reels, and other rescue applications.

24.12.2* Where nonemergency applications are supplied by the chassis air brake system, the air supply shall be from an auxiliary air circuit that is equipped with a pressure protection valve (PPV) and auxiliary air tanks.

24.13 Remote Breathing Air Systems.

Remote breathing air systems for pump panels or other remote locations shall comply with 24.13.1 through 24.13.7.

24.13.1 A breathing air system shall be designed to supply breathing air for a minimum of two persons at the specified location.

24.13.2 The system shall include storage for at least 400 ft^3 (11,320 L) of breathing air and shall meet the requirements of Section 24.5.

24.13.3 Piping System.

24.13.3.1 The piping system shall be arranged with an air regulator that shall limit the air pressure in the piping to the desired operating pressure.

24.13.3.2 A pressure relief valve set to relieve the pressure at 10 percent above the desired operating pressure shall be installed on the downstream side of the regulator.

24.13.4 All valves, pressure regulators, and gauges shall be protected from accidental damage.

24.13.5 The piping or hose system between the air tanks and point of use shall be installed to prevent damage due to abrasion, bending, or pinching.

24.13.6 A holder or box shall be provided for the storage of the breathing air equipment when it is not in use.

24.13.7 A low air warning system shall be provided that monitors the air volume and provides an audible warning when the air volume is at or below 20 percent.

24.14* Breathing Air System Testing and Delivery.

24.14.1 The complete air system shall be tested by the final system installer after its installation on the fire apparatus is complete, using the testing procedure prescribed by the system manufacturer.

24.14.2 The following items shall be tested or verified on all air systems:

(1) Pressure test the system to its maximum operational pressure and check all connections made as a part of the installation for leaks with a leak detection device, which could include bubble fluid or electronic means.

(2) Verify that any leaks detected during the testing in 24.14.2(1) are repaired.

(3) Visually verify the relief valve set points and working pressure of the air tank.

(4) Verify the accuracy of all pressure gauges.

(5) Fully test the operational capabilities of the fill station as established by the manufacturer of the fill station.

(6) Seal all fill adapter connections to eliminate the introduction of contaminants prior to shipment.

24.14.3 If the system's air supply includes a compressor/purification system, the following additional items shall be tested or verified:

(1) Confirm that the fluid levels are at the manufacturer's recommended levels, including the lubricant and coolant if the system is liquid cooled.

(2) Verify the expiration date of the purification filters and cartridges and that they have been installed as required by the manufacturer of the system.

(3) Operate the air compressor for a minimum of 2 hours or the period required to completely fill the onboard air tanks, whichever is longer.

(4) Confirm that all compressor interstage pressures are within guidelines as established by the compressor manufacturer.

(5) Confirm the operation of the compressor shutdown switch at the pressure requested by the purchaser.

(6) Confirm the set point of the final pressure safety relief valve and pressure maintaining valve.

(7) Confirm the factory set limits of all electrical shutdown devices, including low oil pressure, automatic condensate drain system, high air temperature, excessive processed air moisture, high carbon monoxide, and motor amperage draw.

(8) Confirm that the breathing air system is installed in accordance with the breathing air compressor manufacturer's requirements and drawings and confirm that the cooling airflow is adequate.

24.14.4 Breathing Air Quality.

24.14.4.1 Prior to delivery of the apparatus equipped with a breathing air compressor to the end user, the final system installer shall draw an air sample from the breathing air system at each SCBA or SCUBA fill station and at the end of each air hose on an air reel and submit the sample(s) to be tested in accordance with NFPA 1989.

24.14.4.2 The breathing air shall meet the air quality standards defined in NFPA 1989.

24.14.5 The results of all tests, including the air quality analysis, shall be documented and shall be delivered with the fire apparatus.

24.14.6 The contractor shall deliver the apparatus with all air tanks, piping, hose, reels, and other fixed equipment charged with breathing air to a gauge pressure of at least 40 psi (275 kPa).

24.15 Utility Air System Testing.

24.15.1 Prior to delivery of an apparatus with a low pressure utility air compressor and piping, the final installer shall test and certify the performance of the system.

24.15.2 The following items shall be tested or verified on all air systems:

(1) Pressure test the system to its maximum operational pressure and check all connections made as a part of the installation for leaks with a leak detection device, which could include bubble fluid or electronic means.

(2) Verify that any leaks detected during the testing in 24.15.2(1) are repaired.

(3) Visually verify the relief valve set points and working pressure of the air tank.

24.15.3 If the system's air supply includes a compressor system, the following additional items shall be tested or verified:

(1) Confirm that the fluid levels are at the manufacturer's recommended levels, including the lubricant and coolant if the system is liquid cooled.

(2) Operate the air compressor for a minimum of 1 hour.

(3) Confirm operation of the compressor shutdown switch at the pressure requested by the

purchaser.

(4) Confirm that the utility air system is installed in accordance with the air compressor manufacturer’s requirements and that the cooling airflow is adequate.

24.15.4 The results of the testing and certification required by 24.15.1 through 24.15.3 shall be documented and shall be delivered with the fire apparatus.

Chapter 25 Winches

25.1 General.

If a chassis-mounted winch is installed on the apparatus, it shall meet the requirements of this chapter.

25.1.1* The winch shall be designed for the intended use and shall be installed in accordance with the winch manufacturer's recommendations.

25.1.2 All winches shall be equipped with rollers, guides, or both to prevent damage to the winch wire or synthetic rope or the apparatus.

25.1.3 All rollers and guides shall be designed to match the winch capacity and rope size.

25.2 Winch Wire or Synthetic Rope.

25.2.1 The winch shall have a minimum wire rope or synthetic rope length of 75 ft (22 m).

25.2.2 The wire rope or synthetic rope shall be of a type and size recommended by the winch manufacturer.

25.2.3 The wire rope or synthetic rope assembly, including all hardware such as clevises, hooks, and snatch blocks provided for attachment to the winch, shall have a design load rating greater than the line pull capacity of the winch.

25.3* Clutch.

The winch shall be equipped with a clutch assembly to permit free spooling and quick removal of the wire or synthetic rope.

25.3.1 The free spooling clutch shall be accessible without reaching under the apparatus.

25.3.2 If the winch is installed under the apparatus or not visible to the operator, the free spooling clutch control shall be remotely controlled.

25.4 Electric Powered Winches.

25.4.1 Controls.

25.4.1.1* Operation of the electric motor shall be by means of a handheld control with forward, neutral, and reverse positions.

25.4.1.2 The control shall be located at the end of an electrical cord that is a minimum 25 ft (7.6 m) long and that plugs into a receptacle near the winch location or shall be integrated into a handheld transmitter operating on an approved radio frequency for the winch control device.

25.4.2 Power Supply.

25.4.2.1 Dedicated power and ground circuits shall be utilized.

25.4.2.2 Wiring shall be sized in accordance with the winch manufacturer's installation instructions and shall comply with Chapter 13 of this standard.

25.4.3 Removable Electric Winches.

25.4.3.1 Electric winches that are temporarily attached to the apparatus (at sides, rear, or front) shall meet the same requirements as permanently mounted winches.

25.4.3.2 The attachment to the apparatus shall be with quick-release devices.

25.4.3.3 The attachment system on the apparatus shall meet the requirements of Section 15.12.

25.4.4 Electric Power for Removable Winches.

25.4.4.1 The electrical power supply(ies) from the apparatus to the removable winch shall terminate at a quick disconnect receptacle with a connector plug.

25.4.4.2 The receptacle shall have a label indicating its use.

25.4.4.3 The power cord from the receptacle to the winch shall be sized for the power requirements of the winch.

25.4.4.4 The power cord shall be highly flexible and shall be protected from mechanical damage.

25.5 Hydraulically Driven Winches.

25.5.1 Hydraulic Hose.

25.5.1.1 All hydraulic hose shall be designed for the hydraulic pressures expected to be encountered.

25.5.1.2 Hose shall be a wire-braided type with a female swivel on one end.

25.5.2 The forward-neutral-reverse hydraulic control for the winch shall be electrically operated to permit remote control of the hydraulic winch operations.

25.5.2.1 Operation of the hydraulic winch shall be by means of a handheld control with forward, neutral, and reverse positions.

25.5.2.2 The control shall be located at the end of an electrical cord that is a minimum 25 ft (7.6 m) long and that plugs into a receptacle near the winch location or shall be integrated into a handheld transmitter operating on an approved radio frequency for the winch control device.

25.5.3 Hydraulic Tanks.

25.5.3.1 The hydraulic fluid tank shall be sized to prevent overheating of the fluid or cavitation of the hydraulic pump at its maximum output level.

25.5.3.2 The tank shall permit visual checking of the fluid level and easy refilling.

25.5.3.3 The fill point shall have a label permanently attached near the fill point stating the hydraulic oil quantity and type.

25.5.3.4 A drain plug shall be installed to permit complete draining of the tank.

25.5.3.5 A tank return line diffuser shall be installed in the tank.

25.5.3.6 A tank swash partition shall be installed in the tank between the suction and return lines.

25.5.3.7 A vent shall be supplied and shall be designed to prevent dirt and moisture from entering the tank.

25.5.4 The system shall be equipped with necessary filters and strainers to keep the hydraulic fluid within the cleanliness requirements necessary for operation of the hydraulic system.

25.5.5 The hydraulic winch engagement controls shall be located in the driving compartment.

25.5.5.1* A "Hydraulic Winch Engaged" indicator shall be provided in the driving compartment to indicate that the hydraulic pump engagement has been successfully completed.

25.5.5.2 An "OK to Operate Winch" indicator shall be provided in the driving compartment to indicate that the winch is engaged, that the transmission is in the proper gear (automatic transmissions only), and that the parking brake is engaged.

25.5.5.3 An interlock system shall be provided to prevent advancement of the engine speed in the driving compartment or at any operator's panel unless the transmission is in neutral and the parking brake is engaged, or the apparatus is in the "OK to Operate Winch" mode.

Chapter 26 Trailers

26.1 General.

For the purposes of this standard, trailers transporting equipment or other vehicles under emergency response conditions shall be considered fire apparatus, and any components on the trailer designed to support emergency services operations shall meet the applicable requirements defined in Section 4.5.

26.2 Classification of Trailers.

Trailers shall be classified as Type I, Type II, or Type III.

26.2.1* Trailers that are designed to remain connected to their tow vehicle throughout the response event and that are dependent on the tow vehicle to provide the required electrical power and conspicuity shall meet the requirements of this chapter for Type I trailers.

26.2.2* Trailers that are designed to allow separation from their tow vehicle after arrival at the response event and that are not dependent on the tow vehicle to provide the required electrical power and conspicuity shall meet the requirements of this chapter for Type II trailers.

26.2.3* Open trailers designed to transport other vehicles, equipment, or containers that will be removed from the trailer after arrival at the response event and that will not be blocking the right-of way during the incident shall meet the requirements of this chapter for Type III trailers.

26.3 Carrying Capacity.

26.3.1 The GVWR of the trailer shall not be greater than the sum of the tongue weight and the GAWR.

26.3.2 The stated load capacity of the trailer shall be the GVWR of the trailer less the empty weight of the trailer and the weight of the permanently mounted equipment.

26.4 Information Labels and Instruction Plates.

26.4.1 In addition to the label required by 49 CFR 567, "Certification," the final stage manufacturer shall permanently affix an information label that includes the following:

(1) The length and width of the completed trailer in feet/inches (meters)

(2) The stated load capacity

(3) For Type I and Type II trailers, the height of the completed trailer in feet/inches (meters)

(4) The hitch size and type

(5) Maximum tire pressure

(6) The tire manufacturer's maximum speed rating

(7) The proper hitch-locking procedures to secure the trailer to the tow vehicle

(8) A statement that reads: "It is the vehicle operator's responsibility to ensure that the towing vehicle and hitch are adequate to pull this trailer."

26.4.2 For trailers requiring the use of safety chains, an instruction plate shall be provided at or near the hitch location on the trailer that indicates the proper method of chain attachment to the tow vehicle.

26.4.3 For trailers with a braking system, an instruction plate shall indicate the proper method of connecting the braking system and the breakaway cable connections that apply the emergency brakes in the event the hitch fails.

26.5 Fluids and Pressures Specific to the Trailer Chassis.

A permanently mounted informational label shall be provided to specify the following information if it applies:

(1) Brake fluid for trailer brake systems

(2) Grease used for the lubrication of axle bearings

(3) Any other special fluids, pressures, or lubricants required by the trailer manufacturer

26.6 Braking System.

26.6.1* All trailers chassis with a GVWR of 3000 lb (1360 kg) or greater shall be equipped with a braking system on each axle.

26.6.2 All trailers equipped with brakes shall be equipped with a method to use the braking system to limit trailer movement in the event of failure of the hitch mechanism.

26.6.3 All brakes shall be readily accessible for adjustment.

26.6.4 When tow vehicles and trailers are equipped with air brake systems, the service brakes and parking brakes shall be applied by independent means.

26.7 Suspension and Wheels.

26.7.1 Each load-bearing tire and rim shall not carry a weight in excess of the recommended load for the operation of the tires used, as published in *Tire and Rim Association — Year Book* and as recommended by the tire manufacturer.

26.7.2* Any trailer with an angle of departure of less than 8 degrees shall be equipped with means to prevent damage to the trailer if the rear contacts the ground.

26.8 Trailer Hitch.

26.8.1 The trailer hitch shall be selected to meet or exceed the GVWR of the trailer.

26.8.2 The construction and load supported by the trailer frame shall be distributed to maintain a tongue weight at or below the tongue weight rating.

26.8.3 Safety Chains.

26.8.3.1 The installation and use of two safety chains shall be required for trailer hitches designed to use safety chains.

26.8.3.2 Each safety chain and the method of attachment to the trailer and towing vehicle shall have an ultimate strength of not less than the gross weight of the trailer.

26.8.4 When using a fifth wheel hitch, the fifth wheel hitch and trailer body design shall allow full 90-degree jackknifing of the tow vehicle–trailer combination when all doors and exterior mounted items are in the stowed position.

26.9 Wheel Chocks.

26.9.1 For trailers classified as Type II or Type III, four wheel chocks shall be mounted in readily accessible locations.

26.9.2 Each wheel chock shall be designed to hold the trailer on a 10 percent grade when the trailer is loaded to its GVWR and parked independently of the tow vehicle.

26.10 Low Voltage Electrical Systems and Warning Devices.

26.10.1 Any low voltage systems, umbilical cables, and warning devices installed on trailers shall be appropriate for the mounting location and intended electrical load and shall meet the specific requirements of Chapter 13.

26.10.2 If the trailer is classified as Type I or Type II, it shall meet the requirements of Section 13.11.

26.10.3 Power Supply.

26.10.3.1 The final-stage trailer manufacturer shall state the minimum continuous electrical load required to be provided by the tow vehicle.

26.10.3.2 If the trailer is classified as Type I, the combined tow vehicle and trailer shall meet the electrical requirements in Chapter 13.

26.10.3.3 If the trailer is classified as Type II, the combined electrical load for the federally required clearance and marker lighting and the optical warning devices shall not exceed 45 amps.

26.10.3.3.1 An on-board power source shall be provided and sized to power all trailer electrical loads on a continuous basis.

26.10.3.3.2* If a line voltage power source is used, it shall meet the requirements of Chapter 22.

26.10.3.4 If the trailer is classified as Type III, the combined electrical load for the federally required clearance and marker lighting and the optical warning devices shall not exceed 45 amps.

26.10.4* Umbilical Cables and Connections.

26.10.4.1 Umbilical cables shall be constructed of cable that complies with the requirements of Chapter 13.

26.10.4.2 Umbilical cables shall be installed and supported to prevent abrasion or chafing damage during normal operation of the trailer.

26.10.4.3 The umbilical cables shall move freely throughout the trailer's operating range of full turn right to full turn left without damage.

26.10.4.4 For trailers using air brakes, the umbilical cable for the federally required clearance and marker lighting and the ABS brake system shall be connected using a green Type F cable meeting SAE J2394, *Seven-Conductor Cable for ABS Power — Truck and Bus*, and primary connectors meeting SAE J560, *Primary and Auxiliary Seven Conductor Electrical Connector for Truck-Trailer Jumper Cable*. Circuit identification shall conform to SAE J560, Table 4.

26.10.4.5 For trailers using electric or hydraulic brakes, the umbilical cable for the federally required lighting and brake system shall be connected using a seven-wire heavy duty cable and a seven-way flat blade recreational vehicle connector.

26.10.4.6 The optical warning device umbilical cable shall be a yellow cable meeting the requirements of SAE J2394 for Type F cable with auxiliary connectors meeting SAE J560.

26.10.4.6.1 The auxiliary connectors shall have inverted ground terminals to prohibit connection to the primary receptacle (male ground terminal in the plug and the female ground terminal in the receptacle).

26.10.4.6.2 Circuit identification shall conform to SAE J560, Table 4, with the unassigned circuits assigned as follows:

(1) 12 — Green, hazard light signal from trailer *(see 13.11.1)*

(2) 13 — Brown, calling for right-of-way warning lights

(3) 14 — Blue, blocking right-of-way warning lights

26.10.5 Optical Warning Devices.

26.10.5.1 If the trailer is a Type I trailer, the optical warning system requirements of Section 13.8 shall be met by considering the combined tow vehicle and trailer as a single unit with its overall length.

26.10.5.2 If the trailer is a Type II trailer, the optical warning system shall meet the requirements of Section 13.8 when the trailer is considered a single unit.

26.10.5.2.1 The trailer's Zone A lighting shall operate only when the trailer's onboard power source is operational and the tow vehicle is disconnected from the trailer.

26.10.5.3 If the trailer is a Type III trailer, the optical warning system shall meet the requirements of Section 13.8 for lower zones B, C, and D.

26.10.6 Work Lighting.

26.10.6.1 Type I and II trailers shall be equipped with ground lighting that meets the requirements of 13.10.1.2.

26.10.6.2 If the trailer has work surfaces, steps, or walkways, those surfaces shall be equipped with surface lighting that meets the requirements of 13.10.3.

26.10.6.3 If the trailer has interior spaces where a person can walk, the trailer shall be equipped with interior lighting that meets the requirements of 13.10.4.

26.10.6.4 If the trailer has compartments, the compartments shall be equipped with compartment lighting that meets the requirements of 13.10.5.

26.10.7 Stop, Tail, and Directional Lighting. The trailer shall be equipped with stop, tail, and directional lighting meeting the requirements of Section 13.13.

26.10.8 Electrical System Performance Tests.

26.10.8.1 Low voltage electrical systems shall be tested in accordance with the testing requirements of Chapter 13 as applicable.

26.10.8.2 Line voltage electrical systems shall be tested in accordance with the testing requirements of Chapter 22 as applicable.

26.11 Reflective Markings.

26.11.1 Type I trailers shall meet the requirements of 15.9.3 when the combined tow vehicle and trailer are considered a single unit with the overall length.

26.11.2 Type II trailers shall meet the requirements of 15.9.3 when the trailer is considered a single unit.

26.11.3 Reflex reflectors and conspicuity tape shall be installed when required by 49 CFR 571.108, “Lamps, reflective devices, and associated equipment.”

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 The term *new* as applied in this standard is intended to refer to the original construction of a fire apparatus using all new materials and parts.

A.1.3.1 The requirements of this standard apply to fire apparatus that have a GVWR of 10,000 lb (4500 kg) or greater. While the standard was not written specifically to cover vehicles below that size, fire departments should consider using those portions of this standard that address safety issues with smaller emergency vehicles. This would apply particularly to the restraint of equipment in the driving and crew areas and to providing adequate optical warning devices and reflective striping to increase the visibility of the vehicle.

A.1.4 It is not intended that this standard be applied retroactively to existing apparatus. However, if major renovations are made to an existing piece of apparatus, it is suggested that the apparatus be brought into line with this standard as closely as possible. NFPA 1912, *Standard for Fire Apparatus Refurbishing*, covers the requirements for refurbishing a fire apparatus.

A.1.6 Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI). The liter, a unit that is outside of but recognized by SI, is commonly used in international fire protection. Table A.1.6(a) and Table A.1.6(b) provide U.S.-to-SI conversion factors and SI-to-U.S. conversion factors as an aid to the user. Table A.1.6(c) provides other conversion factors that could be useful to the reader. Table A.1.6(d) provides a list of the abbreviations used in this standard and their meanings.

Table A.1.6(a) Conversion Factors: U.S. Units to SI Units

U.S. Units		SI Units
1 gallon per minute (gpm)	=	3.785 liters per minute (L/min)
1 imperial gallon per minute (igpm)	=	4.546 liters per minute (L/min)
1 pound per square inch (psi)	=	6.895 kilopascals (kPa)
1 inch of mercury (in. Hg) at 60°F (15.6°C)	=	3.377 kilopascals (kPa)
1 inch (in.)	=	25.40 millimeters (mm)
1 foot (ft)	=	0.305 meter (m)
1 cubic foot (ft^3)	=	0.0283 cubic meter (m^3)
1 square inch ($in.^2$)	=	645.2 square millimeters (mm^2)
1 mile per hour (mph)	=	1.609 kilometers per hour (km/hr)
1 pound (lb)	=	0.454 kilogram (kg)
1 horsepower (hp)	=	0.746 kilowatt (kW)
1 candlepower (cp)	=	12.566 lumens
1 pound per cubic foot (lb/ft^3)	=	16 kilograms per cubic meter (kg/m^3)
1 footcandle (fc)	=	10.764 lux (lx)
1 footlambert	=	3.427 candela/m^2

Table A.1.6(b) Conversion Factors: SI Units to U.S. Units

SI Units		U.S. Units
1 liter per minute (L/min)	=	0.264 gallon per minute (gpm)
1 liter per minute (L/min)	=	0.22 imperial gallon per minute (igpm)
1 kilopascal (kPa)	=	0.145 pound per square inch (psi)
1 kilopascal (kPa)	=	0.2962 in. Hg at 60°F (15.6°C)
1 millimeter (mm)	=	0.0394 inch (in.)
1 meter (m)	=	3.281 feet (ft)
1 cubic meter (m^3)	=	35.31 cubic feet (ft^3)
1 square millimeter (mm^2)	=	0.00155 square inch ($in.^2$)

Table A.1.6(b) Conversion Factors: SI Units to U.S. Units

SI Units		U.S. Units
1 kilometer per hour (km/hr)	=	0.6214 mile per hour (mph)
1 kilogram (kg)	=	2.2 pounds (lb)
1 kilowatt (kW)	=	1.34 horsepower (hp)
1 lumen	=	0.08 candlepower (cp)
1 kilogram per cubic meter (kg/m^3)	=	0.062 pound per cubic foot (lb/ft^3)
1 lux (lx)	=	0.092 footcandle (fc)
1 candela/m^2	=	0.292 footlambert

Table A.1.6(c) Other Useful Conversion Factors

1 gallon per minute (gpm)	=	0.833 imperial gallon per minute (igpm)
1 imperial gallon per minute (igpm)	=	1.2 gallons per minute (gpm)
1 foot (ft) of water	=	0.433 pound per square inch (psi)
1 pound per square inch (psi)	=	2.31 feet (ft) of water
1 metric ton (mton)	=	1000 kilograms (kg)
1 kilopascal (kPa)	=	0.01 bar
1 bar	=	100 kilopascals (kPa)

Table A.1.6(d) Abbreviations Used in This Standard

Abbreviation	Term
A	ampere(s)
ac	alternating current
C	Celsius
cd	candela(s)
dc	direct current
F	Fahrenheit
fc	footcandle(s)
ft	foot (feet)
gpm	gallon(s) per minute
hp	horsepower
in.	inch(es)
in. Hg	inch(es) of mercury
kg	kilogram(s)
km/hr	kilometer(s) per hour
kPa	kilopascal(s)
kW	kilowatts(s)
L	liter(s)

Table A.1.6(d) Abbreviations Used in This Standard

Abbreviation	Term
L/min	liter(s) per minute
lx	lux
m	meter(s)
mm	millimeter(s)
mph	mile(s) per hour
NH	National Hose
psi	pound(s) per square inch
rms	root mean square
V	volt(s)

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.10 Air Tank. Air tanks might be designated as cylinders, receivers, or vessels.

A.3.3.42 Compound Gauge. On most gauges, zero equals atmospheric pressure. Gauges typically measure pressure above atmospheric pressure in pounds per square inch (psi) [kilopascals (kPa)] and below atmospheric pressure in inches of mercury (in. Hg) [kilopascals (kPa)].

A.3.3.43 Compressed Air Foam System (CAFS). A CAFS consists of a compressed air source, pressurized source of foam solution, and discharge hardware.

A.3.3.46 Contractor. The contractor might not necessarily manufacture the fire apparatus or any portion of the fire apparatus but is responsible for the completion, delivery, and acceptance of the entire unit.

A.3.3.56 Eductor. The pressure at the throat of a venturi is below atmospheric pressure, allowing foam concentrate or other fire-fighting agent at atmospheric pressure in storage to flow into the water stream.

A.3.3.57 Electric Siren (Electromechanical). Only one type of warning sound can be produced by electric sirens, but the level or pitch can be varied by the speed of the motor.

A.3.3.59 Electronic Siren. Varied types of warning sounds can be produced by electronic sirens, such as a wail, yelp, or simulated air horn.

A.3.3.80 GAWR (Gross Axle Weight Rating). It is a requirement of the National Highway Traffic Safety Administration (NHTSA) that the GAWR be posted in the vehicle on a permanently affixed label. The axle system includes, but is not limited to, the axle, tires, suspension, wheels, frame, brakes, and applied engine torque.

A.3.3.81 GCWR (Gross Combination Weight Rating). A combination vehicle is the combination of a towing vehicle and one or more towed units (trailers). When a trailer is detachable, the GCWR limits the maximum loaded weight for any replacement trailer. The in-service weight or gross combination weight, including any connected trailer, should always be equal to or less than the GCWR.

A.3.3.83 Grade. A 45-degree slope is equal to a 100-percent grade.

A.3.3.85 Ground-Fault Circuit Interrupter (GFCI). Class A ground-fault circuit interrupters trip when the current to ground is 6 mA or higher and do not trip when the current to ground is less than 4 mA. For further information, see UL 943, *Standard for Ground-Fault Circuit Interrupters*. [**70,** 2008]

A.3.3.87 GVWR (Gross Vehicle Weight Rating). It is a requirement of the National Highway Traffic Safety Administration (NHTSA) that the GVWR of a vehicle be posted in the vehicle on a permanently affixed label. The GVWR can be equal to or less than the sum of the front GAWR and the rear GAWR. The in-service weight or gross vehicle weight should always be equal to or less than the GVWR.

A.3.3.107 Maximum Pump Close-Off Pressure. Multistage series/parallel pumps are measured with the pump in the pressure (series) setting.

A.3.3.116 Net Pump Pressure. When operating from a hydrant, the net pump pressure typically is less than the discharge pressure. For example, if the discharge pressure gauge reads

150 psi (1034 kPa) and the intake (suction) gauge reads 20 psi (138 kPa), the net pump pressure equals 130 psi (896 kPa). When operating from draft, the net pump pressure will be above the discharge pressure. For example, if the discharge pressure gauge reads 145 psi (1000 kPa) and the intake (suction) gauge reads 10 in. Hg (34 kPa) vacuum, the net pump pressure will be 150 psi (1034 kPa) (1 in. Hg = 0.5 psi = 3.4 kPa).

A.3.3.118 Neutral Point. At the neutral point of the system, the vectorial sum of the nominal voltages from all other phases within the system that utilize the neutral, with respect to the neutral point, is zero potential.

A.3.3.124 Optical Source. An optical source can consist of a single optical element or a fixed array of any number of optical elements whose geometric positioning relative to each other is fixed by the manufacturer of the optical source and is not intended to be modified.

A.3.3.131 Portable Generator. The device has an integral distribution panel with overcurrent protection and receptacle outlets.

A.3.3.135 Preconnected Hose Line. A preconnected hose line is commonly called a bucket line, cross lay, speed lay, or mattydale.

A.3.3.146 Quint. The primary purpose of this type of apparatus is to combat structural and associated fires and to support fire-fighting and rescue operations by positioning personnel-handling materials, providing continuous egress, or discharging water at positions elevated from the ground.

A.3.3.159 Special Services Fire Apparatus. These services could be rescue, command, hazardous material containment, air supply, electrical generation and floodlighting, or transportation of support equipment and personnel.

A.3.3.164 Standard Cubic Feet per Minute (SCFM). Standard temperature is 60°F (15°C), and standard pressure is 14.696 psi (101.33 kPa) or 29.92 in. Hg (760 mm Hg).

A.3.3.174 Turning Clearance Radius. An aerial fire apparatus might have a larger overall clearance diameter if measured at the forwardmost point of the aerial device.

A.3.3.175 Turntable. Some turntables contain an operator's control station.

A.3.3.177 Type 4 Rating. Equipment rated NEMA Type 4 will be undamaged by the formation of ice on the equipment.

A.4.3.1 It is the responsibility of the purchaser to provide the contractor with sufficient information outlining the use of trailers and trailer-mounted equipment. Hitches, axles, frames, and brake systems need to be sized to handle the equipment loads installed inside the trailer. Tow vehicles need to be carefully selected to prevent overloading of the chassis and to ensure the safe stopping distances required by federal regulations. In the case where the purchaser owns a vehicle that will be the intended tow vehicle for the trailer, the purchaser should consider making the tow vehicle available for the contractor to inspect and validate compatibility and interconnectability between the tow vehicle and the trailer before delivery of the trailer.

A.4.9.1 The engine compartment and the underside of the vehicle are not considered areas of normal nonmaintenance operation.

A.4.10.2 All required signs, instruction plates, and labels should be highly visible and placed on the vehicle where they are not subject to damage from wear and tear.

A.4.12.1 The attachment of electric, air, hydraulic, and other control lines and hoses should be with removable mechanically attached fastening devices. The attachment of such equipment with adhesive or glue-on clamps or clips has been found to be inadequate for long-term performance on fire apparatus. The use of plastic ties to bundle wire harnesses and hose is permissible, but ties should not be used to attach such items to a cab, body, frame, or other major structure.

A.4.13.1 Several features and factors affect vehicle safety in a rollover.

Custom Fire Apparatus Cab. The nature of the custom fire apparatus cab makes it much stronger in rollover than typical conventional commercial chassis cabs. There is much anecdotal evidence to indicate that the crashworthiness of a typical custom fire apparatus cab is significantly greater than a typical commercial cab, and most custom chassis manufacturers can provide test data on cab integrity.

Lateral Acceleration Alert Device. There are both mechanical and electronic devices available that will measure the lateral acceleration of a vehicle. Although these devices will not prevent rollover, they can be used effectively as a driver training tool to indicate when the vehicle is approaching the roll threshold and as a reminder to the driver that excessive lateral acceleration can lead to a rollover event.

Side Roll Protection. Many custom fire apparatus manufacturers offer side air bags or curtains that inflate during a roll event and that are usually combined with seat belt pretensioning devices and suspension seat pull-down devices. This option can reduce injury during a rollover as long as the occupants are seated and belted.

Roll Stability Control. This technology electronically senses the lateral acceleration of the vehicle and takes action by depowering the engine and applying the brakes if the vehicle approaches a roll threshold. The effectiveness of this product is limited to events on relatively flat pavement, since it cannot do much to help the situation once a vehicle is off the road and leaning into a ditch.

Electronic Stability Control (ESC). ESC uses a steering wheel position sensor, a vehicle yaw sensor, a lateral accelerometer, and individual wheel brake controls in conjunction with the antilock brake system (ABS). The system tracks the direction that the driver intends to steer and uses brake application at individual wheels to help straighten out the vehicle.

Driver Skill and Experience. While the design and features of the vehicle are important to safe driving, the most important aspect of crash prevention is the skill and experience of the operator. The operator’s attitude, training, experience, qualifications, and the application of those qualities are the most important elements in crash prevention. The operator must ensure that the physical limits of the vehicle are not exceeded. Driver skill is developed only through training and practice.

A.4.13.1.1(1) When a vehicle is on a tilt table, the point of instability is when the vehicle is “balanced” on the verge of rollover, and very little constraining force, if any, is required to restrain the vehicle. This can occur with the front wheels still in contact with the surface of the tilt table or with other wheels in contact with the surface of the tilt table.

A.4.13.2.1 The distribution of the weight between the front wheels and the rear wheels should be a major consideration, because improper design will seriously affect the handling characteristics of the fire apparatus. Too little weight on the front wheels can cause a front-end skid and, on bumpy roads, can cause the front of the fire apparatus to veer from side to side. At the very least, it would be difficult to keep the fire apparatus under control. Too much weight on the front wheels reduces the traction of the rear wheels and can result in a rear-end skid or difficulty in traveling over unpaved roads or in mud.

A.4.13.3.1 It is critical that the purchaser provide the manufacturer the equipment inventory and mounting locations for equipment on the apparatus. This information should include existing equipment and estimated future equipment to be carried. The projections of total equipment payload and mounting locations are essential for proper engineering of a new fire apparatus. It is the responsibility of the purchaser to properly load the fire apparatus and place equipment to comply with the GVWR, the front-to-rear weight distribution, and the right-to-left load balance requirements of this standard.

A.4.13.3.3 The projections of total equipment payload and mounting locations are essential for proper engineering of a new fire apparatus. The purchaser of the fire apparatus should maintain the side-to-side loading requirement in 4.13.3.3 as equipment is loaded or installed on the apparatus.

The percentage difference in side-to-side tire load should be calculated as shown in the following formula:

$$\frac{(\text{Heavier weight} - \text{Lighter weight})}{\text{Total weight}} \times 100 = \text{Percent difference}$$

A.4.13.4 A frequent killer of fire fighters is apparatus rollover. Proper tire inflation improves the handling characteristics and minimizes rollover.

A.4.14.1 The power generated by internal combustion engines can decrease with an increase in altitude. The loss varies with the type of engine, the fuel it uses, and the amount of air inlet supercharging. If the apparatus is going to be regularly used at elevations above 2000 ft (600 m), the manufacturer needs to know the operating elevation to provide an engine that will deliver proper performance. *(See Section 4.3.)*

A.4.14.2 Although the purchaser needs to specify grades in excess of 6 percent *(see Section*

4.3), the fire department should evaluate where the apparatus will be expected to operate in a stationary position on such grades. The occasional exposure to excessive grades while moving over roadways is different from prolonged stationary operations. Apparatus might require special lubrication systems for engines and other modifications to ensure the apparatus will not be damaged by operation on the increased grades.

A.4.14.3 The temperature conditions, either hot or cold, where the fire apparatus will be used or stored should be considered in the design of the vehicle. If the fire apparatus will be used in conditions that exceed 110°F (43°C), additional cooling of the engine, pump, and other components might be necessary. Likewise, if the apparatus is to be used or stored in subfreezing conditions, special system drains, engine heaters, pressure gauge protectors, or other components might be needed to prevent damage or to allow continued use.

A.4.15.1(2) Although this standard recognizes the need for the fire apparatus to be able to accelerate to a high speed while traveling on public roads, caution should be taken with regard to how fast the fire apparatus can travel.

Where fire apparatus has to operate off paved roads, all-wheel drive, a two-speed rear axle, an auxiliary transmission, an automatic transmission, or any combination of these might enhance the fire apparatus's off-road capability.

A.4.15.1(3) The purchaser should specify the performance required on grades in excess of 6 percent. The occasional exposure to excessive grades is different from an everyday occurrence. A combination of steep grades and narrow, winding roads might require consultation with manufacturers prior to finalizing the apparatus specifications and then the designation of special road tests. If the apparatus will be subjected to a class of service not normally encountered, a manufacturer cannot be expected to anticipate the need without sufficient specification details.

A.4.15.2 Special fire service tire ratings could apply that are different from the sidewall rating on the tire. The purchaser might want to consider requesting the tire manufacturer’s rating documentation.

A.4.16.1 Purchasers might want to specify that all routine lubricant and fluid level checks be performed from ground level to reduce the risks of injury from falling from apparatus.

A.4.18.1 Where the point of delivery is over 2000 ft (600 m) of elevation and a fire pump is provided, the pumping engine overload test described in 16.13.3 should be performed to ensure that the engine can develop adequate power at point of delivery. This test should be performed with the pump supplied from draft per Table 16.13.2.2.1.1, with the net pressure maintained at 165 psi (1100 kPa).

A.4.19 It is important for the purchaser and the contractor to agree on the format in which the documentation is to be delivered. It is also important that the purchaser consider the long-term ramifications of changing media technology if electronic format is used for delivery of the documentation. Software and hardware will need to be maintained over the years to utilize electronic documentation.

A.4.20.2.3(6)(g) The equivalent circuit logic could be described in several ways. It might be shown as an equivalent schematic, a word-based description, or a table. In any case, it should define the relationship between input status and output status.

A.4.20.2.4 Suppliers of components and equipment installed or supplied by the contractor often supply operations and maintenance documents with those components or equipment. This standard requires that the contractor deliver these documents to the purchaser. The purchaser should specify if multiple copies of these documents are required.

A.5.4 Fire departments should carefully evaluate their water supply needs and the available water delivery systems when considering water tank size. The minimum tank size of 300 gal (1100 L) might not meet the needs of the department. Fire departments servicing areas with wide hydrant spacing or areas with no hydrants should strongly consider increasing the water tank size. The department should choose a water tank size that will best support efficient and effective fireground operations.

A.5.5 Additional compartmentation might be required to accommodate the size, shape, and weight of special equipment. Any special equipment to be carried on the apparatus should be identified in the specifications so the apparatus manufacturer can ensure the equipment will be properly accommodated within the design of the apparatus.

A.5.6 Hose storage areas are not required to be contiguous. The purchaser should consider arrangements for hose storage that will best support operational procedures. The purchaser should also consider specifying some type of cover for the hose compartment(s). Hinged or removable covers might be advantageous.

A.5.7 The recommended minimum equipment listed in this standard (nozzles, hose, ladders, etc.) might not maximize a community's grading by the insurance rating authority. Individual fire departments should check with the insurance rating authority for their state or jurisdiction for information on what tools and equipment should be carried to maximize their community's grading.

A.5.7.1.2 Where there are no ladder trucks in service, pumpers should normally be equipped with a 35 ft (10.7 m) extension ladder. It might be advantageous to standardize on the 35 ft (10.7 m) extension ladder, regardless of available ladder truck service. The purchaser should consider specifying an extension ladder length that will allow the ladder tip to extend a minimum of 2 ft (0.6 m) above or into a hazard area to be an accessible and visible emergency egress.

A.5.7.2.3 The size of the suction hose specified in Table 16.2.4.1(a) relates to pump certification only. Other sizes of suction hose, compatible with local operations, could be used and should be specified if they are desired.

A.5.8 See A.5.7.

A.5.8.2 Many departments now find it useful to use large diameter supply hose [4 in. (100 mm) or 5 in. (125 mm)] to effectively move water from its source to the fire scene. Fire departments serving areas with wide hydrant spacing or areas with no hydrants often find it desirable to carry additional hose.

It is recommended that the department carry at least 200 ft (60 m) of 2½ in. (65 mm) hose for handline operation. If the operations of the department are geared to using multiple large handlines from single apparatus, the department should consider carrying more 2½ in. (65 mm) hose and additional nozzles. Likewise, the amount and size of hose used to supply large stream devices should be considered in planning the amount and size of hose to be carried.

The department should evaluate its needs and choose the size and amount of hose that will best support its operation and then discuss those hose storage needs with the contractor to ensure the fire apparatus hose storage space will be properly laid out and of sufficient size to accommodate the department's needs.

A.5.8.3 The requirements of service in different communities might necessitate additions to the equipment required. The operational objective is to arrive at the scene of the emergency with the necessary equipment for immediate life safety operations and emergency control.

The mandatory miscellaneous equipment required to be carried on the pumper fire apparatus weighs approximately 600 lb (270 kg). This leaves a capacity of approximately 1400 lb (640 kg), to 1900 lb (865 kg), depending on the volume of cabinetry, for storage of optional equipment. The purchaser should advise the contractor if equipment in excess of the allowance in Table 12.1.2 is to be carried so that the contractor can provide a chassis of sufficient size. *(See Sections 4.3 and 12.1.)*

The following additional equipment is recommended to be carried on pumper fire apparatus. The equipment list provided does not detail each item sufficiently for purchasing purpose. The purchaser should clarify the detailed specifications for these items.

(1) One fire service claw tool

(2) One smoke ejector, 5000 ft^3/min (140 m^3/min) minimum capacity, and, if the ejector is electrically driven, a suitable adapter cord to fit standard house “U” ground outlets and extension cords and outlets on line voltage power sources used in fire departments

(3) One crowbar [36 in. (1 m) minimum] with brackets

(4) One pair of insulated bolt cutters with $\frac{7}{16}$ in. (11 mm) minimum cut

(5) One Halligan-type tool with brackets

(6) One 2½ in. (65 mm) hydrant valve (screw-type gate)

(7) One double-gated reducing leader wye, sized to fit hose used in department

(8) Two shovels (one pointed and one scoop)

(9) Four hose straps

(10) One 125 ft (38 m) length of utility rope having a breaking strength of at least 5000 lb (2200 kg)

(11) One 3000 W (minimum) portable generator if the apparatus does not have a fixed line voltage power source

(12) Two 500 W portable lights

(13) Two cord reels or other means to store and deploy 400 ft (120 m) of electric cord sized for the expected electric loads *(see Table A.22.12.5)* with connectors that are compatible with those on the lights, generator, and smoke ejector

(14) One portable pump

(15) Toolbox with hammers, wrenches, screwdrivers, and other assorted tools

(16) Master stream appliance, 1000 gpm (4000 L/min) minimum

(17) Foam delivery equipment compatible with onboard foam system

(18) One hose clamp

(19) Hose adapters for water supply connections in neighboring communities

A.6.4 Additional compartmentation might be required to accommodate the size, shape, and weight of special equipment. Any special equipment to be carried on the apparatus should be identified in the specifications, so the apparatus manufacturer can ensure the equipment will be properly accommodated within the design of the apparatus.

A.6.5 It should be recognized that apparatus of 500 gpm (2000 L/min) rated pump capacity or more normally require more than 300 ft (90 m) of 2½ in. (65 mm) hose to utilize their pumping capacity and their 2½ in. (65 mm) or larger discharge connections. For example, the 300 ft (90 m) load provides only 150 ft (45 m) lines from the two outlets of a 500 gpm (2000 L/min) apparatus. Experience has shown that, with large capacity pumps, 600 ft to 1000 ft (180 m to 300 m) of hose might be desirable to utilize the available pumping capacity. Additional hose capacity might also be desirable for pumps rated at less than 500 gpm (2000 L/min).

Hose storage areas are not required to be contiguous. The purchaser should consider arrangements for hose storage that will best support operational procedures. The purchaser should also consider specifying some type of cover for the hose compartment(s). Hinged or removable covers might be advantageous.

A.6.6 The recommended minimum equipment listed in this standard (nozzles, hose, ladders, etc.) might not maximize a community's grading by the insurance rating authority. Individual fire departments should check with the insurance rating authority for their state or jurisdiction for information on what tools and equipment should be carried to maximize their community's grading.

A.6.6.2.3 The size of the suction hose specified in Table 16.2.4.1(a) relates to pump certification only. Other sizes of suction hose, compatible with local operations, could be used and should be specified if they are desired.

A.6.7 See A.6.6.

A.6.7.3 The requirements of service in different communities might necessitate additions to the equipment required. The operational objective is to arrive at the scene of the emergency with the necessary equipment for immediate life safety operations and emergency control.

The mandatory miscellaneous equipment required to be carried on the initial attack fire apparatus weighs approximately 350 lb (160 kg). This leaves a capacity of approximately 550 lb (250 kg) for storage of optional equipment while staying within the allowance of 900 lb (410 kg) for the smallest GVWR chassis. The purchaser should advise the contractor if equipment in excess of the allowance in Table 12.1.2 is to be carried so that the contractor can provide a chassis of sufficient size. *(See Sections 4.3 and 12.1.)*

The following additional equipment is recommended to be carried on initial attack fire apparatus. The equipment list provided does not detail each item sufficiently for purchasing purpose. The purchaser should clarify the detailed specifications for these items.

(1) One 6 lb (2.7 kg) flathead axe

(2) One fire service claw tool

(3) One 8 ft (2.4 m) or longer pike pole

(4) One 10 ft (3 m) folding ladder that meets the requirements of NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders*, and mounting brackets

(5) One crowbar [36 in. (1 m) minimum] with brackets

(6) One pair insulated bolt cutters with $\frac{7}{16}$ in. (11 mm) minimum cut

(7) One Halligan-type tool with brackets

(8) One 2½ in. (65 mm) hydrant valve (screw-type gate)

(9) Two shovels (one pointed and one scoop)

(10) Two hose straps

(11) One 125 ft (38 m) length of utility rope having a breaking strength of at least 5000 lb (2200 kg)

(12) One 1500 W (minimum) portable generator if the apparatus does not have a fixed line voltage power source

(13) Two 500 W portable lights

(14) One cord reel or other means to store and deploy 100 ft (30 m) of electric cord sized for the expected electric loads *(see Table A.22.12.5)* with connectors that are compatible

with those on the lights and generator

(15) Toolbox with hammers, wrenches, screwdrivers, and other assorted tools

(16) Foam delivery equipment compatible with onboard foam system

(17) One hose clamp

(18) Hose adapters for water supply connections in neighboring communities

A.7.4 Additional compartmentation might be required to accommodate the size, shape, and weight of special equipment. Any special equipment to be carried on the apparatus should be identified in the specifications so that the apparatus manufacturer can ensure the equipment will be properly accommodated within the design of the apparatus.

A.7.5.1 The purchaser might want to specify the location and the arrangement of the hose storage area to allow carrying the hose preconnected to the tank inlet.

The purchaser should consider specifying some type of cover for the hose compartment. Hinged or removable covers might be desirable.

A.7.6 The recommended minimum equipment listed in this standard (nozzles, hose, ladders, etc.) might not maximize a community's grading by the insurance rating authority. Individual fire departments should check with the insurance rating authority for their state or jurisdiction for information on what tools and equipment should be carried to maximize their community's grading.

A.7.6.3 The size of the suction hose specified in Table 16.2.4.1(a) relates to pump certification only. Other sizes of suction hose, compatible with local operations, could be used and should be specified if they are desired.

A.7.7 See A.7.6.

A.7.7.2.2 The purpose of a mobile water supply apparatus does not include attack fire fighting. However, if a pump is provided, the provision of handlines will allow limited fire-fighting capability, particularly in protecting the apparatus if that becomes necessary.

A.7.7.3.1 The requirements of service in different communities might necessitate additions to the equipment required. The operational objective is to arrive at the scene of the emergency with the necessary equipment for immediate life safety operations and emergency control.

The mandatory miscellaneous equipment required to be carried on the mobile water supply fire apparatus weighs approximately 700 lb (320 kg). This leaves a capacity of approximately 300 lb (135 kg) for storage of optional equipment while staying within the allowance of 1000 lb (455 kg). The purchaser should advise the contractor if equipment in excess of 1000 lb (455 kg) is to be carried so that the contractor can provide a chassis of sufficient size. *(See Sections 4.3 and 12.1.)*

The following additional equipment is recommended to be carried on mobile water supply apparatus. The equipment list provided does not detail each item sufficiently for purchasing purpose. The purchaser should clarify the detailed specifications for these items.

(1) One fire service claw tool

(2) One crowbar [36 in. (1 m) minimum] with brackets

(3) One pair of insulated bolt cutters with $\frac{7}{16}$ in. (11 mm) minimum cut

(4) One Halligan-type tool with brackets

(5) One 2½ in. (65 mm) hydrant valve (screw-type gate)

(6) Two shovels (pointed with long handle)

(7) Four hose straps

(8) One 125 ft (38 m) length of utility rope having a breaking strength of at least 5000 lb (2200 kg)

(9) One portable pump

(10) One low-level strainer for use with portable tanks

(11) Toolbox with hammers, wrenches, screwdrivers, and other assorted tools

(12) One water transfer device to be used between portable tanks

(13) One 1500 gal (6000 L) (minimum) collapsible, portable tank

(14) Hose adapters for water supply connections in neighboring communities

A.8.3 The purchaser should consider the department's need for suction or supply hose if a fire pump is installed and should specify the appropriate hose to meet this need.

A.8.5 Additional compartmentation might be required to accommodate the size, shape, and weight of special equipment. Any special equipment to be carried on the apparatus should be identified in the specifications so that the apparatus manufacturer can properly accommodate the equipment within the design of the apparatus.

A.8.6.1 If the aerial fire apparatus is to carry hose, the purchaser needs to specify the amount and size of hose to be carried and any special requirements for the location in which it is to be carried.

A.8.7 The recommended minimum equipment listed in this standard (nozzles, hose, ladders, etc.) might not maximize a community's grading by the insurance rating authority. Individual fire departments should check with the insurance rating authority for their state or jurisdiction for information on what tools and equipment should be carried to maximize their community's grading.

A.8.7.1 The fire department should study its needs for ground ladders, evaluating which ladders will be arriving at a fire scene with pumpers as well as aerial fire apparatus. Many communities have multiple three- and four-story buildings around which a power-operated aerial device cannot be positioned and that require longer or additional extension ladders to support fire-fighting operations. However, it should be recognized that as requirements for additional ground ladders are added, space for other equipment can become limited.

A.8.7.2 The following list can be used as a ground ladder complement:

(1) One folding ladder a minimum of 10 ft (3 m) in length

(2) Two roof ladders (with folding roof hooks) a minimum of 16 ft (4.9 m) in length

(3) One combination ladder a minimum of 14 ft (4.3 m) in length

(4) One extension ladder a minimum of 24 ft (7.3 m) in length

(5) One extension ladder a minimum of 35 ft (10.7 m) in length

A.8.8 See A.8.7.

A.8.8.2 Axes and long-handled ventilation, salvage, and overhaul poles are now available with wood, fiberglass, or plastic handles. The fire department should specify the handle material desired.

The requirements of service in different communities might necessitate additions to the equipment required. The operational objective is to arrive at the scene of the emergency with the necessary equipment for immediate life safety operations and emergency control.

The mandatory miscellaneous equipment required to be carried on the aerial fire apparatus weighs approximately 1000 lb (455 kg). This leaves a capacity of approximately 1500 lb (680 kg) for storage of optional equipment while staying within the allowance of 2500 lb (1135 kg). The purchaser should advise the contractor if equipment in excess of 2500 lb (1135 kg) is to be carried so that the contractor can provide a chassis of sufficient size. *(See Sections 4.3 and 12.1.)*

The following additional equipment is recommended to be carried on aerial fire apparatus. The equipment list provided does not detail each item sufficiently for purchasing purpose. The purchaser should clarify the detailed specifications for these items.

(1) Three portable floodlights (500 W)

(2) Two shovels (round point)

(3) Two cord reels or other means to store and deploy 400 ft (120 m) of electric cord sized for the expected electric loads *(see Table A.22.12.5)* with connectors that are compatible with those on the lights, generator, and smoke ejector

(4) Three 2-wire to 3-wire adapters

(5) One smoke ejector, 5000 ft^3/min (140 m^3/min) minimum capacity, and, if ejector is electrically driven, suitable adapter cord to fit standard house “U” ground outlets and extension cords and outlets on line voltage power sources used in fire departments

(6) Two 10 ton (9000 kg) hydraulic jacks

(7) Two 20 ton (18,000 kg) hydraulic jacks

(8) One pair of insulated wire cutters capable of cutting 6 AWG wire

(9) Four additional salvage covers, at least 12 ft × 18 ft (3.6 m × 5.5 m)

(10) Two floor runners, at least 3 ft × 18 ft (1 m × 5.5 m)

(11) Four mops

(12) Four brooms

(13) Four squeegees with handles

(14) Two mop wringers with buckets

(15) One roll 15 lb (6.8 kg) tar paper or plastic sheeting at least 8 mil thick

(16) Twelve standard sprinkler heads (assorted temperatures and types)

(17) Two claw hammers, each with assorted nails

(18) One heavy-duty stapler

(19) Six sprinkler stops or wedges

(20) One set of sprinkler head wrenches for the type of heads carried

(21) Two pairs of safety goggles

(22) One power saw (chain or heavy-duty rotary type)

(23) Four assorted handsaws

(24) One portable thermal cutting unit designed for cutting metal

(25) One rescue-type tool with extension rams and assorted lengths of chain

(26) One set of air bags

(27) One power-operated deodorizer unit

(28) One water pickup vacuum

(29) Assorted rolls of tape (duct tape, electrical tape, cellophane tape, etc.)

(30) One pneumatic rescue cushion

(31) One stokes basket

(32) One gas shutoff wrench

(33) One submersible-type pump

(34) Two pairs of lineman's gloves with leather glove protectors

(35) Four bale/mattress hooks

(36) Two four-tine forks

(37) Two blankets

(38) One block and tackle

(39) One line gun with ammunition

(40) One water shutoff wrench

(41) One 3000 W (minimum) portable generator if the apparatus does not have a fixed line voltage power source

A.8.8.4 If the purchaser wants extra length on the hose, a two- or three-inlet siamese, or a shutoff at the base of the ladder, these should be specified. The purchaser might also wish to specify a 500 gpm (2000 L/min) minimum spray nozzle.

The size of hose used to supply the ladder pipe will have been considered by the aerial ladder manufacturer in the design of the ladder. Use of larger size hose could overload the ladder with excessive weight and should be avoided until the aerial ladder manufacturer is consulted.

The hose should be fastened in a straight line up the middle of the aerial ladder. Hose straps not only secure the hose in place but take the strain off couplings and fittings that might otherwise fail and cause injury.

Where the purchaser wants pulleys and rope for vertical control of the stream from the turntable, the purchaser should specify these.

A.9.5 Additional compartmentation might be required to accommodate the size, shape, and weight of special equipment. Any special equipment to be carried on the apparatus should be identified in the specifications so that the apparatus manufacturer can ensure the equipment will be properly accommodated within the design of the apparatus.

A.9.6 Many departments now find it useful to use large diameter supply hose [4 in. or 5 in. (100 mm or 125 mm)] to effectively move water from its source to the fire scene. Fire departments serving areas with wide hydrant spacing or areas with no hydrants often find it advantageous to carry additional hose. The hose storage area provided for in this standard is a minimum to accommodate the smallest size of the amount of hose required to be carried. The department should evaluate its needs and choose the size and amount of hose that will best support its operation and then discuss those hose storage needs with the contractor to ensure the fire apparatus hose storage space will be properly laid out and of sufficient size to accommodate the department's needs.

Hose storage areas are not required to be contiguous. The purchaser should consider arrangements for hose storage that will best support operational procedures. The purchaser should also consider specifying some type of cover for the hose compartment(s). Hinged or removable covers might be desirable.

A.9.7 The recommended minimum equipment listed in this standard (nozzles, hose, ladders, etc.) might not maximize a community's grading by the insurance rating authority. Individual fire departments should check with the insurance rating authority for their state or jurisdiction for information on what tools and equipment should be carried to maximize their community's grading.

A.9.7.2.3 The size of the suction hose specified in Table 16.2.4.1(a) relates to pump certification only. Other sizes of suction hose, compatible with local operations, could be used and should be specified if they are desired.

A.9.8 See A.9.7.

A.9.8.2 It is recommended that the department carry at least 200 ft (60 m) of 2½ in. (65 mm) hose for handline operation. If the operations of the department are geared to using multiple large handlines from single apparatus, the department should consider carrying more 2½ in. (65 mm) hose and additional nozzles. Likewise, the amount and size of hose used to supply large stream devices should be considered in planning the amount and size of hose to be carried.

A.9.8.3 The requirements of service in different communities might necessitate additions to the equipment required. The operational objective is to arrive at the scene of the emergency with the necessary equipment for immediate life safety operations and emergency control.

The mandatory miscellaneous equipment required to be carried on the quint fire apparatus weighs approximately 700 lb (318 kg). This leaves a capacity of approximately 1800 lb (817 kg) for storage of optional equipment while staying within the allowance of 2500 lb (1135 kg). The list of equipment required to be carried on a quint contains all the equipment required on a pumper as well as life safety rope. It is recommended that the purchaser review the list of equipment required to be carried on an aerial fire apparatus *(see 8.8.2)* as well as the lists in A.5.8.3 and A.8.8.2 for other tools and equipment needed to meet the functional objectives for which the quint is being purchased. The purchaser should advise the contractor if equipment in excess of 2500 lb (1135 kg) is to be carried so that the contractor can provide a chassis of sufficient size. *(See Sections 4.3 and 12.1.)*

A.10.3 Additional compartmentation might be required to accommodate the size, shape, and weight of special equipment. Any special equipment to be carried on the apparatus should be identified in the specifications so that the apparatus manufacturer can ensure the equipment will be properly accommodated within the design of the apparatus.

A.10.4 The recommended minimum equipment listed in this standard (nozzles, hose, ladders, etc.) might not maximize a community's grading by the insurance rating authority. Individual fire departments should check with the insurance rating authority for their state or jurisdiction for information on what tools and equipment should be carried to maximize their community's grading.

A.10.4.2.3 The size of the suction hose specified in Table 16.2.4.1(a) relates to pump certification only. Other sizes of suction hose, compatible with local operations, could be used and should be specified if they are desired.

A.10.5 See A.10.4.

A.10.5.2 The mandatory miscellaneous equipment required to be carried on a special service fire apparatus weighs approximately 200 lb (90 kg). This leaves a capacity of approximately 1800 lb (820 kg) for storage of optional equipment while staying within the allowance of 2000 lb (910 kg) for the smallest GVWR chassis. The purchaser should advise the contractor if equipment in excess of the allowance in Table 12.1.2 is to be carried so that the contractor can provide a chassis of sufficient size. *(See Sections 4.3 and 12.1.)*

Special service fire apparatus can be designed to provide a wide variety of support functions (rescue, command, hazardous material containment, air services, electrical generation and floodlighting, and transportation of support equipment and personnel). Because of this variety, the required list of equipment is minimal and the purchaser needs to develop an appropriate equipment list based on a review of the functions and operations that the apparatus will be expected to support.

The following two lists of equipment are provided for consideration where a fire apparatus is to support rescue operations and hazardous materials containment operations. The equipment lists provided do not detail each item sufficiently for purchasing purpose. The purchaser should clarify the detailed specifications for these items.

The equipment in the following list should be considered when deciding what to carry on a rescue apparatus:

(1) 500 ft (150 m) of plastic “Emergency Scene” or equivalent crowd control tape

(2) Forty-eight 30-minute road flares

(3) Twelve road hazard traffic control devices

(4) One 6 lb (2.7 kg) flathead axe

(5) One 6 lb (2.7 kg) pickhead axe

(6) One 6 ft (2 m) pike pole or plaster hook

(7) One 8 ft (2.4 m) or longer nonconductive pike pole

(8) One crowbar [36 in. (1 m) minimum] with brackets

(9) One pair of insulated bolt cutters with $\frac{7}{16}$ in. (11 mm) minimum cut

(10) One Halligan-type tool with brackets

(11) Two shovels (one pointed and one scoop)

(12) Two 12 lb (5.4 kg) sledgehammers

(13) Two Class I life safety harnesses meeting the requirements of NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services*

(14) One 150 ft (45 m) length of general-use life safety rope meeting the requirements of NFPA 1983

(15) One 150 ft (45 m) length of light-use life safety rope meeting the requirements of NFPA 1983

(16) One 150 ft (45 m) length of utility rope having a breaking strength of at least 5000 lb (2200 kg)

(17) One box of tools to include the following:

- (a) One hacksaw with three blades
- (b) One keyhole saw
- (c) One 18 in. (450 mm) pipe wrench
- (d) One hammer
- (e) One pair of tin snips
- (f) One pair of pliers
- (g) One pair of lineman's pliers
- (h) Assorted types and sizes of screwdrivers
- (i) Assorted adjustable wrenches
- (j) Assorted combination wrenches

(18) Two salvage covers, each a minimum of 12 ft × 14 ft (3.7 m × 4.3 m)

(19) One 3000 W (minimum) portable generator if the apparatus does not have a fixed line voltage power source

(20) Two 500 W portable lights

(21) Two cord reels or other means to store and deploy 400 ft (120 m) of electric cord sized for the expected electric loads *(see Table A.22.12.5)* with connectors that are compatible with those on the lights, generator, and smoke ejector

(22) One smoke ejector, 5000 ft^3/min (140 m^3/min) minimum capacity, and, if the ejector is electrically driven, suitable adapter cord to fit standard house "U" ground outlets and extension cords and outlets on line voltage power sources used in fire departments

(23) Two 10 ton (9000 kg) hydraulic jacks

(24) Two 20 ton (18,000 kg) hydraulic jacks

(25) One roll 15 lb (6.8 kg) tar paper or plastic sheeting at least 8 mil (0.203 mm) thick

(26) Two pairs of safety goggles

(27) One power saw (chain or heavy-duty rotary type)

(28) Four assorted handsaws

(29) One portable cutting device

(30) Resuscitator equipment with oxygen administration capability and spare cylinders, which should be compatible with the performance of cardiopulmonary resuscitation

(31) One powered rescue tool capable of cutting and spreading with associated accessory equipment

(32) Shoring of various sizes and lengths

(33) One 10 ft (3 m) and one 15 ft (4.5 m) log chain with hooks

(34) One 4 ton (3500 kg) minimum hydraulic portapower kit

(35) One set of air bags

(36) Assorted rolls of tape (duct tape, electrical tape, cellophane tape, etc.)

(37) One stokes basket

(38) One gas shutoff wrench

(39) Two pairs of lineman's gloves with leather glove protectors

(40) Two blankets

(41) One block and tackle

Equipment in the following list should be considered if the primary use of the apparatus is for hazardous material containment:

(1) One copy of the current edition of the U.S. DOT *Emergency Response Guidebook*

(2) One copy of the Bureau of Explosives *Emergency Action Guide* or equivalent reference guide

(3) One copy of NFPA *Fire Protection Guide to Hazardous Materials* or equivalent reference guide

(4) Two pairs of binoculars

(5) One gas detection instrument that complies with OSHA standards

(6) One radiation-monitoring instrument

(7) One pH test kit

(8) One colorimetric chemical detector tube kit with 20-chemical minimum detection capability

(9) Six vapor-protective suits meeting the requirements of NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*

(10) Twelve liquid splash–protective suits meeting the requirements of NFPA 1992, *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies*

(11) Twenty-four pairs of disposable boot covers

(12) Twenty-four pairs of disposable glove liners or inner gloves

(13) Forty-eight pairs of disposable chemical protective gloves of three different materials as a minimum

(14) Six additional SCBA complying with NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*

(15) One spare SCBA cylinder for each SCBA

(16) Ten traffic cones, 18 in. (0.5 m) minimum height

(17) Four rolls 1000 ft × 3 in. (300 m × 76 mm) banner tape

(18) Two rolls 6 mil (0.152 mm) minimum 10 ft × 100 ft (3 m × 30 m) plastic sheeting

(19) Two rolls 2 in. (51 mm) wide duct tape

(20) Two decontamination containment pools

(21) One decontamination shower

(22) Two 50 ft (15 m) lengths of heavy-duty garden hose with adapters for connection to a fire pump

(23) Two spray nozzles with garden hose thread

(24) Four 30 gal (100 L) open-top containers with sealed covers

(25) Four long-handle scrub brushes

(26) Twenty 50 gal (190 L) capacity heavy-duty garbage bags

(27) One assortment decontamination solution

(28) Four round-point shovels

(29) Four portable explosionproof hand lights with mounting brackets

(30) Four nonspark, plastic, square-point shovels

(31) One 6 lb (2.7 kg) flathead axe or forcible entry tool

(32) Two street brooms

(33) Two floor squeegees with handles

(34) One 6 lb (2.7 kg) sledgehammer

(35) Two nonspark bung wrenches

(36) One gas shutoff wrench

(37) One pair 24 in. (0.6 m) bolt cutters

(38) One drum upender

(39) One nonspark 28 in. (0.7 m) crowbar

(40) One plug and patch kit

(41) One tool box (wrenches, sockets, screwdrivers; minimum 100 units)

(42) Six MC #306/DOT #406 dome clamps

(43) 400 pads 18 in. × 18 in. × $\frac{3}{8}$ in. (450 mm × 450 mm × 9.5 mm) hydrophobic polypropylene-type absorbents

(44) 150 lb (68 kg) of dry granular or loose absorbent in ruptureproof 5 gal (19 L) containers that can be disposed of by approved methods

(45) Four 10 ft (3 m) sorbent booms

(46) 50 lb (22.7 kg) dry lime in ruptureproof 5 gal (19 L) containers

(47) One manually operated product transfer pump with minimum 15 gpm (57 L/min) capacity and appropriate hose

(48) One 55 gal (208 L) drum (UN-1A2)

(49) One 85 gal (322 L) drum (UN-1A2)

A.11.6 Additional compartmentation might be required to accommodate the size, shape, and weight of special equipment. Any special equipment to be carried on the apparatus should be identified in the specifications so that the apparatus manufacturer can ensure the equipment will be properly accommodated within the design of the apparatus.

A.11.7 Many departments now find it useful to use large diameter supply hose [4 in. or 5 in. (100 mm or 125 mm)] to effectively move water from its source to the fire scene. Fire departments serving areas with wide hydrant spacing or areas with no hydrants often find it desirable to carry additional hose. The hose storage area provided for in this standard is a minimum to accommodate the smallest size of the amount of hose required to be carried. The department should evaluate its needs and choose the size and amount of hose that will best support its operation and then discuss those hose storage needs with the contractor to ensure that the fire apparatus hose storage space will be properly laid out and of sufficient size to accommodate the department's needs.

Hose storage areas are not required to be contiguous. The purchaser should consider arrangements for hose storage that will best support their operational procedures. The purchaser should also consider specifying some type of cover for the hose compartment(s). Hinged or removable covers might be advantageous.

A.11.8 The recommended minimum equipment listed in this standard (nozzles, hose, ladders, etc.) might not maximize a community's grading by the insurance rating authority. Individual fire departments should check with the insurance rating authority for their state or jurisdiction for information on what tools and equipment should be carried to maximize their community's grading.

A.11.8.1.3 The size of the suction hose specified in Table 16.2.4.1(a) relates to pump certification only. Other sizes of suction hose compatible with local operations could be used and should be specified if they are desired.

A.11.9 See A.11.8.

A.11.9.2 It is recommended that the department carry at least 200 ft (60 m) of 2½ in. (65 mm) hose for handline operation. If the operations of the department are geared to using multiple large handlines from single apparatus, the department should consider carrying more 2½ in. (65 mm) hose and additional nozzles. Likewise, the amount and size of hose used to supply large stream devices should be considered in planning the amount and size of hose to be carried.

A.11.9.3 The requirements of service in different communities might necessitate additions to the equipment required. The operational objective is to arrive at the scene of the emergency with the necessary equipment for immediate life safety operations and emergency control.

The mandatory miscellaneous equipment required to be carried on the mobile foam fire apparatus weighs approximately 700 lb (320 kg). This leaves a capacity of approximately 1300 lb (590 kg) for storage of optional equipment while staying within the allowance of 2000 lb (910 kg). The purchaser should advise the contractor if equipment in excess of 2000 lb (910 kg) is to be carried so that the contractor can provide a chassis of sufficient size. *(See Sections 4.3 and 12.1.)*

A.12.1 The carrying capacity of a vehicle is one of the least understood features of design and one of the most important. All vehicles are designed for a GVWR, which should not be exceeded by the apparatus manufacturer or by the purchaser after the vehicle has been placed in service. For tractor-drawn vehicles, the in-service weight of the apparatus should not exceed the GCWR. There are many factors that make up the GVWR, including the design of the springs or suspension system, the rated axle capacity, the rated tire and wheel loading, and the distribution of the weight between the front and rear wheels.

Water Tank. One of the most critical factors is the size of the water tank. Water weighs approximately 8.3 lb/gal (1 kg/L). A value of 10 lb/gal (1.2 kg/L) can be used when estimating the weight of the tank and its water, making a 500 gal (2000 L) tank and its water about 5000 lb (2400 kg).

Miscellaneous Equipment. If the finished apparatus is not to be overloaded, the purchaser should provide the contractor with the weight of equipment to be carried if it is in excess of the allowance shown in Table 12.1.2. *(See Section 4.3).*

Large Compartment Capacity. The manufacturer is obligated by this standard to provide only a miscellaneous equipment allowance in compliance with the minimum allowance listed in Table 12.1.2. Purchasers who specify vehicles with large compartment capacity should work closely with the vehicle manufacturer to ensure that the GVWR is sufficient to carry the intended equipment. A vehicle with average compartment loading will have a miscellaneous equipment weight of about 8 lb/ft^3 (125 kg/m^3) of compartment space available for miscellaneous equipment. A lightly loaded vehicle could have as little as 4 lb/ft^3 (65 kg/m^3). A heavily loaded vehicle can reach 12 lb/ft^3 (200 kg/m^3). This volume does not include space occupied by generators, reels, air systems, ladders, hose, and so forth, that are not in the miscellaneous equipment allowance. Total equipment weight varies significantly depending on the density of the equipment and how tightly the fire department chooses to pack it.

Overloading. Overloading of the vehicle by the manufacturer through design or by the purchaser adding a great deal of equipment after the vehicle is in service will materially reduce the life of the vehicle and will undoubtedly result in increased maintenance costs, particularly with respect to the transmissions, clutches, and brakes. Overloading can also seriously affect handling characteristics, making steering particularly difficult.

Underloading. Brake equipment on heavy vehicles can be sensitive to the weight distribution of the vehicle. Specifying a GVWR significantly greater than the estimated in-service weight can lead to poor brake performance, chatter, and squeal. Purchasers who specify configurations with limited compartment volume on a high capacity chassis should consult the manufacturer to ensure that a vehicle with an underloaded condition will not result.

Severe Service. Fire apparatus have to be able to perform their intended service under adverse conditions that might require operation off paved streets or roads. Chassis components should be selected with the rigors of service in mind.

A.12.1.2(4) The 250 lb (114 kg) per person used here does not include the weight of SCBA and tools carried by a fire fighter, because the weight of this equipment is accounted for elsewhere.

Agencies may want to also consider the weight of personal gear when the apparatus could be used for responses of anticipated long duration, such as wildland fire responses, where the crew must take their personal gear with them.

A.12.1.5.1 It is important for fire apparatus drivers to understand the height, length, and weight of the vehicle compared to their personally owned vehicles. It is also important that this information be accurate. Because the height of the apparatus could change after delivery, depending on what equipment might be added, the fire department must note such changes on the plate. Suggested wording for the plate is shown in Figure A.12.1.5.1.

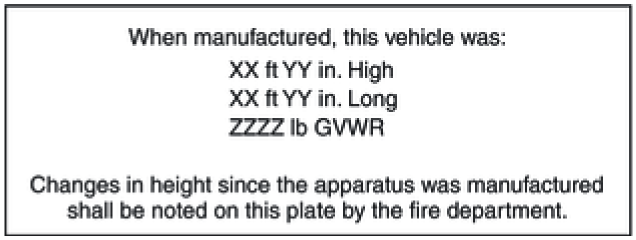


FIGURE A.12.1.5.1 Suggested Plate Showing Dimensions of Fire Apparatus.

A.12.2.1 The standard does not contain any minimum for the size of engine because the size of the engine needs to be chosen to correspond with the conditions of design and service.

Many fire departments favor high-torque low-speed engines for fire department service because such engines have good performance characteristics both when powering the apparatus through city traffic and when driving the pump. However, high-speed engines are frequently employed for fire apparatus, particularly in the case of commercial vehicle chassis. Where high-speed gasoline engines are selected for use in fire apparatus that might have to operate off paved highways, it is recommended that either a two-speed rear axle with high numerical ratio in low range or an auxiliary transmission be specified.

A.12.2.1.1 The maximum governed speed is established by the engine manufacturer as a safe limit of engine speed. The engine governor or electronic fuel control system should prevent the engine from exceeding the safe speed. Most engine manufacturers allow a plus tolerance of 2 percent for maximum governed speed.

A.12.2.1.3 A shutdown beyond the control of the pump operator during fire-fighting operations can result in loss of waterflow from the pump that could severely endanger personnel. Automatic fuel line safety shutoff as required by DOT regulations is not considered an automatic engine shutdown.

A.12.2.1.5.1 An increase in engine speed provides increased alternator output, increased engine cooling, increased air conditioner output, and increased output or performance from other devices that derive their power from the chassis engine.

A.12.2.1.5.2 The purpose of the interlock is to ensure that the chassis engine speed cannot be advanced without disengaging the driving wheels of the apparatus either at the transmission (having it in park or neutral) or by having a split shaft PTO fully engaged in the correct position to drive the component.

A.12.2.2.1 Where a regular production model commercial chassis is used, it is recommended that the heavy-duty radiator option be included when such is available. Radiators with bolted top and bottom tanks and removable side braces, if available, are considered preferable. Optional features that might be desirable include a coolant conditioner, radiator sight gauges, and automatic radiator shutters, any of which, if used, should be of a type approved by the engine manufacturer.

Where local environmental extremes exist — that is, high humidity and temperatures or extreme low temperatures — the purchaser should state specifically under what environmental conditions the apparatus is expected to operate.

A.12.2.3.1 Full flow oil filters are mandatory with some diesel engines.

A.12.2.4 On a diesel engine, a manual emergency engine shutdown might be provided in addition to the normal engine shutoff switch. It could be of the type that will close off either the air supply or the exhaust gas flow of the engine. The activation mechanism should be provided with a guard and marked with a sign that reads "Emergency Shutdown." Provisions to prevent restarting of the engine without a special reset procedure should be included.

A.12.2.4.1 Caution needs to be used because air intake filters might affect the engine manufacturer's air restriction requirements.

A.12.2.4.3 The extent to which air inlet protection is required could depend on specific fire department operations. Departments operating in ember-rich environments, such as wildland fires, should consider specifying a multiscreen ember separator capable of meeting the test requirements defined in the Parker Hannafin, Racor Division, publication LF 1093-90, *Ember Separation Test Procedure*, or an equivalent test. Purchasers of apparatus utilizing commercial chassis should be aware that ember separators capable of meeting these test requirements may have a screen and housing externally mounted on or around the commercial chassis hood or bumper extension.

A.12.2.5.1.1 To prevent engine shutdown due to fuel contamination, dual filters in parallel, with proper valving so that each filter can be used separately, might be preferable. The purchaser should specify if dual filters are desired. Installation of two or more pumps should be designed so that failure of one pump will not nullify the performance of the other pump(s). It should be remembered that commercial vehicles are designed for over-the-road operation, and the fuel system and battery are at least partially cooled by the flow of air resulting from the motion.

A.12.2.5.1.6.1 With the use of diesel engines, the concern for vapor lock common with gasoline engines does not exist, and electric fuel pumps usually are not compatible for connection in series with a diesel engine fuel system. As a result, when an electric fuel pump is specified with a diesel engine, it is arranged as a fuel priming pump only. When not properly marked with a label or when the control valves are not properly set, the auxiliary priming system can cause the diesel engine to lose its prime. In addition, operation of a priming pump during diesel engine operation can boost fuel inlet pressure to the engine's fuel system. This could cause erratic engine behavior and loss of engine speed control. Control systems for priming pumps should allow only momentary operation and prevent the operation of the pump while the engine is operating.

A.12.2.6.1 Emissions from exhaust discharge pipes should be directed away from any fire-fighting tools, since such emissions contain an oily substance that could make the tools difficult to handle and possibly dangerous to use.

A.12.2.6.7 Exhaust temperature while the diesel particulate filter (DPF) is actively regenerating can reach 900°F to 1300°F (480°C to 704°C). The purchaser should be aware that these temperatures are much higher than normal engine idle exhaust temperatures.

Apparatus that make short runs with extended idle time may tend to build up soot in the DPF without giving the engine sufficient opportunity to passively regenerate. If the DPF light illuminates, the vehicle should be driven above 5 mph for a period of time to allow the DPF to regenerate either actively or passively, or it should be parked in a controlled area and a manual regeneration initiated.

Those fire departments that employ in-station exhaust venting equipment while performing pump tests should consult their vent supplier to ensure that the vent system will handle any potential DPF active regeneration event.

A.12.2.6.7.1(1) The requirement for the DPF to automatically initiate only above 5 mph (8 km/hr) ensures that the exhaust gas temperatures will not change suddenly while the apparatus is parked. This will avoid situations where an apparatus is parked next to a curb and pedestrians are suddenly exposed to excessively hot exhaust gas.

A.12.2.6.7.3 The DPF regeneration inhibit switch allows the operator to keep the DPF from regenerating during times when the apparatus is operating in an environment where extremely hot exhaust gas would be a hazard.

The inhibit function must be used carefully. Repeated use of the inhibit function can lead to soot buildup. Excessive buildup of soot can produce an uncontrolled burn inside the DPF, causing significant vehicle damage and dangerous exhaust temperatures. Watch the DPF indicator and provide opportunity to regenerate the DPF soon after using the inhibit function.

A.12.2.6.7.6 Exhaust system temperature mitigation devices might be required to meet the temperature requirement. Exhaust temperature mitigation devices might be affected by the addition of adapters commonly used to hook up to exhaust extraction equipment. The purchaser should ensure that this adaptation is certified by the manufacturer/installer of the adapter that it will not adversely affect the performance of the device.

A.12.3.1.2 Adequate braking capacity is essential for the safe operation of fire apparatus. While this subject is normally covered in state highway regulations, it should be noted that fire apparatus might have a special problem compared with normal vehicles of the same gross vehicle weight. Fire apparatus could have to make successive brake applications in a short period of time when attempting to respond to alarms with minimal loss of time. Thus, the problem of brake "fade" and braking capacity could become critical unless the brakes provided take into account the service requirements. Air-actuated brakes are recommended for fire service vehicles of over 25,000 lb (11,000 kg) GVWR.

Where air brakes are provided, it is important that they be of a quick buildup type with dual tanks and a pressure-regulating valve. The rated compressor capacity should be not less than 12 ft^3/min (0.34 m^3/min) for this class of service. Air brakes require attention to guard against condensation in the air lines, such as might occur in areas subject to changes in climate that affect the moisture content of the air. Automatic moisture ejection of nonfreezing type is recommended. Air pressure drop should be limited to normal air losses. The presence of either of the following conditions indicates the need for immediate service:

(1) Air brake pressure drop of more than 2 psi (14 kPa) in 1 minute for single vehicles or more than 3 psi (21 kPa) in 1 minute for vehicle combinations, with the engine stopped and the service brakes released

(2) Air pressure drop of more than 3 psi (21 kPa) in 1 minute for single vehicles or more than 4 psi (28 kPa) in 1 minute for vehicle combinations, with the engine stopped and the service brakes fully applied

A.12.3.1.2.2 If an onboard automatic electric compressor is provided, it might be low voltage driven or line voltage driven. If it is low voltage driven, it is important that the required battery conditioner or charger be utilized. The shoreline receptacle might be a manual disconnect–type receptacle or an automatic ejection–type receptacle.

A.12.3.1.3 There have been occurrences of the driver becoming disabled while driving a fire apparatus. The purchasers might want to specify the placement of the parking brake control to a location where it can be reached from the officer's seat or require a second control so the officer can stop the vehicle if the driver becomes disabled.

A.12.3.1.4 Purchasers of fire apparatus with a GVWR less than 36,000 lb (16,300 kg) should also consider equipping the apparatus with an auxiliary braking system. Fire apparatus commonly make repeated stops from high speeds that cause rapid brake lining wear and brake fade, sometimes leading to accidents.

Auxiliary braking systems are recommended on apparatus that are exposed regularly to steep or long grades, operate in congested areas where repeated stops are normal, or respond to a high number of emergencies.

Examples of auxiliary braking systems include engine retarders, transmission retarders, exhaust retarders, and driveline retarders. These devices have various levels of effectiveness on braking. In addition, the systems can be activated by various means and settings, both automatic and manual in operation. The purchaser should carefully evaluate all auxiliary braking systems based on vehicle weight, terrain, duty cycle, and many other factors.

Some auxiliary braking devices should be disconnected when the apparatus is operated on slippery surfaces. Follow the auxiliary braking device manufacturer’s recommendations for proper instructions.

A.12.3.1.5 See A.12.3.1.4.

A.12.3.2.1 Fire departments with vehicles that could be subject to continuous long-distance driving need to specify tire rating for continuous operation in place of intermittent operation.

A.12.3.2.3 The angle of approach or departure affects the road clearance of the vehicle going over short steep grades such as would be found in a driveway entrance, crossing a high crowned road at a right angle, or off-road service. Too low an angle of approach or departure will result in the apparatus scraping the ground. Figure A.12.3.2.3 shows the method of determining the angle of departure. The angle of approach (front of vehicle) is measured in the same fashion.

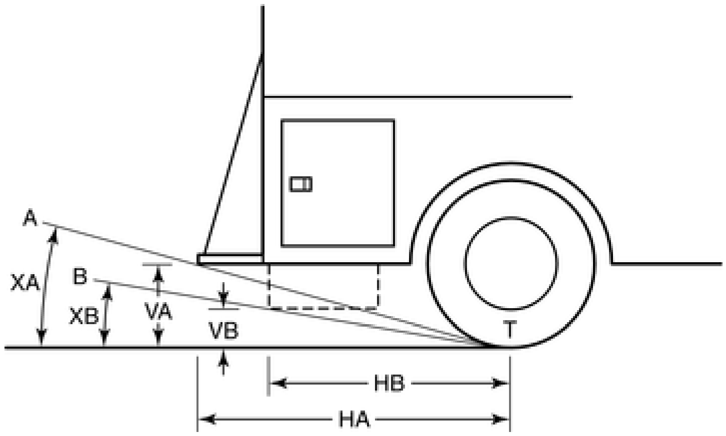


FIGURE A.12.3.2.3 Dimensions for Determining Angle of Departure.

In Figure A.12.3.2.3, the line *AT* represents the circumstance in which the tailboard is the determining lowest point. The line *BT* represents a circumstance in which the tailboard is not the lowest point (in this case, the lowest point is a fuel tank). The angle of departure is shown as *XA* or *XB*. To determine the angle of departure, place a thin steel strip against the rear of the tires where they touch the ground or stretch a string tight from one rear tire to the other at the rear of where they touch the ground. Determine the lowest point (the tailboard, fuel tank, or other equipment or component) that would make the smallest angle of departure. Hang a plumb bob from the lowest point and mark the point on the ground where the point of the plumb bob touches. Measure the vertical distance from the ground to the point where the plumb bob was hung (distance *V*). Measure the horizontal distance from the plumb bob point to the front of the steel strip or to the string running from rear tire to rear tire (distance *H*). Divide the vertical distance (*V*) by the horizontal distance (*H*). The ratio of *V/H* is the tangent of the angle of departure. If this ratio is known, the angle of departure can be determined from a table of trigonometric functions of angles or from a math calculator. The standard requires a minimum angle of departure of 8 degrees; since the tangent of 8 degrees is 0.1405, if *V* divided by *H* is 0.1405 or larger, the angle of departure is 8 degrees or greater.

A.12.3.3 Where automatic transmissions are used, the power takeoff applications could present problems, especially where dual PTO drives are required. In some instances, the PTO drive can be engaged only in torque converter range, with resultant chances of overheating with prolonged use. If the vehicle is accidentally left in gear and high engine rpm occurs, there is a possibility of the output torque overcoming the parking brake and moving the vehicle. Proper operational instructions are essential with automatic transmissions.

A.12.3.4.1 Where a large-capacity fuel tank is desired, as in the case of apparatus designed for rural service, the capacity should be specified by the purchaser.

A.12.3.5 If the purchaser wants the hooks or rings to be accessible without compartment doors having to be opened, the specifications should state that fact.

A.13.1 This chapter defines the requirements for alternators, batteries, load management, and instrumentation to detect incipient electrical system failure. The intent is to require an electrical system that will operate the apparatus using power supplied by the alternator, shed nonessential electrical loads where necessary, and provide early warning of electrical failure in time to permit corrective action.

A.13.2.1 The 125 percent requirement for wiring and circuits is intended to provide reduced voltage drop over wire rated based on ampacity due to heating. In low voltage wiring, voltage drop becomes a problem before the thermal limit of current carrying capacity of a wire is reached. This requirement also ensures that the circuit protection will prevent damage to the wire in the event of a short or an overload. It is not the intent of this requirement to have the final-stage manufacturer replace the chassis manufacturer's original equipment wiring to meet the 125 percent requirement. It is also not the intent of this requirement to have electrical accessories purchased by the apparatus manufacturer rewired to meet the 125 percent requirement. Electrical device manufacturer–supplied wiring can be used to the point where it connects to the apparatus manufacturer's installed wiring.

A.13.2.6 It is the intent of 13.2.6 to provide a unique means of identifying a wire or circuit to prevent confusing it with another wire or circuit if electrical system repairs become necessary. If a color coding scheme is used instead of some other unique identification, that color should not be reused for a wire in any unrelated circuits within the same harness. However, 13.2.6 covers low voltage wiring only and does not apply to shielded cables commonly used for communication purposes or wiring used in line voltage circuits.

A.13.3.2 The minimum alternator size is developed using the loads required to meet the minimum continuous electrical load. Most apparatus will actually have loads exceeding the minimum requirements of this standard. The purchaser should review the maximum current output of the alternator versus the load study supplied for the apparatus from the manufacturer for on-scene and responding modes.

A.13.3.3.1(7) The purchaser should analyze the electrical loads that need to be maintained to fulfill the mission of the apparatus and define those loads for the manufacturer of the apparatus. The purchaser needs to understand, however, that there is a limit to the output capacity of an alternator system on the apparatus's engine and that this standard requires that the apparatus be capable of maintaining the minimum continuous electrical load under the conditions defined in 13.3.2. When that load is exceeded and larger alternators are not available, the purchaser and the manufacturer need to work together to determine how to reduce the minimum continuous electrical load to that which can be sustained under the conditions defined in 13.3.2.

A.13.3.4 The unexpected shutdown of a fire apparatus at a fire can place fire fighters in mortal danger and seriously affect the fire attack. With computer-controlled engines and transmissions as well as electric valves and other controls, an electrical system failure could result in an immediate and total shutdown of the apparatus. The low voltage monitoring system is intended to provide an early warning of an impending electrical failure and provide enough time to permit operator intervention.

A.13.3.6.1 Reduced crew sizes have forced the apparatus operator to assume many new fireground tasks in addition to that of operating an apparatus. Even if the operator is at the apparatus, he or she is too busy with higher priority tasks to pay much attention to monitoring the condition of the electrical system.

Electrical loads on modern fire apparatus frequently exceed the alternator capacity and can be supplied only by the deep discharge of the apparatus batteries. The high-cycle batteries that are designed to provide the large amount of amperage to crank modern diesel engines are severely damaged when deeply discharged. The automatic load management is intended to protect the electrical system from needless damage while maintaining the operation of essential devices.

It is important that the priority of all managed loads be specified by the purchaser so that, as electrical loads are disconnected from the apparatus's electrical systems, they are shed in an order least likely to affect emergency operations. The optical warning devices in excess of the minimum required in this standard can and should be load managed.

A.13.4 Batteries on fire apparatus should be larger than those used on commercial vehicles because, in addition to starting the vehicle, they need to provide the supplemental energy to power high-amperage, intermittent operation devices such as mechanical sirens and electric rewind hose reels.

Batteries usually have two ratings: “cold cranking amperes,” which determine the size engine that can be started, and “reserve capacity,” which provides a measure of the total power that can be provided at a much lower constant rate of discharge. Fire apparatus batteries should be sized to have enough cold cranking amperage and reserve capacity to restart the engine after being substantially discharged.

A.13.4.4.4 Overheating of a battery will cause rapid deterioration and early failure; evaporation of the water in the battery electrolyte can also be expected. Batteries in commercial chassis are often installed to take advantage of the cooling effect of the flow of air from motion in over-the-road operation and could be subject to overheating when the apparatus is operated in a stationary position, such as during pumping operations.

A.13.4.5 The power cord from the onboard charger or battery conditioner should be plugged only into a receptacle protected by a ground-fault circuit interrupter (GFCI) at the shoreline origination point.

A.13.4.6.4 The purchaser might want to consider a second “battery on” pilot light on the outside of the apparatus to warn that the batteries are on when the apparatus is parked in the fire station.

A.13.4.7 Sequential switching devices are sometimes used to minimize the load placed on the electrical system during apparatus startup for an emergency response.

A.13.7 SAE J551/1 provides test procedures and recommended levels to assist engineers in the control of broadband electromagnetic radiation and in the control of radio interference resulting from equipment installed on the apparatus. Adherence to the recommended levels will minimize the degradation effects of potential interference sources on fireground communication equipment or other devices susceptible to electromagnetic interference.

Procedures are included to measure the radiation from a single device or the entire apparatus. Compliance could be determined through actual tests on the completed apparatus or predictions based on tests previously conducted on similarly equipped apparatus. If compliance certification is required, it should be so indicated in the apparatus specifications.

A.13.8.1 The upper-level optical warning devices provide warning at a distance from the apparatus, and the lower-level optical warning devices provide warning in close proximity to the apparatus. *(See Figure A.13.8.1.)*

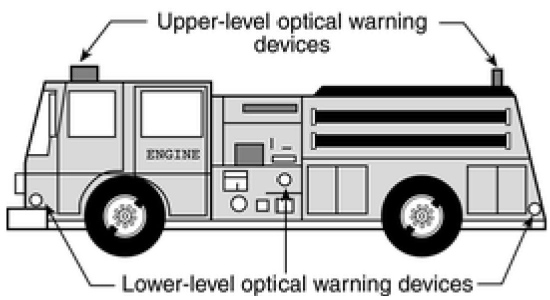


FIGURE A.13.8.1 Upper- and Lower-Level Optical Warning Devices.

A.13.8.7.3 Under typical conditions, the specified optical warning system provides effective, balanced warning. In some situations, however, the safety of the apparatus can be increased by turning off some warning devices. For example, if other vehicles need to pass within close proximity to the parked apparatus, the possibility of distracting other drivers can be reduced if the headlights and lower-level warning lights are turned off. In snow or fog, it might be desirable to turn off forward-facing strobes or oscillating lights to reduce visual disorientation of the apparatus driver.

The intent of the warning light system is to provide full coverage signals through the operation of a single master switch when the apparatus is either responding or blocking the right-of-way. There is no intent to prevent the use of lower levels of warning when the apparatus driver believes such reductions are appropriate, given the vehicle's mission, the weather, or other operational factors. Additional switches downstream of the master switch can be specified by the purchaser to control individual devices or groups of devices.

Purchasers might want to specify traffic flow–type lighting such as amber directional indicators for use in alerting approaching motorists of blocked or partially blocked highways.

A.13.8.10 When a component such as a flasher or power supply is used to operate more than one optical source, the optical sources should be connected so that the failure of this component does not create a measurement point without a warning signal at any point in any zone on either the upper or lower level. Although a single optical source can be used to provide warning signals into more than one zone, the possibility of a total signal failure at a measurement point is increased when the same flasher or power supply is used to operate multiple optical sources, each providing signals into more than one zone.

A.13.8.12 Flashing headlights are used in many areas as warning lights and provide an inexpensive way to obtain additional warning to the front of the apparatus. Daylight flashing of the high beam filaments is very effective and is generally considered safe. Nighttime flashing could affect the vision of oncoming drivers as well as make driving the apparatus more difficult.

In some jurisdictions, headlight flashing is prohibited or limited to certain types of emergency vehicles. If flashing headlights are employed on fire apparatus, they are to be turned off when the apparatus headlights are on. They should also be turned off along with all other white warning lights when the apparatus is in the blocking mode.

Steady burning headlights are not considered warning lights and can be illuminated in the blocking mode to light the area in front of the apparatus. Consideration should be given, however, to avoid shining lights into the eyes of oncoming drivers.

A.13.8.13 The minimum optical warning system should require no more than an average of 40 A for the operation of the upper-level and lower-level devices in the blocking mode. On apparatus whose length requires midship lights, no more than 5 A of additional current should be required for the operation of each set of midship lights. Optical warning systems drawing more than 40 A might necessitate modification of the electrical system specified in Section 13.3 in order to supply the additional power required.

See Figure A.13.8.13(a) and Figure A.13.8.13(b) for illustrations of an optical warning system on a large fire apparatus.

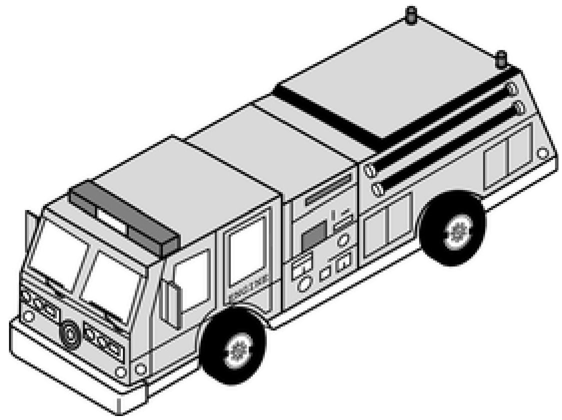


FIGURE A.13.8.13(a) Front and Left Side of an Apparatus with an Optical Warning System.

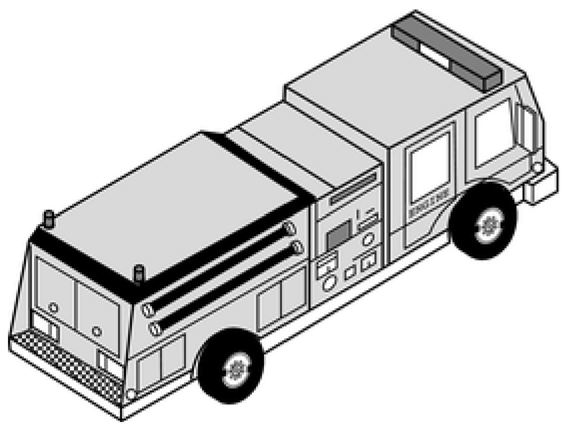


FIGURE A.13.8.13(b) Rear and Right Side of an Apparatus with an Optical Warning System.

A.13.8.13.5 The zone totals reflect the combined performance of the individual optical warning devices oriented as intended on the apparatus when viewed along the perimeter of a circle of 100 ft (30.5 m) radius from the geometric center of the apparatus.

The zone total is the sum of the optical power of all optical sources projecting signals of permissible color into the zone as measured at 5 degree increments along the horizontal plane passing through the optical center *H* throughout the 90 degrees included in the zone (19 data points). The calculation of zone totals assumes that all optical sources are mounted at the geometric center of the apparatus. With the optical center of each optical source oriented as installed, the optical power contributed by every optical source at a given point is taken from the test report, and they are added together to determine the total optical power at that point. The zone total is the sum of the optical power at the 19 measurement points in the zone. The upper- and lower-level optical sources are calculated independently.

The engineering basis of Section 13.8 permits both the design and the certification of an optical warning system by mathematical combination of the individual test reports for any number of optical warning devices of different color, flash rate, optical source, and manufacturer.

Using the test reports provided by the device manufacturer, the contribution of optical energy from each optical source is determined for every data point. The total candela-seconds per minute of optical energy is determined at each point, and then the zone totals are calculated and compared to Table 13.8.13.5.

A.13.8.14 The minimum optical warning system should require no more than an average of 35 A for the operation of the devices in the blocking mode.

A.13.8.16 In a few cases, a manufacturer might wish to type certify by actual measurement of the optical warning system on an apparatus.

Certification of the actual measurement of the performance of the optical warning system is made with each optical source either mounted on the apparatus or on a frame duplicating the mounting of the device on the apparatus. The performance of the system can be directly measured along the perimeter of a circle with a 100 ft (30.5 m) radius from the geometric center of the apparatus. Each optical warning device used should be certified by its manufacturer as conforming to all the requirements of this standard pertaining to mechanical and environmental testing. Photometric testing of the system should be performed by qualified personnel in a laboratory for such optical measurements.

The test voltages and other details should be as called for in this standard for the photometric testing of individual optical warning devices. The elevation of the photometer, however, could be set at the elevation that maximizes the performance of the upper-level devices and at a second, different elevation that maximizes the performance of the lower-level devices.

With the optical center of each device oriented as installed, the sum of the actual value of the optical power contributed by every optical source is then determined at each measurement point. The zone total is the sum of the optical power at the 19 measurement points in the zone.

Measurements are made to determine all the optical requirements of this standard, including the optical power at each of the required measurement points, the zone totals at the horizontal plane passing through the optical center, and the zone totals at 5 degrees above and 5 degrees below the horizontal plane passing through the optical center. Any upper-level warning devices mounted above the maximum height specified by the manufacturer(s) should be tested to demonstrate that at 4 ft (1.2 m) above level ground and 100 ft (30.5 m) from the mounted device, the optical energy exceeds 50 percent of the minimum required at the horizontal plane passing through the optical center.

A.13.9.1.2 If the purchaser wishes to have the siren controls within convenient reach of persons riding in both the right and left front seat positions, that should be specified. In some apparatus, multiple control switches might be necessary to achieve convenient reach from the two positions. If other signal devices, such as an additional siren, bell, air horn(s), or buzzer are desired, the type of device and its control location also should be specified.

A.13.10.1.1 The purchaser might want to specify work area (scene) lighting along the side of the vehicle. This can be provided by low voltage or line voltage lighting.

A.13.10.2 The hose bed lighting can be line voltage lighting provided by mounted line voltage lights that can be directed to provide the required light.

A.13.10.4 The user may want to consider a map light or additional task lighting in the cab.

A.13.11.3 Manually operated floodlights on telescoping poles are not required to be tied into the hazard light in the driving compartment. If the purchaser wishes that these devices be tied into the hazard light or otherwise equipped with an indicator to warn the operator the floodlights are in the up position, that should be specified in the purchase specification.

A.13.12 The purchaser might wish to add camera(s) at the sides or rear of a vehicle with cab monitoring screens or automatic vehicle-stopping devices that sense an obstruction at the rear of the vehicle. In addition, angled backup lights mounted in the wheel well areas will provide additional scene lighting for personnel who might be at the side of the vehicle or lighting of folding tanks or other obstacles on the side of the apparatus. Any such devices will improve safety while vehicles are backing.

A.13.14.1 The purchaser might wish to have the entire low voltage electrical system and warning device system certified by an independent third-party certification organization.

A.14.1.3 The purchaser will need to define how many seating positions are required to carry personnel and might wish to specify the arrangement of the seating positions. Large fire fighters with heavy bunker gear might require special accommodation for seat belt length. Seat belt extenders are not recommended by seat belt manufacturers, because if they are transferred to other apparatus or personal vehicles and used on another manufacturer’s belts, a false latch could result. This can occur if the latch design is similar but not exact. The length of belt that can be accommodated in the retractor is fixed at 89 in., so extra-long belts will not retract all the way, leaving a portion of the belt hanging free. Purchasers who specify extra-long belts must be aware of the potential for the belt to swing into or out of the door.

The ability of a fire fighter to enter the driving or crew riding area, get seated, and properly buckle the seat belt is critical. Studies of fire fighter size have shown that it is not possible to seat four of the largest fire fighters (95th percentile males) wearing their protective clothing side by side across the crew riding area without rubbing shoulders. Purchasers should consider specifying a seating configuration to ensure that all occupants will be able to be buckled into a seating position effectively and efficiently before the apparatus is moving. Alternative seating configurations that can be considered include three or two seats across the width of the riding area and facing seats.

A.14.1.3.2 The minimum effective belt length dimensions were determined from a survey of 300 fire fighters wearing bunker gear. For a lap belt only, the 95th percentile male fire fighter required 48 in. (1220 mm) of belt length, and the largest subject in the survey required 54 in. (1370 mm) The 60 in. (1525 mm) minimum will accommodate the largest subject and provide

12 in. (305 mm) spare for the 95th percentile subject.

A.14.1.3.3 For a lap and shoulder belt assembly, the 95th percentile fire fighter required 98 in. (2490 mm) of effective belt length, and the largest subject in the survey required 109 in. The 110 in. (2800 mm) minimum will accommodate the largest subject and provide 12 in. (305 mm) spare for the 95th percentile subject.

A.14.1.8.1 The H point is the mechanically hinged hip point of the torso and thigh on the devices used in defining and measuring vehicle seating accommodation in SAE J826, *Devices for Use in Defining and Measuring Vehicle Seating Accommodation*. It is an imaginary point located in two-dimensional space above the seat cushion. The H point is measured using a tool that simulates human hips and torso of a specific size and weight. The H point will vary with the size, shape, and material of the seat back, seat frame, and seat cushion. If the H point measurement is not available, it can be approximated by measuring 5 in. (130 mm) ahead of the seat back and 3 in. (75 mm) up from the nondepressed seat cushion surface.

Suspension-style seats have been developed for long-haul truck operations where the operator is driving for many hours at a time. Acceleration and braking are controlled, with an eye to fuel economy. The suspension-style seat in this duty profile provides a smoother ride and reduces fatigue from long hours in the seats. In contrast, the operator of a fire apparatus typically is making short runs with fast acceleration, quick maneuvers, and sudden braking. The bouncing motion of the suspension seat could hinder the driver's ability to maintain precise control of the throttle, brake, steering wheel, and other driving controls.

Selection of seating options should be made with consideration to the frequency of time that the driver will spend in the vehicle each day, and whether the fire department standard operating procedure (SOP) requires or encourages the occupant of the seat to be equipped with head gear during travel. The use of headgear reduces headroom and increases the chance of injury should the vehicle encounter unexpected road undulation or speed bumps. The effect of such road conditions during high-speed operation might be intensified by the action of a seat suspension. Potential for injury is greatly increased by failure to use or properly adjust the seat belt.

Proper seat adjustment is another issue that should be addressed by the fire department SOPs if apparatus are equipped with suspension seats. Too much pressure in a suspension seat air bag will reduce static headroom height and will negate the potential benefits of the suspension. Too little pressure will cause the seat to bounce excessively. The proper amount of pressure is dependent on the weight of the occupant. Departments where multiple drivers share an apparatus should recognize that adjustments need to be made between each shift. Seat adjustment should not be postponed until the driver is exiting the station on the way to a call.

A.14.1.8.4 The minimum seat head height values in this standard assume that the occupants are not wearing fire helmets. The use of a helmet puts the occupant at greater risk of neck or back injury during a rollover or a severe road event.

A.14.1.10.1 SCBA units and other equipment stored in the crew compartment can cause injuries to occupants of the compartment if they fly around the compartment as the result of an accident or other impact.

A.14.3.1 With the requirements for fully enclosed driving and crew compartments, the potential for heat buildup in these areas is greater. The purchaser should be aware of this condition and might wish to specify ventilation fans or air conditioning to keep the ambient temperature in the driving and crew compartment(s) lower.

A.14.3.2 The U.S. standards developed by SAE and the United Nations ECE regulation mirror each other except that SAE J2422 requires a roof preload impact prior to the roof crush. The ECE standard was established in 1958, while the SAE standards did not add performance criteria until 2003. Both the SAE and ECE standards are viable minimum measures of cab integrity. Manufacturers may test in excess of the standards.

A.14.3.4 The purchaser should realize that local conditions or operating procedures could cause the passenger to project into the sight pattern of the driver and therefore cause vision obstructions. Seats should be arranged so that SCBA and any passengers wearing protective clothing do not cause vision obstructions. Movement of the passengers should be considered when installing radios, computers, and other equipment so that forward movement or shifting is reduced to a minimum and does not block the driver's vision.

When specifying new apparatus, the purchaser should consider remotely controlled mirrors, especially on the passenger side. The location and mounting of the mirrors should not be placed where door pillars or other obstructions block the driver’s view. The location and mounting should be placed so warning lights do not reflect in the mirror to blind the driver's view. The location and mounting should not be placed so that the driver must look through the windshield area that is not wiped by the windshield wiper when viewing the passenger side mirror. Convex and other secondary mirrors should be considered to eliminate blind spots not covered by primary mirrors. Where necessary, heated mirrors should also be considered.

A.14.4.3 In many areas, the overall height of the vehicle needs to be restricted in order to clear bridges, station doors, and so forth. The tiller operator's compartment roof is normally the highest point on the vehicle. Careful consideration should be given to the packaging of the tiller body in deciding ground ladder and body compartmentation design to achieve the required seat head height.

A.15.1 Compartmentation that is designed to meet the size, shape, and weight requirements of special equipment might be required. Any special equipment to be carried on the apparatus should be identified in the specifications.

A.15.1.1 A water tank can sweat moisture. Ventilation and drainage should be provided in compartments sharing a common wall with a water tank.

A.15.2 The purchaser needs to provide the apparatus manufacturer with the details of and any special needs for communication equipment such as radio size, power consumption, and location(s) for communication equipment.

A.15.3.1 Fire fighter injuries resulting from climbing on apparatus to retrieve, store, and operate equipment can be minimized if specifications require that equipment be accessible from ground level. Examples of ways to reduce the need to climb on the apparatus include, but are not limited to, using powered equipment racks, using remote control deck guns, lowering of storage areas for preconnected attack lines and using pull-out trays, using slide-out or pull-down storage trays, and providing for the checking of fluid levels from ground level.

A.15.3.2 Where equipment other than that originally mounted on the apparatus is to be carried, the fire department should ensure that the equipment is securely attached to the vehicle with appropriate holders.

A.15.5 SCBA units are typically stored in crew seats, behind bench seats, and on walls, doors, or shelves of storage compartments.

The area where the complete SCBA unit is to be mounted should be arranged to prevent damage to hose, straps, belts, facepiece, regulator, and other attachments. This arrangement should include prevention of wear and tear on the delicate facepiece due to vehicle movement. The facepiece should be stored in a nylon or plastic bag to prevent such abrasion.

Storage of spare hose assemblies, facepieces, regulators, and other SCBA pack accessories should be in a clean and dry area, away from heat-producing devices or mechanical damage. Preferably, the equipment should be stored individually in plastic or noncorrosive bins with dust-free covers. The contents of each bin should be noted on a label on the bin exterior.

A.15.5.5 SCBA cylinders should always be stored with the valve assemblies at the top.

A.15.5.6 SCBA cylinders should be stored with valve assemblies exposed to the compartment opening or storage area to permit inspection of valves or gauges.

A.15.6.5 The purchaser should consider specifying additional doors or removable panels for service, maintenance, or replacement of components in the fire pump installation.

A.15.7.1 Ascending into and descending from certain types of driving and crew compartments is ergonomically difficult and sometimes results in falls and subsequent fire fighter injuries. When designing and specifying apparatus, it is strongly suggested that chassis and apparatus manufacturers be consulted concerning available alternatives to make driving and crew compartment access as ergonomically convenient and as safe as possible.

A.15.7.1.2 The intent of step size and placement requirements is to ensure that the fire fighter's foot is supported 7 in. to 8 in. (175 mm to 200 mm) from the toe when the foot is placed on the step in the normal climbing position. The leading edge is not necessarily the side opposite the fastening location.

A.15.7.4 Apparatus are constructed with surface areas that are not intended to be used as stepping, standing, and walking areas. These include cosmetic and protective coverings on horizontal surfaces. During the design stage of the vehicle, purchasers should designate which areas are stepping, standing, or walking areas. It is important that proper materials are selected for the application and local conditions.

When selecting stepping, standing, and walking surfaces, the purchaser should take into consideration the long-term use of the vehicle. The slip resistance of certain surfaces might deteriorate over time. It is also important for the fire department to properly maintain or replace slip-resistant materials as they deteriorate.

A.15.8.4 Exterior access handrails should be mounted in a way so as to minimize the chances of damage or removal by brushing objects such as trees.

A.15.8.6 The intent is that the apparatus manufacturer does not need to remove and replace those grab handles designed and built into the chassis by a commercial chassis manufacturer. Grab handles inside the door are acceptable.

A.15.9.2 Corrosion protection, commonly known as undercoating, might be advantageous in areas where climatic conditions or road treatment will corrode vehicle components. The material, its application method, and the areas to be protected should be carefully specified so the corrosion protection will adequately protect the vehicle's cab and body sheet metal components subject to corrosive conditions that might be encountered in the fire department's response area.

A.15.9.2.1 The purchaser should give consideration to the choice of paint color(s) as it relates to the total vehicle conspicuousness. In addition, the purchaser needs to specify whether nonferrous body components are to be painted and whether any lettering, numbering, or decorative striping is to be furnished.

A.15.9.3 The purchaser should specify whether the striping required under this standard will be provided by the manufacturer on delivery of the apparatus or will be installed by the purchaser or its designee following delivery. In any event, the required striping must be installed before the unit is placed in emergency service.

A.15.9.3.1 If the purchaser specifies roll-up doors, consideration should be given to affixing a strip of reflective material to the rail area below the door. If the purchaser specifies vertically hinged compartment doors, consideration should be given to affixing 4 in. (100 mm) minimum width reflective stripes or chevron-type reflective stripes on the inside of the doors.

A.15.10 Apparatus provided with booster hose and reel assemblies should have power rewind capability. However, if a manual rewind is provided, attention should be paid to the location of the hand crank. It should be placed in a location that allows the operator to rewind the hose onto the reel without having to climb onto the apparatus.

If the apparatus is to be used or stored in subfreezing conditions, the reel should be equipped with an air chuck mechanism to allow connection of an external source of compressed air to facilitate removal of water within the booster hose assembly. This mechanism should be located on the discharge side of the booster reel valve.

A.15.10.1 The purchaser should specify whether a single or split hose bed is desired and any special arrangements desired for preconnected hose lines.

A.15.10.3 It is also recommended that the purchaser consider specifying some type of cover for the hose compartment. Hinged or removable covers might be advantageous.

A.15.10.7 Many fire departments have experienced fire hose inadvertently coming off apparatus traveling to and from incidents. Several incidents have resulted in injuries, damage to property, and death. Fire departments and manufacturers have developed various methods of preventing inadvertent deployment, including fully enclosed hose bed covers, buckled straps, hook-and-loop straps, fabric covers, webbing mesh, wind deflectors, and other material restraints or combination of restraints. It is also important that fire departments develop methods of storing hose and appliances in a manner that does not promote the inadvertent deployment of the hose and appliances.

A.15.12 Trailer hitch–type receivers are commonly used as anchor points for both removable winches and rope operations. Removable winches are intended for equipment recovery operations only. Rope operations could involve personnel rescue, which requires the receiver and its anchorage to be designed using higher safety factors.

A.15.13.4.4 If the unit is going to be moved onto and off a chassis periodically, the purchaser might wish to specify lifting eyes or forklift slots to facilitate the unit's movement. Provisions to prevent accidental breakaway from the chassis should be provided.

A.16.2.2 If the apparatus is equipped with an automatic transmission, it is acceptable to lightly apply throttle and brakes for short periods of time to maintain this requirement.

If the vehicle is to be used for simultaneous pump-and-roll and fire fighting while the vehicle is moving, remote controlled nozzle(s) or turret(s) should be considered. See also A.6.3.1 of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*.

A.16.2.3.2 Pumps larger than 3000 gpm (12,000 L/min) are used for specialized industrial fire-fighting applications, where the apparatus is typically supplied by a high pressure feed system.

A.16.2.3.3.4 Parallel operation can be referred to as "volume," and series operation can be referred to as "pressure."

A.16.2.4.1 At an altitude of 2000 ft (600 m), the actual (uncorrected) atmospheric pressure equivalent to the sea level reading of 29.9 in. Hg (101 kPa) is 27.8 in. Hg (94.1 kPa).

The values given in Table 16.2.4.1(b) and Table 16.2.4.1(c) are representative values of pressure losses due to flow entrance, velocity, and friction sources through 20 ft (6 m) of suction hose (including strainer) of the diameter indicated.

The basis of the tables on friction loss is tabular data from 1953 testing and other accumulated data and testing. In 1976, the data were reviewed and incorporated in Table 16.2.4.1(b). The data include a velocity head component, and the values account for bending, because the actual values were derived from suction hose bent from the suction intake into the test pit.

A.16.2.4.2 Where the community to which the apparatus is to be delivered is at a considerably higher altitude than the factory or other test location, sufficient excess power should be provided to compensate for the fact that the power of a naturally aspirated internal combustion engine decreases with elevation above sea level. The performance of a fire pump can be adversely affected by the design of the suction piping or the addition of valves to the suction side of the pump. Losses due to additional piping or valves that are added to the fire pump suction can be calculated and used to determine pump performance.

A.16.3.4 A separate pumping engine could use the vehicle chassis battery system, or it could have a separate set of dedicated batteries. Whichever system is used, the battery charging and electrical supply should be designed to meet this standard.

A.16.4.3 Each component in the driveline has a continuous duty torque rating. At this level of usage, each component also has a design life expressed as hours of use at rated torque. The design life of some components can be substantially less than the remaining drive system components. An hourmeter activated by the pumping system and marked with a label should be provided to log the number of hours of drive system usage.

Programming the engine to use an alternate torque curve or sizing the pump and pump gear ratio to limit the torque required is an acceptable means of limiting the net engine output torque.

A.16.5.1 Pumps and piping that are frequently used to pump saltwater, water with additives, or other corrosive waters should be made of bronze or other corrosion-resistant materials. For occasional pumping of such water, pumps made of other materials are satisfactory if properly flushed out with freshwater after such use. Where corrosive water is being pumped and the pump and piping are not made of corrosion-resistant materials, the placement of anodes in the pump might minimize the corrosive effects.

The term *all bronze* indicates that the pump's main casing, impeller, intake and discharge manifolds, and other principal components that are exposed to the water to be pumped, with the exception of the shaft bearings and seals, are made of a high-copper alloy material. It is preferable to use similar materials for the pump and piping.

Corrosion effects are proportional to the mass relationship of bronze to iron. It is, therefore, preferable to use similar materials for the pump and piping. Where both iron and bronze are used, it is preferable to keep the mass of the iron larger than that of the bronze.

A.16.6.1 Intakes can be larger than the size of the suction hose specified in Table 16.2.4.1(a). The sizing of suction hose in Table 16.2.4.1(a) is for the pump manufacturer’s certification of the pump’s capability only. It is recommended that a fire department standardize suction hose size regardless of fire pump size on its apparatus, which will allow extra suction hose to be available if a long horizontal reach is needed to get to the water source. Regional standardization of suction hose sizes will improve interoperability within the region in the event of a major disaster.

It is also advantageous to have valves on one or more of the intakes. The purchaser should specify if larger intakes are to be provided and if any of the intakes are to be equipped with valves.

Intakes at the front or rear of the apparatus or otherwise specially situated might not allow drafting rated capacity at rated pressure. The purchaser should specify the flow rates required from auxiliary intakes, especially front and rear intakes or other intakes located 10 ft (3 m) or more away from the pump. If auxiliary intakes are provided, the purchaser should also consider requiring the manufacturer to certify the actual flow rates from auxiliary intakes.

A.16.6.1.3 Pressurizing a suction inlet could create a dynamic water hammer that might cause a hose or fitting failure, resulting in injury or death to anyone in the immediate vicinity. Valves should be opened and closed slowly, and lines should be charged slowly.

A.16.6.2.2 Sizing of the openings of the strainer(s) is intended for debris of generally uniform dimensions. It is recognized that debris of nonuniform dimensions — that is, long in relation to cross section — might be able to pass through the strainer(s) while not being able to pass through the pump.

A.16.6.5 The bleeder valve should be used prior to the removal of a hose, a cap, or other closure connected to an intake. The bleeder valve should also be used while filling a hose connected to an intake with water. Failure to use the bleeder valve in these situations might result in serious injury or death.

A.16.7 Consideration should be given to providing an additional pump cooling/recirculation line that is automatic in operation, because pumps on fire apparatus are often left unattended and a line that is automatic in operation will ensure that the pump does not overheat.

A.16.7.1 The flows listed for each outlet size are minimum and are for rating purposes only. If piping and valving are sufficient, much higher flows for a given outlet size might be achievable.

A.16.7.2.2 For interoperability among fire departments at major incidents, National Hose threads are required. Adapters can then be used to adapt to locally used hose connections.

A.16.7.3 If flows greater than 200 gpm (750 L/min) through preconnected lines are needed, piping from the pump to preconnected hose lines should be larger than 2 in. (52 mm) in order to keep the friction loss to a reasonable level. If additional preconnected lines are wanted, the location and hose size should be specified.

A.16.7.5.2 Control of discharges on apparatus is available as pull-type actuators, trunnion or swing valves, flexible push/pull controls, gear-operated hand wheel controls, and hydraulic, air, and electric operators. These controls are available with either quick-operating or slow-operating valve mechanisms. The nozzle and hose reaction and “operational effort” for high flow or high pressure discharges are critically important to many fire departments. Because of the variations in types of individuals and characteristics of operators involved with pump operations, a purchaser should carefully evaluate valve controls. Slow-closing gear-operated and other power-operated valves should be considered for valves 3 in. (75 mm) and larger.

A.16.7.9 Where possible, discharge outlets should be positioned in an area away from the pump operator's position.

If a deck gun or monitor is to be mounted on the top of the apparatus, consideration should be given to designing the system so it can be operated without the need for a person to climb to the top of the apparatus. This can be accomplished by using a remotely operated monitor or by positioning the device so it is operable from the pump operator's position.

A.16.9.1 Ideally, having no intake or discharge connections at the operator's position would simplify and improve safety for the operator. If complete removal of these connections is impractical, the reduction and careful placement of these connections, with operator safety in mind, would improve the situation considerably.

Operation of pump and discharge controls should not compromise the clearances of the operator’s space on a top-mount pump panel or provide sharp edges, projections, or barriers to movement. The purchaser might want to state the clear walkway minimum space that is required.

Many fire departments have found it useful to color code the labels that identify the various discharge and intake controls. While this process can simplify pump operations, it can also create confusion if a pattern is not followed on all apparatus in the department. For standardization, the color-coding scheme in Table A.16.9.1 is recommended for all new apparatus labels.

Table A.16.9.1 Color Scheme for Labels on Discharge and Intake Controls

Discharge	Color
Preconnect #1 or front bumper jump line	Orange*
Preconnect #2	Red*
Preconnect #3 or discharge #1	Yellow*
Preconnect #4 or discharge #2	White*
Discharge #3	Blue
Discharge #4	Black
Discharge #5	Green
Deluge/deck gun	Silver
Water tower	Purple
Large-diameter hose	Yellow with white border
Foam line(s)	Red with white border
Booster reel(s)	Gray
Inlets	Burgundy

*Because the vast majority of fires are extinguished using preconnected lines, a fire department should give consideration to matching the hose jacket color to the color of the labels. Fire departments using this system have reported an improvement in fireground operations.

A.16.10 The indicator lights and interlocks specified in this section are minimums. Some manufacturers or users might choose to add additional indicator lights or interlocks.

A.16.10.1.2 Pumps are operated from the side, top, front, or rear of the vehicle, and stationary pumping requires that no power is applied to the wheels during pumping. Therefore, it is essential that any controls that could apply power to the wheels while pumping be equipped with a means to prevent dislocation of the control from its set position in the pumping mode.

A.16.10.2.1 Completion of the pump shift might require that the chassis transmission be shifted into pump gear.

A.16.10.3.1 See A.16.10.2.1.

A.16.10.10.3 Engine speed advancement control at the operator's panel might be required for apparatus with the need to control the engine speed for operation of a generator, aerial device, alternator, or other chassis engine–driven device. The indicating device for this "Throttle Ready" condition is the same indicating device as in 16.10.10.2.

Other apparatus may not have equipment for which there is a need to control engine speed from the pump operator's panel. Engine speed control at the pump operator's panel for these apparatus may not be desirable since, on many chassis engines, activating remote throttle operation will automatically disable the in-cab accelerator pedal. For such apparatus, engine speed advancement control at the pump operator's panel is not required when the chassis transmission is in neutral and the parking brake is engaged, and "Throttle Ready" indication for this condition is not required.

A.16.10.11.3 Engine speed advancement control at the operator's panel might be required for apparatus with the need to control the engine speed for operation of a generator, aerial device, alternator, or other chassis engine–driven device. The indicating device for this "Throttle Ready" condition is the same indicating device as in 16.10.11.2.

Other apparatus may not have equipment for which there is a need to control engine speed from the pump operator's panel. Engine speed control at the pump operator's panel for these apparatus may not be desirable since, on many chassis engines, activating remote throttle operation will automatically disable the in-cab accelerator pedal. For such apparatus, engine speed advancement control at the pump operator's panel is not required when the chassis transmission is in neutral and the parking brake is engaged, and "Throttle Ready" indication for this condition is not required.

A.16.10.14 The purpose of a pressure control system is to control the discharge pressures in order to protect fire fighters who are operating hose streams as well as to protect discharge hose from damage in the event attack hose streams are shut off or other valves are closed, reducing flow rates.

The system could consist of a discharge relief valve, a pressure regulator that controls the speed of the pump, an intake relief valve, or any combination of these devices. Pressure control systems will relieve excess pressure when valves are closed in a normal manner, but some water hammer conditions could occur due to valves being closed so quickly that the system cannot respond fast enough to eliminate damage to equipment. Proper fireground procedures are still required.

A.16.10.14.1 Pressure control systems can be supplied in the following forms:

(1) Integral with the pump and supplied by the pump manufacturer

(2) As an external system of components supplied by the apparatus manufacturer

(3) As an external control system provided by a pressure control manufacturer

Pressure governors control the engine speed, which relates directly to the net pump pressure: If the speed is raised, the pressure goes up; if the speed is lowered, the pressure goes down.

Discharge relief valves control pressure by passing water from the discharge side of the pump back into the intake side of the pump. This type of system works in a pressure differential of approximately 70 psi to 90 psi (500 kPa to 600 kPa) between the intake and discharge sides of the pump. If the pressure differential is not present, the discharge relief valve might not control a pressure rise completely.

If either a discharge relief valve or a pressure governor is used with high incoming inlet pressures, an intake relief valve or total control system must be added.

In the case where an intake relief valve is selected, it must be of sufficient size and response time to handle the pump performance range. It must also be easily controlled by the pump operator so that this incoming pressure can be adjusted for each incident. For best results, the operator should set the intake relief valve to operate at 90 psi (600 kPa) below the desired discharge operating pressure.

The pressure control system should be certified by the appropriate manufacturer or an independent third-party certification organization. Because of the importance of these systems, the purchaser might wish to have performance tests conducted on the installed system.

A.16.10.15 Departments that need to attain a draft while conducting operations off tank water will find that adding a primer selector valve or second priming control valve to allow attaining a draft on the outboard side of the gated pump suction valve will eliminate the danger of cavitation while supplying attack lines. A vacuum line is run to the outboard side of the valve and connected through a selector valve to the primer. Side, front, and rear selector settings can be arranged to allow priming off any side of the unit with one primer.

A.16.11.1 The electronic throttle control systems that are currently available will provide greater flexibility for the operator because they can be set like a traditional throttle or a pressure governor.

A.16.12.1.1 A pumping engine fuel level indicator or red warning light indicating when the fuel level falls below one-fourth of the capacity of the tank(s) should be provided on the pump operator's panel.

A.16.12.3.2 Because the rated operating pressure of large-diameter supply hose is substantially less than that of attack fire hose, an individual pressure gauge is required to allow the operator to control the discharge pressure even where a flowmeter is provided.

A.16.13.1.2.4 The purchaser might wish to have an independent third-party certification organization certify the test results, particularly where the pump is required to meet extended continuous duty pumping applications.

A.16.13.2.1.2 Where tests are performed inside a structure or elsewhere that has limited air circulation, carbon monoxide monitoring equipment should be used. Such equipment should be checked and calibrated regularly and should include a suitable warning device.

A.16.13.2.1.2(4) The suction lift capability of a fire pump is certified by the pump manufacturer for specific conditions of altitude above sea level, atmospheric pressure, water temperature, and friction and entrance loss caused by the flow of water through the intake strainers and hose as stated in 16.2.4.1. As the temperature of the water increases and barometric pressures decreases, the suction lift capability of the fire pump is reduced. While the minimum lift of the test site for the pumping test is 3 ft, the test site configuration must not provide a vertical lift that exceeds the suction lift capability of the pump as a result of elevated water temperatures and reduced barometric pressure. See Table A.16.13.2.1.2(4).

Table A.16.13.2.1.2(4) Effect of Water Temperature and Barometric Pressure on Suction Lift Capability

Water Temperature		Effect on Lift		Barometric Pressure		Effect on Lift	
°F	°C	ft	m	in. Hg	kPa	ft	m
60	16	0	0	29.9	101.3	0	0
90	32	-1	-0.3	29.0	98.2	-1	-0.3
110	43	-2.3	–0.7				
120	49	-3.3	-1.0				

A.16.13.2.2.6 If a counter speed shaft is not provided, the engine speed can be read with a phototachometer or strobe light off a rotating element.

A.16.13.2.3.1 Figure C.3(c) of NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus*, shows a test data form for recording the test readings and other necessary data.

A.16.13.2.3.2 Where an engine is operating at or near full power while stationary, the heat generated could raise the temperature of certain chassis or pumping system components above the level that, when touched, could cause extreme discomfort or injury. However, as long as the apparatus can be operated and used satisfactorily for the required duration of the test under such conditions, it should be considered acceptable.

The suction lift can be determined either by measuring the negative pressure (vacuum) in the pump intake manifold with a manometer or other suitable test gauge that measures vacuum accurately or by adding the vertical lift and the value of friction and entrance loss from Table 16.2.4.1(b) or Table 16.2.4.1(c). To be accurate, gauge readings should be corrected for the difference between the height of the gauge and the centerline of the pump intake, but usually this is not a significant amount and could be ignored. Thus, the net pump pressure can be calculated by using the following formulas.

For inch-pound units:

$$P = D + (H \times 0.5)$$

or

$$P = D + 0.43(L + F)$$

where:

P = net pump pressure (psi)
D = discharge pressure (psi gauge)
H = manometer reading (in. Hg)
L = vertical lift (ft)
F = friction and entrance loss (ft of water)

For SI units:

$$P_m = D_m + H_m$$

or

$$P_m = D_m + F_m + 9.8L_m$$

where:

P_m = net pump pressure (kPa)
D_m = discharge pressure (kPa)
H_m = manometer reading (kPa)
F_m = friction and entrance loss (kPa)
L_m = vertical lift (m)

A.16.13.6.5 When the test is done with intake valves open and intakes capped, the apparatus could have a bad intake valve that would not be detected. By conducting a second test with the intake valves closed and intakes not capped, a leaking intake valve would be detected.

A.16.13.8 The test of the engine speed advancement interlock system should verify proper functioning for the conditions of chassis transmission(s), parking brake and pump shift status indicated in Table A.16.13.8(a) through Table A.16.13.8(d). Testing should be performed with a qualified person positioned in the driving compartment and a qualified person verifying engine speed control status at the pump operator's panel. Shifting of the pump transmission/PTO should be done in accordance with the manufacturer's instructions.

Table A.16.13.8(a) Stationary Pump Driven Through Split-Shaft PTO

Chassis Transmission Gear Selected	Parking Brake Status	Pump Shift Status (Driving Compartment)	Engine Speed Control at Pump Operator's Panel	Requi Tes
Neutral	On	Road	Yes*	
Neutral	Off	Road	No	X
Neutral	On	Engaged	Yes*	
Neutral	Off	Engaged	No	
Pump gear†	On	Engaged, OK to pump	Yes	
Pump gear†	Off	Engaged	No	
Pump gear†	On	Road	No	X
Pump gear†	Off	Road	No	
Any gear other than neutral and pump gear†	On or off	Road	No	
Any gear other than neutral and pump gear†	On or off	Engaged	No	

*Applies only for those apparatus that have "Throttle Ready" indication on the pump operator's panel when the chassis transmission is in neutral and the parking brake is engaged. If there is no "Throttle Ready" indication, there no engine speed control at the pump operator's panel.

†Chassis transmission shift selector is placed in position for pumping as indicated on the label provided in the drivi compartment.

Table A.16.13.8(b) Stationary Pump Driven Through Transmission-Mounted PTO, Front-of-Engine Crankshaft PTO, or Engine Flywheel PTO

Chassis Transmission Gear Selected	Parking Brake Status	Pump Shift Status (Driving Compartment)	Engine Speed Control at Pump Operator's Panel	Requi Tes
Neutral	On	Disengaged	Yes*	
Neutral	Off	Disengaged	No	X
Neutral	On	Engaged, OK to pump	Yes*	
Neutral	Off	Engaged	No	
Any gear other than neutral	On	Engaged	No	X
Any gear other than neutral	Off	Engaged	No	
Any gear other than neutral	On or off	Disengaged	No	

*Applies only for those apparatus that have "Throttle Ready" indication on the pump operator's panel when the chassis transmission is in neutral and the parking brake is engaged. If there is no "Throttle Ready" indication, there no engine speed control at the pump operator's panel.

Table A.16.13.8(c) Stationary and Pump-and-Roll Pump

Chassis Transmission Gear Selected	Parking Brake Status	Pump Shift Status (Driving Compartment)	Engine Speed Control at Pump Operator's Panel	Requi Tes
Neutral	On	Disengaged	Yes*	
Neutral	Off	Disengaged	No	X
Neutral	On	Engaged, OK to pump	Yes*	
Neutral	Off	Engaged	No	
Any gear other than neutral	On	Engaged, OK to pump & roll	No	X
Any gear other than neutral	Off	Engaged, OK to pump & roll	No	
Any gear other than neutral	On or off	Disengaged	No	

*Applies only for those apparatus that have "Throttle Ready" indication on the pump operator's panel when the chassis transmission is in neutral and the parking brake is engaged. If there is no "Throttle Ready" indication, there no engine speed control at the pump operator's panel.

Table A.16.13.8(d) Stationary Pump Driven Through Transfer Case PTO

Chassis Transmission Gear Selected	Transfer Case	Parking Brake Status	Pump Shift Status (Driving Compartment)	Engine Speed Control at Pump Operator's Panel
Neutral	Neutral or engaged	On	Road	Yes*
Neutral	Neutral	Off	Road	No
Neutral	Engaged	Off	Road	No
Neutral	Neutral or engaged	On	Engaged	Yes*
Neutral	Neutral or engaged	Off	Engaged	No
Pump gear†	Neutral	On	Engaged, OK to pump	Yes
Pump gear†	Engaged	On	Engaged, OK to pump	No
Pump gear†	Neutral or engaged	Off	Engaged	No
Pump gear†	Neutral or engaged	On	Road	No
Pump gear†	Neutral or engaged	Off	Road	No
Any gear other than neutral and pump gear†	Neutral or engaged	On or off	Road or engaged	No

†Chassis transmission shift selector is placed in position for pumping as indicated on the label provided in the drivi compartment.

*Applies only for those apparatus that have "Throttle Ready" indication on the pump operator's panel when the cha transmission is in neutral and the parking brake is engaged. If there is no "Throttle Ready" indication, there is no en speed control at the pump operator's panel.

A.16.13.10 If the tests of some components of the apparatus are being certified by an independent third-party certification organization, the purchaser might wish to specify that these tests also be certified by the independent third-party certification organization.

A.17.1 Auxiliary pumps come in a variety of different styles: gear, piston, and centrifugal designs. Where centrifugal designs are specified, the purchaser also has to select if it is to be a single-stage, series-only multistage, or series/parallel multistage–type pump.

The purchaser should indicate the type of operation and performance required from the auxiliary pump. Auxiliary pumps are predominantly for fighting grass, brush, and other small outside fires. Low capacity with high pressure through ¾ in. (19 mm) or 1 in. (25 mm) booster hose is commonly used for these fires. Pump-and-roll capability is often specified.

A.17.3 Various types of pump drive systems are available. These pumps are often driven by power takeoff units attached to SAE PTO openings on the chassis transmission. There are also front-of-engine PTO systems, flywheel PTO systems, split driveline PTO systems, and separate engine drive systems.

A.17.3.1 The volume and pressure that can be obtained safely depend on the torque capacity of the apparatus's transmission or transfer case, power takeoff, and pump driveline. In most cases, the torque rating of the PTO will determine the maximum pump performance. Power takeoff manufacturers assign a torque rating to their products. This torque rating is based on intermittent service, as in operating the PTO at the full torque limit for a period of 5 minutes or less. For continuous duty, the intermittent torque rating is devalued 30 percent.

A.17.3.2 Sustained operations at either high volume, high pressure, or both high volume and high pressure could cause excessive heating of the transmission lubricant. To maintain lubricant temperatures below the component manufacturer's published limits, it might be necessary to employ oil-to-oil or oil-to-water heat exchangers. The latter should be of a type that will not trap water, which would cause serious damage if the water subsequently freezes.

A.17.5.1 The purchaser should indicate the number, size, and location of the pump intake connections or combination of connections desired. The types of pump intake connections are as follows:

(1) External intake

(2) Direct supply line from the water tank

(3) Supply line from the discharge side of the fire pump

A.17.6 The purchaser should indicate the size, number, and location of the pump discharge connections desired. The types of pump discharge connections are as follows:

(1) Discharge line(s) for non-preconnected hose lines

(2) Discharge line(s) to preconnected hose lines

(3) Discharge line(s) to booster reel(s) (if provided)

A.17.6.3.1 For interoperability among fire departments at major incidents, National Hose threads are required. Adapters can then be used to adapt to locally used hose connections.

A.17.9.3 A separate pumping engine could use the vehicle chassis battery system, or it could have a separate set of dedicated batteries. Whichever system is used, battery charging and electrical supply should be designed to meet this standard.

A.18.2.2 Water tanks should have provisions that allow for complete inside cleaning. The purchaser should indicate in the specifications if access to the interior of the tank is required.

A.18.2.3 Water tanks can appear in several different configurations, such as round, elliptical, rectangular, or T-shaped. Handling characteristics of the apparatus can be greatly affected by its vertical and horizontal centers of gravity. The purchaser should indicate the filling and dumping rates required if those rates exceed the requirements of this standard and any other local needs and let the apparatus manufacturer design the tank shape to best meet the axle-loading and center-of-gravity requirements.

If the tanks are made as one unit with the body and compartments, the material used is important. It should be corrosionproof and should not easily sweat.

A.18.2.5 The design of a water tank can be a critical factor in the handling characteristics of fire apparatus. If water is free to travel either longitudinally or laterally in a tank, as would be the case if the tank were half full, a tremendous amount of inertia can build up that will tend to force the fire apparatus in the direction the water has been traveling. When the water reaches the end of the tank, the sudden application of force can throw the fire apparatus out of control and has been known to cause fire apparatus to turn over or skid when going around a curve or coming to a sudden stop. The only way to prevent such accidents is to restrict or disrupt the movement of the water so that the inertia will not build up in one direction. This is done with the installation of swash partitions to either contain the water in smaller spaces within the tank (containment method) or disrupt its momentum by changing its direction of motion (dynamic method). The partitions in a containment system create compartments that are interconnected by openings between them so that air and water can flow at the specified rate when the tank is being filled or emptied. The partitions in a dynamic system are often staggered in an arrangement designed to change the direction of the water and turn it into a turbulent motion that absorbs much of its own energy.

A.18.3.3 A check valve installed in the tank-to-pump line is the most common method used to prevent water from backflowing into the tank at an excessive rate if the pump is being supplied from a hydrant or relay pumper and the tank-to-pump line valve has been inadvertently left in the open position.

A hole up to ¼ in. (6 mm) is sometimes provided in the check valve to release steam or other pressure buildup.

A.18.4.1 Where rapid filling of the water tank from an external source is desired, the purchaser should consider an inlet directly into the tank that is capable of allowing the tank to be filled at a rate of 1000 gpm (4000 L/min). Where such a fill connection is provided, it should conform to the requirements of 18.5.1.

A.18.4.1.1 The intent of 18.4.1.1 is to allow filling the tank by the insertion of a common 2½ in. (65 mm) hose with coupling into the fill opening. The opening does not need to be round in shape.

A.18.4.1.4 An excessive flow rate when a tank is being filled could result in a pressure buildup in the tank that could cause permanent damage or failure.

A.18.4.2.2 A vent/overflow outlet is necessary so that overpressurization does not occur within the tank while it is being filled. However, water is likely to spill out of the vent/overflow while the fire apparatus is moving (e.g., accelerating, decelerating, or cornering). The fill tower and vent/overflow outlet should be arranged so that water spillage is minimized and is directed behind the rear tires.

The purchaser might wish to specify a sealed water tank and overflow system design that will eliminate water spill while the vehicle is in motion.

A.18.4.3.1 If a larger fill line is desired, the buyer should consult with the manufacturer on construction of the tank inlet location and any required reinforcement or alternation of the tank baffles. It is necessary to design the tank with venting and overflow capability for the maximum fill rate.

A.18.4.3.2 See A.18.4.3.1.

A.18.4.3.3 A locking-type ball valve, globe valve, needle valve, or other type of valve capable of regulating flows should be used. A gate valve is not recommended.

A.18.5.1.1 Where large filling rates are used, fill connections should be equipped with a diffuser inside the tank to minimize potential structural damage. It is important that the purchaser evaluate how the apparatus will be used and define the location and type of fittings desired on this tank fill.

Where rapid filling of the water tank on another type of apparatus from an external use is desired, the purchaser should consider an inlet directly into the tank that is capable of allowing the tank to be filled at a rate of 1000 gpm (4000 L/min). Where such a fill connection is provided, it should conform to the requirements of 18.5.1.

A.18.5.2 It is important that the purchaser evaluate how the apparatus will be used and define the location(s) and types of fittings for these outlets.

Where rapid dumping of the contents of the water tank to an external use is desired on other types of apparatus, the purchaser should consider an outlet directly into the tank that is capable of allowing water to be transferred from the tank at an average rate of at least 1000 gpm (4000 L/min).

A.18.5.2.2 Additional methods might be desired to improve the off-loading rate of gravity dumps. These methods include a jet assist or a pneumatic pump. Control should be from the pump operator's position. Two types of jet assists can be used, one directed into the throat of the gravity dump and the other a peripheral jet system. Figure A.18.5.2.2(a) shows how the traditional jet is installed. A smooth-tipped "jet" nozzle is supplied by a pump that is capable of delivering at least 250 gpm (1000 L/min) at a gauge pressure of 150 psi (1000 kPa). Jet nozzles range in size from ¾ in. to 1¼ in. (19 mm to 32 mm). The diameter of the tip will be determined by the capacity of the pump being used and the diameter of the discharge piping and dump valve.

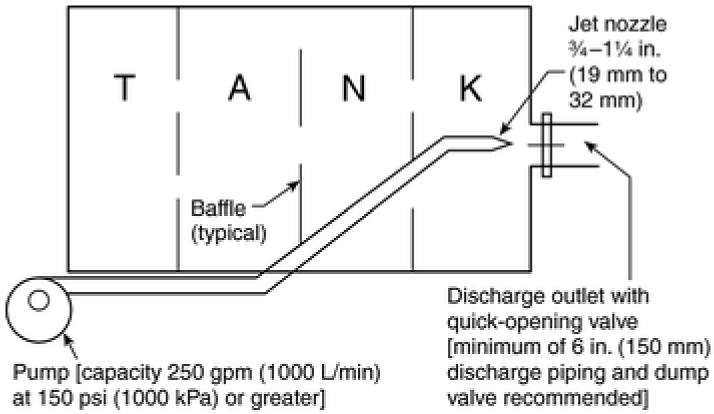


FIGURE A.18.5.2.2(a) Traditional Internal Jet Dump.

The peripheral application of jet assist nozzles has proved highly effective. This approach utilizes two or more jets installed in the sides of the discharge piping just outside the quick dump valve. In addition to the reported discharge advantages of peripheral discharge streams, the externally fed system is easier to plumb and has fewer maintenance problems. The jets, installed 25 degrees to 30 degrees from the piping wall, contact more surface area of the discharging water, thereby increasing water discharge efficiency. Because the water is drawn through the dump valve, less turbulence is created, and the eddy effect often present with traditional in-line jets is overcome. Nozzles made by welding reducer pipe fittings work very effectively as jets. Flow rates of 2000 gpm (8000 L/min) have been obtained using a 300 gpm (1100 L/min) pump to supply two ¾ in. (19 mm) nozzles in a 6 in. (150 mm) dump valve configuration. Figure A.18.5.2.2(b) shows a diagram of a peripheral jet assist arrangement.

A pneumatic system can be used to pressurize a tank and assist in expelling water. The vacuum pumps can also be used for filling the tank.

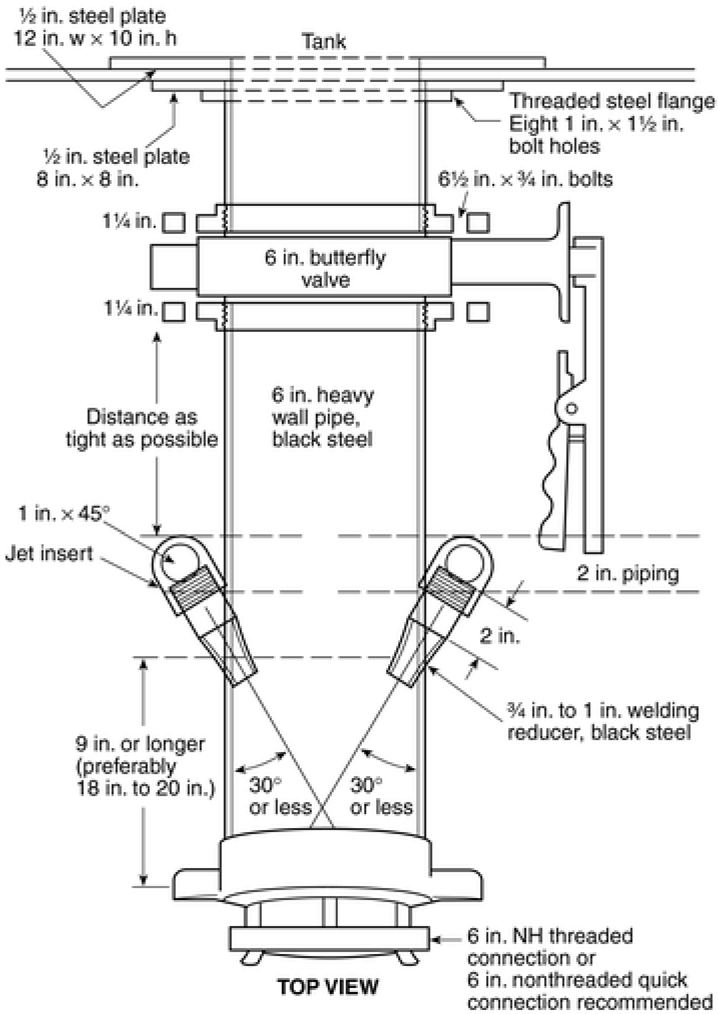


FIGURE A.18.5.2.2(b) Peripheral Jet Assist Arrangement (Top View).

A.18.6.1 If the tests of some components of the apparatus are being certified by an independent third-party certification organization, the purchaser might wish to specify that the water tank capacity also be certified by the independent third-party certification organization.

A.19.1 If the purchaser intends to suspend personnel or equipment from the aerial device using wire ropes or chains, the purchaser should inform the manufacturer of the intended use so proper mounting devices and locations as well as associated capacities can be determined. Equipment users have the potential to overload the aerial device components if improper methods are used.

A.19.2.3 The rated horizontal reach of the aerial ladder could be less than the extended length of the aerial that is used to determine the rated vertical height. This might be necessary to maintain the defined stability requirements as outlined in Section 19.21.

A.19.2.13 Air can be supplied to a secondary operator's position at the tip of the aerial, to the tip of an aerial without a secondary operator's position, and/or the turntable operator's position. If the fire department expects to engage in operations where they will need to supply remote breathing air from the system on the aerial ladder to fire fighters working away from the end of an aerial ladder, such as during a rescue operation in a fuel or chemical tank, coal bin, or silo storage tower, it will be necessary to be able to supply breathing air for at least two persons.

A.19.3.4 Ladder capacity ratings are established in many different operating positions other than full extension and zero degrees elevation. Ladders are often rated at higher tip capacities as elevation angles increase or when the ladder is not fully extended. Most manufacturers provide distributed load capacities (several persons), depending on the ladder's extension and elevation. Combination ratings that include capacity at the tip while discharging water are normally provided. These can vary with elevation and extension and are examples of multiple configurations. It is important that the manufacturer clearly define for the user the ladder's rated capacity in various positions and operation modes.

A.19.4.3.1 A two-way communication system at two positions on the apparatus is considered a minimum. Depending on the configuration of the apparatus, the purchaser might want to consider communication systems at additional positions, such as at a pump panel or at the monitor operating position on the ladder.

A.19.5.2.1 Turntable bearing bolts are required to be checked and retorqued at regular intervals. The apparatus body should be constructed so as to make this task relatively simple by unbolting access panels, ladder slides, and other obstructions. Space should be provided for checking and torquing of the bearing bolts above and below the turntable using the appropriate tools.

A.19.5.4 The controls located at the tip of an aerial ladder are intended primarily to perform the final positioning of the aerial ladder in rescue or other fire-fighting operations. These controls are not intended to replace the lower control position as the primary operating position for the aerial ladder. Where the tip control is used, the operator(s) needs to take the following precautions:

(1) Tip control operators need to be aware of personnel who are on the ladder sections behind them.

(2) Lower control operators need to remain in position and deactivate the tip controls when anyone is moving on the ladder.

(3) Tip control operators need to take care to place their feet on the steps at the tip to avoid injury to their feet from the moving ladder sections below.

(4) Tip control operators need to be belted in position to protect against abrupt or unexpected ladder movements.

A.19.6 The arrangement of the waterway could be a telescoping pipe to a fly section or a nontelescoping pipe to the tip of the base section.

A.19.6.4.5 The tip of an aerial ladder should be capable of being positioned up to a window or other location to allow fire fighters and civilians to climb onto the aerial ladder easily. It might be preferable to keep the monitor behind the last rung of the fly section to protect it in the road position.

A.19.6.6 The arrangement of the external inlet should be specified by the purchaser based on the intended local operation in supplying water to the waterway.

If the normal operations are to supply the waterway through the external inlet, a valve should be provided where large diameter hose is to be used. A valved three- or four-inlet siamese should be provided when 2½ in. or 3 in. (65 mm or 75 mm) supply lines are used. Attention should be given to the inlet arrangement to limit friction loss. Also, if the apparatus is equipped with a fire pump and the purchaser wants to use the auxiliary inlet as a discharge, a slow-operating valve needs to be installed in the riser to the swivel.

A.19.6.9 Where freezing conditions are expected, an automatic drain valve should be specified in order to drain the waterway when water is not flowing.

A.19.7.3 The rated horizontal reach of the aerial platform may be less than the extended length of the aerial that is used to determine the vertical height. This could be necessary to maintain the defined stability requirements as outlined in Section 19.21.

A.19.9.2.1 A two-way communication system at two positions on the apparatus is considered a minimum. Depending on the configuration of the apparatus, the purchaser might want to consider communication systems at additional positions such as the pump panel.

A.19.10.1 Position lights on the outer corners of the platform can be helpful in providing increased visibility of the platform's location from the ground operator's position.

A.19.10.3.1 See A.19.5.2.1.

A.19.12.3.4 Because the water system can be closed at both the top and the bottom of the waterway, the purchaser might want to require a vacuum relief valve.

A.19.12.5 The arrangement of the external inlet should be specified by the purchaser based on the intended local operation in supplying water to the waterway. If the normal operations are to supply the waterway through the external inlet, a valve should be provided where large diameter hose is to be used. A valved three- or four-inlet siamese should be provided when 2½ in. or 3 in. (65 mm or 75 mm) supply lines are used. Attention should be given to the inlet arrangement to limit friction loss. Also, if the apparatus is equipped with a fire pump and the purchaser wants to use the auxiliary inlet as a discharge, a slow-operating valve needs to be installed in the riser to the swivel.

A.19.12.9.1 Where freezing conditions are expected, an automatic drain valve should be specified in order to drain the waterway when water is not flowing.

A.19.13.3 The rated horizontal reach of the water tower could be less than the extended length of the water tower that is used to determine the vertical height. This may be necessary to maintain the defined stability requirements as outlined in Section 19.21.

A.19.15.3.1 See A.19.5.2.1.

A.19.16.5 See A.19.12.5.

A.19.16.9 Where freezing conditions are expected, an automatic drain valve should be specified in order to drain the waterway when water is not flowing.

A.19.18.1 If the operator's position is located on the turntable, the operator should have at least 5 ft^2 (0.46 m^2) of standing and working space exclusive of other space required. The purchaser should specify any special requirements for the operator's position or for other space required on the turntable for personnel to stand or work.

A.19.18.2 Aerial ladder operational controls should be located such that the operator can see the tip of the aerial ladder in all operating positions. The operator's position is often located on the turntable.

A.19.19.7 While this standard requires the hydraulic system to have adequate cooling for continuous operation for 2½ hours, prolonged operations under adverse environmental conditions could cause the hydraulic oil to rise in temperature beyond its recommended temperature range. The purchaser might wish to specify an indicator and an alarm that warns the operator if the fluid temperature begins to overheat.

A.19.20.1 Structural safety factors are widely recognized terms in good engineering practice but can be unfamiliar to those using this standard.

The following combination of loads should be evaluated to determine compliance with this standard. To clarify, the terms are defined as follows:

Dead Load Stress (DL). Stress produced by the aerial device structure and all materials, components, mechanisms, or equipment permanently fastened thereto. If this equipment is installed by the manufacturer before delivery, it is included in the dead load. Equipment added to the aerial device by the fire department that exceeds the manufacturer's recommendations needs to be subtracted from the rated capacity.

Rated Capacity Stress (RL). Stress produced by the rated capacity of the aerial device applied at the tip of the fly section for an aerial ladder [minimum 250 lb (114 kg) at an elevation of zero degrees and full extension] or on the platform of an elevating platform apparatus [minimum 750 lb (340 kg) at an elevation of zero degrees and full extension].

Water Reaction Stress (WL). Stress produced by nozzle reaction force and the weight of the water in the water delivery system.

Material Yield Strength (FY). The stress at which a material exhibits a specified permanent distortion or set.

(1) With no water in the system, the aerial device positioned at full extension, zero-degree elevation and loaded at the rated capacity, the criterion for structural safety is as

follows: The stress produced by two times the dead load stress (*DL*) plus the stress produced by two times the rated capacity stress (*RL*) should not exceed the material yield strength (*FY*), as shown in the following equation. This is a 2:1 safety factor.

$$2 \times DL + 2 \times RL \leq FY$$

(2) With water flowing in the system and the aerial device in the position that creates the highest stress, the criterion for structural safety is as follows: The stress produced by two times the dead load stress (*DL*) plus the stress produced by two times the rated capacity stress (*RL*) plus the stress produced by the water reaction stress (*WL*) should not exceed the material yield strength (*FY*), as shown in the following equation:

$$2 \times DL + 2 \times RL + WL \leq FY$$

Other combinations of loading, including wind loads, ice loads, and impact loads, can be included as additional live loads in determining structural safety factors and rated capacities.

A.19.21.1 Water, hose, ground ladders, and other equipment on the apparatus all provide stability when they are in place. However, at a fire, this equipment and water are often removed. Therefore, stability needs to be measured under worst conditions, which is with the equipment removed.

A.19.24.2.8 The lifting of a tire or stabilizer on the opposite side of the apparatus from the load does not necessarily indicate a condition of instability.

A.19.25 The purchaser might want to specify that this test be conducted with the certification tests required by Section 19.24 and that the test results be certified by the independent third-party certification organization.

A.20.1.1 It is important for the purchaser to understand the types and properties of mechanical foam and its application to specify a foam proportioning system properly. Specific information regarding foam concentrates and their application is available in NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*. Information on foam concentrates for Class A fires is available in NFPA 1150, *Standard on Foam Chemicals for Fires in Class A Fuels*.

The following terms are not used in this document but are associated with foam proportioning systems and are included here to aid understanding.

Aerated Foam. The end product of a discharge of foam solution and air.

Aspirate. To draw in air. Nozzle aspirating systems draw air into the nozzle to mix with the agent solution.

Aspirated Foam. The end product of a mechanically induced air stream that is drawn into the foam solution at atmospheric pressure to create foam. The aeration is generated by the energy of the foam solution stream.

Automatic Regulating Proportioning System. A proportioning system that automatically adjusts the flow of foam concentrate into the water stream to maintain the desired proportioning ratio. These automatic adjustments are made based on changes in waterflow or conductivity.

Batch Mix. The manual addition of foam concentrate to a water storage container or tank to make foam solution.

Foam Blanket. A body of foam used for fuel protection that forms an insulating and reflective layer from heat.

Injector. A device used in a discharge or intake line to force foam concentrate into the water stream.

Manually Regulated Proportioning System. A proportioning system that requires manual adjustment to maintain the proportioning ratio when there is a change of flow or pressure through the foam proportioner.

Proportioning Ratio. The ratio of foam concentrate to water, usually expressed as a percentage.

Surface Tension. The elastic-like force in the surface of a liquid that tends to bring droplets together to form a surface.

Wetting Agent. A chemical that reduces the surface tension of water and causes it to spread and penetrate more effectively than plain water but does not foam.

A.20.2 Foam proportioning systems can be designed with the following features:

(1) The ability to proportion different types of foam concentrate, including Class A and Class B foam concentrates

(2) The ability to proportion foam concentrate at fixed or variable proportioning ratios

(3) The ability to proportion foam concentrate into single or multiple discharge outlets

(4) The ability to supply foam solution and water simultaneously from multiple discharge outlets

(5) Manual or automatic foam proportioning system operation

A.20.2.1 In-line eductor foam proportioning systems are installed in the water pump discharge as a permanently installed device or as a portable device. Water is forced through the eductor venturi by water pump discharge pressure, creating a vacuum that causes foam concentrate to be pushed by atmospheric pressure into the eductor (into the water stream) at the design rate of the device *[see Figure A.20.2.1(a)]*. By design, a nonrecoverable pressure drop of 30 percent or greater is required for eductor operation. The maximum recovered pressure, including friction loss and static head pressure, is nominally 65 percent of the inlet pressure to the eductor. The in-line eductor is a manually regulated foam proportioning system.

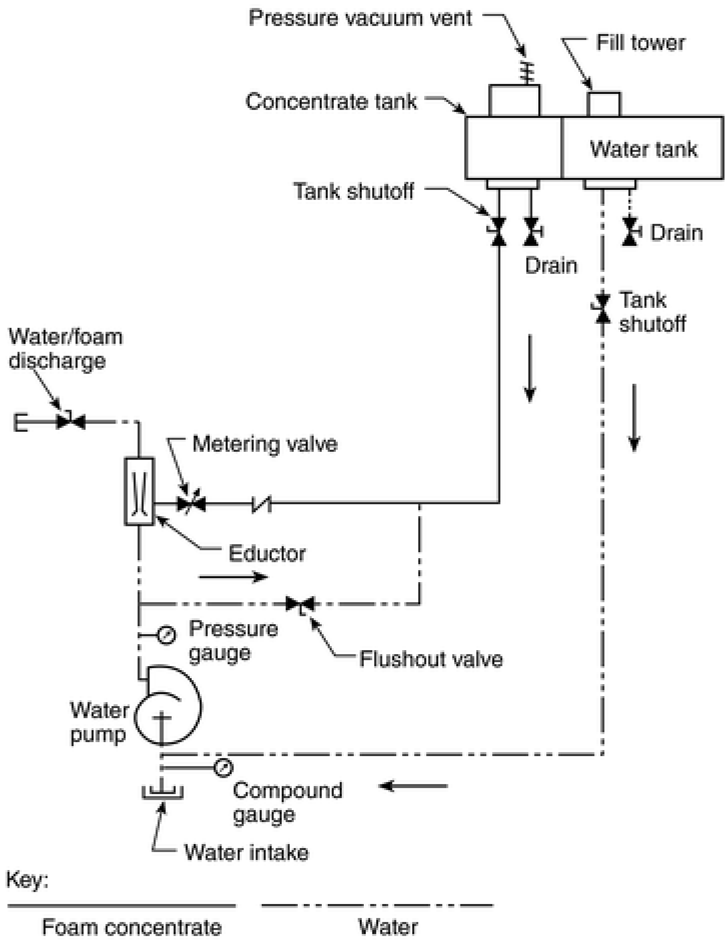


FIGURE A.20.2.1(a) In-Line Eductor Foam Proportioning System.

A variable flow bypass eductor system is a modification of the in-line eductor foam proportioning system. An eductor is placed in a bypass line around the main line waterflow control valve so that when the valve is adjusted to produce waterflow through the bypass eductor, foam concentrate is drawn into the eductor (into the water stream) *[see Figure A.20.2.1(b)]*. The foam solution in the bypass line is then joined with the main line waterflow downstream of the waterflow control valve. The variable flow bypass eductor is a manually regulated foam proportioning system.

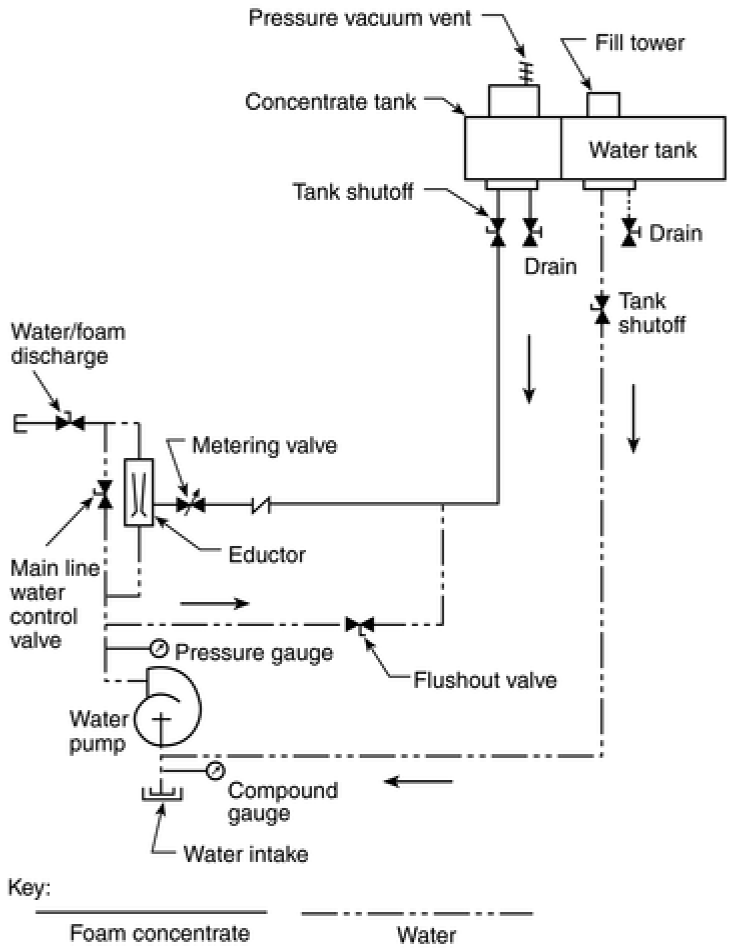


FIGURE A.20.2.1(b) Variable Flow Bypass Eductor System.

A variable pressure eductor is another modification of the in-line eductor foam proportioning system. This type of eductor is designed to automatically adjust the area of the eductor venturi to compensate for changes in water pressure at the inlet of the device. Better performance (less pressure loss) can be achieved by having the eductor in the straight line position with the main line and the waterflow control valve in the offset position. The reason for this is that the small eductor sets the pressure drop and the water control valve merely matches the pressure losses of the eductor and fittings directing flow to the eductor. If the eductor flow has to flow through two branching tees and two elbows, the water control valve must match those pressure losses. If the eductor is in the straight line position, pressure losses of two branching tees and two elbows are not present in the eductor branch of the variable flow bypass eductor; therefore, the total pressure loss across the proportioning system is only that of the eductor. The variable pressure eductor is a manually regulated foam proportioning system.

A.20.2.2 Self-educting master stream nozzles are mounted on the discharge side of the pump. These devices make up a complete foam proportioning system consisting of a foam proportioner and application device (nozzle). Self-educting master stream nozzles have the following operating characteristics:

(1) Automatic or operator-adjustable foam solution rates

(2) Minimal pressure drop

A.20.2.3 An intake-side foam proportioning system is a manually regulated system. An in-line device installed in the water pump intake line provides a connection through a foam concentrate metering valve to the foam concentrate tank. The vacuum created by the water pump allows atmospheric pressure to push foam concentrate directly into the pump intake. Hydrant or relay operation is not possible with this type of foam proportioning system.

A.20.2.4 Around-the-pump proportioning systems operate with an eductor installed between the water pump discharge and the intake. A small flow of water from the water pump discharge passes through the eductor, which creates a vacuum that causes foam concentrate to be pushed into the eductor and discharged into the pump intake. Around-the-pump foam proportioning systems require a pressure differential of 30 percent to 50 percent of inlet pressure for efficient operation.

A manual around-the-pump proportioning system utilizes a manually adjustable foam concentrate metering valve to control the proportioning ratio. *[See Figure A.20.2.4(a).]*

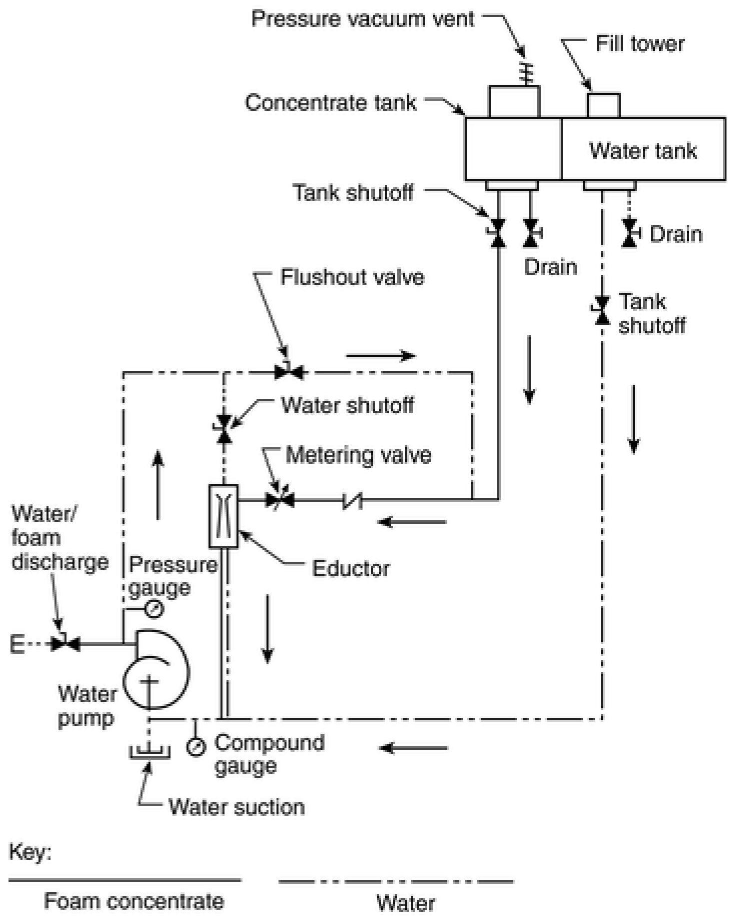


FIGURE A.20.2.4(a) Manual Around-the-Pump Proportioning System.

A flowmeter sensing around-the-pump proportioning system utilizes a flowmeter sensing system to monitor total solution flow and foam concentrate flow. The flow data are transmitted to an electronic control that regulates the proportioning ratio through a foam concentrate metering valve. *[See Figure A.20.2.4(b).]*

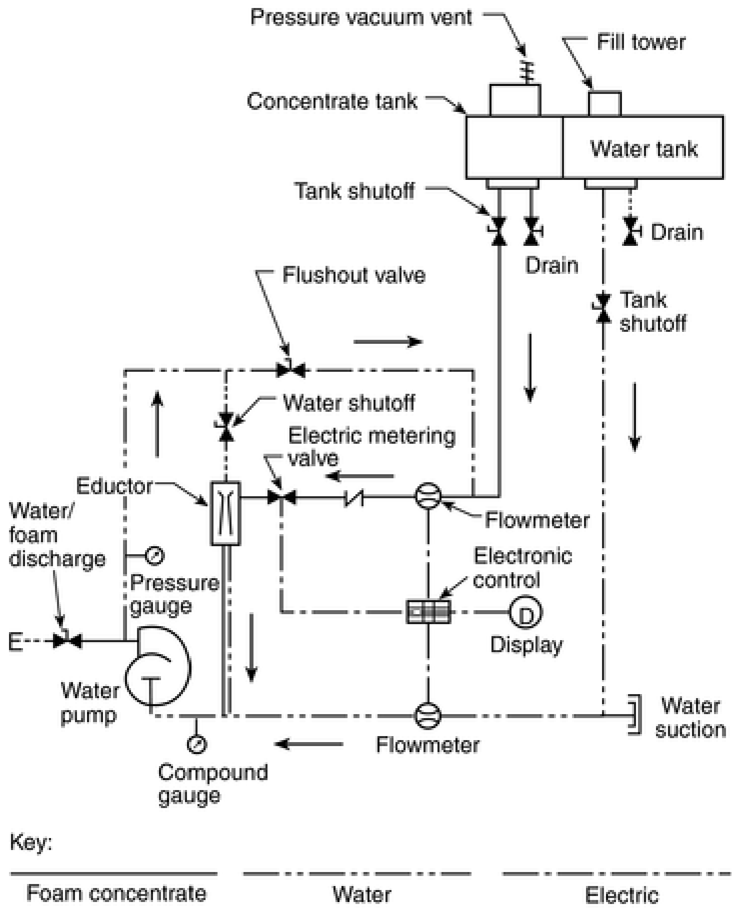


FIGURE A.20.2.4(b) Flowmeter Sensing Around-the-Pump Proportioning System.

A.20.2.5 Balanced pressure foam proportioning systems are installed on the discharge side of the water pump. Two orifices discharge water and foam concentrate into a common ratio controller (proportioner) located in the water pump discharge. By adjusting the area of the orifices to a particular ratio, the percentage of injection can be controlled if the intake pressures are equal. The method of controlling or balancing the foam concentrate pressure with the water pressure varies with different balanced pressure system designs. The two basic types of balanced pressure systems are systems without a foam concentrate pump and systems with a concentrate pump. Balanced pressure foam proportioning systems generally are automatic regulating foam proportioning systems.

Balanced pressure systems without a foam concentrate pump are referred to as "pressure proportioning systems" *[see Figure A.20.2.5(a)]*. These systems utilize a pressure vessel with an internal bladder to contain the foam concentrate. When in operation, water pump pressure is allowed to enter the pressure vessel between the shell and the internal bladder to exert pressure on the internal bladder. The foam concentrate is forced out of the bladder to the foam proportioner at a pressure equal to the water pump pressure.

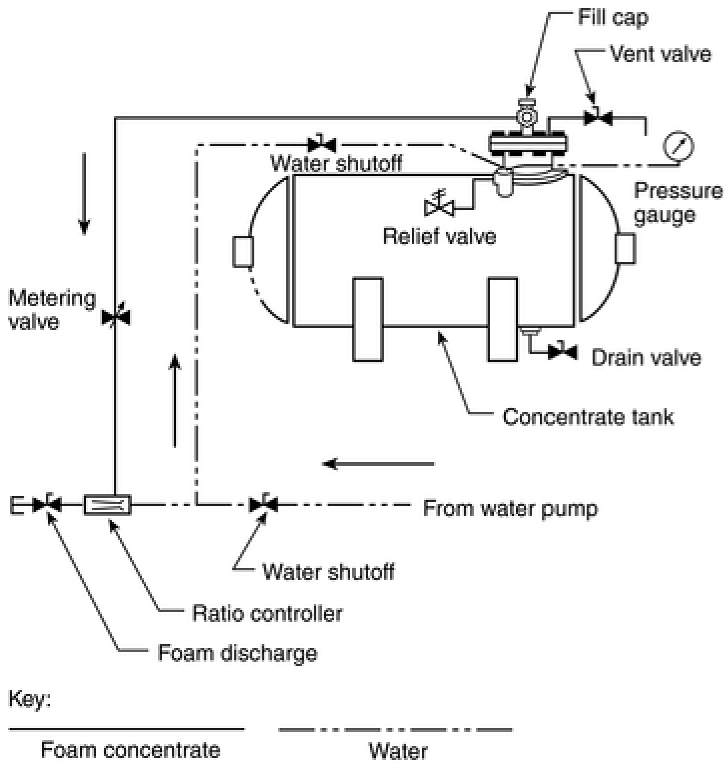


FIGURE A.20.2.5(a) Pressure Proportioning Balanced Pressure Proportioning System.

Two basic types of balanced pressure foam proportioning systems utilize a foam concentrate pump: a bypass system and a demand system. Foam proportioning system operation is not affected by water pump intake pressure or interrupted while refilling the foam concentrate tank in these types of foam proportioning systems.

The bypass system utilizes a valve in the foam concentrate pump recirculating line that balances the foam concentrate and water pressure by bypassing excess foam concentrate. *[See Figure A.20.2.5(b).]*

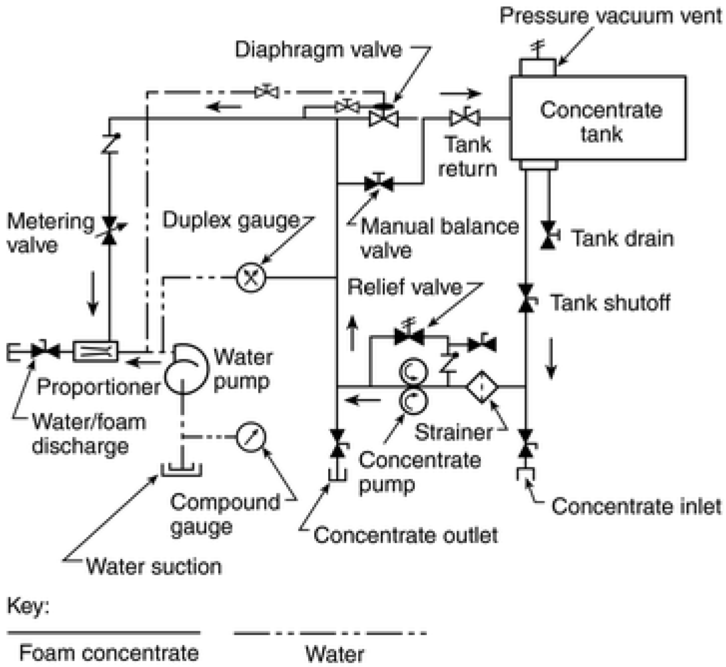


FIGURE A.20.2.5(b) Bypass Balanced Pressure Proportioning System.

The demand system is designed to control the speed of the foam concentrate pump, resulting in control of the pump discharge pressure to achieve a balance of foam concentrate and water pressure within the system. *[See Figure A.20.2.5(c).]*

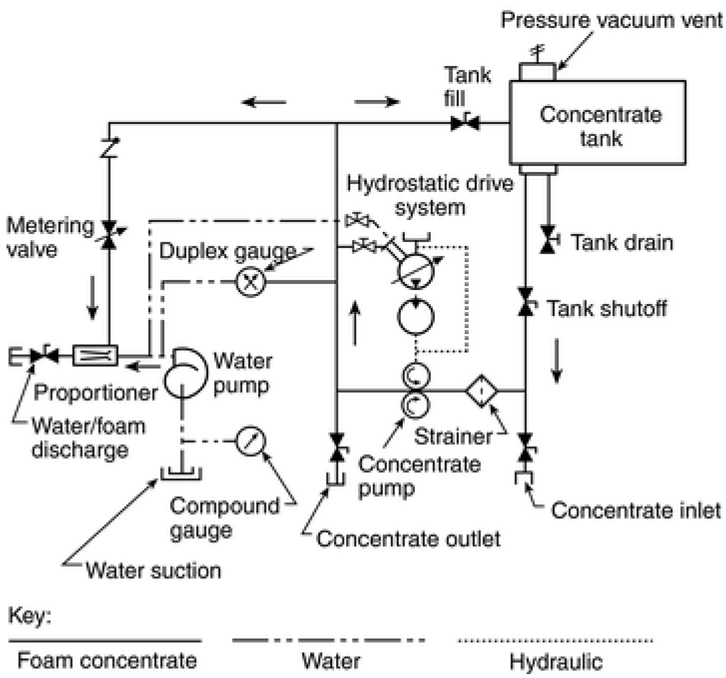


FIGURE A.20.2.5(c) Demand Balanced Pressure Proportioning System.

A.20.2.6 Direct injection foam proportioning systems utilize a foam concentrate pump to inject foam concentrate directly into the water pump discharge. Foam proportioning system operation is not affected by water pump intake pressure or interrupted while the foam concentrate tank is being refilled. Direct injection foam proportioning systems generally are automatic regulating foam proportioning systems.

Automatic flow-sensing direct injection foam proportioning systems utilize an in-line flowmeter(s) to monitor the system operating conditions. System operating data are transmitted to an electronic control, which controls the proportioning ratio. Two different flow-sensing systems are available:

(1) An electronic control receives electronic signals corresponding to the proportioning ratio from the control panel and waterflow data from the flowmeter. The electronic control then commands the foam concentrate pump module to deliver foam concentrate at the proportional rate. *[See Figure A.20.2.6(a).]*

(2) An electronic control receives electronic signals corresponding to the foam concentrate flow from a foam concentrate flowmeter, the proportioning ratio from the control panel, and waterflow data from the water flowmeter. The electronic control regualtes the proportioning ratio through a foam concentrate metering valve. *[See Figure A.20.2.6(b).]*

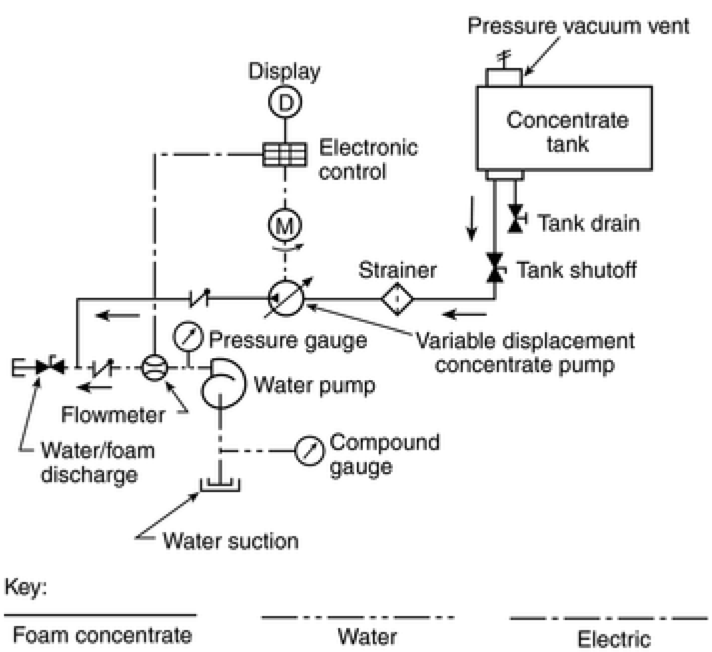


FIGURE A.20.2.6(a) Single-Meter Flow-Sensing Direct Injection Foam Proportioning System.

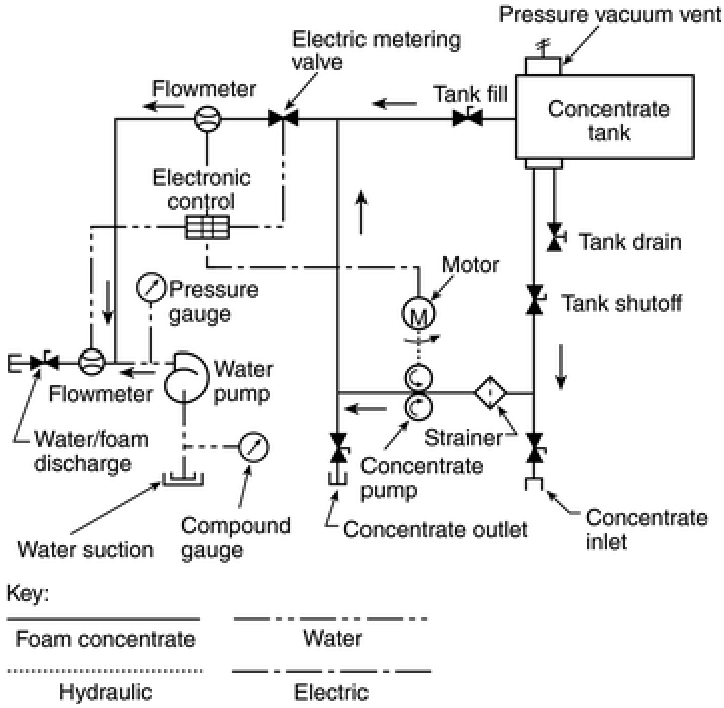


FIGURE A.20.2.6(b) Dual-Meter Flow-Sensing Direct Injection Foam Proportioning System.

A conductivity-sensing direct injection foam system utilizes an electrical conductivity sensor(s) to sample the fire pump discharge water prior to foam concentrate injection and transmits this information to an electronic control. A second electrical conductivity sensor samples the foam solution and transmits this information to the electronic control that regulates the foam pump motor speed based on the ratio selected by the operator. Since flow rate affects conductivity readings, a flowmeter transmits the flow rate through the process manifold to the electronic control. *[See Figure A.20.2.6(c).]*

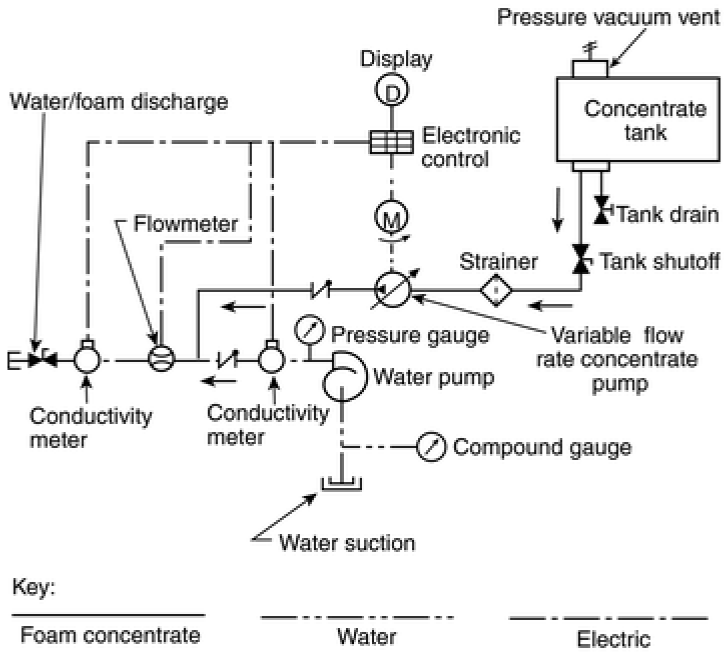


FIGURE A.20.2.6(c) Conductivity-Sensing Direct Injection Foam Proportioning System.

A.20.2.7 In a water motor foam proportioning system, a water motor drives a positive displacement foam concentrate pump. The water motor can be either a positive displacement type or a turbine type. Water motor foam proportioning systems are automatic regulating foam proportioning systems.

Where a positive displacement water motor drives the foam concentrate pump, the ratio of the water motor displacement to the displacement of the foam concentrate pump is the ratio of the desired foam solution. A positive displacement water motor proportioning system requires no external power. *[See Figure A.20.2.7(a).]*

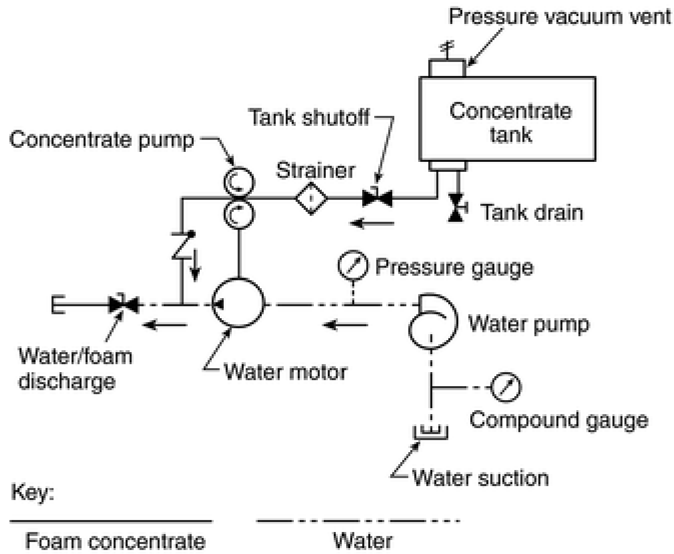


FIGURE A.20.2.7(a) Water Motor Foam Proportioning System.

A water turbine–driven foam proportioning system uses a water turbine to power a positive displacement foam concentrate pump. Flowmeters sense the foam concentrate pump output and the waterflow, sending signals to an electronic control that regulates the proportioning ratio by adjusting the water turbine speed. *[See Figure A.20.2.7(b).]*

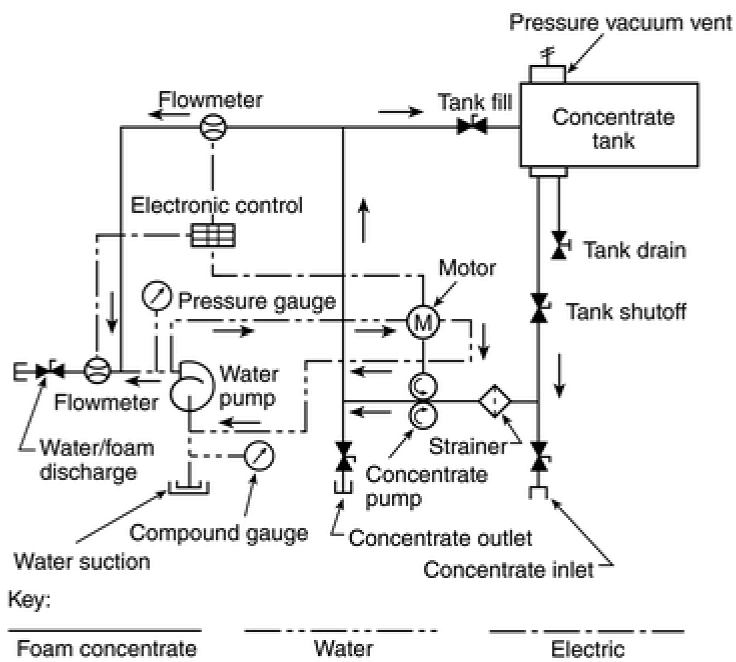


FIGURE A.20.2.7(b) Water Turbine–Driven Flow-Sensing Direct Injection Foam Proportioning System.

A.20.3.1 Foam proportioning systems that inject foam concentrate into the water pumping system at a higher pressure than the water pressure have the potential to force foam concentrate or foam solution into an external water source. This condition will occur when there is no water flowing and the foam proportioning system is activated in the automatic mode. Backflow prevention devices or any other devices that create additional friction loss in the system should be installed only with the approval and specific instructions of the foam proportioning system manufacturer.

A.20.3.4 Most foam concentrate manufacturers differentiate between the materials they recommend for foam proportioning system components that are designed to be flushed with water after operation and those components that are intended to be continuously wetted with foam concentrate.

A.20.4.1 It is desirable to have a visual indicator on the operator's panel that shows whether the foam proportioning system is in the “operating” position or the “off” position. A visual means of indicating positive foam concentrate flow at the operator's panel is also helpful.

A.20.6.3.2 Suitable means to attach the cover to the fill tower could include a threaded cap or a hinged cover with a mechanical latching device.

A.20.6.6 On fire apparatus where a single foam storage tank is used, provisions should be made to flush the tank and all foam concentrate plumbing to avoid contamination of dissimilar foam concentrates when switching types or brands.

A.20.6.8 The foam concentrate tank(s) can be an integral part of the water tank.

A.20.6.10.2 Different types and brands of concentrates can be incompatible with each other and should not be mixed in storage. Concentrate viscosity varies with different types of products and temperatures.

A.20.7 The foam concentrate pump is a critical component of both balanced pressure and direct injection foam proportioning systems. Positive displacement pumps are recommended for several reasons. Positive displacement pumps are relatively slow in speed compared to centrifugal pumps, which is advantageous with viscous foam concentrates that are difficult to shear. Centrifugal pumps can become air bound when trying to pump viscous foam concentrates, which results in a complete shutdown of the system. The self-priming feature of positive displacement pumps allows them to draw foam concentrate from drums or any external source without priming the pump.

A.20.7.2 Corrosion-resistant materials are materials such as brass, copper, Monel®, stainless steel, or equivalent materials.

A.20.7.5 A suitable suction device is required to operate from an external source such as 5 gal (19 L) pails, 55 gal (208 L) drums, and portable tanks or containers.

A.20.9.3(5) It is necessary for the operator to be familiar with the specific types of foam concentrates the foam proportioning system manufacturer has designed the system to operate with and proportion accurately. The foam proportioning system might require modification or recalibration if a foam concentrate is introduced into the system that was not intended by the system's manufacturer for use in the system.

A.20.10 If the tests of some components of the apparatus are being certified by an independent third-party certification organization, the purchaser might wish to specify that these tests also be certified by the independent third-party certification organization.

A.20.10.1 There are four methods for testing a foam proportioning system for calibration accuracy. They are:

(1) Substituting water for foam concentrate

(2) Measuring foam concentrate pump output directly

(3) Determining foam percentage by use of a refractometer

(4) Determining foam percentage by use of a conductivity meter

Test Method 1: Substituting Water for Foam Concentrate. The foam proportioning system is operated at the waterflow rates at which the system is to be tested. Water is used as a substitute for foam concentrate. The substitute water for the foam concentrate is drawn from a calibrated tank instead of foam concentrate from the foam concentrate tank. The volume of water drawn from the calibrated tank divided by the volume of water pumped over the same time period multiplied by 100 represents the percentage of foam the foam proportioning system is producing.

Test Method 2: Measuring Foam Concentrate Pump Output Directly. With some direct injection systems, it is possible to directly measure the foam concentrate pump output. With the foam proportioning system operating at a given waterflow rate and either foam concentrate or water used as a substitute for foam concentrate, the output of the foam concentrate pump is measured by diverting that output into a calibrated container for direct measurement over a given period of time. An alternative is to measure the foam concentrate flow or water substitute with a calibrated meter.

Test Method 3: Determining Foam Percentage by Use of a Refractometer. A refractometer is used to measure the refractive index of a foam solution sample.

First, a base calibration curve is prepared using the same water and foam concentrate that will be used with the system to be tested. Three known foam solution samples are needed and should include the following:

(1) The nominal intended percentage

(2) The nominal intended percentage plus 1 percent

(3) The nominal intended percentage minus 1 percent

If the nominal intended percentage is 1 percent or less, the three samples should be as follows:

(1) The nominal intended percentage

(2) The nominal intended percentage plus 0.3 percent

(3) The nominal intended percentage minus 0.3 percent

The required amount of water is placed in a 100 mL or larger graduated cylinder, leaving space for the foam concentrate. A 10 mL pipette or 10 cc syringe is used to carefully add the required amount of foam concentrate to the water. Each measured foam solution is then poured from the graduated cylinder into a 100 mL or larger plastic bottle, and the bottle is marked indicating the percentage solution it contains. The bottle is capped and thoroughly shaken to mix the foam solution.

An alternative method for making the three foam solution samples is to use a very accurate scale. The density of the foam concentrate must be known and can be found on the product data sheet or the Material Safety Data Sheet (MSDS) for the foam concentrate. For example, to make a 100 ml sample of a 3 percent foam solution using a foam concentrate with a density of 1.04, 97 g of water is measured into a beaker and 3.12 g of foam concentrate is added to the beaker (1.04 × 3 g = 3.12 g).

After the foam solution samples are thoroughly mixed, a refractive index reading is taken of each foam solution sample. This is done by placing a few drops of the solution on the refractometer prism, closing the cover plate, and observing the scale reading at the dark field intersection. Because the refractometer is temperature compensated, it could take 10 seconds to 20 seconds for the sample to be read properly. It is important to take all refractometer readings at ambient temperatures of 50°F (10°C) or above.

Using standard graph paper, the refractive index readings are plotted on one axis and the percentage of concentration on the other. This plotted curve serves as the known baseline for the test series. The solution samples should be set aside in the event the measurements need to be checked.

Foam solution samples are then collected from the proportioning system, making certain that the samples are taken at an adequate distance downstream from the foam proportioning system being tested to allow for complete mixing of the water and the foam concentrate. Refractive index readings of the samples are taken and compared to the plotted curve to determine the percentage of foam.

This method might not be accurate for aqueous film-forming foam (AFFF), alcohol-resistant foam, or certain other types of foam that typically exhibit very low refractive index readings. Also, the refractometer method should not be used when testing foam percentages of 1 percent or lower because the accuracy for determining the percentage of foam concentrate in a solution when using a refractometer is ±0.1 percent, at best. For that reason, Test Method 4, the conductivity method, might be preferable where AFFF, alcohol-resistant foam, or 1 percent or less foam (Class A foam) is to be tested.

Test Method 4: Determining Foam Percentage by Use of a Conductivity Meter. The conductivity test method is based on changes in electrical conductivity as foam concentrate is added to water. Conductivity is a very accurate method, provided there are substantial changes in conductivity as foam concentrate is added to the water in relatively low percentages. Because saltwater and brackish water are very conductive, this method might not be suitable where these waters are used because of the small conductivity changes as foam concentrate is added. If saltwater or brackish water is used, it is necessary to make foam solutions in advance to determine if adequate changes in conductivity can be detected. This method cannot be used if the water has more total solids than the foam concentrate.

The following three variations of this test method can be used to determine the foam percentage by the conductivity method:

(1) *Direct reading conductivity method.* A sample of the water to be used in the test is put in a 100 mL or larger container. The conductivity meter head is immersed in the water sample, and the meter display is set at zero. If the direct reading foam solution conductivity meter is mounted in a discharge line, the meter should be set at zero with plain water flowing.

If the conductivity meter manufacturer does not indicate that the percentage of foam solution can be read directly for the foam concentrate being used, a calibration curve needs to be developed. The calibration curve might show that the direct meter readings are correct for the foam concentrate being used, or it might indicate that the calibration curve needs to be used when that foam concentrate is used in the test.

The foam proportioning system is operated, and a sample of the foam solution produced by the system is collected using a 100 mL or larger container. The conductivity meter head is immersed in the foam solution sample, and the percentage of the foam solution is read on the meter display. If the conductivity meter is mounted in a discharge line, the percentage of the foam solution is read on the meter display while foam solution is being discharged.

(2) *Conductivity comparison method.* A sample of the water to be used in the test is put in a 100 mL or larger container. Using a conductivity meter reading in microsiemens per centimeter (mscm), the conductivity value of the water sample is determined. The foam proportioning system is operated, and a sample of the foam solution produced by the system is collected in a 100 mL or larger container. Using the conductivity meter, the conductivity value of the foam solution sample is determined. The conductivity value of the water sample is subtracted from the conductivity value of the foam solution sample, and the result is divided by 500 to obtain the percentage of foam concentrate in the solution.

$$\%\ \text{foam} = \frac{\begin{matrix}\text{Conductivity} \\ \text{of foam solution}\end{matrix} - \begin{matrix}\text{Conductivity} \\ \text{of water}\end{matrix}}{500}$$

Note that the divisor is 500 only if the conductivity meter units are microsiemens per centimeter. Other units of conductivity can be used, but the value of the divisor (500) will need to be adjusted.

(3) *Conductivity calibration curve method.* A base calibration curve is prepared using the water and foam concentrate from the system to be tested. Three known foam solution samples are made using the procedure in Test Method 3. After the foam solution samples are thoroughly mixed, the conductivity of each solution is measured using a conductivity meter. Care should be taken to ensure that the proper procedures are used for taking readings and that the meter is switched to the correct conductivity range. Most synthetic-based foams used with freshwater result in foam solution conductivity readings of less than 2000 mscm. Protein-based foams used with freshwater generally produce conductivity readings in excess of 2000 mscm. Because of the temperature-compensation feature of the conductivity meter, it could take a short time to obtain a consistent reading.

Once the solution samples have been measured and recorded, the bottles should be set aside as control sample references. The conductivity readings then should be plotted on standard graph paper. It is more convenient to place the foam solution percentage on the horizontal axis and the conductivity readings on the vertical axis.

A straight line should be drawn that approximates the connection of all three points. While it might not be possible to connect all three points with a straight line, they should be very close. If not, the conductivity measurements should be repeated, and, if necessary, new control sample solutions should be prepared and used until all three points plot in a nearly straight line. This plot serves as the known base (calibration) curve to be used for the test series.

Once a base curve has been plotted, foam solution samples are collected from the proportioning system. The conductivity of the test samples is measured, and the percentage of foam solution is determined from the base curve. Foam solution samples that have been allowed to drain from expanded foam should not be used, because they can produce misleading conductivity readings.

A.20.10.1.2 Depending on the foam proportioner technology, the manufacturer could require the system to be calibrated at the low end, at the high end, or somewhere midrange, to ensure the system meets the accuracy requirements in the standard. For example, if the system runs richer as percentages increase, the manufacturer could anchor the low percentage during calibration. Therefore, the manufacturer needs to have the flexibility to pick this point, knowing how the technology reacts over the full operating range.

A.20.11.1(2) Users may want to specify additional test points and viscosities to ensure that their full range of operational requirements is satisfied.

A.20.11.1(3) See A.20.10.1.

A.21.1 The following terms are not used in this document but are associated with CAFS and are included here to aid in understanding.

CAFS-Capable Fire Apparatus. A fire apparatus equipped with a compressed air foam system

(CAFS) with the following capabilities:

(1) Automatic regulating foam proportioning system capable of injecting foam concentrate into the discharge or pressure side of the pump

(2) Air compressor with the capacity to supply the required standard cubic feet per minute (SCFM) of air and automatic air pressure controls

(3) Controls to mix the air and foam solution

Chatter. An unacceptable flow condition wherein air is not fully mixed with the foam solution.

High-Energy Foam Generator. A foam generator that uses a large amount of external energy to aerate the foam.

Low-Energy Foam Generator. A foam generator that uses the energy of the foam stream to aerate the foam.

Mixing Chamber. A device used to produce fine, uniform bubbles in a short distance as foam solution and airflow through it.

Scrubbing. The process of agitating foam solution and air in a confined space such as a hose, pipe, or mixing chamber to produce tiny, uniform bubbles.

Slug Flow. The discharge of distinct pockets of water and air due to the insufficient mixing of foam concentrate, water, and air in a CAFS.

Surge. The sudden decompression of a discharge line caused by the rapid opening of the discharge appliance.

A.21.2.4 It is recommended that compressed air not be injected into the discharge piping until the flow of foam solution has been established. The nozzle reaction at the end of a hose can be quite high if air and water are flowing in the discharge line. The nozzle reaction could be a safety issue if the operator is not expecting or not properly braced to withstand this reaction force. The reaction force is substantially reduced when a foam solution is flowing in the discharge hose. Also, a charged CAFS line should be opened slowly to lower the nozzle reaction force that can be very high if opened rapidly.

A.21.2.5 Pressure in the form of compressed air can remain trapped in a CAFS as a result of the system being deactivated. It is important for the operator to relieve any pressure in the foam proportioning system and connected hose lines before disconnecting hose lines or performing any operation that opens the system to atmosphere.

A.21.4 If the expansion ratio is to be tested, the following equipment and test procedures are recommended:

(1) *Equipment.*

   (a) Gram scale, 1500 g capacity accurate to 0.1 g

   (b) One 1000 mL container that can be struck at 1000 mL (a 1000 mL graduated cylinder cut off at 1000 mL works well)

(2) *Procedure*. The empty container is placed on the scale, and the scale is set to zero. Using the container, a full sample of foam is collected, and the foam is struck at the 1000 ml level. The container is placed on the scale and the mass is read in grams.

$$\text{Expansion} = \frac{1000}{\text{Foam mass in grams}}$$

The foam mass in grams assumes that 1 g of foam solution occupies 1 mL of volume.

A.21.5 Any components of the piping system exposed to pressurized air from the CAFS should be designed for a burst gauge pressure of at least 500 psi (3400 kPa).

A.21.7.6 Some systems provide automatic regulation of the waterflow; however, instrumentation is still useful to the operator. Even automatic systems have adjustments and performance limits that warrant instrumentation. Where the system design does not allow for such automatic regulation or where the operator has the ability to control waterflow or airflow, air and water flowmeters are necessary for the operator to monitor the operational performance of the CAFS where the nozzle person cannot be seen. Where pumping long hose lays or pumping to great heights, the operator needs to know what is flowing in order to be certain the proper product is being delivered.

A.21.9 If the tests of some components of the apparatus are being certified by an independent third-party certification organization, the purchaser might want to specify that these tests also be certified by the independent third-party certification organization.

A.21.9.1.3.3 Care should be taken to avoid injuries to personnel from the discharging airstream. Only those persons actually conducting the tests should be in the test area, and they should wear protection for their ears, eyes, and face from noise and dust during the airflow test.

A.22.1 A typical electrical system might consist of a generator system that is bonded to the chassis frame rail. Conductors making up the power supply assembly include the neutral conductor (N), grounding conductor (G), and line voltage conductors (L_1, L_2, L_3).

The neutral conductor of the power supply assembly is grounded to the generator frame. This is the only location that the neutral conductor is grounded in the entire system. The power supply assembly terminates at the panelboard for distribution to the rest of the system. Figure A.22.1 shows a typical system on a fire apparatus.

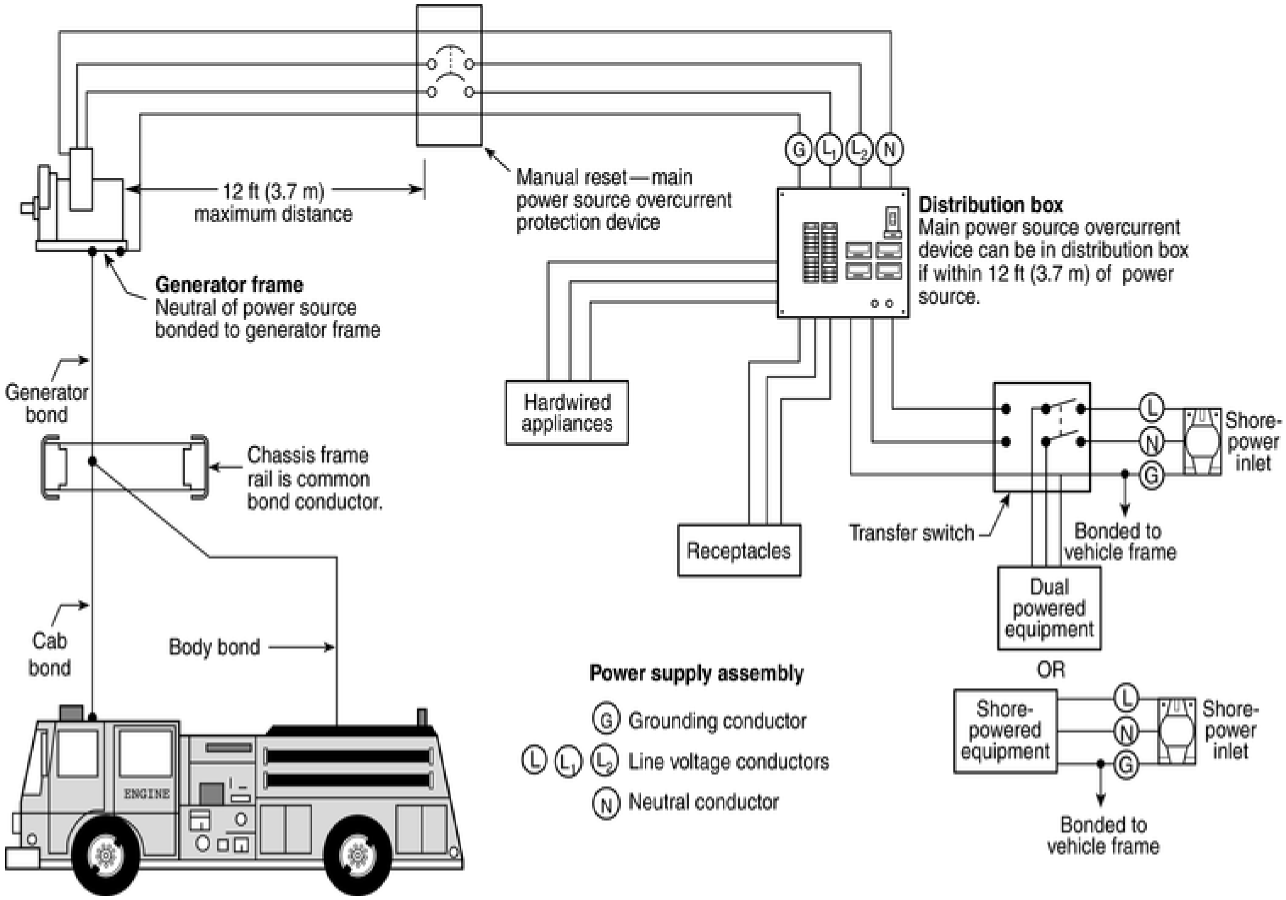


FIGURE A.22.1 Typical Line Voltage Electrical System.

It is the responsibility of the purchaser to provide the contractor with sufficient information to enable the contractor to supply an electrical system that will meet the needs of the fire department.

For each piece of line voltage electrical equipment installed on the apparatus or operated using the apparatus line voltage electrical system, the purchaser should provide the following information:

(1) The type of electrical current required, that is, alternating current (ac), direct current (dc), or either ac or dc, as follows:

(a) If ac is required, the nominal operating voltage, the maximum amperage, and whether it is single-phase or three-phase. For electronic equipment and some motors, the required quality of the ac power should also be stated, including the upper and lower limits of voltage and the allowable variation of frequency and waveform.

(b) If dc is required, the nominal operating voltage and the maximum operating current. For special equipment, the required quality of the dc power should also be stated, including the upper and lower limits of voltage and the amount of ripple voltage.

(2) The required minimum continuous output wattage of the electrical source or sources that power the system, or if more than one type of current or voltage is required, the maximum output wattage for each type of current or voltage.

Generally, the line voltage electrical system should be sized based on the total amount of fixed and portable equipment that is likely to be operated at the same time. In view of the increasing use of line voltage devices on apparatus, the provision of a line voltage electrical system of sufficient capacity is strongly recommended.

Where only incandescent lighting is involved, ac or dc power can be used. Where other electrical devices such as motor-driven equipment or electronic equipment are involved, single-phase ac power at 60 Hz is normally required. However, because of the substantial reduction of size and cost that results from three-phase operation, ac motors larger than 5 hp are usually designed to operate on three-phase ac current. Attempting to operate electrical equipment using the wrong type of electrical power will almost always damage the electrical equipment.

The following factors are guidelines for determining the line voltage electrical loads present on an apparatus and determining the size of power source required. Various electrical loads are placed on apparatus for specific purposes, yet a number are installed for convenience usage. The purchaser should start by creating a tabulated list of line voltage electrical items (lights, cord reels, receptacles, etc.) and their wattage ratings so a total electrical load can be determined. It is the responsibility of the purchaser to specify the ratings to be used when calculating power source loads.

Loads or Receptacles. For plug-connected equipment and receptacles, either work with the loads that can be connected or with the power available from receptacles that could have equipment connected to them. Do not add both in the calculation. If the power source will normally power only equipment carried on that piece of apparatus, use a total of loads carried on the apparatus. If the power source might power equipment carried on other apparatus as well, work with the total capacity represented by the receptacles provided. Fixed loads permanently connected are always included. The following loads and receptacles should be specified:

(1) *Fixed mounted lighting.* All lighting that is mounted directly to the apparatus should be itemized with the manufacturer’s wattage ratings. This includes light towers, brow lights, scene lights, and interior lights.

(2) *Removable lighting.* All lights mounted on the apparatus using a plug and receptacle connection scheme should be itemized with the light manufacturer’s wattage rating. This includes tripod lights mounted on the top or back of apparatus bodies that can be unplugged, removed from the apparatus, set up on the ground or inside a building, and powered with the use of an extension cord.

(3) *Dedicated receptacles.* For receptacles located and intended to always power a specific piece of equipment such as a hydraulic rescue tool (HRT) power unit, battery charger, light, or other piece of equipment, use the wattage of the connected equipment.

(4) *Cord reels.* Rate cord reels to their circuit breaker rated amperage when determining generator loads. Wattage rating should be voltage times circuit breaker amperage. For 120/240 volt cord reels, use 240 times the circuit breaker rating.

(5) *Side-of-body receptacles.* Rate side-of-body receptacles at half their amperage capacity when determining generator loads. If specific devices will be connected to side-of-body receptacles most of the time, the higher wattage rating of the specific device should be used.

(6) *Interior receptacles.* Rate interior duplex receptacles at 180 watts. If specific devices will be connected to specific receptacles, use the higher wattage rating of the specific device connected to the receptacle.

(7) *Motor loads.* Motor loads put large ac demands on generators. Consult the system manufacturer for wattage ratings for motor-driven systems. A general rule is that motors require about 740 W/hp for running. An allowance should be added for the largest motor for starting at about twice the running wattage or the manufacturer's stated starting wattage. Some variable speed motors for smoke fans have little or no additional starting power draw. If equipment with large motors are to be driven, consult with the manufacturer of the equipment for their experience on what size and types of generators have been successfully used for driving their equipment.

Power Source Sizing. Once all the line voltage devices and receptacles on the apparatus have been identified and their wattage rating determined, the size of the generator needed can be determined. It is always a good idea to make an allowance for future additions and spare capacity.

Table A.22.1(a) shows an example of a calculation for sizing a generator that is intended to power the electrical equipment onboard a rescue unit but is not intended to typically power electrical equipment from other apparatus. Note that for the largest motor load, the HRT power unit, the starting load is used. For other motors, the running power is used.

Table A.22.1(a) Sample Calculation of Electric Loads for Equipment Carried on a Rescue Unit

Device	Notes	Rated Voltage	Rated Amperage	Number Carried	Generator Load Wattag
Brow light	Permanently connected	240		1	750
Pole lights	1000 W lights	240		2	2,000
Portable lights	500 W lights	120		4	2,000
16 in. smoke fan	800 W run, 2000 W start	120		1	800
HRT power unit	4000 W run, 9000 W start	240		1	9,000

Table A.22.1(a) Sample Calculation of Electric Loads for Equipment Carried on a Rescue Unit

Device	Notes	Rated Voltage	Rated Amperage	Number Carried	Generator Load Wattag
Battery charger	On transfer switch	120		1	200
Total					14,750

For the equipment in Table A.22.1(a), a 15,000 watt generator would be the minimum that should be considered. A significant driving factor in requiring this size generator is the starting draw of the HRT power unit. Once the power unit is started, the total draw with all equipment running would drop to about 10,000 watts, giving a comfortable safety margin. Some generators have a peak or intermittent rating that exceeds the continuous power rating. This peak capability can be used for motor starting, since such loads last only a few seconds.

Table A.22.1(b) shows the calculations for the electrical load for the equipment and receptacles that might be on an attack pumper.

Table A.22.1(b) Sample Calculation of Electric Loads for Equipment Carried on an Attack Pumper

Device	Notes	Rated Voltage	Rated Amperage	Number Carried	Generator Load Wattage
Brow light	Permanently connected	240		1	750
Pole lights	1500 W light	240		2	3,000
Rear scene light	1500 W light	240		1	1,500
Body receptacles	20 amp, at 50%	120	20	4	4,800
Cord reel	120/240 V, 20 A breaker	240	20	1	4,800
Total					14,850

For this example, a 15,000 watt generator also would be the minimum that should be considered. Because that would allow little reserve capacity for future use, a larger generator might be considered. Even though the pumper might not carry this much equipment, if the apparatus is at the front of the fire building, lights and fans from other apparatus can be brought to the scene and plugged into the electrical system on this apparatus.

The selection of a smaller generator puts the generator at risk of being overloaded and potentially damaged.

It is recommended the purchaser review the line voltage components and review the generator size to verify that proper operation of the apparatus can be achieved. If there is more load than power supply, reducing line voltage loads or selecting a larger generator is recommended.

A.22.2.4 Portable line voltage electrical equipment added by the fire department should also be listed and utilized only in accordance with the manufacturer's instructions.

A.22.2.6.4 Although a splash shield will lessen the amount of road spray that reaches the generator, it will not protect the generator if the apparatus is driven through deep water. Care should also be taken if the apparatus is driven off-road, because a splash shield is not a skid pan and will not protect the generator from physical abuse.

A.22.3.1 It is important that all metal parts of the apparatus and the electrical system be bonded to the vehicle chassis. Any electrical boxes, conduits, or fixtures that are not permanently mounted to the metal body should be bonded to the protective ground wire. It is especially important that the metal light fixtures or housings of pole lights, light towers, and portable lights be grounded through the protective ground wire. *NFPA 70*, *National Electrical Code*, requires the following:

The normally non–current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are connected to the generator frame. [***70*:**250.34(A)(2), 250.34(B)(3)]

Use of a ground rod on apparatus is not recommended. If one is used, the requirements of *NFPA 70*, Article 250, should be followed. These requirements are difficult to achieve in a portable application.

Supplying a building electrical system from a fire apparatus is not recommended, because it commits the apparatus to the task and requires a significantly different grounding scheme, at least while being used for this application, in accordance with *NFPA 70*, 250.20, “Alternating-Current Systems to Be Grounded”; 250.30, “Grounding Separately Derived Alternating-Current Systems”; and other applicable sections of *NFPA 70*. In this situation, the grounding allowed by 250.34 is no longer applicable.

A.22.3.1.1 This refers to the protective ground (green wire), not the “neutral” wire. The ground is the chassis/body of the vehicle, not a connection to an earth ground.

A.22.3.3 Ground fault circuit interrupters (GFCIs) are intended to provide protection from electrical shock, but experience in the fire service has pointed out several considerations about using them:

(1) Due to the presence of water in the fireground environment, GFCIs are much more prone to trips due to leakage currents that do not involve personnel.

(2) Where possible, GFCIs should be located at the end of cords (i.e., in the distribution box at the end of a cord reel) to reduce tripping associated with long cord lengths and to put the reset function closer to the user.

(3) GFCIs might not be compatible with 120/240 volt 4-wire cord reels frequently used in the fire service unless the GFCI is located at the end of the cord reel.

(4) Many plugs and receptacles used in the fire service are twist lock instead of standard nonlocking household plugs and receptacles, and in these cases, the GFCIs integrated with an outlet cannot be used, requiring circuit breaker GFCIs or standalone GFCIs.

(5) The manufacturers of some ventilation fans state that they should not be used on circuits with GFCIs. Others are available that are compatible with GFCIs.

A.22.4.3.1 The 120°F (49°C) requirement is for air inlet temperature to the power source. The completed apparatus is required to operate at an ambient temperature of 110°F (43°C). This difference of only 10°F (6°C) is difficult to achieve due to heat produced by the apparatus engine. The installer should take this temperature into consideration in selecting a location for the power source. If the apparatus is intended to operate at high temperatures, the purchaser may want to specify a larger nameplate rating on the generator and derate it to allow for a higher temperature capability. Consult with the power source manufacturer for more information on extended temperature range operation. In the testing required in 22.15.7 the ambient and air inlet temperatures are recorded, giving a measure of the temperature difference in actual operation.

The following factors could be relevant to power source testing, depending on the type of power source:

(1) *Sampling.* The selection of test unit(s) should be representative of the construction and settings for units that will be supplied to the apparatus manufacturer. The standard does not require that all production units be tested; however, the power source manufacturer should test as needed to maintain confidence in its declaration of the continuous duty rating for all production.

(2) *Clearances, cooling, and ventilation.* Testing should be conducted at the worst-case clearance (usually minimum clearance or minimum compartment size) and worst-case ventilation conditions (minimum inlet/outlet dimensions and maximum inlet/outlet restrictions) specified in the literature. If not in the literature, the power source manufacturer's declaration should indicate the clearances, compartment size, and ventilation that are applicable to the declared continuous duty rating.

(3) *Test duration.* "Continuous" ratings are usually established by tests run until thermal stabilization is achieved. A minimum test of 2 hours, matching the in-apparatus test duration indicated in 22.15.7.3.4, is recommended.

(4) *Air inlet temperature.* Power sources should be tested in a chamber or room where the air temperature supplied to all inlet ducts (radiators, engine induction, windings, heat sinks, etc.), and the air surrounding the test unit, is maintained at 120°F (49°C).

(5) *Barometric pressure.* Pressure (air density) varies with changes in altitude and weather. Its effect is generally greatest on engines, where it affects combustion and cooling efficiency. There is a lesser effect on wound machines due to cooling only. To show compliance with the 2000 ft (600 m) requirement, a test in a chamber simulating 2000 ft

(600 m) would be ideal, but it is not expected. Alternatively, connecting more or less than the rated load can be used to simulate/demonstrate that the engine is capable of the power required for rated output at 2000 ft (600 m). (Several standards organizations, such as SAE and ISO, have standards that describe how to compute load/output correction factors for barometric pressure.)

(6) *Fuel temperature.* Fuel supply for the test should be stabilized at 120°F (49°C) before testing. Increases in fuel tank temperature that can occur as a result of fuel returned to the tank should be controlled so as to provide a result that is representative of expected fuel temperature conditions for the fire apparatus.

(7) *Intake and exhaust restrictions, accessories, hydraulic pumps, and reservoirs.* Components and accessories that might reduce engine power available for electrical output or that consume electrical output from the power source should be installed and be of the type used for the model that will be ordered for fire apparatus use, or their effect should be separately determined and reflected in the certified output.

(8) *Break-in.* Acceptance of a reduced output rating until completion of an in-use break-in period is subject to the prior agreement of the apparatus manufacturer, who might request test evidence. When applicable, the reduced output amount and duration of the break-in period should be indicated in the power supply literature.

(9) *Voltage and frequency.* Tests should be run while maintaining the ±10 percent voltage and ±3 Hz frequency required by 22.2.1. Furthermore, settings for voltage and frequency should be representative of production units.

(10) *Engine speed and hydraulic flow/pressure.* The engine speed and/or hydraulic flow and pressure ranges indicated in the power source's literature should be used to verify that the declared ratings are achievable.

(11) *Hydraulic fluid temperature.* The entire hydraulic power supply system, including hydraulic fluid piping and reservoir, should be located within a test chamber where temperature is controlled to maintain 120°F (49°C). Hydraulic fluid reservoirs should be stabilized at the ambient air test temperature [120°F (49°C)] prior to the testing.

(12) *Component and material temperatures.* Although not specified in the standard, when a power supply designed for light-duty use in open air is proposed for fixed fire apparatus use, the power source manufacturer should evaluate the components to determine whether they will operate within their rated or design temperature limits.

A.22.4.6.3 The instrumentation should be protected from vibration, which can lead to false readings. Particular attention should be paid to reed-type frequency indicators. Digital electronic instrumentation should be selected that incorporates sample times and intervals that accurately report system performance under varying conditions.

A.22.4.8 The indicator lights and interlocks specified in this section are minimums. Some manufacturers or users might choose to add additional indicator lights or interlocks.

A.22.4.8.3 Generators are operated from the side, top, front, or rear of the apparatus, and stationary operation requires that no power is applied to the wheels while operating. Therefore, it is essential that any generator system controls that shift the apparatus out of the road mode of operation to place the generator system in operation be equipped with a means to prevent dislocation of the control from its set position in the power generation mode.

A.22.5.1 A PTO generator system typically consists of a propulsion engine, a controller to regulate the propulsion engine's speed (if required), an appropriate PTO arrangement, drivetrain components, a generator, and other miscellaneous parts.

When a generator and fire pump are both direct driven by the same engine and are both operated at the same time and the generator requires a fixed engine speed, fire pump performance is limited to the generator set speed, and pump pressure is controlled by a pressure relief valve.

Due to variable engine speeds causing uncontrolled voltage and frequency variation with most direct drive generators, most direct drive generators are not acceptable for fire apparatus where "generate and roll" capability is required. Hydraulically driven or separate engine driven generators are suited for these applications.

Where possible, the generator PTO system should be prevented from engaging if engine speed is above idle.

PTO gear ratios and engine governor components should be selected and matched to provide an engine speed high enough to maintain rated performance of the alternator and air conditioning system (if provided). Engine speed should be high enough to maintain rated performance of the low voltage electrical system. Continuous excessive engine speed will result in premature generator drivetrain component failure and unnecessary fuel consumption.

The purchaser should consider specifying a means to automatically disconnect the generator or reduce engine speed to idle in the event of engine overspeed.

A.22.5.2 A hydraulic generator system generally consists of a variable displacement hydraulic pump deriving its power from the propulsion engine, a controller to regulate the hydraulic fluid flow rate, a hydraulic motor driving the generator, hydraulic fluid cooler, reservoir, and other miscellaneous parts.

All hydraulic generator systems have a window of operation (speed range). When selecting the power output of the hydraulic generator system, its speed range should be compared to the operating window of the fire apparatus's engine and the PTO ratios available. By selecting the hydraulic generator system and PTO ratio to match the application, electrical power can be provided over a wide operating range.

The selected PTO should have a gear ratio that will allow the widest possible range of engine speeds without overspeeding the hydraulic pump.

Where possible, engagement of the generator PTO system should be prevented if engine speed is above idle.

A.22.5.2.1 The means can be a mechanical, hydraulic, or electronic device.

A.22.5.2.4.3 The use of 90-degree fittings should be avoided.

A.22.5.2.5 Hose runs should not include “S” turns that would allow air to be trapped.

A.22.5.3 Engine-driven generator systems use an internal combustion engine close-coupled to a generator. Some installations are capable of producing power while the apparatus is in motion. Generators used in these applications should be specifically designed for mobile applications. Remote generator controls in the driving compartment should be considered and specified if desired.

A.22.5.3.2 The purchaser should consider the following additional remote instruments where a prime mover, other than the propulsion engine, is used to drive a generator:

(1) Oil pressure gauge and low pressure indicator light and audible alarm

(2) Engine temperature gauge and high temperature indicator light and audible alarm

The purchaser might want to specify a high temperature indicator to help troubleshoot automatic shutdowns.

A.22.5.3.7 Generators are often positioned away from or remote from the main operator's area (top of apparatus, over pump, hidden in body, etc.). In these cases, the operator needs to be able to control the generator and monitor the instrumentation without having to climb to these remote locations.

A.22.5.3.9.1 Emissions from exhaust discharge pipes should be directed away from any fire-fighting tools, because such emissions contain an oily substance that could make the tools difficult to handle and possibly dangerous to use.

A.22.5.4 Belt-driven generator systems use a voltage regulator and a generator driven off the propulsion engine. The complexity of modern engine drive belt configurations limits power output to about 6000 watts. This system will generally maintain acceptable voltage, but in most units the frequency will vary with engine speed. Motor loads should not be powered by this type of power source unless the frequency is regulated.

An alternative system uses a separately driven alternator to supply electrical energy to an inverter, which in turn produces line voltage electrical power. These systems are separate from and do not affect the performance of the low voltage electrical system. These systems are voltage regulated and provide ample power for scene lighting. Due to the belt-driven configuration, the system is still subject to low voltage at idle conditions, which could damage motors.

A.22.5.5 Brief descriptions of several different types of systems follow. All of these systems can overload the low voltage electrical system and cause the load management system to terminate the generation of line voltage. As a result, the amount of line voltage power that can be supplied at any given time is totally dependent on the other, higher priority demands placed on the low voltage system.

Dynamic Power Inverter. A dynamic power inverter converts alternator output power to 120 volts ac (or 120/240 volts ac). Power is electronically inverted to ac. Usually the largest system of this type is 7500 watts. Voltage and frequency control are typically very good.

Static Power Inverter. A static power inverter converts 12 volt to 14 volt dc power to 120 volt ac (or 120/240 volts ac) power. Power is electronically inverted to ac. Usually the largest system of this type is 2000 watts. Voltage and frequency control are typically very good.

Motor-Driven Generators. A motor-driven generator system converts 12 volt dc power to 120 volt ac (or 120/240 volts ac) power. The 12 volt dc motor drives an ac generator. Typical power ratings are less than 1600 watts. Voltage and frequency control are less precise than some of the other systems available. These types of systems are suited to providing electric power while the apparatus is in motion.

Transformers. Transformer systems convert energy from the alternator, which is then rectified to 120 volt dc power. Typical installations provide 1000 watts. Output voltage is directly dependent on input voltage. Input voltage is dependent on engine and alternator speed.

In most cases, other power sources that do not draw power from the low voltage system are preferable.

A.22.5.5.2 In order to provide adequate power, it may be necessary to provide a means to advance engine speed as described in 22.5.6.

A.22.5.6.3 Operations in conjunction with a fire pump, aerial device, or other component driven off the fire apparatus's engine could require special or alternate interlock systems.

A.22.5.9.1 When a split shaft PTO is used, completion of the generator shift might require that the chassis transmission be shifted into the proper gear.

A.22.5.10 Devices that produce modified sine waves may be less expensive than devices that produce pure sine waves. Power from electric utilities and most traditional mechanical generators are close to a pure sine wave. A modified sine wave output is satisfactory for many types of equipment but may cause problems with some types of equipment, including the following:

(1) Some computer and electronic equipment

(2) Some fluorescent lights with electronic ballasts

(3) Some tools with variable speed motor controls

(4) Some battery chargers

(5) Some medical equipment

(6) Some other equipment

The purchaser should identify what equipment is intended to be powered from the power source and verify with the equipment manufacturers that the equipment is compatible with modified sine wave power sources before specifying such a power source.

A.22.6 Portable generator systems are generally designed with an integral fuel tank and controls in one modular package. This allows the system to be picked up and transported to a remote location from the apparatus. Generators designed for portable use should be accessible for removal. These generators are generally not suited for “enclosed” compartment operation or should be mounted on a slide-out tray for adequate ventilation. Such installations require interlocks or a high temperature alarm to ensure that the generator is operated in slide-out condition.

The generator performance specifications should be evaluated carefully to ensure that the required level of performance can be met. Article 445, “Generators,” of *NFPA 70*, *National Electrical Code*, requires that overcurrent protection be provided on portable generators.

A.22.7.1 The purchaser should specify the location on the apparatus for the power inlet. Consideration should be given to placement of the power inlet so that it disconnects if the apparatus is moved forward. The shoreline and circuit breaker in the fire station should be sized for the anticipated electrical load.

A.22.8.3 Where the wire could be exposed to temperatures above 194°F (90°C), higher temperature rated wire should be used.

A.22.9.3.4 Similar fixed loads should be paired on opposite legs of the power source where practical. If pairs of receptacles are provided on the same side of the apparatus or on the front or rear of the apparatus, they should be connected to opposite legs of the power source. If two 120 volt cord reels are provided, they should be connected to opposite legs of the power source. 120/240 volt cord reels should always be connected to both legs of the power source.

A.22.10 Where the wire could be exposed to temperatures above 194°F (90°C), higher temperature rated wire should be used.

A.22.10.6.1 Locations in which flexible cord might be damaged include but are not limited to compartment walls and floors, exposed outside areas, and exposed interior areas near equipment or walkways.

A.22.11.3 Common connectors and terminations that comply with these requirements include the following:

(1) Welded or brazed connectors

(2) Crimped connectors

(3) Soldered connections that are mechanically secured before soldering

(4) Screw-type positive pressure connectors

(5) Ring terminals

(6) Hooks

(7) Upturned spade

(8) Crimped-on pins

(9) Other methods providing a positive mechanical and electrical connection that are acceptable to the authority having jurisdiction

A.22.11.4 The following switch terminology can be helpful in understanding the different types of switches.

One Pole (1P) or Single Pole (SP). A switch device that opens, closes, or changes connections in a single conductor of an electrical circuit.

Two Pole (2P) or Double Pole (DP). A switch device that opens, closes, or changes connections in both conductors of the same circuit.

Two Circuit (2 CIR). A switch device that opens, closes, or changes connections in a single conductor of two independent circuits.

Single Throw (ST). A switch that opens, closes, or completes a circuit at only one of the extreme positions of its actuator.

Double Throw (DT). A switch that opens, closes, or completes a circuit at both extreme positions of its actuator.

Normally Open (NO). A switch in which one or more circuits are open when the switch actuator is at its normal or rest position.

Normally Closed (NC). A switch in which one or more circuits are closed when the switch actuator is at its normal or rest position.

Switches are rated for the type of load they are designed to control. Switch ratings include the following:

(1) Resistive

(2) Inductive

(3) Horsepower (i.e., motor loads)

(4) Tungsten (i.e., incandescent lamp loads)

(5) Alternating current

(6) Direct current

The ampere rating of a given switch is dependent on the type of load. In particular, switches used to control dc circuits should have the appropriate dc rating.

A.22.11.4.2 In lieu of a switch-rated circuit breaker, a standard circuit breaker could be used with a separate switching device.

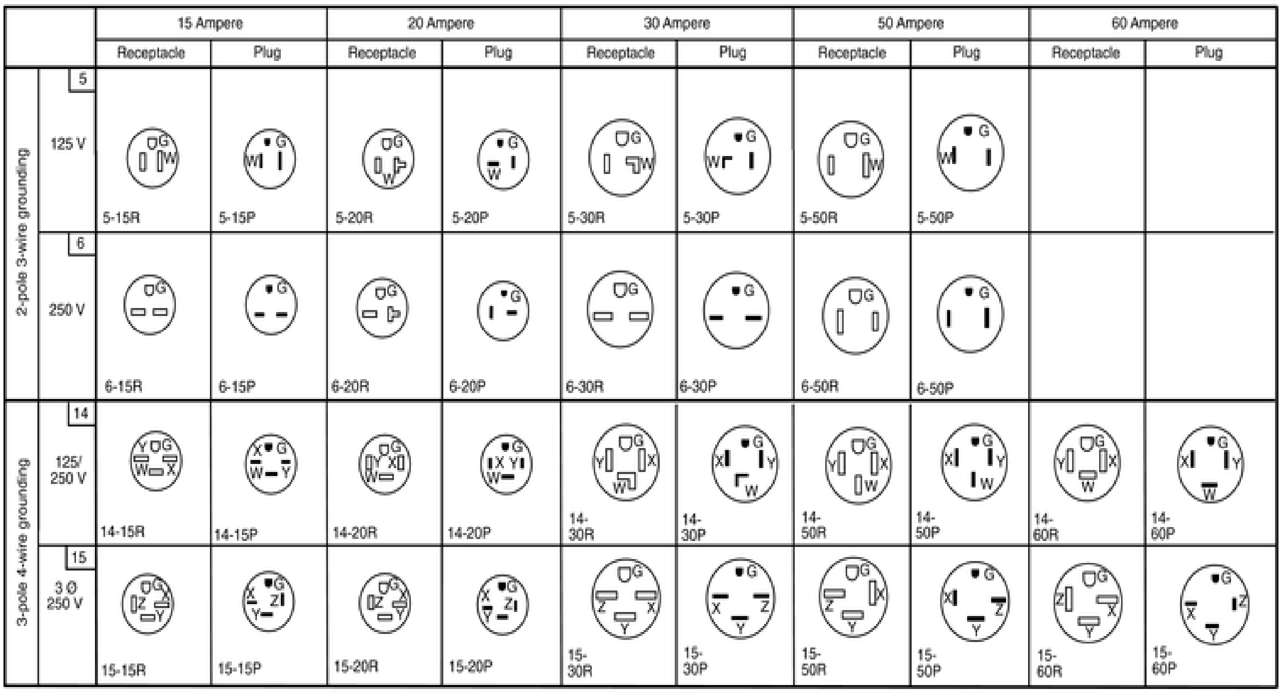
A.22.11.5 The purchaser should specify the number and location of receptacles that are needed to operate the devices to be powered by the system. The purchaser should specify the NEMA number (if applicable), manufacturer, and style of the receptacles desired. For other than NEMA-type receptacles, the purchaser should additionally specify the wiring configuration.

A.22.11.5.1.3 If the offroad fire apparatus is to ford water, the receptacle distance should be increased above 30 in. (750 mm). The purchaser should review the proposed height for any receptacles on the apparatus and specify a higher mounting height if desired.

A.22.11.5.6 While NEMA configurations as defined in NEMA WD 6, *Wiring Devices — Dimensional Requirements*, are recommended to promote compatibility of equipment during mutual aid operations, other configurations are in use and have been adopted by various fire departments.

Acceptable NEMA-type plug and receptacle configurations for various ac voltage and current ratings are shown in Figure A.22.11.5.6.

NONLOCKING PLUGS AND RECEPTABLES



LOCKING PLUGS AND RECEPTACLES

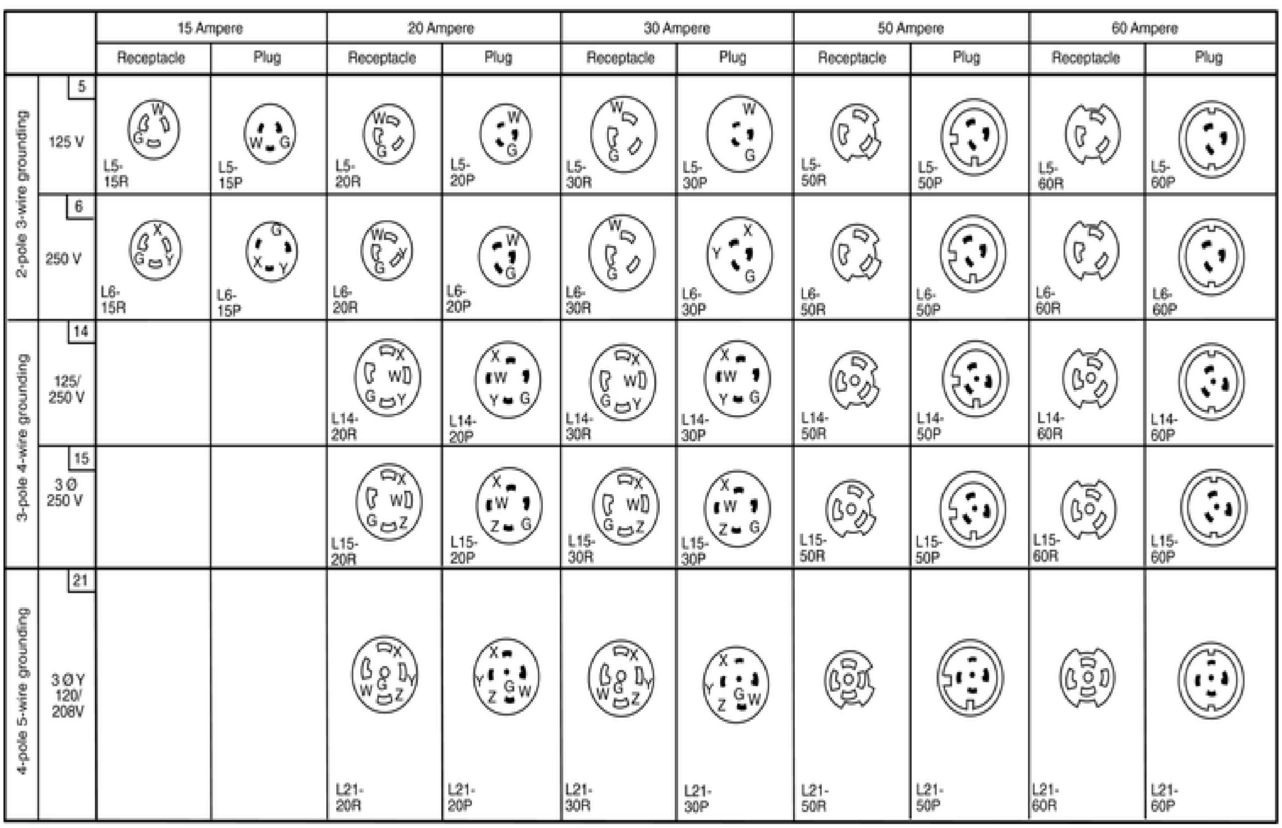


FIGURE A.22.11.5.6 Common NEMA Plug Configurations.*(Source: Reprinted from NEMA WD-6, Wiring Devices—Dimensional Requirements, by permission of National Electrical Manufacturers Association. Copyright 2002 by National Electrical Manufacturers Association.)*

The letter "R" following the configuration number indicates a receptacle, and the letter "P" denotes a plug. For example, the nonlocking, 15-ampere, grounding receptacle found in most homes is configuration 5-15R and accepts a three-prong plug in the configuration of 5-15P.

Locking-type plugs and receptacles are designed to prevent accidental disconnection when subjected to moderate pull-apart loads. Neither locking nor nonlocking connectors are designed to withstand the loads that can be created when pulling long cords up buildings and stairs.

A.22.12.4 A suggested minimum capacity of a reel is at least 100 ft (30 m) of cord rated to carry 20 amps at 120 volts ac. When sizing the reel, extra capacity should be provided when multiple receptacles are attached to the cord stored on the reel.

A cord reel to supply a single 120 volt circuit requires three collector rings and three conductors in the cord, for line, neutral, and ground. If the power source has 120/240 volt outputs, as most power sources do, a second equivalent circuit with the same rating requires only one additional conductor, because the neutral and ground can be common to both circuits. Thus, with approximately 25 percent more reel space and cord cost, the cord reel can supply twice the number of lights or other loads.

A.22.12.5 Table A.22.12.5 lists the suggested cord size for cord reels based on the desired circuit ampacity and the cord length. All cord reels with one or more outlets should be rated at 15 amps or greater.

Table A.22.12.5 Wire Size (AWG) for Various Electrical Cord Lengths

	Cord Length					
Circuit Ampacity	**50 ft (15 m)**	**100 ft (30 m)**	**150 ft (45 m)**	**200 ft (60 m)**	**250 ft (75 m)**	**300 ft (90 m)**
15	12	12	12	12	10	10
20	12	12	12	10	10	8
25	12	12	10	10	8	8
30	10	10	10	8	8	6
35	8	8	8	8	6	6
40	8	8	8	8	6	6
50	6	6	6	6	6	4

For heavy loads such as large smoke fans and hydraulic rescue tool power plants, the purchaser should consider 240 volt units instead of 120 volt units. This will allow the use of smaller cords and reels. For example, a 200 ft (60 m) reel to supply a hydraulic rescue tool (HRT) power plant that draws 15 amps at 240 volts would require 12 gauge wire. The same power unit in a version to run on 120 volts would draw 30 amps and would require 8 gauge wire.

Cord reels for three-phase power or other specialized applications should be designed with the assistance of a qualified electrical engineer.

A.22.12.6 The purchaser may want to specify that the cord on the reel be provided with a disconnect means within 18 in. (457 mm) from the reel for cord removal if the cord is 8 AWG or smaller. A disconnect makes it easier to replace damaged cord or to use the cord to extend another cord, although it reduces the capacity of the reel and makes it harder to coil the cord on the reel.

A.22.12.7 The purchaser might want to color code the cord or cord reel to identify the voltage.

A.22.12.8.2 It might be advantageous to specify a remote power distribution box that has a provision for hanging the unit from a door or ladder.

A.22.12.8.5 The lamps used in this application should be rough-service type. Scene lighting around the remote power distribution box can be provided with an integral, mechanically protected light fixture.

A.22.12.8.5.1 For increased visibility, reflective tape can be applied to the distribution box.

A.22.14.1 The purchaser should specify the type of rotating, telescoping, panning, and tilting operations as well as other features that are required.

A.22.14.2 When the light mast is mounted above the apparatus driving and crew compartment or the body, a brush and tree limb guard should be considered to protect the mast and floodlights.

A.22.14.2.3 To reduce the electrocution hazards associated with the operation of masts above the apparatus, the purchaser should consider specifying a slide-out operator's platform, a wireless remote control, or both.

A.22.14.2.8 The lighting assembly should be supported when it is in transport mode, to prevent damage to the lighting assembly from vibration.

A.22.15 The purchaser should consider the range of temperatures in which the power source is to be operated. If extreme conditions are anticipated, the purchaser should specify the test conditions that are desired.

A.22.15.2.3 Solid state equipment is generally hi-pot tested by the manufacturer. It is very important to connect all hot and neutral buses together so that no current flows through connected loads.

A.22.15.3 The fire department should check the polarity of the wiring in a building prior to interconnecting the fire apparatus–mounted electrical system to the electrical system in a building.

A.22.15.7 It is important that the power source meet the fire department requirements for output. Power sources of the size and type used on fire apparatus are generally advertised with power ratings for operating conditions that are more favorable than the conditions that might be encountered in fire apparatus use. Some power sources are advertised at peak output or intermittent duty ratings and not the continuous duty output required for fire apparatus. The power source manufacturer and apparatus manufacturer might need to establish a reduced rating that is appropriate for fire apparatus. The standard calls for two steps. The power source manufacturer provides a declared rating for 120°F (49°C) air inlet temperature and 2000 ft (600 m) altitude for the minimum clearance and ventilation indicated on the declaration *(see 22.4.3.1 and A.22.4.3.1)*. Then the apparatus manufacturer verifies that the rating printed on the power source specification label can be attained during the apparatus test *(see 22.15.7)*.

Generator Set Rating. Auxiliary engine–powered generator sets are the type of power source most likely to require a reduction from advertised ratings, and generator set literature usually provides rating correction factors for altitude and temperature. These factors could be based on standards for engines, such as ISO 3046-1, *Reciprocating internal combustion engines — Performance — Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods — Additional requirements for engines for general use*, and SAE J1349, *Engine Power Test Code — Spark Ignition and Compression Ignition — Net Power Rating*; standards for generators, such as NEMA MG 1, *Motors and Generators*; or manufacturer testing. As an example of how altitude and temperature affect output capability, consider a typical 10 kW generator set with 0.8 generator efficiency and naturally aspirated diesel engine that is rated at 500 ft (150 m) and 85°F (30°C) for continuous operation without overload or reserve capacity. ISO 3046-1 indicates a factor of -2.1 percent output per 10°F (5.5°C) ambient increase, and a -2.6 percent per 1000 ft (300 m) altitude increase. Generator output is also affected by temperature [about -0.5 percent per 10°F (5.5°C)] and altitude (small and ignored in this example). There is also an effect from combining engine and generator into a generator set due to each heating the other. This may require an additional factor of -1 to -4+ percent per 10°F (5.5°C), depending on the effectiveness of the cooling system and temperature (the factor increases with increasing temperature). Altogether, these factors suggest the 10 kW generator set in this example is capable of about 8.8 kW at the maximum temperature of 110°F (43°C) and altitude of 2000 ft (600 m) specified in the standard. Another way to view this result is that an 11.4 kW generator set would be required to provide 10 kW at 110°F (43°C) and 2000 ft (600 m).

Apparatus Test. Where there is concern that installation or operational circumstances could cause power source intake air to heat above 120°F (49°C) or where the flow of cooling, induction, or exhaust air is more restricted than what is allowed by the manufacturer's literature, advance consultation with the power source manufacturer(s) could help in the selection of a power source that will pass the apparatus test with an output that meets the fire departments needs. Also, weather, like altitude, can affect air density and thus engine and generator set output. The combined effect of altitude and weather is reported as barometric pressure on local weather reports. Low barometric pressure will reduce engine and generator set output capability. High barometric pressure (usually clear cold days) will increase engine and generator set output capacity.

Other Power Source Types. Some output correction factors described in the generator set example apply to other types of power sources, depending on circumstances. For example, PTO and hydraulically driven generators also rely on engine power, but the engine will usually have substantial reserve power, so increased altitude or temperature will not affect their power supply rating. Regardless, best practice for longest life and lowest maintenance is to provide unrestricted airflow at the lowest temperature.

A.22.15.7.3.10.1 For fire pumps rated at less than 750 gpm, the generator test of 2 hours is longer than the pump test portion at 100 percent of capacity at 150 psi (1000 kPa) net pump pressure. The generator test is still required to be 2 hours with the pump running at 100 percent of capacity, the last 30 minutes of which could be the start of the pump test.

A.23.2 The command center could be an area of the crew compartment or the apparatus body or a portion of either of these areas. The environment for the area is subject to wide variations in size, noise levels, facilities, and appointments. Command areas in enclosed body areas could be designed to accommodate several personnel. It is common to separate the crew or equipment areas from command areas. A separate entry and enclosed area might be required by the purchaser.

The exact layout, design, and usage of the command area should be determined by the purchaser. If a separately enclosed area is desired, the purchaser should specify the arrangements desired and whether a locking door is necessary.

A.23.3 If such equipment is to be thermostatically controlled automatically, the purchaser should so state. Powered or nonpowered ventilation equipment should be provided as required by the purchaser.

A.23.4 Supplemental floor, wall, and ceiling acoustical material should be added where required to reduce noise levels below 80 dBA.

A.23.5.2 Command areas in the driving or crew compartments should be provided with 120 volt lighting systems to reduce 12 volt loads. The purchaser might want to specify additional lighting and/or switching to allow a reduced lighting level for computer operation or red lighting to preserve night vision.

A.23.6.1 Removable Plexiglas® or wired safety glass–type surfaces can be added to the top of work surfaces.

A.23.7.1 The seating equipment and arrangement can vary considerably. The equipment could include swing-down seats, stools, permanent chairs, or portable chairs, as required.

A.23.8 The enclosures for cabinets or storage areas could be rollup-type doors, hinged doors, or sliding doors, with protective latches to hold the doors closed in transit. Synthetic netting could also be used in lieu of cabinet doors.

A.23.9.1 The interior surfaces should be bright and easily cleaned.

A.23.10.1 The purchaser needs to provide the manufacturer of the apparatus with all the details of the equipment that is to be installed in the communications area, regardless of who is to install the equipment, so that the area can be laid out properly and appropriate cabinets and consoles can be provided to house this equipment.

The purchaser should also specify the number, size, and type of conduits for wiring and antennas from the communications area to the driving compartment, power supply area, exterior surfaces, or secondary operational or control panels that are necessary to support the installation of equipment by persons other than the body manufacturer. These conduits should have a pull wire installed to pull future wiring into place.

A.23.11 Due to the cost of complying with the special power and installation requirements for most computer equipment, the use of office-type computers and peripherals in mobile applications is not cost effective. Consideration should be given to the use of laptop equipment, which is designed to be transported and used in less-than-ideal environments. Laptop computers and printers can be powered from the vehicle's 12 volt dc power supply or from a 120 volt ac power supply. Laptops run off an internal battery that is rechargeable by one of these two power resources. The input power purity requirements are not that difficult to meet.

The purchaser should obtain technical assistance from the manufacturer of the computer equipment that is selected. The manufacturer's engineering staff can advise the purchaser and the builder in the areas of initial installation and actual startup of the installed computer system.

A.24.2 The type of fire department air system and its size is determined by the number of SCBA units that will be used simultaneously, the number of SCBAs available, and the length of the event requiring the use of SCBA.

The number of users wearing SCBAs simultaneously should be considered under both peak demand and continuous demand. Peak demand is the maximum number of simultaneous SCBA users needed under the worst emergency conditions for which the fire department feels preparation is necessary. Continuous demand is the minimum number of simultaneous SCBA users necessary to maintain operations for a long-term duration.

To allow a specified number of SCBA users to be deployed without interruption, as many as three times that number of SCBA units should be available on the scene. That allows for backup personnel to have their equipment in readiness to immediately relieve those personnel who have exhausted their air supply as well as providing extra units in the event of failures or equipment problems.

The resupply rate of SCBA cylinders on the scene could be accomplished by an air compressor alone, air cascade alone, or a combination of each type of system with a booster system. The users should determine the supply rate and duration, then determine what system will meet this requirement.

An analysis of the existing fire department SCBAs and breathing air system should be performed to determine what needs, if any, exist. This analysis should include the following:

(1) SCBA units: type, quantity, designed duration

(2) Extra SCBA cylinders: type, quantity, designed duration

(3) Air storage system capability

(4) Air compressor capability

A.24.2.1 Special operating conditions such as high temperatures or cold weather might require special equipment modifications or design requirements by component manufacturers and body manufacturers. Fire departments need to be specific in stating their operating temperature range and special requirements. Because of the presence of moisture, special provisions should be made for moisture separator freeze protection in very cold weather operations.

A.24.2.11.6 The purchaser might want to require the air compressor assembler and final-stage installer of the proposed air system to provide drawings of the air equipment arrangement, operator's panel layout, and air piping, to allow prepurchase evaluation of the operational characteristics of the system proposed.

A.24.2.13.1 Expectations for training should be carefully defined in the purchaser's specifications.

A.24.2.13.2 Because of the extremely complicated nature of breathing air compressor systems, training is a critical component of the safe use of the system. Expectations for training should be carefully defined in the purchase specifications.

A.24.3 If filling is to be accomplished with a compressor and a filled air storage system in simultaneous operation, the amount of SCBA fills in the first 1 to 2 hours will increase considerably. The number of SCBA fills from the air storage system should be calculated and added to the air compressor fill rate. The total fills per hour would have to be an estimate, because the compressor could be refilling the air storage system during SCBA connection and disconnection.

If only an air compressor is to be used for refilling SCBA cylinders, the minimum size of the air compressor system needed can be determined based on the number of SCBA cylinders that need to be refilled per hour to meet incident demand requirements. Table A.24.3(a) and Table A.24.3(b) can assist in determining the compressor size.

Table A.24.3(a) Compressor Capacity Requirements in ft^3/min of Free Air Delivery

Desired SCBA Fills per Hour	SCBA Cylinder Rating				
	45 ft^3 at 2216 psi	45 ft^3 at 4500 psi	72 ft^3 at 2250 psi	80 ft^3 at 3000 psi	88 ft^3 at 4500 psi
5	3.8	3.8	6.0	6.7	7.4
10	7.5	7.5	12.0	13.4	14.7
15	11.3	11.3	18.0	20.0	22.0
20	15.0	15.0	24.0	26.7	29.4
25	18.8	18.8	30.0	33.4	36.7

Table A.24.3(a) Compressor Capacity Requirements in ft^3/min of Free Air Delivery

Desired SCBA Fills per Hour	SCBA Cylinder Rating 45 ft^3 at 2216 psi	45 ft^3 at 4500 psi	72 ft^3 at 2250 psi	80 ft^3 at 3000 psi	88 ft^3 at 4500 psi
30	22.5	22.5	36.0	40.0	44.0
35	26.5	26.5	42.0	46.7	51.4
40	30.0	30.0	48.0	53.4	58.7
45	33.8	33.8	54.0	60.0	66.0
50	37.5	37.5	60.0	66.7	73.4
55	41.3	41.3	66.0	73.4	80.7
60	45.0	45.0	72.0	80.0	88.0
65	48.8	48.8	78.0	86.7	95.4
70	52.5	52.5	84.0	93.4	102.7
75	56.3	56.3	90.0	100.0	110.0
80	60.0	60.0	96.0	106.7	117.4
85	63.8	63.8	102.0	113.4	124.7
90	67.5	67.5	108.0	120.0	132.0
95	71.3	71.3	114.0	126.7	139.4
100	75.0	75.0	120.0	133.4	146.7

Note: Typically, a single fill station is limited to approximately 40 SCBA cylinder refills per hour (per operator), normally with two to four fill hose. An additional fill station should be added for each additional 40 SCBA cylinders that are to be filled per hour.

Table A.24.3(b) Compressor Capacity Requirements in L/min of Free Air Delivery

Desired SCBA Fills per Hour	SCBA Cylinder Rating 1275 L at 15,000 kPa	1275 L at 31,000 kPa	2000 L at 15,500 kPa	2250 L at 20,000 kPa	2500 L at 31,000 kPa
5	108	108	170	190	210
10	212	212	340	380	416
15	320	320	510	566	623
20	425	425	680	756	833
25	532	532	850	946	1040
30	637	637	1020	1133	1245
35	750	750	1189	1323	1455
40	850	850	1359	1512	1661
45	957	957	1529	1699	1868
50	1062	1062	1699	1889	2078
55	1170	1170	1869	2078	2285
60	1274	1274	2039	2265	2492
65	1382	1382	2209	2455	2701

Table A.24.3(b) Compressor Capacity Requirements in L/min of Free Air Delivery

Desired SCBA Fills per Hour	SCBA Cylinder Rating 1275 L at 15,000 kPa	1275 L at 31,000 kPa	2000 L at 15,500 kPa	2250 L at 20,000 kPa	2500 L at 31,000 kPa
70	1487	1487	2379	2645	2908
75	1594	1594	2549	2832	3115
80	1699	1699	2718	3021	3324
85	1807	1807	2888	3211	3531
90	1911	1911	3058	3398	3738
95	2019	2019	3228	3588	3947
100	2124	2124	3398	3777	4154

Note: Typically, a single fill station is limited to approximately 40 SCBA cylinder refills per hour (per operator), normally with two to four fill hose. An additional fill station should be added for each additional 40 SCBA cylinders that are to be filled per hour.

A.24.3.2.1 To reduce or prevent contaminated air from entering the compressor, consider the following:

(1) Park the fire apparatus as far from the scene as is practical and attempt to remain upwind from smoke or chemical fumes.

(2) Direct or extend fire apparatus and other engine exhaust outlets away from the point of compressor intake. Locate the air intake to the compressor as remotely as possible.

A.24.3.3.2 Special airflow engineering, supplemental fans, additional doors, and vents might be required for the release of heated air from the air compressor during long periods of operation. These could include automatic operating doors in the roof of the apparatus, manually opened roof doors, large electric driven exhaust fans, and so forth. These extra provisions installed by the final-stage installer could ensure there is adequate cooling to keep the air compressor within the compressor manufacturer's operating temperature range.

A.24.3.3.5 The purchaser should be extremely careful when mounting or storing equipment in compartment areas to not obstruct open airflow paths to a breathing air compressor required for cooling purposes.

A.24.3.6.2 A final-stage pressure gauge might also be desired at the air control panel, in addition to the gauge near the compressor. The hourmeter could be located at either the compressor or the main operator's panel. Interstage pressure gauges should be mounted at the compressor location. The oil gauge or level indicator should be located at the compressor, with alarms located at the main air operator's panel.

A.24.3.6.3 It is important to have a transfer switch or other means to isolate the generator power from the shorepower connection.

Three-phase electric motors with “soft starting” provisions are the most practical electric motors for air compressors. The fire station electrical supply should be checked for capacity and compatibility with the breathing air compressor. The generator should be sized to provide additional capacity for floodlight, emergency power applications, and other utility usage. A general guideline would be to specify a generator output with twice the capacity required for the breathing air compressor.

The fire apparatus should be provided with a compatible shorepower cord and plugs, sized to match electric motor requirements. The shorepower cord needs to be sized to reflect the distance from fire station service entrance to the fire apparatus shorepower receptacle.

A.24.4.1 The purchaser might require a quality of air other than that used for fire fighting. In those situations, it is important that the purchaser specify the standards that such air quality has to meet.

A.24.4.3.2 The purification system should be located where it is easily accessible for service, preferably on slide-out tracks or in a location where purifier cartridges and filter elements can be installed from the top. These units can be remote mounted from the air compressor and the operator's panel.

A.24.5 In some states in the United States, the regulations of the Occupational Safety and Health Administration (OSHA) of the Department of Labor have been interpreted to require that DOT cylinders be used for mobile air tanks to transport air on state highways. If DOT cylinders are not required by state regulations, ASME cylinders should be utilized as air tanks if the design of the apparatus presents a severe difficulty in the removal of cylinders for testing.

A.24.5.7.1 Air tanks should be mounted as low as possible to minimize the adverse effect on the center of gravity of the vehicle.

A.24.6 Booster-type high pressure air compressors, used in conjunction with air tank storage arranged for air cascading, serve the purpose of extracting greater quantities of air from high pressure air storage systems. By adding a high pressure air booster/amplifier to the system, the yield can be increased by over 100 percent.

A.24.10 The size of the air supply piping, air compressor output, air hose size, and size of auxiliary storage reservoirs are of critical importance for supplying utility air–powered tools, confined-space breathing air, and high pressure air supplies to remote locations. The purchaser needs to specify the following information about the air reels that are to be installed on the apparatus so that the manufacturer can design an appropriate system:

(1) Source of air supply to the air reel

(2) Operating pressure range desired

(3) Type of air desired (low or high pressure, utility or breathing air)

(4) Cubic feet (cubic meters) of air output or cubic feet (cubic meters) of air per minute required by air tools or equipment to be used and whether to be used alone or in

combination

(5) Specific air tools, air bags, and other devices to be used from the air system

The use of chassis air brake systems for utility air tools is not recommended. Air brake system–supplied air outlets should be used only for nonemergency applications. Rescue air tools, air bags, or other emergency uses should not be supplied from air brake systems but from a high pressure cascade tank system or a high capacity utility air compressor especially designed for air tool usage. SCBA or SCUBA air cylinders are suitable for intermittent air supply with limited airflow requirements. Where used for this purpose, additional SCBA cylinders should be defined and segregated on the fire apparatus for such usage.

A.24.10.1 Generally, reels for use with air tools or air bags will be rated to a gauge pressure of 300 psi (2000 kPa), while reels for use with high pressure breathing air cascade systems will be rated to a gauge pressure of 6000 psi (40,000 kPa).

To assist in differentiating air pressures on reels on the same apparatus or on multiple apparatus within the fire department, it is suggested the reels be painted distinctive colors. Suggested colors are as follows:

Blue: Reels for utility air hose up to a gauge pressure of 300 psi (2000 kPa)

White: Reels for breathing air hose up to a gauge pressure of 300 psi (2000 kPa)

Yellow: Reels for breathing air hose from a gauge pressure of 301 psi to 3000 psi (2001 kPa to 20,000 kPa)

Red: Reels for breathing air hose more than a gauge pressure of 3000 psi (20,000 kPa)

A.24.10.10 The intent of the low pressure breathing air reel is to supply breathing air through up to 300 ft (90 m) of breathing air hose at an operating gauge pressure of 125 psi (862 kPa) at the outlet point for connection to specific types of breathing apparatus. These arrangements provide for a longer operating duration in toxic or oxygen-deficient atmospheres.

A.24.11.1 The purchaser should evaluate conditions under which utility air hose, high pressure air hose, or low pressure breathing air hose could be used and advise the contractor if special hose is required.

A.24.11.4.1 The discharge end of any breathing air hose could have various fittings, threads, or quick connections installed on the threaded end of the discharge hose. The purchaser needs to specify the particular hose termination, thread size, valve control, quick connection fitting, expected application of hose, and other pertinent information if the manufacturer is to provide appropriate connections.

A.24.11.6 Confined-space low pressure hose supplying multiple users or hose lengths greater than 300 feet (90 m) could require larger hose sizes.

A.24.12 Air supply for low pressure utility applications should be from dedicated air compressors or air cascade storage tanks.

Selection of a low pressure utility compressor should be based on the fire department's air equipment and requirements for cubic foot per minute (liter per minute) capacity and duration of air supply. The compressor drive determines the cost of the compressor, installation requirements, type of operating controls and procedures, and frequency and cost of routine service and maintenance. Air tank storage should be considered to improve air system performance. The following compressor drives are available:

(1) Electric drive

(2) Hydraulic drive

(3) Gasoline or diesel drive

(4) PTO drives

A.24.12.1 The chassis air brake system is not intended to be used for rescue air bags, air tools, air reels, and other rescue applications, due to its limited duration, volume, and pressure.

A.24.12.2 The size of the air supply piping, chassis air compressor cubic feet per minute (liters per minute) rating, and auxiliary air reservoir(s) cubic foot (liter) capacity are of critical importance in supplying nonemergency application utility air outlets. These air outlets could be used to fill truck tires, pressurized water fire extinguishers, and so forth.

A.24.14 If the tests of some components of the apparatus are being certified by an independent third-party certification organization, the purchaser might want to specify that these tests also be certified by the independent third-party certification organization.

A.25.1.1 Winches are classified by manufacturers for different applications and uses. The purchaser might want to specify that winches meet the requirements of SAE J706, *Rating of Winches*. Winches installed on fire apparatus are not designed or suited for lifting or lowering personnel in rescue applications. Winches rated at under 20,000 lbf (89 kN) on fire apparatus are not designed for removal of apparatus from "buried" offroad conditions. A heavy-duty wrecker should be used for towing and lifting of fire apparatus.

Most electric (12 volt or 24 volt dc) winches used for fire apparatus applications are rated at between 5000 lbf (22.2 kN) and 12,000 lbf (53.4 kN) line pull. Smaller winches of the removable type might be specified by the purchaser. Hydraulically driven winches are typically rated for 6000 lbf to 30,000 lbf (26.7 kN to 133.5 kN) line pull.

A.25.3 A fast-idle switch might also be useful to provide additional electric or hydraulic power. The switch should be interlocked with the neutral position of the transmission and to the parking brake to prevent accidental movement of the apparatus.

A.25.4.1.1 There is virtually no control over the speed of a single-speed electric winch. The winch runs at the speed the load dictates — faster with light loads and slower with heavy loads.

Two-speed electric winches provide only for preselection of the winch gear ratio — that is, one gear ratio for pulling heavy loads, a second for light loads — and are not designed for shifting under load to improve line speed.

A.25.5.5.1 Completion of the engagement might require that the chassis transmission be shifted into the proper gear (split shaft PTOs only).

A.26.2.1 Type I trailers include trailers used as fire apparatus such as hazmat or rescue vehicles that are designed as a tow vehicle–trailer combination rather than a straight vehicle.

A.26.2.2 Type II trailers include trailers towed to the scene and then left at the scene while the tow vehicle performs other functions that could include bringing another trailer to the scene.

A.26.2.3 Type III trailers include boat trailers and construction equipment–style trailers transporting bulldozers, tractor-plows, and other types of motorized equipment.

A.26.6.1 The tow vehicle must be capable of supplying the necessary means to activate the trailer braking system when the tow vehicle brakes are applied. Tow vehicles must not be retrofitted with braking systems that are not compatible.

A.26.7.2 Use of skid plates, roller wheels, or another means will meet this requirement.

A.26.10.3.3.2 If a line voltage power source is used to provide low voltage power, the power source should be sized to accommodate the line voltage power needs as well as all low voltage power needs. The purchaser must specify any other devices or receptacles that will require electrical power while the trailer is operating separated from its tow vehicle.

A.26.10.4 The importance of standardizing on specific trailer umbilical connectors is to drive the industry toward a goal of interoperability. This is critical on Type II and Type III trailers that might be shared by mutual aid departments or need to be pulled by multiple vehicles within a department. Initially, these standards may require some modification to the fleet of apparatus that the fire department intends to use for towing. Adapters might be available, but it is preferable to have the towing vehicles rewired to permanently conform to these requirements. American Trucking Association TMC Recommended Practice RP 107B, *Seven Conductor Truck — Trailer & Converter Dolly Jumper Cable & Connector*, provides additional guidance on this subject.

Annex B Specifying and Procuring Fire Apparatus

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 General.

The purchase of new fire apparatus involves a major investment and should be treated as such. Fire apparatus are complex mechanical equipment that should not be purchased in a haphazard manner. A purchase should be made only after a detailed study of the fire department's apparatus needs, taking into consideration other equipment the department owns or plans to buy.

The local fire chief and fire department staff know the conditions under which the apparatus will be used. However, competent advice should also be obtained from knowledgeable and informed sources such as other experienced fire service personnel, trade journals, training instructors, maintenance personnel, and fire equipment and component manufacturers. The fire insurance rating authority should also be consulted.

The study should look not only at current operations and risks to be protected but also at how these might change over the life of the fire apparatus.

B.2 Writing the Specifications.

This standard provides the minimum technical requirements that new fire apparatus are expected to meet. It is recognized that many purchasers will want additional features of operation over and above these minimum requirements. The requirements in this standard, together with the annex material, should be studied carefully. Details, such as anywhere that the apparatus being specified needs to exceed the minimum requirements or where a specific arrangement is desired, should be carefully defined in the specifications for the apparatus. This might include special performance requirements, defining the number of seats and the seating arrangement for fire fighters riding on the apparatus, or providing space for extra hose or equipment the apparatus will be required to carry.

If a trailer is being purchased, the purchaser needs to provide the contractor with sufficient information about how the trailer will be towed, used, and equipped so the trailer manufacturer can provide a trailer appropriate for the application. Hitches, axles, frames, and brake systems need to be sized to handle the equipment loads installed inside the trailer. Tow vehicles need to be carefully selected to prevent overloading of the tow vehicle chassis and to ensure the safe stopping distances required by federal regulations. For trailers being designed for use under emergency response conditions, the trailer must include the reflective striping and emergency lighting required by this standard to provide adequate visibility.

If the purchaser owns a vehicle that will be the intended tow vehicle for the trailer, the purchaser needs to make that vehicle available for the contractor to inspect to validate compatibility and connectibility of the tow vehicle to the trailer before delivery of the trailer.

B.2.1 The first consideration in the design of a fire apparatus is a definition of the mission of the apparatus. The purchaser should define the basic specifications as follows:

(1) The type of apparatus to be purchased (pumper, aerial, initial attack, other)

(2) Types of responses (structure fires, wildland fires, automobile accidents, suburban environment, downtown city, medical assistance, rural water supply, etc.)

(3) The response environment (old city downtown with narrow streets and alleys, suburban neighborhoods, garden apartments, rural roads, major expressways, distances of hundreds of miles, etc.)

(4) Crew size (number of seats)

(5) Size of pump, if any

(6) Size of tank(s), if any

(7) Aerial device type and length, if any

(8) Hose load, if any

(9) EMS capability, if any

(10) Commercial or custom chassis

(11) Chassis configuration (conventional, cab over, cab forward, rear engine)

(12) Size or weight limitations due to firehouse, roads, bridges, terrain, neighborhoods

(13) Budget considerations

(14) Expected service life (years) and duty cycle (runs per day or month)

B.2.2 The second consideration in the design of a fire apparatus is the fixed equipment components. These major "support function" components can represent the most concentrated and heaviest load elements of the vehicle. It is vital that these elements be laid out early in the initial designs and be situated on the vehicle to provide for the following:

(1) Good load distribution

(2) Balance (both front to rear and right to left)

(3) Low center of gravity

Fixed components can be located in exterior compartments or in the interior of the vehicle to be functional and organized in a layout to be user friendly in emergency applications. The following are examples of fixed equipment:

(1) Electrical generators

(2) Water tanks, fire pumps, and other fire-fighting equipment

(3) Air cascades or compressors

(4) Reels of all types

B.2.3 A major support function of any fire apparatus, no matter the type, is the portable equipment. That is why this document places so much emphasis on final GVWR and carrying capacity of the completed vehicle, which includes both fixed and portable equipment.

The listings of portable and fixed equipment are so variable, depending on the mission of the vehicle, that the fire department needs to measure and weigh its specific equipment.

The fire department should classify the equipment as follows:

(1) Existing — currently owned equipment that will be carried

(2) Proposed — new equipment that will be carried as the apparatus goes in service

(3) Future — equipment that might be carried in the future

In this way, a chassis with an adequate GVWR can be provided to ensure that the vehicle will not be overloaded in the future.

B.2.4 After determining the list of present, proposed, and future equipment, the fire department should analyze the "actual" cubic feet (cubic meters) of space necessary for the equipment. One source of information is a comparison of the equipment to be carried on the new apparatus with the equipment carried on existing apparatus and thus the relative space requirements. The actual usable space in compartments also should be considered, in addition to the individual cubic feet (cubic meters) for each item of equipment to be carried. The following factors might increase the required cubic feet (cubic meters) of storage space required and thus the size of the vehicle body:

(1) Compartment door and box pan interference

(2) Mounting implications

(3) Compartment shelving

(4) Slide trays

(5) Components of the body such as compartment flanges, notches, and other interferences that affect removal of equipment from compartments

(6) Ventilation of generator, air compressor, or other equipment

B.2.5 Where local operating conditions necessitate apparatus of unusual design, the purchaser needs to define carefully the special requirements in the specifications. Height, width, under-vehicle clearance, wheelbase, turning radius, length, and so forth, might occasionally need special attention. For example, a community with many narrow, winding streets should have apparatus capable of easily negotiating switchbacks.

B.2.6 This standard is designed to ensure sound equipment that is capable of good performance, with the inclusion of restrictive features only where needed to specify minimum requirements. The tests are an important feature, and the results should be carefully analyzed to ensure that the completed apparatus meets the specified performance.

Since the passage of Public Law 89-563, the National Traffic and Motor Vehicle Safety Act of 1966, the federal government has adopted certain motor vehicle safety standards applicable to all manufacturers of trucks, including fire apparatus. It is unlawful for a manufacturer to deliver a truck not in compliance with these federal standards. These federal safety standards are frequently changed, and their provisions make the incorporation of certain features and devices mandatory. Apparatus manufacturers cannot build apparatus to specifications that would require them to delete required items or to include any that are illegal, and they face substantial penalties for infraction of these rules.

Additional requirements are placed on both apparatus and engine manufacturers by the Clean Air Act, which is enforced by the Environmental Protection Agency (EPA). These EPA standards have resulted in major changes in the performance of many engines. Neither the engine manufacturer nor the apparatus manufacturer is permitted to modify an engine once it has been certified to EPA standards. Because of the EPA standards, it is often necessary to install larger engines than might have been previously used in order to obtain the same apparatus performance.

B.2.7 It is often useful, especially for complex apparatus, to plan an engineering meeting with the apparatus manufacturer's design team before construction begins. This allows for the optimum combination of the user's understanding of the requirements and the manufacturer's design experience in creating solutions.

Many apparatus purchasers find it favorable to provide for an interim inspection at the apparatus assembly plant. The advantages of such a provision include the opportunity to evaluate construction prior to final assembly and painting. The specifications should detail the particulars of such an inspection trip.

These trips sometimes are viewed as vacation paid for by the manufacturer rather than as a constructive part of the procurement process; one way to avoid this perception is to budget the travel separately rather than making it part of the bid package. An analogy would be to compare the apparatus purchase to the construction of a public building. Municipalities do not contract a new building and then not meet with the contractor or not view the construction process until the building is complete. In reality, the municipality assigns someone to manage the process. Travel is more visible than the monitoring of a project within the municipality. If the apparatus were built near the municipality, visits during the production would not be questioned.

The chief of the fire department (or a designated representative) normally exercises the acceptance authority following satisfactory completion of tests and inspections for compliance with purchase specifications. The specifications should provide details of delivery expectations, including the desired instruction, the required acceptance tests, and who is responsible for the various costs associated with the delivery and acceptance.

B.2.8 Instruction and demonstrations for designated fire department personnel are essential to ensure that the purchaser and user are aware of and instructed in the proper operation, care, and maintenance of the apparatus acquired. The instruction and demonstrations should provide the initial instruction on the new apparatus. This is typically delivered by a qualified representative of the contractor in the user's community. The specifications should clearly identify the arrangement for furnishing the instruction, including where it is to be provided, its duration, and what instructional aids, such as video tapes or manuals, are to be furnished.

B.2.9 The purchaser should also define in the specifications the warranty desired for the completed apparatus. The warranty is a written guarantee of the integrity of the apparatus or its components that defines the manufacturer's responsibility within a given time period. The warranty is sometimes extended for a second warranty period beyond the terms of the basic warranty for specific components, such as the engine, pump, frame, and water tank. If a secondary manufacturer is involved in modifying components that are warranted by the original manufacturer, the responsibility for warranty work should be clearly understood by the original manufacturer, the secondary manufacturer, the contractor, and the purchaser.

B.2.10 The purchaser might want a warranty bond to ensure that any warranty work will be performed, even if the apparatus manufacturer should go out of business. A warranty bond is a third-party secured bond established by the manufacturer before delivery of a vehicle to guarantee workmanship, quality of material, or other stated performance of the vehicle components.

B.2.11 Finally, it is recommended that the fire chief, fire department staff, or committee assigned to develop the specifications consult with the purchaser's attorney, engineer, and other appropriate officials for assistance in developing the detailed specifications.

B.2.12 The form in Figure B.2.12 is a good way to document the specifications. Completion of the form should assist the purchaser in developing the specifications and provide the information required in the various sections of this document. The purchaser should fill in only the required sections (marked with *) and only those other sections where there are specific requirements over and above the standard. All the items of information marked with an asterisk (*) generally are required for the manufacturer to bid on and build the apparatus. The other items are details about which the purchaser might want to specify special requirements. In many cases, the purchaser should specify additional details only if the purchaser is experienced in that area and has specific, unusual requirements. Consult with manufacturers or others with experience in apparatus architecture and specifications if necessary. Care must be taken not to specify incompatible requirements, such as a 3000 gal (11,400 L) water tank, which weighs approximately 30,000 lb (13,600 kg), and a 10,000 lb (4500 kg) GVWR chassis. When more restrictive details are specified, fewer manufacturers will be able to bid, and the cost of the apparatus might be higher.

APPARATUS PURCHASING SPECIFICATION FORM

Procurement Issues

*Date of bid opening: ____________________

*Purchaser's name and address: ____________________

____

*Contact name and telephone number: ____________________

____

*Sealed bid envelope information, address, and identification marking: ____________________

____

____

*The bidder is to honor the bid price for __________ days.

*If an interim inspection trip(s) to the assembly plant is to be provided, indicate:

number of trips __________ number of participants __________

who will pay expenses ____________________

How many service and operation manuals are to be provided? ____________________

*Where is the delivery of the apparatus to occur? ____________________

____

____

*Where and when is the acceptance to occur? ____________________

____

____

*The operation and service instruction and demonstration are to be conducted at ____________________

____

for ________ persons for ________ days.

Specify the details of any special payment plan or schedule required: ____________________

____

____

Is an approval drawing required? ❑ Yes ❑ No

Is a bid bond required? ❑ Yes ❑ No

What percent of the bid price? ____________________

Is a performance bond required? ❑ Yes ❑ No

What percent of the bid price? ____________________

If an extended warranty on specific components is required, indicate which components and the length of the warranty:

____

____

____

Is a warranty bond required? ❑ Yes ❑ No

In what amount? ____________________

***Required information**

FIGURE B.2.12 A Sample Apparatus Purchasing Specification Form.

General Requirements — Chapter 4

Special design features required on this apparatus: ____________________

____

____

____

____

What are the maximum allowable dimensions of the apparatus?

Overall height in inches (millimeters): ________ (measured at the highest projection)

Overall length in inches (millimeters): ________ (measured at the front and rearmost projections)

Wheelbase in inches (millimeters): ________ (measured from the center of the front axle to the center of the rear axle)

Width in inches (millimeters): ________ (measured at the outside of the mirrors)

Gross vehicle weight in pounds (kilograms): ____________________

Maximum weight on the front axle in pounds (kilograms): ____________________

Maximum weight on the rear axle in pounds (kilograms): ____________________

What is the maximum wall-to-wall turning radius allowable? __________ ft (m)

Maximum elevation at which the apparatus will operate if over 2000 ft (600 m): ____________________

____

Maximum grade that apparatus will climb if over 6 percent: ____________________

____

Specify the minimum ambient air temperature in which the apparatus is to operate: __________ °F (°C)

Specify the maximum ambient air temperature in which the apparatus is to operate: __________ °F (°C)

Specify the apparatus road performance if it is to exceed the minimum specified in this standard: ________

____

____

____

*Specify the maximum road speed required: ____________________

*Specify the number of crew riding positions required: ____________________

Hose Thread Size Information

TPI × OD or size and type (e.g., 2½ in. NH or 4 in. storz)

1 in. =	1½ in. =
2 in. =	2½ in. =
3 in. =	3½ in. =
4 in. =	4½ in. =
5 in. =	6 in. =
Hydrant =	

***Required information**

FIGURE B.2.12 ***Continued***

Testing and Acceptance

If independent certification of tests is required for the pump system, aerial device, line voltage power source, or other systems, what independent testing organization is to certify the tests? ______

Is anyone to witness the manufacturer's predelivery tests? ______

Where are the road tests to be conducted? ______

*What tests will the contractor be required to perform on delivery? ______

Apparatus Type — Chapters 5 through 11

*This apparatus is to be used as a(n):

- ❑ Pumper (*see Chapter 5*)
- ❑ Initial attack apparatus (*see Chapter 6*)
- ❑ Mobile water supply apparatus (*see Chapter 7*)
- ❑ Aerial fire apparatus (*see Chapter 8*)
- ❑ Quint fire apparatus (*see Chapter 9*)
- ❑ Special service apparatus (*see Chapter 10*)
- ❑ Mobile foam fire apparatus (*see Chapter 11*)
- ❑ Other

*What functions or services is this apparatus to perform? ______

***Suction Hose** (*See 5.7.2, 6.6.2, 7.6, 9.7.2, 10.4.2, and 11.8.1.*)

*Is suction hose required? ❑ Yes ❑ No

*Soft or hard: ______

*Size and length: ______

*Connection type and size: ______

Mounting arrangement, bracket style, and location: ______

***Required information**

FIGURE B.2.12 *Continued*

*Ground Ladders to Be Carried *(See 5.7.1, 6.6.1, Section 8.7, 9.7.1, and 10.4.1.)*

Number	Length	Type	Mounting Location and Bracket Type

Indicate if a specific type or make of ladder is desired: ______

*Breathing Apparatus

Quantity	Make/Model	Mounting Location

*The breathing apparatus is to be supplied by the ❑ contractor ❑ purchaser.

Special requirements for the breathing apparatus or its mounting, including diameters of SCBA cylinders to be utilized: ______

*Equipment Carried on Apparatus *(See Sections 5.8, 6.8, 7.7, 8.8, 9.8, 10.5, and 11.9.)*

*Miscellaneous equipment allowance if it exceeds the standard's minimum weight: ______

*Attach a list of equipment and tools to be supplied by the contractor with the apparatus, stating the item, quantity, where it is to be mounted or carried, the weight of each item, and its dimensions (L × W × D).

*Attach a list of equipment and tools to be supplied by the fire department to be carried on the apparatus, stating the item, quantity, where it is to be mounted or carried, contractor's responsibility for mounting, the weight of each item, and its dimensions (L × W × D).

*Attach a list of equipment and tools that might be carried on the apparatus in the future, stating the item, quantity, the desired mounting location or compartment where it is likely to be carried, the weight of each item, and its dimensions (L × W × D).

*Attach a list of fixed and permanent components required on the apparatus, showing the item, quantity, weight of each, and dimensions (L × W × H), as well as the location where it is to be carried.

If additional compartment space is required in addition to what is necessary to store the equipment on the attached four lists, indicate space requirements. ______

***Required information**

FIGURE B.2.12 *Continued*

Chassis and Vehicle Components — Chapter 12

Desired chassis make and model or style: ______________________________

____

____

Specify the desired location of the engine: ______________________________

Type of propulsion engine: ______________________________

Is an electric fuel pump or repriming pump required? ❑ Yes ❑ No

Specify any special lubrication system requirements: ______________________________

____

Specify any special cooling system requirements: ______________________________

____

Is a manual emergency engine shutdown required? ❑ Yes ❑ No

Type of fuel filters required: ______________________________

____

Type of air filters required: ______________________________

____

Enhanced performance ember separator requirements: ______________________________

____

Specify the exiting location of the exhaust system: ______________________________

Specify the type of brake system required: ______________________________

____

Is an auxiliary brake system required? ❑ Yes ❑ No

Specify the type and control: ______________________________

Specify the style and type of tires required: ______________________________

____

Indicate whether cast spoke, hub piloted, stud piloted, steel disc, or aluminum wheels are required: ______________

____

Are rear fender liners required? ❑ Yes ❑ No

Are automatic tire chains required? ❑ Yes ❑ No

Should the apparatus be designed to operate "off paved roads?" ❑ Yes ❑ No

Specify if an increased underbody clearance is required: ______________________________

____

Specify if a greater angle of approach is required: ______________________________

Specify if a greater angle of departure is required: ______________________________

Specify the steering system cramp angle if it exceeds the standard's minimum: ______________________________

____

Specify if a drive axle traction control or no-spin differential is required: ______________________________

____

Specify if rear wheel steering is required: ______________________________

Specify if a special suspension system is required: ______________________________

FIGURE B.2.12 ***Continued***

Is an automatic or manual transmission required? ______________________________

____

Specify the fuel tank capacity required: __________ gal (L)

Must tow hooks be accessible without opening compartment doors? ❑ Yes ❑ No

Special cab trim features: ______________________________

____

____

____

Low-Voltage Electrical Systems and Warning Devices — Chapter 13

*Indicate whether a battery charger, conditioner, or a polarized receptacle is to be provided (*see 13.4.5*): __________

____

If a built-in battery charger or conditioner is provided, indicate the required charging rate: __________

____

Specify the location of the receptacle for the battery charger or conditioner: __________

____

Is a second "battery on" pilot light on the outside of the vehicle required? ❑ Yes ❑ No

Where? ______________________________

Specify any electrical loads beyond those defined in the standard that are to be part of the minimum continuous electrical load: ______________________________

____

If a load management system is required, specify the sequence of control (shutdown): __________

____

____

Warning Light Information

Location	Make and Model	Color
Upper level, forward facing		
Upper level, side-facing, front		
Upper level, side-facing, midship		
Upper level, side-facing, rear		
Upper level, rear facing		
Lower level, forward facing		
Lower level, side-facing, front		
Lower level, side-facing, midship		
Lower level, side-facing, rear		
Lower level, rear facing		

Specify the make, model, location, and controls of the siren: ______________________________

____

***Required information**

FIGURE B.2.12 *Continued*

Are air horns required? ❑ Yes ❑ No If yes, specify the make preferred, type of control, and their location: ______

Specify any special emergency lighting or warning features or equipment that is required: ______

Are cab hand lights or mounted adjustable spotlights required? ❑ Yes ❑ No
Specify if additional work lighting is required: ______

Specify if additional driving or crew compartment lighting is required: ______

Are provisions needed for rechargeable equipment? ❑ Yes ❑ No
If yes, make and model of equipment: ______

Is a backup camera system required? ❑ Yes ❑ No
If yes, make and model: ______

Describe any scene lighting required: ______

Driving and Crew Areas — Chapter 14

Specify any special seating requirements or arrangements for the driver: ______

Specify any special seating requirements or arrangements for the officer: ______

Specify any special seating requirements or arrangements for the crew: ______

Helmets will be stored:
- ❑ In the driving/crew compartment in holders
- ❑ In the driving/crew compartment in compartments
- ❑ In body compartments

Is an intercom system required? ❑ Yes ❑ No
Make, model, or type: ______
Locations: ______
Radio interface: ______
Special requirements: ______

Specify any special requirements for carrying tools or equipment within the driving or crew compartment: ______

Specify any special requirements for carrying EMS equipment within the driving or crew compartment: ______

Specify any special step or handrail arrangements required: ______

FIGURE B.2.12 *Continued*

If a tiller-steered apparatus is to be provided, specify the type of communication system required between the tiller operator and the apparatus driver: ______

Is a tilt or telescoping steering column required? ______
Specify any extra driving compartment instrument panel features required: ______

Specify the type and style of driving compartment mirrors: ______

Body, Compartments, and Equipment Mounting — Chapter 15

Body material: ______

Compartment capacity required: ______ ft^3 (m^3)
Specify any special compartment features and finish required: ______

Specify if a special compartment floor material or covering is required: ______

Specify the type and style of compartment doors required: ______

Specify the style of door latches, locks, or stays required: ______

Specify the type of compartment lighting required: ______

Radio equipment to be used:
- Is the manufacturer to provide the radio? ❑ Yes ❑ No
- Is the manufacturer to install the radio? ❑ Yes ❑ No
- Make and model: ______
- Mounting location for radio: ______
- Mounting location for control(s) and speaker(s): ______

Provisions required for computer equipment or electronics: ______

Type of body tread plate material required: ______

FIGURE B.2.12 ***Continued***

Type of step and platform material required: ______________________________

____

*Color of apparatus: ______________________________

Paint number and manufacturer, if known: ______________________________

Striping, decoration, and lettering required: ______________________________

____

____

List any areas not to be painted: ______________________________

____

____

Miscellaneous body trim: ______________________________

____

____

Is rustproof treatment required? ❑ Yes ❑ No Provide details of locations to be treated: ______________________________

____

____

Hose to Be Carried for Preconnected Lines (*See Sections 5.6, 6.5, 7.5, 8.6, 9.6, and 10.7.*)

Length	Size	Location	Bed or Reel

***Hose to Be Carried in Hose Bed or on Reels** (*See Sections 5.6, 6.5, 7.5, 8.6, 9.6, and 10.7.*)

Length	Size	Location	Bed or Reel

If a hose bed cover(s) is desired, specify type: ______________________________

____

Is the fire-fighting system to be a slip-on unit? ❑ Yes ❑ No

Specify the lifting arrangement required: ______________________________

____

Specify the anchoring system required: ______________________________

____

***Required information**

FIGURE B.2.12 ***Continued***

Fire Pump — Chapter 16

*Is a fire pump required? ❑ Yes ❑ No
*Pump rated capacity: __________ gpm (L/min)
*Number of pump stages required: __________
*Pump type: __________
Pump location: __________
How is the pump to be driven? __________
Type of engine to drive pump if other than the chassis propulsion engine: __________
____
Pump testing authority: __________
____
If pump-and-roll is required, specify:
Flow __________ gpm (L/min) at __________ psi (kPa)
Vehicle speed __________ mph (kmph)
Type of primer system: __________
____
Special pump performance requirements:
If altitude over 2000 ft (600 m), specify altitude: __________
If lift over 10 ft (3 m), specify lift: __________
If through more than 20 ft (6 m) of suction hose, specify length: __________
Do local water conditions require special materials for pump construction and piping? __________
____
____
Location of pump operator's panel: __________
Pump panel and gauge panel material: __________
Type of intake and discharge valve controls desired: __________
____
Specify the size of the master gauges: __________
____
Are individual line pressure gauges required? ❑ Yes ❑ No
If yes, are there any special requirements? __________
____
Are individual line flow meters required? ❑ Yes ❑ No
If yes, are there any special requirements? __________
____
Are any special gauges, instruments, or other features required at the pump operator's panel? __________
____
Should the engine speed control at the pump operator's panel be enabled when the apparatus is parked but not in pump mode? ❑ Yes ❑ No
Are special pump and piping features required to deal with extremely low temperatures? __________
____

***Required information where equipment/system to be provided**

FIGURE B.2.12 ***Continued***

Is the intake relief system to be adjustable at the panel? ❏ Yes ❏ No

If no, where: ______

Is a pump pressure governor or a relief valve to be supplied? ______

*Pump Intake Connections

Size	Type of Connection	Location	Valved (Y/N)

Are special adapters required on the pump intakes? ______

*Will a valve, siamese, or adapter be carried on any intakes? ❏ Yes ❏ No

If yes, specify where, make, and model (*see 16.6.11*): ______

*Pump Discharge Outlets Without Preconnected Hose Lines

List the 2½ in. (65 mm) or larger discharge outlets required:

Quantity	Size	Type of Connection	Location	Flow Requirement

*Pump Discharge Outlets for Preconnected Hose Lines

Quantity	Size	Type of Connection	Location	Flow Requirement

***Required information where equipment/system to be provided**

FIGURE B.2.12 ***Continued***

Is a deck gun required? ❑ Yes ❑ No

Type: ____

Mounting location: ____

Piping size and arrangement: ____

Is pump panel color coding required? ❑ Yes ❑ No

Specify details: ____

Is a booster reel required? ❑ Yes ❑ No

How many reels? ____

Location: ____

Hose size and length: ____

Reel rewind type: ____

Piping to reel: ____

Auxiliary Pump — Chapter 17

*Is an auxiliary pump required? ❑ Yes ❑ No

Type of auxiliary pump operations: ____

Auxiliary pump performance: ____

Type of auxiliary pump: ____

How is the auxiliary pump to be driven? ____

Auxiliary pump location: ____

Is the auxiliary pump to be connected to the fire pump? ❑ Yes ❑ No

Do local water conditions require special materials for pump construction and piping? ____

*Auxiliary Pump Intake Connections

Size	Type of Connection	Location	Valved (Y/N)

***Required information where equipment/system to be provided**

FIGURE B.2.12 ***Continued***

* Auxiliary Pump Discharge Outlet Connections

Quantity	Size	Type of Connection	Location	Flow Requirement

Where are the auxiliary pump controls to be located? ____________________

____

Is a booster reel required? ❑ Yes ❑ No

How many reels? ____________________

Location: ____________________

Hose size and length: ____________________

Reel rewind type: ____________________

Piping to reel: ____________________

Water Tank — Chapter 18

Is a water tank required? ❑ Yes ❑ No

Water tank capacity (*see Sections 5.4, 6.3, 7.3, 8.4, and 9.4*): ____________________

Tank construction material: ____________________

____

Is an internal coating required? ❑ Yes ❑ No

Is a removable tank lid required? ❑ Yes ❑ No

Type of tank level indicator(s): ____________________

Location of additional tank level indicator(s): ____________________

____

Tank to pump flow rate required: ____________________

Pump to tank fill rate required: ____________________

Is a tank dump valve required? ❑ Yes ❑ No

Style of valve: ____________________

Size: ____________________

Performance required: ____________________

Location: ____________________

Type of connector: ____________________

Is a direct tank fill required? ❑ Yes ❑ No

Style of valve: ____________________

Size: ____________________

Performance required: ____________________

Location: ____________________

Type of connector: ____________________

*** Required information where equipment/system to be provided**

FIGURE B.2.12 *Continued*

Aerial Devices — Chapter 19

*Is an aerial device required? ❑ Yes ❑ No

*Indicate whether the aerial device is to be an aerial ladder, elevating platform, or water tower: ______________

Indicate maximum slope for aerial device operation if it exceeds 5 degrees (8.7 percent): ______________

Communication system type, locations, radio interface, head set connections: ______________

Aerial Ladder

*Rated vertical height required: ____________ ft (m)

*Rated horizontal reach required: ____________ ft (m)

*Capacity rating (tip load) required: ____________ lb [250 lb (114 kg) minimum]

Is a breathing air system to be supplied to the operator's position? ❑ Yes ❑ No

Is a breathing air system to be supplied to the tip of the ladder? ❑ Yes ❑ No

If a breathing air system is to be supplied, are there any special requirements, makes, or models for the components of the breathing air system desired? ______________

Location of any secondary speaker/microphone required on the aerial ladder: ______________

Is a prepiped waterway required? ❑ Yes ❑ No

If yes, to what ladder section is the pipe to be extended? ______________

Should the prepiped waterway be pinnable to multiple sections? ❑ Yes ❑ No

What make and model of monitor are required [minimum flow 1000 gpm (4000 L/min) at 100 psi (700 kPa)]?

____

If the monitor is power operated, are additional sets of controls beyond those required at the ladder operator's position required? ❑ Yes ❑ No

If yes, describe arrangement and location: ______________

What make and model of nozzle are required? ______________

Indicate the external inlet arrangement desired, including size, type, and number of inlets and valving arrangement: ______________

Is a hose connection required at the ladder tip? ❑ Yes ❑ No

If yes, describe size and arrangement: ______________

***Required information where equipment/system to be provided**

FIGURE B.2.12 *Continued*

Is a three-lever, two-lever, or single-lever control system required? ________________

List any aerial ladder equipment or features required: ________________

Elevating Platform

*Rated vertical height required: __________ ft (m)

*Rated horizontal reach required: __________ ft (m)

*Capacity rating (tip load) required: __________ lb (kg) [750 lb (340 kg) minimum]

Is the elevating platform to be equipped with a ladder that provides continuous access between the platform and the turntable? ❑ Yes ❑ No

If yes, specify details: ________________

Is a breathing air system to be supplied to the platform? ❑ Yes ❑ No

Is a breathing air system to be supplied to the lower control station? ❑ Yes ❑ No

If a breathing air system is to be supplied, are there any special requirements, makes, or models for the components of the breathing air system desired? ________________

Specify the number of monitors to be supplied on the platform: ________________

What make and model of monitor are required [minimum flow 1000 gpm (4000 L/min) at 100 psi (700 kPa)]? ________________

What make and model of nozzle are required? ________________

Is a hose connection to be provided on the platform from the water delivery system? ❑ Yes ❑ No

If yes, describe number, size, and arrangement: ________________

Are any special arrangements to be provided for hose lines from the platform water delivery system? ________________

Indicate the external inlet arrangement required, including the size, type, and number of inlets and the valving arrangement: ________________

Is a three-lever, two-lever, or single-lever control system required? ________________

***Required information where equipment/system to be provided**

FIGURE B.2.12 *Continued*

Low Voltage Lighting Requirement

Quantity	Spot/Flood	Location	Specify Details

Line Voltage Lighting Requirement

Quantity	Spot/Flood	Wattage	Location	Specify Details

List any elevating platform equipment or features required: ____________________

____

____

____

____

Water Tower

*Is the water tower to be telescoping, articulating, or both? ____________________

____

*Rated vertical height required: __________ ft (m)

*Rated horizontal reach required: __________ ft (m)

Waterway capacity required if in excess of 1000 gpm (4000 L/min): ____________________

____

What make and model of monitor are required [minimum flow 1000 gpm (4000 L/min) at 100 psi (700 kPa)]?

____

____

What make and model of nozzle are required? ____________________

____

Where are the monitor and nozzle controls to be located? ____________________

____

Indicate the external inlet arrangement desired, including the size, type, and number of inlets and the valving arrangement: ____________________

____

____

Is a three-lever, two-lever, or single-lever control system required? ____________________

____

***Required information where equipment/system to be provided**

FIGURE B.2.12 *Continued*

List any water tower equipment or features required: ______

______

______

______

______

Foam System — Chapter 20

*Is a foam system required? ❑ Yes ❑ No

*Type of foam system required: ______

______

*Type of foam(s) to be used: ______

______

*Foam concentrate storage capacity: ______ gal (L)

***Discharge Outlets to Be Used with Foam and Their Performance**

Discharge Location	Required Flow	Proportioning Rate	Hose Length	Hose Diameter

*Is an outside foam system inlet or pickup required? ❑ Yes ❑ No

Type: ______

Is a foam tank refill system required? ❑ Yes ❑ No

If yes, performance requirements: ______

______

Compressed Air Foam System — Chapter 21

*Is a CAFS required? ❑ Yes ❑ No

*What is the total SCFM required? ______

What type of compressor and driver is required? ______

______

What is the total water pump capacity required? ______

______

Specify the type of system controls and interlocks required: ______

______

______

***Required information where equipment/system to be provided**

FIGURE B.2.12 ***Continued***

*Discharge Outlets to Be Used with the CAFS and Their Performance

Discharge Location	Required Flow	Hose Length	Hose Diameter

Specify if an airflow meter is required (SCFM): ______

Specify the type of wet/dry control required: ______

Line Voltage Electrical System — Chapter 22

*Is a line voltage electrical system required? ❑ Yes ❑ No

*Continuous rated wattage of power source: ______

*Voltage of power source: ______

*Type of power source:

- ❑ Portable generator
- ❑ Hydraulically driven generator
- ❑ Direct drive generator
- ❑ Auxiliary engine driven generator
- ❑ Belt driven generator or alternator
- ❑ Derived from apparatus low voltage power supply system
- ❑ Other: ______

Make, model, or other details of power source: ______

______

______

Location of power source: ______

______

______

Mounting of power source: ______

______

______

Panelboard location: ______

______

______

***Required information where equipment/system to be provided**

FIGURE B.2.12 ***Continued***

*Receptacle Information

Quantity	Amps/Volts	Style of Receptacle	Location

*Circuit Remote Control Information

Controlled Circuit	Switch Location

*120/240 Volt Lighting Information

Style/Make	Location	Wattage/Bulb	Type Mounting

*Cord Reel Information

	Reel #	Reel #	Reel #	Reel #
Mounting location				
Amperage				
Voltage				
Length of cord in feet				
Receptacle style				
Distribution box				
Rewind system				

*Is a power-operated light mast required? ❑ Yes ❑ No

If yes, specify the make and model required: ______________________________

____

List any equipment to be powered from a shorepower inlet: ______________________________

____

***Required information where equipment/system to be provided**

FIGURE B.2.12 *Continued*

Command and Communications — Chapter 23

*Is a separate command area required? ❑ Yes ❑ No

*Is the area to be enclosed by walls and doors? ______________________________

*Size of the area: ____________ ft (m) × ____________ ft (m) or ____________ ft² (m²)

*Number of persons to be seated and able to work in the area: ______________________________

Is special lighting required? ❑ Yes ❑ No

Describe ______________________________

List the make and model for each piece of communication equipment to be in the command and communications area and whether the contractor or the purchaser is to provide and install the equipment: ______________________________

List the make and model for each piece of computer equipment to be in the command and communications area and whether the contractor or the purchaser is to provide and install the equipment: ______________________________

List the make and model for each other piece of equipment to be in the command and communications area and whether the contractor or the purchaser is to provide and install the equipment: ______________________________

*Is external video equipment to be used on the apparatus? ❑ Yes ❑ No

*If yes, where is it to be mounted? ______________________________

Air Systems — Chapter 24

*Is an air system required? ❑ Yes ❑ No

*What is the function of the air system?

❑ Refill SCBA cylinders

❑ Supply remote breathing air

❑ Supply high pressure breathing air hose

❑ Supply utility air

***Required information where equipment/system to be provided**

FIGURE B.2.12 ***Continued***

* Is a cascade system to be supplied? ❑ Yes ❑ No

* How many SCBA cylinders are to be filled? ____________________

* What is the size of the cylinders to be filled? ____________ ft^3 (m^3)

* To what pressure are the cylinders to be filled? ____________ psi (kPa)

* Is a compressor required? ❑ Yes ❑ No

* If yes, what free air delivery (FAD) rating is required? ____________ ft^3 (m^3) at ____________ psi (kPa)

* Is a SCBA refill station required? ❑ Yes ❑ No

If yes, what is the location of the refill station? ____________________

Number of refill lines: ____________________

* For each air hose required, specify the following:

(a) Discharge flow required in CFM ____________________

(b) Discharge pressure required in psi ____________________

(c) Whether breathing air or utility air is to be supplied ____________________

(d) Length of hose in feet ____________________

(e) Whether hose is to be stored on a reel ____________________

(f) Mounting location of reel, if applicable ____________________

(g) Fitting or device at the end of the hose ____________________

What ambient temperatures will be expected if beyond 32°F (0°C) to 110°F (43°C): ____________________

Winches — Chapter 25

* Is a winch required? ❑ Yes ❑ No

* What is the single line pull rating required? ____________________

What is the wire rope length required? ____________________

Is the power source for the winch to be electric or hydraulic? ____________________

Specify the winch location: ____________________

Type of control required: ____________________

Location of control: ____________________

Trailers — Chapter 26

* Classification of trailer:

❑ Type I (remain connected)

❑ Type II (operate at scene with independent power)

❑ Type III (transport only)

* What will the purpose/function of the trailer be? ____________________

* What will the trailer carry? List equipment or total weight. ____________________

____

* Tow hitch type and size preferred/required: ____________________

Other requirements should be specified in the appropriate sections above.

*** Required information where equipment/system to be provided**

FIGURE B.2.12 ***Continued***

B.3 Obtaining and Studying Proposals.

When the specifications are complete, they should be distributed to apparatus manufacturers and contractors with a request for bids or proposals to furnish the specified apparatus. The request should specify a date, time, and place for the formal opening of the bids. This date should allow at least 1 month for the engineering departments of apparatus manufacturers to study the specifications and estimate the cost of the apparatus. More time could be required if engineering drawings of the proposed apparatus are required.

B.3.1 The request also should state the time period during which the purchaser expects the bidder to honor the bid price and whether a bid bond is required. A bid bond guarantees that if a contract is offered to the bidder within the defined time period, the bidder will enter into the contract under the terms of the bid.

B.3.2 It is recommended that a pre-bid meeting be held between the purchaser of a piece of fire apparatus and the apparatus manufacturers or their agents prior to the official release of the apparatus specifications. Such a meeting is designed to allow for a detailed review of the draft specifications by all present at the meeting. Problems with the specifications, ideas on how to provide the purchaser with the desired apparatus in other ways, clarification of the purchaser's intent, and other questions can be resolved prior to the formal bid process. The meeting can often resolve misunderstandings or prevent problems before they occur.

B.3.3 With a performance specification, it is usually possible to obtain more favorable bids, since there is genuine competition and the specifications are not overly restrictive. The bid should be accompanied by a detailed description of the apparatus, a list of equipment to be furnished, and other construction and performance details, including, but not limited to, estimated weight, wheelbase, principal dimensions, transmission, and axle ratios. The purpose of the contractor's specifications is to define what the contractor intends to furnish and deliver to the purchaser.

B.3.4 Manufacturers' proposals might include amendments and exceptions. Frequently, these changes are offered to meet price requirements or because individual manufacturers prefer to build apparatus in a manner more convenient to them. If the intent of the original specification is not changed and the bid is favorable, the purchaser should consider accepting these amendments with the approval of the purchasing authority. On the other hand, extreme care should be taken to avoid allowing exceptions that devalue the apparatus and give one bidder an advantage.

B.3.5 The purchaser should study the proposals, look for deviations from the specifications, and obtain clarification where necessary. If the purchaser has specifically provided for alternatives when calling for bids, extra care should be exercised when evaluating the proposals because combinations of complicated bid information will need careful analysis. The financial arrangements, a delivery date, and the method of delivery should be stipulated and agreed to by the purchasing authority.

B.4 Awarding the Contract.

With the award of a contract, it is important for the purchasing authority to understand exactly whom the contract is with and the nature of the relationship with the apparatus manufacturer. Some apparatus manufacturers work through a dealer network in which the dealer purchases the apparatus from a manufacturer, including taking title, and then resells the apparatus to the purchasing authority. Other manufacturers work through sales agents or representatives who solicit and negotiate a contract between a purchasing authority and a manufacturer but who never take title to the apparatus. This difference can affect where the responsibility lies for the proper fulfillment of the contract.

B.4.1 Some purchasing authorities require a performance bond as part of the contract. A performance bond is a bond executed in connection with a contract that guarantees that the contractor will fulfill all the undertakings, covenants, terms, conditions, and agreements contained in the contract. Should the contractor fail to meet the terms of the contract, the bonding company will be responsible for the difference in cost between the original contract price and the new price of the apparatus when it has to be supplied by another contractor.

B.4.2 Before signing a contract, the purchaser should make certain that the successful bidder has a complete and thorough understanding of the specifications. If there are any disagreements, these should be resolved in writing and made part of the contract. If any changes are agreed upon, they should be stated in writing and be signed by both parties. The contract should not be signed until the fire chief (or a designee) and the purchasing authority are satisfied.

B.5 Acceptance.

B.5.1 When the apparatus is ready for delivery and acceptance, the purchaser has a responsibility to check the completed apparatus carefully against the specifications, the contract, and the requirements of this document to ensure that all that was required is being delivered. This includes witnessing any required acceptance tests and verifying that the gross vehicle weight and the axle weight distribution are within the chassis and axle ratings. The delivery inspection form shown as Figure B.5.1(a) and the as-delivered weight analysis calculation worksheet shown as Figure B.5.1(b) can be useful in the inspection process. The weight distribution of in-service fire apparatus is critical to the safe operation of the apparatus. Figure B.5.1(b) and Table B.5.1 can help evaluate weight issues to confirm that the apparatus weight and distribution are within the chassis manufacturer's safe limits.

Table B.5.1 Typical Hose Weight Data

Nominal Hose Diameter		Weight per Unit Length	
in.	**mm**	**lb/ft**	**kg/m**
1	25	0.30	0.41
1 ½	38	0.38	0.53

Table B.5.1 Typical Hose Weight Data

Nominal Hose Diameter		Weight per Unit Length	
in.	mm	lb/ft	kg/m
1¾	44	0.43	0.59
2	52	0.50	0.69
2 ½	65	0.70	0.97
3	75	0.80	1.10
4	100	0.85	1.18
5	125	1.10	1.52
6	150	1.35	1.87

The instructions for completing the as-delivered weight analysis calculation worksheet in Figure B.5.1(b) are as follows:

(1) In row (a), fill in the vehicle weights from a certified scale, measured under the following conditions:

(a) All manufacturing work completed

(b) Water, fuel, and foam tanks full

(c) Ground ladders stored on the vehicle

(2) In rows (b) through (k), calculate the expected hose load by multiplying the length of hose by the standard values for weight per unit length and enter the result in column 7. Use the values in Table B.5.1 or obtain specific values for the brand of hose being used.

(3) In row (l), multiply the number of seat belt–equipped seating positions by the NFPA allowance of 250 lb (113 kg) per person and enter the result in column 7.

(4) In row (m), enter the miscellaneous equipment allowance from 12.1.2(7) in column 7.

(5) Divide the hose, personnel, and equipment weights in column 7 in rows (b) through (m) between the front and rear axles according to the indicated percentages (or, as appropriate, from a detailed weight analysis).

(6) In row (n), enter the sum of the values from rows (a) through (m) for each of columns 7 through 10.

(7) In row (o), record the gross vehicle and gross axle weight ratings from the manufacturer's data label affixed inside the driving compartment.

(8) Subtract the values in row (n) from row (o) and enter the difference in row (p). This is the expected reserve axle capacity of the in-service vehicle. If this number is negative, consult the vehicle manufacturer.

FIRE APPARATUS DELIVERY INSPECTION FORM

NFPA 1901 Paragraph	Topic	Description	Yes (Pass)	No (Fail)	N/A
4.9.1	Personnel protection	Guards or shields are provided around hot, moving, or rotating parts.	❑	❑	❑
4.9.2	Personnel protection	Isolation or insulation is provided to protect personnel from electrical shock.	❑	❑	❑
4.10.1	Controls and gauges	All controls, switches, instructions, gauges, and instruments needed for operation are illuminated.	❑	❑	❑
4.17.8 4.17.9	Brakes	Stopping distance measurement provided.	❑	❑	❑
4.20.1	Documentation and manuals	Required manufacturer's data provided.	❑	❑	❑
4.20.2	Documentation and manuals	Chassis operation and maintenance manual provided.	❑	❑	❑
4.20.2	Documentation and manuals	Pump operation and maintenance manual provided.	❑	❑	❑
4.20.2	Documentation and manuals	Aerial device operation and maintenance manual provided.	❑	❑	❑
4.20.2	Documentation and manuals	Aerial device load chart provided.	❑	❑	❑
4.20.2.3(4)	Documentation and manuals	Parts replacement information provided.	❑	❑	❑
4.20.2.3(6)	Documentation and manuals	Wiring diagram provided.	❑	❑	❑
4.20.2.3(7)	Documentation and manuals	Lubrication chart provided.	❑	❑	❑
4.20.2.4	Documentation and manuals	Major component manufacturers' manuals provided.	❑	❑	❑
5.3.3	Pump operator's panel	Platform for pump operator provided — pumper with aerial device.	❑	❑	❑
5.3.4	Warning signs	Electrocution hazard sign is visible to pump operator — pumper with aerial device.	❑	❑	❑
8.3.1	Pump operator's panel	Platform for pump operator provided — aerial apparatus with pump.	❑	❑	❑
8.3.2	Warning signs	Electrocution hazard sign is visible to pump operator — aerial apparatus with pump.	❑	❑	❑
9.2.3	Pump operator's panel	Platform for pump operator provided — quint.	❑	❑	❑
9.2.4	Warning signs	Electrocution hazard sign is visible to pump operator — quint.	❑	❑	❑
11.3.3	Pump operator's panel	Platform for pump operator provided — mobile foam with aerial device.	❑	❑	❑
11.3.4	Warning signs	Electrocution hazard sign is visible to pump operator — mobile foam with aerial device.	❑	❑	❑
12.1.4	Documentation and manuals	Federal Motor Vehicle Safety weight certification label.	❑	❑	❑
12.1.5.1	Information label	Label indicating the height, length, and GVWR of the vehicle is visible to the driver.	❑	❑	❑
12.3.1.4	Brakes	Auxiliary braking system functions [required above 36,000 lb (16,000 kg) GVWR].	❑	❑	❑
12.3.2.3	Approach angle	Angle of approach at least 8 degrees (vertical / horizontal greater than 0.1405).	❑	❑	❑
12.3.2.3	Departure angle	Angle of departure at least 8 degrees (vertical / horizontal greater than 0.1405).	❑	❑	❑
12.3.4.2	Engine and fuel tank	Label is provided at the fuel fill to indicate type of fuel.	❑	❑	❑
13.8.12.1	Warning lights — responding	No yellow lights in Zone A in the "calling for right-of-way" mode.	❑	❑	❑
13.8.12.1	Warning lights — responding	No white lights in Zone C in the "calling for right of way" mode.	❑	❑	❑

FIGURE B.5.1(a) Delivery Inspection Form.

NFPA 1901 Paragraph	Topic	Description	Yes (Pass)	No (Fail)	N/A
13.8.12.1	Warning lights — blocking	No white lights in any zone in the "blocking right of way" mode.	❑	❑	❑
13.8.16	Warning lights	Compliance documentation provided.	❑	❑	❑
13.9.1.1	Audible warning	Sirens certified to SAE J1849.			
13.9.2	Driving and crew compartment occupant protection	Audible warning devices and sirens are mounted low and in front of vehicle.	❑	❑	❑
13.10.1.1	Ground lighting	Rear of apparatus is illuminated for working.	❑	❑	❑
13.10.1.2	Ground lighting	Ground lighting is provided at areas where personnel will be stepping or climbing.	❑	❑	❑
13.10.1.3	Ground lighting	Ground lighting illuminates automatically with the cab doors.	❑	❑	❑
13.10.2.1	Work lighting	Hose bed is illuminated for working.	❑	❑	❑
13.10.5.1	Pump compartment	Pump compartment is illuminated.	❑	❑	❑
13.10.5.2	Pump compartment	Priming lubricant or reservoir area is illuminated.	❑	❑	❑
13.11.1(1)	Hazard light	Red light in driving compartment flashes if the parking brake is released and passenger or compartment doors are not closed.	❑	❑	❑
13.11.1(2)	Hazard light	Red light in driving compartment flashes if the parking brake is released and a ladder or equipment rack is not stowed.	❑	❑	❑
13.11.1(3)	Hazard light	Red light in driving compartment flashes if the parking brake is released and stabilizers are not stowed.	❑	❑	❑
13.11.1(4)	Hazard light	Red light in driving compartment flashes if the parking brake is released and a powered light tower is not stowed.	❑	❑	❑
13.11.1(5)	Hazard light	Red light in driving compartment flashes if the parking brake is released and other permanently attached device is extended or deployed.	❑	❑	❑
13.14.3.2	Electrical, low voltage	Reserve capacity test documentation provided.	❑	❑	❑
13.14.3.3	Electrical, low voltage	Alternator performance test at idle documentation provided.	❑	❑	❑
13.14.3.4	Electrical, low voltage	Alternator performance test at full load documentation provided.	❑	❑	❑
13.14.4	Electrical, low voltage	Low voltage alarm test documentation provided.	❑	❑	❑
13.15	Electrical, low voltage	Load analysis documentation provided.	❑	❑	❑
14.1.1	Cab occupant protection	Driving and crew compartment(s) fully enclosed.	❑	❑	❑
14.1.2	Warning signs	Cab occupant capacity sign provided and visible to the driver.	❑	❑	❑
14.1.3	Driving and crew compartment occupant protection	Seat belts are provided for each driving and crew compartment occupant.	❑	❑	❑
14.1.3.8	Warning signs	A "Seat Belts Required" sign is visible from every seating position.	❑	❑	❑
14.1.8	Driving and crew compartment occupant protection	Headroom at each seating position meets 14.1.8 requirement.	❑	❑	❑
14.1.10.1	Driving and crew compartment occupant protection	Each SCBA bracket is provided with a positive latching mechanical retaining device.	❑	❑	❑

FIGURE B.5.1(a) ***Continued***

NFPA 1901 Paragraph	Topic	Description	Yes (Pass)	No (Fail)	N/A
14.1.11.1	Driving and crew compartment occupant protection	All equipment required to be used during a response is fastened.	❑	❑	❑
14.1.11.2	Driving and crew compartment occupant protection	Equipment not required to be used during a response is contained or fastened.	❑	❑	❑
15.4.2	Powered equipment rack	The rack has a device to lock it in the stowed position.	❑	❑	❑
15.4.4	Powered equipment rack	Operator can watch the rack from the controls while it is being deployed.	❑	❑	❑
15.4.6	Powered equipment rack	The rack is equipped with lights that flash when it is not stowed.	❑	❑	❑
15.4.7	Powered equipment rack	The rack has retroreflective devices to make it more visible when deployed.	❑	❑	❑
15.6.2	Pump compartment	Pump compartment access — no dimension less than 18 in. (460 mm).	❑	❑	❑
15.7.1.1	Step height	First step no more than 24 in. (610 mm) and no more than 18 in. (460 mm) between any other step.	❑	❑	❑
15.7.1.2	Step size	All steps have minimum area of 35 in.^{2} (22,580 mm^2).	❑	❑	❑
15.7.1.2	Step size	All steps have at least 8 in. (200 mm) clearance between leading edge and any obstruction.	❑	❑	❑
15.7.1.2	Step size	All steps can have a 5 in. (125 mm) diameter disk placed on them without overlapping the edge.	❑	❑	❑
15.7.1.3	Platform size	All platforms have at least 8 in. (200 mm) clearance between leading edge and any obstruction.	❑	❑	❑
15.7.1.4	Ladder rungs	All ladder rungs have at least 8 in. (200 mm) between the leading edge and the body or other obstruction.	❑	❑	❑
15.7.2	Step surfaces	Steps, platforms, and ladders sustain 500 lb (227 kg) load	❑	❑	❑
15.7.4.5	Step surfaces	Step surface slip-resistance documentation provided.	❑	❑	❑
15.7.5	Warning signs	Sign warning that riding is prohibited should be visible at rear platform.	❑	❑	❑
15.7.5	Warning signs	Sign warning that riding is prohibited should be visible at cross walkway.	❑	❑	❑
15.8.1	Hand rails	Handrails are provided at each entrance to a driving or crew compartment.	❑	❑	❑
15.8.1	Hand rails	Handrails are provided at each position where steps or ladders for climbing are provided.	❑	❑	❑
15.8.3	Hand rails	All handrails have a diameter between 1 in. and 1⅝ in. (25 mm and 42 mm).	❑	❑	❑
15.8.3	Hand rails	All handrails have 2 in. (50 mm) of clearance to any other surface.	❑	❑	❑
15.8.4	Hand rails	All handrails are designed to reduce the possibility of hand slippage.	❑	❑	❑
15.9.3.1	Reflective trim	Side of vehicle has stripe at least 4 in. (100 mm) wide and 50 percent of vehicle length.	❑	❑	❑
15.9.3.1	Reflective trim	Front of vehicle has stripe at least 4 in. (100 mm) wide and 25 percent of the front width.	❑	❑	❑
15.9.3.1	Reflective trim	Rear of vehicle has alternating yellow and red stripes 6 in. (150 mm) wide in chevron pattern covering at least 50% of rear vertical surfaces.	❑	❑	❑

FIGURE B.5.1(a) ***Continued***

NFPA 1901 Paragraph	Topic	Description	Yes (Pass)	No (Fail)	N/A
16.6.1.3	Warning signs	A "serious injury or death" sign is visible.	❑	❑	❑
16.7.9.1	Pump operator's panel	All discharge connections at pump panel are 2½ in. (65 mm) or less.	❑	❑	❑
16.9.2	Pump operator's panel	All gauges, intakes, outlets, and controls are illuminated.	❑	❑	❑
16.11.2	Pump operator's panel	Engine throttle control is between 42 in. (1070 mm) and 72 in. (1830 mm) above operator's standing position for vertical pump panel.	❑	❑	❑
16.11.3	Pump operator's panel	Engine throttle control is between 32 in. (810 mm) and 50 in. (1270 mm) above operator's standing position for horizontal pump panel.	❑	❑	❑
16.12.1.1	Pump operator's panel	The instruments listed in 16.12.1.1 are all located on the pump panel in a group.	❑	❑	❑
16.12.1.4	Pump operator's panel	Visible and audible warnings are provided for low engine oil pressure and high coolant temperature.	❑	❑	❑
16.12.2.1	Pump operator's panel	Master intake and pump discharge gauges no more than 8 in. (200 mm) apart edge to edge.	❑	❑	❑
16.12.2.1	Pump operator's panel	Master intake is located to the left of or below the pump discharge gauge.	❑	❑	❑
16.12.2.1.4	Pump operator's panel	Gauges are labeled as "Pump Intake" and "Pump Discharge."	❑	❑	❑
16.12.3.3	Pump operator's panel	Discharge instrumentation is within 6 in. (150 mm) of the control.	❑	❑	❑
16.13.7	Tank and piping capacity	Tank-to-pump flow documentation provided.	❑	❑	❑
18.6.2	Tank and piping capacity	Tank capacity certification provided.	❑	❑	❑
19.18.2	Aerial operator's station	Platform for aerial device operator provided.	❑	❑	❑
19.18.3	Warning signs	Electrocution hazard sign is visible to aerial device operator.	❑	❑	❑
19.25	Piping test	Aerial device water system hydrostatic test documentation provided.	❑	❑	❑
20.9.4	Documentation and manuals	Foam system operations and maintenance manual provided.	❑	❑	❑
20.11	Calibration and testing	Foam system calibration and testing documentation provided.	❑	❑	❑
21.8.4	Documentation and manuals	CAFS operation and maintenance manual provided.	❑	❑	❑
21.9	Testing	CAFS testing documentation provided			
22.4.9	Electrical, line voltage	Power source specification label located at the operator's control station.	❑	❑	❑
22.15.7	Electrical, line voltage	Third-party certification of testing provided.	❑	❑	❑
23.6.2	Work surfaces	Chair-level work surfaces are 28 in. to 30 in. (710 mm to 760 mm) above the floor.	❑	❑	❑
23.6.3	Work surfaces	Stand-up work surfaces are 36 in. to 40 in. (900 mm to 1000 mm) above the floor.	❑	❑	❑
24.9.7	SCBA fill station	Test certification is provided.	❑	❑	❑
24.14.4	Air purification	Test documentation or certification that pure air is being produced is provided.	❑	❑	❑

FIGURE B.5.1(a) *Continued*

AS-DELIVERED WEIGHT ANALYSIS CALCULATION WORKSHEET

Axle Rating Reserve Capacity Determination

	1	2	3	4	5	6	7	8	9	10
							Total Vehicle	**Front Axle**	**Rear Axle or Tandem**	**Tiller Axle**
a	Weight at delivery (with water)									
			Hose Length (ft or m)		**Weight per Unit Length (lb or kg)**				**(100%)**	
b	Hose allowance	Main hose bed		(×)		(=)				
c	Hose allowance	Main hose bed		(×)		(=)				
d	Hose allowance	Main hose bed		(×)		(=)				
								(50%)	**(50%)**	
e	Hose allowance	Cross lay		(×)		(=)				
f	Hose allowance	Cross lay		(×)		(=)				
g	Hose allowance	Cross lay		(×)		(=)				
								(100%)		
h	Hose allowance	Front bumper		(×)		(=)				
i	Hose allowance	Suction hose		(×)		(=)				
j	Hose allowance	Other		(×)		(=)				
k	Hose allowance	Other		(×)		(=)				
			Seating Capacity (people)		**Weight per person**			**(100%)**		
l	Personnel allowance			(×)	250 lb (113 kg)	(=)				
									(100%)	
m	Miscellaneous equipment allowance [from 12.1.2(7)]									
n	Total expected in-service weight (sum of rows a through m)									
o	Axle weight ratings (from chassis manufacturer's data label)									
p	Expected reserve capacity									

FIGURE B.5.1(b) As-Delivered Weight Analysis Calculation Worksheet.

B.5.2 The purchaser also should arrange for any instruction and demonstration included as part of the delivery and ensure that it is properly delivered.

Only when the purchaser is totally satisfied that the contract has been fulfilled should payment be authorized.

Annex C Weights and Dimensions for Common Equipment

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1

The Fire Apparatus Manufacturers Association (FAMA) provides a worksheet for use by purchasers to calculate the portable equipment load anticipated to be carried on an apparatus. To ensure that the apparatus chassis is capable of carrying the installed equipment (pump, tank, aerial device, etc.) plus the specified portable equipment load with an appropriate margin of safety, the purchaser should use this worksheet to provide apparatus vendors with the weight of the equipment they anticipate carrying when the apparatus is placed in service.

C.1.1 The approximate measurements and weights of equipment that are commonly available and used during fire department operations are listed on the worksheet. The purchaser should fill in the number of units of each piece of anticipated equipment in the column titled “Quantity” and multiply that by the weight per unit to get the total weight. The dimensions of each piece of equipment are given to assist in planning compartment size or the location on the fire apparatus. Where the purchaser wants to carry specific equipment in a specific compartment, that compartment designation should be shown in the column titled “Compartment Location.”

C.1.2 The worksheet can be downloaded as an Excel spreadsheet from the FAMA website, *www.fama.org*, and customized to show only the equipment a department expects to carry. There are additional columns on the spreadsheet to assist the fire department in maintaining records of the equipment it carries on the apparatus.

Annex D Guidelines for First-Line and Reserve Fire Apparatus

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

D.1 General.

To maximize fire fighter capabilities and minimize risk of injuries, it is important that fire apparatus be equipped with the latest safety features and operating capabilities. In the last 10 to 15 years, much progress has been made in upgrading functional capabilities and improving the safety features of fire apparatus. Apparatus manufactured prior to 1991 usually included only a few of the safety upgrades required by the recent editions of the NFPA fire department apparatus standards or the equivalent Underwriters' Laboratories of Canada (ULC) standards. Because the changes, upgrades, and fine tuning to NFPA 1901, *Standard for Automotive Fire Apparatus*, have been truly significant, especially in the area of safety, fire departments should seriously consider the value (or risk) to fire fighters of keeping fire apparatus older than 15 years in first-line service.

It is recommended that apparatus greater than 15 years old that have been properly maintained and that are still in serviceable condition be placed in reserve status and upgraded in accordance with NFPA 1912, *Standard for Fire Apparatus Refurbishing*, to incorporate as many features as possible of the current fire apparatus standard *(see Section D.3)*. This will ensure that, while the apparatus might not totally comply with the current edition of the automotive fire apparatus standards, many of the improvements and upgrades required by the recent versions of the standards are available to the fire fighters who use the apparatus.

Apparatus that were not manufactured to the applicable NFPA fire apparatus standards or that are over 25 years old should be replaced.

D.2 How the Standards Have Changed.

It is a generally accepted fact that fire apparatus, like all types of mechanical devices, have a finite life. The length of that life depends on many factors, including vehicle mileage and engine hours, quality of the preventative maintenance program, quality of the driver training program, whether the fire apparatus was used within the design parameters, whether the apparatus was manufactured on a custom or commercial chassis, quality of workmanship by the original manufacturer, quality of the components used, and availability of replacement parts, to name a few.

In the fire service, there are fire apparatus with 8 to 10 years of service that are simply worn out. There are also fire apparatus that were manufactured with quality components, that have had excellent maintenance, and that have responded to a minimum number of incidents that are still in serviceable condition after 20 years. Most would agree that the care of fire apparatus while being used and the quality and timeliness of maintenance are perhaps the most significant factors in determining how well a fire apparatus ages.

Prior to 1991, NFPA 1901 was basically a "reactive standard." If something worked well in field use for a few years, it might have been suggested for inclusion in NFPA 1901. It was a very basic standard. In the late 1980s, the Technical Committee on Fire Department Apparatus decided to become proactive and to greatly enhance the value of the standard for the fire service. Task groups were appointed to develop reasonable requirements for the various components that made up a fire apparatus, and a safety task group was charged with looking at issues across the board that would improve the safety of fire fighters who use the apparatus.

The completely revised 1991 editions of the NFPA fire department apparatus standards were the result of those efforts and the full committee's strong desire to make the automotive fire apparatus standards not only more safety oriented but also more user friendly.

Contained within the 1991 edition of the fire department apparatus standards were requirements for such items as fully enclosed riding areas with reduced noise (dBA) levels to keep crew members safe and informed, seats and seat belts for all crew members riding on the apparatus, fail-safe door handles so the sleeve of a coat did not inadvertently catch a handle and open a door, and signs requiring everyone to be seated and belted. Also included were increased battery capacity to ensure starting under most conditions; improved warning lights, including intersection lights for increased visibility; removal of all roof-mounted audible warning devices to reduce hearing problems; a flashing light in the cab to warn if a cab or body door is open; a backup alarm; an automatic transmission to make it easier to drive (unless the purchaser has a specific reason for a manual transmission); auxiliary braking systems; and reflective striping.

The tip load for an aerial ladder was required to have a minimum carrying capacity of 250 lb (114 kg) when the aerial ladder was at zero degrees elevation and maximum extension. Other requirements, such as a minimum rail height, the minimum design strength of the rungs, and a minimum load-carrying requirement for folding steps, were added to make the aerial ladder safer for fire fighters to use. Where a water tower was equipped with a ladder, the same requirements that applied to an aerial ladder were required of the ladder on the water tower.

The carrying capacity of elevating platforms at zero degrees elevation and maximum extension was raised to 750 lb (340 kg). Elevating platforms were also required to have handrails, breathing air available in the platform (with low-air warning capability) for at least two fire fighters, and a water curtain cooling system under the platform.

All aerial devices had to be capable of supporting a static load of one and one-half times their rated capacity in any position. A requirement for a stabilizer movement alarm and reflective striping with warning lights was added. Interlocks to prevent inadvertent movement to an unsupported side and to prevent raising the aerial device prior to the stabilizers being deployed were specified. One hundred percent nondestructive tests (NDT) became a requirement. All these requirements were included in the 1991 editions of the NFPA fire department apparatus standards

In the pump area, the standard specified that 3 in. (75 mm) or larger valves be "slow close," that caps on intakes and discharge outlets be tested to 500 psi (3400 kPa), that an intake relief valve be provided to help manage incoming pressure, that 30-degree sweep elbows be provided on the discharges to eliminate hose kinking, and that all 3 in. (75 mm) and larger discharges be eliminated from the pump panel to reduce the possibility of injuries to the pump operator.

Fire apparatus equipped with electronic or electric engine throttle controls were required to include an interlock system to prevent engine speed advancement, unless the chassis transmission was in neutral with the parking brake engaged or unless the parking brake was engaged, the fire pump was engaged, and the chassis transmission was in the correct pumping gear.

The 1991 editions have been recognized as the benchmark from which improved and safer fire apparatus have evolved.

In 1996, many requirements were added throughout the document to improve the safety for fire fighters using the apparatus. These requirements included limiting the height of controls to 72 in. (1830 mm) above the standing position of the operator, requiring equipment in driving and crew areas to be securely fastened or in a compartment, increasing work lighting around the apparatus, and better grouping of pump controls to keep the operator away from the intake and discharge outlets. The low voltage electrical chapter was totally rewritten to require load analysis and load management if the total connected load could not be supplied by the vehicle's alternator. The requirements for warning lights were also rewritten to provide for different lighting for “calling for right-of-way” versus “blocking right-of-way.” Requirements for warning lights were increased to provide more visibility of the fire apparatus.

The 1999 edition of NFPA 1901 added requirements to further increase the safety for the users. In the body area, the minimum step surface size, slip resistance, and load-carrying capabilities were increased. Handrails were required to be slip resistant, and reflective striping was required on all four sides of the apparatus. To ensure the capability for continuous operation at fire scenes, a 2-hour, maximum load electrical test for line voltage systems was implemented.

The 1999 standard also required more secure mounting of equipment in the driving and crew compartment, minimum performance and pre-delivery testing of foam systems, and design of fill stations for breathing air cylinders to totally contain a rupturing cylinder.

The 2003 edition continued to refine the requirements in the driving and crew riding areas, increasing the head height at seating positions, bright-red seat belts, reflective material inside each cab door, automatic door-open lights, and more secure mounting of SCBAs in seat backs, all aimed at reducing fire fighter injuries. The test protocol for slip resistance of standing and walking surfaces was better defined. Because of the size of emergency vehicles, a label was required to remind operators of the height, length, and weight of the apparatus.

D.3 Upgrading Fire Apparatus.

Any apparatus, whether in first-line or reserve service, should be upgraded in accordance with NFPA 1912, as necessary, to ensure that the following features are included as a minimum:

(1) Fully enclosed seating is provided for all members riding on the fire apparatus.

(2) Warning lights meet or exceed the current standard.

(3) Reflective striping meets or exceeds the current standard.

(4) Slip resistance of walking surfaces and handrails meets the current standard.

(5) A low-voltage electrical system load manager is installed if the total connected load

exceeds the alternator output.

(6) The alternator output is capable of meeting the total continuous load on the low voltage electrical system.

(7) Where the gross vehicle weight rating (GVWR) is 36,000 lb (16,000 kg) or more, an auxiliary braking system is installed and operating correctly.

(8) Ground and step lighting meets or exceeds the current standard.

(9) Noise levels in the driving and crew compartment(s) meet the current standard, or appropriate hearing protection is provided.

(10) All horns and sirens are relocated to a position as low and as far forward as possible.

(11) Seat belts are available for every seat and are new or in serviceable condition.

(12) Signs are present stating that no riding is allowed on open areas.

(13) A pump shift indicator system is present and working properly for vehicles equipped with an automatic chassis transmission.

(14) For vehicles equipped with electronic or electric engine throttle controls, an interlock system is present and working properly to prevent engine speed advancement at the operator's panel, unless either the chassis transmission is in neutral with the parking brake engaged, or the parking brake is engaged, the fire pump is engaged, and the chassis transmission is in pumping gear.

(15) All loose equipment in the driving and crew areas is securely mounted to prevent its movement in case of an accident.

D.4 Proper Maintenance of Fire Apparatus.

In addition to needed upgrades to older fire apparatus, it is imperative that all fire apparatus be checked and maintained regularly to ensure that they will be reliable and safe to use. The manufacturer's instructions should always be followed when maintaining the fire apparatus. Special attention should be paid to ensure that the following conditions, which are particularly critical to maintaining a reliable unit exist:

(1) Engine belts, fuel lines, and filters have been replaced in accordance with the manufacturers' maintenance schedule(s).

(2) Brakes, brake lines, and wheel seals have been replaced or serviced in accordance with the manufacturers' maintenance schedule.

(3) Tires and suspension are in serviceable condition, and tires are not more than 7 years old.

(4) The radiator has been serviced in accordance with the manufacturer's maintenance schedule, and all cooling system hoses are new or in serviceable condition.

(5) The alternator output meets its rating.

(6) A complete weight analysis shows the fire apparatus is not over individual axle rating or total GVWR.

(7) The fire pump meets or exceeds its original pump rating.

(8) The water tank and baffles are not corroded or distorted.

(9) If the apparatus is equipped with an aerial device, a complete test to original specifications has been conducted and certified by a certified testing laboratory.

(10) If so equipped, the generator and line voltage accessories have been tested and meet the current standard.

D.5 Refurbishing or Replacing Fire Apparatus.

Fire department administrators and fire chiefs should exercise special care when evaluating the cost of refurbishing or updating an apparatus versus the cost of a new fire apparatus. Apparatus that are refurbished should comply with the requirements of NFPA 1912, *Standard for Fire Apparatus Refurbishing*. A thorough cost–benefit analysis of the value of upgrading or refurbishing a fire apparatus should be conducted. In many instances, it will be found that refurbishing costs will greatly exceed the current value of similar apparatus.

Some factors to consider and evaluate when considering whether to refurbish or replace a fire apparatus include the following:

(1) What is the true condition of the existing apparatus? Has it been in a major accident, or has something else happened to it that would make spending significant money on it ill advised?

(2) Does the current apparatus meet the program needs of the area it is serving? Is it designed for the way the fire department operates today and is expected to operate into the foreseeable future, or is the apparatus functionally obsolete? Can it carry everything that is needed to do the job without being overloaded?

(3) If the apparatus is refurbished, will it provide the level of safety and operational capability of a new fire apparatus? Remember, in many cases, refurbishing does not mean increasing the GVWR, so it is not possible to add a larger water tank or additional foam agent tanks or to carry massive amounts of additional equipment. Enclosing personnel riding areas might add enough weight to the chassis that existing equipment loads need to be reduced to avoid overloading the chassis. An aerial ladder that does not have a 250 lb (114 kg) tip load rating at zero degrees elevation and maximum extension cannot be made stronger.

(4) What is the anticipated cost per year to operate the apparatus if it were refurbished? What would the cost per year be for a new apparatus? Do not forget insurance costs, downtime costs, maintenance costs, depreciation, reliability, and the safety of the users

and the public. At what rate are those costs rising each year? Are parts still readily available for all the components on the apparatus? A refurbished 15-year-old apparatus still has 15-year-old parts in it. How long could the fire department operate without the apparatus if it suddenly needed major repairs?

(5) Is there a current trade-in value that will be gone tomorrow? Most apparatus over 12 years old have little trade-in value. Are there creative financing plans or leasing options that can provide a new fire apparatus for little more than the cost of refurbishing or maintaining an older apparatus?

D.6 Conclusion.

A fire apparatus is an emergency vehicle that must be relied on to transport fire fighters safely to and from an incident and to operate reliably and properly to support the mission of the fire department. A piece of fire apparatus that breaks down at any time during an emergency operation not only compromises the success of the operation but might jeopardize the safety of the fire fighters relying on that apparatus to support their role in the operation. An old, worn-out, or poorly maintained fire apparatus has no role in providing emergency services to a community.

Annex E History of NFPA 1901

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

E.1 History of Specification.

A report of the NFPA Committee on Fire Engines adopted at the 1906 NFPA Annual Meeting included many of the provisions and test procedures since followed in standards for fire department pumping apparatus.

In 1911, at the convention of the International Association of Fire Engineers, the Committee of Exhibits conducted performance tests on automobile pumping engines. The following year, with the assistance of engineers of the National Board of Fire Underwriters, tests were conducted on pumping engines discharging under net pump pressures of 120 psi, 200 psi, and 250 psi. By the 1913 convention of the International Association of Fire Engineers, the committee had developed a standard test procedure of specified duration.

The first national specification on municipal fire apparatus was NFPA 19, *Automobile Fire Apparatus, Suggested Specifications for Combination Pumping Engine and Hose Wagon*, which was adopted by NFPA in 1914. This was followed in 1916 by specifications adopted by NFPA covering an automobile combination chemical and hose wagon and an automobile service ladder truck. These specifications received the endorsement of the Committee on Fire Department Engineering of the International Association of Fire Engineers and were adopted and published in 1920 by the National Board of Fire Underwriters. The work of the original

NFPA Committee on Automobile Apparatus was suspended in 1920.

A new NFPA Committee on Municipal Fire Apparatus was organized in 1938, and NFPA adopted revised editions of NFPA 19 in 1938, 1939, and 1942. In 1948, the Committee on Fire Department Equipment was organized. The scope of the committee was broadened to include fire department tools and appliances as well as motorized fire apparatus for both municipal and rural service. There were numerous revisions of the standard to keep it abreast of current practice, and editions were issued in 1949, 1950, 1951, 1952, 1954, 1955, 1956, 1957, 1958, 1960, 1961, 1963, and 1965.

The work of the Committee on Municipal Fire Apparatus was an outstanding example of cooperation among the various fire service organizations concerned with standards for fire department apparatus and equipment. A chief engineer of the former National Board of Fire Underwriters was chairman of the original committee. A significant contribution of the National Board for over half a century was the listing of thousands of pump and engine combinations that met the specified pumper performance requirements. Recognition is also due the various insurance rating and inspection bureaus, most of which are now part of the Insurance Services Office, whose representatives witnessed the acceptance tests of apparatus built under these specifications.

The International Association of Fire Chiefs has actively participated in this work since 1912. A fire chief has served as chairman of the committee responsible for these specifications since 1938. In 1952, the Technical Committee of the Fire Apparatus Manufacturers Association was reactivated and has made significant contributions to each subsequent edition of these specifications.

In 1965, the American Insurance Association (AIA), which replaced the National Board of Fire Underwriters, decided to terminate its field testing by rating bureaus and recordkeeping by the AIA. The Fire Department Equipment Committee in conjunction with Underwriters Laboratories Inc. (UL) and the Technical Committee of the Fire Apparatus Manufacturers Association worked with AIA to transfer the testing program to UL. This program appeared in the standard in the 1966 edition and has been an accepted testing program.

Further revisions were completed and editions issued in 1967, 1968, 1969, 1970, 1971, and 1973. In 1975, the numerical designation of the document was changed to NFPA 1901 in a general renumbering of public fire protection standards, and the name was changed to *Standard on Automotive Fire Apparatus*. Partial revisions were made, and new editions were issued in 1979 and 1985.

In 1991, NFPA 1901 was extensively rewritten and split into four documents. These documents were NFPA 1901, *Standard for Pumper Fire Apparatus*; NFPA 1902, *Standard for Initial Attack Fire Apparatus*; NFPA 1903, *Standard for Mobile Water Supply Fire Apparatus*; and NFPA 1904, *Standard for Aerial Ladder and Elevating Platform Fire Apparatus*.

Significant changes to the 1991 edition included requiring total enclosure of driving and crew areas, limiting the maximum stepping height, requiring access handrails, and requiring additional warning lights and reflective striping. The minimum pump size for a fire pump on a pumper was raised to 750 gpm (3000 L/min), and the minimum water tank size was set at 500 gal (1900 L). The documents also addressed line voltage electrical systems and foam systems for the first time.

The test and delivery data requirements were updated to ensure that more of the performance requirements of the standards were tested as part of the delivery process and that proper documentation was provided to the purchaser. Appendix A was expanded to provide more discussion of the requirements in the standard, and a new appendix was added to provide a form that a purchaser could use to define the information needed by the contractor to properly design, build, and deliver the fire apparatus.

Recognizing that many apparatus are multifunctional and that the process of maintaining separate documents for the traditional types of fire apparatus did not always address the need for nontraditional types or use of fire apparatus, the committee combined the four documents back into a single fire apparatus standard for the 1996 edition and organized the standard to cover not only the traditional types of fire apparatus but also multifunctional and nontraditional use apparatus. New chapters were added to cover compressed air foam systems, air systems, command and communication areas, and winches.

Many requirements were added throughout the document to improve the safety for fire fighters using the apparatus. These requirements included limiting the height of controls to 72 in. (1830 mm) above the standing position of the operator, requiring equipment in driving and crew areas to be securely fastened or in a compartment, increasing work lighting around the apparatus, and better grouping of pump controls to keep the operator away from the intake and discharge outlets. The low voltage electrical chapter was totally rewritten to require load analysis and load management if the total connected load could not be supplied by the vehicle's alternator. The requirements for warning lights were also rewritten to provide for different lighting for “calling for right-of-way” versus “blocking right-of-way.” Requirements for warning lights were increased to provide more visibility of the fire apparatus.

New requirements were added for powered equipment racks, SCBA and cylinder storage, pump and plumbing access, and slip-on fire-fighting modules. The baffling requirements for water tanks were changed to allow either containment or dynamic baffling to be used. As a fundamental change in the aerial device chapter, water towers were redefined as aerial devices with elevated stream capability only. If water towers had a ladder on them, they were considered aerial ladders. Requirements were also added for secondary controls at the tip of an aerial ladder if such controls were provided.

The 1999 edition was a general update of the 1996 edition. Two new chapters were added, one covering the requirements for quint fire apparatus, the other covering the requirements for mobile foam fire apparatus. NFPA 11C, *Standard for Mobile Foam Apparatus*, which was the basis for the chapter on mobile foam fire apparatus, was withdrawn.

Among the significant changes were the addition of a coefficient of friction for steps and walkways, the establishment of 10,000 GVWR chassis size as the smallest fire apparatus covered by the standard, the definition of the ambient temperatures the apparatus is to operate in, the allowance of more versatility in the selection of ground ladders for fire apparatus, the allowance of more flexibility in the placement of warning lights on the sides of fire apparatus, and the addition of a requirement that SCBA air refill stations on fire apparatus be fully enclosed so as to contain the fragments if a cylinder ruptures during refilling.

The 2003 edition reorganized the standard to comply with the *Manual of Style for NFPA Technical Committee Documents* and added text to clarify requirements. All metric values were reviewed and revised where necessary to provide a complete set of metric values to which a piece of fire apparatus could be built. Requirements were added governing third parties and manufacturers that certify test results.

The requirements for head height at seating positions and for storage of SCBAs in seat backs were modified, both aimed at reducing fire fighter injuries. The requirement for slip resistance of standing and walking surfaces was revised to allow a second method of measurement, and the testing protocol was better defined. There was a general cleanup of the requirements in the chapter on line voltage systems, including ensuring that the performance stated on the power source specification label could be met on a continuous basis. New requirements were added for receivers and anchors for rope and removable winches. Performance requirements were established for wheel chocks.

The chapter on transfer pumps was deleted, and a new chapter on industrial supply pumps added. More specific rating points were established for auxiliary pumps. Annex B was expanded to include the discussion on developing specifications and procuring fire apparatus, and material was added to assist the purchaser in evaluating the delivered fire apparatus. A new Annex C was added showing the dimensions and weight of most equipment carried on fire apparatus to help purchasers determine the amount of storage space and the weight allowance needed for such equipment. A new Annex D was added to establish guidelines for first line and reserve fire apparatus.

Annex F Informational References

F.1 Referenced Publications.

The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

F.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471, www.nfpa.org.

Fire Protection Guide to Hazardous Materials, 13th edition, 2001.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2005 edition.

NFPA 70®, *National Electrical Code®*, 2008 edition.

NFPA 1150, *Standard on Foam Chemicals for Fires in Class A Fuels*, 2004 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program,* 2007 edition.

NFPA 1911, *Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus*, 2007 edition.

NFPA 1912, *Standard for Fire Apparatus Refurbishing*, 2006 edition.

NFPA 1931, *Standard for Manufacturer's Design of Fire Department Ground Ladders*, 2004 edition.

NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, 2007 edition.

NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services*, 2006 edition.

NFPA 1991, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*, 2005 edition.

NFPA 1992, *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies,* 2005 edition.

F.1.2 Other Publications.

F.1.2.1 American Trucking Association Publications. American Trucking Association, 950 North Glebe Road, Arlington, VA 22203-4181, www.truckline.com.

TMC Recommended Practice RP 107B, *Seven Conductor Truck — Trailer & Converter Dolly Jumper Cable & Connector*, 2007.

F.1.2.2 Bureau of Explosives Publications. TTCI/BOE, P.O. Box 1020, Sewickley, PA 15143, www.boepublications.com.

Emergency Action Guide, 2006.

F.1.2.3 ISO Publications. International Standards Organization, 1 rue de Varembé, Case Postale 56, CH-1211 Geneve 20, Switzerland, www.standardsinfo.net.

ISO 3046-1, *Reciprocating internal combustion engines — Performance — Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods — Additional requirements for engines for general use*, 2007.

F.1.2.4 NEMA Publications. National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209, www.NEMA.org.

MG 1, *Motors and Generators*, 2006.

WD 6, *Wiring Devices — Dimensional Requirements*, 2002.

F.1.2.5 Parker Hannifin, Racor Division Publications. Parker Hannifin, Racor Division, Attn: Dan Haggard, 805 West Street, Holly Springs, MS 38634.

LF 1093-90, *Ember Separation Test Procedure*, January 2003.

F.1.2.6 SAE Publications. Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096, www.SAE.org.

SAE J551/1, *Performance Levels and Methods of Measurement of Electromagnetic Compatibility of Vehicles, Boats (up to 15 m), and Machines (16.6 Hz to 18 GHz)*, 2006.

SAE J706, *Rating of Winches*, 2003.

SAE J826, *Devices for Use in Defining and Measuring Vehicle Seating Accommodation*, 2008.

SAE J1349, *Engine Power Test Code — Spark Ignition and Compression Ignition — Net Power Rating*, 2008.

SAE J1849, *Emergency Vehicle Sirens*, 2008.

SAE J2422, *Cab Roof Strength Evaluation — Quasi-Static Loading Heavy Trucks*, 2003.

F.1.2.7 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062, www.UL.com.

UL 943, *Standard for Ground-Fault Circuit Interrupters*, 1993, with revisions through August 2, 2005.

F.1.2.8 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402, www.gpo.gov.

Department of Transportation (DOT), *Emergency Response Guidebook*, current edition.

F.2 Informational References. (Reserved)

F.3 References for Extracts in Informational Sections.

NFPA 70®, *National Electrical Code*®, 2008 edition.

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Tentative Interim Amendment

Tentative Interim Amendment

NFPA 1901
Standard for Automotive Fire Apparatus

2009 Edition

Reference: Various Sections
TIA 09-1
(SC 08-10-8/TIA Log #934)

Pursuant to Section 5 of the NFPA Regulations Governing Committee Projects, the National Fire Protection Association has issued the following Tentative Interim Amendment to NFPA 1901, *Standard for Automotive Fire Apparatus,* 2009 edition. The TIA was processed by the Technical Committee on Fire Department Apparatus, and was issued by the Standards Council on October 28, 2008, with an effective date of November 17, 2008.

A Tentative Interim Amendment is tentative because it has not been processed through the entire standards-making procedures. It is interim because it is effective only between editions of the standard. A TIA automatically becomes a proposal of the proponent for the next edition of the standard; as such, it then is subject to all of the procedures of the standards-making process.

1. Revise 3.3.66 to read as follows:

3.3.66 Fire Pump. A water pump with a rated capacity of at least 250 gpm (1000 L/min) but less than ~~through~~ 3000 gpm (12,000 L/min) at 150 psi (1000 kPa) net pump pressure, or a water pump with rated capacity ~~over~~ of 3000 gpm (12,000 L/min) or greater at 100 psi (700 kPa) net pump pressure, that is mounted on a fire apparatus and used for fire fighting.

2. Revise 16.2.3.1 to read as follows:

16.2.3.1 If the pumping system is rated at less than 3000 gpm (12,000 L/min) ~~or less~~, it shall be capable of delivering the following:
(1) One hundred percent of rated capacity at 150 psi (1000 kPa) net pump pressure
(2) Seventy percent of rated capacity at 200 psi (1400 kPa) net pump pressure
(3) Fifty percent of rated capacity at 250 psi (1700 kPa) net pump pressure.

3. Revise 16.2.3.2 to read as follows:

16.2.3.2* If the pumping system is rated at ~~over~~ 3000 gpm (12,000 L/min) or greater, it shall be capable of delivering the following:
(1) One hundred percent of rated capacity at 100 psi (700 kPa) net pump pressure
(2) Seventy percent of rated capacity at 150 psi (1000 kPa) net pump pressure
(3) Fifty percent of rated capacity at 200 psi (1400 kPa) net pump pressure.

4. Revise A.16.2.3.2 to read as follows:

A.16.2.3.2 Pumps ~~larger than~~ of 3000 gpm (12,000 L/min) or greater capacity are used for specialized industrial fire-fighting applications, where the apparatus is typically supplied by a high pressure feed system.

5. Revise 16.2.4.1 to read as follows:

16.2.4.1* The pump manufacturer shall certify that the fire pump is capable of pumping 100 percent of rated capacity at 150 psi (1000 kPa) net pump pressure for pumps rated at less than 3000 gpm (12,000 L/min) ~~or less~~ or at 100 psi (700 kpa) for pumps rated ~~greater than~~ at 3000 gpm (12,000 L/min) or greater from draft through 20 ft (6 m) of suction hose with a strainer attached under the following conditions:
(1) An altitude of 2000 ft (600 m) above sea level
(2) …..

(continued)

6. Revise 16.2.4.2 to read as follows:

16.2.4.2* The pump manufacturer shall certify that the pump is capable of pumping rated capacity at 150 psi (1000 kPa) net pump pressure for pumps rated at less than 3000 gpm (12,000 L/min) ~~or less~~ or at 100 psi (700 kPa) for pumps rated ~~greater than~~ at 3000 gpm (12,000 L/min) or greater at any of the following special conditions when these conditions are specified by the purchaser:

(1) At an elevation above 2000 ft (600 m)

(2) At lifts higher than those listed in Table 16.2.4.1(a), through more than 20 ft (6 m) of suction hose, or both

(3) For pumps having a rated capacity of 1500 gpm (6000 L/min) or larger, through a single suction hose only, or through the number of hose listed in Table 16.2.4.1(a) attached to one side of the apparatus only

7. Revise 16.3.3 to read as follows:

16.3.3 If the fire pump is rated at 750 gpm (3000 L/min) or greater but ~~not greater~~ less than 3000 gpm (12,000 L/min), the engine/pump combination shall be capable of delivering the rated pump capacity at 165 psi (1100 kPa) net pump pressure.

8. Revise 16.13.1.1.2 to read as follows:

16.13.1.1.2 If the fire pump is rated at 750 gpm (3000 L/min) or greater but ~~not greater~~ less than 3000 gpm (12,000 L/min), the pumping engine overload test *(see 16.13.3)* shall be included.

9. Revise 16.13.2.3.4 to read as follows:

16.13.2.3.4 If the apparatus is equipped with a fire pump rated at 750 gpm (3000 L/min) or greater but ~~not greater~~ less than 3000 gpm (12,000 L/min), the pump shall be subjected to a 3-hour pumping test from draft consisting of 2 hours of continuous pumping at rated capacity at a minimum of 150 psi (1000 kPa) net pump pressure, followed by ½ hour of continuous pumping at 70 percent of rated capacity at a minimum of 200 psi (1400 kPa) net pump pressure and ½ hour of continuous pumping at 50 percent of rated capacity at a minimum of 250 psi (1700 kPa) net pump pressure.

10. Revise 16.13.2.3.5 to read as follows:

16.13.2.3.5 If the apparatus is equipped with a fire pump rated at ~~greater than~~ 3000 gpm (12,000 L/min) or greater, the pump shall be subjected to a 3-hour pumping test from draft consisting of 2 hours of continuous pumping at rated capacity at a minimum of 100 psi (700 kPa) net pump pressure, followed by ½ hour of continuous pumping at 70 percent of rated capacity at a minimum of 150 psi (1000 kPa) net pump pressure and ½ hour of continuous pumping at 50 percent of rated capacity at a minimum of 200 psi (1400 kPa) net pump pressure.

11. Revise 16.13.3 to read as follows:

16.13.3 Pumping Engine Overload Test. If the pump has a rated capacity of 750 gpm (3000 L/min) or greater but ~~not greater~~ less than 3000 gpm (12,000 L/min), the apparatus shall be subjected to an overload test consisting of pumping rated capacity at 165 psi (1100 kPa) net pump pressure for at least 10 minutes.

12. Revise 16.13.4.1 to read as follows:

16.13.4.1 If the pump is rated at less than 3000 gpm (12,000 L/min) ~~or less~~, the pressure control system on the pump shall be tested as follows:

(1) The pump shall be operated at draft, delivering rated capacity at a discharge gauge pressure of 150 psi (1000 kPa).

(2) ……

13. Revise 16.13.4.2 to read as follows:

16.13.4.2 If the pumping system is rated at ~~greater th~~an 3000 gpm (12,000 L/min) or greater, the pressure control system on the pump shall be tested as follows:

(1) The pump shall be operated at draft, delivering rated capacity at a discharge gauge pressure of 100 psi (700 kPa).

(2) ……

Issue Date: October 28, 2008
Effective Date: November 17, 2008

(Note: For further information on NFPA Codes and Standards, please see www.nfpa.org/codelist)

DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Health Facilities and Emergency Medical Services Division

EMERGENCY MEDICAL SERVICES

6 CCR 1015-3

[Editor's Notes follow the text of the rules at the end of this CCR Document.]

CHAPTER ONE – RULES PERTAINING TO EMS EDUCATION AND CERTIFICATION

Section 1 – Purpose and Authority for Rules

1.1 These rules address the recognition process for emergency medical services (EMS) education programs; the certification process for all levels of EMS Providers; and the procedures for denial, revocation, suspension, limitation, or modification of a certificate.

1.2 The authority for the promulgation of these rules is set forth in Section 25-3.5-101 et seq., C.R.S.

Section 2 – Definitions

2.1 All definitions that appear in Section 25-3.5-103, C.R.S., shall apply to these rules.

2.2 "Advanced Cardiac Life Support (ACLS)" - A course of instruction designed to prepare students in the practice of advanced emergency cardiac care.

2.3 "Advanced Emergency Medical Technician (AEMT)"- An individual who has a current and valid AEMT certificate issued by the Department and who is authorized to provide limited acts of advanced emergency medical care in accordance with the Rules Pertaining to EMS Practice and Medical Director Oversight.

2.4 "Basic Cardiac Life Support (CPR)" – A course of instruction designed to prepare students in cardiopulmonary resuscitation techniques.

2.5 "Certificate" – Designation as having met the requirements of Section 5 of these rules, issued to an individual by the Department. Certification is equivalent to licensure for purposes of the state Administrative Procedure Act, Section 24-4-101, et seq., C.R.S.

2.6 "Certificate Holder" – An individual who has been issued a certificate as defined above.

2.7 "Continuing Education" - Education required for the renewal of a certificate.

2.8 "Department" - Colorado Department of Public Health and Environment.

2.9 "Emergency Medical Practice Advisory Council (EMPAC)" – The council established pursuant to Section 25-3.5-206, C.R.S., that is responsible for advising the Department regarding the appropriate scope of practice for EMS Providers and for the criteria for physicians to serve as EMS medical directors.

2.10 "Emergency Medical Technician (EMT)" - An individual who has a current and valid EMT certificate issued by the Department and who is authorized to provide basic emergency medical care in accordance with the Rules Pertaining to EMS Practice and Medical Director Oversight. For the purposes of these rules, EMT includes the historic EMS Provider level of EMT-Basic (EMT-B).

2.11 "Emergency Medical Technician Intermediate (EMT-I)" - An individual who has a current and valid EMT-I certificate issued by the Department and who is authorized to provide limited acts of advanced emergency medical care in accordance with the Rules Pertaining to EMS Practice and Medical Director Oversight. For the purposes of these rules, EMT-I includes the historic EMS Provider level of EMT-Intermediate (EMT-I or EMT-I 99).

2.12 "Emergency Medical Technician with IV Authorization (EMT-IV)" – An individual who has a current and valid EMT certificate issued by the Department and who has met the conditions defined in the Rules Pertaining to EMS Practice and Medical Director Oversight relating to IV authorization.

2.13 "EMS Education Center" - A state-recognized provider of initial courses, EMS continuing education topics and/or refresher courses that qualify graduates for state and/or National Registry EMS provider certification.

2.14 "EMS Education Group" - A state-recognized provider of EMS continuing education topics and/or refresher courses that qualify individuals for renewal of a state and/or National Registry EMS provider certification.

2.15 "EMS Education Program" - A state-recognized provider of EMS education including a recognized education group or center.

2.16 "EMS Education Program Standards" - Department approved minimum standards for EMS education that shall be met by state-recognized EMS education programs.

2.17 "EMS Provider" – Means an individual who holds a valid emergency medical service provider certificate issued by the Department and includes Emergency Medical Technician, Advanced Emergency Medical Technician, Emergency Medical Technician Intermediate and Paramedic.

2.18 "Graduate Advanced Emergency Medical Technician" - A certificate holder who has successfully completed a Department recognized AEMT education course but has not yet successfully completed the AEMT certification requirements set forth in these rules.

2.19 "Graduate Emergency Medical Technician Intermediate" - A certificate holder who has successfully completed a Department recognized EMT-I education course but has not yet successfully completed the EMT-I certification requirements set forth in these rules.

2.20 "Graduate Paramedic" – A certificate holder who has successfully completed a Department recognized Paramedic education course but has not yet successfully completed the Paramedic certification requirements set forth in these rules.

2.21 "Initial Course" - A course of study based on the Department approved curriculum that meets the education requirements for issuance of a certificate for the first time.

2.22 "Initial Certification" - First time application for and issuance by the Department of a certificate at any level. This shall include applications received from persons holding any level of certification issued by the Department who are applying for either a higher or lower level certificate.

2.23 "Letter of Admonition" - A form of disciplinary sanction that is placed in a certificate holder’s file and represents an adverse action against the certificate holder.

2.24 "Medical Director" – For the purposes of these rules, a physician licensed in good standing who authorizes and directs, through protocols and standing orders, the performance of students-in-training enrolled in Department-recognized EMS education programs and/or certificate holders who perform medical acts, and who is specifically identified as being responsible to assure the performance competency of those EMS Providers as described in the physician's medical continuous quality improvement program.

2.25 "National Registry of Emergency Medical Technicians (NREMT)" - A national non-governmental organization that certifies entry-level and ongoing competency of EMS providers.

2.26 "Paramedic" - An individual who has a current and valid Paramedic certificate issued by the Department and who is authorized to provide acts of advanced emergency medical care in accordance with the Rules Pertaining to EMS Practice and Medical Director Oversight. For the purposes of these rules, Paramedic includes the historic EMS Provider level of EMT-Paramedic (EMT-P).

2.27 "Practical Skills Examination" - A skills test conducted at the end of an initial course and prior to application for national or state certification.

2.28 "Provisional Certification" - A certification, valid for not more than 90 days, that may be issued by the Department to an applicant seeking certification.

2.29 "Refresher Course" - A course of study based on the Department approved curriculum that contributes in part to the education requirements for renewal of a certificate.

2.30 "Rules Pertaining to EMS Practice and Medical Director Oversight" - Rules adopted by the Executive Director or Chief Medical Officer of the Department upon the advice of the EMPAC that establish the responsibilities of medical directors and all authorized acts of certificate holders, located at 6 CCR 1015-3, Chapter Two.

2.31 "State Emergency Medical and Trauma Services Advisory Council (SEMTAC)" – A council created in the Department pursuant to Section 25-3.5-104, C.R.S., that advises the Department on all matters relating to emergency medical and trauma services.

Section 3 - State Recognition of Emergency Medical Services (EMS) Education Programs

3.1 Specialized Education Curricula

3.1.1 The specialized education curricula established by the Department include but are not limited to the following:

A) EMT initial and refresher courses

B) Intravenous therapy (IV) and medication administration course

C) AEMT initial and refresher courses

D) EMT-I initial and refresher courses

E) Paramedic initial and refresher courses

3.2 Application for State Recognition as an EMS Education Program

3.2.1 The Department may grant recognition for any of the following types of EMS education programs:

A) EMT education center

B) EMT education group

C) EMT IV education group

D) AEMT education center

E) AEMT education group

F) EMT-I education center

G) EMT-I education group

H) Paramedic education center

I) Paramedic education group

3.2.2 An EMS education program recognized as an education center at any level shall also be authorized to serve as an education group at the same level(s).

3.2.3 EMS education programs recognized prior to the effective date of these rules shall be authorized to continue providing services at the same level(s) for the remainder of the current recognition period.

3.2.4 EMS education programs recognized at the EMT-I level shall also be authorized to provide services at the AEMT level for the remainder of the current recognition period.

3.2.5 Any education provider seeking to conduct EMS education to prepare graduates for national or state certification shall apply for state recognition as described below.

3.2.6 Initial EMS education program recognition shall be valid for a period of three (3) years from the date of the Department's written notice of recognition.

3.2.7 EMS education programs shall utilize personnel who meet the qualification requirements in the Department's EMS education program standards.

3.2.8 State-recognized EMS education programs are required to present the Rules Pertaining to EMS Practice and Medical Director Oversight at 6 CCR 1015-3, Chapter Two, including the current Colorado EMS scope of practice content as established in those rules, within every initial and refresher course.

3.2.9 EMS education centers that provide initial education at the Paramedic level shall obtain accreditation from the Commission on Accreditation of Allied Health Education Programs (CAAHEP). The EMS education center shall provide the Department with verification that an application for accreditation has been submitted to CAAHEP prior to the EMS education center initiating a second course.

3.2.10 EMS education centers that provide initial education at the Paramedic level shall maintain accreditation from CAAHEP. Loss of CAAHEP accreditation by an EMS education center shall result in proceedings for the revocation, suspension, limitation or modification of state recognition as an EMS education program.

3.2.11 Applicants for state EMS education program recognition shall submit the following documentation to the Department:

A) a completed application form provided by the Department;

B) a personnel roster, to include a current resume for the program director and medical director;

C) a description of the facilities to be used for course didactic, lab, and clinical instruction and a listing of all education aids and medical equipment available to the program;

D) program policies and procedures, which at a minimum shall address:

1) admission requirements;

2) attendance requirements;

3) course schedule that lists as separate elements the didactic, lab, clinical, skills and written testing criteria of the education program;

4) discipline/counseling of students;

5) grievance procedures;

6) successful course completion requirements;

7) testing policies;

8) tuition policy statement;

9) infection control plan;

10) description of insurance coverage for students, both personal liability and worker's compensation;

11) practical skills testing policies and procedures;

12) a continuous quality improvement plan: and

13) recognition of continuing medical education provided by outside parties including, but not limited to, continuing medical education completed by members of the armed forces or reserves of the United States or the National Guard, military reserves or naval militia of any state.

3.2.12 After receipt of the application and other documentation required by these rules, the Department shall notify the applicant of recognition or denial as an EMS education program, or shall specify a site review or modification of the materials submitted by the applicant.

3.2.13 If the Department requires a site visit, the applicant shall introduce staff, faculty, and medical director, and show all documentation, equipment, supplies and facilities.

3.2.14 Applications determined to be incomplete shall be returned to the applicant.

3.2.15 The Department shall provide written notice of EMS education program recognition or denial of recognition to the applicant. The Department's determination shall include, but not be limited to, consideration of the following factors:

A) fulfillment of all application requirements;

B) demonstration of ability to conduct EMS education in compliance with the Department's EMS education program standards;

C) demonstration of necessary professional staff, equipment and supplies to provide the education.

3.2.16 Denial of recognition shall be in accordance with Section 4 of these rules.

3.3 EMS Education Program Recognition Renewal

3.3.1 Renewal of recognition shall be valid for a period of five (5) years from the date of the Department's notice of recognition renewal and shall be based upon satisfactory past performance and submission of an updated application form.

3.3.2 Additional information as specified in Section 3.2.11 may be required by the Department. The Department may require a site review in conjunction with the renewal application.

3.4 Incorporation by Reference

3.4.1 These rules incorporate by reference the Commission on Accreditation of Allied Health Education Programs (CAAHEP) Standards and Guidelines for the Accreditation of Educational Programs in the Emergency Medical Services Professions as revised in 2005. Such incorporation does not include later amendments to or editions of the referenced material. The Health Facilities and Emergency Medical Services Division of the Department maintains copies of the incorporated material for public inspection during regular business hours, and shall provide certified copies of any non-copyrighted material to the public at cost upon request. Information regarding how the incorporated material may be obtained or examined is available from the Division by contacting:

EMTS Section Chief

Health Facilities and EMS Division

Colorado Department of Public Health and Environment

4300 Cherry Creek Drive South

Denver, CO 80246-1530

3.4.2 The incorporated material may be obtained at no cost from the website of the Committee on Accreditation of Education Programs for the Emergency Medical Services Professions at www.coaemsp.org/standards.htm.

Section 4 - Disciplinary Sanctions and Appeal Procedures for EMS Education Program Recognition

4.1 The Department, in accordance with the State Administrative Procedure Act, Section 24-4-101, et seq., C.R.S., may initiate proceedings to deny, revoke, suspend, limit or modify EMS education program recognition for, but not limited to, the following reasons:

4.1.1 the applicant fails to meet the application requirements specified in Section 3 of these rules.

4.1.2 the applicant does not possess the necessary qualifications to conduct an EMS education program in compliance with EMS education program standards.

4.1.3 the applicant fails to demonstrate access to adequate clinical or internship services as required in EMS education program standards.

4.1.4 fraud, misrepresentation, or deception in applying for or securing EMS education program recognition.

4.1.5 failure to conduct the EMS education program in compliance with EMS education program standards.

4.1.6 failure to notify the Department of changes in the program director or medical director.

4.1.7 providing false information to the Department with regard to successful completion of education or practical skill examination.

4.1.8 failure to comply with the provisions in Section 3 of these rules.

4.2 If the Department initiates proceedings to deny, revoke, suspend, limit or modify an EMS education program recognition, the Department shall provide notice of the action to the EMS education program (or program applicant) and shall inform the program (or program applicant) of its right to appeal and the procedure for appealing. Appeals of Departmental actions shall be conducted in accordance with the State Administrative Procedure Act, Section 24-4-101, et seq., C.R.S.

Section 5 - Emergency Medical Services Provider Certification

5.1 General Requirements

5.1.1 The Department may issue the following EMS Provider certifications:

A) EMT

B) AEMT

C) EMT-I

D) Paramedic

E) Provisional 90-day certification at the EMT, AEMT, EMT-I or Paramedic level.

5.1.2 No person shall hold himself or herself out as a certificate holder or offer, whether or not for compensation, any services included in these rules, or authorized acts permitted by the Rules Pertaining to EMS Practice and Medical Director Oversight, unless that person holds a valid certificate.

5.1.3 Certificates shall be effective for a period of three (3) years after the date of issuance. The date of issuance shall be determined by the date the Department approves the application.

5.1.4 Multiple certificates within the levels of EMS Provider shall not be permitted. Certification at a higher level indicates that the certificate holder may also provide medical care allowed at all lower levels of certification.

5.1.5 If a certificate holder seeks a higher or lower level of certification, he or she shall satisfy the requirements for initial certification at the new level, except as described below.

A) If the higher level certificate is valid and in good standing or within six months of the expiration date, the applicant for a lower level certificate shall not be required to submit current and valid certification from the NREMT at the lower level.

5.2 Initial Certification

5.2.1 Applicants for initial certification shall be no less than 18 years of age at the time of application.

5.2.2 Applicants for initial certification shall submit to the Department a completed application provided by the Department, including the applicant's signature in a form and manner as determined by the Department, that contains the following:

A) evidence of compliance with criminal history record check requirements:

1) The applicant is not required to submit to a fingerprint-based criminal history record check if the applicant has lived in Colorado for more than three (3) years at the time of application and the applicant has submitted to a fingerprint-based criminal history record check through the Colorado Bureau of Investigations (CBI) for a previous Colorado certification application.

2) If the applicant has lived in Colorado for more than three (3) years at the time of application and has not submitted to a fingerprint-based criminal history record check as described in subparagraph 1 above, the applicant shall submit to a fingerprint-based criminal history record check generated by the CBI.

3) If the applicant has lived in Colorado for three (3) years or less at the time of application, the applicant shall submit to a fingerprint-based criminal history record check generated by the Federal Bureau of Investigations (FBI) through the CBI.

4) If, in accordance with subparagraphs 2 or 3 above, an applicant has twice submitted to a fingerprint-based criminal history record check and the FBI or CBI has been unable to classify the fingerprints, then the Department may accept a CBI and/or FBI name-based criminal history report generated through the CBI.

B) evidence of current and valid certification from the NREMT at or above the EMS Provider level being applied for, except as provided for in Paragraph F below.

1) NREMT certification at the Emergency Medical Technician – Intermediate 1985 national standard curriculum level (NREMT-I 85) shall be recognized at the EMT level for the purposes of this section.

C) evidence of current and valid professional level Basic Cardiac Life Support (CPR) course completion from a national or local organization approved by the Department, except as provided for in Paragraph F below.

D) In addition to paragraph C above, EMT-I and Paramedic applicants shall submit evidence of current and valid Advanced Cardiac Life Support (ACLS) course completion from a national or local organization approved by the Department, except as provided for in Paragraph F below.

E) evidence of lawful presence in the United States.

F) While stationed or residing within Colorado, an individual serving in the armed services of the United States or the spouse of the individual may apply for certification to practice in Colorado. The individual or spouse is exempt from the requirements of paragraphs B,C, and D if the applicant provides evidence of a valid EMS provider certificate or license to provide emergency medical services from another state, district or Territory, the certificate or license is current, and the person is in good standing.

1) The Department may require evidence of military status and appropriate orders in order to determine eligibility for this exemption.

5.3 Renewal of Certification

5.3.1 General Requirements

A) Upon the expiration date of a Department-issued certificate, the certificate is no longer valid and the individual shall not hold himself or herself out as a certificate holder, except under the circumstances specified below in paragraph F.

B) Persons who have permitted their certification to expire for a period not to exceed six (6) months from the expiration date may renew their certification by complying with the provisions of Section 5.3 of these rules (Renewal of Certification).

C) Persons who have permitted their certification to expire for a period of greater than six (6) months from the expiration date shall not be eligible for renewal and shall comply with the provisions of Section 5.2 of these rules (Initial Certification), unless exempted pursuant to 5.3.1(G) below.

D) All certificates renewed by the Department shall be valid for three (3) years from the date of issuance.

E) Date of issuance is the date of application approval by the Department, except, for applicants successfully completing the renewal of certification requirements during the last six (6) months prior to their certificate expiration date, the date of issuance shall be the expiration date of the current valid certificate being renewed.

F) Pursuant to Section 24-4-104(7), C.R.S., of the State Administrative Procedure Act, if a certificate holder has made timely and sufficient application for certification renewal and the Department fails to take action on the application prior to the certificate's expiration date, the existing certification shall not expire until the Department acts upon the application. The Department, in its sole discretion, shall determine whether the application was timely and sufficient.

G) Certificate holders who have been called to federally funded active duty for more than 120 days to serve in a war, emergency or contingency, shall be exempt from the requirements of Sections 5.3.2(B)(2) and (3) and (C) below, provided the holder's certificate expired:

1) during the service or

2) during the six months after the completion of service.

The Department may require appropriate documentation of service to determine eligibility for this exemption.

5.3.2 Application for Renewal of Certification

An applicant for renewal of a certification shall:

A) submit to the Department a completed application form provided by the Department, including the applicant's signature in a form and manner as determined by the Department;

B) submit to the Department with a completed application form all of the following:

1) evidence of compliance with criminal history record check requirements:

a. The applicant is not required to submit to a fingerprint-based criminal history record check if the applicant has lived in Colorado for more than three (3) years at the time of application and the applicant has submitted to a fingerprint-based criminal history record check through the Colorado Bureau of Investigations (CBI) for a previous Colorado certification application.

b. If the applicant has lived in Colorado for more than three (3) years at the time of application and has not submitted to a fingerprint-based criminal history record check as described in subparagraph a above, the applicant shall submit to a fingerprint-based criminal history record check generated by the CBI.

c. If the applicant has lived in Colorado for three (3) years or less at the time of application, the applicant shall submit to a fingerprint-based criminal history record check generated by the Federal Bureau of Investigations (FBI) through the CBI.

d. If, in accordance with subparagraphs b or c above, an applicant has twice submitted to a fingerprint-based criminal history record check and the FBI or CBI has been unable to classify the fingerprints, then the Department may accept a CBI and/or FBI name-based criminal history report generated through the CBI.

2) evidence of current and valid professional level Basic Cardiac Life Support (CPR) course completion from a national or local organization approved by the Department.

3) In addition to paragraph 2 above, EMT-I and Paramedic applicants shall submit evidence of current and valid Advanced Cardiac Life Support (ACLS) course completion from a national or local organization approved by the Department.

4) evidence of lawful presence in the United States.

C) complete one of the following:

1) current and valid NREMT certification at or above the EMS Provider level being renewed.

2) appropriate level refresher course as described in Section 5.3.3 conducted or approved through signature of a Department-recognized EMS education program representative and skill competency as attested to by signature of medical director or department-recognized EMS education program representative.

3) the minimum number of education hours as described in Section 5.3.3 completed or approved through signature of a Department-recognized EMS education program representative and skill competency as attested to by signature of medical director or department-recognized EMS education program representative.

5.3.3 Education Requirements to Renew a Certificate Without the Use of a Current and Valid NREMT Certification

A) For renewal of a certificate without the use of a current and valid NREMT certification, the following education is required:

1) Education required for the renewal of an EMT or AEMT certificate shall be no less than thirty-six (36) hours and shall be completed through one of the following:

a. a refresher course at the EMT or AEMT level conducted or approved by a Department-recognized EMS education program plus additional continuing education topics such that the total education hours is no less than thirty-six (36) hours.

b. continuing education topics consisting of no less than thirty-six (36) hours of education that is conducted or approved through a Department-recognized EMS education program consisting of the following minimum content requirements on the EMT or AEMT level:

i) one (1) hour of preparatory content that may include scene safety, quality improvement, health and safety of EMS providers, or medical legal concepts.

ii) two (2) hours of obstetric patient assessment and treatment.

iii) two (2) hours of pediatric patient assessment and treatment.

iv) six (6) hours of trauma patient assessment and treatment.

v) five (5) hours of patient assessment.

vi) three (3) hours of airway assessment and management.

vii) six (6) hours of medical/behavioral emergency patient assessment and management.

viii) eleven (11) hours of elective content that is relevant to the practice of emergency medicine.

2) Education required for the renewal of an EMT-I or Paramedic certificate shall be no less than fifty (50) hours and shall be completed through one of the following methods:

a. a refresher course at the EMT-I or Paramedic level conducted or approved by a Department-recognized EMS education program plus additional continuing education topics such that the total education hours is no less than fifty (50) hours.

b. continuing education topics consisting of no less than fifty (50) hours of education that is conducted or approved through a Department-recognized EMS education program consisting of the following minimum content requirements at the EMT-I or Paramedic level:

No less than twenty-five (25) hours as described below:

i) eight (8) hours of airway, breathing, and cardiology assessment and treatment.

ii) four (4) hours of medical patient assessment and treatment.

iii) three (3) hours of trauma patient assessment and treatment.

iv) four (4) hours of obstetric patient assessment and treatment.

v) four (4) hours of pediatric patient assessment and treatment.

vi) two (2) hours of operational tasks and no less than twenty-five (25) hours of elective content that is relevant to the practice of emergency medicine.

5.3.4 In satisfaction of the requirements of Section 5.3.3 above, the Department may accept continuing medical education, training, or service completed by a member of the armed forces or reserves of the United States or the National Guard, military reserves or naval militia of any state, upon presentation of satisfactory evidence by the applicant for renewal of certification.

A) Satisfactory evidence may include but is not limited to the content of the education, method of delivery, length of program, qualifications of the instructor and method(s) used to evaluate the education provided.

5.4 Provisional Certification

5.4.1 General Requirements

A) The Department may issue a provisional certification to an applicant whose fingerprint-based criminal history record check has not been received by the Department at the time of application for certification.

B) To be eligible for a provisional certification, the applicant shall, at the time of application, have satisfied all requirements in these rules for initial or renewal certification.

C) A provisional certification shall be valid for not more than ninety days.

D) The Department may impose disciplinary sanctions pursuant to these rules if the Department finds that a certificate holder who has received a provisional certification has violated any of the certification requirements or any of these rules.

E) Once a provisional certification becomes invalid, an applicant may not practice or act as a certificate holder unless an initial or renewal certification has been issued by the Department to the applicant.

5.4.2 Application for Provisional Certification

An applicant for a provisional certification shall:

A) submit to the Department a completed application form provided by the Department.

1) The applicant shall request a provisional certification.

B) submit to a fingerprint-based criminal history record check as provided in Sections 5.2.2 and 5.3.2 of these rules. At the time of application, the applicant shall have already submitted the required materials to the CBI to initiate the fingerprint-based criminal history record check.

C) submit to the Department with a completed application form all of the following:

1) a fee in the amount of $23.00.

2) a name-based criminal history record check.

a. If the applicant has lived in Colorado for more than three (3) years at the time of application, a name-based criminal history report conducted by the CBI, including any internet-based system on CBI's website, or other name-based report as determined by the Department.

b. If the applicant has lived in Colorado for three (3) years or less at the time of application, a name-based criminal history report for each state in which the applicant has lived for the past three (3) years, conducted by the respective states' bureaus of investigation or equivalent state-level law enforcement agency, or other name-based report as determined by the Department.

c. Any name-based criminal history report provided to the Department for purposes of this paragraph c shall have been obtained by the applicant not more than 90 days prior to the Department's receipt of a completed application.

Section 6 - Disciplinary Sanctions and Appeal Procedures for EMS Provider Certification

6.1 For good cause, the Department may deny, revoke, suspend, limit, modify, or refuse to renew a certificate, may impose probation on a certificate holder, or may issue a letter of admonition in accordance with the State Administrative Procedure Act, Section 24-4-101, et seq., C.R.S.

6.2 Good cause for disciplinary sanctions listed above shall include, but not be limited to:

6.2.1 failure to meet the requirements of these rules pertaining to issuance and renewal of certification.

6.2.2 fraud, misrepresentation, or deception in applying for or securing certification.

6.2.3 aiding and abetting in the procurement of certification for any person not eligible for certification.

6.2.4 utilizing NREMT certification that has been illegally obtained, suspended or revoked, to obtain a state certification.

6.2.5 unlawful use, possessing, dispensing, administering, or distributing controlled substances.

6.2.6 driving an emergency vehicle in a reckless manner, or while under the influence of alcohol or other performance altering substances.

6.2.7 responding to or providing patient care while under the influence of alcohol or other performance altering substances.

6.2.8 demonstrating a pattern of alcohol or other substance abuse.

6.2.9 materially altering any Department certificate, or using and/or possessing any such altered certificate.

6.2.10 having an EMS provider certificate or license, or other health care certificate or license, suspended or revoked in Colorado or in another state or country.

6.2.11 unlawfully discriminating in the provision of services.

6.2.12 representing qualifications at any level other than the person's current EMS Provider certification level.

6.2.13 representing oneself to others as a certificate holder or providing medical care without possessing a current and valid certificate issued by the Department.

6.2.14 failing to follow accepted standards of care in the management of a patient, or in response to a medical emergency.

6.2.15 failing to administer medications or treatment in a responsible manner in accordance with the medical director's orders or protocols.

6.2.16 failing to maintain confidentiality of patient information.

6.2.17 failing to provide the Department with the current place of residence or failing to promptly notify the Department of a change in current place of residence or change of name.

6.2.18 a pattern of behavior that demonstrates routine response to medical emergencies without being under the policies and procedures of a designated emergency medical response agency and/or providing patient care without medical direction when required.

6.2.19 performing medical acts not authorized by the Rules Pertaining to EMS Practice and Medical Director Oversight and in the absence of any other lawful authorization to perform such medical acts.

6.2.20 failing to provide care or discontinuing care when a duty to provide care has been established.

6.2.21 appropriating or possessing without authorization medications, supplies, equipment, or personal items of a patient or employer.

6.2.22 falsifying entries or failing to make essential entries in a patient care report, EMS education document, or medical record.

6.2.23 falsifying or failing to comply with any collection or reporting required by the state.

6.2.24 failing to comply with the terms of any agreement or stipulation regarding certification entered into with the Department.

6.2.25 violating any state or federal statute or regulation, the violation of which would jeopardize the health or safety of a patient or the public.

6.2.26 unprofessional conduct at the scene of an emergency that hinders, delays, eliminates, or deters the provision of medical care to the patient or endangers the safety of the public.

6.2.27 failure by a certificate holder to report to the Department any violation by another certificate holder of the good cause provisions of this section when the certificate holder knows or reasonably believes a violation has occurred.

6.2.28 committing or permitting, aiding or abetting the commission of an unlawful act that substantially relates to performance of a certificate holder’s duties and responsibilities as determined by the Department.

6.2.29 committing patient abuse including the willful infliction of injury, unreasonable confinement, intimidation, or punishment, with resulting physical harm, pain, or mental anguish, or patient neglect, including the failure to provide goods and services necessary to attain and maintain physical and mental well-being.

6.3 Good cause for disciplinary sanctions also includes conviction of, or a plea of guilty, or of no contest, to a felony or misdemeanor that relates to the duties and responsibilities of a certificate holder, including patient care and public safety. For purposes of this paragraph, "conviction" includes the imposition of a deferred sentence.

6.3.1 The following crimes set forth in the Colorado Criminal Code (Title 18, C.R.S.) are considered to relate to the duties and responsibilities of a certificate holder:

A) offenses under Article 3 - offenses against a person.

B) offenses under Article 4 - offenses against property.

C) offenses under Article 5 - offenses involving fraud.

D) offenses under Article 6 - offenses involving the family relations.

E) offenses under Article 6.5 - wrongs to at-risk adults.

F) offenses under Article 7 - offenses related to morals.

G) offenses under Article 8 - offenses - governmental operations.

H) offenses under Article 9 - offenses against public peace, order and decency.

I) offenses under Article 17 - Colorado Organized Crime Control Act.

J) offenses under Article 18 - Uniform Controlled Substances Act of 1992.

6.3.2 The offenses listed above are not exclusive. The Department may consider other pleas or criminal convictions, including those from other state, federal, foreign or military jurisdictions.

6.3.3 In determining whether to impose disciplinary sanctions based on a plea or on a felony or misdemeanor conviction, the Department may consider, but is not limited to, the following information:

A) the nature and seriousness of the crime including but not limited to whether the crime involved violence to or abuse of another person and whether the crime involved a minor or a person of diminished capacity;

B) the relationship of the crime to the purposes of requiring a certificate;

C) the relationship of the crime to the ability, capacity or fitness required to perform the duties and discharge the responsibilities of an EMS Provider; and

D) the time frame in which the crime was committed.

6.4 Appeals

6.4.1 If the Department denies certification, the Department shall provide the applicant with notice of the grounds for denial and shall inform the applicant of the applicant's right to request a hearing.

A) A request for a hearing shall be submitted to the Department in writing within sixty (60) calendar days from the date of the notice.

B) If a hearing is requested, the applicant shall file an answer within sixty (60) calendar days from the date of the notice.

C) If a request for a hearing is made, the hearing shall be conducted in accordance with the State Administrative Procedure Act, Section 24-4-101 et seq., C.R.S.

D) If the applicant does not request a hearing in writing within sixty (60) calendar days from the date of the notice, the applicant is deemed to have waived the opportunity for a hearing.

6.4.2 If the Department proposes disciplinary sanctions as provided in this section, the Department shall notify the certificate holder by first class mail to the last address furnished to the Department by the certificate holder. The notice shall state the alleged facts and/or conduct warranting the proposed action and state that the certificate holder may request a hearing.

A) The certificate holder shall file a written answer within thirty (30) calendar days of the date of mailing of the notice.

B) A request for a hearing shall be submitted to the Department in writing within thirty (30) calendar days from the date of mailing of the notice.

C) If a request for a hearing is made, the hearing shall be conducted in accordance with the State Administrative Procedure Act, Section 24-4-101 et seq., C.R.S.

D) If the certificate holder does not request a hearing in writing within thirty (30) calendar days of the date of mailing of the notice, the certificate holder is deemed to have waived the opportunity for a hearing.

6.4.3 If the Department summarily suspends a certificate, the Department shall provide the certificate holder notice of such in writing, which shall be sent by first class mail to the last address furnished to the Department by the certificate holder. The notice shall state that the certificate holder is entitled to a prompt hearing on the matter. The hearing shall be conducted in accordance with the State Administrative Procedure Act, Section 24-4-101, et seq., C.R.S.

CHAPTER TWO - RULES PERTAINING TO EMS PRACTICE AND MEDICAL DIRECTOR OVERSIGHT

SECTION 1 - Purpose and Authority for Establishing Rules

1.1 The purpose of these rules is to define the qualifications and duties of medical directors to Emergency Medical Services (EMS) agencies and to define the authorized medical acts of EMS providers.

1.2 The general authority for the promulgation of these rules by the executive director or chief medical officer of the department is set forth in Sections 25-3.5-203 and 206, C.R.S.

1.3 These rules apply to and are controlling for any physician functioning as a medical director to an EMS organization and who authorizes and directs the performance of medical acts by EMS providers at all levels of certification in the State of Colorado. These rules also define the scope of practice for EMS providers.

SECTION 2 - Definitions - All definitions that appear in Section 25-3.5-103, C.R.S., and 6 CCR 1015-3, CHAPTER ONE shall apply to these rules.

2.1 "Advanced Cardiac Life Support (ACLS)" - a course of instruction designed to prepare students in the practice of advanced emergency cardiac care.

2.2 "Advanced Emergency Medical Technician (AEMT)" - an individual who has a current and valid AEMT certificate issued by the department and who is authorized to provide limited acts of advanced emergency medical care in accordance with these rules.

2.3 "Colorado Medical Board" - the Colorado Medical Board established in Title 12, Article 36, C.R.S., formerly known as the state Board of Medical Examiners.

2.4 "Department" - the Colorado Department of Public Health and Environment.

2.5 “Direct Verbal Order" - verbal authorization given to an EMS provider for the performance of specific medical acts through a Medical Base Station or in person.

2.6 "Emergency Medical Practice Advisory Council (EMPAC)" - the council established pursuant to Section 25-3.5-206, C.R.S., that is responsible for advising the department regarding the appropriate scope of practice for EMS providers and for the criteria for physicians to serve as EMS medical directors.

2.7 "Emergency Medical Technician (EMT)" - an individual who has a current and valid EMT certificate issued by the department and who is authorized to provide basic emergency medical care in accordance with these rules.

2.8 "Emergency Medical Technician with Intravenous Authorization (EMT-IV)" - an individual who has a current and valid EMT certificate issued by the department and who has met the conditions defined in Section 5.5 of these rules.

2.9 "Emergency Medical Technician-Intermediate (EMT-I)" - an individual who has a current and valid EMT-Intermediate certificate issued by the department and who is authorized to provide limited acts of advanced emergency medical care in accordance with these rules.

2.10 "EMS Provider" - means an individual who holds a valid emergency medical service provider certificate issued by the department and includes Emergency Medical Technician, Advanced Emergency Medical Technician, Emergency Medical Technician-Intermediate and Paramedic.

2.11 "EMS service agency" - any organized agency including but not limited to a "rescue unit" as defined in Section 25-3.5-103(11), C.R.S., using EMS providers to render initial emergency medical care to a patient prior to or during transport. This definition does not include criminal law enforcement agencies, unless the criminal law enforcement personnel are EMS providers who function with a "rescue unit" as defined in Section 25-3.5-103(11), C.R.S. or are performing any medical act described in these rules.

2.12 "Graduate Advanced EMT" - an individual who has a current and valid Colorado EMT certification issued by the department and who has successfully completed a department-recognized AEMT initial course but has not yet successfully completed the certification requirements set forth in the Rules Pertaining to EMS Education and Certification, 6 CCR 1015-3, Chapter One.

2.13 "Graduate EMT-Intermediate" - an individual who has a current and valid Colorado EMT or AEMT certification issued by the department and who has successfully completed a department-recognized EMT-Intermediate course but has not yet successfully completed the certification requirements set forth in the Rules Pertaining to EMS Education and Certification, 6 CCR 1015-3, Chapter One.

2.14 "Graduate Paramedic" - an individual who has a current and valid Colorado EMT certificate, AEMT certificate, or EMT-I certificate issued by the department and who has successfully completed a department-recognized paramedic initial course but has not yet successfully completed the certification requirements set forth in the Rules Pertaining to EMS Education and Certification, 6 CCR 1015-3, Chapter One.

2.15 "Licensed in Good Standing" - as used in these rules, means that a physician functioning as a medical director holds a current and valid license to practice medicine in Colorado that is not subject to any restrictions.

2.16 "Medical Base Station" - the source of direct medical communications with EMS providers.

2.17 "Medical Director" - for purposes of these rules means a physician licensed in good standing who authorizes and directs, through protocols and standing orders, the performance of students-in-training enrolled in department-recognized EMS education programs, graduate AEMTs, EMT-Is or paramedics, or EMS providers of a prehospital EMS service agency and who is specifically identified as being responsible to assure the competency of the performance of those acts by such EMS providers as described in the physician's medical CQI program.

2.18 "Paramedic" - an individual who has a current and valid paramedic certificate issued by the department and who is authorized to provide advanced emergency medical care in accordance with these rules.

2.19 "Protocol" - written standards for patient medical assessment and management approved by a medical director.

2.20 "Rules Pertaining to EMS Education and Certification" - rules governing the education and certification of EMS providers, located at 6 CCR 1015-3, Chapter One, promulgated by the state Board of Health.

2.21 "Scope of Practice" - refers to the medication administration and acts authorized in these rules for EMS providers.

2.22 "State Emergency Medical and Trauma Services Advisory Council (SEMTAC)" - a council created in the department pursuant to Section 25-3.5-104, C.R.S., that advises the department on all matters relating to emergency medical and trauma services.

2.23 "Standing Order" - written authorization provided in advance by a medical director for the performance of specific medical acts by EMS providers independent of making medical base station contact.

2.24 "Supervision" - oversee, direct or manage. Supervision may be through direct observation or by indirect oversight as defined in the medical director's CQI program.

2.25 "Waiver" - a department-approved exception to these rules granted to a medical director.

2.26 “Written Order" - written authorization given to an EMS provider for the performance of specific medical acts.

SECTION 3 - Emergency Medical Practice Advisory Council

3.1 The Emergency Medical Practice Advisory Council (EMPAC), under the direction of the executive director of the department, shall advise the department in the areas set forth below in Section 3.8.

3.2 The EMPAC shall consist of the following eleven members:

3.2.1 Eight voting members appointed by the governor as follows:

A) Two physicians licensed in good standing in Colorado who are actively serving as EMS medical directors and are practicing in rural or frontier counties;

B) Two physicians licensed in good standing in Colorado who are actively serving as EMS medical directors and are practicing in urban counties;

C) One physician licensed in good standing in Colorado who is actively serving as an EMS medical director in any area of the state;

D) One EMS provider certified at an advanced life support level who is actively involved in the provision of emergency medical services;

E) One EMS provider certified at a basic life support level who is actively involved in the provision of emergency medical services; and

F) One EMS provider certified at any level who is actively involved in the provision of emergency medical services;

3.2.2 One voting member who is a member of the SEMTAC, appointed by the executive director of the department; and

3.2.3 Two nonvoting ex officio members appointed by the executive director of the department.

3.3 EMPAC members shall serve four-year terms; except that, of the members initially appointed to the EMPAC by the governor, four members shall serve three-year terms.

3.4 A vacancy on the EMPAC shall be filled by appointment by the appointing authority for that vacant position for the remainder of the unexpired term.

3.5 EMPAC members serve at the pleasure of the appointing authority and continue in office until the member's successor is appointed.

3.6 The EMPAC shall meet at least quarterly and more frequently as necessary to fulfill its obligations.

3.7 The EMPAC shall elect a chair and vice-chair from its members.

3.8 The duties of the EMPAC include:

3.8.1 Provide general technical expertise on matters related to the provision of patient care by EMS providers;

3.8.2 Advise or make recommendations to the department on:

A) The acts and medications that EMS providers are authorized to perform or administer under the direction of a medical director.

B) Requests by medical directors for waivers to the scope of practice of EMS providers as established in these rules.

C) Modifications to EMS provider certification levels and capabilities.

D) Criteria for physicians to serve as EMS medical directors.

SECTION 4 - Medical Director Qualifications and Duties

4.1 A medical director shall possess the following minimum qualifications:

4.1.1 Be a physician currently licensed to practice medicine in the State of Colorado.

4.1.2 Be trained in Advanced Cardiac Life Support.

4.1.3 Physicians acting as medical directors for department-recognized EMS education programs must possess authority under their licensure to perform any and all medical acts to which they extend their authority to EMS providers, including any and all curricula presented by EMS education programs.

4.2 The duties of a medical director shall include:

4.2.1 Be actively involved in the provision of emergency medical services in the community served by the EMS service agency being supervised. Involvement does not require that a physician have such experience prior to becoming a medical director, but does require such involvement during the time that he or she acts as a medical director. Active involvement in the community could include, by way of example and not limitation, those inherent, reasonable and appropriate responsibilities of a medical director to interact with patients, the public served by the EMS service agency, the hospital community, the public safety agencies and the medical community and should include other aspects of liaison oversight and communication normally expected in the supervision of EMS providers.

4.2.2 Be actively involved on a regular basis with the EMS service agency being supervised. Involvement does not require that a physician have such experience prior to becoming a medical director, but does require such involvement during the time that he or she acts as a medical director. Involvement could include, by way of example and not limitation, involvement in continuing education, audits and protocol development. Passive or negligible involvement with the EMS service agency and supervised EMS providers does not meet this requirement.

4.2.3 Notify the department on an annual basis of the EMS Service Agencies for which medical control functions are being provided in a manner and form as determined by the department.

4.2.4 Establish a medical continuous quality improvement (CQI) program for each EMS service agency being supervised. The medical CQI program shall assure the continuing competency of the performance of that agency's EMS providers. This medical CQI program shall include, but not be limited to: appropriate protocols and standing orders and provision for medical care audits, observation, critiques, continuing medical education and direct supervisory communications.

4.2.5 Submit to the department an affidavit that attests to the development and use of a medical CQI program for all EMS service agencies supervised by the medical director. As set forth below in section 4.3, the department may review the records of a medical director to determine compliance with the CQI requirements in these rules.

4.2.6 Provide monitoring and supervision of the medical field performance of each supervised EMS service agency's EMS providers. This responsibility may be delegated to other physicians or other qualified health care professionals designated by the medical director. However, the medical director shall retain ultimate authority and responsibility for the monitoring and supervision, for establishing protocols and standing orders and for the competency of the performance of authorized medical acts.

4.2.7 Ensure that all protocols issued by the medical director are appropriate for the certification and skill level of each EMS provider to whom the performance of medical acts is delegated and authorized and compliant with accepted standards of medical practice.

4.2.8 Be familiar with the training, knowledge and competence of EMS providers under his or her supervision and ensure that EMS providers are appropriately trained and demonstrate ongoing competency in all skills, procedures and medications authorized in accordance with Section 4.2.7.

4.2.9 Be aware that certain skills, procedures and medications authorized in accordance with Section 4.2.7 (and as identified by the department) may not be included in the National EMS Education Standards and ensure that appropriate additional training is provided to supervised EMS providers.

4.2.10 Ensure that any data and/or documentation required by these rules are submitted to the department.

4.2.11 Notify the department within fourteen business days excluding state holidays prior to his or her cessation of duties as medical director.

4.2.12 Notify the department within fourteen business days excluding state holidays of his or her termination of the supervision of an EMS provider for reasons that may constitute good cause for disciplinary sanctions pursuant to the Rules Pertaining to EMS Education and Certification, 6 CCR 1015-3, Chapter One. Such notification shall be in writing and shall include a statement of the actions or omissions resulting in termination of supervision and copies of all pertinent records.

4.2.13 Physicians acting as medical directors for EMS education programs recognized by the department that require clinical and field internship performance by students shall be permitted to delegate authority to a student-in-training during their performance of program-required medical acts and only while under the control of the education program.

4.3 Departmental review of medical directors

4.3.1 The department may review the records of a medical director to determine compliance with the requirements and standards in these rules and with accepted standards of medical oversight and practice.

4.3.2 Complaints in writing against medical directors for violations of these rules may be initiated by any person, the Colorado Medical Board or the department.

4.3.3 Complaints in writing against medical directors may be referred to the Colorado Medical Board for review as deemed appropriate by the department.

SECTION 5 - Medical Acts Allowed for the EMT

5.1 An EMT may, under the supervision and authorization of a medical director, perform emergency medical acts consistent with and not to exceed those listed in Appendices A and C of these rules for an EMT.

5.2 An EMT may, under the supervision and authorization of a medical director, administer and monitor medications and classes of medications consistent with and not to exceed those listed in Appendices B and D of these rules for an EMT.

5.3 Any EMT who is a member or employee of an EMS service agency and who performs said emergency medical acts must have authorization and be supervised by a medical director to perform said emergency medical acts.

5.4 EMTs may carry out a physician order for a mental health hold as set forth in Section 27-65-105(1), C.R.S. Such physician order may be a direct verbal order or by electronic communications.

5.5 An EMT who has successfully completed a department-recognized Intravenous Therapy and Medication Administration Course may be referred to as an Emergency Medical Technician with Intravenous Authorization (EMT-IV). Any provisions of these rules that are applicable to an EMT shall also be applicable to an EMT-IV. In addition to the acts an EMT is allowed to perform, an EMT-IV may, under supervision and authorization of a medical director, perform medical acts consistent with and not to exceed those listed in Appendices A and C of these rules for an EMT-IV. In addition to the medications and classes of medications an EMT is allowed to administer and monitor pursuant to these rules, an EMT-IV may, under supervision and authorization of a medical director, administer and monitor medications and classes of medications consistent with and not to exceed those listed in Appendices B and D of these rules for an EMT-IV.

5.6 An EMT-IV may, under the supervision and authorization of a medical director, administer and monitor medications and classes of medications which exceed those listed in Appendices B and D of these rules for an EMT-IV under the direct visual supervision of an AEMT, EMT-I or paramedic when the following conditions have been established:

5.6.1 The patient must be in cardiac arrest or in extremis.

5.6.2 Drugs administered must be limited to those authorized by these rules for an AEMT, EMT-I or paramedic as stated in Appendices B and D.

5.6.3 The medical director shall amend the appropriate protocols and medical CQI program used to supervise the EMS providers to reflect this change in patient care. The medical director and the protocols of the EMT-IV and the AEMT, EMT-I or paramedic shall all be in agreement.

5.7 In the event of a governor-declared disaster or public health emergency, the chief medical officer for the department or his or her designee may temporarily authorize the performance of additional medical acts, such as the administration of other immunizations, vaccines, biologicals or tests not listed in these rules.

SECTION 6 - Medical Acts Allowed for the Advanced EMT

6.1 An AEMT may, under the supervision and authorization of a medical director, perform emergency medical acts consistent with and not to exceed those listed in Appendices A and C of these rules for an AEMT.

6.2 An AEMT may, under the supervision and authorization of a medical director, administer and monitor medications and classes of medications consistent with and not to exceed those listed in Appendices B and D of these rules for an AEMT.

6.3 Any AEMT who is a member or employee of an EMS service agency and who performs said emergency medical acts must have authorization and be supervised by a medical director to perform said emergency medical acts.

6.4 AEMTs may carry out a physician order for a mental health hold as set forth in Section 27-65-105(1), C.R.S. Such physician order may be a direct verbal order or by electronic communications.

6.5 An AEMT may, under the supervision and authorization of a medical director, administer and monitor medications and classes of medications which exceed those listed in Appendices B and D of these rules for an AEMT under the direct visual supervision of an EMT-I or paramedic when the following conditions have been established:

6.5.1 The patient must be in cardiac arrest or in extremis.

6.5.2 Drugs administered must be limited to those authorized by these rules for EMT-I or paramedic as stated in Appendices B and D.

6.5.3 The medical director shall amend the appropriate protocols and medical CQI program used to supervise the EMS providers to reflect this change in patient care. The medical director and the protocols of the AEMT and the EMT-I or paramedic shall all be in agreement.

6.6 In the event of a governor-declared disaster or public health emergency, the chief medical officer for the department or his or her designee may temporarily authorize the performance of additional medical acts, such as the administration of other immunizations, vaccines, biologicals or tests not listed in these rules.

SECTION 7 - Medical Acts Allowed for the EMT-Intermediate

7.1 In addition to the acts an EMT, an EMT-IV and an AEMT are allowed to perform pursuant to these rules, an EMT-I may, under the supervision and authorization of a medical director perform advanced emergency medical care acts consistent with and not to exceed those listed in Appendices A and C of these rules for an EMT-I.

7.2 In addition to the medications and classes of medications an EMT, an EMT-IV and an AEMT are allowed to administer and monitor pursuant to these rules, an EMT-I may, under the supervision and authorization of a medical director, administer and monitor medications and classes of medications defined in Appendices B and D of these rules for an EMT-I.

7.3 An EMT-I may carry out a physician order for a mental health hold as set forth in Section 27-65-105(1), C.R.S. Such physician order may be a direct verbal order or by electronic communications.

7.4 An EMT-I may, under the supervision and authorization of a medical director, administer and monitor medications and classes of medications which exceed those listed in Appendices B and D of these rules for an EMT-I under the direct visual supervision of a paramedic, when the following conditions have been established:

7.4.1 Drugs administered must be limited to those authorized by these rules for paramedics as stated in Appendices B and D.

7.4.2 The medical director shall amend the appropriate protocols and medical CQI program used to supervise the EMS providers to reflect this change in patient care. The medical director and protocols of the EMT-I and paramedic shall all be in agreement.

7.5 In the event of a governor-declared disaster or public health emergency, the chief medical officer for the department or his or her designee may temporarily authorize the performance of additional medical acts, such as the administration of other immunizations, vaccines, biologicals or tests not listed in these rules.

SECTION 8 - Medical Acts Allowed for the Paramedic

8.1 In addition to the acts an EMT-I is allowed to perform pursuant to these rules, a paramedic may, under the supervision and authorization of a medical director, perform advanced emergency medical care acts consistent with and not to exceed those listed in Appendices A and C of these rules for a paramedic.

8.2 In addition to the medications and classes of medications an EMT-I is allowed to administer and monitor pursuant to these rules, a paramedic may, under the supervision and authorization of a medical director, administer and monitor medications and classes of medications defined in Appendices B and D for a paramedic.

8.3 Paramedics may carry out a physician order for a mental health hold as set forth in Section 27-65-105(1), C.R.S. Such physician order may be a direct verbal order or by electronic communications.

8.4 In the event of a governor-declared disaster or public health emergency, the chief medical officer for the department or his or her designee may temporarily authorize the performance of additional medical acts, such as the administration of other immunizations, vaccines, biologicals or tests not listed in these rules.

SECTION 9 - Graduate Advanced EMTs, Graduate EMT-Intermediates and Graduate Paramedics

Medical directors may supervise graduate AEMTs as defined in these rules acting as AEMTs for a period of no more than six months following successful completion of an appropriate department-recognized initial course. Medical directors may supervise graduate EMT-Is as defined in these rules acting as EMT-Is for a period of no more than six months following successful completion of an appropriate department-recognized initial course. Medical directors may supervise graduate paramedics as defined in these rules acting as paramedics for a period of no more than six months following successful completion of an appropriate department-recognized initial course. Such graduate AEMTs, graduate EMT-Is and graduate paramedics must successfully complete certification requirements, as specified in Rules Pertaining to EMS Education and Certification, 6 CCR 1015-3, Chapter One, within six months of the successful completion of a department-recognized initial course to continue to function under the provisions of these rules.

SECTION 10 - General Acts Allowed

10.1 Any EMS provider working for an EMS service agency shall be supervised by a medical director who complies with the requirements in these rules.

10.2 A medical director may limit the scope of practice of any EMS provider.

10.3 The gathering of laboratory and/or other diagnostic data for the sole purpose of providing information to another health care provider does not require a waiver provided:

10.3.1 The method by which the data is gathered is within the scope of practice of the EMS provider as contained in these rules;

10.3.2 The collection method and analysis of the information collected is done in accordance with applicable regulations including but not limited to the Clinical Laboratory Improvement Amendments (CLIA), and FDA requirements; and,

10.3.3 Unless otherwise allowed in Table A.6, the information obtained will not be used to alter the prehospital treatment or destination of the patient without a direct verbal order.

A medical director shall obtain a waiver as set forth in Section 11 of these rules for any other data gathering activities that do not meet the provisions listed above.

10.4 EMS providers may function in acute care settings. Functioning in this environment must be in compliance with the Colorado Medical Board's statutes and rules, under the auspices of a medical director and within parameters of the acts allowed or waiver as described in these rules.

10.5 EMS providers may not practice in camps in a nursing capacity including the dispensing of medications.

SECTION 11 - Waivers to Scope of Practice

11.1 Any medical director may apply to the department for a waiver to the scope of practice set forth in these rules for EMS providers under his or her supervision in specific circumstances, based on established need, provided that on-going quality assurance of each EMS provider's competency is maintained by the medical director.

11.2 A waiver is not necessary for the allowed skills and medications listed in Appendices A, B, C or D of this rule.

11.3 All levels of EMS provider may, under the supervision and authorization of a medical director, perform specific skills or administer specific medications not listed in Appendices A, B, C or D of this rule, only if the medical director has been granted a waiver from the department for that specific skill or medication. Waivered skills or medication administration may be authorized by the medical director under standing orders or direct verbal orders of a physician, including by electronic communications. No EMS provider shall function beyond the scope of practice identified in these rules for their level until their medical director has received official written confirmation of the waiver being granted by the department.

11.4 Medical directors seeking a waiver shall submit a completed application to the department in a form and manner determined by the department.

11.4.1 The application shall include, but not be limited to, a description of the act or medication to be waived, information regarding the justification for the waiver, the proposed education, training and quality assurance process, literature review, and copies of the applicable protocols. The forms and affidavit required by Section 4 of these rules shall also be included.

11.4.2 The department may require the applicant to provide additional information if the initial application is determined to be insufficient.

11.4.3 An application shall not be considered complete until the required information is submitted.

11.4.4 The completed waiver application shall be submitted to the department in a timely fashion as specified by the department.

11.4.5 The application shall be a matter of public record and is subject to disclosure requirements under the Colorado Open Records Act (C.R.S. § 24-72-200.1 *et seq* .).

11.5 The EMPAC shall review waiver requests and make recommendations to the department. The EMPAC may make recommendations, including but not limited to: deny, approve, table, request more information from the medical director or impose special conditions on the waiver.

11.6 After receiving recommendations from the EMPAC, the department shall make a decision on the waiver request and send notice of that decision to the medical director within thirty (30) calendar days of the recommendation. If granted, the notice shall include the effective date and expiration date of the waiver.

11.6.1 If the waiver is granted, the department may:

A) Specify the terms and conditions of the waiver.

B) Specify the duration of the waiver.

C) Specify any reporting requirements.

11.6.2 The department may require the submission of data or other information regarding waivers.

A) Unless otherwise specified by the department, any data or information submitted to the department shall not contain patient-identifying information.

B) If the department requires submission of data or reports containing patient-identifying information for purposes of overseeing a statewide continuing quality improvement system, that information shall be kept confidential pursuant to C.R.S. § 25-3.5-704(2)(h)(I)(E).

C) If the department requires submission of data, information, records or reports related to the identification of individual patient's, provider's or facility's care outcomes for purposes of overseeing a statewide continuing quality improvement system, that information shall be kept confidential pursuant to C.R.S. § 25-3.5-702(2)(h)(II).

11.6.3 The department may deny, revoke or suspend a waiver if it determines:

A) That its approval or continuation jeopardizes the health, safety and/or welfare of patients.

B) The medical director has provided false or misleading information in the waiver application.

C) The medical director has failed to comply with conditions or reporting on an approved waiver.

D) That a change in federal or state law prohibits continuation of the waiver.

11.7 If the department denies a waiver application or revokes or suspends a waiver, it shall provide the medical director with a notice explaining the basis for the action. The notice shall also inform the medical director of his or her right to appeal and the procedure for appealing the action.

11.8 Appeals of departmental actions shall be conducted in accordance with the state Administrative Procedure Act, Section 24-4-101, et seq., C.R.S.

11.9 If the rule pertaining to a waived skill or medication administration is amended or repealed obviating the need for the waiver, the waiver shall expire on the effective date of the rule change.

11.10 If a medical director has made timely and sufficient application for renewal of a waiver and the department fails to take action on the application prior to the waiver's expiration date, the existing waiver shall not expire until the department acts upon the application. The department, in its sole discretion, shall determine whether the application was timely and sufficient.

11.11 In the case of exigent circumstances, including but not limited to, the death or incapacitation of a medical director or the termination of the relationship between a medical director and an EMS service agency, the department may transfer waivers upon request by a replacement medical director for a period not to exceed six (6) months. The medical director shall then apply for new waiver(s) for consideration and department action within sixty (60) days of the transfer.

SECTION 12 - Technology and Pharmacology Dependent Patients

The transport of patients with continuous intravenously administered medications and nutritional support, previously prescribed by licensed health care workers and typically managed day-to-day at their residence by either the patient or caretakers, shall be allowed. The EMS provider is not authorized to discontinue, interfere with, alter or otherwise manage these patient medication/nutrition systems except by direct verbal order or where cessation and/or continuation of medication pose a threat to the safety of the patient.

SECTION 13 - Combination Benzodiazepine and Opiate Therapy

13.1 The administration of a combination of benzodiazepines and opiates, for the purpose of pain management, anxiolysis and/or muscle relaxation is permitted. Safeguards shall be taken to maximize patient safety including but not limited to the patient's ability to:

13.1.1 Independently maintain an open airway and normal breathing pattern,

13.1.2 Maintain normal hemodynamics, and

13.1.3 Respond appropriately to physical stimulation and verbal commands.

13.2 The administration of combination therapy requires appropriate monitoring and care including but not limited to: IV or IO access, continuous waveform capnography, pulse oximetry, ECG monitoring, blood pressure monitoring and administration of supplemental oxygen.

SECTION 14 - Scope of Practice

14.1 All of the following appendices define the maximum skills, acts or medications that may be delegated to an EMT, EMT-IV, AEMT, EMT-I and paramedic under appropriate supervision by a medical director.

14.2 A medical director may establish the circumstances and methods by which an EMS provider obtains authorization to perform any medical act, skill or medication contained in these rules including, but not limited to: standing order, direct verbal order, written order.

14.2.1 "Y" = YES: May be performed or administered by EMS providers with physician supervision as described in these rules.

14.2.2 "VO" = Verbal Order: May only be performed or administered by EMS providers if authorized by direct verbal order by a physician unless specific exception criteria are established by the supervising physician. Exception criteria may include, but are not limited to cardiac arrest, behavioral management or communications failure. Supervising physicians shall not develop exception criteria that merely waive all direct verbal order requirements.

14.2.3 “N” = NO: May not be performed or administered by EMS providers except with an approved waiver as described in Section 11 of these rules.

14.2.4 “EMT” = Medical acts, skills or medications that may be performed or administered by an EMT with appropriate medical director supervision and training recognized by the department.

14.2.5 “EMT-IV” = Medical acts, skills or medications that may be performed or administered by an EMT-IV with appropriate medical director supervision and training recognized by the department.

14.2.6 “AEMT” = Medical acts, skills or medications that may be performed or administered by an AEMT with appropriate medical director supervision and training recognized by the department.

14.2.7 “EMT-I” = Medical acts, skills or medications that may be performed or administered by an EMT-I with appropriate medical director supervision and training recognized by the department.

14.2.8 “P” = Medical acts, skills or medications that may be performed or administered by a paramedic with appropriate medical director supervision and training recognized by the department.

Note: SECTION 15 - INTERFACILITY TRANSPORT begins following APPENDIX B.

APPENDIX A

<u>PREHOSPITAL</u>

MEDICAL SKILLS AND ACTS ALLOWED

A.1.1 Additions to these medical skills and acts allowed cannot be delegated unless a waiver has been granted as described in Section 11 of these rules.

A.1.2 Not all medical skills and acts allowed are included in initial education for various EMS provider levels. Medical directors shall ensure providers are appropriately trained as noted in Sections 4.2.8 and 4.2.9.

TABLE A.1 - AIRWAY/VENTILATION/OXYGEN ADMINISTRATION

Skill	EMT	EMT-IV	AEMT	EMT-I	P
Airway - Supraglottic	Y	Y	Y	Y	Y
Airway - Nasal	Y	Y	Y	Y	Y
Airway - Oral	Y	Y	Y	Y	Y
Bag - Valve - Mask (BVM)	Y	Y	Y	Y	Y
Carbon Monoxide Monitoring	Y	Y	Y	Y	Y
Chest Decompression - Needle	N	N	N	Y	Y
Chest Tube Insertion	N	N	N	N	N
CPAP	Y	Y	Y	Y	Y
PEEP	Y	Y	Y	Y	Y
Cricoid Pressure - Sellick's Maneuver	Y	Y	Y	Y	Y
Cricothyroidotomy - Needle	N	N	N	N	Y
Cricothyroidotomy - Surgical	N	N	N	N	Y
End Tidal CO_2 Monitoring/Capnometry/ Capnography	Y	Y	Y	Y	Y
Flow Restrictive Oxygen Powered Ventilatory Device	Y	Y	Y	Y	Y
Gastric Decompression - NG/OG Tube Insertion	N	N	N	N	Y
Inspiratory Impedence Threshold Device	Y	Y	Y	Y	Y
Intubation - Digital	N	N	N	N	Y
Intubation - Bougie Style Introducer	N	N	N	Y	Y
Intubation - Lighted Stylet	N	N	N	Y	Y
Intubation - Medication Assisted (non-paralytic)	N	N	N	N	N
Intubation - Medication Assisted (paralytics) (RSI)	N	N	N	N	N
Intubation - Maintenance with paralytics	N	N	N	N	N
Intubation - Nasotracheal	N	N	N	N	Y
Intubation - Orotracheal	N	N	N	Y	Y
Intubation - Retrograde	N	N	N	N	N
Extubation	N	N	N	Y	Y
Obstruction - Direct Laryngoscopy	N	N	N	Y	Y
Oxygen Therapy – Humidifiers	Y	Y	Y	Y	Y
Oxygen Therapy - Nasal Cannula	Y	Y	Y	Y	Y
Oxygen Therapy - Non-rebreather Mask	Y	Y	Y	Y	Y
Oxygen Therapy - Simple Face Mask	Y	Y	Y	Y	Y
Oxygen Therapy - Venturi Mask	N	N	Y	Y	Y
Peak Expiratory Flow Testing	N	N	N	Y	Y
Pulse Oximetry	Y	Y	Y	Y	Y
Suctioning – Tracheobronchial	N	N	Y	Y	Y
Suctioning - Upper Airway	Y	Y	Y	Y	Y
Tracheostomy Maintenance - Airway management only	Y	Y	Y	Y	Y
Tracheostomy Maintenance - Includes replacement	N	N	N	N	Y
Ventilators - Automated Transport (ATV) [1]	N	N	N	N	Y

[1] Use of automated transport ventilators (ATVs) is restricted to the manipulation of tidal volume (TV or VT), respiratory rate (RR), fraction of inspired oxygen (FIO2), and positive end expiratory pressure (PEEP). Manipulation of any other parameters of mechanical ventilation devices by EMS providers requires a waiver to these rules.

TABLE A.2 - CARDIOVASCULAR/CIRCULATORY SUPPORT

Skill	EMT	EMT-IV	AEMT	EMT-I	P
Cardiac Monitoring - Application of electrodes and data transmission	Y	Y	Y	Y	Y
Cardiac Monitoring - Rhythm and diagnostic EKG interpretation	N	N	N	Y	Y
Cardiopulmonary Resuscitation (CPR)	Y	Y	Y	Y	Y
Cardioversion - Electrical	N	N	N	N	Y
Carotid Massage	N	N	N	N	Y
Defibrillation - Automated/Semi-Automated (AED)	Y	Y	Y	Y	Y
Defibrillation - Manual	N	N	N	Y	Y
External Pelvic Compression	Y	Y	Y	Y	Y
Hemorrhage Control - Direct Pressure	Y	Y	Y	Y	Y
Hemorrhage Control - Pressure Point	Y	Y	Y	Y	Y
Hemorrhage Control - Tourniquet	Y	Y	Y	Y	Y
Implantable cardioverter/defibrillator magnet use	N	N	N	N	N
Mechanical CPR Device	Y	Y	Y	Y	Y
Transcutaneous Pacing	N	N	N	Y	Y
Transvenous Pacing - Maintenance	N	N	N	N	N
Therapeutic Induced Hypothermia (TIH) [2]	N	N	N	VO	Y
Arterial Blood Pressure Indwelling Catheter - Maintenance	N	N	N	N	N
Invasive Intracardiac Catheters - Maintenance	N	N	N	N	N
Central Venous Catheter Insertion	N	N	N	N	N
Central Venous Catheter Maintenance/Patency/Use	N	N	N	Y	Y
Percutaneous Pericardiocentesis	N	N	N	N	N

[2] Therapeutic Induced Hypothermia (TIH) -

1. Approved methods of cooling include:

    a. Surface cooling methods including ice packs, evaporative cooling and surface cooling blankets or surface heat-exchange devices.

    b. Internal cooling with the intravenous administration of cold crystalloids (4°C / 39°F)

2. Esophageal temperature probe allowed for monitoring core temperatures in patients undergoing TIH.

3. The medical director should work with the hospital systems to which their agencies transport in setting up a "systems" approach to the institution of TIH. Medical directors should not institute TIH without having receiving facilities that also have TIH programs to which to transport these patients.

TABLE A.3 - IMMOBILIZATION

Skill	EMT	EMT-IV	AEMT	EMT-I	P
Spinal Immobilization - Cervical Collar	Y	Y	Y	Y	Y
Spinal Immobilization - Long Board	Y	Y	Y	Y	Y
Spinal Immobilization - Manual Stabilization	Y	Y	Y	Y	Y
Spinal Immobilization - Seated Patient	Y	Y	Y	Y	Y
Splinting - Manual	Y	Y	Y	Y	Y
Splinting - Rigid	Y	Y	Y	Y	Y
Splinting - Soft	Y	Y	Y	Y	Y
Splinting - Traction	Y	Y	Y	Y	Y
Splinting - Vacuum	Y	Y	Y	Y	Y

TABLE A.4 - INTRAVENOUS CANNULATION / FLUID ADMINISTRATION / FLUID MAINTENANCE

Skill	EMT	EMT-IV	AEMT	EMT-I	P
Blood/Blood By-Products Initiation (out of facility initiation)	N	N	N	N	N
Colloids - (Albumin, Dextran) - Initiation	N	N	N	N	N
Crystalloids (D5W, LR, NS) - Initiation/Maintenance	N	Y	Y	Y	Y
Intraosseous - Initiation	N	N	Y	Y	Y
Medicated IV Fluids Maintenance - As Authorized in Appendix B	N	N	N	Y	Y
Peripheral - Excluding External Jugular - Initiation	N	Y	Y	Y	Y
Peripheral - Including External Jugular - Initiation	N	N	Y	Y	Y
Use of Peripheral indwelling Catheter for IV medications (Does not include PICC)	N	Y	Y	Y	Y

TABLE A.5 - MEDICATION ADMINISTRATION ROUTES

Skill	EMT	EMT-IV	AEMT	EMT-I	P
Aerosolized	Y	Y	Y	Y	Y
Atomized	Y	Y	Y	Y	Y
Auto-Injector	Y	Y	Y	Y	Y
Buccal	Y	Y	Y	Y	Y
Endotracheal Tube (ET)	N	N	N	Y	Y
Extra-abdominal umbilical vein	N	N	N	Y	Y
Intradermal	N	N	N	Y	Y
Intramuscular (IM)	N	N	Y	Y	Y
Intranasal (IN)	N	Y	Y	Y	Y
Intraosseous	N	N	Y	Y	Y
Intravenous (IV) Piggyback	N	N	N	Y	Y
Intravenous (IV) Push	N	Y	Y	Y	Y
Nasogastric	N	N	N	N	Y
Nebulized	Y	Y	Y	Y	Y
Ophthalmic	N	N	N	Y	Y
Oral	Y	Y	Y	Y	Y
Rectal	N	N	N	Y	Y
Subcutaneous	N	N	Y	Y	Y
Sublingual	Y	Y	Y	Y	Y
Sublingual (nitroglycerin)	Y	Y	Y	Y	Y
Topical	Y	Y	Y	Y	Y
Use of Mechanical Infusion Pumps	N	N	N	Y	Y

TABLE A.6 - MISCELLANEOUS

Skill	EMT	EMT-IV	AEMT	EMT-I	P
Aortic Balloon Pump Monitoring	N	N	N	N	N
Assisted Delivery	Y	Y	Y	Y	Y
Capillary Blood Sampling	Y	Y	Y	Y	Y
Diagnostic Interpretation - Blood Glucose [3]	Y	Y	Y	Y	Y
Diagnostic Interpretation - Blood Lactate [3]	N	N	Y	Y	Y
Dressing/Bandaging	Y	Y	Y	Y	Y
Esophageal Temperature Probe for TIH	N	N	N	VO	Y
Eye Irrigation Noninvasive	Y	Y	Y	Y	Y
Eye Irrigation Morgan Lens	N	N	N	Y	Y
Maintenance of Intracranial Monitoring Lines	N	N	N	N	N
MAST/Pneumatic Anti-Shock Garment	Y	Y	Y	Y	Y
Physical examination	Y	Y	Y	Y	Y
Restraints - Verbal	Y	Y	Y	Y	Y
Restraints - Physical	Y	Y	Y	Y	Y
Restraints - Chemical	N	N	N	Y	Y
Urinary Catheterization - Initiation	N	N	N	N	Y
Urinary Catheterization - Maintenance	Y	Y	Y	Y	Y
Venous Blood Sampling - Obtaining	N	Y	Y	Y	Y

[3] See also Section 10.3

APPENDIX B

PREHOSPITAL

FORMULARY OF MEDICATIONS ALLOWED TO BE ADMINISTERED

B.1.1 Additions to this medication formulary cannot be delegated unless a waiver has been granted as described in Section 11 of these rules.

B.1.2 Not all medical skills and acts allowed are included in initial education for various EMS provider levels. Medical directors shall ensure providers are appropriately trained as noted in Sections 4.2.8 and 4.2.9.

TABLE B.1 - GENERAL

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Over-the-counter-medications	Y	Y	Y	Y	Y
Oxygen	Y	Y	Y	Y	Y
Specialized prescription medications to address acute crisis [1]	VO	VO	VO	VO	VO

[1] EMS providers may assist with the administration of, or may directly administer, specialized medications prescribed to the patient for the purposes of alleviating an acute medical crisis event provided the route of administration is within the provider's scope as listed in Appendix A.

TABLE B.2 – ANTIDOTES

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Atropine	N	N	N	VO	Y
Calcium salt - Calcium chloride	N	N	N	N	Y
Calcium salt - Calcium gluconate	N	N	N	N	Y
Cyanide antidote	N	N	N	Y	Y
Glucagon	N	N	VO	VO	Y
Naloxone	Y	Y	Y	Y	Y
Nerve agent antidote	Y	Y	Y	Y	Y
Pralidoxime	N	N	N	N	Y
Sodium bicarbonate	N	N	N	N	Y

TABLE B.3 - BEHAVIORAL MANAGEMENT

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Anti-Psychotic - Droperidol	N	N	N	VO	Y
Anti-Psychotic - Haloperidol	N	N	N	VO	Y
Anti-Psychotic - Olanzapine	N	N	N	VO	Y
Anti-Psychotic - Ziprasidone	N	N	N	VO	Y
Benzodiazepine - Diazepam	N	N	N	VO	Y
Benzodiazepine - Lorazepam	N	N	N	VO	Y
Benzodiazepine - Midazolam	N	N	N	VO	Y
Diphenhydramine	N	N	N	VO	Y

TABLE B.4 - CARDIOVASCULAR

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Adenosine	N	N	N	VO	Y
Amiodarone - bolus infusion only	N	N	N	VO	Y
Aspirin	Y	Y	Y	Y	Y
Atropine	N	N	N	VO	Y
Calcium salt - Calcium chloride	N	N	N	N	Y
Calcium salt - Calcium gluconate	N	N	N	N	Y
Diltiazem - bolus infusion only	N	N	N	N	Y
Dopamine	N	N	N	N	Y
Epinephrine	N	N	N	VO	Y
Lidocaine - bolus and continuous infusion	N	N	N	VO	Y
Magnesium sulfate - bolus infusion only	N	N	N	N	Y
Morphine sulfate	N	N	N	VO	Y
Nitroglycerin - sublingual (patient assisted)	VO	VO	Y	Y	Y
Nitroglycerin - sublingual (tablet or spray)	N	N	Y	Y	Y
Nitroglycerin - topical paste	N	N	VO	VO	Y
Sodium bicarbonate	N	N	N	VO	Y
Vasopressin	N	N	N	VO	Y
Verapamil - bolus infusion only	N	N	N	N	Y

TABLE B.5 - DIURETICS

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Bumetanide	N	N	N	N	Y
Furosemide	N	N	N	VO	Y
Mannitol (trauma use only)	N	N	N	N	Y

TABLE B.6 - ENDOCRINE AND METABOLISM

Medications	EMT	EMT-IV	AEMT	EMT-I	P
IV Dextrose	N	Y	Y	Y	Y
Glucagon	N	N	Y	Y	Y
Oral glucose	Y	Y	Y	Y	Y
Thiamine	N	N	N	N	Y

TABLE B.7 - GASTROINTESTINAL MEDICATIONS

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Anti-nausea - Droperidol	N	N	N	VO	Y
Anti-nausea - Metoclopramide	N	N	N	VO	Y
Anti-nausea - Ondansetron ODT	VO	VO	Y	Y	Y
Anti-nausea - Ondansetron IM/IVP	N	N	Y	Y	Y
Anti-nausea - Prochlorperazine	N	N	N	N	Y
Anti-nausea - Promethazine	N	N	N	VO	Y
Decontaminant - Activated charcoal	Y	Y	Y	Y	Y
Decontaminant - Sorbitol	Y	Y	Y	Y	Y

TABLE B.8 - PAIN MANAGEMENT

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Anesthetic - Lidocaine (for intraosseous needle insertion)	N	N	Y	Y	Y
Benzodiazepine - Diazepam	N	N	N	VO	Y
Benzodiazepine - Lorazepam	N	N	N	VO	Y
Benzodiazepine - Midazolam	N	N	N	VO	Y
General - Nitrous oxide	N	N	VO	VO	Y
Narcotic Analgesic - Fentanyl	N	N	N	VO	Y
Narcotic Analgesic - Hydromorphone	N	N	N	N	Y
Narcotic Analgesic - Morphine sulfate	N	N	N	VO	Y
Ophthalmic anesthetic-Opthaine	N	N	N	Y	Y
Ophthalmic anesthetic-Tetracaine	N	N	N	Y	Y
Topical Anesthetic - Benzocaine spray	N	N	N	N	Y
Topical Anesthetic - Lidocaine jelly	N	N	N	N	Y

TABLE B.9 - RESPIRATORY AND ALLERGIC REACTION MEDICATIONS

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Antihistamine - Diphenhydramine	N	N	VO	VO	Y
Bronchodilator - Anticholinergic - Atropine (aerosol/nebulized)	N	N	N	VO	Y
Bronchodilator - Anticholinergic - Ipratropium	N	N	VO	VO	Y
Bronchodilator - Beta agonist - Albuterol	VO	VO	VO	VO	Y
Bronchodilator - Beta agonist - L-Albuterol	VO	VO	VO	VO	Y
Bronchodilator - Beta agonist - Metaproterenol	N	N	N	VO	Y
Corticosteroid - Dexamethasone	N	N	N	N	Y
Corticosteroid - Hydrocortisone	N	N	N	VO	Y
Corticosteroid - Methylprednisolone	N	N	N	VO	Y
Corticosteroid – Prednisone	N	N	N	N	Y
Epinephrine 1:1,000 IM or SQ Only	N	N	VO	VO	Y
Epinephrine IV Only	N	N	N	VO	Y
Epinephrine Auto-Injector	Y	Y	Y	Y	Y
Magnesium Sulfate - bolus infusion only	N	N	N	N	Y
Racemic Epinephrine	N	N	N	VO	Y
Short Acting Bronchodilator meter dose inhalers (MDI) (Patient assisted)	VO	VO	VO	Y	Y
Short Acting Bronchodilator meter dose inhalers (MDI)	VO	VO	VO	VO	Y
Terbutaline	N	N	N	N	Y

TABLE B.10 - SEIZURE MANAGEMENT

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Benzodiazepine – Diazepam	N	N	N	VO	Y
Benzodiazepine - Lorazepam	N	N	N	VO	Y
Benzodiazepine – Midazolam	N	N	N	VO	Y
OB -associated - Magnesium sulfate - bolus infusion only	N	N	N	VO	Y

TABLE B.11 - VACCINES

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Post-exposure, employment, or pre-employment related - Hepatitis B	N	N	N	N	Y
Post-exposure, employment, or pre-employment related - Tetanus	N	N	N	N	Y
Post-exposure, employment, or pre-employment related - Influenza	N	N	N	N	Y
Post-exposure, employment, or pre-employment related - PPD placement & interpretation	N	N	N	N	Y
Public Health Related - Vaccine administration in conjunction with county public health departments and local EMS medical direction, after demonstration of proper training, will be authorized for public health vaccination efforts and pandemic planning exercises.	N	N	Y	Y	Y

TABLE B.12 - MISCELLANEOUS

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Analgesic Sedative - Etomidate	N	N	N	N	N
Benzodiazepine - Midazolam for TIH	N	N	N	VO	Y
Lidocaine - bolus for intubation of head-injured patients	N	N	N	VO	Y
Narcotic Analgesic - Fentanyl for TIH	N	N	N	VO	Y
Topical Hemostatic agents	Y	Y	Y	Y	Y

SECTION 15 - INTERFACILITY TRANSPORT

15.1 The EMS medical director, in collaboration with the transferring facility's medical director, should have protocols in place to ensure the appropriate level of care is available during interfacility transport.

15.2 The transporting EMS provider may decline to transport any patient he or she believes requires a level of care beyond his or her capabilities.

15.3 Inter-facility transport typically involves three types of patients:

15.3.1 Those patients whose safe transport can be accomplished by ambulance, under the care of an EMT, EMT-IV, AEMT, EMT-I, or paramedic, within the acts allowed under these rules.

15.3.2 Those patients whose safe transport can be accomplished by ambulance, under the care of a paramedic, but may require skills to be performed or medications to be administered that are outside the acts allowed under these rules, but have been approved through waiver granted by the department.

15.3.3 Those patients whose safe transport requires the skills and expertise of a critical care transport team under the care of an experienced critical care practitioner.

15.4 The hemodynamically unstable patient (typically from an Intensive Care setting) who requires special monitoring (e.g. central venous pressure, intracranial pressure), multiple cardioactive/vasoactive medications, or specialized critical care equipment (i.e. intra-aortic balloon pump) should remain under the care of an experienced critical care practitioner, and every attempt should be made to transport that patient while maintaining the appropriate level of care. The capabilities of the institution, the capabilities of the transporting agency and, most importantly, the safety of the patient should be considered when making transport decisions.

15.5 Unless otherwise noted, the following Appendices C and D indicate hospital/facility initiated interventions and/or medications.

15.5.1 Additions to these medical skills and acts allowed cannot be delegated unless a waiver has been granted as described in Section 11 of these rules.

15.5.2 The following medical skills and acts are approved for interfacility transport of patients, with the requirements that the skill, act or medication allowed must have been initiated in a medical facility under the direct order and supervision of licensed medical providers, and are NOT authorized for field initiation. EMS continuation and monitoring of these interventions is to be allowed with any alterations in the therapy requiring direct verbal order. The EMS provider should continue the same medical standards of care with regards to patient monitoring that were initiated in the facility.

15.5.3 It is understood that these skills, acts or medications may not be addressed in the National EMS Education Standards for EMT, AEMT, EMT-I or paramedic. As such, it is the joint responsibility of the medical director and individuals performing these skills to obtain appropriate additional training needed to safely and effectively utilize and monitor these interventions in the interfacility transport environment.

APPENDIX C

INTERFACILITY TRANSPORT - ONLY

MEDICAL SKILLS AND ACTS ALLOWED

TABLE C.1 - AIRWAY/VENTILATION/OXYGEN ADMINISTRATION

Skill	EMT	EMT-IV	AEMT	EMT-I	P
Ventilators - Automated Transport (ATV) [1]	N	N	N	N	Y

[1] Use of automated transport ventilators (ATVs) is restricted to the manipulation of tidal volume (TV or VT), respiratory rate (RR), fraction of inspired oxygen (FIO_2), and positive end expiratory pressure (PEEP). Manipulation of any other parameters of mechanical ventilation devices by EMS providers requires a waiver to these rules.

TABLE C.2 - CARDIOVASCULAR/CIRCULATORY SUPPORT

Skill	EMT	EMT-IV	AEMT	EMT-I	P
Aortic Balloon Pump Monitoring	N	N	N	N	N
Chest Tube Monitoring	N	N	N	N	Y
Central Venous Pressure Monitor Interpretation	N	N	N	N	N

APPENDIX D

INTERFACILITY TRANSPORT - ONLY

FORMULARY OF MEDICATIONS ALLOWED TO BE ADMINISTERED

TABLE D.1 - CARDIOVASCULAR

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Anti-arrhythmic - Amiodarone - continuous infusion	N	N	N	Y	Y
Anti-arrhythmic - Lidocaine - continuous infusion	N	N	N	Y	Y
Anticoagulant - Glycoprotein inhibitors	N	N	N	N	Y
Anticoagulant - Heparin (unfractionated)	N	N	N	N	Y
Anticoagulant - Low Molecular Weight Heparin (LMWH)	N	N	N	N	Y
Diltiazem	N	N	N	N	Y
Dobutamine	N	N	N	N	N
Nicardipine	N	N	N	N	Y
Nitroglycerin, intravenous	N	N	N	N	Y

TABLE D.2 - HIGH RISK OBSTETRICAL PATIENTS

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Magnesium sulfate	N	N	N	N	Y
Oxytocin - infusion	N	N	N	N	Y

TABLE D.3 - INTRAVENOUS SOLUTIONS

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Monitoring and maintenance of hospital/medical facility initiated crystalloids	N	Y	Y	Y	Y
Monitoring and maintenance of hospital/medical facility initiated colloids (non-blood component) infusions	N	N	N	Y	Y
Monitoring and maintenance of hospital/medical facility initiated blood component infusion	N	N	N	N	Y
Initiate hospital/medical facility supplied blood component infusions	N	N	N	N	Y
Total parenteral nutrition (TPN) and/or vitamins	N	N	N	Y	Y

TABLE D.4 - MISCELLANEOUS

Medications	EMT	EMT-IV	AEMT	EMT-I	P
Antibiotic infusions	N	N	N	Y	Y
Antidote infusion - Sodium bicarbonate infusion	N	N	N	N	Y
Electrolyte infusion - Magnesium sulfate	N	N	N	N	Y
Electrolyte infusion - Potassium chloride	N	N	N	N	Y
Insulin	N	N	N	N	Y
Mannitol	N	N	N	N	Y
Methylprednisolone - infusion	N	N	N	N	Y
Octreotide	N	N	N	N	Y
Pantoprazole	N	N	N	N	Y

CHAPTER THREE – RULES PERTAINING TO EMERGENCY MEDICAL SERVICES DATA AND INFORMATION COLLECTION AND RECORD KEEPING

Section 1 – Purpose and Authority for Rules

1.1 The authority and requirement for data collection is provided in C.R.S. § 25-3.5-501(1), which states, "Each ambulance service shall prepare and transmit copies of uniform and standardized records, as specified by regulation adopted by the department, concerning the transportation and treatment of patients in order to evaluate the performance of the emergency medical services system and to plan systematically for improvements in said system at all levels."

Additional authority for data collection and analysis is provided in C.R.S. § 25-3.5-307, requiring data collection and reporting by air ambulance agencies, and C.R.S. § 25-3.5-704(2)(h), requiring the establishment of a continuous quality improvement system to evaluate the statewide emergency medical and trauma services system.

1.2 This section consists of rules for the collection and reporting of essential data related to the performance, needs and quality assessment of the statewide emergency medical and trauma services system. These rules focus primarily on the data that ambulance agencies are required to collect and provide to the Department. Rules regarding the collection of data by designated trauma facilities can be found in 6 CCR 1015-4, Chapter 1.

Section 2 - Definitions

2.1 Agency or agencies as used in this Chapter Three means (ground) ambulance services and air ambulance services.

2.2 Air Ambulance means a fixed-wing or rotor-wing aircraft that is equipped to provide air transportation and is specifically designed to accommodate the medical needs of individuals who are ill, injured, or otherwise mentally or physically incapacitated and who require in-flight medical supervision.

2.3 Air Ambulance Service means any governmental or private organization that transports in an aircraft patient(s) who require in-flight medical supervision to a medical facility.

2.4 Ambulance means any privately or publicly owned ground vehicle that meets the requirements of C.R.S. § 25-3.5-103(1.5).

2.5 Ambulance service means the furnishing, operating, conducting, maintaining, advertising, or otherwise engaging in or professing to be engaged in the transportation of patients by ambulance. Taken in context, it also means the person so engaged or professing to be so engaged. The person so engaged and the vehicles used for the emergency transportation of persons injured at a mine are excluded from this definition when the personnel utilized in the operation of said vehicles are subject to the mandatory safety standards of the federal mine safety and health administration, or its successor agency.

2.6 Patient means any individual who is sick, injured, or otherwise incapacitated or helpless.

Section 3 – Reporting Requirements

3.1 All ambulance service agencies and air ambulance service agencies licensed in Colorado shall provide the Department with the required data and information as specified in Sections 3.2 and 3.3 below in a format determined by the Department or in an alternate media acceptable to the Department.

3.2 The required data and information for the agency profile shall be based on the Colorado Emergency Medical Services Information System (CEMSIS).

3.2.1 Agency profile data shall include but not be limited to information about licensing, service types and level, agency contact information, agency director and medical director contact information, demographics of the service area, number and types of responding personnel, number of calls by response type, data collection methods, counties served, organizational type, and number and type of vehicles.

3.2.2 Agencies shall provide agency profile data to the Department using the CEMSIS portal website.

3.2.3 Agencies shall update agency profile data whenever changes occur and at least annually.

3.3 The required data and information on patient care shall be based on the National Emergency Medical Services Information System (NEMSIS).

3.3.1 These rules incorporate by reference the National Highway Traffic Safety Administration (NHTSA) Uniform Pre-Hospital Emergency Medical Services Dataset, Version 2.2.1, National Elements Subset, published in 2006. Such incorporation does not include later amendments to or editions of the referenced material. The Health Facilities and Emergency Medical Services Division of the Department maintains copies of the complete text of required data elements for public inspection during regular business hours, and shall provide certified copies of any non-copyrighted material to the public at cost upon request. Information regarding how the incorporated materials may be obtained or examined is available from the Division by contacting:

EMTS Section Chief

Health Facilities and EMS Division

Colorado Department of Public Health and Environment

4300 Cherry Creek Drive South

Denver, CO 80246-1530

These materials have been submitted to the state publications depository and distribution center and are available for interlibrary loan. The incorporated material may be examined at any state publications depository library. Submission of the National Elements Subset as stated above is required, however, ambulance services may provide additional data as outlined in the complete NEMSIS NHTSA Version 2.2.1 Data Dictionary or as suggested by the Department.

3.3.2 All agencies licensed in Colorado shall report the required data elements on all responses that resulted in patient contact. Although not required, agencies may also report the required data elements on responses that did not result in patient contact or transport (all calls).

3.3.3 Agencies shall obtain approval from the Department prior to using third party media to submit the required data.

3.3.4 Agencies shall provide the data to the Department at least quarterly based on a calendar year or on a schedule submitted to and approved by the Department. The quarterly download must be submitted to the Department within 60 days of the end of the quarter (i.e., data for EMS responses occurring in January through March must be submitted by June 1; for responses in April through June by September 1; for responses in July through September by December 1; for responses in October through December by March 1). The data may be submitted more frequently than quarterly.

3.4 In order to be eligible to apply for funding through the EMTS grants program, agencies shall provide agency profile information as described in Section 3.2 and regularly submit patient care information as described in Section 3.3.

3.5 If an agency fails to comply with these rules, the Department may report this lack of compliance to the county(ies) in which the agency is licensed and/or to the agency's medical director.

Section 4 - Confidentiality of Data and Information on Patient Care

4.1 The data and information provided to the Department in accordance with Section 3.3 of these rules shall be used to conduct continuing quality improvement of the Emergency Medical and Trauma System, pursuant to C.R.S. § 25-3.5-704 (2)(h)(I). Any data provided to the department that identifies an individual patient's, provider's or facility's care outcomes or is part of the patient's medical record shall be strictly confidential, whether such data are recorded on paper or electronically. The confidentiality protections provided in C.R.S. § 25-3.5-704 (2)(h)(II) apply to this data.

4.2 Any patient care data in the EMS data system that could potentially identify individual patients or providers shall not be released in any form to any agency, institution, or individual, except as provided in Section 4.3.

4.3 An agency may retrieve the patient care data that the agency has submitted via the Department's web-based data entry utility and that are stored on the Department's servers.

4.4 Results from any analysis of the data by the Department shall only be presented in aggregate according to established Department policies.

4.5 The Department may establish procedures to allow access by outside agencies, institutions or individuals to information in the EMS data system that does not identify patients, providers or agencies. These procedures are outlined in the Colorado EMS Data System Data Release Policy and other applicable Department data release policies.

CHAPTER FOUR – RULES PERTAINING TO LICENSURE OF GROUND AMBULANCE SERVICES

Section 1 – Purpose and Scope

1.1 These rules are promulgated pursuant to § 25-3.5-308, CRS. They are consistent with § 25-3.5-301, 302, and 304 -306, CRS. Each county may adopt rules that exceed these rules adopted herein.

Section 2 – Definitions

2.1 Based: an ambulance service headquartered, having a substation, office ambulance post or other permanent location in a county.

2.2 County: county or city and county government within Colorado.

2.3 Department: the Colorado Department of Public Health and Environment.

2.4 Ambulance: any public or privately owned land vehicle especially constructed or modified and equipped, intended to be used and maintained or operated by, ambulance services for the transportation, upon the roads, streets and highways of this state, of individuals who are sick, injured, or otherwise incapacitated or helpless.

2.5 Ambulance-advanced life support: a type of permit issued by a county to a vehicle equipped in accordance with Section 9 of these rules and operated by an ambulance service authorizing the vehicle to be used to provide ambulance service limited to the scope of practice of the advanced emergency medical technician, emergency medical technician-intermediate or paramedic as defined in the EMS Practice and Medical Director Oversight Rules at 6 CCR 1015-3 Chapter Two.

2.6 Ambulance-basic life support: a type of permit issued by a county to a vehicle equipped in accordance with Section 9 of these rules and authorized to be used to provide ambulance service limited to the scope of practice of the emergency medical technician as defined in the EMS Practice and Medical Director Oversight Rules at 6 CCR 1015-3 Chapter Two.

2.7 Ambulance service license: a legal document issued to an ambulance service by a county as evidence that the applicant meets the requirements for licensure to operate an ambulance service as defined by county resolution or regulations.

2.8 Ambulance service: the furnishing, operating, conducting, maintaining, advertising, or otherwise engaging in or professing to be engaged in the transportation of patients by ambulance. Taken in context, it also means the person so engaged or professing to be so engaged and the vehicles used for the emergency transportation of persons injured at a mine are excluded from this definition when the personnel utilized in the operation of said vehicles are subject to the mandatory safety standards of the federal mine safety and health administration, or its successor agency.

2.9 EMS Provider: refers to all levels of Emergency Medical Technician certification issued by the department, including Emergency Medical Technician, Advanced Emergency Medical Technician, Emergency Medical Technician Intermediate and Paramedic.

2.10 Medical Director: a Colorado licensed physician who establishes protocols and standing orders for medical acts performed by EMS Providers of a prehospital EMS service agency and who is specifically identified as being responsible to assure the competency of the performance of those acts by such EMS Providers as described in the physician's medical continuous quality improvement program. Any reference to a "physician advisor" in any previously adopted rules shall apply to a "medical director" as defined in these rules.

2.11 Patient Care Report: a medical record of an encounter between any patient and a provider of medical care.

2.12 Permit: the authorization issued by the governing body of a local government with respect to an ambulance used or to be used to provide ambulance service in this state.

2.13 Medical quality improvement program: a process consistent with the EMS Practice and Medical Director Oversight Rules at 6 CCR 1015-3 Chapter Two, used to objectively, systematically and continuously monitor, assess and improve the quality and appropriateness of care provided by the medical care providers operating on an ambulance service.

2.14 Rescue Unit: any organized group chartered by this state as a corporation not for profit or otherwise existing as a nonprofit organization whose purpose is the search for and the rescue of lost or injured persons and includes, but is not limited to, such groups as search and rescue, mountain rescue, ski patrols, (either volunteer or professional), law enforcement posses, civil defense units, or other organizations of governmental designation responsible for search and rescue.

2.15 Quick Response Teams: provides initial care to a patient prior to the arrival of an ambulance.

Section 3 – County Issuance of Licenses and Permit

3.1 License Required

3.1.1 Within one year following adoption of these rules, no person or agency, private or public, shall transport a patient from any point within Colorado in an ambulance, to any point within or outside Colorado unless that person or agency holds a valid license and permits issued by the county where the service is based and by the county where the patient originates, except as provided in Section 3.2 of these rules.

3.1.2 Ambulance services that are based outside Colorado, but respond within Colorado and transport patients originating in Colorado are required to be licensed in Colorado by the county in which they provide service.

3.1.3 Counties may enter into reciprocal licensing and permitting agreements with other counties and neighboring states.

3.2 County Exemptions From Licensure or Permit Requirements

3.2.1 Vehicles used for the transportation of persons injured at a mine when the personnel used on the vehicles are subject to the mandatory safety standards of the federal mine safety and health administration, or its successor agency.

3.2.2 Vehicles used by other agencies including quick response teams and rescue units that do not routinely transport patients or vehicles used to transport patients for extrication from areas inaccessible to a permitted ambulance. Vehicles used in this capacity may only transport patients to the closest practical point for access to a permitted ambulance or hospital.

3.2.3 Vehicles, including ambulances from another state, used during major catastrophe or mass casualty incident rendering services when permitted ambulances are insufficient.

3.2.4 An ambulance service that does not transport patients from points originating in Colorado, or transporting a patient originating outside the borders of Colorado.

3.2.5 Vehicles used or designed for the scheduled transportation of convalescent patients, individuals with disabilities, or persons who would not be expected to require skilled treatment or care while in the vehicle.

3.2.6 Vehicles used solely for the transportation of intoxicated persons or persons incapacitated by alcohol as defined in § 25-1-302, CRS but who are not otherwise disabled or seriously injured and who would not be expected to require skilled treatment or care while in the vehicle.

3.2.7 Ambulances operated by a department or an agency of the federal government, originating from a federal reservation for the purpose of responding to, or transporting patients under federal responsibility.

3.3 General Requirements For County Licensure Of Ambulance Services

3.3.1 Counties shall adopt by resolution or regulations a process for licensure of ambulance services. The process shall include, but not be limited to:

A. Compliance with applicable federal, state, and local laws and regulations to operate an ambulance service in Colorado.

B. An application form adopted by the county.

C. An application fee, as defined in county resolution or regulations.

D. Submission to the county, upon request, of copies of the ambulance service's written policy and procedure manual, operational or medical protocols, or other documentation the county may deem necessary.

E. Demonstration by the applicant of minimum vehicle insurance coverage as defined by § 10-4-609, CRS and § 42-7-103 (2), CRS with the county(s) identified as the certificate holder.

F. Demonstration by the applicant of proof of any additional insurance as identified in county resolution or regulations. In making a decision about additional insurance requirements at any time it deems necessary to promote the public health, safety and welfare, the county shall require a minimum level of worker's compensation consistent with the Colorado worker's compensation act of Colorado Revised Statutes title 8, article 40-47.

G. Documentation from the applicant that information regarding the amount of professional liability insurance the ambulance service carries was provided to employees.

H. Prior to beginning operations and upon change of ownership of an ambulance service, the new owner or operator must file for and obtain an ambulance license and ambulance permit.

I. The county may adopt minimum acceptable vehicle design standards for ambulances. In doing so, the county shall consider vehicle design standards such as those established by the US General Services Administration: federal specifications for ambulances KKK-A-1822 (e), 2003.

J. The county shall verify that each ambulance is inspected annually by qualified representatives, as defined and appointed by the county commissioners, to assure compliance with these rules.

K. Counties shall verify that all equipment on the ambulance is properly secured, and medications and supplies are maintained and stored according to the manufacturer's recommendations and any federal, state or local requirements.

L. A county may delegate or contract the ambulance inspection process but not the responsibility of licensure as set forth in § 25-3.5-301, *et seq.*, CRS.

M. An ambulance service license or vehicle permit may not be assigned, sold or otherwise transferred.

3.3.2 These rules incorporate by reference vehicle design standards by the US General Services Administration: federal specifications for ambulances KKK-A-1822 (e), 2003 (Section 3.3.1I). These rules do not include later amendments to or editions of the incorporated materials. The Department of Public Health and Environment maintains copies of the complete text of the incorporated materials for public inspection during regular business hours, and shall provide certified copies of any non-copyrighted material to the public at cost upon request. The incorporated material may be examined at any state publications depository library.

A. Information regarding how the incorporated materials may be obtained or examined is available from:

Emergency Medical and Trauma Services Section Chief

Health Facilities and Emergency Medical Services Division

Colorado Department of Public Health and Environment

4300 Cherry Creek Drive South, Denver, Colorado 80246

3.4 Licensure Process

3.4.1 Ambulance Service License

A. An ambulance service license shall be issued by county upon compliance with these rules and all license requirements duly established by that county. The type of license issued shall describe the maximum level of ambulance service that could be provided at any time by the service.

3.4.2 Permits Of Vehicles

A. The county shall create a process and procedure for the issuing of permits for each vehicle used by the ambulance service.

B. The type of permit issued will describe the maximum level of service that could be provided at any time by that vehicle and appropriate staff. Types of permissible permits are limited to:

1. Ambulance basic life support

2. Ambulance advanced life support

3. Each county shall include in their resolution or regulations the requirements for identification of the permitted level of service on each vehicle issued a permit.

3.5 Licensure Period

3.5.1 The licensure period for all ambulance services shall be for twelve months.

3.6 License Renewal

3.6.1 Counties shall create an annual license renewal process. The license renewal process shall require the ambulance service to submit a completed renewal application form and the required licensure fee, as defined in county resolution or regulations. The licensure renewal process shall require the receipt of applications for renewal no less than 30 days before the date of license expiration.

Section 4 - Complaints

4.1 Each county must have a written complaint and investigation policy and procedure to address:

4.1.1 complaints against any ambulance service licensed in the county.

4.1.2 allegations of unlicensed ambulance services or vehicles without a valid permit operating within the county.

4.2 The policy shall include, but not be limited to, the procedures associated with complaint intake; complaint validation; criteria for initiating an investigation; a method for notification to the complainant about the resolution of the investigation; and a method for the notification of other local entities with jurisdiction over ambulance services, the department and/or the Colorado Medical Board for complaints regarding EMS Providers or other medical personnel associated with the service or the medical director.

4.3 The county shall notify the primary medical director of the ambulance service, in writing, of any violation of the ambulance licensing regulations by the ambulance service or alleged complaints or violations by individual medical providers operating on an ambulance service.

Section 5 – Denial, Revocation, Or Suspension Of Licensure And Vehicle Permits

5.1 Each county shall develop policies and procedures for the denial, suspension or revocation of an ambulance service license or ambulance permit consistent with § 25-3.5-304, CRS.

Section 6 – Minimum Data Collection And Reporting Requirements

6.1 The county shall require that licensed ambulance services complete a patient care report for each patient that is assessed. The patient care report shall include the minimum pre-hospital care data set as set forth in the Rules Pertaining to Emergency Medical Services Data and Information Collection and Record Keeping at 6 CCR 1015-3, Chapter Three.

6.2 The county shall require that the ambulance service provide patient care information to the department pursuant to the Rules Pertaining to Emergency Medical Services Data and Information Collection and Record Keeping at 6 CCR 1015-3, Chapter Three.

6.3 The county shall require that each licensed ambulance service complete and submit to the department an agency profile as defined by the State Emergency Medical and Trauma Services Advisory Council and approved by the department to provide information on resources available for planning and coordination of statewide emergency medical and trauma services on an annual basis.

Section 7 – Minimum Staffing Requirements

7.1 The county shall establish by resolution or regulations ambulance staffing requirements to include, but not be limited to:

7.1.1 The minimum requirement for the person responsible for providing direct emergency medical care to patients transported in an ambulance is certification as an EMS Provider as defined in the Rules Pertaining to EMS Education and Certification at 6 CCR 1015-3, Chapter One.

7.1.2 The minimum requirement for the ambulance driver shall be a valid driver’s license.

7.2 Consistent with § 25-3.5-202, CRS in the case of an emergency in any ambulance service area where no person possessing the qualifications required by this section is present or available to respond to a call for the emergency treatment and transportation of patients by ambulance, any person may operate such ambulance to transport any sick, injured, or otherwise incapacitated or helpless person in order to stabilize the medical condition of such person pending the availability of personnel meeting these minimum qualifications.

Section 8 – Medical Oversight and Quality Improvement

8.1 The county shall require each ambulance service operating within their jurisdiction to have a primary medical director meeting the requirements as defined in the EMS Practice and Medical Director Oversight Rules at 6 CCR 1015-3, Chapter Two to supervise the medical acts performed by all personnel on the ambulance service. The county shall require a licensee to inform the county within 15 calendar days, in writing, of changes in medical oversight of the ambulance service and/or the medical director of record.

8.2 The county ambulance service licensure application shall include an attestation by the medical director of willingness to provide medical oversight and a medical continuous quality improvement program for the ambulance service.

8.3 The county shall require each licensed ambulance service operating within their jurisdiction to have an ongoing medical continuous quality improvement program consistent with the requirements as defined in the EMS Practice and Medical Director Oversight Rules at 6 CCR 1015-3, Chapter Two.

Section 9 – Minimum Equipment Requirements

9.1 Counties shall ensure that permitted ambulances are in compliance with the minimum equipment list for the type of service defined by their permit as defined in 9.2 and 9.3 of these rules.

9.2 Minimum Equipment For Basic Life Support Ambulances

9.2.1 Ventilation And Airway Equipment

A. portable suction unit, and a house (fixed system) or backup suction unit, with wide bore tubing, rigid pharyngeal curved suction tip, and soft catheter suction tips to include pediatric sizes 6 fr. through 14 fr.

B. bulb syringe

C. house oxygen and portable oxygen bottle, each with a variable flow regulator.

D. transparent, non-re breather oxygen masks and nasal cannula in adult sizes, and transparent, non-re breather oxygen masks in pediatric sizes.

E. hand operated, self inflating bag-valve mask resuscitators with oxygen reservoirs and standard 15mm /21mm fittings in the following sizes:

1. 500cc bag for infant and neonate

2. 750cc bag for children

3. 1000cc bag for adult

4. Transparent masks for infants, neonate patients, children and adults.

F. nasopharyngeal airways in adult sizes 24 fr. through 32 fr.

G. oropharyngeal airways in adult and pediatric sizes to include: infant, child, small adult, adult and large adult.

9.2.2 Patient Assessment Equipment

A. blood pressure cuffs to include large adult, regular adult, child and infant sizes.

B. stethoscope.

C. penlight.

9.2.3 Splinting Equipment

A. lower extremity traction splint.

B. upper and lower extremity splints.

C. long board, scoop™, vacuum mattress or equivalent with appropriate accessories to immobilize the patient from head to heels.

D. short board, K.E.D. or equivalent, with the ability to immobilize the patient from head to pelvis.

E. pediatric spine board or adult spine board that can be adapted for pediatric use.

F. adult and pediatric head immobilization equipment.

G. adult and pediatric cervical spine immobilization equipment per medical director protocol.

9.2.4 Dressing Materials

A. bandages - various types and sizes per agency needs and medical director protocol.

B. multiple dressings (including occlusive dressings), various sizes per ambulance service requirements, needs and medical director protocol.

C. sterile burn sheets.

D. adhesive tape per ambulance service requirements, needs and medical director protocol.

9.2.5 Obstetrical Supplies

A. sterile ob kit to include: towels, 4x4 dressings, umbilical tape or cord clamps, scissors, bulb syringe, sterile gloves and thermal absorbent blanket.

B. neonate stocking cap or equivalent.

9.2.6 Miscellaneous Equipment

A. heavy bandage scissors, shears or equivalent capable of cutting clothing, belts, boots, etc.

B. two working flashlights.

C. blankets and appropriate heat source for the ambulance patient compartment.

9.2.7 Ambulance Service Medical Treatment Protocols.

9.2.8 Communications Equipment

A. All communications equipment shall be maintained in good working order. The communications equipment must be capable of transmitting and receiving clear voice communications.

B. Two-way communications that will enable the ambulance personnel to communicate with:

1. ambulance service's dispatch.

2. medical control facility or a physician

3. receiving facilities

4. mutual aid agencies

9.2.9 Extrication Equipment

A. Each ambulance should carry extrication equipment appropriate for the level of extrication the ambulance service provides and in accordance with the requirements established by the county in which the ambulance is licensed.

9.2.10 Body Substance Isolation (BSI) Equipment Properly Sized To Fit All Personnel

A. non-sterile disposable gloves, to include a minimum 1 box of latex free gloves.

B. protective eyewear.

C. non-sterile surgical masks.

D. safety protection gear for extrication consistent with the ambulance service extrication capabilities.

E. sharps containers for the appropriate disposal and storage of medical waste and biohazards.

F. HEPA masks, which can be of universal size.

9.2.11 Safety Equipment

A. a set of three (3) warning reflectors.

B. one (1) ten pound (10 lb.) or two (2) five pound (5 lb.) ABC fire extinguishers, with a minimum of one extinguisher accessible from the patient compartment and vehicle exterior.

C. child safety seat or appropriate protective restraints for patients, crew, accompanying family members and other vehicle occupants.

D. properly secured patient transport system (i.e. wheeled stretcher).

E. triage tags as approved by the department.

9.3 Minimum Equipment Requirement for Advanced Life Support Ambulances

9.3.1 All Equipment Listed In Section 9.2

9.3.2 Ventilation Equipment

A. adult and pediatric endotracheal intubation equipment to include stylets and an endotracheal tube stabilization device and endotracheal tubes uncuffed range from 2/5 - 5/5, and cuffed size range from 6.0-8.0 per medical director protocol.

B. laryngoscope and blades, straight and/or curved of sizes 0-4.

C. adult and pediatric magill forceps.

D. end tidal co_2 detector or alternative device, approved by the FDA, for determining end tube placement.

9.3.3 Patient Assessment Equipment

A. portable, battery operated cardiac monitor- defibrillator with strip chart recorder and adult and pediatric EKG electrodes and defibrillation capabilities.

B. pulse oximeter with adult and pediatric probes.

C. electronic blood glucose measuring device.

9.3.4 Intravenous Equipment

A. adult and pediatric intravenous solutions and administration equipment per medical director protocol.

B. adult and pediatric intravenous arm boards.

9.3.5 Pharmacological Agents

A. pharmacological agents and delivery devices per medical director protocol.

B. pediatric "length based" device for sizing drug dosage calculations and sizing equipment.

CHAPTER FIVE – RULES PERTAINING TO AIR AMBULANCE LICENSING

Section 1 – Purpose

1.1 These rules are promulgated pursuant to Section 25-3.5-307, C.R.S.

Section 2- Definitions

2.1 Air Ambulance: A fixed-wing or rotor-wing aircraft that is equipped to provide air transportation and is specifically designed to accommodate the medical needs of individuals who are ill, injured, or otherwise mentally or physically incapacitated and who require in-flight medical supervision.

2.2 Air Ambulance License: A legal document issued by the department as evidence that an air ambulance service meets the requirements for licensing as defined in these rules.

2.3 Air Ambulance Service: Any governmental or private organization that transports in an aircraft patient(s) who require in-flight medical supervision to a medical facility.

2.4 Aircraft: A rotor or fixed wing vehicle.

2.5 Commission on Accreditation of Medical Transport Systems (CAMTS): A national not for profit organization that provides accreditation services for air medical and inter-facility transport services.

2.6 Department: The Colorado Department of Public Health and Environment.

2.7 Federal Aviation Regulations (FAR): Regulations promulgated by the Federal Aviation Administration of the U.S. Department of Transportation, governing the operation of all aircraft in the United States.

2.8 Medical Protocol: Written standards for patient medical assessment and management.

2.9 Patient Care Report (PCR): A medical record of an encounter between any patient and a provider of medical care.

2.10 Rescue Unit: Any organized group chartered by this state as a corporation not for profit or otherwise existing as a nonprofit organization whose purpose is the search for and the rescue of lost or injured persons and includes, but is not limited to, such groups as search and rescue, mountain rescue, ski patrols, (either volunteer or professional), law enforcement posses, civil defense units, or other organizations of governmental designation responsible for search and rescue.

Section 3 - Licensing

3.1 Licensing Required

Upon the effective date of these rules, no person, agency, or entity, private or public, shall transport a sick or injured person by aircraft from any point within Colorado, to any point within or outside Colorado unless that person, agency, or entity holds a valid air ambulance license to do so that has been issued by the department, except as provided in Sections 3.2 and 3.3 of these rules.

3.2 Exception from Licensing-Exigent Circumstances

Upon request, the department may authorize an air ambulance service that does not hold an air ambulance license to provide a particular transport upon a showing of exigent circumstances. Exigent circumstances include but are not limited to:

A. A humanitarian transport as determined by the department. In determining whether to authorize a humanitarian transport, the department shall consider the following factors:

1. Whether the transport is provided directly or indirectly by an organization whose mission is primarily dedicated toward non-profit or charitable or community care services;

2. Other available options for the transport;

3. Whether the transport will be of no cost to the patient;

4. Whether the transport is subsidized by a person or entity associated with the patient;

5. The qualifications of the transport personnel;

6. Information obtained from facilities and/or staff involved in the transport;

7. The air ambulance service's membership in organizations that support safe medical care;

8. Air ambulance service insurance coverage as applicable;

9. Authorization under local and federal laws to conduct operations;

10. Licensure in other states or by other governmental agencies;

11. The air ambulance service's safety record;

12. Whether or not the air ambulance service has been subject to disciplinary sanctions in other jurisdictions;

13. The air ambulance service's prior contacts with the department, if any; and

14. Any other considerations deemed relevant by the department on a case by case basis.

B. A disaster or mass casualty event in Colorado that limits the availability of licensed air ambulance services;

C. A need for specialized equipment not otherwise readily available through Colorado licensed air ambulance services.

3.3 Licensing Not Required

3.3.1 An air ambulance service that solely transports patients from points originating outside Colorado is not required to be licensed in Colorado.

3.3.2 Rescue unit aircraft that are not specifically designed to accommodate the medical needs of individuals who are ill, injured, or otherwise mentally or physically incapacitated and who require in-flight medical supervision.

Section 4 – Out Of State Air Ambulance Services Licensing Requirements

Air ambulance services that are based outside the state, but pick up patients in Colorado, are required to be licensed in Colorado by the department, except as provided in Sections 3.2 and 3.3 of these rules.

Section 5 – Application For Licensing

5.1 At the time of application, applicants must be in compliance with all Federal Aviation Regulations such as proof of insurance, aircraft inspection certificates, Federal Aviation Administration part 135 certificate and Federal Communications Commission part 90.

5.2 Accreditation by CAMTS. Except as provided in Section 5.3 below, applicants that are currently accredited by CAMTS may receive an air ambulance license upon completion of the documentation and fees that are required by the department and proof of such accreditation.

5.3 The department may issue a conditional air ambulance license to an applicant that has not yet received CAMTS accreditation upon proof that the applicant is actively working toward CAMTS accreditation. The department may require that such proof be verified by CAMTS. Any applicant that receives a conditional air ambulance license shall complete its CAMTS accreditation within two years after issuance of the initial conditional air ambulance license.

5.4 If the holder of a conditional air ambulance license fails to complete CAMTS accreditation within two years after the issuance of the initial conditional air ambulance license, its conditional air ambulance license shall be revoked and no license of any type shall be issued until it demonstrates successful completion of CAMTS accreditation.

5.5 At such time as any air ambulance service licensed under Section 3.1 of these rules receives a "notification of potential withdrawal of accreditation" from CAMTS, or is no longer CAMTS accredited, the air ambulance service shall immediately notify the department.

Section 6 - Fees

6.1 All applicants seeking air ambulance licensure by the department under these rules shall submit the following non-refundable fees with each initial or renewal licensure application:

6.1.1 $860 for each air ambulance service, plus $100 for each aircraft used by the air ambulance service.

6.1.2 For applicants who are not CAMTS accredited, the applicant shall pay a fee of $525 to the department in addition to the fee set forth in Subsection 6.1.1 above.

Section 7 – Licensing Process

7.1 To become licensed and maintain licensed status, an air ambulance service shall:

7.1.1 Achieve and maintain CAMTS accreditation.

7.1.2 Demonstrate compliance with applicable federal, state, and local laws and regulations to operate a business in Colorado.

7.1.3 Submit to the department a completed application form and the required application fee.

7.1.4 Demonstrate compliance with these rules.

7.1.5 Upon request, submit to the department copies of the air ambulance service's written policy and procedure manual, operation/medical protocols, and other documentation the department may deem necessary.

7.2 The department may conduct an inspection of the air ambulance service and its aircraft to assure compliance with these rules.

7.3 When change of ownership of an air ambulance service licensed by the department occurs, the new owner or operator must file for and obtain an air ambulance license from the department prior to beginning operations.

Section 8 – Licensing Period

Any air ambulance license issued by the department shall be valid for a period not to exceed one year.

Section 9 – Licensing Renewal

9.1 To renew an existing air ambulance license, the licensee shall submit a renewal application and fees, as set by the department, no later than three (3) months prior to the date of air ambulance license expiration.

9.2 A renewal inspection may be required by the department to assure air ambulance service compliance with these rules.

Section 10 – Types Of Service

10.1 In order to identify the types of services to be provided, air ambulance licenses shall be issued for each of the following types of service.

10.1.1 Rotor wing advanced life support (RW-ALS)

10.1.2 Rotor wing critical care (RW-CC)

10.1.3 Rotor wing specialty care (RW-SC)

10.1.4 Fixed wing basic life support (FW-BLS)

10.1.5 Fixed wing advanced life support (FW-ALS)

10.1.6 Fixed wing critical care (FW-CC)

10.1.7 Fixed wing specialty care (FW-SC)

Section 11 – General Operational Requirements for Air Ambulance Services Licensed by the Department

11.1 Each air ambulance service shall work in coordination with all other air ambulance services to assure optimal minimal response times.

11.2 Policies for responding to requests for services shall include:

11.2.1 Consultation with the requesting party regarding how and to whom those flights will be referred, based on the air ambulance service's scope of service, geographical proximity, transport capability and type of call.

11.2.2 The closest appropriate licensed air ambulance service shall be dispatched unless a specific licensed air ambulance service is requested by the requesting party.

11.2.3 All air ambulance services must have a communications system in place capable of providing appropriate, timely referrals.

11.2.4 Factors affecting the estimated time of arrival (ETA) of air ambulance service shall be communicated to the calling party as soon as possible, within five (5) minutes for inter-facility transports and three (3) minutes for scene requests.

11.2.5 Scene requests shall be referred within three (3) minutes to the next closest, available, appropriate resource if the initial requested air ambulance service does not have an aircraft and crew immediately available.

11.2.6 Inter-facility transport requests shall be referred within five (5) minutes to the next closest, available, appropriate resource if the initial requested air ambulance service does not have an aircraft and crew immediately available.

11.2.7 Air ambulance service response policies and times shall be available to the public, upon request.

11.2.8 In accordance with the Rules Pertaining to Emergency Medical Services Data and Information Collection and Record Keeping at 6 CCR 1015-3, Chapter Three, Colorado licensed air ambulance services shall complete a patient care report (PCR) to include the minimum pre-hospital care data set for each patient that is transported. The minimum data elements identified by the department shall be compiled and submitted to the department in a format and frequency specified by the department.

11.2.9 Each licensed air ambulance service shall complete and submit to the department an agency profile to provide information on resources available for planning and coordination of statewide emergency medical and trauma services.

Section 12 - Complaints

Complaints in writing relating to the quality and conduct of any air ambulance service may be made by any person or may be initiated by the department. The department may make inquiry as to the validity of such complaint prior to initiating an investigation. If the department determines that the complaint warrants a more extensive review, an investigation may be initiated. If the complaint does not warrant further review or the inquiry determines that the complaint is not within regulatory jurisdiction of the department, the department will notify the complainant of the results of the inquiry. The department shall refer complaints that are related to the requirements of CAMTS or a successor organization to CAMTS or such successor organization for investigation. The department may forward complaints to other regulatory agencies.

Section 13 - Denial, Revocation, Suspension, Summary Suspension, or Limitations of Air Ambulance Licenses

13.1 If the department proposes for good cause to deny, revoke, suspend, summarily suspend or limit the license of an air ambulance service, the department shall notify the air ambulance service of its right to appeal the denial, revocation, suspension, summary suspension, or limitation, and the procedure for appealing. Appeals of departmental denials, revocations, suspensions, summary suspensions, or limitations shall be conducted in accordance with the State Administrative Procedure Act, Section 24-4-101, et seq., C.R.S.

13.2 In accordance with Section 24-4-104(4) C.R.S., the department may summarily suspend an air ambulance license when the department has objective and reasonable grounds to believe and finds, upon a full investigation, that the holder of the license has been guilty of deliberate and willful violation or that the public health, safety or welfare imperatively requires emergency action by the department. If the department summarily suspends a license, the department shall provide the air ambulance service with notice of such suspension in writing. The notice shall state that the air ambulance service is entitled to a prompt hearing on the matter.

13.3 Good cause for sanctions include but are not limited to:

13.3.1 An applicant or licensee who fails to meet the requirements for licensing as set forth in these rules.

13.3.2 An applicant or licensee who has committed fraud, misrepresentation, or deception in applying for a license.

13.3.3 Falsifying reporting information provided to the department.

13.3.4 Violating any state or federal statute, rule or regulation that would jeopardize the health or safety of a patient or the public.

13.3.5 Unprofessional conduct, which hinders, delays, eliminates, or deters the provision of medical care to the patient or endangers the safety of the public.

13.3.6 Failure to achieve or maintain CAMTS accreditation.

Section 14 – General Requirements

14.1 These rules incorporate by reference the following materials:

14.1.1 For air ambulance services whose most recent application for CAMTS accreditation is submitted on or after July 1, 2011: the 8th Edition Accreditation Standards of the Commission on Accreditation of Medical Transport Systems, published October 2010.

14.1.2 Such incorporation does not include later amendments to or editions of the referenced material. The referenced material can be obtained from the Commission on Accreditation of Medical Transport Systems website at www.camts.org. The Health Facilities and Emergency Medical Services Division of the Colorado Department of Public Health and Environment maintains copies of the complete text of the incorporated materials for public inspection during regular business hours, and shall provide certified copies of any non-copyrighted material to the public at cost upon request. Information regarding how the incorporated materials may be obtained or examined is available from the division by contacting:

EMTS Section Chief

Health Facilities and EMS Division

Colorado Department of Public Health and Environment

4300 Cherry Creek Drive South

Denver, Colorado 80246-1530

14.2 These materials have been submitted to the state publications depository and distribution center and are available for interlibrary loans. The incorporated material may be examined at any state publications depository library.

Editor's Notes

History

Section 13 eff. 03/01/2008.

Section 11 eff. 05/30/2008.

Sections 1-6 eff. 12/30/2009.

Chapter Two eff. 12/15/2010.

Entire Rule eff. 06/30/2011.

Chapter One eff. 03/17/2013.

Chapter Two eff. 06/14/2013.

Annotations

Rule 5.4.1.D (adopted 11/18/2009) was not extended by Senate Bill 11-078 and therefore expired 05/15/2011.

Colorado Department
of Public Health
and Environment

DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Health Facilities and Emergency Medical Services Division

6 CCR 1015-4

STATEWIDE EMERGENCY MEDICAL AND TRAUMA CARE SYSTEM
(PROMULGATED BY THE STATE BOARD OF HEALTH)

CHAPTER TWO
Last amended 01/19/11, effective 03/02/11

CHAPTER TWO - STATE EMERGENCY MEDICAL AND TRAUMA CARE SYSTEM STANDARDS

201. In order to ensure effective system development, all regions must comply with the following minimum standards.

202. Minimum Standards for Regional Emergency Medical and Trauma Care Resources

A. Communication

The region must provide communication and dispatch systems that insure coordinated coverage, specifically:

1. Utilization of the universal 9-1-1 or a local equivalent that is well publicized and accessible for citizens and visitors to the region.

2. Adequate dispatch services.

3. Paging and alerting system for notification of emergency medical/trauma personnel who routinely respond to emergency medical/trauma incidents.

4. Two-way communications between and among ambulances.

5. Two-way communications between ambulances and non-designated facilities and designated trauma facilities.

6. Two-way communications between ambulances and trauma facilities outside the Regional Emergency Medical and Trauma Advisory Council (RETAC) area.

7. A plan for utilization of an alternative communications system to serve as a back-up to the primary system.

8. A disaster communications plan.

9. A system for notification and alerting trauma teams, fixed and rotary wing emergency services, and trauma centers.

10. A system that is compatible with systems in adjacent regions.

B. Prehospital

First response units and ambulance services must meet the following criteria:

1. Minimum acceptable level of service:

    a. Basic life support (BLS) service - Must have at least 1 person who is at first responder or higher level of training

    b. Advanced life support (ALS) service - Must have at least 1 person who is at EMT-I or EMT-P level of training

2. Emergency response times for ground transport agencies:

.	.	.	<u>Time Limit</u>
.	a.	High density areas (metropolitan)	.

.	.	(1) Provider service area encompasses 100,000 people or more	11 minutes, 90% of the time
.	b.	Mid-density areas (urban or mixed)	.
.	.	(1) Provider service area encompasses12,000 to 100,000 people	20 minutes, 90% of the time
.	c.	Low density areas (rural, frontier)	.
.	.	(1) Provider service area encompasses <12,000 people	45 minutes, 90% of the time
	.		

3. Optimal scene time limits 15 minutes, 90% of the time

   Scene time = time of arrival of transport agency at the scene to departure of the scene

4. Agencies shall conduct quality improvement monitoring for all response and scene times that exceed these parameters and make a plan of correction where necessary

5. Triage and transport of trauma patients must be in accordance with the prehospital transport destination algorithms (exhibits A and B to these regulations)

C. Interfacility Transfer and Consultation - Adult - Age 15 and older

1. Levels II and III trauma centers caring for the critically injured adult trauma patients listed below must comply with the actions required:

   a. Bilateral pulmonary contusions requiring nontraditional ventilation

   b. Patient with multisystem trauma with pre-existing coagulopathy (hemophilia)

   c. Pelvic fractures with unrelenting hemorrhage

   d. Aortic tears

   e. Liver injuries requiring emergency surgery and requirement for liver packing or vena cava injury

   <u>Actions Required:</u>

   (1) Mandatory, timely (but within 6 hours after recognition of condition) consultation is required with a Level I trauma surgeon (who is a member of the attending staff) for consideration of transfer of the patient. The attending trauma surgeon of the referring facility should initiate the consultation.

   (2) Consultation with the attending trauma surgeon is required in the determination of the necessity of transfer and the circumstances of

transfer including, but not limited to, additional diagnostic/therapeutic issues, availability of resources, weather conditions.

2. Level III trauma centers caring for the high risk adult trauma patients with the following traumatic injuries must comply with the actions required:

   a. Significant head injuries (intracranial bleeding or Glasgow Coma Scale (GCS) ≤ 10) or spinal cord injury with neurologic deficit where neurosurgical consultation and evaluation are not promptly available

   b. Significant multisystem trauma as defined by:

      (1) Head injury (intracranial bleeding or GCS ≤ 10) or spinal cord injury with neurologic deficit complicated by either significant chest and/or abdominal injuries as defined by:

         (a) Chest Injury (as part of multisystem injuries):

            i) Multiple rib fractures > 4 unilaterally or > 2 bilaterally

            ii) Hemothorax

         (b) Abdominal Injury (as part of multisystem trauma):

            i) Significant intra or retroperitoneal bleeding

            ii) Hollow organ or solid visceral injury

   c. Bilateral femur fracture or posterior pelvic fracture complicated by significant chest and/or abdominal injuries as defined above

   d. Trauma patient on mechanical ventilation for > 4 days

   e. Life threatening complications, such as acute renal failure (creatinine > 2.5 mg/dl) or coagulopathy (twice the normal value for individual facility)

   <u>Actions Required:</u>

      (1) Mandatory timely (but within 12 hours after recognition of condition) consultation is required with a Level I or key resource facility trauma surgeon (who is a member of the attending staff) for consideration of transfer of the patient. The primary attending physician at the Level III facility should initiate the consultation.

      (2) Consultation with the trauma surgeon is required in the determination of the necessity of transfer and the circumstances of transfer including, but not limited to, additional diagnostic/therapeutic issues, availability of resources, weather conditions.

      (3) Consultation and/or transfer decisions in patients with traumatic injuries less severe than those listed above shall be determined by the RETAC based on resources, facilities, and personnel available in the region and shall be made in accordance with RETAC protocols.

3. Level IV trauma centers caring for patients with the following traumatic injuries must comply with the actions required:

    a. Critical injuries listed in 6 CCR 1015-4, Chapter Two, Section 202, C.1

    b. Significant head injuries (intracranial bleeding or GCS $\leq$ 10) or spinal cord injury with neurologic deficit

    c. Significant multisystem trauma as defined by:

        (1) Head injury (intracranial bleeding or GCS $\leq$ 10) or spinal cord injury with neurologic deficit complicated by either significant chest and/or abdominal injuries as defined by:

            (a) Chest Injuries (as part of multisystem trauma):

                i) Multiple rib fractures > 4 unilaterally or > 2 bilaterally

                ii) Hemothorax

            (b) Abdominal Injuries (as part of multisystem trauma):

                i) Significant intra or retroperitoneal bleeding

                ii) Hollow organ or solid visceral injury

    d. Bilateral femur fracture or posterior pelvic fracture complicated by either significant chest or abdominal injuries as defined above

    e. Trauma patient on mechanical ventilation

    f. Life threatening complications, such as acute renal failure (creatinine > 2.5 mg/dl) or coagulopathy (twice the normal value for individual facility)

    <u>Actions required:</u>

        (1) Mandatory timely (but within 6 hours after recognition of condition) transfer is required for patients with the above defined injuries.

        (2) The primary attending physician at the level IV trauma center shall consult with the attending trauma surgeon at the key resource facility prior to transfer to determine the most appropriate destination for such patients and to discuss the circumstances of transfer such as additional diagnostic/therapeutic issues, availability of resources, weather conditions, etc.

        (3) Consultation and/or transfer decisions in patients with traumatic injuries less severe than those listed above shall be determined by the RETAC based on resources, facilities, and personnel available in the region and shall be in accordance with RETAC protocols.

4. Nondesignated Facilities

    Within two hours of recognition that a patient has experienced a significant injury or mechanism as defined in 6 CCR 1015-4, Chapter Two, Sections 202C, 202D or the prehospital algorithms (exhibits A and B), the facility shall resuscitate, stabilize and/or initiate transfer of the patient, after consultation with a trauma surgeon or emergency physician at the closest designated trauma center. Transfer shall be to the closest appropriate trauma facility as defined by RETAC protocols and as determined in consultation with the trauma surgeon or emergency physician. Nondesignated facilities must transfer all trauma patients except those defined in 6 CCR 1015-4, Chapter Two, Section 202.C.5.

5. Noncomplicated Trauma Injuries

   Interfacility transfer of single system injuries that are not threatening to life or limb and whose care is not complicated by co-morbid conditions shall be made in accordance with RETAC protocols. RETACs must monitor transport within their regions and report systematic exceptions to the protocols or regulations to the department.

6. RETACs must monitor treatment and transfer of patients with the above conditions.

   Documentation and quality improvement monitoring must be completed on such patients. Systematic exceptions of the standards must be reported to the department. For example, if significantly injured patients with multisystem trauma injuries are consistently transported to undesignated or level IV facilities, such transport deviation from the standards would constitute a systematic exception that must be reported.

7. RETACs are responsible for ensuring that interfacility transfer agreements exist in all facilities transferring patients within and outside the area.

D. Interfacility Transfer and Consultation [1,2] - Pediatric - Age 0-14

1. For the purpose of 6 CCR 1015-4, Chapter Two, Section 202.D. "critical injuries" are defined as any of the following:

   a. Bilateral pulmonary contusions requiring non-traditional ventilation

   b. Multisystem trauma with preexisting or life threatening coagulopathy

   c. Pelvic fractures with unrelenting hemorrhage

   d. Aortic tears

   e. Liver injuries with vena cava injury or requiring emergency surgery with liver packing

   f. Coma for longer than 6 hours or with focal neurologic deficit

2. For the purpose of 6 CCR 1015-4, Chapter Two, Section 202.D,"high risk injuries" are defined as any of the following:

   a. Penetrating injuries to head, neck, torso, or proximal extremities

   b. Injuries resulting in the need for mechanical ventilation of > 16 hours

   c. Persistent in-hospital evidence of physiologic compromise including: tachycardia relative to age plus signs of poor perfusion (capillary refill test > 2 seconds, cool extremities, decreased pulses, altered mental status, or respiratory distress), hypotension

d. Hemodynamically stable children with documented visceral injury admitted for "observational" management and requiring blood transfusion or fluids > 40cc/kg

e. Injury Severity Score ≥ 9 including, but not limited to:

(1) Multisystem blunt injuries (> 2 systems)

(2) Pelvic or long bone fractures in conjunction with multisystem injuries

(3) Altered mental status (GCS <10) with significant trauma

3. For the purpose of 6 CCR 1015-4, Chapter Two, Section 202.D. "high risk mechanisms" are defined as any of the following high energy transfer mechanisms:

a. Falls > 20 feet

b. Auto crashes with significant vehicle body damage

c. Significant motorcycle crashes

d. All terrain vehicle crashes

4. Level II trauma centers with pediatric commitment designation (LII/PC) that care for pediatric patients (age 0-14 years) with critical injuries must comply with the actions required:

<u>Actions required:</u>

a. Mandatory timely (but within 6 hours after recognition of condition) consultation [1,2] is required with an attending trauma surgeon from a Regional Pediatric Trauma Center (RPTC) or a Level I trauma center with Pediatric Commitment (LI/PC).

5. Level I and II trauma centers without pediatric commitment and Level III centers caring for pediatric trauma patients (age 0-14 years) with critical injuries or high risk injuries must comply with the actions required:

<u>Actions required:</u>

a. <u>Children 0 - 5 years</u> of age with critical injuries shall be transferred with prior consultation [1,2] to a RPTC. If such a center is not available, then transfer [1,2] shall be to a LI/PC. If such a center is not available, then transfer shall be to a LII/PC. If no center with pediatric commitment is available, transfer [1,2] shall be to the highest level trauma center available.

b. <u>Children 6 - 14 years</u> of age with critical injuries. Mandatory timely (but within 6 hours after recognition of condition) consultation [1,2] is required with an attending trauma surgeon at a RPTC or a LI/PC for consideration of transfer of the patient.

c. <u>Children 0 - 14 years</u> of age with high risk injuries. Mandatory timely (but within 6 hours of recognition of condition) consultation [1,2] is required with an attending trauma surgeon at a RPTC or LI/PC for consideration of transfer of the patient.

6. Level IV trauma centers and nondesignated facilities caring for pediatric patients (age 0-14 years) with critical injuries or high risk injuries must comply with the actions required:

<u>Actions required:</u>

a. Children 0 - 5 years of age with critical injuries shall be transferred [1,2] to a RPTC. If such a center is not available, then transfer [1,2] shall be to a LI/PC. If such a center is not available, then transfer shall be to a LII/PC. If no center with pediatric commitment is available, transfer [1,2] shall be to the highest level trauma center available.

b. Children 6 - 14 years of age with critical injuries shall be transferred [1,2] to a RPTC or a LI/PC. If such a center is not available, then to a LII/PC. If no center with pediatric commitment is available, transfer [1,2] to the highest level trauma center available.

c. Children 0 - 5 years of age with high risk injuries shall be transferred [1,2] to either a RPTC or a LI/PC. If such a center is not available, then to a LII/PC. If no center with pediatric commitment is available transfer [1,2] to the highest level trauma center available.

d. Children 6 - 14 years of age with high risk injuries shall be transferred with prior consultation [1,2] to either a RPTC, LI/PC or LII/PC. If no center with pediatric commitment is available then transfer to the highest level trauma center available.

7. Level IV trauma centers and nondesignated facilities caring for pediatric patients (age 0- 14 years) who are injured by high risk mechanisms shall comply with the actions required:

Actions required:

a. Mandatory timely (but within 6 hours) consultation [1,2] is required with an attending trauma surgeon from a RPTC , LI/PC or LII/PC for consideration of transfer.

8. Consultation and/or transfer decisions in pediatric patients with traumatic injuries less severe than those listed above shall be determined by the RETAC based on resources, facilities, and personnel available in the region and shall be in accordance with the RETAC protocols.

9. Nondesignated Facilities

Nondesignated facilities that receive and are accountable for pediatric trauma patients (age 0-14 years) with any traumatic conditions other than non-complicated, non-life threatening, single system injuries must transfer those patients to the appropriate, designated trauma center. Transfer agreements are required.

10. RETACs must monitor transport of pediatric trauma patients within their regions and report systematic exceptions to the protocols or regulations to the department.

11. Where superscript [1] and/or [2] appear, the following shall apply:

1 Consultation is required in the determination of the necessity of transfer and the circumstances of transfer including, but not limited to, additional diagnostic/therapeutic issues, availability of resources, weather conditions.

2 Consultation must be initiated by the attending trauma surgeon of the referring Level I, II, or III trauma center or attending physician of the Level IV or nondesignated facility.

E. Divert

If coordinated within the RETAC and pursuant to protocol, facilities may go on divert status for the following reasons:

1. Lack of critical equipment
2. Operating room saturation
3. Emergency department saturation
4. Intensive care unit saturation
5. Facility structural compromise
6. Disaster
7. Lack of critical staff

Redirection of trauma patient transport shall be in accordance with the prehospital trauma triage algorithms (exhibits A and B) and these regulations when a trauma center is on divert status.

Trauma facilities must keep a record of times and reasons for going on divert status. This information must be made available for RETAC and/or department audit.

RETACs must audit facility diversion of trauma patients in their areas. Upon consideration of the reason for divert status, the authorizing personnel and other pertinent facts, RETACs may institute corrective action if the diversion was not reasonable or necessary.

F. Bypass

At times the prehospital trauma triage algorithms (exhibits A and B) may require that prehospital providers bypass the nearest facility to transport the patient to a higher level trauma center. The necessity for such bypass must be initially determined by the physiologic criteria in the algorithms. However, certain situations may require different transport such as excessive expected transport time to the nearest trauma center, or lengthy extrication time requiring air evacuation, or other emergency conditions (traumatic cardiac arrest or transfer to a subspecialty center).

RETACs must develop protocols for patient destination within their areas that address bypass for situations not addressed in the algorithms. Bypass situations must be monitored, and the RETAC must require justification for deviation.

203. Exemptions or Variances

The State Emergency Medical and Trauma Services Advisory Council (SEMTAC) may grant exemptions from one or more standards of these regulations if the applicant submits information that demonstrates that such exemption is justified.

SEMTAC must find, based upon the information submitted and other pertinent factors, that particular standards are inappropriate because of special circumstances, which would render such compliance unreasonable, burdensome or impractical. Exemptions or variances may be limited in time, or may be conditioned, as SEMTAC considers necessary to protect the public welfare.

EXHIBIT A

Prehospital Trauma Triage Algorithm
Adult Patients (Ages 15 and older)

UNABLE TO ADEQUATELY VENTILATE

Yes → **DESTINATION INSTRUCTIONS PER RETAC PROTOCOL**

No ↓

PHYSIOLOGIC CRITERIA

Any one of the following:

1. Intubation or assisted ventilation
2. Respiratory rate < 10 or > 29
3. Systolic BP < 90
4. GCS **motor score** ≤ 5

Yes → **DESTINATION INSTRUCTIONS PER RETAC PROTOCOL**

No ↓

ANATOMIC CRITERIA

Any one of the following (<u>known or suspected</u>):

1. Penetrating injuries to the head, neck, torso or extremities above the elbow or knee
2. Flail chest
3. Two or more proximal long bone fractures (humerus and/or femur)
4. Unstable pelvic fracture
5. Paralysis or other evidence of spinal cord injury
6. Amputation above the wrist or ankle
7. Crushed, degloved or mangled extremity
8. Open or depressed skull fracture

Yes → **DESTINATION INSTRUCTIONS PER RETAC PROTOCOL**

No ↓

MECHANISM OF INJURY CRITERIA

Any one of the following:

1. Falls > 20 feet
2. High risk auto crash, with such components as:
   - --Intrusion of vehicle of ≥ 12 inches in occupant compartment; >18 inches any site
   - --Ejection (partial or complete) from automobile
   - --Death in same passenger compartment
3. Auto vs. pedestrian/bicyclist thrown, run over, or with significant impact (auto going >20 mph)
4. Motorcycle crash > 20 mph
5. Events involving high energy dissipation, such as:
   - --Ejection from motorcycle, ATV, animal, etc.
   - --Striking a fixed object with momentum
   - --Blast or explosion
6. High energy electrical injury

Yes → **DESTINATION INSTRUCTIONS PER RETAC PROTOCOL**

No ↓

OTHER CONSIDERATIONS

1. Older adult: The risk of death increases after age 55 years
2. Anticoagulation or bleeding disorders
3. End-stage renal disease requiring dialysis
4. Pregnancy >20 weeks
5. Suspicion of hypothermia
6. Suspicion of abdominal injury/seatbelt sign
7. Burns > 10% TBSA (2nd or 3rd degree) and/or burns to the hands, face, feet, groin and/or inhalation burns
8. EMS provider judgment for triage to a higher level trauma center

Yes → **DESTINATION INSTRUCTIONS PER RETAC PROTOCOL**

No → **DESTINATION INSTRUCTIONS PER RETAC PROTOCOL**

EXHIBIT B

Prehospital Trauma Triage Algorithm
Pediatric Patients (Less than 15 years old)

UNABLE TO ADEQUATELY VENTILATE

Yes → **DESTINATION INSTRUCTIONS PER RETAC PROTOCOL**

No ↓

PHYSIOLOGIC CRITERIA

Any one of the following:

1. Intubation or assisted ventilation
2. Any signs or symptoms of respiratory insufficiency, such as:
   --Severe hypoxia
   --Accessory muscle use, grunting or abdominal breathing
3. Any signs or symptoms of abnormal perfusion, such as:
   --Decreased capillary refill (> 2 sec)
   --Low systolic BP for age
4. Only responsive to pain or unresponsive [AVPU]

Age	SBP (mmHg)
<1 year	<60
1-10 years	<70 + 2 x Age
>10 years	<90

Yes → **DESTINATION INSTRUCTIONS PER RETAC PROTOCOL**

No ↓

ANATOMIC CRITERIA

Any one of the following (known or suspected):

1. Penetrating injuries to the head, neck, torso or extremities above the elbow or knee
2. Flail chest
3. Two or more proximal long bone fractures (humerus and/or femur)
4. Unstable pelvic fracture
5. Paralysis or other evidence of spinal cord injury
6. Amputation above the wrist or ankle
7. Crushed, degloved or mangled extremity
8. Open or depressed skull fracture

Yes → **DESTINATION INSTRUCTIONS PER RETAC PROTOCOL**

No ↓

MECHANISM OF INJURY CRITERIA

Any one of the following criteria:

1. Falls > 15 feet or 3x the height of the child
2. High risk auto crash, with such components as:
   --Intrusion of vehicle of ≥ 12 inches in occupant compartment; >18 inches any site
   --Ejection (partial or complete) from automobile
   --Death in same passenger compartment
   --Moderate/high speed crash with unrestrained or improperly restrained child
3. Auto vs. pedestrian/bicyclist thrown, run over, or with significant impact (auto going >20 mph)
4. Motorcycle crash > 20 mph
5. Events involving high energy dissipation, such as:
   --Ejection from motorcycle, ATV, animal, etc.
   --Striking a fixed object with momentum
   --Blast or explosion
6. High energy electrical injury

Yes → **DESTINATION INSTRUCTIONS PER RETAC PROTOCOL**

No ↓

OTHER CONSIDERATIONS

1. Suspicion for non-accidental trauma
2. Anticoagulation or bleeding disorders
3. End-stage renal disease requiring dialysis
4. Pregnancy >20 weeks
5. Suspicion of hypothermia
6. Intra-abdominal injury: abdominal tenderness, distension or seatbelt mark on the torso
7. Burns > 10% TBSA (2nd or 3rd degree) and/or burns to the hands, face, feet, or groin; or inhalation injury
8. EMS provider judgment for triage to a higher level trauma center

Yes → **DESTINATION INSTRUCTIONS PER RETAC PROTOCOL**

No → **DESTINATION INSTRUCTIONS PER RETAC PROTOCOL**

Editor's Notes

History

Chapters Two and Three eff. 08/30/2007.

Chapter Two eff. 03/02/2011.

APPENDIX F – ALTERNATIVES COST ESTIMATES

APPENDIX F – FACILITY COST ESTIMATES

VEHICLES

Vehicles	Quantity	Unit Cost	Total
Class A Engine (New-crew cab 4x4)	1	$300,000	$300,000
Water Tender Truck (New - 1800 gallon 4x4)	1	$175,000	$175,000
Rescue Squad (New - Suburban type 4x4)	1	$65,000	$65,000
Type 6 Brush Truck (New)	1	$80,000	$80,000
		Total	**$620,000**

Source: Representatives of Carbondale & Rural Fire Protection District

VEHICLE EQUIPMENT (SUMMARY)

Vehicle Equipment	Quantity	Unit Cost	Total
Extrication Tool	1	$15,000	$15,000
Extrication Equipment		$7,345	$7,345
Portable Pump - 250 gpm		$850	$850
Engine Equipment		$20,420	$20,420
Rescue Squad Equipment		$5,050	$5,050
Tender Equipment		$3,165	$3,165
Type 6 Brush Truck Equipment		$4,640	$4,640
		Total	**$56,470**

Source: Representatives of Carbondale & Rural Fire Protection District

ENGINE EQUIPMENT – EXTRICATION

Extrication Equipment	Quantity	Unit Cost	Total
Extrication Tool - Cutter, Spreader, Power Unit	1	$15,000	$15,000
Extrication - Cribbing	1 set	$495	$495
Extrication - Hydraulic Rams (2)	2	$1,100	$2,200
Extrication - Vehicle Stabilizers (rescue jacks)	4	$975	$3,900
Air chisel	1	$750	$750

Source: Representatives of Carbondale & Rural Fire Protection District

ENGINE EQUIPMENT

Engine Equipment - ref: NFPA 1901 & ISO	Quantity	Unit Cost	Total
Hose - 1.75" in attack hose	400'	$175	$700
Hose – 3" supply hose	1200'	$225	$5,400
Hose - 2.5 attack hose	400'	$200	$800
Nozzles - 1.5"	2	$450	$900
Nozzles - 2.5"	1	$500	$500
Solid Stream Nozzle - 2.5"	1	$600	$600
Combination Nozzle - 1.5"	1	$450	$450
Distributing Nozzle - 1.5"	1	$150	$150
Master Stream Device - 500 gpm minimum	1	$1,500	$1,500
Foam eductor - class B	1	$450	$450
Class B foam	15 gallons	$70	$210
Salvage Covers	2	$95	$190
Electric Generator - 5kw	1	$1,800	$1,800
Portable floodlights	2	$150	$300
Smoke ejector fan	1	$800	$800
Ventilation Saw (chain type)	1	$1,400	$1,400
Demo Saw (K-12 type)	1	$1,200	$1,200
Handlights	4	$100	$400
Hose clamp	1	$250	$250
Hydrant hose gate 2.5"	1	$175	$175
Burst hose jacket (leather)	1	$35	$35
Gated wye 2.5' x 1.5"	1	$250	$250
Pike poles – 6', 8', 12'	3	$55	$165
24' extension ladder	1	$500	$500
14' roof ladder	1	$275	$275
10' collapsible ladder	1	$175	$175
Pick head axe	1	$55	$55
Flat head axe	1	$50	$50
Crowbar or pry bar	1	$35	$35
Bolt cutter	1	$55	$55
Halligan tool	1	$200	$200
Fire extinguisher - dry chem 20lb	1	$150	$150
Fire extinguisher - water	1	$50	$50
Hydrant/spanner wrench set	2	$125	$250
		Total	**$20,420**

Source: Representatives of Carbondale & Rural Fire Protection District

TENDER EQUIPMENT

Tender Equipment	Quantity	Unit Cost	Total
Porta Tank - 2500 gallon	1	$975	$975
Hose – 3' supply hose	200'	$225	$900
Hose - 1.5" wildland hose	200'	$175	$700
Hose – 1" wildland hose	400'	$80	$320
Nozzle - 1.5" wildland	2	$25	$50
Nozzle – 1" wildland	2	$25	$50
Gated wye 1.5" x 1'	1	$45	$45
Hydrant/spanner wrench set	1	$125	$125
		Total	**$3,165**

Source: Representatives of Carbondale & Rural Fire Protection District

RESCUE SQUAD EQUIPMENT

Rescue Squad Equipment	Quantity	Unit Cost	Total
Automatic External Defibrillator (AED)	1	$1,600	$1,600
Basic Life Support Bag (BLS) w/ equipment	1	$650	$650
Low angle rescue - uphaul kit	1	$1,500	$1,500
Stokes litter	1	$350	$350
Oxygen cylinder – "E" cylinder	2	$150	$150
Long backboard	2	$150	$300
Patient immobilization kit	2	$150	$300
Portable suction unit	1	$200	$200
		Total	**$5,050**

Source: Representatives of Carbondale & Rural Fire Protection District

Type 6 Brush Truck Equipment

Type 6 Brush Truck	Quantity	Unit Cost	Total
Fireline Pack w/ fire shelter	4	$400	$1,600
Hose pack (progressive hose lay)	2	$150	$300
Nozzle - 1.5" wildland	2	$25	$50
Nozzle – 1" wildland	4	$25	$100
Nozzle - ¾" wildland	4	$10	$40
Pulaski	4	$45	$180
Shovel	4	$45	$180
Mcleoud tool	2	$55	$110
Miscellaneous adapters & fittings - wildland		$150	$150
Chain saw	1	$800	$800
Hose - 1.5" wildland	400'	$80	$320
Hose – 1" wildland	400'	$80	$320
Hose - 3/4" wildland	400'	$30	$240
Small portable pump - wildland	1	$250	$250
		Total	**$4,640**

Source: Representatives of Carbondale & Rural Fire Protection District

Fire Fighter Equipment

Item	Quantity	Unit Cost	Total
Structural PPE (Coat & Pants)	12	$2,000	$24,000
Structural Helmet	12	$275	$3,300
Structural Boots	12	$225	$2,700
Structural Gloves	12	$45	$540
Nomex Hood	12	$25	$300
Self Contained Breathing Apparatus (SCBA)	6	$4,500	$27,000
Individual SCBA face pieces	12	$750	$9,000
Spare SCBA Bottles	6	$500	$3,000
Wildland Pants	12	$175	$2,100
Wildland Shirt	12	$110	$1,320
Wildland Helmet	12	$45	$540
Wildland Gloves	12	$20	$240
Wildland Goggles	12	$35	$420
		Total	**$74,460**

Source: Representatives of Carbondale & Rural Fire Protection District

STATION EQUIPMENT

Station Equipment	Quantity	Unit Cost	Total
Breathing Air Compressor	1	$20,000	$20,000
Oxygen Cascade System	1	$1,800	$1,800
Station hose 3"	200'	$225	$900
Station hose 2.5"	200'	$200	$800
Station hose 1.75"	200'	$175	$700
Spare Class B foam	30 gallons	$70	$420
Tool Chest & Basic automotive tool set	1	$1,000	$1,000
		Total	**$25,620**

Source: Representatives of Carbondale & Rural Fire Protection District

COMMUNICATIONS EQUIPMENT

Communication Equip Costs	Main Station	Substation		Total
BLM special use permit	$550			$550
Repeater Site Development	$10,000			$10,000
Repeater Radio & Installation	$10,000			$10,000
Legal & consulting	$10,000			$10,000
Pagers & chargers (12 @ 400 ea)	$4,800	8 @ 400 ea	$3,200	$8,000
Mobile Radios (4 @ 2500)	$10,000	3 @ 2500 ea	$7,500	$17,500
Portable Radios (12 @ 1500)	$18,000	6 @ 1500 ea	$9,000	$27,000
Base Station & Console	$10,000			$10,000
Total Estimate	**$73,350**		**$19,700**	**$93,050**

Source: Representatives of Carbondale & Rural Fire Protection District; Bureau of Land Management Rental Fee Schedule for Communications Uses

OPERATING COSTS

Operating Costs	Main Station	Substation	Total
T-1 Line	$4,320	$4,320	$8,640
Maintenance Contracts	$2,000	--	$2,000
Communication Board Fees	$2,000	--	$2,000
Supplies	$2,000	$2,000	$4,000
Total Estimate	**$10,320**	**$6,320**	**$16,640**

Source: Representatives of Carbondale & Rural Fire Protection District

Station Development Costs

Main Station

Station Development Costs	Main Station
Main Station Construction (4 Bays)	$2,512,300
Land Lease	$25,000
Total Estimate	**$2,537,300**

Source: Jviation, Inc.; TG Malloy Consulting, LLC

Substation

Station Development Costs	Main Station
Substation Construction (2 Bays)	$768,720
Land Acquisition	$6,500
Total Estimate	**$1,297,000**

Source: Jviation, Inc.; TG Malloy Consulting, LLC

Station Development Costs	Main Station
Substation with 1 Bedroom Apartment Construction (4 Bays)	$1,777,920
Land Acquisition	$6,500
Substation with 1 Bedroom Apartment Construction (2 Bays)	$918,720
Land Acquisition	$6,500
Total Estimate	**$2,109,640**

Personnel & Training Costs

Station Development Costs	Main Station
Paid Fire Chief	$75,000
Paid Staff (4 paid firefighters)*	$220,000
Training Costs (12 firefighters)	$32,000
Total Estimate	**$327,680**

Source: Representatives of Carbondale & Rural Fire Protection District; Jviation, Inc.
**Excludes paid fire chief*