FM-200® TOTAL FLOOD FIRE SUPPRESSION SYSTEM

HYGOOD

DESIGN, INSTALLATION, AND MAINTENANCE MANUAL



UL FM APPROVED

025592

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Johnson Controls

This manual is intended for use with the HYGOOD® FM-200® Clean Agent Total Flood Fire Suppression System. These systems are specifically engineered for total flooding application in either unoccupied or occupied areas. Planning, design, installation, operation, recharge, and maintenance of the system must conform to the limitations detailed in this manual. An individual holding a valid certification from an FM-200 system training program with training to plan, install, and maintain the FM-200 system shall install and maintain the FM-200 system.

Those who design, install, operate, reset, inspect, maintain, and recharge these systems should read this entire manual. Specific sections are of particular interest depending upon one's responsibilities.

As with all electrical, mechanical, and pneumatic equipment, the system needs periodic care to provide maximum assurance that it operates effectively and safely. Inspection frequency shall be performed consistently, depending on operating and environmental conditions. Maintenance shall be performed semiannually, or more frequently, depending on operating and environmental conditions.

The application and use of the FM-200 system is limited to the applications and uses described in this manual. For other applications, contact an Authorized HYGOOD Distributor, Territory Manager, or the Technical Services Department.

Note: The converted values in this document are provided for dimensional reference only and do not reflect an actual measurement.

DISCLAIMER:

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All instructions contained herein relate to a typical installation.

Date: 2020-SEP-14
Part No.: 14A-07H-03

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⚠ DANGER

Indicates a hazardous situation in which a person ***will*** **experience serious personal injury or death** if the situation is not avoided.

⚠ WARNING

Indicates a hazardous situation in which a person ***could*** **experience serious personal injury or death** if the situation is not avoided.

⚠ CAUTION

Indicates a hazardous situation in which a person **could experience minor or moderate personal injury** if the situation is not avoided.

CAUTION

Addresses practices not related to personal injury, such as a system part malfunctioning, property damage, or system failure.

NOTICE

Addresses general practices or observations related to system function that are *not* related to personal injury.

Date	Page	Description
2020-SEP-14	–	New manual format. All sections reformatted. Updated consolidated hardware components for 25 bar systems across entire manual. Main updates are listed in this revision record. Working temperature range and CE numbers updated across components section, where applicable.
	1-3	Added pressure and temperature statement on PESO seamless containers and DOT welded containers at end of FM-200 section.
	2-1	Revised bulk filling container details.
	2-2	Added typical manifold system schematic. Added additional callouts.
	2-3	Updated container and valve assembly details. Revised paint specification details.
	2-4	Revised container part numbers and technical details. Added note for CR part numbers.
	2-6	Revised container label details.
	2-7	Revised valve assembly technical specification and opening text.
	2-9	Burst disc section revised. Technical specification updated.
	2-10	Pressure gauge technical specification revised.
	2-11	Added Johnson Controls Connected Fire Container Monitoring section.
	2-13	Mounting brackets page revised. Added multi-container bracket image and updated bracket details table.
	2-14	Added electrical actuator - conduit version.
	2-15	Manual actuator text and specification revised. Updated pneumatic actuator specification.
	2-16	Added manual pneumatic actuator page.
	2-17	Added cable pneumatic manual (CPM) actuator page. Test pressure updated.
	2-18	Added AUTOMAN II-C releasing device page.
	2-19	Added AUTOPULSE control system page.
	2-20	Added valve union adaptor page.
	2-22 – 2-24	Flexible discharge hose pages revised. Body text and specifications revised.

Date	Page	Description
2020-SEP-14	2-25	Discharge check valve and assembly section added.
	2-26	Adjustable height adaptor page added.
	2-27	Manifold check valve specification updated.
	2-28	Manifolds section revised to include requirements bullet points, manifold reducing bushings, NPT sockets, manifold reducing bush plugs, and manifold blind caps.
	2-29	Manifolds table revised.
	2-30	Manifold inlets table revised.
	2-31	Added new manifold union adaptor page.
	2-33	Added new female actuation hose section.
	2-34 – 2-42	Multiple components (stud couplings, tees, straight couplings, copper tubing, bleed valves, Dowty seal, and adaptors) added to actuation components section.
	2-43	Discharge pressure switch page added.
	2-44	Low pressure switch section moved to this page with revised specification.
	2-45	Alternate low pressure switch moved to this page with revised specification.
	2-46	Discharge nozzle section reformatted. Technical specification updated.
	2-47	Added revised nozzle coverage details.
	2-48	Discharge nozzle tables revised. Added drill size columns.
	2-51	Added new discharge nozzle filter section.
	2-52	Added new pressure trip section.
	2-53	Added new safety vent valve section.
	2-54	Added new manual pull box and cable with swaged end fittings sections.
	2-55	Added new cable clamp and flared end fitting sections.
	2-56	Added new corner pulley and thread adaptor sections.
	2-57	Added new pilot container section with container details for 50 °C range.
	2-59	Added contacted pressure gauge.

Date	Page	Description
2020-SEP-14	2-60	Added safety burst disc for pilot container section with revised specification.
	2-61	Added new pilot container solenoid.
	2-63	Added new placement indicator switch assembly.
	2-64	Added new pilot container manual actuator section.
	2-65	Added new pilot container valve section.
	2-66	Pilot container valve table revised for 50 °C range.
	2-67	Added pilot valve adaptor section.
	2-68	Added pilot container brackets section.
	2-69	Added decompression screw section.
	2-70	Added vent valve section.
	2-71	Added liquid level measuring device details.
	2-72	Reformatted door notice and manual release notice sections.
	3-1	Added new section for general information.
	4-1	Added new planning section.
	5-1	Added new system design section. Added new section for release options.
	5-2	Added new room integrity section.
	5-3	Added new design concentration section including revised specifications for Class A, B, and C fires.
	5-5	Added new system limitations section, including nozzle coverage details.
	5-9	New piping practices section added.
	5-10	Added SDC, FM-200 system flow calculation program details, and design / flow calculation limitations. Added estimated FM-200 pipe size.
	5-11 – 5-21	Added new system design procedure section.
	5-21 – 5-24	Added new system design tables.
	6-1 – 6-36	Installation section reformatted and updated.
	6-3	Added new bracket mounting heights.
	6-4	Added installing manifolds section including manifold construction details table.

Date	Page	Description
2020-SEP-14	6-7	Added new manifold bracket installation section including manifold bracket mounting height details. Step 7 updated to include manifold check valve installation steps including new diagrams.
	6-9	Revised and reformatted pipework installation section.
	6-12	Revised nozzle installation section and added nozzle filter location image. Revised installing actuation components section with new diagrams.
	6-17 – 6-27	Installing the pilot container components section added.
	6-28	Ancillary equipment section revised.
	6-30 – 6-32	Added installing the placement indicator switch section.
	6-33	Added solenoid valve and electrical installation sections.
	6-34	Added accessories section.
	6-35	Revised and reformatted system verification section.
	6-36	Revised and reformatted final connections. Revised imperial conversion for temperature range in hand-over procedures.
	7-1 – 7-4	Revised and reformatted maintenance section.
	8-1 – 8-8	Recharging procedure revised with updated steps, diagrams, and tables throughout section.
	9-1	Added commissioning schedule.
	9-6	Added servicing and maintenance schedule.
	9-13	Added updated FM-200 material safety data sheet.
	9-24	Added developed pressure chart and actuation line length limitations details.
	9-29	Added actuation line schematics.
	9-46	Added updated FM-200 flow calculation report.
	9-69	Moved removable electrical actuator section (including installation steps) to appendix.
	9-71	Added legacy container label details.

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ABOUT THIS MANUAL

This manual is a comprehensive guide that contains the information necessary to design, install, and maintain the FM-200 engineered fire suppression system. The manual does not include information relating to fire detection.

Refer to the following standards:

- *NFPA 2001, Standard For Clean Agent Fire Extinguishing Systems*
- *NFPA 72, National Fire Code*
- *NFPA 70, National Electrical Code*
- *EN 15004*
- *ISO 14520*

Refer to the appropriate AUTOPULSE technical manual for detailed panel and design information and other applicable standards.

Users of this manual are assumed to be competent fire engineers with a basic knowledge of such systems. Users who are not familiar with the equipment should first read the complete manual.

DEFINITIONS

FM-200 FM-200 is a trademark of Chemours Chemical Corporation.

System In this manual, **system** refers to the suppression equipment and does not include any detection system that may initiate an agent release.

Engineered A system requiring individual calculation and design to determine the flow rates, nozzle pressure, pipe sizes, area, or volume protected by each nozzle, quantity of agent, and the number and types of nozzles and their placement in a specific system.

CONTACTS

Should any part of this manual not be understood, or there are queries concerning the system, contact Johnson Controls Technical Support using the following details:

- US Technical Support:
  ansul.us.techsupport.engineered@tycoint.com
- EMEA Technical Support:
  techservices-engineered@tyco-bspd.com
- APAC Technical Support:
  techserv-asia-specialhazards@tycofp.com

Use the following details to contact the manufacturer:

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Hewett Road
Gapton Hall Ind. Estate
Great Yarmouth
NR31 0NN
UK
Phone No. +44(0)1493 417600

INTRODUCTION

FM-200 is a clean, safe, fire fighting suppressant for use in total flooding automatic suppression systems. It is intended as a long term replacement for Halon 1301. Developed as a replacement to Halon, FM-200 is an alternative to HFCs, HCFCs, and PFCs in special hazard, high value applications. However, FM-200 is not a direct replacement for existing Halon 1301 installations due to the difference in agent quantity and discharge characteristics. See Section 5 - System Design for minimum design concentration or contact Johnson Controls Technical Services. Contact Johnson Controls Technical Services for specific fuel design concentrations.

The US Environmental Protection Agency (EPA) accepts use in normally occupied areas where the concentration does not exceed 9%. The safe use criteria has further been confirmed by the *Halon Alternatives Group (HAG)* report. Refer to *NFPA 2001 - Clean Agent Fire Suppression Systems,* for additional exposure requirements.

The systems described in this manual are **engineered**. Engineered systems, for example, may consist of several FM-200 fire suppressant containers, modularized or manifolded together and connected with a pipe network to a specified number of discharge nozzles.

System actuation can be achieved manually, pneumatically, or electrically. Actuation can occur automatically with a signal from a fire control panel.

This manual provides sufficient information to plan, design, purchase components, install, operate, and maintain the system. However, if part of the document is not understood, or if concerns about the suitability of the protection arise, contact Johnson Controls Technical Services.

APPROVALS AND STANDARDS

The manufactured equipment and FM-200 have comprehensive approvals and listings providing further support to the overall product.

FM-200 Approvals

Approvals and listings include, but are not limited to:

- Factory Mutual (FM)
- Underwriters Laboratories Inc. (UL) Recognized Component
- US EPA SNAP Report (Unrestricted Listed Alternative)

Manufactured Systems

Approvals and listings include, but are not limited to:

- UL (Underwriters Laboratories) Inc. Listed
- FM Approved
- EN 12094 (CE)

FM-200 is manufactured in strict accordance with the internationally recognized *Quality Assurance Standard* and approved to *ISO 9002.*

Qualified and trained personnel must design, install, inspect, maintain, test, and recharge FM-200 systems in accordance with *NFPA 2001, Clean Agent Fire Extinguishing Systems*, *ISO 9001,* and use in accordance with *Environmental Protection Agency (EPA) Significant New Alternatives Program (SNAP)*. Where determined as appropriate by the Authority Having Jurisdiction, other applicable standards may additionally be utilized to specific system requirements for these purposes.

HEALTH AND SAFETY

A correctly designed and installed fire suppression system should not present any significant health or safety problems. Take basic precautions to avoid accidents. The various aspects of the system's operation must be understood. End users often require reassurance regarding the safety of personnel. This can only be given if a thorough understanding of the properties of the agent and its effects in different situations are known. Observe best practices.

FM-200 suppresses through a combination of physical and chemical means and does not significantly deplete oxygen levels. Exposure to FM-200 at concentrations of up to 9% is not hazardous to health. Exposure to higher concentrations is permissible for limited periods. Refer to *NFPA 2001* or other relevant standards for exposure requirements. Similar to halons, the US EPA and the National Fire Protection Association (NFPA) recommend that unnecessary exposure to any agent shall be avoided and that personnel evacuate the protected areas as quickly as possible to avoid the decomposition products of the fire.

FM-200 can decompose at high temperatures to form halogen acids. If this occurs, their presence is readily detected as a sharp, pungent odor long before hazardous maximum exposure levels are reached. Fire toxicity studies conclude that decomposition products from the actual fire, such as carbon monoxide, smoke, heat, and oxygen depletion, create a greater hazard.

The noise created by FM-200 discharging is loud enough to startle people in the vicinity, but is unlikely to cause any permanent injury. Turbulence caused by the high velocity discharge can dislodge substantial objects directly in its path, and cause enough general turbulence in the protected area to move paper and light objects.

Direct contact with the vaporizing liquid discharged from an FM-200 nozzle has a chilling effect on objects and in extreme cases can cause frostbite to the skin. The liquid phase vaporizes rapidly when mixed with air and therefore limits the risk in the immediate vicinity of the nozzle. Minor reduction in visibility may occur for a brief period because of the condensation of water vapor. For further health and safety details, refer to the Material Safety Data Sheet located in the appendix of this document.

⚠ WARNING

The discharge of clean agent systems to suppress a fire can result in a potential hazard to personnel from the natural form of the clean agent or from the products of decomposition that results from exposure of the agent to the fire or hot surfaces. Unnecessary exposure of personnel either to the natural agent or to the products of decomposition shall be avoided.

FIRST AID

A Material Safety Data Sheet (MSDS) is located in the appendix for reference only. Reference the following link for the most up-to-date MSDS documents:

www.fireproductsds.com

FM-200

FM-200 (HFC-227ea) is a clean agent containing no particles or oily residues. It is produced under *ISO 9002* guidelines to strict manufacturing specifications ensuring product purity. FM-200 leaves no residue or oily deposits on delicate electronic equipment, and can be removed from the protected space by ventilation.

FM-200 is thermally and chemically stable, but without the extremely long atmospheric lifetimes associated with some other clean agents. The atmospheric lifetime of the clean agent is 36.5 years. The US EPA SNAP does not consider FM-200 as a long-lived substance when discharged, and as such has placed no restrictions on its use. See *Environmental Protection Agency's Significant New Alternatives Program*.

Typical areas protected by an FM-200 fire suppression system include the following examples:

- Bank vaults
- Libraries
- Rare book stores
- Electronic data processing
- Telephone exchanges
- Studios
- Communication centers
- Transformer and switch-rooms
- Control rooms
- Test laboratories
- Flammable liquid stores

The present understanding of the functioning of FM-200 is that 80% of its fire fighting effectiveness is achieved through heat absorption and 20% through direct chemical means (action of the fluorine radical on the chain reaction of the flame). Complete suppression using FM-200 has the following advantages:

- Less visual obscurity and minimal risk to personnel.
- Most effective when used with automatic detection to introduce the agent within a six to ten second discharge.
- Ability to prevent reignition providing concentration levels are maintained.

FM-200 is stored as a liquid and discharges into the protected area as a vapor. It is stored in approved TPED, DOT/TPED, PESO seamless containers, or DOT welded containers and super-pressurized with dry nitrogen to 25 bar at 20 °C (360 psi at 70 °F).

⚠ WARNING

FM-200 shall not be used on fires involving the following materials unless tested to the satisfaction of the Authority Having Jurisdiction:

- Certain chemicals or mixtures of chemicals, such as cellulose nitrate and gunpowder, that are capable of rapid oxidation in the absence of air.
- Reactive metals such as lithium, sodium, potassium, magnesium, titanium, zirconium, uranium, and plutonium.
- Metal hydrides.
- Chemicals capable of undergoing autothermal decomposition, such as certain organic peroxidase and hydrazine.
- Deep seated fires.

AGENT PHYSICAL PROPERTIES

Table 1-1, Table 1-2, and Table 1-3 list the physical properties of FM-200 and Nitrogen.

TABLE 1-1: FM-200 PHYSICAL PROPERTIES

Agent Physical Properties	**HFC-227ea**
Chemical structure	CF_3CHFCF_3
Chemical name	Heptafluoropropane
Molecular weight	170
Boiling point	-16.40 °C (2.4°F)
Freezing point	-131 °C (-204 °F)
Critical temperature	101.7 °C (214 °F)
Critical pressure	2912 kPa (424 psi)
Critical volume	274 cc/mole (0.0280 ft³/lbm.)
Critical density	621 kg/m³ (35.77lbm./ft³)
Saturated vapour density at 20 °C (68 °F)	31.18 kg/m³ (1.95 lb./ft³)

Reference: *NFPA 2001*

TABLE 1-2: NITROGEN PHYSICAL PROPERTIES

Agent Physical Properties	
Chemical structure	N_2
Chemical name	Nitrogen
Molecular weight	28
Boiling point	-195.80 °C (-320.4 °F)
Freezing point	-210.00 °C (-346 °F)
Critical temperature	-146.90 °C (-232.4 °F)
Critical pressure	34.0 bar (492.9 psi)

TABLE 1-3: FM-200 ENVIRONMENTAL TOXICOLOGY

Environmental	
Ozone depletion potential (ODP)	0
Atmospheric lifetime	36.5 years
Toxicology	
Acute exposure LC50	> 80.0%
Cardiac sensitization No observable adverse effect level (NOAEL)	9.0%
Lowest observable adverse effect level (LOAEL)	> 10.5%

Reference: *NFPA 2001*

FM-200 BULK TANK

Where alternate manufacturing locations order empty container assemblies for initial filling, FM-200 is supplied in either a 522.1 kg (1151 lb) DOT or TPED bulk tank. The bulk tank comes complete with lifting eyes located on the top of the tank and can subsequently be hoisted. The liquid port located on the top of the bulk tank connects to the agent fill pump. The vapour port located on the top of the bulk tank connects to the vapour line port of the agent fill pump.

Technical information - FM-200 Bulk Tank (DOT)

Part No.	300.205.010 (Supply from UK) 300.205.004 (Supply from APAC) 570038 (Supply from USA)
Bulk container type:	DOT 4BW240 approved bulk tank
Material:	Carbon steel
Color	Blue
Nominal capacity:	454 L (120 gal)
Maximum fill:	522.1 kg (1151 lb)
Working pressure:	16.5 bar (239.3 psi)
Liquid port:	3/4 in. BSPP (M), complete with siphon tube
Vapour port:	3/4 in. BSPP (M)
Pressure relief:	2 x (25 bar (363 psi) and 30 bar (435 psi)
Nominal tare weight:	125 kg (336 lb)
Dimensions:	762 mm (30 in.) Dia. x 1.45 m (57 in.) height

Technical information - FM-200 Bulk Tank (TPED)

Part No.	452036 (Supply from UK)
Bulk container type:	TPED Approved bulk tank
Material:	Carbon steel
Color:	Red
Nominal capacity:	456 L (120 gal)
Maximum fill:	522.1 kg (1151 lb)
Working pressure:	16.5 bar (239.3 psi)
Liquid port:	3/4 in. BSPP Male, complete with siphon tube
Vapour port:	3/4 in. BSPP Male
Pressure relief:	2 x (20 bar (290 psi) and 30 bar (435 psi)
Nominal tare weight:	170 kg (375 lb)
Dimensions:	762 mm (30 in.) Dia. x 1.6 m (63 in.) height



FIGURE 2-1
FM-200 BULK TANK
025503

TABLE 2-1: BULK TANK CONTAINER DETAILS

Part No.	Description	Agent Weight	
		kg	(lb)
300.205.010 / 300.205.004	FM-200 DOT Bulk Tank (filled)	522.1	1151
15724	Deposit for DOT Bulk Tank	N/A	N/A
452036	FM-200 TPED Bulk Tank (filled)	522.1	1151
452037	Deposit for TPED Bulk Tank	N/A	N/A
570038	FM-200 DOT Bulk Tank (filled)	522.1	1151

Note: When ordering an FM-200 tank, order both the filled and deposit part number as below:

a. 300.205.010 and 15724

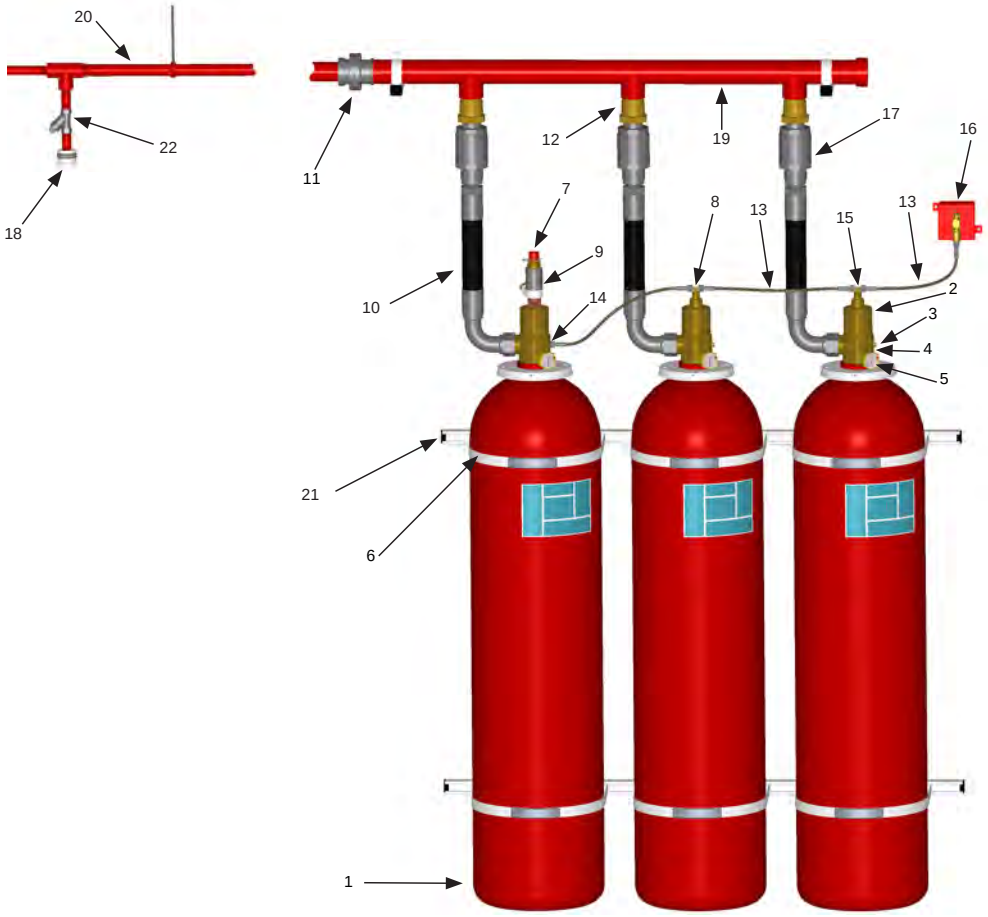
b. 300.205.004 and 15724

c. 452036 and 452037

For Part No. 570038, the deposit is billed separately.

TYPICAL MANIFOLD SYSTEM

The following figure illustrates a typical three container system complete with electrical actuation, manual actuator, discharge pressure switch, low pressure switches, flexible connections, distribution pipework, and nozzles.



Item	Description	Part No.	Page
1.	Container	See Table 2-3 to Table 2-6	2-4
2.	Container valve	302.209.001 302.209.002	2-7
3.	Burst disc	26108 and 21981	2-9
4.	Low pressure switch	304.205.006 305.209.005 305.209.007	2-44
5.	Pressure gauge	302.205.026 302.205.025 302205032	2-10
6.	Mounting brackets	See Table 2-12	2-13
7.	Manual actuator	304.209.002	2-15
8.	Pneumatic actuator	304.209.004	2-15
9.	Electrical actuator	304205030 304205040	2-14
10.	Flexible discharge hose	306.207.002 306.207.003	2-22
11.	Manifold union adaptor	See Table 2-25	2-31

Item	Description	Part No.	Page
12.	Manifold check valve	302.209.004 302.209.005	2-27
13.	Female actuation hose	306.205.003 306205010 306205011	2-33
14.	Male adaptor	309.013.005	2-34
15.	Male actuation tee	309.200.021	2-34
16.	Discharge pressure switch and adaptor	437900 305.209.009	2-43
17.	Adjustable height adaptor	306700003 306700004	2-26
18.	Discharge nozzle	See Table 2-28	2-48
19.	Manifold	See Table 2-23	2-29
20.	Pipe and fittings	—	6-9
21.	Back channel*	—	6-3
22.	Discharge nozzle filter	See Table 2-30	2-51

Note: *Back channel included within the bracket assembly.

FIGURE 2-2
TYPICAL MANIFOLD SYSTEM
E000882

AGENT CONTAINER AND VALVE ASSEMBLY (Part No., see tables on page 2-4 to 2-5)

The container assembly consists of a container fitted with a valve and internal siphon tube, factory filled with FM-200, and super-pressurized with dry nitrogen to 25 bar at 20 °C (360 psi at 70 °F). TPED, DOT/TPED, PESO seamless containers, or DOT welded containers sharing the same manifold shall be equal in size and fill density. The containers are finished in red and are available in various sizes. A nameplate is mounted to the container displaying the valve and container assembly part number, agent weight, tare weight, gross weight (including nitrogen), fill density, fill date, and fill location. A pressure gauge is fitted as standard. The low pressure switch is optional and must be specified when ordering.

Container and valve assembly technical information

Nominal working pressure:	25 bar at 20 °C (360 psi at 70 °F)
Maximum system pressure:	34 bar at 54 °C (493 psi at 130 °F)
Maximum fill density:	1.00 kg / L (62.4 lb / ft^3)
Minimum fill density:	0.5 kg / L (31.2 lb / ft^3)
Temperature rating:	0 °C to 50 °C (32 °F to 122 °F) (CE)
	0 °C to 54 °C (32 °F to 130 °F) (UL and FM)



FIGURE 2-3
SEAMLESS CONTAINER AND VALVE ASSEMBLY
025506

TPED and DOT/TPED seamless container technical information

The 15 L, 30 L, 45 L, 60 L, 120 L, 150 L, and 180 L containers are manufactured in accordance with ISO 9809-1 or ISO 9809-2 as applicable, and are stamped π and USA for TPED and DOT approval respectively.

Hydraulic test pressure:	200 bar (2900 psi)
Maximum working pressure:	120 bar (1740 psi)
Material:	Carbon steel

TABLE 2-2: PAINT SPECIFICATION

Container Description	Coating System	Color
15 L – 30 L seamless	Wet paint system - Epoxy primer, acryl-polyurethane top coat	Red body (RAL3000)
45 L – 180 L seamless	Powder paint system – Akzo nobel D1036	
4.5 L – 343 L welded	Red epoxy polyester or red polyester powder coated	Federal red

DOT welded container technical information

The 4.5 L container is manufactured to DOT 4BW500. The 8 L, 16 L, 32 L, 52 L, 106 L, 147 L, 180 L, and 343 L containers are manufactured in accordance with DOT 4BW450 or 4BW500.

Material:	Carbon steel
4BW450	
Hydraulic test pressure:	62.1 bar (900 psi)
Maximum working pressure:	31.0 bar (450 psi)
4BW500	
Hydraulic test pressure:	69.0 bar (1000 psi)
Maximum working pressure:	34.5 bar (500 psi)

PESO container technical information

The containers are manufactured in accordance with *IS:7285 (Pt 2)* under BIS and CCoE approval.

Hydraulic test pressure:	250 bar (3626 psi)
Maximum working pressure:	150 bar (2176 psi)
Material:	Carbon steel
Paint specification:	Epoxy primer, red urethane top coat

AGENT CONTAINER AND VALVE ASSEMBLY (Continued)

TPED Container Assemblies

TPED containers are not available for US and Canadian markets.

TABLE 2-3: TPED SEAMLESS CONTAINER ASSEMBLY (UL AND FM)

Part No.	Container Size L	Pressure Gauge Type	Temp. °C (°F)	Fill Density Min. kg/L (lb/ft³)	Fill Density Max. kg/L (lb/ft³)	Minimum and Maximum Fills (Weight) Min. kg (lb)	Minimum and Maximum Fills (Weight) Max. kg (lb)	Valve Size mm (in.)	Height from Floor to Outlet (Nom.) mm (in.)	Dia. mm (in.)	Nominal Tare Weight kg (lb)	Nominal Gross Weight at Max. Fill Density Excluding N_2 kg (lb)
303205300	15	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	7.5 (17)	15 (33)	25 (1)	695 (27.4)	204 (8)	29.3 (64.6)	44.3 (97.7)
303205301	30	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	15 (33)	30 (66)	25 (1)	1010 (39.8)	229 (9)	38.8 (85.5)	68.8 (151.7)
303205302	45	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	22.5 (50)	45 (99)	25 (1)	1110 (43.7)	267 (10.5)	60.4 (133.2)	105.4 (232.4)
303205303	60	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	30 (67)	60 (132)	50 (2)	1428 (56.2)	267 (10.5)	80.1 (176.6)	140.1 (308.9)
303205304	120	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	60 (133)	120 (264)	50 (2)	1543 (60.7)	360 (14.2)	140.6 (310)	260.6 (574.5)
303205305	150	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	75 (166)	150 (330)	50 (2)	1893 (74.5)	360 (14.2)	166.6 (367.3)	316.6 (698)
303205306	180	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	90 (199)	180 (396)	50 (2)	1743 (68.6)	406 (16)	214.8 (473.6)	394.8 (870.4)

DOT/TPED Container Assemblies

TABLE 2-4: DOT/TPED SEAMLESS CONTAINER ASSEMBLY (UL AND FM)

Part No.	Container Size L	Pressure Gauge Type	Temp. °C (°F)	Fill Density Min. kg/L (lb/ft³)	Fill Density Max. kg/L (lb/ft³)	Minimum and Maximum Fills (Weight) Min. kg (lb)	Minimum and Maximum Fills (Weight) Max. kg (lb)	Valve Size mm (in.)	Height from Floor to Outlet (Nom.) mm (in.)	Dia. mm (in.)	Nominal Tare Weight kg (lb)	Nominal Gross Weight at Max. Fill Density Excluding N_2 kg (lb)
303205310	15	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	7.5 (17)	15 (33)	25 (1)	695 (27.4)	204 (8)	29.3 (64.6)	44.3 (97.7)
303205311	30	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	15 (33)	30 (66)	25 (1)	1010 (39.8)	229 (9)	38.8 (85.5)	68.8 (151.7)
303205312	45	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	22.5 (50)	45 (99)	25 (1)	1110 (43.7)	267 (10.5)	60.4 (133.2)	105.4 (232.4)
303205313	60	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	30 (67)	60 (132)	50 (2)	1428 (56.2)	267 (10.5)	80.1 (176.6)	140.1 (308.9)
303205314	120	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	60 (133)	120 (264)	50 (2)	1543 (60.7)	360 (14.2)	140.6 (310)	260.6 (574.5)
303205315	150	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	75 (166)	150 (330)	50 (2)	1893 (74.5)	360 (14.2)	166.6 (367.3)	316.6 (698)

Note: The above DOT/TPED 25 bar seamless container assemblies are not approved for transportation within North America.

AGENT CONTAINER AND VALVE ASSEMBLY (Continued)

PESO Container Assemblies

PESO containers are available only for the Indian market for UL approved systems only.

TABLE 2-5: PESO SEAMLESS CONTAINER ASSEMBLY

Part No.*	Container Size L	Pressure Gauge Type	Temp. °C (°F)	Fill Density Min. kg/L (lb/ft³)	Fill Density Max. kg/L (lb/ft³)	Minimum and Maximum Fills (Weight) Min. kg (lb)	Minimum and Maximum Fills (Weight) Max. kg (lb)	Valve Size mm (in.)	Height from Floor to Outlet (Nom.) mm (in.)	Dia. mm (in.)	Nominal Tare Weight kg (lb)	Nominal Gross Weight at Max. Fill Density Excluding N_2 kg (lb)
303.205.035	34	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	17 (38)	34 (74)	25 (1)	865 (34.1)	267 (10.5)	47 (103.6)	81 (178.6)
303.205.032	80	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	40 (89)	80 (176)	50 (2)	1792 (70.6)	267 (10.5)	93 (205)	173 (381.4)
303.205.033	120	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	60 (133)	120 (264)	50 (2)	1317 (51.9)	356 (14)	144 (317.5)	264 (582)
303.205.034	140	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	70 (155)	140 (308)	50 (2)	1492 (58.7)	406 (16)	175 (385.8)	315 (694.5)
303.205.036	180	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	90 (199)	180 (396)	50 (2)	1837 (72.3)	406 (16)	210 (463)	390 (859.8)

Note: *Add suffix **CR** to part numbers for high corrosion resitanance painted container assemblies. For example Part No. 303.205.035 uses standard paint and Part No. 303.205.035CR uses high corrosion resistance paint.

DOT Welded Container Assemblies

TABLE 2-6: DOT WELDED CONTAINER ASSEMBLY

Part No.	Container Size L	Pressure Gauge Type	Temp. °C (°F)	Fill Density Min. kg/L (lb/ft³)	Fill Density Max. kg/L (lb/ft³)	Minimum and Maximum Fills (Weight) Min. kg (lb)	Minimum and Maximum Fills (Weight) Max. kg (lb)	Valve Size mm (in.)	Height from Floor to Outlet (Nom.) mm (in.)	Dia. mm (in.)	Nominal Tare Weight kg (lb)	Nominal Gross Weight at Max. Fill Density Excluding N_2 kg (lb)
303.205.026	4.5	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	2.5 (5.5)	4.5 (10)	25 (1)	324 (12.8)	178 (7)	7.7 (17)	12.2 (26.9)
303.205.015	8	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	4 (9)	8 (17)	25 (1)	305 (12)	254 (10)	14.8 (32.6)	22.8 (50.3)
303.205.016	16	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	8 (18)	16 (35)	25 (1)	504 (19.8)	254 (10)	18.4 (40.6)	34.4 (75.8)
303.205.017	32	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	16 (36)	32 (70)	25 (1)	836 (32.9)	254 (10)	26.1 (57.5)	58.1 (128.1)
303.205.018	52	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	26 (58)	52 (114)	50 (2)	595 (23.4)	406 (16)	49.1 (108.2)	101.1 (222.9)
303.205.019	106	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	53 (117)	106 (233)	50 (2)	1022 (40.2)	406 (16)	71.8 (158.3)	177.8 (392)
303.205.020	147	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	73.5 (163)	147 (324)	50 (2)	1356 (53.4)	406 (16)	89.9 (198.2)	236.9 (522.3)
303.205.021	180	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	90 (199)	180 (396)	50 (2)	1635 (64.4)	406 (16)	105.8 (233.2)	285.8 (630.1)
303.205.022	343	PG	50/54 (122/130)	0.5 (31.2)	1 (62.4)	171.5 (379)	343 (756)	80 (3)	1466 (57.7)	610 (24)	207 (456.4)	550 (1212.5)

CONTAINER LABELS

The container label details the container valve assembly part number, agent weight, tare weight, gross weight, fill density, charge date, and fill location. The label is not field replaceable. The following table lists the details for the container labels.

Technical information

Material:	Aluminum
Adhesive:	Pre-applied 3M adhesive 9485
Approvals:	UL and FM and UL only
Weight:	0.05 kg (0.11 lb)

TABLE 2-7: LABEL DETAILS

Part No.	Nominal Charge Pressure	Language	Certification	Label Size	Where Used
314205306	25 bar (360 psi)	English	UL and FM	241.3 mm × 165.1 mm (9.5 in. × 6.5 in.)	**Seamless container:** 15 L, 30 L, 34 L, 45 L, 60 L, 80 L, 120 L, 140 L, 150 L and 180 L
314205307	25 bar (360 psi)	English	UL	241.3 mm × 165.1 mm (9.5 in. × 6.5 in.)	**Welded container:** 32 L, 106 L, 147 L, 180 L, and 343 L
314205322	25 bar (360 psi)	English	UL and FM	558.8 mm × 50.8 mm (22 in. x 2 in.)	**Welded container:** 4.5 L, 8 L, 16 L, and 52 L
314205323	25 bar (360 psi)	English	UL	558.8 mm × 50.8 mm (22 in. x 2 in.)	
452686	25 bar (360 psi)	French, German, Spanish, and Italian	UL and FM*	267.0 mm x 90.0 mm (10.5 in. x 3.5 in.)	**Seamless container:** 15 L, 30 L, 45 L, 60 L, 120 L, 150 L, and 180 L

Note: *For UL or UL/FM container assemblies sold in the EU, label part number 452686 must be additionally attached to the container.

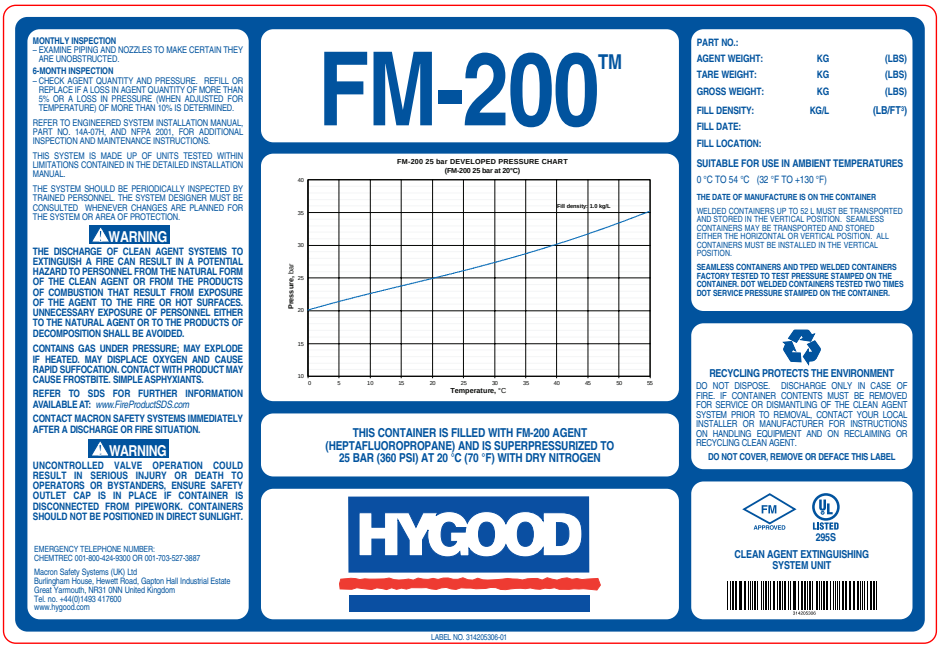


FIGURE 2-4
CONTAINER LABEL (PART NO. 314205306)
E001555

VALVE ASSEMBLY

The valve assembly is factory-fitted to the container and is supplied pre-assembled with a pressure gauge. A replacement valve assembly is available. The 25 mm (1 in.), 50 mm (2 in.), and 80 mm (3 in.) valve assemblies are supplied with a plug in the pressure gauge port. The replacement pressure gauge (Part No. 302.205.026 (WIKA), 302.205.025 (MIJA), or 302205032 (MILJOCO)) must be ordered separately. The replacement valve is 100% leak tested before it leaves the factory.

Location on system

The valve assembly connects to the container.

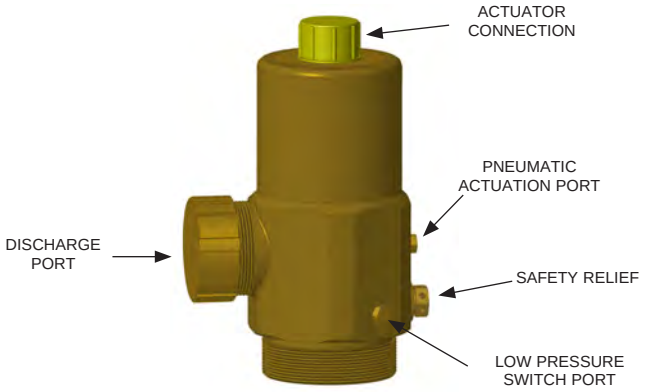


FIGURE 2-5
VALVE ASSEMBLY
025545

Technical information

Valve size:	25 mm (1 in.) Valve	50 mm (2 in.) Valve
Part No:	**302.209.001 / 570535** (Valve assembly with plug and no pressure gauge) **302.209.001P** (Valve assembly with plug, no pressure gauge and indvidually packaged)	**302.209.002 / 570536** (Valve assembly with plug and no pressure gauge) **302.209.002P** (Valve assembly with plug, no pressure gauge and indvidually packaged)
Body material:	Brass CZ122 (CW617N)	Brass CZ122 (CW617N)
Thread type:	2 in. 8UN	3 1/4 in. 8UN
Outlet connection:	1 in. BSPP	2 in. BSPP
Outlet safety cap material:	Brass CZ121	Brass CZ121
Maximum working pressure:	34 bar (493 psi)	34 bar (493 psi)
Test pressure:	51 bar (740 psi)	51 bar (740 psi)
Free flow cross sectional area:	507 mm² (0.78 in.²)	1810 mm² (2.8 in.²)
Equivalent length:	6.096 m (20 ft)	10.668 m (35 ft)
Siphon tube:	Rigid straight	Rigid straight
Maximum actuation force:	26 N (5.8 lbf) at max. working pressure	26 N (5.8 lbf) at max. working pressure
Burst disc rating:	53.4 bar ± 5% (50.7 - 56.1 bar) at 50 °C (775 psi ± 5% (736 – 814 psi) at 122 °F)	53.4 bar ± 5% (50.7 - 56.1 bar) at 50 °C (775 psi ± 5% (736 – 814 psi) at 122 °F)
Burst disc port:	M18 x 1.0	M18 x 1.0
Low pressure port:	1/8 in. NPT (plugged off)	1/8 in. NPT (plugged off)
Gauge port:	1/8 in. NPT	1/8 in. NPT
Pilot pressure port:	1/4 in. BSPP	1/4 in. BSPP
Working temperature range:	-20 °C to 50 °C (-4 °F to 122 °F) (CE)	-20 °C to 50 °C (-4 °F to 122 °F) (CE)
	-18 °C to 54 °C (0 °F to 130 °F) (UL and FM)	-18 °C to 54 °C (0 °F to 130 °F) (UL and FM)
Weight:	3.36 kg (7.40 lb)	8.74 kg (19.27 lb)
Approvals and listings:	UL, FM, and PESO	UL, FM, and PESO
Certification:	EN 12094-4	EN 12094-4
CE certification number:	0832-CPD-2039 2831-CPR-S2039	0832-CPD-2039 2831-CPR-S2039
Year of CE marking:	2008	2008
CE marking requirements:	Manufacturer's mark, part number, DN25, serial number, CE_{0832} or CE_{2831}	Manufacturer's mark, part number, DN50, serial number, CE_{0832} or CE_{2831}
Method of marking:	Laser or engraved	Laser or engraved
Valve type:	Type 2	Type 2
Overall size:	157 mm x 100 mm (6.18 in. x 3.94 in.)	211 mm x 138 mm (8.31 in. x 5.43 in.)

VALVE ASSEMBLY (Continued)

Technical information

Valve size:	80 mm (3 in.) Valve
Part No.:	**445977** (Valve assembly with plug and no pressure gauge) **302.205.002 / 570302** (Valve assembly with MIJA FM-200 pressure gauge)
Body material:	Brass UNSC37700
Thread type:	4 in. 8UN-2A
Outlet connection:	3.5 in. 12UN-2A
Outlet safety cap material:	Brass UNSC36000
Maximum working pressure:	34 bar (493 psi)
Test pressure:	40 bar (580 psi)
Free flow cross sectional area:	3167 mm² (4.9 in.²)
Equivalent length:	25.91 m (85.0 ft)
Siphon tube:	Rigid straight
Maximum actuation force:	26 N (5.8 lbf) at max. working pressure
Burst disc rating:	53.4 bar ± 5% (50.7 - 56.1) at 50 °C (775 psi ± 5% (736 - 814) at 122 °F)
Burst disc port:	0.9375 in. 16UN-3A
Low pressure port:	1/8 in. NPT (plugged off)
Gauge port:	1/8 in. NPT
Pilot pressure port:	1/4 in. BSPP
Working temperature range:	-18 °C to 54 °C (0 °F to 130 °F)
Weight:	18.82 kg (41.5 lb)
Approvals and listings:	UL and FM
Valve type:	Type 2
Overall size:	252 mm x 174 mm (9.94 in. x 6.85 in.)

Note: *Separate outlet adaptors are available for 3 in. NPT, BSP and grooved. This valve is not certified in accordance with EN 12094-4 and cannot be installed in the UK and EU. This valve can be used only with MIJA and MILJOCO pressure gauges.



FIGURE 2-6
80 mm (3 IN.) VALVE ASSEMBLY
E001462

* WIKA, MIJA, and MILJOCO are trademarks of their respective owners.

BURST DISC

Each valve incorporates a safety burst disc assembly. It is designed to relieve pressure if the container becomes over pressurized when subjected to temperatures above the designed storage temperature of the container.

TABLE 2-8: BURST DISC DETAILS

Part No.	Description	Where Used
26108	M18 53.4 bar burst disc (WEHBERG*)	25 mm and 50 mm valve
21981	M18 53.4 bar burst disc (MATRIX*)	25 mm and 50 mm valve
15330 / 570300	0.9375-16UN-3A 52 bar (754 psi) burst disc (MATRIX*)	80 mm valve



FIGURE 2-7
BURST DISC
009672

Technical information

Valve size:	25 mm (1 in.) and 50 mm (2 in.) Valve	25 mm (1 in.) and 50 mm (2 in.) Valve	80 mm (3 in.) Valve
Part No.:	21981 (MATRIX)	26108 (WEHBERG)	15330 / 570300 (MATRIX)
Body material:	Brass	Brass	Brass
Rating:	53.4 bar ± 5% (50.7 - 56.1) at 50 °C	53.4 bar ± 5% (50.7 - 56.1) at 50 °C	53.4 bar ± 5% (50.7 - 56.1) at 50 °C
	(775 psi ± 5% (736 - 814) at 122 °F)	(775 psi ± 5% (736 - 814) at 122 °F)	(775 psi ± 5% (736 - 814) at 122 °F)
Thread:	M18 x 1.00	M18 x 1.00	0.9375-16UN-3A
Hole orientation:	90° to Body	90° to Body	90° to Body
Torque:	35 N•m (25.8 ft-lb)	25 N•m (18.4 ft-lb)	81 N•m (59.7 ft-lb)
Working temperature range:	-20 °C to 50 °C (-4 °F to 122 °F) (CE)	-20 °C to 50 °C (-4 °F to 122 °F) (CE)	-18 °C to 54 °C (0 °F to 130 °F) (UL and FM)
	-18 °C to 54 °C (0 °F to 130 °F) (UL and FM)	-18 °C to 54 °C (0 °F to 130 °F) (UL and FM)	
Overall size:	20 mm (L) x 18 mm (Dia)	20 mm (L) x 18 mm (Dia)	33.3 mm (L) x 18 mm (Dia)
	(0.79 in. (L) x 0.71 in. (Dia))	(0.79 in. (L) x 0.71 in. (Dia))	(1.3 in. (L) x 0.7 in. (Dia))
Weight:	0.028 kg (0.062 lb)	0.028 kg (0.062 lb)	0.088 Kg (0.194 lb)
Certification:	CE	CE	-
Approvals and listings:	UL and FM	UL and FM	UL and FM

* WEHBERG and MATRIX are trademarks of their respective owners.

PRESSURE GAUGE (UL, FM, AND EN) (Part No. 302.205.026)

The pressure gauge is factory fitted to the valve, and is field replaceable.



FIGURE 2-8
PRESSURE GAUGE
E001443

Technical information

Type:	Bourdon tube pressure gauge
Entry:	Back axial
Measurement system:	Copper alloy
Movement:	Copper alloy
Nominal Size:	Dia 50 mm x 53 mm (2 in. x 2.1 in.)
Units of outer scale:	bar
Units of inner scale:	psi
Pressure range:	0 bar to 60 bar (0 psi to 870 psi)
Connection:	1/8 in. NPT
Connection material:	Brass CZ121 (CW614N)
Case:	Stainless steel
Ingress Protection class:	IP65
Window:	Polycarbonate
Restrictor:	Brass Dia 0.5 mm (0.02 in.)
Accuracy:	± 1.6%
Language:	English
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE) 0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Nominal charge pressure:	25 bar (360 psi)
Approvals and listings:	UL, FM, and EN
Certification:	EN 12094-10 and EN 837-1
CE certification number:	0832-CPR-S0054 2831-CPR-S0054
Year of CE marking:	2017
CE marking requirements:	Manufacturer's mark, bar (psi), CL1.6, EN837-1, CE_{0832} or CE_{2831}
Method of marking:	Part of gauge artwork
Weight:	0.12 kg (0.27 lb)

PRESSURE GAUGE (UL AND FM) (Part No. 302.205.025 and 302205032)

A pressure gauge is factory fitted to the valve, and is field replaceable.



FIGURE 2-9
PRESSURE GAUGE
E001440

Technical information

Part No.:	302.205.025 (MIJA) 302205032 (MILJOCO)
Type:	Dial gauge
Entry:	Back axial
Body material:	Stainless steel
Connection material:	Brass CZ121
Nominal size:	Dia 41 mm x 27 mm (1.6 in. x 1.1 in.)
Units of outer scale:	Bar
Units of inner scale:	psi
Connection:	1/8 in. NPT
Language:	English
Working temperature range:	0 °C to 54 °C (32 °F to 130 °F)
Nominal charge pressure:	25 bar (360 psi)
Pressure range:	0 to 48 bar (0 to 696 psi)
Weight:	0.022 kg (0.049 lb)
Approvals and listings:	UL and FM (MIJA) UL (MILJOCO)

JOHNSON CONTROLS CONNECTED FIRE CONTAINER MONITORING

Johnson Controls Connected Fire Container Monitoring is an entire solution with a gauge option for remotely monitoring system pressure. With the sensor, electronic gauge, and gateway the system status can be monitored through an online dashboard or mobile application. This solution monitors, in real time, the temperature and pressure of the container. The information can be processed and transmitted to the Johnson Controls cloud, allowing predictive maintenance before a fault may occur. The devices are fully configurable for agent and system pressure, and addressable for container location in order for the user to quickly locate a container, ensuring 24/7 monitoring of the container. The Johnson Controls Connected Fire Container Monitoring solution is ideal for remote locations that are otherwise difficult or impractical to reach. For full product details, system installation, and maintenance instructions, refer to the Johnson Controls Connected Fire Container Monitoring product manual, Part No. 452120.

Electronic gauge display

The electronic gauge, shown in Figure 2-10, features the LoRa wireless protocol. LoRa uses license-free sub-gigahertz radio frequency bands like 868 MHz (Europe) and 915 MHz (North America) for long-range transmissions with low power consumption. LoRa penetrates deep through walls and ceilings and is a practical option when sensors and the gateway require additional spacing from one another. Two AA batteries power the electronic gauge device. A graphic display shows pressure, an indication of whether or not the pressure is within the normal range, units of measurement, temperature compensation, and gauge status (normal or trouble).

The electronic gauge display is a control unit with a digital processor with associated memory for data storage, data analysis, and wireless communication with the gateway. It repeatedly senses temperature and pressure. It processes the data to generate output in conformance with the analysis. When installing in the field, the electronic gauge display connects to the electronic gauge sensor.

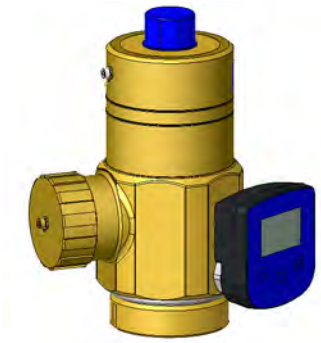


FIGURE 2-10
ELECTRONIC GAUGE
E001472

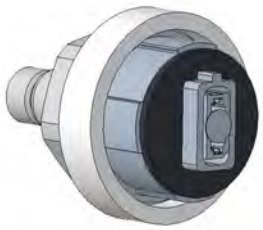


FIGURE 2-11
ELECTRONIC GAUGE SENSOR
E001473

Electronic gauge sensor

The electronic gauge sensor, shown in Figure 2-11, is a digital pressure transducer connected to the container discharge valve at the pressure gauge port. The pressure transducer incorporates digital signal processing that requires no additional compensation. The electronic gauge sensor comes factory installed to a valve for new system installations, and can be a gauge replacement for retrofits in the field.



FIGURE 2-12
COMMUNICATION GATEWAY
E001474

Gateway

The Johnson Controls communication gateway, shown in Figure 2-12, connects the electronic gauges to the Johnson Controls cloud. The electronic gauges use the LoRaWAN low power network to connect to the gateway, while the gateway uses high bandwidth networks such as Ethernet or cellular to connect to the Johnson Controls cloud. A single gateway can connect with thousands of devices. The gateway receives the device's messages and forwards them to the Johnson Controls cloud where customers can monitor and configure their setup from a dashboard. The dashboard and mobile application display notifications and warnings. Early warnings are automatically sent to the users smart phone, enabling faster reaction times to take proactive intervention and schedule maintenance.

The Johnson Controls communication gateway is a configurable, manageable, and scalable LoRa gateway for industrial IoT applications. Network connectivity includes carrier approved 4G-LTE, 3G, 2G, and Ethernet.

NOTICE

The Johnson Controls Connected Fire Container Monitoring solution is **not** currently UL listed.

JOHNSON CONTROLS CONNECTED FIRE CONTAINER MONITORING (Continued)

TABLE 2-9: ELECTRONIC GAUGE DISPLAY SPECIFICATION

Part No.	451694	451695	451696	451697	451698
Electronic gauge display models	DISPLAY EU868	DISPLAY US915	DISPLAY AS923	DISPLAY AU915	DISPLAY IN865
Region / Country	Europe	North America	Asia Pacific	Australia	India
Communication	LoRaWAN 1.0.2 complaint, Class A and Class C				
Antenna	868 MHz ISM 863-870 MHz Omni-Directional Linear Polarization	915 MHz ISM 902-928 MHz Omni-Directional Linear Polarization	915 MHz ISM 902-928 MHz Omni-Directional Linear Polarization	915 MHz ISM 902-928 MHz Omni-Directional Linear Polarization	868 MHz ISM 863-870 MHz Omni-Directional Linear Polarization

TABLE 2-10: ELECTRONIC GAUGE SENSOR SPECIFICATION

Part No.	451692
Thread	1/8 in. NPT
Measuring range	160 bar (2320 psi)
Process connection	Standard 1/8 NPT
Valve compatibility / fire suppression systems	1 in. and 2 in. / SAPPHIRE and FM-200 Pilot container N_2 with process connection adapter (Part No. 451961)

TABLE 2-11: GATEWAY MODEL SPECIFICATION

Part No.	451957	451958	451963	452671
Gateway description	COMM GATEWAY L4E1 LORA-868 (Europe)	COMM GATEWAY L4N1 LORA-915 (USA)	COMM GATEWAY LAP3 LORA-915 (Australia)	COMM GATEWAY L4E1 LORA-915
Region / Country	Europe, Middle East and India	North America, Canada, LATAM and some Asia regions	Australia	Singapore and other Asia regions
Model	MTCDT-L4EU1	MTCDT-L4N1	MTCDT-LAP3	MTCDT-L4EU1
Cellular performance	4G - LTE Category 4	4G-LTE Category 4	LTE Category 1	4G-LTE Category 4
LoRa frequency band	868 MHz	915 MHz	915 MHz	915 MHz
LoRa channel plan	EU868/IN865	US915/AS923	AU915	US915/AS923

Additional gateway components

- Part No. 451959: Communication gateway GPIO card
- Part No. 451960: Communication gateway GPIO cable

MOUNTING BRACKETS

The bracket assembly consists of a nut and bolt with two bracket straps and a back channel of UNISTRUT*, Series P1000T 41 mm x 41 mm (1.6 in. x 1.6 in.), to securely hold the container in position. Each container requires two bracket assemblies.

Each strap is notched for insertion into the back channel allowing for the proper alignment of the container. The bracket assembly mounts to a rigid vertical surface with the container assembly resting fully on the floor. Container bracket assemblies are available for single containers (Part No. 311700002 to 311700006, 311700013, 311700014 and 311.205.019) and for multi-containers (Part No. 311700007 to 311700012). Each installation requires two sets of bracket assemblies. The following table lists the mounting bracket details.



FIGURE 2-13
CONTAINER BRACKET ASSEMBLY
025776 / 025777

Technical information

Material: Stainless steel 316

Mounting: UNISTRUT channel

TABLE 2-12: MOUNTING BRACKET DETAILS

Part No.	Description	Container Size L	Container Type	Container Diameter mm (in.)	Weight kg (lb)
311700002	Container bracket assembly	15	Seamless	204 (8.0)	1.67 (3.68)
311700003		30		229 (9.0)	1.72 (3.79)
311700004		34, 45, 60, 80		267 (10.5)	1.78 (3.92)
311700005		120, 150		360 (14.2)	2.43 (5.36)
311700006		120 (PESO), 180		406 (16.0)	2.50 (5.51)
		52, 106, 147, 180	Welded	406 (16.0)	2.50 (5.51)
311700013		4.5		178 (7.0)	1.47 (3.24)
311700014		8, 16, 32		254 (10.0)	1.63 (3.59)
311.205.019		343		610 (24.0)	3.59 (7.91)
311700007	Multi-container bracket assembly x 4 containers	120, 150	Seamless	360 (14.2)	9.62 (21.2)
311700008	Multi-container bracket assembly x 6 containers				13.66 (30.12)
311700009	Multi-container bracket assembly x 8 containers				17.78 (39.20)
311700010	Multi-container bracket assembly x 4 containers	120 (PESO), 180	Seamless (120 L)	406 (16.0)	9.85 (21.72)
311700011	Multi-container bracket assembly x 6 containers		Seamless (180 L)		14.11 (31.11)
311700012	Multi-container bracket assembly x 8 containers		Welded (180 L)		18.19 (40.10)

*UNISTRUT is a trademark of Atkore International, Inc.

ELECTRICAL ACTUATOR – CONDUIT VERSION (Part No. 304205030 and 304205040)

Country of origin: US (304205030)
China (304205040)

The electrical actuator electrically operates the system's master container. The electrical actuator is fitted with an internal placement switch to provide a fault indication at the panel if incorrectly fitted. A manual, manual-pneumatic, pneumatic, or CPM actuator fits on top of the electrical actuator.

The reset tool is attached to the actuator.

Note: If no additional actuator is fitted to the top of the electrical actuator, the protection cap must remain in place.

Location on system

The electrical actuator is installed to the top of the container valve.

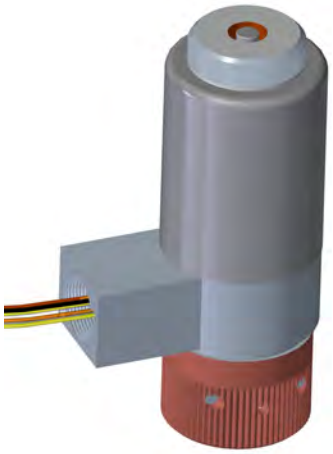


FIGURE 2-14
ELECTRICAL ACTUATOR
E001130

Technical information

Body:	Mild steel and dull nickel
Body finish:	Electroless nickel plate
Actuation pin:	Stainless steel
Loose nut:	Brass CZ121 (CW614N)
Actuation type:	Latching
Reset requirement:	Manually with reset tool supplied
Connection:	1 in. BSPP
Nominal voltage:	24 VDC
Minimum firing voltage:	CE 20.5 VDC UL 864 65% of nominal voltage (15.6 VDC)
Minimum current:	0.32 A
Nominal current:	0.43 A
Maximum current:	0.54 A
Maximum monitoring current:	30 mA
Minimum duration of trigger signal:	1 s
Duty:	Continuous
Manual actuation force:	50 N (11.00 lbf)
Nominal pin travel:	4.57 mm (0.18 in.)
Electrical connection:	1/2 in. NPT Female conduit with inbuilt bridge rectifier
Back EMF protection:	Bridge rectifier
Working temperature range:	-20 °C to 50 °C (-4 °F to 122 °F) (CE) -18 °C to 54 °C (0 °F to 130 °F) (UL and FM)
Life span:	25 years
Testing:	100% check on start / finish position
Maximum humidity:	80% to 90% RH non-condensing
Ingress Protection class:	IP54
Approvals and listings:	UL, FM, and CE
Certification:	EN 12094-4
CE certification number:	0832-CPR-S0072 2831-CPR-S0072
Year of CE marking:	2019 (304205030) 2020 (304205040)
CE marking requirements:	Manufacturer's mark, part number, serial number, 24 VDC , 0.90 A, CE_{0832} or CE_{2831}
Method of marking:	Laser or engraved
Overall size:	132 mm (L) x 73 mm (W) (5.19 in. (L) x 2.87 in. (W))
Weight:	1 kg (2.2 lb)
Actuation force / PIN travel:	Minimum 66.4 N at 1 mm from unactivated Minimum 60.7 N at 2 mm from unactivated Minimum 55.0 N at 3 mm from unactivated Minimum 49.3 N at 4 mm from unactivated

MANUAL ACTUATOR
(Part No. 304.209.002)

The manual actuator operates the system's master container. The actuator may be fitted to the top of the valve assembly or electrical actuator. A safety clip prevents inadvertent operation which is removed before activation.

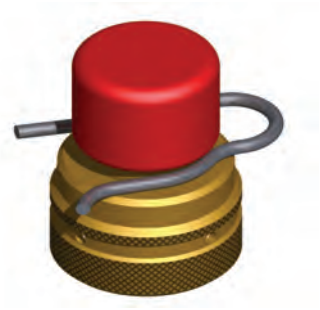


FIGURE 2-15
MANUAL ACTUATOR
009675

Location on system

The manual actuator connects to the top of the container discharge valve or on top of the electrical actuator. **Note:** Per NFPA 2001, discharge pressure switch must be utilized if using manual actuation (NFPA 2001).

Technical information

Body:	Brass CZ121 (CW614N)
Knob:	PVC (color - red)
Safety pin:	Stainless steel 303
Actuator pin:	Brass CZ121 (CW614N)
Minimum actuation force:	25.5 N (5.73 lbf)
Vent area:	31.77 mm² (0.049 in.^{2})
Stroke:	6 mm (0.24 in.)
Minimum duration of actuation force:	1 s
Weight:	0.26 kg (0.58 lb)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE)
	0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Testing of actuator:	Possible
Approvals and listings:	UL, FM, and CE
Certification:	EN 12094-4
CE certification number:	0832-CPD-2039 0832-CPR-S0072 2831-CPR-S2039 2831-CPR-S0072
Year of CE marking:	2008
CE marking requirements:	Manufacturer's mark, part number, serial number, CE_{0832} or CE_{2831}
Method of marking:	Laser or engraved
Overall size:	52 mm (L) x 41.5 mm (Dia) (2.05 in. (L) x 1.63 in. (Dia))

PNEUMATIC ACTUATOR
(Part No. 304.209.004)

The pneumatic actuator operates the subordinate system container. The actuator may be fitted to the top of the valve assembly or electrical actuator. Pressure from a master container, AUTOMAN II-C release, or pilot container actuates the valve.



FIGURE 2-16
PNEUMATIC ACTUATOR
009676

Location on system

The pneumatic actuator connects to the top of the container discharge valve, for subordinate containers.

Technical information

Body:	Brass CZ121 (CW614N)
Actuator pin:	Brass CZ121 (CW614N)
Pipe connection:	1/4 in. NPT Female
Maximum working pressure:	120 bar (1740 psi)
Test pressure:	180 bar (2610 psi)
Vent area:	31.77 mm² (0.049 in.^{2})
Stroke:	3.7 mm (0.15 in.)
Minimum trigger pressure:	5.2 bar (75.4 psi)
Nominal trigger pressure:	Dependent on actuation source (Master or AUTOMAN II-C)
Maximum trigger pressure:	120 bar (1740 psi)
Minimum duration of trigger pressure:	1 s
Weight	0.23 kg (0.50 lb)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE)
	0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Testing of actuator:	Possible
Approvals and listings:	UL, FM, and CE
Certification:	EN 12094-4
CE certification number:	0832-CPD-2039 0832-CPR-S0072 2831-CPR-S2039 2831-CPR-S0072
Year of CE marking:	2008
CE marking requirements:	Manufacturer's mark, part number, serial number, WP-120 bar, CE_{0832} or CE_{2831}
Method of marking:	Laser or engraved
Overall size:	48.0 mm (L) x 41.5 mm (Dia) (1.89 in. (L) x 1.63 in. (Dia))

MANUAL PNEUMATIC ACTUATOR (Part No. 304700003)

The manual pneumatic actuator operates the system's master container. It does not actuate pilot containers. The actuator fits to the top of the valve assembly or electrical actuator.

Location on system

The manual pneumatic actuator connects to the top of the container discharge valve or on top of the electrical actuator.

Technical information

Body:	Brass CZ121 (CW614N)
Actuation pin:	Brass CZ121 (CW614N)
Knob:	PVC (color - red)
Safety pin:	Stainless steel 303
Pipe connection:	1/4 in. NPT Female
Maximum working pressure:	120 bar (1740 psi)
Test pressure:	180 bar (2610 psi)
Vent area:	31.77 mm² (1.25 $in.^2$)
Stroke:	3.5 mm (0.14 in.)
Maximum duration of actuation force:	1 s
Minimum actuation force:	76.0 N (17.08 lbf)
Minimum trigger pressure:	5.2 bar (75.4 psi)
Nominal trigger pressure:	Dependent on actuation source (Master or AUTOMAN II-C)
Maximum trigger pressure:	120 bar (1740 psi)
Minimum duration of trigger pressure:	1 s
Weight:	0.4 kg (0.88 lb)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE) 0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Testing of actuator:	Possible
Approvals and listings:	UL, FM, and CE
Certification:	EN 12094-4
CE certification number:	0832-CPR-S0072 2831-CPR-S0072
Year of CE marking:	2018
CE marking requirements:	Manufacturer's mark, part number, serial number, WP-120 bar, CE_{0832} or CE_{2831}
Method of marking:	Laser or engraved
Overall size:	61.0 mm (L) x 44.0 mm (Dia) (2.40 in. (L) x 1.73 in. (Dia))

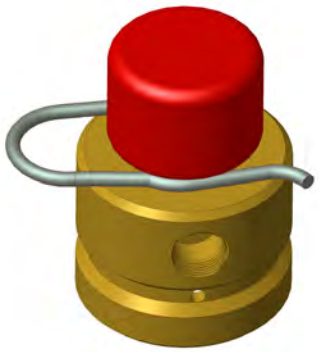


FIGURE 2-17
MANUAL PNEUMATIC ACTUATOR
025504

CPM ACTUATOR
(Part No. 304.209.013)

The cable pneumatic manual actuator (CPM actuator) operates the system from a remote position using a manual release unit connected to the CPM Actuator by wire rope run in conduit. Local manual actuation is possible using this actuator.

Pneumatic operation is available through the actuation port in the body of the actuator. The CPM actuator is designed so that it fits to the top of the valve assembly or used in conjunction with an electrical actuator.

A safety pin prevents accidental operation for manual operation and a disable key for cable operation which shall be removed before activation.

Note: The CPM actuator is not for use on installations within the EU.



FIGURE 2-18
CPM ACTUATOR
009675

Technical information

Body:	Brass C36000
Lever:	Brass C36000
Safety pin:	Stainless steel
Actuation pin:	Stainless steel
Loose nut:	Brass C36000
Loose nut connection:	1 in. BSPP
Pipe connection:	1/8 in. NPT
Minimum actuation pressure:	14.6 bar (212 psi)
Minimum actuation force:	128.8 N (28.96 lb)
Nominal trigger pressure:	Dependent on actuation source (AUTOMAN II-C or pilot)
Maximum working pressure:	120 bar (1740 psi)
Test pressure:	180 bar (2611 psi)
Working temperature range:	-18 °C to 54 °C (0 °F to 130 °F) (UL and FM)
Overall size:	180 mm (L) x 137 mm (H) x 79 mm (D) (7.09 in. x 5.39 in. x 3.11 in.)
Weight:	1.20 kg (2.65 lb)
Approvals and listings:	UL and FM



FIGURE 2-19
CPM ACTUATOR (MANUALLY ACTUATED POSITION)
025248

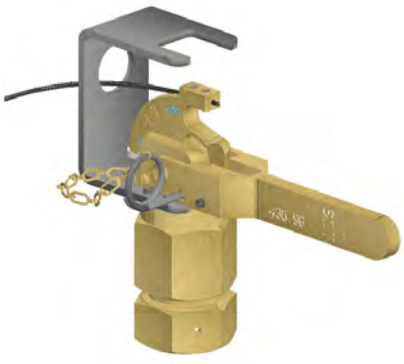


FIGURE 2-20
CPM ACTUATOR (CABLE ACTUATED POSITION)
025247

AUTOMAN II-C RELEASING DEVICE

The AUTOMAN II-C releasing device consists of a metal enclosure which contains a spring-loaded puncture pin release mechanism, an actuation cartridge, electrical circuitry, and an input/output terminal strip for making electrical connections. The AUTOMAN II-C releasing device provides automatic pneumatic actuation of the FM-200 system. When wired to an AUTOPULSE control system, it provides supervised electric detection and release. It also provides manual actuation using the strike button on the release. When an AUTOPULSE control system is used, manual actuation is accomplished using an electric manual pull station.

The AUTOMAN II-C releasing device requires an LT-30-R nitrogen cartridge for system actuation. Order the cartridge separately.

The AUTOMAN II-C releasing device is UL Listed and FM Approved.

TABLE 2-13: AUTOMAN II-C PART DETAILS

Part No.	Description
17728	AUTOMAN II-C releasing device, 24 VDC
5373	LT-30-R nitrogen cartridge (ordered separately)
26310	Cocking lever (ordered separately)
31492	AUTOMAN II-C releasing device, explosion-proof, 24 VDC
35620	AUTOMAN II-C releasing device, weather-proof, 24 VDC
35623	AUTOMAN II-C releasing device, explosion and weather-proof, 24 VDC



FIGURE 2-21
AUTOMAN II-C RELEASING DEVICE
009680

Technical information

Cartridge body:	Steel
Cartridge volume:	0.692 L (0.18 gal)
Gas type:	Nitrogen
Cartridge pressure:	144.8 bar (2100 psi) at 21 °C (70 °F)
Actuation method:	Burst disc
Dimensions: (17728 and 31492)	662 mm x 311 mm x 108 mm (24.4 in. x 12.4 in. x 4.2 in.)
Dimensions: (35620 and 35623)	610 mm x 406 mm x 182 mm (24.0 in. x 16.0 in. x 7.16 in.)
Weight:	17728 – 11.79 kg (26 lb) 31492 – 14.97 kg (33 lb) 35620 – 16.33 kg (36 lb) 35623 – 40.37 kg (89 lb)

For further technical details, refer to AUTOMAN II-C release manual part number 17788 (standard) or part number 31496 (explosion proof).

AUTOPULSE CONTROL SYSTEM

The AUTOPULSE control system monitors fixed fire hazards. The control system automatically actuates the fire suppression system after receiving an input signal from one or more initiating devices, such as the manual pull station or detector. Several models of the AUTOPULSE Control System are available depending on the type of hazard being protected. Refer to the *Detection and Control Application Manual* for detailed information regarding AUTOPULSE Control Systems.

Note: Do not use the AUTOPULSE Z-10 agent release control system for installations within the EU.

The AUTOPULSE control system is UL Listed and FM Approved. All devices connected to a UL Listed and FM Approved panel need to be compatible. Refer to the *AUTOPULSE Device Compatibility Document* for a list of all compatible devices.



FIGURE 2-22
AUTOPULSE RELEASE CONTROL PANEL GROUP
025778



FIGURE 2-23
AUTOPULSE Z-20 AGENT RELEASE CONTROL SYSTEM
025605

VALVE UNION ADAPTOR

The valve union adaptor easily assembles or disassembles the rigid pipework to the container valve outlet.

TABLE 2-14: VALVE UNION ADAPTOR PART DETAILS

Part No.	Description
309002016	1 in. BSPP x 1 in. NPT Union Adaptor
309002017	2 in. BSPP x 2 in. NPT Union Adaptor
309002018	1 in. BSPP x 1 in. BSPT Union Adaptor
309002019	2 in. BSPP x 2 in. BSPT Union Adaptor



FIGURE 2-24
VALVE UNION ADAPTOR
025495

Technical information

Union adaptor size:	25 mm (1 in.)	50 mm (2 in.)
Body material:	Steel 230 M07 Pb 11SMnPb37	Steel 230 M07 Pb 11SMnPb37
Plating specification:	ZINKLAD* 1000 plating (Hexavalent Chromium-Free)	ZINKLAD* 1000 plating (Hexavalent Chromium-Free)
Seal material:	Nitrile	Nitrile
Joint type:	(i) 1 in. BSPP swivel cone (hydraulic) x 1 in. NPT fixed female (Part No. 309002016) or 1 in. BSPT fixed female (Part No. 309002018) (ii) 2 in. BSPP swivel cone (hydraulic) x 2 in. NPT fixed female (Part No. 309002017) or 2 in. BSPT fixed female (Part No. 309002019)	2 in. BSPP swivel cone (hydraulic) x 2 in. NPT fixed Female
Overall size:	75 mm (L in extended position) x 41 mm (A/F) (2.95 in. (L) x 1.61 in. (A/F))	100 mm (L in extended position) x 70 mm (A/F) (3.94 in. (L) x 2.76 (in.) (A/F)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE) 0 °C to 54 °C (32 °F to 130 °F) (UL and FM)	0 °C to 50 °C (32 °F to 122 °F) (CE) 0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Maximum working pressure:	120 bar (1740 psi)	120 bar (1740 psi)
Equivalent length:	1.27 m (4.17 ft)	1.45 m (4.76 ft)
Test pressure:	180 bar (2611 psi)	180 bar (2611 psi)
Weight:	0.38 kg (0.84 lb)	1.18 kg (2.60 lb)

* ZINKLAD is a trademark of MacDermid Acumen, Inc.

80 mm (3 IN.) VALVE CONTAINER ADAPTORS

When a single 343 L container is being used or if the 343 L container is being used with 3 in. check valve hard pipe option, three swivel adaptors are available for connection to the discharge outlet, either NPT, BSP or grooved.

Technical information

Body:	Cadmium plated mild steel
<u>3 in. Flared to 3 in. BSPT</u>	
Overall size:	115 mm (L) x 102 mm (W) (4.51 in. (L) x 4.00 in. (W))
Weight:	2.84 kg (6.27 lb)
Equivalent length:	0.55 m (1.8 ft)
<u>3 in. Flared to 3 in. NPT</u>	
Overall size:	115 mm (L) x 102 mm (W) (4.51 in. (L) x 4.00 in. (W))
Weight:	2.84 kg (6.27 lb)
Equivalent length:	0.55m (1.8 ft)
<u>3 in. Flared to 3 in. Grooved</u>	
Overall size:	72 mm (L) x 102 mm (W) (2.82 in. (L) x 4.00 in. (W))
Weight:	1.95 kg (4.30 lb)
Equivalent length:	0.55 m (1.8 ft)



FIGURE 2-25
80 mm (3 IN.) VALVE CONTAINER ADAPTOR
025495

3 in. Flared to 3 in. BSPT: Part No. 309.002.013 (570363)
3 in. Flared to 3 in. NPT: Part No. 309.002.014 (69470)
3 in. Flared to 3 in. Grooved: Part No. 309.002.015 (69471)

FLEXIBLE DISCHARGE HOSE - 25 mm (1 IN.) HOSE

FM-200 agent container installations may be connected to the system with a flexible discharge hose. This enables containers to disconnect for maintenance or recharge without dismantling other container mountings, manifold connections, and pipework. The flexible discharge hose has a swivel fitting at the inlet.

TABLE 2-15: 25 mm (1 IN.) FLEXIBLE DISCHARGE HOSE

Part No.	Description	Dimension A		Dimension B	
		mm	(in.)	mm	(in.)
306.207.002	25 mm (1 in.) hose	405.0	(15.9)	92.0	(3.62)

Technical information

Hose construction:	Single steel wire braided oil resistant seamless synthetic rubber core to EN853 1SN
Connection:	Zinc passivated mild steel 1 in. NPT straight fixed Male 1 in. BSPP 90° Female swivel union with o-ring
Plating specification:	ZINKLAD 1000 plating (Hexavalent Chromium-Free)
Hose inner diameter:	25.4 mm (1 in.)
Connection inner diameter:	19.5 mm (0.77 in.)
Maximum working pressure:	49 bar (711 psi) (according to EN 12094-8)
Test pressure:	88 bar (1276 psi)
Minimum burst pressure:	350 bar (5076 psi)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE) 0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Minimum bend radius:	300 mm (11.8 in.)
Maximum bend angle:	15°
Equivalent length:	3.14 m (10.3 ft)
Weight:	1.25 kg (2.76 lb)
Hose type:	Type 1
Overall size:	102 mm x 429 mm (4.02 in. x 16.89 in.)
Center dimensions:	A = 405 mm ± 5 mm (15.94 in. ± 0.2 in.) B = 81.5 mm ± 1.5 mm (3.21 in. ± 0.06 in.)
Approvals and listings:	UL, FM, and CE
Certification:	EN 12094-8
CE certification number:	0832-CPD-2040 2831-CPR-S2040
Year of CE marking:	2008
CE marking requirements:	Manufacturer's mark, part number, batch number, WP-49 bar, hose type 1, CE_{0832} or CE_{2831}
Method of marking:	Laser

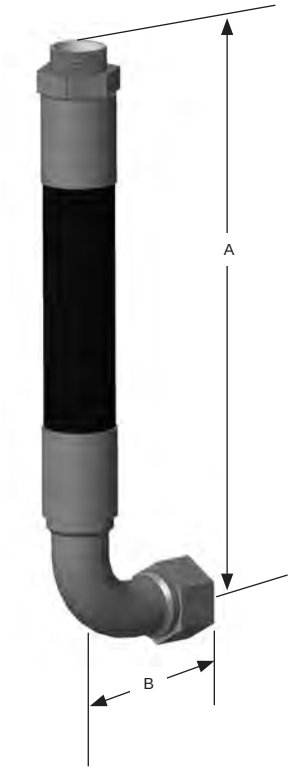


FIGURE 2-26
FLEXIBLE DISCHARGE HOSE
025544

Location on system

The flexible discharge hose connects between the container valve outlet and the adjustable height adaptor / manifold check valve.

FLEXIBLE DISCHARGE HOSE - 50 mm (2 IN.) HOSE

The following table lists the 50 mm (2 in.) flexible discharge hose details.

TABLE 2-16: 50 mm (2 IN.) FLEXIBLE DISCHARGE HOSE

Part No.	Description	Dimension A		Dimension B	
		mm	(in.)	mm	(in.)
306.207.003	50 mm (2 in.) hose	520.0	(20.5)	125.0	(4.9)

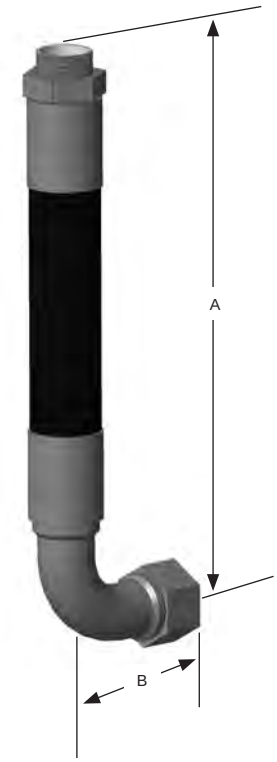


FIGURE 2-27
FLEXIBLE DISCHARGE HOSE
025544

Technical information

Hose construction:	Twin steel wire braided oil resistant seamless synthetic rubber core to EN853 25N
Connection:	Zinc passivated mild steel 2 in. NPT straight fixed Male 2 in. BSPP 90° Female swivel union with o-ring
Plating specification:	ZINKLAD 1000 plating (Hexavalent Chromium-Free)
Hose inner diameter:	50.8 mm (2.0 in.)
Connection inner diameter:	44 mm (1.73 in.)
Maximum working pressure:	49 bar (711 psi) according to EN 12094-8
Test pressure:	80 bar (1160 psi)
Minimum burst pressure:	320 bar (4641 psi)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE) 0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Minimum bend radius:	630 mm (24.8 in.)
Maximum bend angle:	15°
Equivalent length:	5.36 m (17.59 ft)
Weight:	3.9 kg (8.6 lb)
Hose type:	Type 1
Overall Size:	160 mm x 560 mm (6.30 in. x 22.05 in.)
Centre dimensions:	A = 520 mm ± 5 mm (20.47 in. ± 0.2 in.) B = 125 mm ± 1.5 mm (4.9 in. ± 0.06 in.)
Approvals and listings:	UL, FM, and CE
Certification:	EN 12094-8
CE certification number:	0832-CPD-2040 2831-CPR-S2040
Year of CE marking:	2008
CE marking requirements:	Manufacturer's mark, part number, batch number, WP-49 bar, hose type 1, CE_{0832} or CE_{2831}
Method of marking:	Laser

Location on system

The flexible discharge hose connects between the container valve outlet and the adjustable height adaptor / manifold check valve.

FLEXIBLE DISCHARGE HOSE - 80 mm (3 IN.) HOSE / CHECK VALVE ASSEMBLY (Part No. 306.205.006)

The discharge hose/check valve assembly combines the elbow, hose, check valve, and swivel coupling for connection to the valve discharge outlet and the discharge manifold. The check valve provides the facility for a 40 mm (1.5 in.) height adjustment.



FIGURE 2-28
80 mm (3 IN.) FLEXIBLE DISCHARGE HOSE
E001120

Technical information

Hose:	Double braid stainless steel
Elbow:	Stainless steel UNS 30400
Valve swivel nut:	Stainless steel UNS 30400
Check valve swivel nut:	Cadmium plated mild steel
Check valve body:	Cadmium plated mild steel
Check valve seal and seat:	Brass UNS 36000
Spring:	Stainless steel
Maximum working pressure:	34.5 bar (500 psi)
Test pressure:	51.7 bar (750 psi)
Minimum burst pressure (hose):	137.9 bar (2000 psi)
Equivalent length:	15.85 m (52 ft)
Working temperature range:	0 °C to 54 °C (32 °F to 130 °F)
Overall size (Minus check valve):	619 mm (L) x 254 mm (W) (24.37 in. (L) x 10.00 in. (W))
Total length:	765.5 mm (30.1 in.)
Weight:	20.50 kg (45.20 lb)

Note: This hose and check valve assembly is not certified in accordance with EN 12094-4 and cannot be installed within the UK and EU.

FLEXIBLE DISCHARGE HOSE - 80 mm (3 IN.) HOSE (Part No. 306.205.005)

The discharge hose is used with the 80 mm (3 in.) NPT single tank adaptor and 90° elbow to connect the container valve outlet to the distribution piping in single tank systems. The hose is constructed of corrugated stainless steel tubing with stainless braid cover.



FIGURE 2-29
80 mm (3 IN.) FLEXIBLE DISCHARGE HOSE
E001121

Technical information

Hose construction:	Double braid stainless steel
Maximum working pressure:	34.5 bar (500 psi)
Test pressure:	51.7 bar (750 psi)
Minimum burst pressure (hose):	137.9 bar (2000 psi)
Minimum bend radius:	460 mm (18 in.)
Equivalent length:	2.7 m (8.8 ft)
Working temperature range:	0 °C to 54 °C (32 °F to 130 °F)
Overall size:	406 mm (L) x 76 mm (Dia) (15.98 in. (L) x 2.99 in. (Dia))
Weight:	3.0 kg (6.6 lb)

Note: This hose is not certified in accordance with EN 12094-4 and cannot be installed within the UK and EU.

80 mm (3 IN.) DISCHARGE CHECK VALVE AND ADAPTOR ASSEMBLY (Part No. 452162)

The discharge check valve and adaptor assembly combines the check valve, swivel nut, and 3 in. NPT threaded adaptor to be used for the hard pipe option from the valve discharge outlet and the discharge manifold. The check valve provides the facility for a 38.1 mm (1 1/2 in.) height adjustment.

Technical information

Check valve body:	Cadmium plated mild steel
Check valve seal and seat:	Brass UNS 36000
Spring:	Stainless steel
Check valve swivel nut:	Cadmium plated mild steel
Check valve 3 in. threaded adaptor:	Stainless Steel UNS S30400
Joint type:	3 in. NPT male x 3 in. NPT male
Maximum working pressure:	34.5 bar (500 psi)
Test pressure:	51.7 bar (750 psi)
Overall size:	350 mm (L) x 157 mm (Dia) (13.78 in. (L) x 6.18 in. (Dia))
Weight:	Approx. 16.25 kg (35.82 lb)
Equivalent length:	13.15 m (43.143 ft)

Note: This check valve is not certified in accordance with EN 12094-4 and cannot be installed in the UK and EU.



FIGURE 2-30
80 mm (3 IN.) DISCHARGE CHECK VALVE AND ADAPTOR ASSEMBLY
E001516

ADJUSTABLE HEIGHT ADAPTOR (Part No. 306700003 and 306700004)

All manifolded systems have the option of using the adjustable height adaptor to provide height adjustment functionality due to possible variations in seamless container heights. The adaptor is installed between the hose outlet and manifold check inlet and allows for a maximum height adjustment of 35 mm (1.4 in.).

Note: The adjustable height adaptor is an optional item. For manifold mounting bracket heights with or without the adjustable height adaptor, see Section 6 - Installation.

TABLE 2-17: ADJUSTABLE HEIGHT ADAPTOR

Part No.	Description
306700003	25 mm (1 in.) adjustable height adaptor
306700004	50 mm (2 in.) adjustable height adaptor



FIGURE 2-31
ADJUSTABLE HEIGHT ADAPTOR
025509

Technical information

Adaptor size:	25 mm (1 in.)	50 mm (2 in.)
Body construction:	Zinc-Nickel plated steel F-211	Zinc-Nickel plated steel F-211
Body material:	Steel	Steel
Plating specification:	ZINKLAD 1000 plating (Hexavalent Chromium-Free)	ZINKLAD 1000 plating (Hexavalent Chromium-Free)
Nut construction:	Zinc-Nickel plated steel F-211	Zinc-Nickel plated steel F-211
Tube construction:	Zinc-Nickel plated steel F-112	Zinc-Nickel plated steel F-112
Connections:	Inlet connection thread 1 in. NPT Female	Inlet connection thread 2 in. NPT Female
	Outlet connection thread 1 in. NPT Male	Outlet connection thread 2 in. NPT Male
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE)	0 °C to 50 °C (32 °F to 122 °F) (CE)
	0 °C to 54 °C (32 °F to 130 °F) (UL and FM)	0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Maximum working pressure:	120 bar (1740 psi)	120 bar (1740 psi)
Equivalent length:	0.44 m (1.44 ft)	0.96 m (3.15 ft)
Test pressure:	180 bar (2611 psi)	180 bar (2611 psi)
Weight:	2.15 kg (4.74 lb)	4.94 kg (10.9 lb)
Installation information:	55 mm and 39 mm A/F (2.17 in. and 1.54 in.)	65 mm and 90 mm A/F (2.56 in. and 3.54 in.)
Approvals and listings:	UL, FM, and CE	UL, FM, and CE
Certification:	EN 12094-8	EN 12094-8
CE certification number:	0832-CPR-S0071 2831-CPR-S0071	0832-CPR-S0071 2831-CPR-S0071
CE marking requirements:	Manufacturer's mark, part number, CE_{0832} or CE_{2831}	Manufacturer's mark, part number, CE_{0832} or CE_{2831}
Year of CE marking:	2018	2018

MANIFOLD CHECK VALVE

The check valve prevents loss of suppression agent during discharge from an outlet, should a container be removed. The check valve is installed between the flexible discharge hose and the manifold.

Manifold check valves are available in two sizes, 25 mm and 50 mm (1 in. and 2 in.).

TABLE 2-18: MANIFOLD CHECK VALVE PART DETAILS

Part No.	Description
302.209.004	25 mm (1 in.) manifold check valve
302.209.005	50 mm (2 in.) manifold check valve

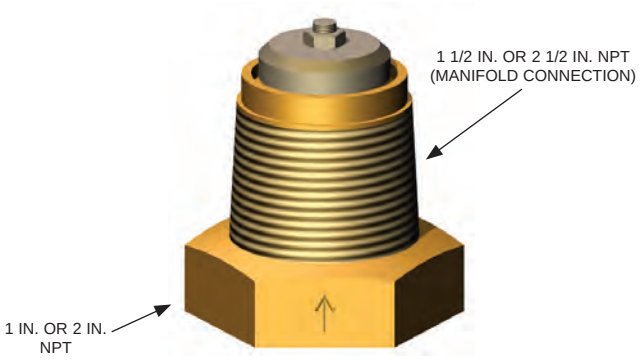


FIGURE 2-32
MANIFOLD CHECK VALVE
009686

Location on system

The manifold check valve connects between the adjustable height adaptor and the manifold. The manifold check valve must be threaded into the manifold tee.

Technical information

Check valve:	25 mm (1 in.)	50 mm (2 in.)
Body material:	Brass CZ122 or HTB1	Brass CZ122 or HTB1
Stem material:	Stainless steel	Stainless steel
Spring material:	Stainless steel	Stainless steel
Top plate material:	Stainless steel	Stainless steel
Bottom plate material:	Brass CZ121	Brass CZ121
Seal material:	Nitrile	Nitrile
Inlet connection thread:	1 in. NPT Female	2 in. NPT Female
Outlet connection thread:	1 1/2 in. NPT Male	2 1/2 in. NPT Male
Overall size:	73 mm (L) x 60 mm (W) (2.87 in. (L) x 2.36 in. (W))	96 mm (L) x 94 mm (W) (3.78 in. (L) x 3.70 in.(W))
Cross sectional area:	320 mm²	320 mm²
Equivalent length:	0.40 m (1.3 ft)	6.66 m (21.8 ft)
Maximum working pressure:	120 bar (1740 psi)	120 bar (1740 psi)
Test pressure:	180 bar (2611 psi)	180 bar (2611 psi)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE)	0 °C to 50 °C (32 °F to 122 °F) (CE)
	0 °C to 54 °C (32 °F to 130 °F) (UL and FM)	0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Approvals and listings:	UL, FM, and CE	UL, FM, and CE
Certification:	EN 12094-13	EN 12094-13
CE certification number:	0832-CPD-2041 2831-CPR-S2041	0832-CPD-2041 2831-CPR-S2041
Year of CE marking:	2008	2008
CE marking requirements:	Manufacturer's mark, part number, DN25, WP-120 bar, vertical, ↑, serial number, CE_{0832} or CE_{2831}	Manufacturer's mark, part number, DN25, WP-120 bar, vertical, ↑, serial number, CE_{0832} or CE_{2831}
Method of marking:	Laser or engraved	Laser or engraved
Weight:	0.63 kg (1.39 lb)	1.60 kg (3.53 lb)

MANIFOLDS

For some markets (Europe, Middle East, Africa, and Asia-Pacific), factory manufactured manifolds are available, see Table 2-23. Refer to the local price list for availability. Manifolds are assembled from screwed pipe and fittings or are a welded construction. They enable multiple containers to connect to a common pipe network reducing the amount of piping required by utilizing a single pipe run. They may also be used in systems where main or reserve container arrangements are required. Table 2-23 lists the manifold part details. The following list specifies the manifolding requirements:

- Use Schedule 80 black iron, galvanized, chrome-plated, or stainless steel pipe conforming to ASTM A53, or A106. All fittings must be a minimum Class 3000, malleable or ductile iron.
- After welding, make certain all inlet holes in the pipe are clean of any weld spatter and are completely open.
- Pipe unions are acceptable.
- Reducing bushings and reducing fittings is allowed when reducing pipe size.
- Cast iron pipe and fittings are not acceptable.
- PTFE (TEFLON*) tape is the only acceptable pipe sealant and must be applied to male threads only.
- Do not allow tape to overlap the pipe opening, as this could cause possible blockage of the agent. Thread sealant or compound must not be used.
- Before assembling the pipe and fittings, make certain all ends are carefully reamed and blown clear of chips, debris, and scale. The inside of the pipe and fittings must be free of oil and dirt.
- NPT Sockets (see Table 2-20) in conjunction with manifold reducing bushings (see Table 2-19) can be utilized for connecting to the discharge pressure switch. Alternatively, manifold blind caps (see Table 2-22) or a combination of sockets / reducing bushings and plugs (see Table 2-21) can be used to close the manifold end.
- Assemblies do not include check valves and end caps. Flanges are only available on 6 in. manifolds. Table 2-20 lists the NPT sockets available for closing manifold ends.
- NPT × NPT union adaptors should be utilized where screwed manifold sections are required to be joined.

Note: All check valves, unions, blind caps, sockets, reducing bushings and plugs must be ordered separately.

Technical information

Material:	ASTM A53 or ASTM A106 Grade B
Inlet:	NPT
Outlet:	NPT - 65 mm (2.5 in.), 80 mm (3 in.), and 100 mm (4 in.) manifolds
	Flanged - 150 mm (6 in.) manifolds
Maximum working pressure:	120 bar (1740 psi) - Threaded 50 bar (725 psi) - Flanged
Test pressure:	180 bar (2611 psi) - Threaded 75 bar (1088 psi) - Flanged)
Finish:	Primed and ready to paint on site

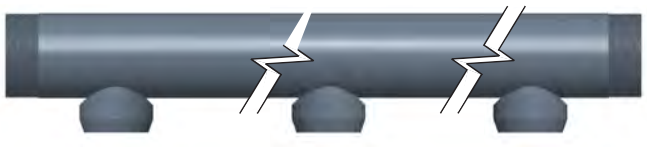


FIGURE 2-33
TYPICAL MANIFOLD ASSEMBLY
025408

TABLE 2-19: MANIFOLD REDUCING BUSHINGS

Part No.	Description
309.008.033	3 in. x 1/2 in. NPT reducing bushing galvanized 3000 lb
309.008.034	4 in. x 1/2 in. NPT reducing bushing galvanized 3000 lb
309.008.035	3 in. x 1/2 in. BSPT reducing bushing galvanized 3000 lb
309.008.036	4 in. x 1/2 in. BSPT reducing bushing galvanized 3000 lb
309.008.040	2.5 in. x 1/2 in. NPT reducing bushing galvanized 3000 lb
309.008.041	2.5 in. x 1/2 in. BSPT reducing bushing galvanized 3000 lb

TABLE 2-20: NPT SOCKETS FOR MANIFOLD ENDS

Part No.	Description
309.001.010	2 1/2 in. NPT socket galvanized 3000 lb
309.001.011	3 in. NPT socket galvanized 3000 lb
309.001.012	4 in. NPT socket galvanized 3000 lb

TABLE 2-21: MANIFOLD REDUCING BUSHING PLUGS

Part No.	Description
309.007.003	1/2 in. NPT plug galvanized 3000 lb
309.007.013	1/2 in. BSPT plug galvanized 3000 lb

TABLE 2-22: MANIFOLD BLIND CAPS

Part No.	Description
35009006	2 1/2 in. NPT blind cap
35009007	3 in. NPT blind cap
35009008	4 in. NPT blind cap

*TEFLON is a trademark of Chemours Chemical Corporation.

MANIFOLDS (Continued)

TABLE 2-23: MANIFOLDS

Part No.	No. of Inlets	Nominal Manifold Pipe Size mm (in.)	Inlet to End Cap Distance mm (in.)	Inlet to Inlet Distance mm (in.)	Inlet to End Connection Distance mm (in.)	Container Size L	Overall Length mm (in.)	End Thread Connection	Weight kg (lb)
307.209.001	2	65 (2.5)	145 (5.7)	350 (13.8)	145 (5.7)	4.5 to 45	640 (25.2)	2 1/2 in. NPT	8.06 (17.8)
307.209.002	3	65 (2.5)	145 (5.7)	350 (13.8)	145 (5.7)	4.5 to 45	990 (39.0)	2 1/2 in. NPT	12.44 (27.4)
307.209.003	4	65 (2.5)	145 (5.7)	350 (13.8)	145 (5.7)	4.5 to 45	1340 (52.8)	2 1/2 in. NPT	19.79 (43.6)
307700004	2	80 (3)	216 (8.5)	500 (20)	216 (8.5)	52 to 180	932 (36.7)	3 in. NPT	12.57 (27.7)
307700005	3	80 (3)	216 (8.5)	500 (20)	216 (8.5)	52 to 180	1432 (56.4)	3 in. NPT	19.20 (42.3)
307700006	4	80 (3)	216 (8.5)	500 (20)	216 (8.5)	52 to 180	1932 (76.0)	3 in. NPT	25.84 (57.0)
307700007	5	80 (3)	216 (8.5)	500 (20)	216 (8.5)	52 to 180	2432 (95.7)	3 in. NPT	32.47 (71.6)
307700008	6	80 (3)	216 (8.5)	500 (20)	216 (8.5)	52 to 180	2932 (115.4)	3 in. NPT	39.10 (86.2)
307700009	2	100 (4)	216 (8.5)	500 (20)	216 (8.5)	52 to 180	932 (36.7)	4 in. NPT	21.85 (48.2)
307700010	3	100 (4)	216 (8.5)	500 (20)	216 (8.5)	52 to 180	1432 (56.4)	4 in. NPT	33.55 (74.0)
307700011	4	100 (4)	216 (8.5)	500 (20)	216 (8.5)	52 to 180	1932 (76.0)	4 in. NPT	45.24 (99.7)
307700012	5	100 (4)	216 (8.5)	500 (20)	216 (8.5)	52 to 180	2432 (95.7)	4 in. NPT	56.93 (125.5)
307700013	6	100 (4)	216 (8.5)	500 (20)	216 (8.5)	52 to 180	2932 (115.4)	4 in. NPT	68.62 (151.3)
307209050	3	150 (6)	200 (7.9)	500 (20)	200 (7.9)	52 to 180	1400 (55.1)	6 in. Flange	85.0 (3.3)
307209051	4	150 (6)	200 (7.9)	500 (20)	200 (7.9)	52 to 180	1900 (74.8)	6 in. Flange	136.8 (5.4)
307209052	5	150 (6)	200 (7.9)	500 (20)	200 (7.9)	52 to 180	2400 (94.5)	6 in. Flange	160.4 (6.3)
307209053	6	150 (6)	200 (7.9)	500 (20)	200 (7.9)	52 to 180	2900 (114.2)	6 in. Flange	184.0 (7.2)
307209054	7	150 (6)	200 (7.9)	500 (20)	200 (7.9)	52 to 180	3400 (133.9)	6 in. Flange	207.5 (8.2)
307209055	8	150 (6)	200 (7.9)	500 (20)	200 (7.9)	52 to 180	3900 (153.5)	6 in. Flange	231.1 (9.1)
307209056	9	150 (6)	200 (7.9)	500 (20)	200 (7.9)	52 to 180	4400 (173.2)	6 in. Flange	282.9 (11.1)
307209057	10	150 (6)	200 (7.9)	500 (20)	200 (7.9)	52 to 180	4900 (192.9)	6 in. Flange	278.3 (11.0)
307.209.035	2	100 (4)	150 (6)	711 (28)	150 (6)	343	1011 (39.8)	4 in. NPT	26.9 (1.1)
307.209.036	3	100 (4)	150 (6)	711 (28)	150 (6)	343	1722 (67.8)	4 in. NPT	45.0 (1.8)
307.209.037	4	100 (4)	150 (6)	711 (28)	150 (6)	343	2433 (95.8)	4 in. NPT	63.1 (2.5)
307.209.041	2	150 (6)	150 (6)	711 (28)	200 (7.9)	343	1111 (43.7)	6 in. Flange	66.2 (2.6)
307.209.042	3	150 (6)	150 (6)	711 (28)	200 (7.9)	343	1822 (71.7)	6 in. Flange	98.9 (3.9)
307.209.043	4	150 (6)	150 (6)	711 (28)	200 (7.9)	343	2533 (99.7)	6 in. Flange	159.0 (6.3)
307.209.044	5	150 (6)	150 (6)	711 (28)	200 (7.9)	343	3244 (127.7)	6 in. Flange	191.7 (7.5)
307.209.045	6	150 (6)	150 (6)	711 (28)	200 (7.9)	343	3955 (155.7)	6 in. Flange	224.4 (8.8)
307.209.046	7	150 (6)	150 (6)	711 (28)	200 (7.9)	343	4666 (183.7)	6 in. Flange	256.2 (10.1)
307.209.047	8	150 (6)	150 (6)	711 (28)	200 (7.9)	343	5377 (211.7)	6 in. Flange	288.9 (11.4)
307.209.048	9	150 (6)	150 (6)	711 (28)	200 (7.9)	343	6088 (239.7)	6 in. Flange	349.8 (13.8)
307.209.049	10	150 (6)	150 (6)	711 (28)	200 (7.9)	343	6799 (267.7)	6 in. Flange	353.5 (13.9)

For ease of assembly, flanged manifolds are available for 150 mm (6 in.) diameter. 150 mm (6 in.) flanged manifolds with either three or four ports are supplied as a one piece assembly. Manifolds with five to ten ports are made up from smaller sections due to the size and weight. See the following list for details:

- 5 port manifold - 2 port + 3 port
- 6 port manifold - 3 port x 2
- 7 port manifold - 4 port + 3 port
- 8 port manifold - 4 port + 4 port
- 9 port manifold - 3 port x 3
- 10 port manifold - 4 port + 3 port x 2

All 150 mm (6 in.) flanged manifolds include an end cap.

MANIFOLD INLET SOCKET

For some markets, manifold inlets are available for the construction of system manifolds. Refer to the local price list for availability. The following table lists manifold inlet part details.

Technical information

Material:	Carbon steel per ASTM A105 / ASTM A350 LF2
Dimensions:	Per ANSI B16.11 / BS3799
Pressure rating:	3000 lb

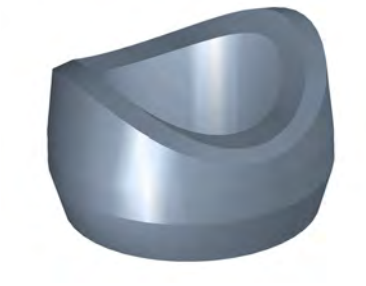


FIGURE 2-34
THREADED INLET FOR MANIFOLDS
025102

TABLE 2-24: MANIFOLD INLETS PART DETAILS

Part No.	Manifold Pipe Size mm (in.)	Seamless Container Size L	Welded Container Size L	Overall Diameter mm (in.)	Thread Connection	Overall Height mm (in.)	Weight kg (lb)
17036	65 (2 1/2)	15, 30, 34, and 45	4.5, 8, 16, and 32	75 (2.95)	1 1/2 in. NPT	44 (1.73)	0.71 (1.57)
17037	80 (3)	60, 80, 120, 150, and 180	52, 106, 147, and 180	100 (3.94)	2 1/2 in. NPT	63 (2.48)	1.20 (2.65)
17038	100 (4)	60, 80, 120, 150, and 180	52, 106, 147, 180, and 343	100 (3.94)	2 1/2 in. NPT	63 (2.48)	1.52 (3.35)
17467	150 (6)	60, 80, 120, 150, and 180	52, 106, 147, 180, and 343	100 (3.94)	2 1/2 in. NPT	63 (2.48)	1.54 (3.40)

MANIFOLD UNION ADAPTOR

Manifold union adaptors connect threaded manifolds to the system pipework. Manifold union adaptors are available in NPT x NPT and NPT x BSPT thread types. See the following table for connector sizes.

TABLE 2-25: MANIFOLD UNION ADAPTORS

Connector size (mm / in.)	NPT to NPT (Female)	NPT to BSPT (Female)	Weight kg (lb)
25 (1)	30888002	30888028	0.8 (1.8)
40 (1 1/2)	30888004	30888030	1.5 (3.3)
50 (2)	30888005	30888031	3.0 (6.6)
65 (2 1/2)	30888006	30888032	4.1 (9.0)
80 (3)	30888007	30888033	5.8 (12.8)
100 (4)	30888008	30888034	8.3 (18.3)



FIGURE 2-35
MANIFOLD UNION ADAPTOR
025505

Technical information

Material:	Zinc plated steel
Maximum working pressure:	240 bar (3481 psi)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE)
	0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Test pressure:	360 bar (5221 psi)

MANIFOLD BRACKET ASSEMBLY

For some markets (Europe, Middle East, Africa, and Asia-Pacific), manifold brackets are available for the construction of system manifolds. Refer to the local price list for availability. A manifold bracket assembly consists of two lengths of UNISTRUT, mounted vertically on a wall or bulk head to enable height adjustment of the manifold assembly. Cantilever brackets are fastened to the UNISTRUT and are held in position using a uninut long spring, washer, and hex head screw. Manifold brackets slot into the cantilever and are clamped using a hex head screw and plain nut. Each manifold bracket assembly is supplied in pairs. Where double manifold brackets are required, installers should construct to local requirements taking into account the manifold weight and wall specifications.

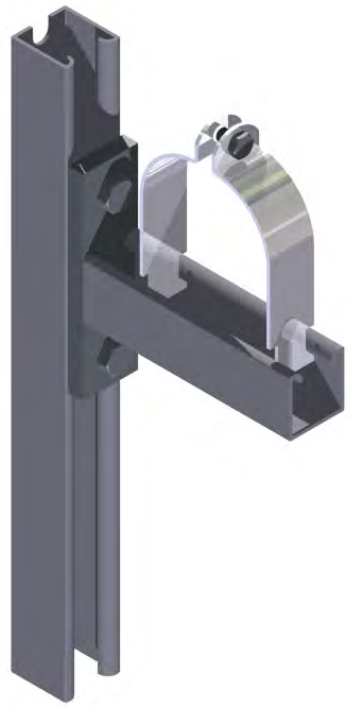


FIGURE 2-36
MANIFOLD BRACKET
025103

Technical information

Part No.:	311.205.015	311.205.010	311.205.011	311700001
Manifold bracket size:	65 mm (2.5 in.)	80 mm (3 in.)	100 mm (4 in.)	150 mm (6 in.)
UNISTRUT channel length:	400 mm (15.75 in.)	500 mm (16.69 in.)	500 mm (16.69 in.)	500 mm (16.69 in.)
Cantilever arm length:	150 mm (5.91 in.)	300 mm (11.81 in.)	300 mm (11.81 in.)	300 mm (11.81 in.)
Weight per bracket:	2.4 kg (5.29 lb)	2.5 kg (5.51 lb)	2.6 kg (5.73 lb)	2.7 kg (5.95 lb)

FEMALE ACTUATION HOSE

The 710 mm (Part No. 306.205.003), 815 mm (Part No. 306205010), and 1070 mm (Part No. 306205011) length hoses pneumatically actuate subordinate containers or smaller containers, typically for void protection, through the pilot port on the master container.

Location on system

The female actuation hose connects between the master container valve pilot port and the subordinate container pneumatic actuator, subordinate to subordinate container pneumatic actuator, and pilot container to master container pneumatic actuator.

Technical information

Hose construction:	Stainless steel wire braid PTFE liner to ISO 12086 Part 1
Connection:	Zinc passivated mild steel 2 off 1/4 in. BSP straight female swivel union
Plating specification:	ZINKLAD 1000 (Hexavalent Chromium-Free)
Nominal hose internal diameter:	6 mm (0.24 in.)
Connection inner diameter:	4 mm (0.16 in.)
Maximum working pressure:	120 bar (1740 psi)
Test pressure:	180 bar (2611 psi)
Minimum burst pressure:	724 bar (7603 psi)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE) 0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Bend angle:	360°
Minimum bend radius:	60 mm at 0 °C (2.4 in. at 32 °F) according to EN 12094-8
Hose volume:	20.07 cm^3
Approvals and listings:	UL, FM, and CE
Certification:	EN 12094-8
CE certification number:	0832-CPD-2040 0832-CPR-S0071 2831-CPR-S0071
Year of CE marking:	2008 (306.205.003) 2018 (306205010 and 306205011)
CE marking requirements:	Manufacturer's mark, part number, batch number, WP-120 bar, hose type 3, CE_{0832} or CE_{2831}
Method of Marking:	Laser
Hose Type:	Type 3
Overall Size:	See Table 2-26
Weight:	See Table 2-26



FIGURE 2-37
FEMALE ACTUATION HOSE
009701

TABLE 2-26: FEMALE ACTUATION HOSES

Part No.	Length	Weight kg (lb)
306.205.003	DN1/4 in. PTFE flexible actuation hose x 710 mm (27.9 in.)	0.15 (0.33)
306205010	DN1/4 in. PTFE flexible actuation hose x L1 815 mm (32.1 in.)	0.17 (0.37)
306205011	DN1/4 in. PTFE flexible actuation hose x L2 1070 mm (42.1 in.)	0.19 (0.42)

ACTUATION COMPONENTS

The following fittings are typical examples of the requirements for the actuation system and do not limit the use of other acceptable fittings. See Section 9 - Appendix for examples of actuation system layouts.

Male adaptor

Part No.	Description	Picture	Technical information	
309.013.005	The male adaptor connects the pilot hose to the 25 mm (1 in.) and 50 mm (2 in.) container valve assembly.	 025547	Material:	Steel 230 M07 Pb, zinc passivated
			Connection:	1/4 in. BSPT x 1/4 in. BSPP
			Maximum working pressure:	350 bar (5076 psi)
			Overall size:	34.0 mm x 19.0 mm Hex A/F (1.35 in. x 0.75 in.)
			Weight:	0.034 kg (0.07 lb)

Male adaptor

Part No.	Description	Picture	Technical information	
309.013.006	The male adaptor connects the female actuation hose to the discharge pressure switch.	 025546	Material:	Steel 230 M07 Pb, zinc passivated
			Connection:	1/4 in. NPT x 1/4 in. BSPP
			Maximum working pressure:	350 bar (5076 psi)
			Overall size:	34.0 mm x 19.0 mm Hex A/F (1.35 in. x 0.75 in.)
			Weight:	0.034 kg (0.07 lb)

Male actuation tee

Part No.	Description	Picture	Technical information	
309.200.021	The male actuation tee connects the female actuation hoses to the pneumatic actuator. The actuation tee's 1/4 in. BSPP thread connects to the female actuation hose and a 1/4 in. NPT thread connects to the pneumatic actuator on the container discharge valve.	 025559	Material:	Steel 230 M07 Pb, zinc passivated
			Connection:	1/4 in. BSPP x 1/4 in. BSPP x 1/4 in. NPT
			Maximum working pressure:	450 bar (6527 psi)
			Overall size:	42.0 mm x 29.0 mm (0.16 in. x 1.14 in.)
			Weight:	0.075 kg (0.165 lb)

ACTUATION COMPONENTS (Continued)

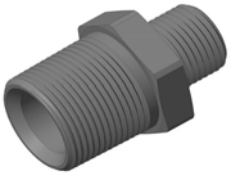
Male actuation elbow

Part No.	Description	Picture	Technical information	
309.013.009	The male actuation elbow connects the female actuation hose to the pneumatic actuator. The elbow's 1/4 in. BSPP thread connects to the hose and the 1/4 in. NPT thread connects to the pneumatic actuator on the container discharge valve.	 025560	Material:	Steel 230 M07 Pb, zinc passivated
			Connection:	1/4 in. BSPP x 1/4 in. NPT
			Maximum working pressure:	450 bar (6527 psi)
			Overall size:	28.0 mm x 25.0 mm (1.10 in. x 0.98 in.)
			Weight:	0.05 kg (0.110 lb)

Male pilot hose connector

Part No.	Description	Picture	Technical information	
309.013.007	The male connector connects the two female actuation hoses together, or actuation hose to the non-return valve.	 025548	Material:	Steel 230 M07 Pb, zinc passivated
			Connection:	1/4 in. BSPP x 1/4 in. BSPP
			Maximum working pressure:	350 bar (5076 psi)
			Overall size:	30.0 mm x 19.0 mm Hex A/F (1.18 in. x 0.75 in.)
			Weight:	0.034 kg (0.07 lb)

Male adaptor

Part No.	Description	Picture	Technical information	
309.013.036	The male adaptor connects the pilot hose to the discharge pressure switch (Part No. 305.209.009). This adaptor is supplied with the standard pressure switch.	 025500	Material:	Steel 230 M07 Pb, zinc passivated
			Connection:	3/8 in. NPT x 1/4 in. BSPP
			Maximum working pressure:	350 bar (5076 psi)
			Overall size:	34.0 mm x 19.0 mm Hex A/F (1.34 in. x 0.75 in.)
			Weight:	0.036 kg (0.8 lb)

6 mm Copper nickel pipe

Part No.	Description	Picture	Technical information	
302.002.001	The copper nickel pipe connects pressure activated devices to the system, for example, a subordinate container or a pressure switch. The pipe is supplied per meter (foot) and is suitable for bending.	 025493	Material:	Copper nickel alloy
			Specification:	CN102
			Maximum working pressure:	149.5 bar (2168 psi)
			Supplied length:	Ordered per meter (foot)
			Weight:	0.078 kg/m (0.052 lb/ft)

ACTUATION COMPONENTS (Continued)

6 mm Half hard pipe

Part No.	Description	Picture	Technical information	
302.002.002	Where extensive actuation runs are required, 6 mm half hard copper pipe can be used. The pipe is supplied in 3 m lengths and is not suitable for bending.	 025492	Material:	Phosphorous deoxidized copper
			Specification:	BS6017 grade Cu-DHP
			Maximum working pressure:	149.5 bar (2168 psi)
			Supplied length:	3.0 m (9.83 ft)
			Weight:	0.078 kg/m (0.052 lb/ft)

1/4 in. Copper tubing

Part No.	Description	Picture	Technical information	
447609	Where extensive actuation runs are required, a 50 ft coil of 1/4 in. copper tubing can be used. The pipe is suitable for bending.	 025492	Material:	122 soft copper ASTM B280
			Specification:	1/4 in. OD x 0.03 in. wall thickness
			Maximum working pressure:	100 bar at 21 °C (1450 psi at 70 °F)
			Supplied length:	50 ft (15.25 m)
			Weight:	0.08 lb/ft (0.12 kg/m)

6 mm Compression tee

Part No.	Description	Picture	Technical information	
30880015	The 6 mm compression tee primarily connects pilot lines from one subordinate container to the next.	 025647	Material:	Brass
			Connection:	6 mm DIN 2353 compression fittings
			Maximum working pressure:	150 bar (2176 psi)
			Overall size:	44.0 mm x 27.5 mm (1.73 in. x 1.08 in.)
			Weight:	0.04 kg (0.09 lb)

1/4 in. Compression tee

Part No.	Description	Picture	Technical information	
441430	The 1/4 in. compression tee primarily connects pilot lines from one subordinate container to the next.	 025648	Material:	Brass
			Connection:	1/4 in. compression fittings
			Maximum working pressure:	150 bar (2176 psi)
			Overall size:	44.0 mm x 27.5 mm (1.73 in. x 1.08 in.)
			Weight:	0.04 kg (0.09 lb)

ACTUATION COMPONENTS (Continued)

6 mm Straight coupling

Part No.	Description	Picture	Technical information	
30880020	The 6 mm straight coupling connects the 6 mm copper pipe.	 025649	Material:	Brass
			Connection:	6 mm DIN 2353
			Maximum working pressure:	150 bar (2176 psi)
			Overall size:	32.0 mm x 11.0 mm / 13.0 mm Hex A/F
			Weight:	0.026 kg (0.057 lb)

1/4 in. Straight coupling

Part No.	Description	Picture	Technical information	
441544	The 1/4 in. straight coupling connects the 1/4 in. copper tubing.	 025650	Material:	Brass
			Connection:	1/4 in. compression fittings
			Maximum working pressure:	150 bar (2176 psi)
			Overall size:	1.26 in. x 0.43 in. / 0.51 in. Hex A/F
			Weight:	0.026 kg (0.057 lb)

6 mm Stud coupling

Part No.	Description	Picture	Technical information	
30880060	The 6 mm stud coupling is used in the pilot line when using copper nickel pipe to connect to the discharge pressure switch (Part No. 305.209.009). The stud coupling is supplied with the discharge pressure switch (Part No. 305.209.009) but must be ordered separately with the alternative discharge pressure switch (Part No. 437900).	 025651	Material:	Brass
			Connection:	3/8 in. NPT x 6 mm stud coupling
			Maximum working pressure:	150 bar (2176 psi)
			Overall size:	18.0 mm Hex A/F x 40.5 mm
			Weight:	0.05 kg (0.11 lb)

1/4 in. Stud coupling

Part No.	Description	Picture	Technical information	
441550	The 1/4 in. stud coupling is used in the pilot line when using copper nickel tubing to connect to the discharge pressure switch (Part No. 305.209.009 and 43700). The stud coupling must be ordered separately.	 025652	Material:	Brass
			Connection:	3/8 in. NPT x 1/4 in. stud coupling
			Maximum working pressure:	150 bar (2176 psi)
			Overall size:	1.54 in. x 0.51 in. Hex A/F
			Weight:	0.037 kg (0.082 lb)

ACTUATION COMPONENTS (Continued)

6 mm Stud coupling

Part No.	Description	Picture	Technical information	
30880061	The 6 mm stud coupling is used in the pilot line when using copper nickel pipe and fits into the pressure switch, the pneumatic actuator (Part No. 304.209.004) and also into the bleed valve (Part No. 302.200.076).	 025653	Material:	Brass
			Connection:	1/4 in. NPT x 6 mm stud coupling
			Maximum working pressure:	150 bar (2176 psi)
			Overall size:	26.0 mm x 14.0 mm Hex A/F
			Weight:	0.028 kg (0.062 lb)

1/4 in. Stud coupling

Part No.	Description	Picture	Technical information	
441545	The 1/4 in. stud coupling is used in the pilot line when using copper nickel tubing and fits into the pressure switch, the pneumatic actuator (Part No. 304.209.004) and also into the bleed valve (Part No. 302.200.076).	 025654	Material:	Brass
			Connection:	1/4 in. NPT x 1/4 in. stud coupling
			Maximum working pressure:	150 bar (2176 psi)
			Overall size:	1.02 in. x 0.55 in. Hex A/F
			Weight:	0.028 kg (0.062 lb)

6 mm Stud coupling

Part No.	Description	Picture	Technical information	
30880007	The 6 mm stud coupling is used in the pilot line when using copper nickel pipe. The 6 mm stud coupling fits into the 25 mm (1 in.) container valve assembly (Part No. 302700001) and the 50 mm (2 in.) container valve assembly (Part No. 302700002).	 025655	Material:	Brass
			Connection:	1/4 in. BSPT Male x 6 mm stud coupling
			Maximum working pressure:	150 bar (2176 psi)
			Overall size:	26.0 mm x 14.0 mm Hex A/F
			Weight:	0.024 kg (0.053 lb)

1/4 in. Stud coupling

Part No.	Description	Picture	Technical information	
441546	The 1/4 in. stud coupling is used in the pilot line when using copper nickel tubing. The 1/4 in. stud coupling fits into the 25 mm (1 in.) container valve assembly (Part No. 302700001) and the 50 mm (2 in.) container valve assembly (Part No. 302700002).	 025656	Material:	Brass
			Connection:	1/4 in. BSPT x 1/4 in. stud coupling
			Maximum working pressure:	150 bar (2176 psi)
			Overall size:	1.02 in. x 0.55 in. Hex A/F
			Weight:	0.024 kg (0.053 lb)

ACTUATION COMPONENTS (Continued)

6 mm Stud coupling

Part No.	Description	Picture	Technical information	
30880062	The 6 mm stud coupling allows a connection between the 6 mm copper tube and a 6 mm BSPP Female actuation hose. It is most commonly used at the end of a 6 mm copper pipe to provide a female actuation hose (Part No. 306.205.003) connection to the discharge pressure switch (Part No. 437900).	 025657	Material:	Brass
			Connection:	1/4 in. BSPP Male x 6 mm stud coupling
			Maximum working pressure:	200 bar (2901 psi)
			Overall size:	18.95 mm Hex A/F x 31.5 mm
			Weight:	0.030 kg (0.066 lb)

1/4 in. Stud coupling

Part No.	Description	Picture	Technical information	
441548	The 1/4 in. stud coupling allows a connection between the 1/4 in. copper tube and a 1/4 in. BSPP Female actuation hose. It is most commonly used at the end of a 1/4 in. copper tubing to provide a female actuation hose (Part No. 306.205.003) connection to the discharge pressure switch (Part No. 437900).	 025658	Material:	Brass
			Connection:	1/4 in. BSPP Male x 1/4 in. stud coupling
			Maximum working pressure:	150 bar (2176 psi)
			Overall size:	1.02 in. x 0.67 in. Hex A/F
			Weight:	0.034 kg (0.075 lb)

6 mm Stud coupling

Part No.	Description	Picture	Technical information	
30880063	The 6 mm stud coupling connects the decom-pression screw (Part No. 30027301) and the bleed valve (Part No. 302.200.075) through a 1/4 in. Dowty seal (Part No. 31199816) to the 6 mm copper tube.	 025673	Material:	Brass
			Connection:	1/4 in. BSPP Female x 6 mm stud coupling
			Maximum working pressure:	150 bar (2176 psi)
			Overall size:	32.0 mm x 17.0 mm Hex A/F
			Weight:	0.034 kg (0.075 lb)

1/4 in. Stud coupling

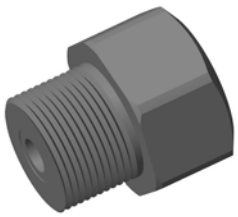
Part No.	Description	Picture	Technical information	
441547	The 1/4 in. stud coupling connects the decom-pression screw (Part No. 30027301) and the bleed valve (Part No. 302.200.075) through a 1/4 in. Dowty seal (Part No. 31199816) to the 1/4 in. copper tube.	 025673	Material:	Brass
			Connection:	1/4 in. BSPP Female x 1/4 in. stud coupling
			Maximum working pressure:	150 bar (2176 psi)
			Overall size:	1.26 in. x 0.67 in. Hex A/F
			Weight:	0.034 kg (0.075 lb)

ACTUATION COMPONENTS (Continued)

1/4 in. NPT socket

Part No.	Description	Picture	Technical information	
309.001.002	The 1/4 in. NPT socket provides a connection for the safety vent valve (Part No. 15677) to a 1/4 in. copper tube through a 1/4 in. x 1/4 in. NPT stud coupling.	 025562	Material:	A105N
			Type:	3000 lb fitting
			Connection:	1/4 in. NPT Female
			Overall size:	36.3 mm x Dia 20.0 mm (1.43 in. x Dia 0.79 in.)
			Weight:	0.057 kg (0.126 lb)
			Working pressure:	210 bar (3046 psi)

Bleed valve

Part No.	Description	Picture	Technical information	
302.200.075	This bleed valve is used in system configurations with a pilot container or AUTOMAN II-C release. Systems utilizing a pilot container for operation require a fitted bleed valve in the pilot line. The bleed valve relieves a gradual pressure build-up in the actuation line. The bleed valve automatically relieves a minimum pressure build-up to approximately 3.5 bar (50.8 psi) minimum, and seals at pressures above this. It connects into the outlet adaptor on the pilot container assembly and is supplied within the DOT, TPED, and PESO pilot container assemblies.	 025575	Body:	Stainless steel
			Internal parts:	Stainless steel
			Seat:	Nitrile
			Connection:	1/4 in. BSPP Male
			Closing pressure:	3.5 bar (50.8 psi)
			Maximum working pressure:	370 bar (5366 psi)
			Overall size:	19.0 mm x 16.0 mm Hex A/F (0.75 in. x 0.63 in.)
			Weight:	0.02 kg (0.04 lb)

ACTUATION COMPONENTS (Continued)

Bleed valve

Part No.	Description	Picture	Technical information	
302.200.076	This bleed valve is used in system configurations with master and subordinate containers. On manifolded systems with a connected reserve, the bleed valve must be fitted to the pneumatic actuator tee of the last subordinate container using a 1/4 in. NPT x 1/4 in. BSPP swivel female adaptor (Part No. 309.013.048) where actuation hoses are utilized. For 6 mm copper tube, use a 6 mm stud coupling x 1/4 in. NPT adaptor (Part No. 30880061). For 1/4 in. copper tube, use a 1/4 in. stud coupling x 1/4 in. NPT adaptor (Part No. 441545). The bleed valve relieves a gradual pressure build up in the actuation line. The bleed valve automatically relieves a pressure of up to approximately 3.5 bar (50.8 psi) minimum, and seals at pressures above this.	 025502	Body:	Stainless steel
			Internal parts:	Stainless steel
			Seat:	Nitrile
			Connection:	1/4 in. NPT Female
			Closing pressure:	3.5 bar (50.8 psi)
			Maximum working pressure:	120 bar (1740 psi)
			Overall size:	32.0 mm x 16.0 mm Hex A/F (1.26 in. x 0.63 in.)
			Weight:	0.04 kg (0.09 lb)

Female adaptor

Part No.	Description	Picture	Technical information	
309.013.048	The female adaptor connects the bleed valve (Part No. 302.200.076) to the male actuation tee (Part No. 309.200.021).	 025532	Material:	Steel 11SMnPb37, passivated
			Connection:	1/4 in. NPT Male x 1/4 in. BSPP Swivel Female
			Maximum working pressure:	350 bar (5076 psi)
			Overall size:	39.0 mm x 19.0 mm Hex A/F (1.54 in. x 0.75 in.)
			Weight:	0.04 kg (0.09 lb)

Dowty seal

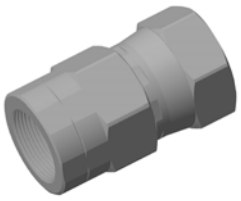
Part No.	Description	Picture	Technical information	
31199816	The Dowty seal fastens the decompression screw (Part No. 30027301) or the bleed valve (Part No. 302.200.075) to the appropriate 1/4 in. BSPP fitting.	 025587	Material:	Nitrile and steel. 85 ± 5 Shore A
			Maximum working pressure:	≤ 1500 bar (21,756 psi)
			Overall size:	2.03 mm x Dia 20.57 mm (0.08 in. x Dia 0.81 in.)
			Weight:	0.005 kg (0.01 lb)

ACTUATION COMPONENTS (Continued)

Male actuation tee

Part No.	Description	Picture	Technical information	
309013049	The 1/4 in. BSPP equal male tee connects the female actuation hoses.	 025589	Material:	Steel 230 MO7 Pb, zinc passivated
			Connection:	1/4 in. BSPP Male
			Maximum working pressure:	450 bar (6527 psi)
			Overall size:	44.7 mm x 19.0 mm Hex A/F (1.76 in. x 0.75 in.)
			Weight:	0.33 kg (0.73 lb)

Female adaptor

Part No.	Description	Picture	Technical information	
309013050	The 1/4 in. BSPP swivel Female x 1/4 in. BSPP fixed Female connects the decom-pression screw (Part No. 30027301) through a 1/4 in. Dowty seal (Part No. 31199816) to the 1/4 in. BSPP Male tee.	 025634	Material:	Steel 230 MO7 Pb, zinc passivated
			Connection:	1/4 in. BSPP swivel Female x 1/4 in. BSPP fixed Female
			Maximum working pressure:	450 bar (6527 psi)
			Overall size:	30.9 mm x 19.0 mm Hex A/F (1.22 in. x 0.75 in.)
			Weight:	0.31 kg (0.68 lb)

DISCHARGE PRESSURE SWITCH (Part No. 437900 / 305.209.009)

The discharge pressure switch activates from agent pressure during discharge and signals to a control panel that the system discharged. The discharge pressure switch latches on operation and contains a reset plunger. The discharge pressure switch ordered under part number 437900 is supplied with a 3/8 in. NPT Male x 1/4 in. NPT Female adaptor. To connect to an actuation hose, use a 1/4 in. NPT x 1/4 in. BSPP Male adaptor (Part No. 309.013.006). Order this adaptor separately. The discharge pressure switch ordered under part number 305.209.009 consists of part number 437900 and two additional adaptors, 3/8 in. NPT Male x 1/4 in. BSPP Male and 3/8 in. NPT Male x 6mm stud adaptor.

Note: If a manual actuator is fitted on the valve assembly, a discharge pressure switch should be used.



FIGURE 2-38
DISCHARGE PRESSURE SWITCH
009693

Technical information

Switch case and cover:	C.R. steel (painted red)
Body:	C37700 forged brass
Switch point:	2.8 bar rising (40 psi)
Tolerance:	± 0.7 bar (± 10 psi)
IP rating:	IP65
Electrical connection:	1/2 in. and 3/4 in. conduit knockouts with #6-32 UNC terminal screws
Pressure connection:	3/8 in. NPT Female
Adaptor:	3/8 in. NPT Male x 1/4 in. NPT Female
Range:	1 bar to 3 bar
Reset method:	Manual through plunger
Minimum actuation pressure:	3.4 bar (50 psi)
Maximum operating pressure:	200 bar (2900 psi)
Electrical ratings:	10 A 250 VAC 15 A 125 VAC 3/4HP, 250 VAC 1-, 2-, or 3-phase
Switch configuration:	Three pole, double throw (3PDT)
Installation environment:	Indoor / non-corrosive
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (EU) 0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Conformity:	EN 12094-10
Marking requirements:	Manufacturer's mark, part number, maximum working pressure, serial number
Method of marking:	Permanent, non-flammable
Overall size:	114 mm (L) x 114 mm (H) x 67 mm (W) (4.49 in. (L) x 4.49 in. (H) x 2.64 in. (W))
Weight:	1.0 kg (2.20 lb)
Approvals and listings:	LPCB (Part No. 305.209.009) UL and FM (Part No. 437900)

Location on system

The discharge pressure switch connects to the pilot port on the valve through a pilot hose or pneumatic tubing for single container systems or to the pneumatic actuation line.

LOW PRESSURE SWITCH (STANDARD OPEN ON FALL) (Part No. 304.205.006)

A low pressure warning switch is factory fitted and must be ordered seperately. The device continuously monitors the container pressure and in the event of the pressure dropping below 20 bar (290 psi) the switch operates to enable the condition to be signalled to a control unit.



FIGURE 2-39
LOW PRESSURE SWITCH (STANDARD OPEN ON FALL)
E001293

Technical information

Standard - Open on fall	(Part No. 304.205.006)
Body:	Hermetically sealed stainless steel
Electrical housing:	Epoxy sealed terminals
Ingress Protection class:	IP65
Connection:	Brass 1/8 in. NPT
Switch type:	Normally open at atmospheric pressure
Switch point:	Open on fall at 20 bar (290 psi)
	Close on rise at 24.1 bar (350 psi)
Tolerance:	+/- 0.7 bar (+/- 10 psi)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE)
	0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Maximum working pressure:	34 bar (493 psi)
Proof pressure:	345 bar (5003 psi)
Electrical connection:	0.9 m (3 ft) x 2 core cable
Maximum current:	2.9 A
Voltage range:	5 to 28 VDC
Weight:	0.087 kg (0.192 lb)
Approvals and listings:	UL, FM, and CE
Certification:	EN 12094-10
CE Certification No.:	0832-CPD-2048 2831-CPR-S2048
Year of CE marking:	2008
CE marking requirements:	Manufacturer's mark, PS80-K2-1949 (designation), Serial No., 290-350 (set point and switch point), and CE_{0832} or CE_{2831}
Method of marking:	Permanent, non-flammable screenprint
Overall size:	38 mm (L) x 16 mm (Dia) (1.50 in. (L) x 0.63 in. (Dia))

LOW PRESSURE SWITCH (SPECIAL CLOSE ON FALL) (Part No. 305.209.005)

A low pressure warning switch is factory fitted and must be ordered seperately. The device continuously monitors the container pressure and in the event of the pressure dropping below 20 bar (290 psi) the switch operates to enable the condition to be signalled to a control unit.



FIGURE 2-40
LOW PRESSURE SWITCH (SPECIAL CLOSE ON FALL)
E001293

Technical information

Special - Close on fall	(Part No. 305.209.005)
Body:	Hermetically sealed stainless steel
Electrical housing:	Epoxy sealed terminals
Ingress Protection class:	IP65
Connection:	Brass 1/8 in. NPT
Switch type:	Normally closed at atmospheric pressure
Switch point:	Open on fall at 20 bar (290 psi)
	Close on rise at 24.1 bar (350 psi)
Tolerance:	+/- 0.7 bar (+/- 10 psi)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE)
	0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Maximum working pressure:	34 bar (493 psi)
Proof pressure:	345 bar (5003 psi)
Electrical connection:	0.9 m (3 ft) x 2 core cable
Maximum current:	2.9 A
Voltage range:	5 to 28 VDC
Weight:	0.087 kg (0.192 lb)
Approvals and listings:	UL, FM, and CE
Certification:	EN 12094-10
CE Certification No.:	0832-CPD-2048 2831-CPR-S2048
Year of CE marking:	2008
CE marking requirements:	Manufacturer's mark, PS80-K1-1949 (designation), Serial No., 290-350 (set point and switch point), and CE_{0832} or CE_{2831}
Method of marking:	Permanent, non-flammable screenprint
Overall size:	38 mm (L) x 16 mm (Dia) (1.50 in. (L) x 0.63 in. (Dia))

LOW PRESSURE SWITCH
(ALTERNATE - TRANSFER ON FALL OPTION 1 - GEMS*)
(Part No. 305.209.007)

A low pressure warning switch is factory fitted and must be ordered separately. The device continuously monitors the container pressure and in the event of the pressure dropping below 20.3 bar (294 psi), the switch operates to enable the condition to be signalled to a control unit.

This low pressure switch is the primary supply (option #1), of a dual source component used in order to maintain the supply chain and ensure that adequate stock levels are available to fully support customers and installers.

Note: Not available for use with TPED or DOT/TPED seamless containers.



FIGURE 2-41
LOW PRESSURE SWITCH OPTION 1 - GEMS
(ALTERNATE - TRANSFER ON FALL)
E001295

Technical information

Body:	Zinc plated steel and kapton diaphragm
Switch type:	1 x SPDT (Single pole, double throw)
Switch point:	Transfers on fall at 20.3 bar (294 psi) Resets on rise at 24.1 bar (350 psi)
Tolerance:	+/-0.7 bar (± 10 psi)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE) 0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Proof pressure:	206.8 bar (3000 psi)
Contact reset method:	Auto resetting contacts
Connection:	1/8 in. NPT Male
Electrical rating:	5 A at 24 VDC (resistive)
Electrical connection:	DIN 43650A connector with 1/2 in. NPT Female conduit connection
Pin 1:	Common at atmospheric pressure
Pin 2:	Normally closed at atmospheric pressure
Pin 3:	Normally open at atmospheric pressure
Certification:	UL Recognised
Approvals and listings:	UL, FM, and CE
IP Rating:	IP65
Overall size:	104 mm (L) x 28 mm (Dia) (4.10 in. (L) x 1.12 in. (Dia))
Weight:	0.16 kg (0.35 lb)
CE Certification No.:	0832-CPD-2054 2831-CPR-S2054
Year of CE marking:	2010
CE marking requirements:	Manufacturer's mark, PS71, 294F (Set Point), Serial No., 229684, and CE_{0832} or CE_{2831}
Method of marking:	Pin stamped

*GEMS and NASON are trademarks of their respective owners.

LOW PRESSURE SWITCH
(ALTERNATE - TRANSFER ON FALL OPTION 2 - NASON*)
(Part No. 305.209.007)

A low pressure warning switch is factory fitted and must be ordered separately. The device continuously monitors the container pressure and in the event of the pressure dropping below 20 bar (290 psi) the switch operates to enable the condition to be signalled to a control unit.

This low pressure switch is the secondary supply, (option #2), of a dual source component used in order to maintain the supply chain and ensure that adequate stock levels are available to fully support customers and installers.

Note: Not available for use with TPED or DOT/TPED seamless containers.



FIGURE 2-42
LOW PRESSURE SWITCH OPTION 2 - NASON
(ALTERNATE - TRANSFER ON FALL)
E001296

Technical information

Body:	Brass and anodized aluminum
Switch type:	1 x SPDT (Single pole, double throw)
Switch point:	Transfers on Fall at 20 bar (290 psi) Resets on Rise at 22.8 bar (330 psi)
Tolerance:	+/-1.0 bar (± 15 psi)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE) 0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Proof pressure:	413.7 bar (6000 psi)
Contact reset method:	Auto resetting contacts
Connection:	1/8 in. NPT Male
Electrical rating:	5 A at 24 VDC (Resistive)
Electrical connection:	DIN 43650A Connector with 1/2 in. NPT Female conduit connection
Pin 1:	Common at atmospheric pressure
Pin 2:	Normally Closed at atmospheric pressure
Pin 3:	Normally Open at atmospheric pressure
Certification:	UL Recognised
Approvals and listings:	UL, FM, and CE
IP Rating:	IP65
Overall size:	104 mm (L) x 32 mm (Dia) (4.40 in. (L) x 1.25 in. (Dia))
Weight:	0.21 kg (0.46 lb)
CE Certification No.:	0832-CPD-2055 2831-CPR-S2055
Year of CE marking:	2010
CE marking requirements:	Manufacturer's mark, FVFC CD 234, 290 (set point), Serial No., and CE_{0832} or CE_{2831}
Method of marking:	Identification label

DISCHARGE NOZZLES
(Part No., see Table 2-28)

FM-200 distributes within the protected area by the discharge nozzle which is sized to ensure the correct flow of agent for the risk. Nozzles are available with seven port (180°) or sixteen port (360°) horizontal discharge patterns. Ports are drilled in 0.1 mm increments by the manufacturer to the specified system design. Nozzles are supplied in aluminum, brass, or stainless steel. Table 2-28 lists the discharge nozzle details.

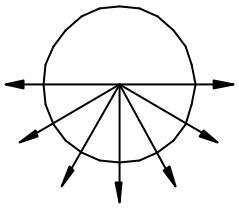
Location on system

At the end of the discharge pipework.

Technical information

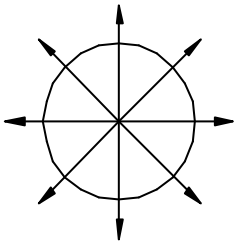
Material:	Brass or stainless steel
Thread type:	BSPP or NPS Female (NPS thread is denoted by v-groove around knurling)
Sizes:	10 mm (3/8 in.), 15 mm, (1/2 in.), 20 mm (3/4 in.), 25 mm (1 in.), 32 mm (1 1/4 in.), 40 mm (1 1/2 in.), and 50 mm (2 in.)
Drilling increments:	0.1 mm
Nozzle types:	8 port (360°) or 7 port (180°)
Nozzle coverage radius:	See Table 2-27
Maximum protection height:	4.87 m (16 ft)
Minimum protection height:	0.3 m (1.0 ft)
Maximum distance from ceiling:	300 mm (12.0 in.)
Minimum / Maximum distance from wall to center of 180° nozzle:	50 mm to 300 mm (2.0 in. to 12.0 in.)
Maximum coverage area per nozzle:	See Table 2-27
Minimum nozzle pressure:	4.861 bar (70.5 psi)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE) 0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Orientation:	Pendant / Upright
Approvals and listings:	UL and FM





180° nozzle pattern (7 ports)





360° nozzle pattern (8 ports)

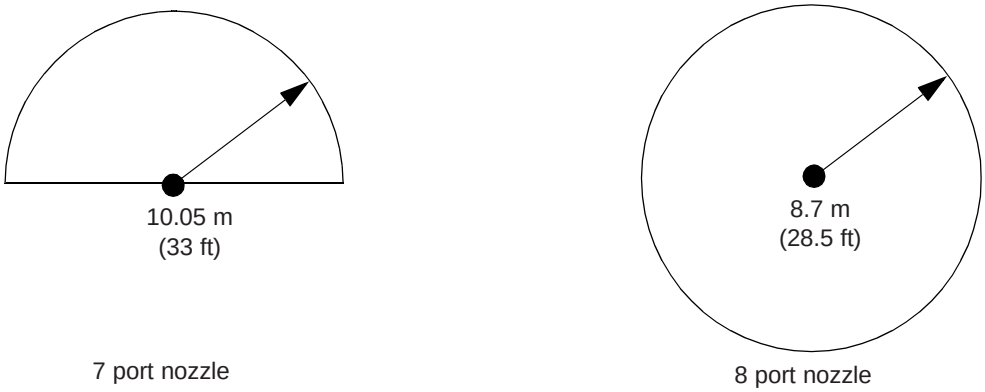
FIGURE 2-43
7 AND 8 PORT NOZZLES BRASS CONFIGURATION
E001436 / E001437 / E001438

DISCHARGE NOZZLES (Continued)

The following figures illustrate the coverage achieved from the discharge nozzles when the FM-200 system activates. For temperature ranges, see the following table.

TABLE 2-27: NOZZLE COVERAGE DETAILS

	Temperature Range	Approvals	Nozzle Coverage Radius 7 port (180°) Nozzle	Nozzle Coverage Radius 16 port (360°) Nozzle	Maximum Coverage Area
Standard area coverage	0 °C to 50 °C (32 °F to 122 °F)	UL and FM (within EU)	10.05 m (33 ft)	8.7 m (28.5 ft)	95.3 m^3 (1026 ft^2)
	0 °C to 54 °C (32 °F to 130 °F)	UL and FM (outside EU)			



7 port nozzle

8 port nozzle

FIGURE 2-44
STANDARD AREA COVERAGE
025038

DISCHARGE NOZZLES (Continued)

TABLE 2-28: DISCHARGE NOZZLES

BRASS NPS

	Nozzle Size			Length		Diameter		Weight		Drill Size (Min.) Sch 40		Drill Size (Max.) Sch 40	
Part No.	mm	in	Nozzle Type	mm	in	mm	in	kg	lb	mm	in	mm	in
310.205.215	10	3/8	7 port	33.5	1.32	25.0	0.98	0.10	0.22	2.2	0.09	4.2	0.17
310.205.217	15	1/2	7 port	41.0	1.61	29.0	1.14	0.15	0.33	2.7	0.11	5.3	0.21
310.205.219	20	3/4	7 port	47.0	1.85	34.5	1.36	0.21	0.46	3.6	0.14	7.0	0.28
310.205.221	25	1	7 port	52.0	2.05	41.3	1.63	0.27	0.60	4.6	0.18	9.0	0.35
310.205.223	32	1 1/4	7 port	62.0	2.44	50.0	1.97	0.41	0.90	6.0	0.24	11.8	0.46
310.205.225	40	1 1/2	7 port	68.0	2.68	60.0	2.36	0.46	1.01	7.0	0.28	13.8	0.54
310.205.227	50	2	7 port	89.0	3.50	76.0	2.99	0.83	1.83	8.9	0.35	17.7	0.70
310.205.216	10	3/8	8 port	33.5	1.32	25.0	0.98	0.10	0.22	2.0	0.08	3.9	0.15
310.205.218	15	1/2	8 port	41.0	1.61	29.0	1.14	0.15	0.33	2.5	0.10	4.9	0.19
310.205.220	20	3/4	8 port	47.0	1.85	34.5	1.36	0.21	0.46	3.4	0.13	6.6	0.26
310.205.222	25	1	8 port	52.0	2.05	41.3	1.63	0.27	0.60	4.3	0.17	8.4	0.33
310.205.224	32	1 1/4	8 port	62.0	2.44	50.0	1.97	0.41	0.90	5.6	0.22	11.0	0.43
310.205.226	40	1 1/2	8 port	68.0	2.68	60.0	2.36	0.46	1.01	6.5	0.26	12.9	0.51
310.205.228	50	2	8 port	89.0	3.50	76.0	2.99	0.83	1.83	8.4	0.33	16.6	0.65

STAINLESS STEEL NPS

	Nozzle Size			Length		Diameter		Weight		Drill Size (Min.) Sch 40		Drill Size (Max.) Sch 40	
Part No.	mm	in	Nozzle Type	mm	in	mm	in	kg	lb	mm	in	mm	in
310.205.315	10	3/8	7 port	33.5	1.32	25.0	0.98	0.09	0.20	2.2	0.09	4.2	0.17
310.205.317	15	1/2	7 port	41.0	1.61	29.0	1.14	0.14	0.31	2.7	0.11	5.3	0.21
310.205.319	20	3/4	7 port	47.0	1.85	34.5	1.36	0.20	0.44	3.6	0.14	7.0	0.28
310.205.321	25	1	7 port	52.0	2.05	41.3	1.63	0.25	0.55	4.6	0.18	9.0	0.35
310.205.323	32	1 1/4	7 port	62.0	2.44	50.0	1.97	0.38	0.84	6.0	0.24	11.8	0.46
310.205.325	40	1 1/2	7 port	68.0	2.68	60.0	2.36	0.43	0.95	7.0	0.28	13.8	0.54
310.205.327	50	2	7 port	89.0	3.50	76.0	2.99	0.78	1.72	8.9	0.35	17.7	0.70
310.205.316	10	3/8	8 port	33.5	1.32	25.0	0.98	0.09	0.20	2.0	0.08	3.9	0.15
310.205.318	15	1/2	8 port	41.0	1.61	29.0	1.14	0.14	0.31	2.5	0.10	4.9	0.19
310.205.320	20	3/4	8 port	47.0	1.85	34.5	1.36	0.20	0.44	3.4	0.13	6.6	0.26
310.205.322	25	1	8 port	52.0	2.05	41.3	1.63	0.25	0.55	4.3	0.17	8.4	0.33
310.205.324	32	1 1/4	8 port	62.0	2.44	50.0	1.97	0.38	0.84	5.6	0.22	11.0	0.43
310.205.326	40	1 1/2	8 port	68.0	2.68	60.0	2.36	0.43	0.95	6.5	0.26	12.9	0.51
310.205.328	50	2	8 port	89.0	3.50	76.0	2.99	0.78	1.72	8.4	0.33	16.6	0.65

DISCHARGE NOZZLES (Continued)

TABLE 2-28: DISCHARGE NOZZLES (Continued)

BRASS BSPP

Part No.	Nozzle Size		Nozzle Type	Length		Diameter		Weight		Drill Size (Min.) Sch 40		Drill Size (Max.) Sch 40	
	mm	in		mm	in	mm	in	kg	lb	mm	in	mm	in
310.205.201	10	3/8	7 port	33.5	1.32	25.0	0.98	0.10	0.22	2.2	0.09	4.2	0.17
310.205.203	15	1/2	7 port	41.0	1.61	29.0	1.14	0.15	0.33	2.7	0.11	5.3	0.21
310.205.205	20	3/4	7 port	47.0	1.85	34.5	1.36	0.21	0.46	3.6	0.14	7.0	0.28
310.205.207	25	1	7 port	52.0	2.05	41.3	1.63	0.27	0.60	4.6	0.18	9.0	0.35
310.205.209	32	1 1/4	7 port	62.0	2.44	50.0	1.97	0.41	0.90	6.0	0.24	11.8	0.46
310.205.211	40	1 1/2	7 port	68.0	2.68	60.0	2.36	0.46	1.01	7.0	0.28	13.8	0.54
310.205.213	50	2	7 port	89.0	3.50	76.0	2.99	0.83	1.83	8.9	0.35	17.7	0.70
310.205.202	10	3/8	8 port	33.5	1.32	25.0	0.98	0.10	0.22	2.0	0.08	3.9	0.15
310.205.204	15	1/2	8 port	41.0	1.61	29.0	1.14	0.15	0.33	2.5	0.10	4.9	0.19
310.205.206	20	3/4	8 port	47.0	1.85	34.5	1.36	0.21	0.46	3.4	0.13	6.6	0.26
310.205.208	25	1	8 port	52.0	2.05	41.3	1.63	0.27	0.60	4.3	0.17	8.4	0.33
310.205.210	32	1 1/4	8 port	62.0	2.44	50.0	1.97	0.41	0.90	5.6	0.22	11.0	0.43
310.205.212	40	1 1/2	8 port	68.0	2.68	60.0	2.36	0.46	1.01	6.5	0.26	12.9	0.51
310.205.214	50	2	8 port	89.0	3.50	76.0	2.99	0.83	1.83	8.4	0.33	16.6	0.65

STAINLESS STEEL BSPP

Part No.	Nozzle Size		Nozzle Type	Lenth		Diameter		Weight		Drill Size (Min.) Sch 40		Drill Size (Max.) Sch 40	
	mm	in		mm	in	mm	in	kg	lb	mm	in	mm	in
310.205.301	10	3/8	7 port	33.5	1.32	25.0	0.98	0.09	0.20	2.2	0.09	4.2	0.17
310.205.303	15	1/2	7 port	41.0	1.61	29.0	1.14	0.14	0.31	2.7	0.11	5.3	0.21
310.205.305	20	3/4	7 port	47.0	1.85	34.5	1.36	0.20	0.44	3.6	0.14	7.0	0.28
310.205.307	25	1	7 port	52.0	2.05	41.3	1.63	0.25	0.55	4.6	0.18	9.0	0.35
310.205.309	32	1 1/4	7 port	62.0	2.44	50.0	1.97	0.38	0.84	6.0	0.24	11.8	0.46
310.205.311	40	1 1/2	7 port	68.0	2.68	60.0	2.36	0.43	0.95	7.0	0.28	13.8	0.54
310.205.313	50	2	7 port	89.0	3.50	76.0	2.99	0.78	1.72	8.9	0.35	17.7	0.70
310.205.302	10	3/8	8 port	33.5	1.32	25.0	0.98	0.09	0.20	2.0	0.08	3.9	0.15
310.205.304	15	1/2	8 port	41.0	1.61	29.0	1.14	0.14	0.31	2.5	0.10	4.9	0.19
310.205.306	20	3/4	8 port	47.0	1.85	34.5	1.36	0.20	0.44	3.4	0.13	6.6	0.26
310.205.308	25	1	8 port	52.0	2.05	41.3	1.63	0.25	0.55	4.3	0.17	8.4	0.33
310.205.310	32	1 1/4	8 port	62.0	2.44	50.0	1.97	0.38	0.84	5.6	0.22	11.0	0.43
310.205.312	40	1 1/2	8 port	68.0	2.68	60.0	2.36	0.43	0.95	6.5	0.26	12.9	0.51
310.205.314	50	2	8 port	89.0	3.50	76.0	2.99	0.78	1.72	8.4	0.33	16.6	0.65

ROSETTE
(Part No. see Table)

A rosette is a plastic trim ring used to reinforce the penetration of a nozzle into the hazard area. It is drilled for the system piping through ceilings or walls, and attaches directly to the discharge nozzle. A rosette is used to enhance the look of a discharge nozzle installation and is available in seven sizes, one for each nozzle size.

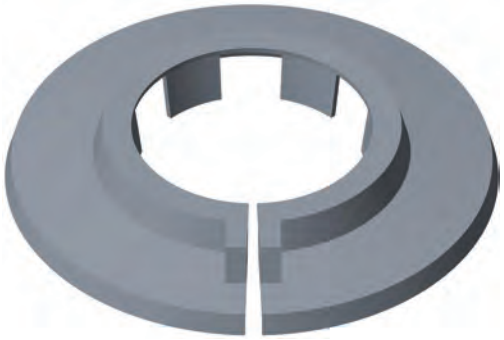


FIGURE 2-45
ROSETTE
009752

TABLE 2-29: ROSETTE DETAILS

Part No.	Nozzle size mm (in.)	Diameter mm (in.)
570171	10 (3/8)	56 (2.20)
570172	15 (1/2)	60 (2.39)
570174	20 (3/4)	71 (2.80)
570175	25 (1)	76 (3.00)
570176	32 (1 1/4)	90 (3.54)
570178	40 (1 1/2)	97 (3.80)
570179	50 (2)	110 (4.32)

DISCHARGE NOZZLE FILTER

Nozzle filters protect nozzles from blockages. They should be fitted to nozzles with an orifice area less than 7 mm^2, equivalent to a drill size of less than 3 mm (0.12 in.). Order these filters separately from the discharge nozzle. The following table lists the discharge nozzle filter details.

Location on system

The nozzle filter is located in the discharge pipework near the discharge nozzle.

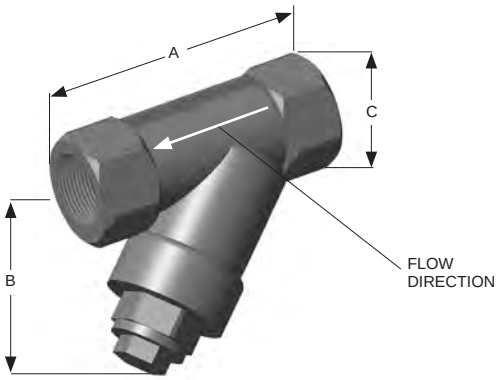


FIGURE 2-46
DISCHARGE NOZZLE FILTER
025576

TABLE 2-30: DISCHARGE NOZZLE FILTER DETAILS

Part No.	Material	Size	Dimension A mm (in.)	Dimension B mm (in.)	Dimension C
310.209.001	Stainless steel	1/2 in. (DN15)	65 (2.6)	41.5 (1.6)	1/2 in. BSP
310.209.002	Stainless steel	3/4 in. (DN20)	80 (3.1)	52 (2.0)	3/4 in. BSP
310.209.005	Stainless steel	1/2 in. (DN15)	65 (2.6)	41.5 (1.6)	1/2 in. NPT
310.209.006	Stainless steel	3/4 in. (DN20)	80 (3.1)	52 (2.0)	3/4 in. NPT

Technical information

Material:	316 Stainless steel (Corrosion resistant material)
Maximum working pressure:	55 bar (800 psi)
Mesh size:	500 micron to 800 micron (Measured in the plane of the hole)
Weight:	0.20 kg (0.4 lb) — 1/2 in. nozzle filter 0.40 kg (0.9 lb) — 3/4 in. nozzle filter
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (CE) 0 °C to 54 °C (32 °F to 130 °F) (UL and FM)
Note:	Unrestricted filter surface is at least five times the nozzle cross section.

PRESSURE TRIP
(Part No. 5156)

The pressure trip connects to the actuation piping from the AUTOMAN II-C release. By either pneumatic or manual actuation, the pressure trip can release spring or weight powered devices to close doors and windows, open fuel dump valves, close fire dampers, or close fuel line valves. The pressure trip is constructed of brass with two 1/4 in. NPT fittings for connection to actuation piping. The link on the pressure switch releases either pneumatically, by nitrogen pressure from the cartridge in the AUTOMAN II-C release, or manually, by use of the pull ring. The link then releases the device which performs the auxiliary functions.

Operating pressure must be a minimum of 5.2 bar (75 psi) with a maximum load of 31.7 kg (70 lb).

NOTICE

The pressure trip must not be installed in the agent discharge piping.

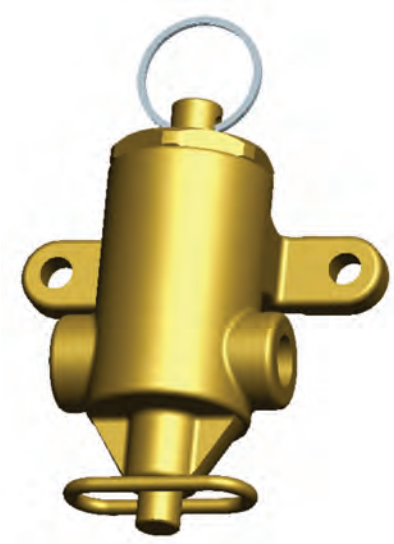


FIGURE 2-47
PRESSURE TRIP
009696

Technical information

Body:	Brass
Spring:	Stainless steel
Pull ring:	Stainless steel
Pressure ports:	1/4 in. NPT
Mounting holes:	7.1 mm (0.28 in.) Dia
Minimum operating pressure:	5.2 bar (75 psi)
Maximum operating pressure:	144.8 bar (2100.1 psi)
Maximum load at 5.2 bar (75.4 psi):	31.7 kg (69.9 lb)
Working temperature range:	0 °C to 54 °C (32 °F to 130 °F)
Approvals and listings:	UL and FM
Overall size:	95 mm (L) x 76 mm (W) (3.75 in. (L) x 3 in. (W))
Weight:	0.5 kg (1.1 lb)

SAFETY VENT VALVE
(Part No. 15677)

The safety vent valve automatically relieves the nitrogen pressure in the actuation line after the system actuates through an AUTOMAN II-C release. After agent discharge, pulling the ring on the vent valve relieves the remaining pressure in the line.

Technical information

Body:	Brass
Spring:	Stainless steel
Pull ring:	Stainless steel
Inlet:	1/4 in. Male
Set point:	18.3 bar (265 psi)
Maximum installation torque:	27 N•m (20 ft-lb)
Working temperature range:	0 °C to 54 °C (32 °F to 130 °F)
Approvals and listings:	UL and FM
Overall size:	50.8 mm (L) x 17.5 mm (W) (2 in. (L) x 0.69 in. (W))
Weight:	0.046 kg (0.101 lb)



FIGURE 2-48
SAFETY VENT VALVE
009697

MANUAL PULL BOX - LATCHED DOOR TYPE (Part No. 304.207.008)

The pull box provides mechanical release of the system from a manually operated remote station. The latched door has a solid cast brass door which must be opened to reach the pull handle. A 3/8 in. NPT Female opening is provided at the back of the enclosure for connection of the cable housing. The unit is painted red.

A pulley elbow may be attached directly to the back of the pull box, if necessary, to provide immediate changes in pull cable direction. With this option, the pull box can be extended an additional 89 mm (3 1/2 in.) from the mounting surface by using support legs attached to the back of the pull box.

The support legs (Part No. 304.207.009) are supplied in a pack with two legs, two screws, and two nuts to allow connection to the pull box.



FIGURE 2-49
LATCH DOOR TYPE PULL BOX
025249

Technical information

Latch Door Type Pull Box (Part No. 304.207.008)

Material:	Brass
Coating:	Painted red
Overall size:	106 mm (W) x 104 mm (H) x 49 mm (D) (4.17 in. (W) x 4.09 in. (H) x 1.93 in. (D))
Weight:	1.07 kg (2.36 lb)

Support Legs (Part No. 304.207.009)

Material:	Brass
Overall size:	90 mm (L) x 40 mm x 32 mm (3.54 in. (L) x 1.57 in. x 1.26 in.)
Kit weight:	0.25 kg (0.55 lb)

CABLE WITH SWAGED END FITTINGS

The 1/16 in. diameter cable connects the remote manual pull box to the CPM actuator.

The cable is constructed of stranded, stainless steel wire. The cable is available in lengths of 15.2 m, 30.5 m, and 45.7 m (50 ft, 100 ft, and 150 ft). The cable assemblies include a brass swaged end fitting for attaching to the remote pull box.



FIGURE 2-50
1.6 mm (1/16 IN.) CABLE WITH SWAGED END FITTING
025250

TABLE 2-31: CABLE PART DETAILS

Part No.	Description
304.207.010	15.2 m (50 ft) cable
304.207.011	30.5 m (100 ft) cable
304.207.012	45.7 m (150 ft) cable

Technical information

Cable material:	Stainless steel
Swaged fitting material:	Brass
Cable end overall size:	16 mm (L) x 10 mm (Dia) (0.63 in. (L) x 0.39 in. (Dia))
Weights:	304.207.010, 0.178 kg (0.39 lb) 304.207.011, 0.341 kg (0.75 lb) 304.207.012, 0.519 kg (1.14 lb)

CABLE CLAMP
(Part No. 304.207.013)

The cable clamp is used to create a loop in the wire rope for attachment of the wire rope to a lever release actuator.

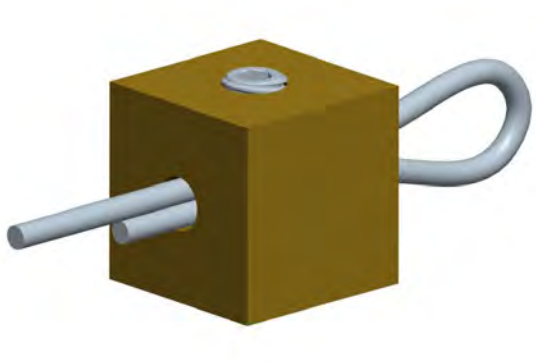


FIGURE 2-51
CABLE CLAMP
025251

Technical information

Material:	Brass
Overall size:	13 mm x 13 mm x 13 mm (0.5 in. x 0.5 in. x 0.5 in.)
Weight:	0.015 kg (0.03 lb)

FLARED END FITTING
(Part No. 304.207.014)

The flared end fitting provides a smooth transition on the end of a pipe run for the pull cable. When the wire rope exits the pipe to connect to lever actuators on pilot containers or globe valves, the fitting prevents chafing of the wire rope due to sharp edges on the end of the pipe. Use the flared end fitting on pipe ends if the wire rope extends beyond the piping.

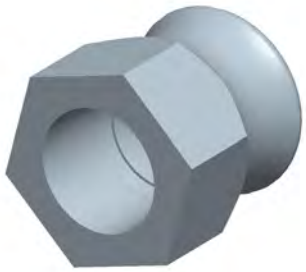


FIGURE 2-52
FLARED END FITTING
025252

Technical information

Material:	Brass
Overall size:	25 mm x 22 mm Hex (0.98 in. x 0.866 in. Hex)
Weight:	0.042 kg (0.09 lb)

CORNER PULLEY
(Part No. 304.207.015 / 423250)

If a mechanical release pull cable run involves a change in direction, use the corner pulley. Corner pulleys are installed as part of the cable housing (pipe) and provide 90° direction changes with minimal force loss and no induced kinking.

The corner pulley (Part No. 304.207.015) is made of forged brass and is threaded for 3/8 in. NPT pipe. This pulley is watertight and is designed for location inside or outside the protected space.

The corner pulley (Part No. 423250) is made of aluminum and connects to 1/2 in. EMT conduit pipe. This pulley has a compression fitting.

Note: Only the brass NPT pulley is watertight.



FIGURE 2-53
CORNER PULLEY - SHEAVE TYPE
025550

Technical information - 304.207.015

Material:	Brass
Thread type:	3/8 in. NPT
Overall size:	68 mm x 68 mm x 29 mm (2.68 in. x 2.68 in. x 1.14 in.)
Weight:	0.46 kg (1.01 lb)

Technical information - 423250

Material:	Aluminum
Connection:	Compression to 1/2 in. EMT
Overall size:	71.88 mm x 71.88 mm x 26.67 mm (2.83 in. x 2.83 in. x 1.05 in.)
Weight:	0.09 kg (0.2 lb)

THREAD ADAPTOR
(Part No. 304.207.016)

A two piece adaptor consisting of a coupling nut and a hex nipple is available to simplify the installation.

The coupling nut has a 3/8 in. - 18 NPT Female thread on one end and a 0.625 in. - 18 left hand Female thread on the other.

The hex nipple has a 3/8 in. - 18 NPT male thread on one end and a 0.625 in. - 18 left hand male thread on the other.

Installation is accomplished by first threading the male NPT end of the hex nipple into the corner pulley. The female 3/8 in. NPT end of the coupling nut can then be engaged onto the 3/8 in. conduit. At the same time, the male 0.625 in. - 18 left hand thread of the hex nipple and the female 0.625 in. - 18 left hand thread of the coupling nut are engaged into each other. This allows the two pieces to pull together as the coupling nut tightens.



FIGURE 2-54
THREAD ADAPTOR
025254

Technical information

Material:	Brass
Coupling thread types:	3/8 in. - 18 NPT Female
	0.625 in. - 18 Left Hand Female
Hex nipple thread types:	0.625 in. - 18 Left Hand Male
	3/8 in. - 18 NPT Male
Overall size:	38 mm x Hex (1.50 in. x Hex)
Weight:	0.053 kg (0.117 lb)

PILOT CONTAINER - STANDARD

Alternative pilot containers are available depending upon market requirements (TPED / DOT/ PESO). These pilot containers pneumatically operate an FM-200 system. Table 2-32 lists the maximum number of FM-200 containers operated by these actuation containers. The maximum actuation line tubing lengths are detailed in Table 6-12.

The pilot container is supplied with a solenoid, manual actuator, contacted pressure gauge, outlet adaptor, pipe / hose adaptors, and brackets. The contacted pressure gauge has a switch point that is factory set to 90 bar (1305 psi).

Note: If actuated manually, the actuation burst disc (Part No. 20938000) must be replaced.

Technical information - see next page

TABLE 2-32: PILOT CONTAINER BRACKETS

Bracket (See page 2-68)	Part No.
3 L Bracket assembly - DOT 13 L Bracket assembly - TPED, PESO	30621310
3 L Bracket assembly - TPED	30620310
13 L Bracket assembly - DOT	441408
50 L Bracket assembly - DOT, TPED, PESO	30625010



FIGURE 2-55
PILOT CONTAINER DETAILS (3 L SHOWN)
025523

TABLE 2-33: PILOT CONTAINER DETAILS

Part No.	Nom. Size L	Water Cap. L	Height A mm (in.)	Height B mm (in.)	Dia C mm (in.)	Maximum Number of Containers Operated	Weight kg (lb)	Approvals and Listings
304700009 (TPED 50 ºC)	3	3.0	555 (21.9)	495 (19.5)	100 (3.9)	12	10.6 (23.4)	UL and FM
304700008 (TPED CE 50 ºC)	3	3.0	555 (21.9)	495 (19.5)	100 (3.9)	12	10.6 (23.4)	CE
304700010 (DOT 50 ºC)	3	3.4	415.6 (16.4)	355.6 (14.0)	132 (5.2)	12	11.3 (25.0)	UL and FM
304700017 (TPED 50 ºC)	13	13.4	1124 (44.3)	1064 (41.9)	140 (5.5)	12	21.2 (46.7)	UL and FM
304700016 (TPED CE 50 ºC)	13	13.4	1124 (44.3)	1064 (41.9)	140 (5.5)	12	21.2 (46.7)	CE
304700014 (PESO 50 ºC)	13	13.4	1124 (44.3)	1064 (41.9)	140 (5.5)	12	21.2 (46.7)	UL
304700019 (DOT 50 ºC)	13	14.2	708 (27.9)	648 (25.5)	188 (7.4)	12	23.5 (51.8)	UL and FM
304700022 (TPED 50 ºC)	50	50.0	1500 (59.1)	1440 (56.7)	229 (9.0)	12	51.2 (112.9)	UL and FM
304700021 (TPED CE 50 ºC)	50	50.0	1500 (59.1)	1440 (56.7)	229 (9.0)	12	51.2 (112.9)	CE
304700026 (PESO 50 ºC)	50	50.0	1500 (59.1)	1440 (56.7)	229 (9.0)	12	51.2 (112.9)	UL
304700024 (DOT 50 ºC)	50	50.0	1495 (58.9)	1435 (56.5)	236 (9.3)	12	67.0 (147.7)	UL and FM

PILOT CONTAINER - STANDARD (Continued)

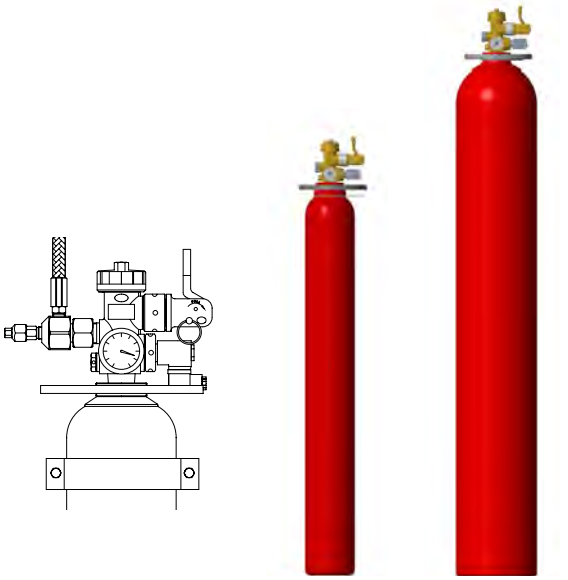


FIGURE 2-56
VALVE CONNECTIONS, 13 L AND 50 L PILOT CONTAINERS
025522

Technical information

Valve body:	Brass CZ121
TPED container thread type:	DIN477 (W28.8)
DOT/PESO container thread type:	1 in. NGT
Valve outlet:	DIN477 (W21.7)
Valve outlet adaptor connection:	1/4 in. BSPP
Container volume:	See Table 2-33
Gas type:	Nitrogen
Container:	Carbon steel
Container pressure:	100 bar at 15 °C (1450 psi at 59 °F)
Container test pressure (TPED / PESO):	300 bar (4351 psi)
Container test pressure (DOT):	207 bar (3000 psi)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F) (UL, FM, and CE)
Actuation method:	Manual and electrical
Bracket type:	See Page 2-68
Weight:	See Table 2-33

CONTACTED PRESSURE GAUGE (TPED PILOT CONTAINER CE) (Part No. 30116054)

A contacted pressure gauge (CPG) is factory fitted to the TPED CE pilot container valve and is field replaceable. The lock nut (Part No. 30210808) and o-ring (Part No. 22000502) are supplied separately. A CPG with lock nut included is available on order (Part No. 42116061).



FIGURE 2-57
WIKA CONTACTED PRESSURE GAUGE (TPED CE PILOT CONTAINER)
025599

Technical information

Type:	Bourdon tube pressure gauge
Entry:	Back axial
Measurement system:	Copper alloy
Movement:	Copper alloy
Nominal size:	DN40 (1.6 in.)
Units of outer scale:	bar
Units of inner scale:	psi
Connection:	M10 x 1 DIN13
Case:	Stainless steel
Ingress Protection Class:	IP 54
Window:	Polycarbonate
Restrictor:	Brass Dia 0.5 mm
Accuracy:	± 1.6%
Language:	English
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F)
Pressure range:	0 bar to 160 bar (0 psi to 2321 psi)
Nominal charge pressure:	100 bar (1450 psi)
Maximum operating pressure:	113.6 bar (1648 psi)
Setpoint:	90 bar (1306 psi)
Voltage:	4.5 VDC to 24 VDC
Current:	5 mA to 100 mA
Maximum consumption:	2.4 W
Approvals and listings:	CE
Certification:	EN 12094-10
CE certification number:	0786-CPR-30089
Year of CE Marking:	2015
CE marking requirements:	Manufacturer's mark, bar (psi), CL1.6, CE_{0786}
Method of marking:	Part of gauge artwork
Weight:	0.05 kg (0.11 lb)

CONTACTED PRESSURE GAUGE (TPED, DOT, AND PESO PILOT CONTAINER 50 °C) (Part No. 30213401)

A contacted pressure gauge (CPG) is factory fitted to the TPED, DOT, and PESO pilot container valve and is field replaceable.



FIGURE 2-58
MIJA CONTACTED PRESSURE GAUGE (TPED, DOT AND PESO PILOT CONTAINER)
025539

Technical information

Type:	Bourdon tube pressure gauge
Entry:	Back axial
Measurement system:	Copper alloy
Movement:	Copper alloy
Nominal size:	DN40 (1.6 in.)
Units of outer scale:	bar
Case:	Stainless steel
Pressure range:	0 bar to 134 bar (0 psi to 1944 psi)
Connection:	M10 x 1 DIN13
Ingress Protection Class:	IP 54
Window:	Polycarbonate
Restrictor:	Brass Dia 0.5 mm
Accuracy:	± 4% at charge ± 8% at upper and lower limits
Language:	English
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F)
Nominal charge pressure:	100 bar (1450 psi)
Setpoint:	88 bar (1276 psi)
Voltage:	18 VDC to 30 VDC
Current:	5 mA to 100 mA
Maximum consumption:	3 W
Weight:	0.06 kg (0.13 lb)
Approvals and listings:	UL and FM

SAFETY BURST DISC - PILOT CONTAINER

A burst disc is factory fitted to every valve assembly. It ruptures if the container becomes over pressurized if subjected to temperatures above the designed storage temperature of the container.

Technical information

Valve size:	12 mm (0.47 in.)
Disc Part No.:	29999911
Plug Part No.:	22000001
Body material:	Copper / Nickel (disc) Brass CW614N (plug)
Rating:	160 bar to 180 bar at 20 °C (68 °F) (2321 psi to 2611 psi at 20 °C (68 °F))
	152 bar to 172 bar at 55 °C (131 °F) 2205 psi to 2495 psi at 55 °C (131 °F)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F)
Thread:	M12 x 1.5 DIN13
Hole orientation:	2 x 180° radial, 1 x axial
Torque:	20 N•m (14.8 lbf)
Overall size:	15 mm x 15.5 mm A/F (plug) (0.59 in. x 0.61 in.)
	10 mm (Dia) x 2.2 mm (disc) (0.39 in. x 0.09 in.)
Weight:	0.02 kg (0.07 lb)

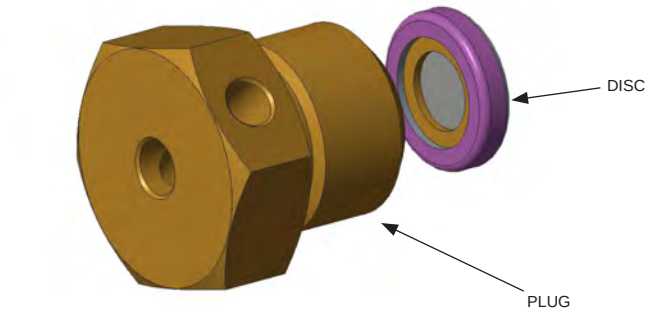


FIGURE 2-59
PILOT CONTAINER SAFETY BURST DISC
025573

PILOT CONTAINER SOLENOID (CE)
(Part No. 3023024B)

The pilot container valve includes a factory fitted solenoid.

Note: The pilot container solenoid (Part No. 3023024B) is not UL Listed or FM Approved.



FIGURE 2-60
PILOT CONTAINER SOLENOID VALVE
025525

Technical information

Actuation type:	Solenoid
Reset method:	Automatic
Connection:	Factory fitted
Voltage:	24 VDC (20.4 - 27.6)
Maximum working pressure :	166 bar (2407 psi)
Consumption:	11 W
Maximum current:	0.53 A
Minimum duration of trigger signal:	Continuous duty
Electrical connection:	DIN Plug
Protection:	IP 65
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F)
Weight:	0.25 kg (0.55 lb)
Approvals and listings:	CE
Certification:	EN 12094
CE certification number:	0786-CPR-30062
Year of CE marking:	2014
CE marking requirements:	Manufacturer’s mark, part number, working pressure, batch number

PILOT CONTAINER SOLENOID (UL AND FM)
(Part No. 21006401)

The pilot container valve includes a factory fitted solenoid.

Technical information

Actuation type:	Solenoid
Reset method:	Automatic
Connection:	Factory fitted
Voltage:	24 VDC (21.6 to 27.6)
Maximum working pressure :	170 bar (2465 psi)
Consumption:	13 W
Maximum current:	0.56 A
Minimum duration of trigger signal:	Continuous duty
Electrical connection:	DIN Plug
Protection:	IP 65
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F)
Weight:	0.25 kg (0.55 lb)
Approvals and listings:	UL and FM



FIGURE 2-61
PILOT CONTAINER SOLENOID VALVE
025525

PLACEMENT INDICATOR SWITCH ASSEMBLY - PILOT CONTAINER SOLENOID (Part No. 441872)

The placement indicator switch monitoring device indicates the proper placement of the pilot container solenoid. The placement indicator switch mounts to the pilot container solenoid, and becomes active when depressed. This allows a small electric current to pass through the end-of-line resistor which enables the fire control panel to indicate that the pilot container solenoid is in the correct position for system operation. If the pilot container solenoid is not in the proper position, the placement indicator switch is open. This means that the current does not pass through the end-of-line resistor, and does not indicate that the solenoid is in the proper position.

Technical information

Housing:	Plastic
Switch:	Stainless steel
Mount bracket:	Stainless steel
Contacts:	Gold
Connection:	1/2 in. - 14 NPSM
Nominal voltage:	24 VDC
Nominal current:	0.4 A
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F)
Approvals and listings:	UL and FM
Overall size:	46 mm (W) x 73 mm (H) x 20 mm (D) (1.8 in. (W) x 2.9 in. (H) x 0.8 in. (D))
Weight:	0.23 kg (0.49 lb)



FIGURE 2-62
PLACEMENT INDICATOR SWITCH KIT
025372



FIGURE 2-63
PLACEMENT INDICATOR MOUNT BRACKET
025727

MANUAL ACTUATOR - PILOT CONTAINER (Part No. 31009401)

The manual actuator fits to the pilot container valve to mechanically operate the actuation system. The manual actuator is included in the pilot container assembly.

A steel safety pin prevents accidental manual release. To activate the local manual actuator, remove the steel safety pin. After removing the steel safety pin, pull the lever in the direction indicated by the arrow embossed on the unit's body to achieve manual operation.

⚠WARNING

Failure to reset the actuator prior to fitting onto the container valve results in the immediate operation of the container valve and a potentially hazardous discharge of the container.

Location on system

The manual actuator connects to the side of the pilot container valve.

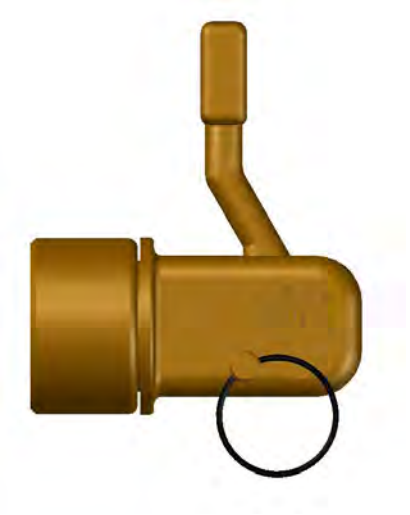


FIGURE 2-64
MANUAL ACTUATOR
025775

Technical information

Body:	Brass
Safety pin:	Steel
Lever:	Brass
Swivel nut:	Brass
Pin nominal stroke:	6.0 mm (0.2 in)
Weight:	0.49 kg (1.08 lb)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F)
Overall size:	82.0 mm x 72.0 mm (3.2 in x 2.8 in)
Approvals and listings:	UL and FM
Certification:	EN 12094-4
CE certification number:	0786-CPR-30062
Year of CE marking:	2014
CE marking requirements:	Manufacturer's mark, part number, batch number, CE 0786

PILOT CONTAINER ACTUATION BURST DISC

This burst disc must be replaced if the pilot container has been manually actuated.

Technical information

Part No.:	20938000
Material:	Copper nickel
Burst pressure:	285 bar to 315 bar at 20 °C (4134 psi to 4569 psi at 68 °F)
Overall size:	Dia 14.0 mm
Weight:	0.2 kg (0.4 lb)

PILOT CONTAINER VALVE
(Part No. 441400, 20012128, and 29012804)

For pilot container valve options, see Table 2-34.

⚠ WARNING

Should the solenoid valve malfunction in any way, return the complete pilot container assembly to Johnson Controls. Do not attempt to remove the solenoid base on site.

Location on system

The pilot container valve connects to the pilot container.



FIGURE 2-65
PILOT CONTAINER VALVE
025526

Technical information

Body material:	Brass CZ 121
Piston:	Brass
Thread type (128 - 90):	W28.8 DIN477
Thread type (128 - 97):	1 in. NGT
Outlet connection:	W21.7 DIN477
Outlet safety cap material:	Brass CW617N
Maximum working pressure:	166 bar (2408 psi)
Free flow cross sectional area:	50.26 mm^2 (2.0 $in.^2$)
Maximum actuation force:	111 N (25 lbf) at maximum working pressure
Burst disc rating:	170 bar ± 10 bar (2465 psi ± 145 psi)
Burst disc port:	M12 x 1.5
Gauge port:	M10 x 1
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F)
Weight:	1.95 kg (4.3 lb)
Approvals and listings:	UL, FM, and CE
Certification:	EN 12094-4
CE certification number:	0786-CPR-30062 (CPR) 0832-TPED-015 (TPED)
Year of CE marking:	2014
CE marking requirements 128-90UL:	Manufacturer's mark, 20012128, 128-90UL, batch number, 140 bar, CE 0786, π 0832, VdS G300020
CE marking requirements 128-97:	Manufacturer's mark, 21114008, 128-97, batch number, 140 bar, CE 0786, π 0832, LPCB 446a/10, VdS G300020
CE marking requirements 128-90:	Manufacturer's mark, 29012804, 128-90, batch number, 140 bar, CE 0786, π 0832, LPCB 446a/10, VdS G300020
Method of marking:	Laser or engraved
Valve type:	Type 2
Overall size:	148 mm x 76 mm (5.83 in. x 2.99 in.)

PILOT CONTAINER VALVE (Continued)

TABLE 2-34: PILOT CONTAINER VALVE DETAILS

Valve Part No.	Thread Type	Components included within Valve Part Number	Where Used
441400	1 in. NPT	· 128-97 valve (Part No. 21114008) · 50 °C MIJA contacted pressure gauge 0 - 134 bar, normally closed under pressure (Part No. 30213401) · Solenoid (Part No. 21006401) · Manual actuator (Part No. 31009401)	3 L, 13 L, and 50 L (DOT) UL and FM pilot container assembly (Part No. 304700010, 304700019 and 304700024) 13 L and 50 L (PESO) UL pilot container assembly (Part No. 304700014 and 304700026)
20012128	28.8 DIN 477	· 128-90 UL valve including 50 °C MIJA contacted pressure gauge 0 - 134 bar, normally closed under pressure (Part No. 30213401) Pilot container assembly includes solenoid (Part No. 21006401) and manual actuator (Part No. 31009401)	3 L, 13 L, and 50 L (TPED) UL and FM pilot container assembly (Part No. 304700009, 304700017, and 304700022)
29012804	28.8 DIN 477	· LPG128-90 valve including 50 °C WIKA contacted pressure gauge 0 - 160 bar, normally closed under pressure (Part No. 30116054) Pilot container assembly includes solenoid (Part No. 3023024B) and manual actuator (Part No. 30180APB)	3 L, 13 L, and 50 L (TPED) CE certified pilot container assembly (Part No. 304700008, 304700016 and 304700021)

Note: For valve part numbers 20012128 and 29012804, the solenoid actuator and manual actuator are included in the pilot container bill of materials. If replacing the pilot container valves, the solenoid actuator and manual actuator must be purchased separately.

PILOT VALVE ADAPTOR
(Part No. 35116381)

The pilot container valve adaptor connects the valve to the pilot actuation hose or tubing and bleed valve (Part No. 302.200.075).

Technical information

Body:	Steel (zinc coated)
Connection:	1/4 in. BSPP
Working pressure:	100 bar (1450 psi)
Overall size:	53.5 mm x 39 mm (2.1 in x 1.5 in)
Weight:	0.26 kg (0.6 lb)



FIGURE 2-66
PILOT VALVE ADAPTOR
025527

ACTUATION PILOT CONTAINER BRACKETS

The bracket assembly consists of two bolts and either two brackets or a bracket with UNISTRUT channel and plastic bumpers to securely hold the container in position during a system discharge. Each container requires two bracket assemblies which are supplied as part of the pilot container assembly.

Note: DOT pilot containers only require one bracket assembly.

TABLE 2-35: BRACKET DETAILS

Bracket	Part No.
3 L Bracket assembly - DOT 13 L Bracket assembly - TPED, PESO	30621310
3 L Bracket assembly - TPED	30620310
13 L Bracket assembly - DOT	441408
50 L Bracket assembly - DOT, TPED, PESO	30625010

Container mounting type:

Wall mounted – 3 L

Floor mounted – 13 L and 50 L



3 L (DOT) and 13 L (TPED, PESO) Pilot Container Bracket
(Part No. 30621310)
E000994



3 L (TPED) Pilot Container Bracket
(Part No. 30620310)
E000995



50 L (DOT, TPED, and PESO) Pilot Container Bracket
(Part No. 30625010)
E000996



13 L (DOT) Pilot Container Bracket
(Part No. 441408)
E001054

FIGURE 2-67
PILOT CONTAINER BRACKETS

DECOMPRESSION SCREW
(Part No. 30027301)

After actuation of a container bank, the pneumatic actuation line retains pressure from the pilot container. To enable the safe release of the pressure, a decompression screw fits to the last pneumatic actuator tee using either a 1/4 in. BSPP swivel female x 1/4 in. BSPP fixed female adapter (Part No. 309013050) and a 1/4 in. dowty seal (Part No. 31199816), or a 6 mm stud coupling x 1/4 in. fixed female adapter (Part No. 30880063) and a 1/4 in. dowty seal (Part No. 31199816).



FIGURE 2-68
DECOMPRESSION SCREW
025726

Technical information

Body:	Brass
Internal parts:	Nitrile
Connection:	1/4 in. BSPP
Test pressure:	420 bar (6092 psi)
Maximum working pressure:	140 bar (2031 psi)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F)
Overall size:	68.0 mm x 23.5 mm (Hex 22.0 mm) (2.68 in. x 0.93 in.)
Weight:	0.23 kg (0.51 lb)
Marking:	Manufacturer, part number, UL, serial number, working pressure
Method of marking:	Engraving
Approvals and listings:	UL and FM

VENT VALVE
(Part No. 302700014)

The vent valve allows for the safe venting of agent to the atmosphere if it becomes trapped in a closed pipework system. The vent valve is fitted with two limit switches to monitor a valve open or a valve closed indication. The valve is provided with a locking bracket into which a standard padlock may be fitted.

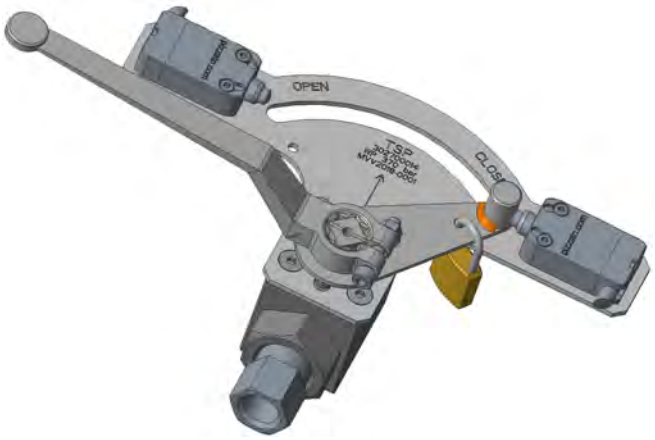


FIGURE 2-69
VENT VALVE
025719

Technical information

Ball valve body:	1.0737
Ball valve connection:	3/4 in. NPT Female
Vent valve assembly connection:	1/2 in. NPT Female (3/4 in. x 1/2 in. adaptor both sides)
Operation voltage:	250 VAC (50 Hz) / 24 VDC
Ingress protection:	IP67 and IP69K
Switch indication:	Valve open (OPEN)
	Valve closed (CLOSED)
Maximum working pressure:	370 bar (5366 psi)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F)
Approvals and listings:	UL and FM
Additional feature:	Pad lockable
Overall size:	215 mm x 110 mm x 82 mm (8.46 in. x 4.33 in. x 3.23 in.)
Weight:	2.3 kg (5.1 lb)

LIQUID LEVEL MEASURING DEVICE
(Part No. 300.015.127 and 300.015.128)

The measuring device is used to measure the level of liquid FM-200 in 106 L, 147 L, 180 L, and 343 L containers. The weight of the FM-200 in the container is determined by converting the level measurement into a weight measurement using the weight conversion tables.

The liquid level is found by lifting the measuring tape from inside the tube to the end (or approximately 75 mm (3 in.) above the anticipated liquid level) and slowly lowering the tape until a magnetic interlock with the float is felt. The tape then remains in the upward position, allowing a reading at the top of the housing. The liquid level measuring device is ordered as part of the assembly for 106 L, 147 L, and 180 L containers but must be ordered as a separate line item for 343 L containers.

The device must be installed in an empty container assembly before filling. The liquid level measuring device must be ordered as a separate line item.

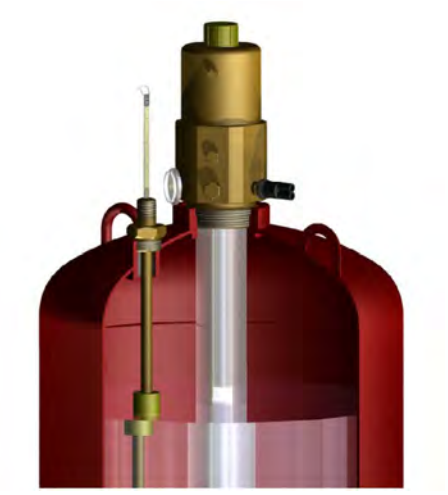


FIGURE 2-70
LIQUID LEVEL MEASURING DEVICE
E001420

Technical information

106 L liquid level:	Part No. 300.015.127
147 L, 180 L, and 343 L liquid level:	Part No. 300.015.128
Mounting thread:	1.3125-12UN-2A
Stem material:	Brass
Mounting material:	Brass
Float material:	ECCO
Model:	Diptape Indicator
Approximate length:	900 mm (35.4 in.) (Part No. 300.015.127) 1170 mm (46.0 in.) (Part No. 300.015.128)
Working temperature range:	0 °C to 50 °C (32 °F to 122 °F)
Weight:	0.53 kg (1.17 lb) (Part No. 300.015.127) 0.61 kg (1.34 lb) (Part No. 300.015.128)

DOOR NOTICE

Each entrance of the hazard area requires a door notice to advise personnel that they are entering a protected area.

TABLE 2-36: DOOR NOTICE DETAILS

Part No.	Concentration
314.205.001	Less than NOAEL
314.205.002	Greater than NOAEL. For use in unoccupied spaces only.

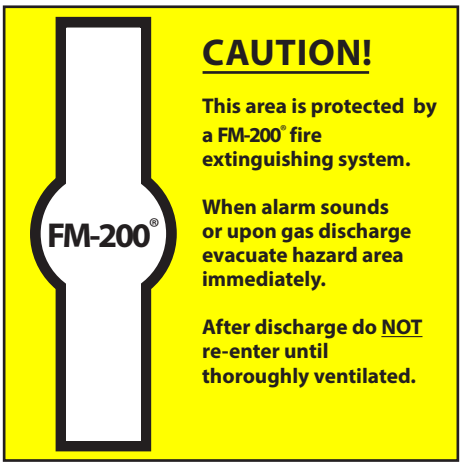


FIGURE 2-71
DOOR NOTICE (LESS THAN NOAEL)

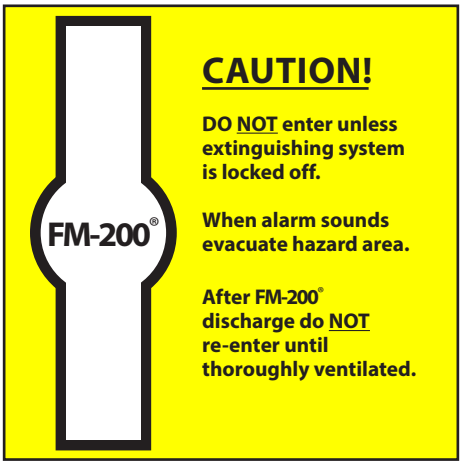


FIGURE 2-72
DOOR NOTICE (GREATER THAN NOAEL)

Technical information

Material:	2 mm (0.08 in.) craylon
Finish:	Gloss, scratch resistant
Overall size:	210 mm (L) x 210 mm (W) (8.25 in. (L) x 8.25 in. (W))

MANUAL RELEASE NOTICE (Part No. 314.205.003)

A notice shall be located at each manual release position.



FIGURE 2-73
MANUAL RELEASE SIGN

Technical information

Material:	2 mm (0.08 in) craylon
Finish:	Gloss, scratch resistant
Overall size:	212 mm (L) x 75 mm (W) (8.25 in. (L) x 3.00 in. (W))

INTRODUCTION

FM-200 is a clean, safe, and effective fire fighting agent for use in total flooding automatic suppression systems.

FM-200 systems utilize one or more storage containers arranged to provide the protected area with a predetermined quantity of agent.

The agent storage containers are designed to hold the agent in liquid form. Nitrogen is used to super-pressurize the container to 25 bar at 20 °C (360 psi at 70 °F).

Handling and installation of FM-200 equipment should only be conducted by persons trained in dealing with this type of equipment.

FM-200 contains no particulates or oily residues and is produced under *ISO 9002* guidelines to strict manufacturing specifications ensuring product purity.

The agent suppresses fires quickly through a combination of heat absorption (80%) and direct chemical means (20%).

The primary objective of an FM-200 system is to detect and suppress a fire in its incipient stage long before smoke generation causes damage. Fire often begins before smoke or fire is visible, or before intense heat is present. When fires are stopped at the incipient stage, the risks of explosion, production of toxic combustion by products, or extensive damage are eliminated.

Once a system has discharged, remove the agent and any harmful combustion by-products from the space by simple ventilation.

HEALTH AND SAFETY

A correctly designed and installed suppression system should not present any significant health or safety problems. However, there are basic precautions to take to avoid accidents, and aspects of the system operation that should be fully understood.

Reference should be made to *NFPA 2001, Clean Agent Fire Extinguishing Systems*, *EN 15004*, and *ISO 14520* for the toxic and asphyxiating hazards of clean agent replacement.

The agent has an acceptable toxicity level for use in occupied spaces when used as specified in the United States Environmental Protection Agency (EPA) proposed *Significant New Alternative Policy (SNAP)* program rules, as well as *NFPA 2001*.

FM-200 suppresses fires primarily through its cooling effect, not through the displacement of oxygen, the suppressing mechanism of CO_2.

Exposure to the agent at the design concentration of up to 9% is not a health hazard. Exposure to higher concentrations is permissible for limited periods. Refer to *NFPA 2001* or exposure limits. As with halons, the EPA and the National Fire Protection Association (NFPA) recommend avoiding any unnecessary exposure to a suppression agent. Personnel must evacuate protected areas as quickly as possible to avoid the decomposition products of a fire.

The noise created by the discharging agent can be loud enough to startle people in the vicinity, but it is unlikely to cause any permanent injury. Turbulence caused by the high velocity discharge can dislodge substantial objects directly in its path, and cause general turbulence within the protected area and may move paper and light objects.

Direct contact with the vaporizing liquid discharged from a nozzle has a chilling effect on objects and in extreme cases can cause frostbite to the skin. The liquid phase vaporizes rapidly when mixed with air and therefore limits the risk to the immediate vicinity of the nozzle. Reduction in visibility will occur due to the condensation of water vapor.

In most discharge situations, the positive pressure is greater than the initial decrease. Thus, care must be taken not to over-pressurize the room. The nominal leakage of most existing rooms generally ensures against over-pressurization. In fact, many areas need additional sealing to assure a satisfactory holding time for the fire suppressing agent.

⚠ CAUTION

The discharge of clean agent systems to suppress a fire can result in a potential hazard to personnel from the natural form of the clean agent or from the products of combustion that result from exposure of the agent to the fire or hot surfaces. Unnecessary exposure of personnel to either of these potential hazards must be avoided.

DESCRIPTION OF FM-200 SYSTEM

FM-200 systems are designed to suppress fires in Class A, B, and C hazards.

⚠ CAUTION

FM-200 is not effective on the following hazards:

- Class A Deep seated fires
- Class D Combustible metals
- Chemicals capable of auto-thermal decomposition
- Chemicals capable of rapid oxidation
- Enclosures with hot surfaces (> 400 °C or 752 °F)

FM-200 suppresses fires by a combination of physical and chemical means. It does not significantly deplete the oxygen content in the room.

A system consists of one or more containers connected to a system of piping and nozzles. The agent is liquefied compressed gas, super-pressurized with nitrogen pressure and stored in steel containers, each of which is fitted with a valve specially designed to allow the contents of the container to discharge within 10 seconds. When the valve opens, the agent flows into the distribution piping and then to the discharge nozzles where it is rapidly dispersed as a vapor.

Discharged FM-200 gives the appearance of a fog which may reduce visibility. This normally clears rapidly and should not obstruct the ability of personnel to safely exit the protected area.

FM-200 engineered fire suppression systems are particularly valuable in suppressing fires in enclosures containing hazards, where a clean, electrically non-conductive agent is essential; or where the cleaning up of foam, water, or dry chemical would be difficult.

APPROVALS

The FM-200 fire suppression system is tested, UL Listed (EX5104), and FM Approved as an engineered system for Class A, B, and C fire suppression. Components are tested to *EN 12094* for CE marking requirements.

TYPE OF SYSTEM

Total flooding is the approved type of system available. A total flooding system normally consists of a fixed supply of agent connected to piping with nozzles which will direct the agent into an enclosed hazard space. In a total flooding system, the enclosure around the hazard must be tight enough to hold the required percentage of agent concentration for a period of time to suppress the fire.

TYPES OF ACTUATION

There are three basic types of actuation for FM-200 systems: electrical, mechanical, and pneumatic.

Electrical

Automatic electric actuation of the container valve, through an approved control panel, can be accomplished by using an electric actuator. The actuator is energized by an electric signal from the control panel. When using the electric actuator, a mechanical actuating device can be attached as a secondary means of actuation. When using electric actuation, a means of manual release must also be provided.

Mechanical

Mechanical actuation is accomplished by means of a local manual actuator mounted on top of the container valve or on top of the electric actuator. The container is actuated by removing the safety pin on the actuator and depressing the strike knob, or mechanically by remote pull station, in combination with the CPM actuator. The pin in the actuator opens the container valve, allowing the container to discharge the agent.

Note: If mechanical actuation is used, per NFPA, a discharge pressure switch is required.

Pneumatic

Pneumatic actuation is accomplished with the AUTOMAN II-C Release or pilot container assembly and pneumatic actuators on the containers.

TYPES OF DETECTION

The approved type of detection available for the FM-200 system is by use of an electronic control panel.

Electronic Control Panel

Electric actuation of the FM-200 system is obtained through the use of electronic control systems that monitor and control various system functions. All detection equipment must be installed according to *NFPA 70* and *NFPA 72.* Available detection devices include ionization smoke detectors, photoelectric smoke detectors, flame detectors, and rate compensated heat detectors.

Note: When designing the system, use an appropriate detector for the type of hazard, to attain a proper response if a fire situation occurs.

For FM-200 fire suppression systems, the typical area coverage for a single smoke detector is 23.2 m^2 (250 ft^2) and 20.9 m^2 (225 ft^2) for a heat detector. When a detector senses a fire, a signal is sent to the control panel. The panel in turn sends an electrical signal to the actuator located on the master container valve. The actuator opens the master valve, actuating that container and causing pneumatic actuation of the remaining containers from the pressure of the master container.

SYSTEM OPERATION - GENERAL COMMENTS

The method of system operation is chosen at the design stage to suit the protection required for the hazard area and the environmental factors appropriate for the area.

Personnel required to work within the protected area must be trained in the appropriate fire procedures for the detection and suppression equipment that is installed.

System Detection and Actuation

Each system is designed to suit the hazard area, whether the area is normally occupied or unoccupied, and whether the detection and actuation devices are to be manual or automatic. The variation of systems is large. From an operational viewpoint, the systems are best grouped as the following:

- Manual
- Fully Automatic with or without a key maintenance switch

MANUAL SYSTEM

Manual systems depend on human detection of a fire in the hazard area. They also depend on prompt action to activate the manual actuator for the FM-200 fire suppression agent system to discharge and flood the protected area and suppress the fire.

All other instructions associated with manual operation form part of the user's procedures on safety precautions and fire drills. If required, assistance can be provided to help the user prepare procedures for safety and fire precautions.

Once a system has discharged, remove the agent and any harmful combustion by-products from the space by simple ventilation.

FULLY AUTOMATIC SYSTEM

Where a sensitive fire detection system is included for the automatic release of suppression agent, the system shall only be capable of automatic release once two or more detectors on separate zones detect the fire.

The number of detectors and their spacing is designed to ensure a satisfactory response time. To ensure personnel may safely evacuate the risk area, an adjustable time delay should be fitted such that sufficient time may elapse prior to system discharge. The delay period shall not exceed 30 seconds.

Prior to system discharge, and at the commencement of any time delay period, a clearly audible alarm different from any other used shall sound and continue until the complete system is reset. In areas of high ambient noise level, a visual indication may also be required, in addition to the audible warning.

The design of a system for automatic detection, signal distribution, or alarms is not always supplied by this manufacturer. Details pertaining to fire detection and alarm operation and maintenance are not included in this document.

UL Listed Detection and Control Equipment

Where UL system approval is required, detectors shall be UL Listed for the intended application. Control panels shall be UL Listed for releasing device service and compatible with the detection and FM-200 Total Flooding Fire Suppression System.

FM Approved Detection and Control Equipment

Where FM system approval is required, detectors shall be FM Approved for the intended application. Control panels shall be FM Approved for releasing device service and compatible with the detection and FM-200 Total Flooding Fire Suppression System.

OPERATING THE SYSTEM COMPONENTS

Follow the operating guidelines for the FM-200 system components outlined in this section when operating the system.

Container Valves

The discharge valve operates through manual, pneumatic, cable, or electrical actuation. The discharge valve actuates automatically and discharges agent through the piping system into the protected area. After discharge, the valve requires refurbishment before refilling.

Pressure Gauge

The pressure gauge works within the predetermined system operating conditions. For low pressure switches, the contact switches at the predetermined setpoint on fall of pressure and automatically resets with a pressure increase to normal operating parameters.

Electrical Actuator Bridge Rectifier

The electrical actuator operates after receiving a 24 VDC nominal voltage signal from the panel. The electrical actuator latches in the fire position after the signal terminates. The electrical actuator requires manual resetting by removing the unit from the valve and inserting the reset tool. The reset tool shall be screwed into place. Removal of the electrical actuator automatically triggers the placement indicator switch which resets once refitted correctly.

Manual Actuator

The local manual actuator operates by removing the safety pin and applying the required force for the minimum duration to the red PVC strike knob. The local manual actuator remains in the fire position and requires manual resetting before refitting to the discharge valve or electrical actuator.

Pneumatic Actuator

The pneumatic actuator operates by pressure from either a master container, pilot, or AUTOMAN II-C release. The pneumatic actuator remains in the fire position and requires manual resetting before refitting to the discharge valve or electrical actuator.

OPERATING THE SYSTEM COMPONENTS (Continued)

Manual Pneumatic Actuator

The manual pneumatic actuator operates by removing the safety pin and applying the required force for the minimum duration to the red PVC strike knob or by pressure from either a master container, pilot container, or AUTOMAN II-C release. The manual pneumatic actuator remains in the fire position and requires manual resetting before refitting to the discharge valve or electrical actuator.

Cable Pneumatic Manual (CPM) Actuator

The CPM actuator operates manually by removing the safety pin and applying the required force to move the lever 90^{o} in an upwards direction. It operates pneumatically from pressure from the master container, pilot container, AUTOMAN II-C release, or from a cable. When the CPM pneumatically operates through a cable, a pull station applies force on the actuation wire. The CPM remains in the fire position and requires manual resetting before refitting to the discharge valve or electrical actuator.

AUTOMAN II-C Releasing Device

The AUTOMAN II-C actuator operates automatically through an electrical signal from an approved fire panel, such as an AUTOPULSE fire panel, or manually by removing the safety pin and applying the required force to the red PVC strike knob. Both actuation methods puncture a nitrogen cartridge. The AUTOMAN II-C strike pin remains in the fire position and requires manual resetting before refitting to the replacement LT-30-R nitrogen cartridge.

Female Actuation Hose

The female actuation hose is a pressure connector and requires no operating instructions.

Flexible Discharge Hose

The flexible discharge hose is a pressure connector and requires no operating instructions.

Manifold Check Valve

The manifold check valve automatically opens on system discharge and closes at the end of discharge. It requires no operating instructions.

Discharge Pressure Switch

The discharge pressure switch works within the predetermined system operating conditions. The switch auto resets at the end of the system discharge once all residual pressure is released from the system.

Decompression Screw

The decompression screw is assembled into the pneumatic actuation line and is a means for relieving trapped pressure after a discharge. During recharge, the cap is removed, reversed, and threaded back in to open a port allowing trapped pressure to escape.

Nozzle and Discharge Nozzle Filter

The nozzle and, where required, the nozzle filter, work within predetermined system operating conditions and require no operating instructions.

Adjustable Height Adaptor

The adjustable height adaptor is a pressure connector and requires no operating instructions.

INTRODUCTION

Planning for the design and installation of an FM-200 system must start when the customer is first contacted in regards to protecting a hazard with FM-200. Most of the information needed for the design of a system is collected during the first meeting with the customer. The information gathered at this point determines the ease or difficulty of the rest of the project. One of the key elements for fire protection is to correctly define the hazard and conduct a complete survey to determine if the system will properly protect the hazard. Coordination with all parties involved in the project further improves the flow of the overall project.

A thorough hazard analysis is required to determine the amount of protection required. It is important to cover each element and accurately record the information. This information is used to determine the size and location of the FM-200 system and can be used to determine if any changes were made to the hazard after the system was installed. Information necessary for the design of a system is listed in the following paragraphs.

Initial General Information

When planning for the design and installation of an FM-200 system, the following questions should be considered:

1. Are Specifications available? If so, obtain a copy.
2. Who is the Authority Having Jurisdiction? Is it the owner?
3. Will the system need to be approved by any other regulatory or insurance agencies?
4. Will any special requirements apply to the system design or installation?

Hazard Information

When planning for the design and installation of an FM-200 system, the following information should be obtained:

1. Secure the general arrangement drawings of the areas to be protected.
2. If the general arrangement drawings do not include all of the necessary information, then you must obtain it.
3. Record all dimensions of the hazard areas, for example, length, width, ceiling height, and angles of corners if not 90°.
4. Draw a sketch including plan and elevation views of the hazard area if drawings are not available.
5. Indicate the quantity and location of all exits from the hazard area on the sketches.
6. Record all dimensions for any structural objects such as beams or columns, built-in cabinets, and ducts, for example, which may allow a reduction of the hazard volume.
7. Identify anything unique about the hazard area that would affect system design or installation.
8. Identify the normal, maximum, and minimum ambient temperatures of the hazard area.
9. Will the hazard area normally be occupied?
10. Identify any openings or potential openings in the hazard enclosure that may cause loss of agent during or after discharge.
11. Identify all potential fire hazards and determine the corresponding agent concentration requirements. Select the highest design concentration determined for protection of the hazard area.

Agent Supply Requirements and Considerations

When planning for the design and installation of an FM-200 system, the following questions should be considered:

1. Will the containers be located in a dedicated space? If so, record the dimensions of the space.
2. Is the operating temperature range within the minimum and maximum temperature of the container storage location?
3. Determine if the floor will support the containers and bracketing.
4. Will the container bracketing be secured to a wall? If so, is the wall strong enough to support the bracketing and the containers?
5. Will a reserve supply of agent be required? If so, will it need to be connected to the manifold?
6. Will a discharge test be required?

Actuation and Alarm Requirements and Considerations

When planning for the design and installation of an FM-200 system, the following questions should be considered:

1. Will the system be actuated automatically as well as manually?
2. What type of manual actuation is required?
3. Will multiple areas be protected by a single system? If so, will the areas be protected separately or simultaneously?
4. Identify locations of all manual release and abort stations
5. If automatic detection is a part of the system, provide ceiling details.
6. What types of alarm devices are required: audible and/or visible?
7. Where will the system actuation be annunciated?
8. Does the hazard area require explosion-proof or weather-proof wiring and devices?
9. What devices need to be shut down or started up? Identify the number of contacts required.

Piping and Wiring Information

When planning for the design and installation of an FM-200 system, the following information should be obtained:

1. Determine the container location.
2. Identify the preferred supply piping routes.
3. Indicate any obstructions to the piping or wiring runs.
4. Distribution piping will be installed only with approved piping.
5. Pipe size reductions may be made by using reducing tees, bushings, or couplings.

VENTILATION AND LEAKAGE CONCERNS

When planning for the design and installation of an FM-200 system, consider the following points:

1. Identify any unclosable openings regardless of their size.
2. Identify if the air conditioning and forced ventilation will affect the system performance and the quantity of agent required.
3. Advise the customer of the possible need to seal these openings to prevent agent loss.
4. Will dampers be required for inlet or exhaust ducts? If so, how will they be operated: electrically or pneumatically?
5. After the FM-200 discharge, if needed, install a normally closed means to manually purge agent to the atmosphere.

Hazard Structure and Contents

When planning for the design and installation of an FM-200 system, consider the following points:

1. The protected enclosure shall be bounded by rigid elements of building construction. The ceiling height shall not be less than 300 mm (11.8 in.).
2. During agent discharge, the hazard enclosure experiences a pressure change. The hazard structure must be capable of withstanding the peak pressure, positive or negative, created during system discharge. It is the client's responsibility to provide information regarding the maximum acceptable pressure change for the hazard structure.
3. In total flooding applications, the hazard area must be an enclosed space with no significant openings so that the design concentration can be achieved and maintained. The calculation is based on an empty area. Subsequent furniture and fittings having little effect on the actual concentration.
4. Large equipment cabinets and control panels shall not be considered in the calculation as it is assumed that the internal area is required to be filled with agent.
5. Each enclosed space is considered as a hazard area and requires at least one nozzle. Subfloors, false ceilings, and cable ducts, for example, are treated as separate adjacent areas and require a simultaneous discharge to occur.
6. Nozzles may be installed a maximum of 300 mm (12 in.) below the ceiling to avoid discharging the agent against obstructions, such as beams. If nozzles are installed more than 300 mm (12 in.) below the ceiling it is not guaranteed that the design concentration will reach anywhere above the nozzle level. Areas with obstructions more than 300 mm (12 in.) below the ceiling level may require additional nozzles to guarantee an effective agent distribution.
7. Dampers shall be installed in both supply and return air ducts as close as possible to the area. The duct volume between the unit and the damper must be added to the overall volume.

SYSTEM DESIGN

There are four main elements of system design. The first is the risk assessment as described in Section 4 - Planning. The second is Room Integrity (page 5-2). The third and fourth elements of system design are explained in the remainder of this section under Design Concentration (page 5-3) and System Limitations (page 5-5). To understand the calculation process steps, refer to the System Design Procedure, examples starting on page 5-11.

All systems are designed in accordance with a relevant design standard, for example, *NFPA 2001*, *ISO 14520*, *EN 15004*. FM-200 systems are manufactured in accordance with ISO 9001 and FM-200 is manufactured to ISO 9002.

Multiple Container Actuation

Where several containers comprise one system and are discharged simultaneously, one container is designated as the **master** container, and the others are **subordinate** containers. The master container can be actuated electrically or manually. The subordinate containers are actuated pneumatically by the action of the master container discharging.

The maximum number of subordinate actuated containers is nine, for a total of ten containers, including one master and nine subordinates.

RELEASE OPTIONS

AUTOPULSE Control Panel - Electric

The master container actuates electrically using an electrical actuator connected to an AUTOPULSE control panel. Additional subordinate containers pneumatically actuate from the master container valve actuation port. See Figure 5-1.

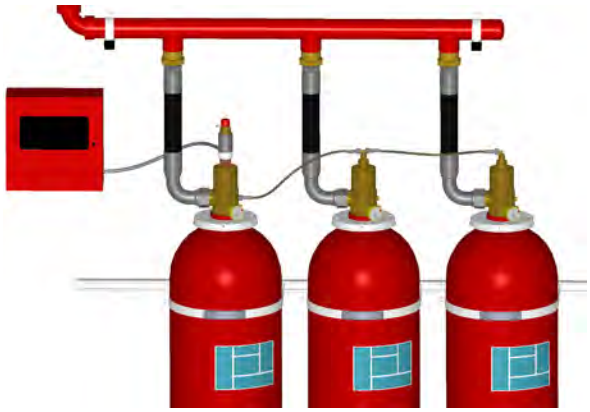


FIGURE 5-1
ELECTRICAL ACTUATION WITH AUTOPULSE PANEL
025534

AUTOMAN II-C Release - Pneumatic

The master container actuates pneumatically using the AUTOMAN II-C releasing device. Additional subordinate containers pneumatically actuate from the master container valve actuation port. See Figure 5-2. See the *Actuation Line Schematics* in Section 9 - Appendix.

Note: The appropriate pilot container assembly can be used as an alternative to the AUTOMAN II-C pneumatic release.

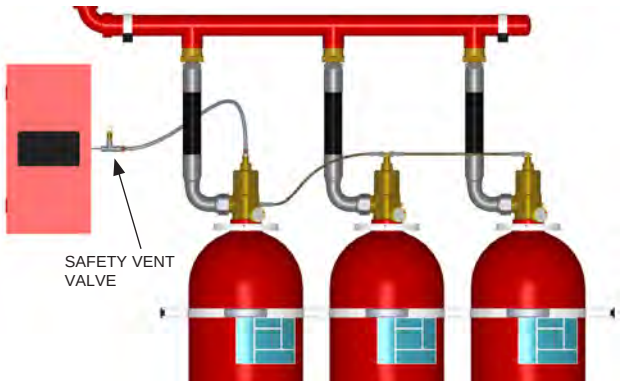


FIGURE 5-2
MASTER AND SUBORDINATE ACTUATION WITH AUTOMAN II-C RELEASE
025536

ROOM INTEGRITY

The room integrity is the ability of the hazard enclosure to retain the discharged FM-200. For a total flooding suppression system to be effective, the design concentration must be achieved and maintained for at least ten minutes. The only method of testing the agent retention within the protected area is to verify the integrity of the enclosure by applying proven test procedures.

The enclosure integrity test has been developed to locate the source of leaks and, from the data collected, predict the retention time, proving system performance and removing the need for actual agent discharge. In order to determine with a degree of confidence that the hazard area holds the gas for the required time period, an Enclosure Integrity Test in accordance with *NFPA 2001* and the Authority Having Jurisdiction (AHJ) must be conducted.

Principle

The test is conducted with a **door fan**, which has been used in the energy conservation field for over 30 years. It has three basic components:

- An adjustable panel that fits in the doorway of the protected area
- A calibrated fixed speed fan
- A variable speed fan

The pressure created by the door fan causes the air to move through leaks in the enclosure at high speed making it easy to identify leaks. A cool chemical smoke or other air current indicator detects the approximate size and location of leaks.

Equivalent Leakage Area (ELA)

The test to measure the ELA is conducted by blowing air into or out of the enclosure to develop the same pressure differential as would be created by discharging agent. By measuring the air flow required, it becomes possible to calculate the ELA, which is the total of all cracks, gaps, and holes in the enclosure. The leakage measurement achieved by taking air out of the enclosure (depressurization), and then blowing air into the enclosure (pressurization), is then averaged.

Below Ceiling Leakage Area (BCLA)

Leakage above a suspended ceiling has a negligible effect on the agent concentration. FM-200 tends to escape from leaks in the lower part of the enclosure caused by the weight of the mixture above it. The rate at which agent is lost is primarily governed by the leakage below the floor, and walls beneath the ceiling. This is called the *Below Ceiling Leakage Area*.

Predicting Retention Time

Once the ELA, BCLA, and static pressures have been measured, calculate the retention time of the enclosure. The formula is derived from a standard engineering and fluid dynamics principle. The result of the calculation is the number of minutes it takes for the agent and air interface to reach the minimum protected height required, normally about 75% of the height of the enclosure area.

Slab to Slab Walls

The only major limitation is that the formula for predicting retention time cannot be used to accurately predict a retention time if the perimeter walls do not extend from slab to slab. The enclosure will almost invariably fail due to extensive leakage through the ceiling tiles.

Coordination and Planning

It is essential to ensure that the enclosure is ready, and the relevant people have been informed. Having established all outstanding works are completed prior to the test date, advise all interested parties in writing, if necessary, outlining the testing method and principles involved.

DESIGN CONCENTRATION

Design Concentrations - NFPA 2001

FM-200 systems are suitable for use in normal commercial and industrial environments. See the following table for the minimum design concentrations.

TABLE 5-1: MINIMUM DESIGN CONCENTRATIONS

Fire Classification	UL	FM
Class A	6.7%	7.17%
Class B	Contact Technical Services	
Class C	7.23%	8.06%

Reference: *NFPA 2001*

FM-200 is suitable for use with the following materials:

- **Class A** fires involving solid materials usually of an organic nature, in which combustion normally takes place with the formation of glowing embers.
- **Class B** fires involving flammable liquids or liquefiable solids and flammable gases.
- **Class C** fires involving energized electrical equipment where the electrical non-conductivity of the suppression agent is of importance.

To determine other recommended design concentrations for Class B flammable liquids, refer to the methodology within *NFPA 2001*. All design concentration calculations are based on minimum extinguishing concentrations plus a 20% safety factor for Class A, 30% safety factor for Class B, and 35% safety factor for Class C.

All agent quantities are calculated at minimum design temperature to determine the agent quantity. The maximum achieved concentration should be calculated at the maximum anticipated enclosure temperature, and compared to NOAEL and LOAEL values.

NOAEL (No Observable Adverse Effect Level) = < 9%

LOAEL (Lowest Observable Adverse Effect Level) = > 10.5%

Where egress takes longer than 30 seconds, and less than one minute, the halocarbon agent shall not be used in concentration exceeding LOAEL.

Concentration above LOAEL shall be permitted provided that personnel in the area can escape within 30 seconds.

Calculations to Determine Minimum Design Concentration

Formula: Cup burner or fire test concentration x safety factor x nozzle efficiency factor

Safety factor: Class A = 1.2
Class B = 1.3
Class C = 1.35

Class A fire test concentration = 5.2% (UL) and 5.8% (FM)

The agent cup burner value is 6.7% for commercial grade Heptane, as defined in *NFPA 2001*. Actual distribution test concentration is 6.9%. Therefore:

$$\text{Nozzle efficiency factor} = \frac{6.9\%}{6.7\%} = 1.03$$

Note: Manual only operated systems require a safety factor, as determined by the Authority Having Jurisdiction (AHJ).

Class A Fires (UL Listed System)

Class A minimum design concentration = fire test concentration x safety factor x nozzle efficiency factor **or** heptane cup burner value (whichever is greater).

Class A minimum design concentration = 5.2 x 1.2 x 1.03 = 6.43% **or** 6.7%

NFPA 2001 states that the design concentration should not be less than the heptane cup burner value of 6.7%.

Therefore, Class A minimum design concentration is 6.7% for UL Listed systems.

Class A Fires (FM Approved System)

Class A minimum design concentration = fire test concentration x safety factor x nozzle efficiency factor **or** heptane cup burner value (whichever is greater).

Class A minimum design concentration = 5.8 x 1.2 x 1.03 = 7.17% **or** 6.7%.

NFPA 2001 states that the design concentration should not be less than the heptane cup burner value of 6.7%.

Therefore, Class A minimum design concentration is 7.17% for FM Approved systems.

Class B Fires (Commercial Grade Heptane)

Class B minimum design concentration = fire test concentration x safety factor x nozzle efficiency factor

Class B minimum design concentration (commercial grade heptane) = 6.7% x 1.3 x 1.03 = 8.97%

Note: For other Class B fuels, contact Johnson Controls Technical Services.

Class C Fires (UL Listed System)

Class C minimum design concentration = fire test concentration x safety factor x nozzle efficiency factor **or** Class A minimum design concentration (whichever is greater).

Class C minimum design concentration = 5.2 x 1.35 x 1.03 = 7.23% **or** 6.7%

NFPA 2001 states that the minimum design concentration for Class C hazards shall be at least that for Class A surface fires.

Therefore, Class C minimum design concentration is 7.23% for UL Listed system.

Class C Fires (FM Approved System)

Class C minimum design concentration = fire test concentration x safety factor x nozzle efficiency factor **or** Class A minimum design concentration (whichever is greater).

Class C minimum design concentration = 5.8 x 1.35 x 1.03 = 8.06% **or** 7.17%

NFPA 2001 states that the minimum design concentration for class C hazards shall be at least that for Class A surface fires.

Therefore, Class C minimum design concentration is 8.06% for FM Approved system.

DESIGN CONCENTRATION (Continued)

Design Concentrations - ISO 14520 / EN 15004

FM-200 systems are suitable for use in normal commercial and industrial environments. See the following table for the minimum design concentrations.

TABLE 5-2: MINIMUM DESIGN CONCENTRATIONS

Fire Classification	ISO 14520 and EN 15004
Class A	7.9%
Class A Higher Hazard	8.5%
Class B	9.0% (Heptane). For other fuels, refer to Johnson Controls Technical Services.

Reference: *ISO 14520* and *EN 15004.*

FM-200 is suitable for use with the following materials:

- **Class A** fires involving solid materials usually of an organic nature, in which combustion normally takes place with the formation of glowing embers.
- **Class B** fires involving flammable liquids or liquefiable solids and flammable gases.

To determine other recommended design concentrations for Class B flammable liquids, refer to the methodology within *ISO14520* and *EN 15004*.

The minimum design concentration for Surface Class A fuels are based on the highest extinguishing concentrations of wood crib, PMMA, PP, or ABS, plus a 30% safety factor. The minimum design concentration for Higher Hazard Class A fuels shall be the higher of the Surface Class A or 95% of the Class B minimum design concentration. The minimum design concentration for Class B fuel is the value of the heptane cup burner or room test heptane extinguishing concentration plus a 30% safety factor.

All agent quantities are calculated at minimum design temperature to determine the agent quantity. The maximum achieved concentration should be calculated at the maximum anticipated enclosure temperature, and compared to NOAEL and LOAEL values.

NOAEL (No Observable Adverse Effect Level) = < 9%

LOAEL (Lowest Observable Adverse Effect Level) = > 10.5%

Where egress takes longer than 30 seconds, and less than one minute, the halocarbon agent shall not be used in concentrations exceeding LOAEL.

Concentrations above LOAEL shall be permitted provided that personnel in the area can escape within 30 seconds.

Calculations to Determine Minimum Design Concentration

Formula: Cup burner or fire test concentration x safety factor x nozzle efficiency factor

Safety factor: Class A and Class B = 1.3

The minimum design concentration for Surface Class A fuels are based on the highest extinguishing concentrations of wood crib, PMMA, PP or ABS which is 6.1%.

The agent cup burner value is 6.7% for commercial grade Heptane, as defined in *ISO 14520* and *EN15004*. The actual distribution test concentration is 6.9%. Therefore:

$$\text{Nozzle efficiency factor} = \frac{6.9\%}{6.7\%} = 1.03$$

Note: 1.03 is for Class B fires, and is not applicable for Class A fires. Manual only operated systems require a safety factor, as determined by the AHJ.

Class A Fires (*ISO 14520* and *EN 15004*)

Class A minimum design concentration = fire test concentration x safety factor

Class A minimum design concentration = 6.1 x 1.3 = 7.93% rounded to one decimal place = 7.9%

Class A Fires (*ISO 14520* and *EN 15004*) Higher Hazard

Class A higher hazard minimum design concentration = Class A minimum design concentration **or** 95% of Class B minimum design concentration (whichever is greater).

Class A higher hazard minimum design concentration = 7.9 **or** 0.95 x 8.97 = 8.52% rounded to one decimal place = 8.5%

Therefore, Class A higher hazard minimum design concentration is 8.5%.

Class B Fires (Commercial Grade Heptane)

Class B minimum design concentration = fire test concentration x safety factor x nozzle efficiency factor

Class B minimum design concentration (commercial grade heptane) = 6.7% x 1.3 x 1.03 = 8.97% rounded to one decimal place = 9.0%

Note: For other Class B fuels, contact Johnson Controls Technical Services.

Rugged environments, and those requiring intrinsically safe or explosion-proof equipment, require special consideration and should be fully discussed with regional Technical Services before finalizing a system design.

SYSTEM LIMITATIONS

The calculation method is designed for specific types of fittings, pipe, and pipe inside diameter. When these limitations are not maintained, there is a risk that the system may not supply the required quantity of agent.

Nozzle Selection and Location

The number of nozzles required is based on the hazard size and configuration and the coverage provided by the nozzle (see Figures 5-3 to 5-5). Nozzles are available in 7 port or 8 port versions to provide 180° or 360° discharge patterns respectively. See Tables 5-3 to 5-5 for further details. When considering the optimum nozzle location, take the following factors into account:

- The shape of the hazard area affects the nozzle location.
- The maximum area coverage is 95.3 m^2 (1026 ft^2) and must be within nozzle radius limits.
- Nozzle orifices must not be placed where they may discharge into nearby objects.
- If nozzle velocity is a concern, additional nozzles may be added to lower the individual nozzle velocity.
- Nozzles can be installed up to a maximum of 300 mm (12 in.) below the ceiling.
- Maximum nozzle height above floor level for a single row of nozzles is 4.87 m (16 ft). For ceiling heights above 4.3 m (14 ft) additional rows of nozzles may be added.
- 180° nozzles must be mounted within 50 mm to 300 mm (2 in. to 12 in.) of the wall and point at the center of the hazard.
- The minimum ceiling height, for subfloors, false ceilings, plenums, for example, is 300 mm (12 in.).
- Nozzles are positioned vertically, either up or down.
- The maximum elevation difference between the container outlet and the highest horizontal pipe run or discharge nozzle shall not exceed 9.1 m (30 ft), see Figure 5-6.
- The maximum elevation difference between the highest horizontal pipe runs or discharge nozzles shall not exceed 9.1 m (30 ft), see Figure 5-7.
- If the room is an odd shape, the designer may increase the nozzle quantity to provide a more even agent distribution.
- The nozzles must be located in the hazard area to be protected. Separate enclosures or partial enclosures located within one common, protected hazard area may require additional nozzles within the enclosure to assure proper agent distribution within the entire common hazard area.
- If nozzle velocity is a concern, the designer may wish to add additional nozzles to lower the individual nozzle velocity to an acceptable limit.
- If the room is an odd shape, the designer may wish to increase the nozzle quantity to provide a more even distribution of agent.
- For multiple level hazards, the intermediate levels of nozzles must be positioned at the top of the designed height for each intermediate level.

Note: If a system breaks any of the above limits, the system design must be modified to comply with all the limitations.

Standard Area Coverage Max. Radial Distance per Nozzle*

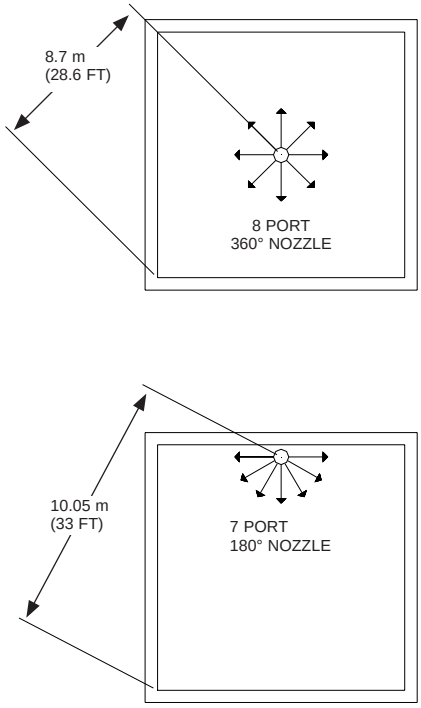


FIGURE 5-3
NOZZLE DISCHARGE RADIUS
E001439

SYSTEM LIMITATIONS (Continued)

Nozzle Selection and Location (Continued)

TABLE 5-3: NOZZLE COVERAGE DETAILS

Nozzle Coverage - Radial Distance		Temperature	Approvals and Listings
Standard radial coverage	8.7 m (28.6 ft) for 8 port nozzle	0 °C to 50 °C (32 °F to 122 °F)	EU, UL, and FM
	10.05 m (33 ft) for 7 port nozzle	0 °C to 54 °C (32 °F to 130 °F)	

TABLE 5-4: 360° NOZZLE AREA COVERAGE - MAX. MAX. 95.3 m^2 (1026 ft^2)

m		(ft)	
A	**B**	**A**	**B**
1.83	17.37	(6)	(57)
2.13	17.37	(7)	(57)
2.44	17.37	(8)	(57)
2.74	17.07	(9)	(56)
3.05	17.07	(10)	(56)
3.35	17.07	(11)	(56)
3.66	17.07	(12)	(56)
3.96	17.07	(13)	(56)
4.27	16.76	(14)	(55)
4.57	16.76	(15)	(55)
4.88	16.76	(16)	(55)
5.18	16.76	(17)	(55)
5.49	16.46	(18)	(54)
5.79	16.46	(19)	(54)
16.46	5.79	(54)	(19)
16.76	4.88	(55)	(16)
17.07	3.66	(56)	(12)
17.37	1.52	(57)	(5)

Note: Values are approximate; coverage must be within the nozzle radius and area limits.

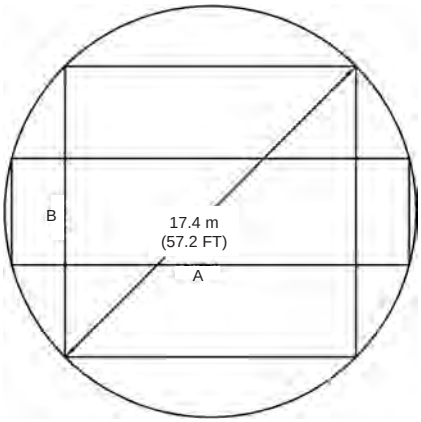


FIGURE 5-4
DIMENSIONS FOR 360° NOZZLE
008629

Note: Nozzle should be placed as close to the center of the hazard as possible. On multiple nozzle systems, the nozzles should be as equally spaced as possible.

SYSTEM LIMITATIONS (Continued)

Nozzle Selection and Location (Continued)

TABLE 5-5: 180° NOZZLE AREA COVERAGE - MAX. 95.3 m^2 (1026 ft^2)

m		(ft)	
A	**B**	**A**	**B**
1.83	10.06	(6)	(33)
2.13	10.06	(7)	(33)
2.44	10.06	(8)	(33)
2.74	10.06	(9)	(33)
3.05	10.06	(10)	(33)
3.35	10.06	(11)	(33)
3.66	9.75	(12)	(32)
3.96	9.75	(13)	(32)
4.27	9.75	(14)	(32)
4.57	9.75	(15)	(32)
4.88	9.75	(16)	(32)
5.18	9.75	(17)	(32)
5.49	9.75	(18)	(32)
5.79	9.75	(19)	(32)
6.10	9.45	(20)	(31)
6.40	9.45	(21)	(31)
6.71	9.45	(22)	(31)
7.01	9.45	(23)	(31)
7.32	9.45	(24)	(31)
7.62	9.45	(25)	(31)
7.92	9.14	(26)	(30)
8.23	9.14	(27)	(30)
8.53	9.14	(28)	(30)
8.84	9.14	(29)	(30)
9.14	8.84	(30)	(29)
9.45	8.84	(31)	(29)
9.75	8.84	(32)	(29)
10.06	8.84	(33)	(29)
10.36	8.53	(34)	(28)
10.67	8.53	(35)	(28)
10.97	8.53	(36)	(28)
11.28	8.23	(37)	(27)
11.58	8.23	(38)	(27)
16.46	5.79	(54)	(19)
16.76	5.49	(55)	(18)
17.07	5.18	(56)	(17)
17.37	5.18	(57)	(17)

Note: Coverage must be within the nozzle radius and area limits.

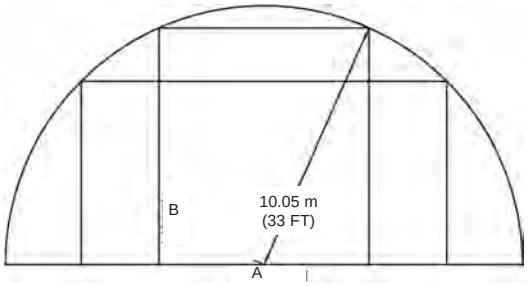


FIGURE 5-5
DIMENSIONS FOR 180° NOZZLE
008630

SYSTEM LIMITATIONS (Continued)

Nozzle Selection and Location (Continued)

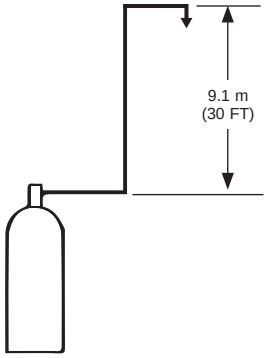


FIGURE 5-6
MAXIMUM ELEVATION BETWEEN NOZZLES AND CONTAINER OUTLET
009744

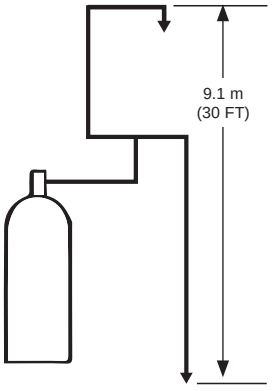


FIGURE 5-7
MAXIMUM ELEVATION BETWEEN HORIZONTAL PIPE RUNS AND NOZZLES
009745

Manifolds

Containers are manifolded together for three main reasons:

- To reduce the amount of piping required if modular system design was used
- For systems that require main and reserve container arrangements
- To combine the correct container fill weights to obtain the required quantity of agent for protection of hazard areas.

When manifolding the containers, observe the following rules:

- All containers connected to the same manifold or pipe must be the same size and fill weight.
- Locate the agent containers in a single row and space them according to the Inlet to Inlet Distance column in Table 6-4 (see Section 6 - Installation).
- A connected reserve may be employed in some circumstances providing a secondary supply of agent.
- Use flexible discharge hoses or hard pipe (union, pipe, and elbows) and check valves at each manifold inlet.

SYSTEM LIMITATIONS (Continued)

Piping Practices

Because of the two phase flow of agent, certain piping practices must be adhered to, mainly that the flow split must be on the horizontal plane. Two types of tees are used in FM-200 systems, a side tee and a bull tee. Both have limitations on the minimum and maximum allowable flow splits. See Figures 5-8 to 5-11.

When designing the system, adhere to the following system design factors:

- Allow a minimum length of 10 times the nominal pipe diameter around the tee splits before any change of direction.
- Use balanced or unbalanced pipe networks. If possible, use balanced pipe networks.
- Use minimum lengths of pipe.
- Use the minimum number of elbows.
- Maximize pipe volume before the first tee.
- Incorporate similar pipe run lengths to the nozzles.

NOTICE

The side tee splits shall be between 10% to 30%. The bull tee splits shall be between 30% to 70%. All tee outlets must be in the same horizontal plane.

EXAMPLE: TEE SPLIT DESIGNS

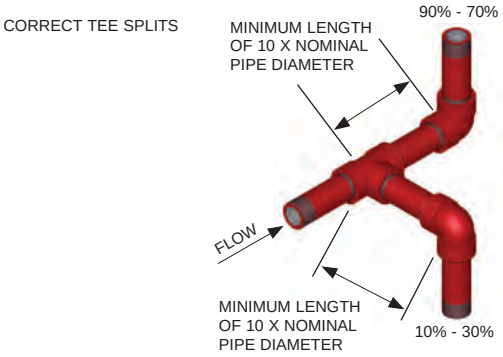


FIGURE 5-8
SIDE TEE SPLIT LIMITS
009746



FIGURE 5-9
INCORRECT SIDE TEE ORIENTATION
009747

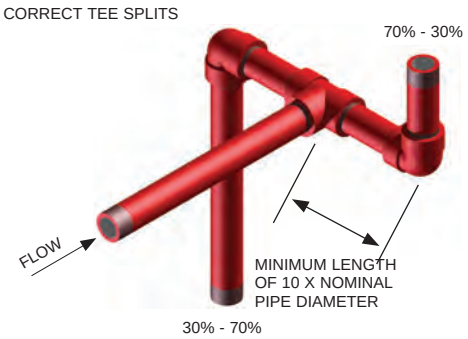


FIGURE 5-10
BULL TEE SPLIT LIMITS
009748



FIGURE 5-11
INCORRECT BULL TEE ORIENTATION
009749

SYSTEM LIMITATIONS (Continued)

FM-200 System Flow Calculation Program

The FM-200 system flow calculation is modelled through either a stand alone version from JENSEN HUGHES or a web based software program. This web based software program is referred to as the **Suppression Design Center (SDC)**, and will be available for authorized distributors at www.suppressiondesigncenter.com. FM-200 is scheduled for development into the SDC as a future project. A technical bulletin will be released on completion and certification by UL/FM. Until this time, continue to use the JENSEN HUGHES standalone software for FM-200 hydraulic software calculations.

As system design calculations are critical to the successful operation of the suppression system, only trained personnel are permitted to perform system calculations. All system calculations must be conducted by Johnson Controls Technical Services or through authorized distributors.

⚠ CAUTION

The calculation method has been designed for specific types of fittings, pipes, and pipe inside diameter. When these limitations are not maintained, the system may not supply the required quantity of suppression agent.

Design / Flow Calculation Limitations

- Minimum nozzle pressure: 4.86 bar (70.5 psi)
- Maximum equivalent % of agent volume in pipe: 80%
- Maximum agent arrival time imbalance: 1.0 s
- Maximum liquid run out time: 2.0 s
- Side tee split limit: Side tee (10% to 30%), Through tee (90% to 70%)
- Bull tee split limit: 30% to 70%
- Minimum fill density: 0.5 kg/L (31.2 lb/ft^3)
- Maximum fill density: 1.0 kg/L (62.4 lb/ft^3)
- Discharge time: 6 s to 10 s
- Maximum number of nozzles per enclosure: 20
- Maximum number of containers: 10
- Tee outlet orientation: Horizontal plane
- Minimum pipe lengths around tees: 10 x internal pipe diameter
- Maximum elevation in pipe run: 9.1 m (30 ft)
- Maximum pipe volume unbalance: 10% (if percentage of agent in pipe exceeds 80%)
- The ratio between the nozzle area and the nominal pipe cross sectional area is limited to a minimum of 20% and a maximum of 80%.

TABLE 5-6: ESTIMATED FM-200 PIPE SIZE

Pipe Size			Internal Diameter	Estimation Minimum Flow		Estimation Maximum Flow	
mm	(in.)	Schedule	mm (in.)	kg/s	(lb/s)	kg/s	(lb/s)
10	(3/8)	40	12.5 (0.490)	0.272	(0.6)	0.907	(2)
15	(1/2)	40	15.8 (0.622)	0.454	(1)	1.361	(3)
20	(3/4)	40	20.9 (0.823)	0.907	(2)	2.495	(5.5)
25	(1)	40	26.6 (1.047)	1.588	(3.5)	3.855	(8.5)
32	(1 1/4)	40	35.1 (1.382)	2.722	(6)	5.67	(12.5)
40	(1 1/2)	40	40.9 (1.610)	4.082	(9)	9.072	(20)
50	(2)	40	52.5 (2.067)	6.35	(14)	13.61	(30)
65	(2 1/2)	40	62.7 (2.469)	9.072	(20)	24.95	(55)
80	(3)	40	77.9 (3.067)	13.61	(30)	44.82	(99)
100	(4)	40	102.3 (3.824)	24.95	(55)	56.70	(125)
125	(5)	40	128.2 (5.047)	40.82	(90)	90.72	(200)
150	(6)	40	154.1 (6.067)	54.43	(120)	136.10	(300)

Note: Hydraulic flow calculation software must be used to determine the final pipe sizes. Use this table for estimations.

SYSTEM DESIGN PROCEDURE

Follow this procedure when designing the FM-200 system:

1. Determine the hazard volumes.
2. Calculate the reduced volume.
3. Determine the minimum design concentration.
4. Determine the minimum quantity of FM-200 fire suppression agent required.
5. Adjust the quantity of agent with the altitude correction factor.
6. Adjust the quantity of agent to correct for dead space volume in the pipework.
7. Determine the total system agent quantity required.
8. Determine the estimated number of containers required.
9. Determine the design concentration at the maximum ambient temperature.
10. Determine the nozzle quantity.
11. Estimate the agent flow rate for each area.
12. Estimate the nozzle flow rates.
13. Determine the nozzle locations and lay out the interconnecting piping.
14. Complete an isometric sketch of the piping layout.
15. Estimate the pipe size for all areas (optional).
16. Perform flow calculations.
17. Verify system performance.
18. Complete the layout of the system.
19. Create an estimated bill of materials.
20. Create installation drawings.

SYSTEM DESIGN PROCEDURE (Continued)

STEP 1 Determine Hazard Volumes

The first step in the design of the FM-200 system is to calculate the volume of each area to be protected. To do this, complete the following steps:

1. Multiply the length times the width to determine the area.
2. Multiply the area times the height to determine the volume for each hazard area. If any area is an odd shape, it may need to be divided up into regular shapes to allow volume calculations.
3. Total all of the volumes together to determine the actual volume of that area.

If the irregular shape affects the distribution of agent, calculate sections of the hazard as separate areas and include nozzles for each of these areas.

If the ceiling height exceeds the maximum allowable ceiling height as defined in Section 5 - Nozzle Selection and Location, multiple levels of nozzles must be designed into the system. In this case, it is beneficial to treat each level as a separate protected area so that proper agent distribution is achieved.

Complete this section for each area protected by the system.

Example (see Figure 5-12):

- Computer Room
  10.06 m x 4.57 m x 3.05 m = **140.22 m^3**
  (33 ft x 15 ft x 10 ft = **4950 ft^3**)
- Subfloor
  10.06 m x 4.57 m x 0.3 m = **13.79 m^3**
  (33 ft x 15 ft x 1 ft = **495 ft^3**)
- Switch Room
  3.66 m x 3.66 m x 3.05 m = **40.86 m^3**
  (12 ft x 12 ft x 10 ft = **1440 ft^3**)

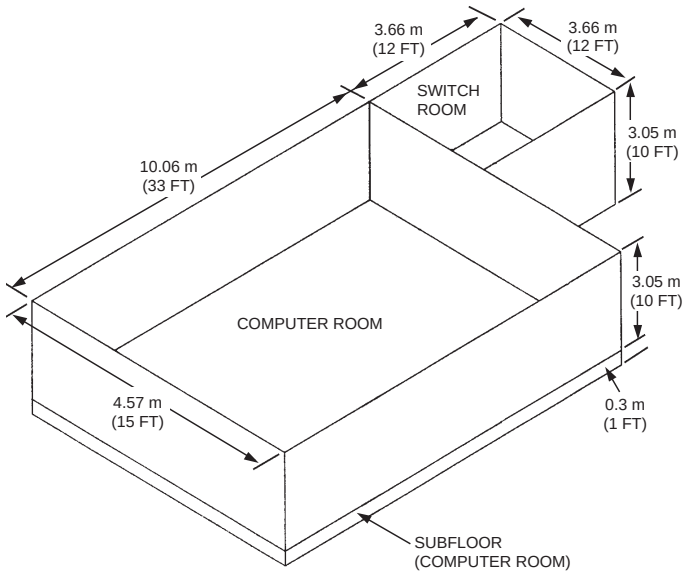


FIGURE 5-12
HAZARD AREA
007400

STEP 2 Calculate Reduced Volume

The volume of solid objects in each hazard area that are not removable can be deducted from the volume of the hazard. This volume may include columns, beams, cut-out room sections, ducts that pass completely through the area without any openings, and any other large, permanently fixed objects that cannot be removed from the hazard enclosure.

To calculate the reduced volume, complete the following steps:

1. Calculate the volume of all solid, permanent objects and add them together for each hazard to determine the amount of space to be subtracted from the total volume of the hazard area.
2. Subtract the volume of solid, permanent objects from each of the hazard volumes calculated in STEP 1. The result is considered to be the reduced volume for the hazard.

Volume – Solid Object Volume = Reduced Volume

Complete this step for each area protected by the system.

Example:

In this example, there is no reduced volume to deduct from these hazard areas.

STEP 3 Determine Minimum Design Concentration

Minimum design concentration is defined by *NFPA 2001* as the extinguishing concentration for the specific fuel plus a 20% safety factor for Class A fuel and a 30% safety factor for Class B fuel. Extinguishing concentration is the agent concentration required to extinguish a test fire.

The minimum design concentration for various fuels is shown in the following table:

TABLE 5-7: AGENT MINIMUM DESIGN CONCENTRATIONS

	NFPA 2001		
Fire Class	**UL**	**FM**	**ISO 14520 and EN 15004**
Class A	6.70%	7.17%	7.9%
Class A higher hazard	Not applicable		8.5%
Class B	Refer to Johnson Controls Technical Services		
Class C	7.23%	8.06%	Not applicable

For design concentrations for Class B flammable liquids, consult Johnson Controls Technical Services. The minimum design concentration for flammable liquids is 9.0% (when rounded to one decimal place) based on commercial grade heptane. Class A, B, and C hazards are UL Listed and FM Approved for FM-200 systems. Contact Johnson Controls Technical Services for more information.

Complete this step for each area protected by the system.

Design concentrations are determined by *ISO 14520, EN 15004, NFPA 2001, UL 2166,* and *FM 5600*.

Manually actuated systems require a safety factor determined by the Authority Having Jurisdiction. For this example, a design concentration of **7.2%** was selected.

SYSTEM DESIGN PROCEDURE (Continued)

STEP 4 Determine the Minimum Quantity of FM-200 Required

This step determines the minimum amount of agent (FM-200) required to protect each hazard area. The amount of agent in the system must always be at least this much and may be exceeded.

CAUTION

Failure to supply the minimum amount of agent calculated may inhibit the system from suppressing a fire.

To determine the minimum quantity of agent required, complete the following steps:

1. Determine the lowest anticipated ambient temperature for the area being protected.
2. Determine the design concentration required for the material to be suppressed.

Minimum Ambient Temperature is defined as the lowest anticipated temperature in the enclosure during normal conditions and is usually determined by the environmental conditions or the air handling system. This temperature is used in the design because it is the worst case scenario, meaning that it requires the highest amount of agent.

Using these two variables, the weight of agent required for a hazard can be calculated from the following formula:

First: The formula in *NFPA 2001* can be used.

$$W = \frac{V}{S} \times \left(\frac{C}{100 - C}\right)$$

Where:

W = Weight of agent required in kg (lb)

V = Hazard volume in m^3 (ft^3)

S = Specific vapor volume in m^3/kg (ft^3/lb)

where S = 0.1269 + 0.000513T m^3/kg

(where S = 1.885 + 0.0046T ft^3/lb)

T = Design temperature in hazard area in °C (°F)

C = Required agent design concentration (% by volume) at design temperature (T)

Note: This formula includes an allowance for the normal leakage (efflux) from a tight enclosure due to agent expansion.

NOTICE

The actual design concentration of agent cannot be less than the concentration selected in STEP 3.

Metric example using NFPA 2001 formula

S = 0.1269 + (0.000513 x 20 °C) = 0.137162 m^3/kg

- Computer Room:
  7.2% required design concentration example only.

$$W = \frac{140.22\ m^3}{0.137162\ m^3/kg} \times \left(\frac{7.2\%}{100 - 7.2\%}\right) = 79.32\ kg$$

- Subfloor:
  7.2% required design concentration example only.

$$W = \frac{13.79\ m^3}{0.137162\ m^3/kg} \times \left(\frac{7.2\%}{100 - 7.2\%}\right) = 7.80\ kg$$

- Switch Room:
  7.2% required design concentration example only.

$$W = \frac{40.86\ m^3}{0.137162\ m^3/kg} \times \left(\frac{7.2\%}{100 - 7.2\%}\right) = 23.11\ kg$$

English example using NFPA 2001 formula

S = 1.885 + (0.0046 x 70 °F) = 2.207 ft^3/lb

- Computer Room:
  7.2% required design concentration example only.

$$W = \frac{4950\ ft^3}{2.207\ ft^3/lb} \times \left(\frac{7.2\%}{100 - 7.2\%}\right) = 174.02\ lb$$

- Subfloor:
  7.2% required design concentration example only.

$$W = \frac{495\ ft^3}{2.207\ ft^3/lb} \times \left(\frac{7.2\%}{100 - 7.2\%}\right) = 17.40\ lb$$

- Switch Room:
  7.2% required design concentration example only.

$$W = \frac{1440\ ft^3}{2.207\ ft^3/lb} \times \left(\frac{7.2\%}{100 - 7.2\%}\right) = 50.62\ lb$$

The second option for calculating the required quantity of agent is to use the Flooding Factors Table (5-10 or 5-11) to determine the correct flooding factor to use. To do this, complete the following steps:

1. Locate the Minimum Ambient Temperature in the left column.
2. Follow this line across to the Minimum Design Concentration column needed for the design. Use the number listed where the temperature line and the concentration column meet as the Flooding Factor.

   Note: If the minimum temperature or the minimum design concentration, or both are not listed, interpolation is required.
3. Multiply the Reduced Hazard Volume by the Flooding Factor determined from the table to calculate the quantity of agent.

Complete STEP 4 for each area protected by the system (see STEP 4 example, next page).

SYSTEM DESIGN PROCEDURE (Continued)

STEP 4 (Continued)

Example using flooding factors

Minimum Ambient Temperature = 20 °C (70 °F)

Minimum Design Concentration = 7.2%

Flooding Factor = 0.5647 kg/L (0.0352 lb/ft^3)

- Computer Room

  140.22 m^3 x 0.5647 kg/m^3 = 79.18 kg of agent
  (4950 ft^3 x 0.0352 lb/ft^3 = 174.24 lb of agent)

- Subfloor

  13.79 m^3 x 0.5647 kg/m^3 = 7.79 kg of agent
  (495 ft^3 x 0.0352 lb/ft^3 = 17.42 lb of agent)

- Switch Room

  40.86 m^3 x 0.5647 kg/m^3 = 23.07 kg of agent
  (1440 ft^3 x 0.0352 lb/ft^3 = 50.69 lb of agent)

STEP 5 Adjust the Agent Quantity with the Altitude Correction Factor

It may be necessary at this point to adjust the required initial FM-200 quantity for altitude effects. An increase in altitude causes the agent to expand and occupy more space, which leads to a higher concentration if the agent quantity is not reduced accordingly. A decrease in altitude causes the opposite effect, increasing the quantity of agent required. This same effect applies to increases or decreases in the ambient pressure that could be caused by ventilation systems designed to maintain a positive or negative pressure within the enclosure. To apply the proper adjustment, follow these steps:

1. Identify the altitude or pressure of the hazard using Table 5-9: Agent Altitude Correction Factors.
2. Determine the total agent required by multiplying the quantity of agent required (see STEP 4) by the Altitude Correction Factor.

If the altitude is between 914 m (3000 ft) below sea level and 914 m (3000 ft) above sea level, use of the altitude correction factor is optional. Interpolation of the table may be necessary if the actual altitude or pressure is not listed.

Example: The hazard altitude is at sea level. The altitude correction factor of sea level is 1.00. See Table 5-9: Agent Altitude Correction Factors, page 5-21. There is no change in FM-200 quantities.

Example – Continue using *NFPA 2001* formula values

- Computer Room

  79.18 kg of agent x 1.00 = 79.18 kg of agent
  (174.24 lb of agent x 1.00 = 174.24 lb of agent)

- Subfloor

  7.79 kg of agent x 1.00 = 7.79 kg of agent
  (17.42 lb of agent x 1.00 = 17.42 lb of agent)

- Switch Room

  23.07 kg of agent x 1.00 = 23.07 kg of agent
  (50.69 lb of agent x 1.00 = 50.69 lb of agent)

STEP 6 Adjust the Quantity of Agent to Correct for Dead Space Volume in the Pipework

A supplemental amount of agent shall be added to the quantity determined in STEP 4 to compensate for FM-200 that may be retained in part of the pipework, known as the **dead volume** (see Figure 5-13). Use Table 5-8 to determine the total dead volume by adding each applicable volume based on the system configuration. Use the specified density of FM-200 at 20 °C (70 °F), to calculate the mass of agent retained in this dead volume.

Note: When building custom manifolds, dead volume is calculated based on manifold volume that is not accounted for in the hydraulic calculation, see Figure 5-13.

Use the volume formula for m^3 (ft^3):

$V = \pi r^2 L =$

Where:

$\pi = 3.1416$

r = internal radius (1/2 the internal diameter) of manifold (if diameter is mm (in.), convert to m (ft))

L = length of the manifold section.

Then multiply V by the density of FM-200, 1410 kg/m^3 (88.0 lb/ft^3), to determine the additional agent weight required. If needed, contact Technical Services for assistance.

Example: Using 4 in. schedule 80 pipe, half of the manifold is dead volume from a main and reserve two container system. The total manifold length is 1.22 m (4 ft). See Option 2 image in Figure 5-13 as an example.

Manifold dead volume length: 0.6 m (2 ft)

Internal diameter 97.0 mm (3.8 in.) converts to:
0.097 m (0.32 ft)

Therefore, r= 0.097 m / 2 = 0.0485 m
(0.32 ft / 2 = 0.16 ft)

$\pi = 3.1416$

r = 0.0485 m (0.16 ft)

L = 0.6 m (2 ft)

$V = 3.1416 \times (0.0485^2) \times 0.61 = 0.0045$ m^3

($V = 3.1416 \times (0.16^2) \times 2 = 0.1608$ ft^3)

Dead volume quantity= 0.0045 m^3 x 1410 kg/m^3 = 6.35 kg
(0.1608 ft^3 x 88.0 lb/ft^3= 14.15 lb)

This quantity needs to be added to the design quantity when selecting the container size, but remains trapped in the pipe network at discharge. It is not added into the room concentration calculation.

SYSTEM DESIGN PROCEDURE (Continued)

STEP 6 Adjust the Quantity of Agent to Correct for Dead Space Volume in the Pipework (Continued)

TABLE 5-8: DEAD VOLUME CALCULATION

Manifold size	DN 65 (2.5 in.)	DN 80 (3.25 in.)	DN 100 (4 in.)	DN 150 (6 in.)
Length - mm (in.)				
Container manifold inlet to end cap	150 (5.9)	150 (5.9)	150 (5.9)	150 (5.9)
Container spacing	350 (13.8)	500 (19.7)	500 (19.7)	500 (19.7)
Internal diameter (Schedule 80)	58.9 (2.3)	73.7 (2.9)	97 (3.8)	146.3 (5.8)
Volume - L (gal)				
Container manifold dead end	0.41 (0.11)	0.64 (0.17)	1.11 (0.29)	2.52 (0.67)
Volume for each reserve container manifold section	0.95 (0.25)	2.13 (0.56)	3.69 (0.97)	8.41 (2.22)
Weight - kg (lb)				
Quantity container manifold dead end	0.58 (1.28)	0.90 (1.98)	1.57 (3.46)	3.55 (7.83)
Quantity for each reserve container manifold section	1.34 (2.95)	3.00 (6.61)	5.20 (11.46)	11.86 (26.15)

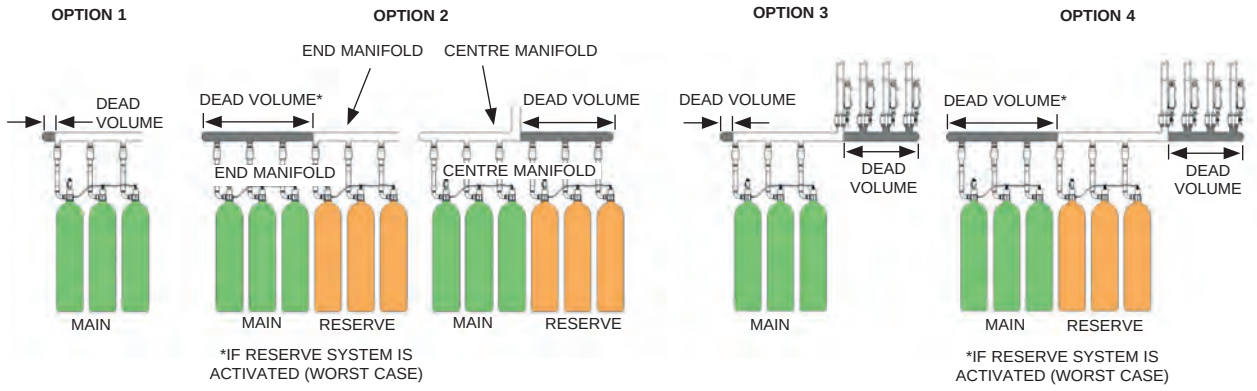


FIGURE 5-13
DEAD VOLUME AREAS
025731

SYSTEM DESIGN PROCEDURE (Continued)

STEP 7 Determine the Total System Agent Quantity Required

Add quantities from all areas to determine the minimum total agent quantity required for the entire system.

Complete this step for each area protected by the system.

Example:

Minimum Quantity Required:

79.18 kg + 7.79 kg + 23.07 kg = 110.04 kg
rounded up to **110.5 kg** of agent

(174.24 lb + 17.42 lb + 50.69 lb = 242.35 lb
rounded up to **243 lb** of agent)

Calculate the achieved concentration in the hazard by using the following equation:

$$C_{Resulting} = \frac{100 \times Q_{Discharged}}{\left(\frac{V}{0.0664 + 0.000274 \times T_{Max}} + Q_{Discharged} \right) \times C_{Alt}}$$

Where:

$C_{Resulting}$ = Achieve concentration [%]

$Q_{Discharged}$ = Stored agent quantity [kg]

V = Hazard volume [m^3]

T_{Max} = Maximum hazard temperature [ºC]

C_{Alt} = Altitude correction factor

The mass of agent added in STEP 4 to account for **dead space** volume may lead to a higher concentration in one or more of the protected areas. If the calculated concentration of agent exceeded the LOAEL or NOAEL level, refer to all applicable regulations and standards to address this situation as necessary.

STEP 8 Determine the Estimated Number of Containers Required

When the minimum quantity of agent has been calculated the weight is compared to the available agent container size. The container size must be equal to or greater than the weight of agent. See Section 2 - System Components, Tables 2-3 to Table 2-6 (Min./Max. Fills (Weight) column).

Note: When manifolding tanks, all tanks on the manifold must be the same size and fill weight.

With the appropriate container selected, the previous equation can be rearranged to determine the concentration based on the actual weight as containers are filled to the nearest kg.

$$C = \frac{100\ WS}{(WS + V)}$$

To calculate the required agent for each hazard volume as a percentage of the total agent required use the following equation:

$$\%\ Hazard\ Agent = \frac{Individual\ hazard\ volume}{Sum\ of\ hazard\ volumes}$$

Calculate the required agent for each hazard volume:

Example:

- Computer Room $= \frac{140.22\ m^3}{194.87\ m^3} = 71.96\%$

  $\frac{(4950\ ft^3)}{(6885\ ft^3)} = (71.90\%)$

- Subfloor $= \frac{13.79\ m^3}{194.87\ m^3} = 7.08\%$

  $\frac{(495\ ft^3)}{(6885\ ft^3)} = (7.19\%)$

- Switch Room $= \frac{40.86\ m^3}{194.87\ m^3} = 20.97\%$

  $\frac{(1440\ ft^3)}{(6885\ ft^3)} = (20.92\%)$

Note: The subfloor is less than 10% of the total volume. A separate container may be required because of hydraulic limitations.

SYSTEM DESIGN PROCEDURE (Continued)

STEP 8 Determine the Estimated Number of Containers Required (Continued)

Therefore:

- Computer Room = $\frac{140.22\ m^3}{181.08\ m^3}$ = 77.44%

  $\frac{(4950\ ft^3)}{(6390\ ft^3)}$ = (77.46%)

- Switch Room = $\frac{40.86\ m^3}{181.08\ m^3}$ = 22.56%

  $\frac{(1440\ ft^3)}{(6390\ ft^3)}$ = (22.54%)

- Subfloor = $\frac{13.79\ m^3}{13.79\ m^3}$ = 100%

  $\frac{(495\ ft^3)}{(495\ ft^3)}$ = (100%)

To determine the size and quantity of the containers required, add the hazard agent quantities together:

- Computer Room + Switch Room

  79.18 kg + 23.07 kg = 102.26 kg rounded up to 102.5 kg
  (174.24 lb + 50.69 lb = 224.93 lb rounded up to 225 lb)

- Subfloor

  7.79 kg rounded up to 8.0 kg
  (17.42 lb rounded up to 18.0 lb)

Final Quantity required after rounding up:

- Computer Room = 102.5 kg x 0.7744 = **79.38 kg**
  (225 lb x 0.7746 = **174.29 lb**)
- Switch Room = 102.5 kg x 0.2256 = **23.12 kg**
  (225 lb x 0.2254 = **50.72 lb**)
- Subfloor = 8.0 kg x 1.0 = **8.0 kg**
  (18 lb x 1.0 = **18 lb**)

It is estimated that a 120 L, 150 L, or 180 L (370 lb, 470 lb, or 560 lb) container may be used for the computer room and switch room and a 15 L (50 lb) container may be used for the subfloor.

Note: Actual container sizes and fill weights may change based upon the FM-200 system flow calculation program.

Complete this step for each area protected by the system.

STEP 9 Determine the Design Concentration at the Maximum Ambient Temperature for Each Area

This step determines the design concentration of agent in each protected area using the reduced volume. See STEP 3 and the supplied quantity of agent for the area at the maximum ambient temperature. It is necessary to avoid over-concentrating the area due to the additional agent actually supplied to the area and the increased volume of agent caused by increased temperature.

Example:

Maximum Ambient Temperature = 26.7 °C (80 °F)

The following calculation is used:

$$C = \frac{100W}{\frac{V}{S} + W}$$

Where:

W = Weight of agent used - kg (lb)

V = Volume of hazard - m^3 (ft^3)

S = Specific vapor volume in m^3/kg (ft^3/lb)

where S = 0.1269 + 0.0005131T m^3/kg

(where S = 1.885 + 0.0046T ft^3/lb)

T = Maximum ambient temperature - °C (°F)

C = Design agent concentration at maximum ambient temperature (T)

Then, C ÷ altitude correction factor
= design concentration at maximum temperature

SYSTEM DESIGN PROCEDURE (Continued)

STEP 9 Determine the Design Concentration at the Maximum Ambient Temperature for Each Area

Example:

• Computer Room

W = 79.38 kg (174.29 lb)

V = 140.22 m^3 (4950 ft^3)

$$C = \frac{100\ (79.38\ kg)}{\frac{140.22\ m^3}{0.14059977\ m^3/kg} + 79.38\ kg}$$

C= 7.37 where S = 0.1406

$$\left(C = \frac{100\ (174.29\ lb)}{\frac{4950\ ft^3}{2.253\ ft^3/lb} + 174.29\ lb} \right)$$

C = 7.35 where S = 2.253

Design concentration at maximum temperature
= 7.37% (7.35%) ÷ 1.00 (altitude correction factor)
= 7.37% (7.35%)

• Switch Room

W = 23.12 kg (50.72 lb)

V = 40.86 m^3 (1440 ft^3)

$$C = \frac{100\ (23.12\ kg)}{\frac{40.86\ m^3}{0.14059977\ m^3/kg} + 23.12\ kg}$$

C = 7.37 where S = 0.1406

$$\left(C = \frac{100\ (50.72\ lb)}{\frac{1440\ ft^3}{2.253\ ft^3/lb} + 50.72lb} \right)$$

C = 7.35 where S = 2.253

Design concentration at maximum temperature
= 7.37% (7.35%) ÷ 1.00 (altitude correction factor)
= 7.37% (7.35%)

• Subfloor

W = 8.00 kg (18.00 lb)

V = 13.79 m^3 (495 ft^3)

$$C = \frac{100\ (8.0\ kg)}{\frac{13.79\ m^3}{0.14059977\ m^3/kg} + 8.0\ kg}$$

C = 7.54 where s = 0.1406

$$\left(C = \frac{100\ (18.00\ lb)}{\frac{495\ ft^3}{2.253\ ft^3/lb} + 18.00\ lb} \right)$$

C = 7.57 where S = 2.253

Design concentration at maximum temperature
= 7.54% (7.57%) ÷ 1.00 (altitude correction factor)
= 7.54% (7.57%)

When completing this step, adhere to the following point:

• Verify that the actual agent concentration is within the design concentration range of 7.2% to 9.0%. It is important to verify that the worst case design concentration will not exceed limits for fire suppression on the low end and life safety on the high end.

Note: Normally occupied space is defined as one that is intended for occupancy by *NFPA 2001*. The appendix of *NFPA 2001* states that spaces occasionally visited by personnel, such as transformer bays, switch-houses, pump rooms, vaults, engine test stands, cable trays, tunnels, microwave relay stations, flammable liquid storage areas, and enclosed energy systems, are examples of areas considered not normally occupied.

Refer to *NFPA 2001* for detailed exposure conditions.

Complete this step for each area protected by the system.

Example:

The Computer Room example has a design concentration of 7.35%. This is between 7.2% to 9.0%. The system is therefore considered acceptable.

SYSTEM DESIGN PROCEDURE (Continued)

STEP 10 Determine the Nozzle Quantity

Nozzle quantity is determined by many factors, such as the size and shape of the hazard area, the ceiling height, the flow rates through the nozzles, and the available orifice sizes, for example.

The number of nozzles required is based on the hazard size and configuration, as well as the coverage provided by the nozzle. To determine the quantity of nozzles required, complete the following steps:

1. Divide the area by 95.3 m^2 (1026 ft^2) and round up to the next whole number. This whole number is the minimum number of nozzles required.
2. See page 5-5 to 5-8 for nozzle placement specifications.

Complete this step for each area protected by the system.

Example:

The maximum coverage area per nozzle is 167.2 m^2 (1800 ft^2). See Nozzle Selection and Location on page 5-5.

- Computer Room
  10.06 m x 4.57 m = 45.97 m^2
  45.97 m^2 ÷ 95.3 m^2 = **1 nozzle**
  (33 ft x 15 ft = 495 ft^2)
  (495 ft^2 ÷ 1026 ft^2 = **1 nozzle**)

- Switch Room
  3.66 m x 3.66 m = 13.40 m^2
  13.40 m^2 ÷ 95.3 m^2 = **1 nozzle**
  (12 ft x 12 ft = 144 ft^2)
  (144 ft^2 ÷ 1026 ft^2 = **1 nozzle**)

- Subfloor
  10.06 m x 4.97 m = 45.97 m^2
  45.97 m^2 ÷ 95.3 m^2 = **1 nozzle**
  (33 ft x 15 ft = 495 ft^2)
  (495 ft^2 ÷ 1026 ft^2 = **1 nozzle**)

One nozzle is required for each hazard area (Computer Room, Switch Room, and Subfloor).

STEP 11 Estimate the Agent Flow Rate for Each Area

This step estimates the total flow rate into each protected space, allowing the designer to estimate nozzle sizes for quotation purposes.

Note: This is an estimate only. It is the designer's responsibility to assess the correctness of this estimate. If the flow rate approaches the top end of the allowable flow rate for a given size pipe, it may be in the designer's best interest to increase the pipe size.

Complete this step for each area protected by the system.

Example:

- Computer Room
  79.38 kg ÷ 10 seconds = 7.94 kg/s
  (174.29 lb ÷ 10 seconds = 17.43 lb/s)
- Switch Room
  23.12 kg ÷ 10 seconds = 2.31 kg/s
  (50.72 lb ÷ 10 seconds = 5.07 lb/s)
- Subfloor
  8.0 kg ÷ 10 seconds = 0.80 kg/s
  (18.00 lb ÷ 10 seconds = 1.8 lb/s)

STEP 12 Estimate the Nozzle Flow Rates

If all of the nozzles within the hazard area have the same flow rate, complete the following step:

- Divide the Estimated Flow Rate for the Area (STEP 12) by the nozzle quantity (STEP 10).

If all of the nozzles within the hazard area will not have the same flow rate, complete the following steps:

1. Perform a percentage calculation using the volume protected by each nozzle divided by the total volume for the area.
2. Multiply the flow rate for the area (STEP 13) by the volume percent calculated previously to determine the flow rate for that nozzle.
3. Complete this procedure for each nozzle in the system.

Include all nozzles on all levels in this step if the design includes multiple levels of nozzles.

Complete this step for each area protected by the system.

Example:

- Computer Room
  7.94 kg/s ÷ 1 nozzle = 7.94 kg/s per nozzle
  (17.43 lb/s ÷ 1 nozzle = 17.43 lb/s per nozzle)
- Switch Room
  2.31 kg/s ÷ 1 nozzle = 2.31 kg/s per nozzle
  (5.07 lb/s ÷ 1 nozzle = 5.07 lb/s per nozzle)
- Subfloor
  0.80 kg/s ÷ 1 nozzle = 0.80 kg/s per nozzle
  (1.80 lb/s ÷ 1 nozzle = 1.80 lb/s per nozzle)

SYSTEM DESIGN PROCEDURE (Continued)

STEP 13 Determine the Nozzle Locations and Lay Out the Interconnecting Piping

To complete this part of the procedure, complete the following steps:

1. Locate each nozzle and the containers using a plan view drawing of the protected areas. Nozzles should be located at the top of the hazard area, aimed upwards or downwards. Nozzles in the subfloor can also be aimed upwards or downwards.
2. Connect the nozzles with the piping following the piping guidelines listed in Section 1 - Introduction and Section 6 - Installation.
3. Lay out the piping to the containers and the manifold after all of the nozzles are connected.

Complete this step for each area protected by the system.

STEP 14 Complete an Isometric Sketch of the Piping Layout (Optional)

To complete this part of the procedure, follow these steps:

1. Create an isometric sketch of the piping for use when inputting the information in the Johnson Controls FM-200 System Flow Calculation Program.
2. Identify all of the pipe lengths, after the sketch is complete.

Piping Node Points

A node point defines the start or end of a branch (segment) in the piping. A branch can consist of a run of pipe or another object such as a flex hose or check valve. Each node point is indicated on the isometric screen of the software by a circle.

Segment 1 (Node 1 to 2) always represents the container. This segment can never be changed. The pipe length is the siphon tube or valve length, which is also the elevation change for the vertical container. The total equivalent length is the calculated equivalent length of the siphon tube or valve assembly. The designer program numbers the rest of the pipe segments as they are entered.

Nozzles

The designer program assigns the nozzle indicators. Sequential placement is not required. The designer should use a numbering system to prevent confusion.

STEP 15 Estimate the Pipe Size for All Areas (Optional)

To complete this part of the procedure, complete the following steps:

1. Label all nozzle flow rates.
2. Working backwards from the nozzles, determine the flow rate for each section of pipe using the flow rate limitations and design/calculation limitations. The flow calculation program estimates pipe sizes automatically. Therefore, this step is optional. The designer may wish to use the pipe size estimation chart in Table 5-6 to estimate the nozzle pipe sizes for quotation purposes.

Note: This is an estimate only. It is the designer's responsibility to assess the correctness of this estimate. If the flow rate approaches the top end of the allowable flow rate for a given size, it may be in the designer's best interest to increase the pipe size.

Example:

- Computer Room

  7.94 kg/s per nozzle = 40 mm pipe
  (17.43 lb/s per nozzle = 1 1/2 in. pipe)

- Switch Room

  2.31 kg/s per nozzle = 25 mm pipe
  (5.07 lb/s per nozzle = 1 in. pipe)

- Subfloor

  0.80 kg/s per nozzle = 15 mm pipe
  (1.80 lb/s per nozzle = 1/2 in. pipe)

STEP 16 Perform Flow Calculations

With the information developed in STEP 15, run the computer program to determine the final pipe sizes and nozzle orifice sizes. The Johnson Controls Flow Calculation Program, either SDC (Suppression Design Center) or JENSEN HUGHES stand alone software version, are the only calculation methods used with Johnson Controls FM-200 Engineered Systems.

Complete this step for each area protected by the system.

STEP 17 Verify System Performance

Once a flow calculation has been completed, the designer must review all results to verify system performance. The Johnson Controls FM-200 *System Flow Calculation Flow Program* flags most errors and prevents a completed flow calculation until they have been corrected. However, this does not guarantee that the system's performance matches the designer's expectations. The designer must review the *System Acceptance* report to verify that the minimum design concentrations have been achieved in all hazard enclosures. Careful review is an important step in the design of any fire protection system, which must be completed before final approval of the system.

Review the revised worksheet to verify the following details:

- The agent concentration at the maximum temperature is within acceptable limits of up to 10% for occupied spaces.
- The agent quantity is above the minimum agent requirement for the individual hazard areas. See STEP 5.

Complete this step for each area protected by the system.

SYSTEM DESIGN PROCEDURE (Continued)

STEP 18 Complete Layout of the System

At this point, all final details of the system can be finalized.

STEP 19 Create an Estimated Bill of Materials

Create a list of all materials necessary to install the system.

Note: Actual container sizes and fill weights may change based upon the flow calculation program system calculations.

STEP 20 Create Installation Drawings

The final step in the design of an FM-200 system is the completion of installation drawings for submittal to the appropriate authority and customer. These drawings should include all details necessary for the installation of this system.

Sample Applications

Refer to the Johnson Controls flow calculation printout example in the appendix. A review of this example may answer some questions concerning the total design process.

SYSTEM DESIGN TABLES

The following table lists the altitude correction factors for FM-200 per *ISO 14520,* and *NFPA 2001*.

TABLE 5-9: AGENT ALTITUDE CORRECTION FACTORS

ISO 14520 / EN 15004		NFPA 2001	
Altitude (m)	**Factor**	**Altitude (ft)**	**Factor**
0	1.000	0	1.000
1000	0.885	1000	0.960
1500	0.830	2000	0.930
2000	0.785	3000	0.890
2500	0.735	4000	0.860
3000	0.690	5000	0.820
3500	0.650	6000	0.780
4000	0.610	7000	0.750
4500	0.565	8000	0.720
–	–	9000	0.690
–	–	10,000	0.660

Note: On systems between – 914 m and +914 m (– 2999 ft and + 2999 ft), using the altitude correction factor is optional.

SYSTEM DESIGN TABLES (Continued)

TABLE 5-10: FM-200 WEIGHT CALCULATIONS (METRIC)

Temp.	Specific Vapor Volume	Weight Requirements of Hazard Volume, W/V (kg/m^3) Design Concentration (% per volume)										
t (°C)[c]	s (m^3/kg)[d]	6.4	7	7.17	8	9	10	11	12	13	14	15
-10	0.1215	0.5615	0.6196	0.6357	0.7158	0.8142	0.9147	1.0174	1.1225	1.2301	1.3401	1.4527
-5	0.1241	0.5499	0.6064	0.6223	0.7005	0.7987	0.8951	0.9957	1.0985	1.2038	1.3114	1.4216
0	0.1268	0.5388	0.5936	0.6091	0.6858	0.7800	0.8763	0.9748	1.0755	1.1785	1.2839	1.3918
5	0.1294	0.5281	0.5816	0.5968	0.6719	0.7642	0.8586	0.9550	1.0537	1.1546	1.2579	1.3636
10	0.132	0.5179	0.5700	0.5851	0.6585	0.7490	0.8414	0.9360	1.0327	1.1316	1.2328	1.2264
15	0.1347	0.5080	0.5589	0.5734	0.6457	0.7344	0.8251	0.9178	1.0126	1.1096	1.2089	1.3105
20	0.1373	0.4985	0.5483	0.5625	0.6335	0.7205	0.8094	0.9004	0.9934	1.0886	1.1859	1.2856
25	0.1399	0.4894	0.5382	0.5520	0.6217	0.7071	0.7944	0.8837	0.9750	1.0684	1.164	1.2618
30	0.1425	0.4805	0.5284	0.5420	0.6104	0.6943	0.7800	0.8676	0.9573	1.0490	1.1428	1.2388
35	0.1450	0.4720	0.5190	0.5326	0.5996	0.6819	0.7661	0.8522	0.9402	1.0303	1.1224	1.2168
40	0.1476	0.4638	0.5099	0.5232	0.5891	0.6701	0.7528	0.8374	0.9230	1.0124	1.1029	1.1956
45	0.1502	0.4559	0.5012	0.5142	0.5790	0.6586	0.7399	0.8230	0.0908	0.9950	1.0840	1.1751
50	0.1570	0.4482	0.4929	0.4919	0.5694	0.6476	0.7276	0.8093	0.8929	0.9784	1.0660	1.1555
55	0.1553	0.4408	0.4847	0.4973	0.5600	0.6369	0.7156	0.7960	0.8782	0.9623	1.0484	1.1365

FM-200 Equation Calculations

The weight of agent required for a hazard area can also be calculated from the formula shown below;

W = (V/S) * (C/100-C)

W = Weight of agent required kg (lb)

V = Hazard volume m^3 (ft^3)

S = Specific Vapour Volume cu.m/kg (ft^3/lb)

where S = 0.1269 + 0.0005131 t (°C)

or (S= 1.885 + 0.0046 t °F)

t = Design Temperature in Hazard Area °C (°F)

C = Required FM-200 Design Conc. (% by volume) at Design Temperature (t).

SYSTEM DESIGN TABLES (Continued)

TABLE 5-11: FM-200 WEIGHT CALCULATIONS (IMPERIAL)

Temp.	Specific Vapor Volume	Weight Requirements of Hazard Volume, W/V (lb/ft^3) Design Concentration (% per volume)										
t (°F)[c]	s (ft^3/lb)[d]	6.4	7	7.17	8	9	10	11	12	13	14	15
10	1.9264	0.0354	0.0391	0.0401	0.0451	0.0513	0.0570	0.0642	0.0708	0.0776	0.0845	0.0916
20	1.9736	0.0346	0.0381	0.0391	0.0441	0.0501	0.0563	0.0626	0.0691	0.0757	0.0825	0.0894
30	2.0210	0.0338	0.0372	0.0382	0.0430	0.0489	0.0550	0.0612	0.0675	0.0739	0.0805	0.0873
40	2.0678	0.0330	0.0364	0.0373	0.0421	0.0478	0.0537	0.0598	0.0659	0.0723	0.0787	0.0853
50	2.1146	0.0323	0.0356	0.0365	0.0411	0.0468	0.0525	0.0584	0.0645	0.0707	0.0770	0.0835
60	2.1612	0.0316	0.0348	0.0357	0.0402	0.0458	0.0514	0.0572	0.0631	0.0691	0.0753	0.0817
70	2.2075	0.0310	0.0341	0.0349	0.0394	0.0448	0.0503	0.0560	0.0618	0.0677	0.0737	0.0799
80	2.2538	0.0303	0.0334	0.0342	0.0386	0.0439	0.0493	0.0548	0.0605	0.0663	0.0722	0.0783
90	2.2994	0.0297	0.0327	0.0335	0.0378	0.0430	0.0483	0.0538	0.0593	0.0650	0.0708	0.0767
100	2.3452	0.0292	0.0321	0.0329	0.0371	0.0422	0.0474	0.0527	0.0581	0.0637	0.0694	0.0752
110	2.3912	0.0286	0.0315	0.0323	0.0364	0.0414	0.0465	0.0517	0.0570	0.0625	0.0681	0.0738
120	2.4366	0.0281	0.0309	0.0316	0.0357	0.0406	0.0456	0.0507	0.0560	0.0613	0.0668	0.0724
130	2.4820	0.0275	0.0303	0.0311	0.0350	0.0398	0.0448	0.0498	0.0549	0.0602	0.0656	0.0711
140	2.5720	0.0270	0.0298	0.0306	0.0344	0.0391	0.0440	0.0489	0.0540	0.0591	0.0644	0.0698

FM-200 Equation Calculations

The weight of agent required for a hazard area can also be calculated from the formula shown below;

W = (V/S) * (C/100-C)

W = Weight of agent required kg (lb)

V = Hazard volume m^3 (ft^3)

S = Specific Vapour Volume cu.m/kg (ft^3/lb)

where S = 0.1269 + 0.0005131 t (°C)

or (S= 1.885 + 0.0046 t °F)

t = Design Temperature in Hazard Area °C (°F)

C = Required FM-200 Design Conc. (% by volume) at Design Temperature (t).

SYSTEM DESIGN TABLES (Continued)

TABLE 5-12: EQUIVALENT LENGTH FOR PIPE FITTINGS

Nominal Pipe Size		90° Elbow		45° Elbow		Thru Tee		Side Tee		Union	
mm	(in.)	m	(ft)	m	(ft)	m	(ft)	m	(ft)	m	(ft)
15	(1/2)	0.52	(1.6)	0.24	(0.7)	0.3	(0.9)	1.04	(3.2)	0.12	(0.4)
20	(3/4)	0.67	(2.0)	0.3	(0.9)	0.42	(1.3)	1.37	(4.2)	0.15	(0.5)
25	(1)	0.85	(2.6)	0.4	(1.2)	0.55	(1.7)	1.74	(5.3)	0.18	(0.6)
32	(1 1/4)	1.13	(3.4)	0.52	(1.6)	0.7	(2.1)	2.29	(7.0)	0.24	(0.7)
40	(1 1/2)	1.31	(4.0)	0.61	(1.7)	0.82	(2.5)	2.65	(8.0)	0.27	(0.8)
50	(2)	1.68	(5.1)	0.79	(2.4)	1.06	(3.2)	3.41	(10.4)	0.37	(1.1)
65	(2 1/2)	2.01	(6.1)	0.94	(1.5)	1.25	(3.8)	4.08	(12.4)	0.43	(1.3)
80	(3)	2.5	(7.6)	1.16	(3.5)	1.55	(4.7)	5.06	(15.4)	0.55	(1.7)
100	(4)	3.26	(10.0)	1.52	(4.6)	2.01	(6.1)	6.64	(20.2)	0.73	(2.2)
125	(5)	4.08	(12.4)	1.92	(5.9)	2.56	(7.8)	8.35	(25.5)	0.91	(2.8)
150	(6)	4.94	(15.0)	2.32	(7.1)	3.08	(9.4)	10.00	(30.5)	1.07	(3.3)

Note: Figures are based upon Schedule 40 ASTM A 106-77 pipe.

TABLE 5-13: EQUIVALENT LENGTH FOR OTHER SYSTEM COMPONENTS - SCHEDULE 40

Component	Part No.	Size mm (in)	Equivalent Length m (ft)
Valve	302.209.001	25 (1)	6.096 (20.0)
	302.209.002	50 (2)	10.688 (35.0)
	445977 / 302.205.002	80 (3)	25.91 (85.0)
Flexible Discharge Hose	306.207.002	25 (1)	3.14 (10.3)
	306.207.003	50 (2)	5.36 (17.6)
Discharge Hose	306.205.005 (69990)	80 (3)	2.7 (8.8)
Check Valve	302.209.004	25 (1)	0.40 (1.3)
	302.209.005	50 (2)	6.66 (21.8)
Check Valve and Adaptor Assembly	452162	80 (3)	13.15 (43.143)
Flex Hose and Check Valve Assembly	-	25 (1)	3.54 (11.6)
	-	50 (2)	12.02 (39.4)
	306.205.006 (69841)	80 (3)	15.85 (52)
Adjustable height adaptor	306700003	25 (1)	0.44 (1.44)
	306700003	50 (2)	0.96 (3.15)
Valve Union Adaptor	309002016	25 (1)	1.27 (4.17)
	309002017	50 (2)	1.45 (4.76)
	309002018	25 (1)	1.27 (4.17)
	309002019	50 (2)	1.45 (4.76)
Valve Outlet Adaptor	309.002.014 (69470)	80 (3) Flared to NPT	0.55 (1.8)
	309.002.015 (69471)	80 (3) Flared to Grooved	0.55 (1.8)
	309.002.013 (570363)	80 (3) Flared to BSP	0.55 (1.8)

Figures are based on Schedule 40 ASTM A 106-77 pipe. Table 5-12 lists the nominal pipe size.

SYSTEM DESIGN TABLES (Continued)

TABLE 5-14: EQUIVALENT LENGTH FOR OTHER SYSTEM COMPONENTS - SCHEDULE 80

Component	Part No.	Size mm (in)	Equivalent Length m (ft)
Valve	302.209.001	25 (1)	3.9 (12.81)
	302.209.002	50 (2)	7.81 (25.64)
Flexible Discharge Hose	306.207.002	25 (1)	2.44 (8.0)
	306.207.003	50 (2)	3.34 (10.97)
Adjustable Height Adaptor	306700003	25 (1)	0.28 (0.92)
	306700003	50 (2)	0.71 (2.32)
Check Valve	302.209.004	25 (1)	0.26 (0.84)
	302.209.005	50 (2)	4.88 (16.01)
Valve Union Adaptor	309002016	25 (1)	0.81 (2.66)
	309002017	50 (2)	1.06 (3.48)
	309002018	25 (1)	0.81 (2.66)
	309002019	50 (2)	1.06 (3.48)

DATE: _____

QUOTE/JOB NUMBER: _____

CUSTOMER: _____

FM-200 SYSTEM
DESIGN CALCULATION WORKSHEET

Page 1 of 2

VOLUME CALCULATIONS:	AREA 1	AREA 2	AREA 3	AREA 4	AREA 5
Area Name:					
Length (ft):					
Width (ft):					
Height (ft):					
Area (ft^2):					
Volume (ft^3):					
Gross Volume (ft^3):					

Volume Reductions:

Structural Reductions (ft^3):	
Net Volume:	
(Volume – Structural Reductions)	

ROOM MINIMUM AMBIENT TEMPERATURE:					
DESIGN CONCENTRATION:					
FLOODING FACTOR:					
(From Table)					

INITIAL AGENT QUANTITY CALC.:					
Quantity (lb):					

(Total Reduced Volume x Flooding Factor) or (Formula from Design Manual)

ALTITUDE CORRECTION:

Height Above or Below Sea Level:	
Factor:	
(From Design Manual Table)	

ACTUAL AGENT QUANTITY (lb):					

(Initial Agent Quantity x Altitude Correction Factor)

TOTAL AGENT QTY. (lb):
(Sum of all Actual Agent quantities) | |

FM-200 SYSTEM
DESIGN CALCULATION WORKSHEET

DATE: _____

QUOTE/JOB NUMBER: _____

CUSTOMER: _____

TOTAL AGENT QTY. (lb):
(From Page 1)

	AREA 1	AREA 2	AREA 3	AREA 4	AREA 5
Area Name:					
ACTUAL AGENT PER AREA:					
ACTUAL AGENT FLOODING FACTOR:					

[(Actual Agent Qty. ÷ Total Agent Qty.) x Agent Supplied]

[(Actual Agent per Area ÷ Alt. Correction Factor) ÷ Total Reduced Volume]

CONCENTRATION RANGE CHECK:
(Design Conc. Must be Between 6.7% to 10.5% For Occupied Spaces)

Room Maximum Ambient Temperature:					
Design Concentration at Maximum Temperature:					

(Locate Actual Agent Conc. at Maximum Temperature on Table, or Use Calc. in Design Manual)

DISCHARGE TIME:					
Normal Ambient Temperature:					
Design Concentration at Ambient Temperature:					

(Locate Actual Agent Conc. at Ambient Temperature on Table, or Use Calc. in Design Manual)

Nozzle Quantity:					

[area ÷ 1026 (rounded to next highest wole number) then verify maximum radial distance]

Estimated Nozzle Pipe Size:					
Pipe Size:					

(Refer to Pipe Sizing Chart)

NOTES:

GENERAL INFORMATION

All installations shall be performed by an Authorized HYGOOD Distributor in accordance with the parameters of this manual and all appropriate codes and standards from Authorities Having Jurisdiction.

Specific installation drawings must be prepared for the hazard area in accordance with the system design as calculated by the FM-200 *System Flow Calculation Program*. Follow these drawings closely to ensure the system meets its design criteria. The pipe network is sized to obtain the correct discharge time, nozzle pressures, agent quantity, and various other design considerations. If, for any reason, the pipe network requires modifications, recalculate the system before proceeding with the installation. Installation drawings contain the following information:

- Enclosure volumes
- Agent quantities
- Scaled pipe network plan
- Pipe network isometric
- Pipe diameters, pipe length drops, and rises
- Nozzle data
- Container data
- Electrical actuator technical data
- Low pressure switch wiring chart
- Fittings data
- Reflective ceiling plan

The FM-200 system components are designed and tested to operate in the temperature ranges listed in this manual, or as stated in separate component approvals. Installation drawings shall be submitted for approval to the appropriate authority prior to system installation. On receipt, unpack the supplied items and ensure the components comply with the packing list and installation drawings.

The container weight is checked at the factory prior to shipment and recorded on the label attached to the container. If there is any doubt regarding the weight, or a leakage is suspected, the container should be weighed to confirm no weight loss. Determine the container storage temperature and refer to the Temperature Correction Table in Section 8 - Recharging, to check the pressure within the container.

INSTALLATION OVERVIEW

- Container bank (container and manifold)
- Distribution piping
- Nozzles
- Actuation components
- Detection and control systems
- Ancillary equipment
- Accessories
- Final connections

GROUNDING AND ELECTRICAL CLEARANCE

Systems within electrical substations or switch rooms shall be efficiently grounded to prevent the metalwork from becoming electrically charged. Adequate grounding of systems minimizes the risk of electrostatic discharge.

All system components shall be located to maintain no less than minimum clearances from energized electrical parts (see Table 6-1). The following references shall be considered as the minimum electrical clearance requirements for the installation of clean agent systems:

- *ANSI C2*
- *NFPA 70*
- *29 CFR 1910, Subpart S*

Where the design basic insulation level (BIL) is not available, and where nominal voltage is used for the design criteria, the highest minimum clearance listed for this group shall be used. Reference *NFPA 2001* and the following table.

TABLE 6-1: SAFETY CLEARANCES

Maximum Rated Voltage - kV	Minimum Section Clearance		Minimum Ground Clearance	
	m	(ft)	m	(ft)
15	2.60	(8.5)	-	-
33	2.75	(9.0)	-	-
44	2.90	(9.5)	-	-
66	3.05	(10.0)	-	-
88	3.21	(10.5)	2.44	(8.0)
110	3.35	(11.0)	2.44	(8.0)
132	3.51	(11.5)	2.44	(8.0)
165	3.81	(12.5)	2.44	(8.0)
220	4.27	(14.0)	2.44	(8.0)
275	4.35	(15.9)	2.44	(8.0)

INSTALLING FM-200 CONTAINER VALVES

The discharge valve is supplied factory fitted to the container. Before connecting to the pipe work or discharge hose, ensure the container is secured with the appropriate container brackets. When connecting container valves to the pipe network, install a 25 mm (1 in.), 50 mm (2 in.), or 80 mm (3 in.) valve union adaptor and tighten securely.

When connecting container valves to a discharge hose, directly install the hose to the outlet and tighten securely.

INSTALLING A SINGLE CONTAINER

When installing a single container, see Table 6-2 and complete the following steps:

1. Mount the back channels of the container brackets to the wall at the appropriate heights using suitable hardware. This hardware is not supplied. See Table 6-2 for bracket mounting height details.
2. Position the container against the back channel with the valve outlet pointing left.
3. Insert the container bracket strap and secure with the bolts provided. See Figure 6-3.
4. Remove the outlet safety cap from the valve outlet. See Figure 6-1.
5. With the outlet safety cap removed from the valve outlet, install a valve union adaptor or a flexible discharge hose. See Figure 6-2.

⚠ CAUTION

Do not over tighten the container connection. Excessive tightening may damage the valve outlet thread and adversely affect system operation.

6. Install the initial pipe run and then disconnect the container.
7. Refit the outlet safety cap to the valve outlet. See Section 6 - Installation, Installing the Pipework, page 6-9.
8. Reconnect the pipe to the container after completing the pipework system and the discharge nozzles are installed.

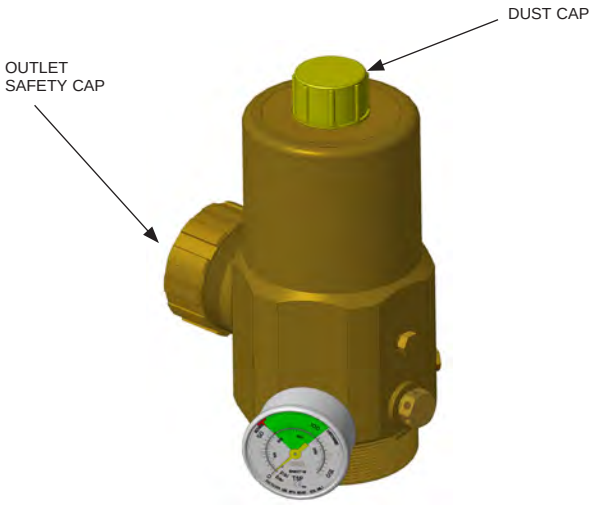


FIGURE 6-1
OUTLET SAFETY AND DUST CAPS
025516

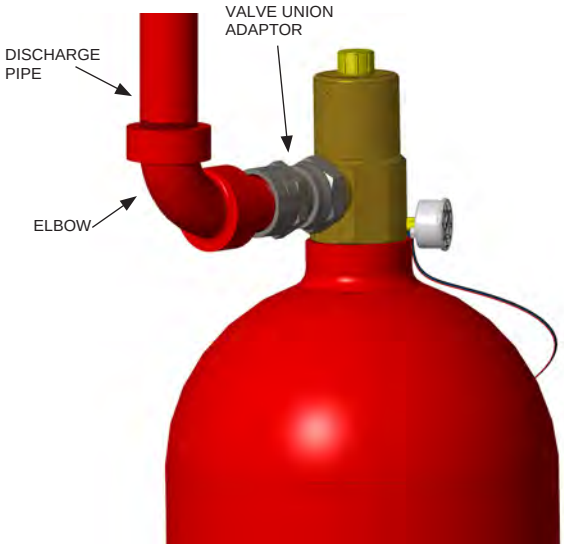


FIGURE 6-2
DISCHARGE OUTLET CONNECTIONS
025529

INSTALLING A SINGLE CONTAINER (Continued)

TABLE 6-2: BRACKET MOUNTING HEIGHTS

Container Size	Dia.	Number of Back Channels	Height from Floor to Bracket (A)	Height from Floor to Bracket (B)
L	mm (in.)		mm (in.)	mm (in.)
Seamless containers				
15	204 (8.0)	2	130 (5.1)	450 (17.7)
30	229 (9.0)	2	300 (11.8)	710 (28.0)
45	267 (10.5)	2	300 (11.8)	820 (32.3)
60	267 (10.5)	2	300 (11.8)	1130 (44.5)
120	360 (14.2)	2	300 (11.8)	1190 (46.9)
150	360 (14.2)	2	300 (11.8)	1530 (60.2)
180	406 (16.0)	2	300 (11.8)	1370 (53.9)
PESO seamless containers				
34	267 (10.5)	2	160 (6.3)	600 (23.6)
80	267 (10.5)	2	400 (15.7)	1510 (59.4)
120	356 (14.0)	2	400 (15.7)	1315 (51.8)
140	406 (16.0)	2	400 (15.7)	1155 (45.5)
180	406 (16.0)	2	400 (15.7)	1500 (59.1)
DOT welded containers				
4.5	178 (7)	1	–	170 (6.7)
8	254 (10)	1	100 (3.9)	–
16	254 (10)	2	150 (6.0)	320 (12.6)
32	254 (10)	2	170 (6.7)	620 (24.4)
52	406 (16)	2	190 (7.5)	380 (15.0)
106	406 (16)	2	260 (10.2)	740 (29.1)
147	406 (16)	2	260 (10.2)	1070 (42.1)
180	406 (16)	2	260 (10.2)	1350 (53.1)
343	610 (24)	2	310 (12.2)	1100 (43.3)

Note: Each container requires two sets of brackets with the exception of the 4.5 L and 8 L containers which only require one set. The height (B) of the upper bracket is positioned a nominal 90 mm (3.5 in.) below the start of the curved section of the container.

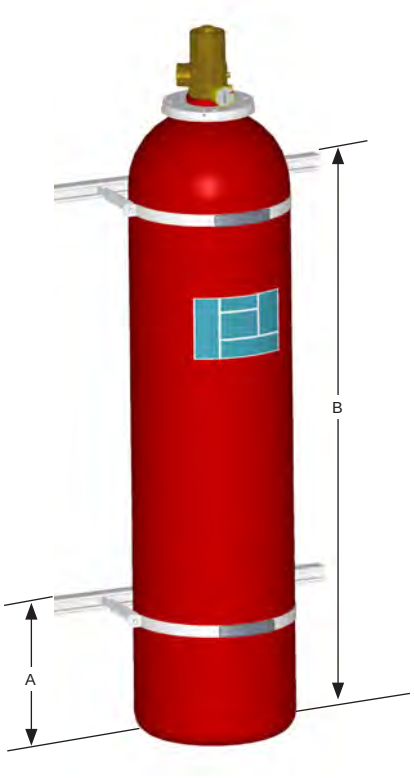


FIGURE 6-3
CONTAINER STRAP LOCATION
025512

INSTALLING MANIFOLDS

NOTICE

For some markets (Europe, Middle East, Africa, and Asia), factory manufactured manifolds are available. Refer to the local price list for availability. Where manifolds are supplied by third parties, the information supplied within this section is to assist the design and installation process.

Manifolds can either be assembled from threaded pipe and fittings or be of welded construction. The manifolds enable multiple containers to connect to a common pipe network. Manifolds may also be used in systems where Main / Reserve container arrangements are required. For further details, see Table 6-3.

CAUTION

- Do not use elbows for the installation of 25 mm (1 in.) and 50 mm (2 in.) check valves. The check valve may not fully open.
- Do not allow tape to overlap the pipe opening, as this could cause a possible blockage of the agent.
- Do not use thread sealant or compound.
- Before assembling the pipe and fittings, make certain all ends are carefully reamed and blown clear of chips, debris and scale. The inside of pipe and fittings must be free of oil and dirt.

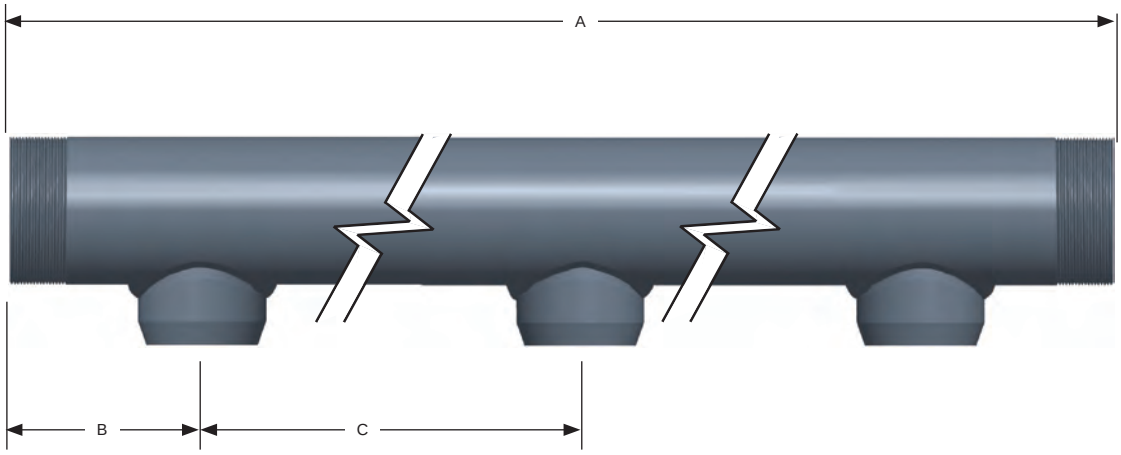


FIGURE 6-4
TYPICAL THREADED MANIFOLD ASSEMBLY
009712

Note: See the following table for further details.

INSTALLING MANIFOLDS (Continued)

TABLE 6-3: MANIFOLD CONSTRUCTION DETAILS

Part No.	No. of Inlets	Overall Length (A) mm (in.)	Inlet to End Connection Distance (B) mm (in.)	Inlet to Inlet Distance (C) mm (in.)
307.209.001	2	640 (25.2)	145 (5.7)	350 (13.8)
307.209.002	3	990 (39.0)	145 (5.7)	350 (13.8)
307.209.003	4	1340 (52.8)	145 (5.7)	350 (13.8)
307700004	2	932 (36.7)	216 (8.5)	500 (20)
307700005	3	1432 (56.4)	216 (8.5)	500 (20)
307700006	4	1932 (76.0)	216 (8.5)	500 (20)
307700007	5	2432 (95.7)	216 (8.5)	500 (20)
307700008	6	2932 (115.4)	216 (8.5)	500 (20)
307700009	2	932 (36.7)	216 (8.5)	500 (20)
307700010	3	1432 (56.4)	216 (8.5)	500 (20)
307700011	4	1932 (76.0)	216 (8.5)	500 (20)
307700012	5	2432 (95.7)	216 (8.5)	500 (20)
307700013	6	2932 (115.4)	216 (8.5)	500 (20)
307209050	3	1400 (55.1)	200 (7.9)	500 (20)
307209051	4	1900 (74.8)	200 (7.9)	500 (20)
307209052	5	2400 (94.5)	200 (7.9)	500 (20)
307209053	6	2900 (114.2)	200 (7.9)	500 (20)
307209054	7	3400 (133.9)	200 (7.9)	500 (20)
307209055	8	3900 (153.5)	200 (7.9)	500 (20)
307209056	9	4400 (173.2)	200 (7.9)	500 (20)
307209057	10	4900 (192.9)	200 (7.9)	500 (20)
307.209.035	2	1011 (39.8)	150 (6)	711 (27.6)
307.209.036	3	1722 (67.8)	150 (6)	711 (27.6)
307.209.037	4	2433 (95.8)	150 (6)	711 (27.6)
307.209.041	2	1111 (43.7)	200 (7.9)	711 (27.6)
307.209.042	3	1822 (71.7)	200 (7.9)	711 (27.6)
307.209.043	4	2533 (99.7)	200 (7.9)	711 (27.6)
307.209.044	5	3244 (127.7)	200 (7.9)	711 (27.6)
307.209.045	6	3955 (155.7)	200 (7.9)	711 (27.6)
307.209.046	7	4666 (183.7)	200 (7.9)	711 (27.6)
307.209.047	8	5377 (211.7)	200 (7.9)	711 (27.6)
307.209.048	9	6088 (239.7)	200 (7.9)	711 (27.6)
307.209.049	10	6799 (267.7)	200 (7.9)	711 (27.6)

Note: See the following table for further details.

INSTALLING MANIFOLDS (Continued)

TABLE 6-4: MANIFOLD ASSEMBLY DETAILS

Part No.	No. of Inlets	End Thread Connection	Nominal Manifold Pipe Size mm (in.)	Inlet to End Cap Distance mm (in.)	Inlet to Inlet Distance mm (in.)	Inlet to End Connection Distance mm (in.)	Container Size L	Overall Length mm (in.)	Weight kg (lb)
307.209.001	2	2 1/2 in. NPT	65 (2.5)	145 (5.7)	350 (13.8)	145 (5.7)	15 to 45 and 4.5 to 32	640 (25.2)	8.06 (17.8)
307.209.002	3	2 1/2 in. NPT	65 (2.5)	145 (5.7)	350 (13.8)	145 (5.7)		990 (39.0)	12.44 (27.4)
307.209.003	4	2 1/2 in. NPT	65 (2.5)	145 (5.7)	350 (13.8)	145 (5.7)		1340 (52.8)	19.79 (43.6)
307700004	2	3 in. NPT	80 (3)	216 (8.5)	500 (20)	216 (8.5)	60 to 180 and 52 to 180	932 (36.7)	12.57 (27.7)
307700005	3	3 in. NPT	80 (3)	216 (8.5)	500 (20)	216 (8.5)		1432 (56.4)	19.20 (42.3)
307700006	4	3 in. NPT	80 (3)	216 (8.5)	500 (20)	216 (8.5)		1932 (76.0)	25.84 (57.0)
307700007	5	3 in. NPT	80 (3)	216 (8.5)	500 (20)	216 (8.5)		2432 (95.7)	32.47 (71.6)
307700008	6	3 in. NPT	80 (3)	216 (8.5)	500 (20)	216 (8.5)		2932 (115.4)	39.10 (86.2)
307700009	2	4 in. NPT	100 (4)	216 (8.5)	500 (20)	216 (8.5)	60 to 180 and 52 to 180	932 (36.7)	21.85 (48.2)
307700010	3	4 in. NPT	100 (4)	216 (8.5)	500 (20)	216 (8.5)		1432 (56.4)	33.55 (74.0)
307700011	4	4 in. NPT	100 (4)	216 (8.5)	500 (20)	216 (8.5)		1932 (76.0)	45.24 (99.7)
307700012	5	4 in. NPT	100 (4)	216 (8.5)	500 (20)	216 (8.5)		2432 (95.7)	56.93 (125.5)
307700013	6	4 in. NPT	100 (4)	216 (8.5)	500 (20)	216 (8.5)		2932 (115.4)	68.62 (151.3)
307209050	3	6 in. Flange	150 (6)	200 (7.9)	500 (20)	200 (7.9)	52 to 180	1400 (55.1)	85.0 (187.4)
307209051	4	6 in. Flange	150 (6)	200 (7.9)	500 (20)	200 (7.9)		1900 (74.8)	136.8 (301.6)
307209052	5	6 in. Flange	150 (6)	200 (7.9)	500 (20)	200 (7.9)		2400 (94.5)	160.4 (353.6)
307209053	6	6 in. Flange	150 (6)	200 (7.9)	500 (20)	200 (7.9)		2900 (114.2)	184.0 (405.7)
307209054	7	6 in. Flange	150 (6)	200 (7.9)	500 (20)	200 (7.9)		3400 (133.9)	207.5 (457.5)
307209055	8	6 in. Flange	150 (6)	200 (7.9)	500 (20)	200 (7.9)		3900 (153.5)	231.1 (509.5)
307209056	9	6 in. Flange	150 (6)	200 (7.9)	500 (20)	200 (7.9)		4400 (173.2)	282.9 (623.7)
307209057	10	6 in. Flange	150 (6)	200 (7.9)	500 (20)	200 (7.9)		4900 (192.9)	278.3 (613.5)
307.209.035	2	4 in. NPT	100 (4)	150 (6)	711 (27.6)	150 (6)	343	1011 (39.8)	26.9 (59.3)
307.209.036	3	4 in. NPT	100 (4)	150 (6)	711 (27.6)	150 (6)		1722 (67.8)	45.0 (99.2)
307.209.037	4	4 in. NPT	100 (4)	150 (6)	711 (27.6)	150 (6)		2433 (95.8)	63.1 (139.1)
307.209.041	2	6 in. Flange	150 (6)	150 (6)	711 (27.6)	200 (7.9)		1111 (43.7)	66.2 (145.9)
307.209.042	3	6 in. Flange	150 (6)	150 (6)	711 (27.6)	200 (7.9)		1822 (71.7)	98.9 (218.0)
307.209.043	4	6 in. Flange	150 (6)	150 (6)	711 (27.6)	200 (7.9)		2533 (99.7)	159.0 (350.5)
307.209.044	5	6 in. Flange	150 (6)	150 (6)	711 (27.6)	200 (7.9)		3244 (127.7)	191.7 (422.6)
307.209.045	6	6 in. Flange	150 (6)	150 (6)	711 (27.6)	200 (7.9)		3955 (155.7)	224.4 (494.7)
307.209.046	7	6 in. Flange	150 (6)	150 (6)	711 (27.6)	200 (7.9)		4666 (183.7)	256.2 (564.8)
307.209.047	8	6 in. Flange	150 (6)	150 (6)	711 (27.6)	200 (7.9)		5377 (211.7)	288.9 (636.9)
307.209.048	9	6 in. Flange	150 (6)	150 (6)	711 (27.6)	200 (7.9)		6088 (239.7)	349.8 (771.2)
307.209.049	10	6 in. Flange	150 (6)	150 (6)	711 (27.6)	200 (7.9)		6799 (267.7)	353.5 (779.3)

INSTALLING MULTIPLE CONTAINERS

1. Mount the back channels of the container brackets to the wall at the appropriate heights, using suitable hardware. The hardware is not supplied. For further information, see Table 6-2, page 6-3.
2. Position the containers against the back channels with the pressure gauge facing forward at the required spacing for the manifold ports.
3. Insert the container bracket and secure it with the bolts provided. See Figure 6-3, page 6-3.

INSTALLING THE MANIFOLD BRACKETS

A typical manifold assembly consists of the manifold. Check valves and end caps must be installed separately.

Where manifold brackets (Part No. 311.205.015, 311.205.010, 311.205.011 and 311700001) are utilized, ensure that the appropriate height adjustment is available on the back channels. See Figure 6-5.

To install the manifold bracket, complete the following steps:

1. Mount the two back vertical channels to the wall at the appropriate height using suitable hardware. See Table 6-2, page 6-3.
2. Locate and secure the cantilever brackets to each channel using M10 x 40 mm (3/8 UNC x 1 1/2 in.) hex head screw and UNISTRUT long spring 10 mm (3/8 in.). Adjust the cantilever height as required and secure in position.
3. Position the manifold on the cantilever brackets.
4. Locate the manifold brackets in the cantilever channel around the manifold and secure with bolts. Fit UNISTRUT end caps.
5. Install the manifold check valves using PTFE tape as the sealing method and tighten securely.
6. Where required, fit the adjustable height adaptor using PTFE tape as the sealing method and tighten securely.

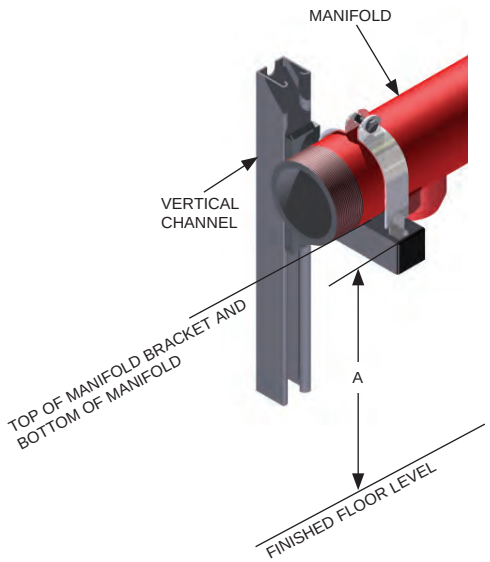


FIGURE 6-5
MANIFOLD ASSEMBLY
009714

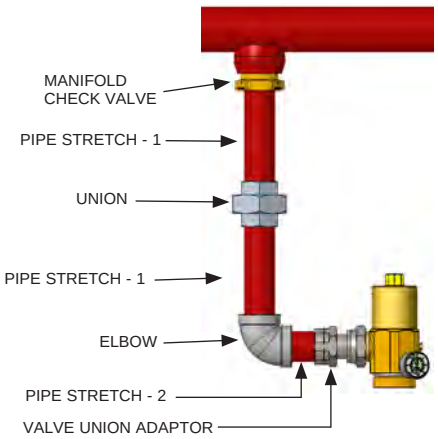
7a. Discharge hose connection from the valve to the manifold:

Remove the container valve outlet safety cap. Attach the discharge hose between the valve outlet and the adjustable height adaptor or manifold check valve. Where the adjustable height adaptor is utilized, adjust each adjustable height adaptor to allow for a variation in the container height.

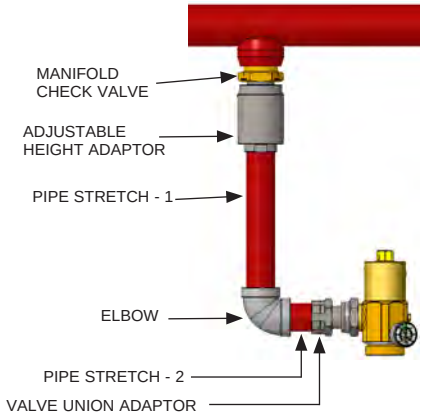
7b. Hardpipe connection from the valve to the manifold:

Remove the container valve outlet safety cap. Install hardpipe sections between the valve outlet through the valve union adaptor used on the 25 mm (1 in.) and 50 mm (2 in.) valve, or flared adaptor used on the 80 mm (3 in.) valve, and a 90° elbow to the adjustable height adaptor (if utilized) or manifold check valve ensuring correct vertical height alignment with the valve outlet.

For 1 in. or 2 in. manifold check valve installations, if an adjustable height adaptor is **not** utilized, install a union adaptor on the vertical pipe section between the elbow and check valve to allow radial adjustment to achieve correct alignment with the valve outlet. Where the adjustable height adaptor **is** utilized, fix each adjustable height adaptor to allow for a variation in the container height. Refer to the approximate pipe stretch length from Table 6-5. Refer to Figure 6-6 for 1 in. and 2 in. manifold check valve installations, hard pipe options with or without the AHA.



TYPICAL DISCHARGE OUTLET CONNECTION 1 in. OR 2 in. – HARD PIPE OPTION WITHOUT ADJUSTABLE HEIGHT ADAPTOR



TYPICAL DISCHARGE OUTLET CONNECTION 1 in. OR 2 in. – HARD PIPE OPTION WITH ADJUSTABLE HEIGHT ADAPTOR

FIGURE 6-6
1 in. AND 2 in. MANIFOLD CHECK VALVE INSTALLATIONS - HARD PIPE OPTIONS
E001518 / E001519

7b. Connecting the hardpipe from the valve to the manifold. (Continued)

TABLE 6-5: PIPE STRETCH LENGTH DETAILS FOR INSTALLATION AND DESIGN CALCULATION

Matched to corresponding discharge hose length for 25 mm (1 in.): 405 mm (15.94 in.) and 50 mm (2 in.): 520 mm (20.47 in.).

	Valve Size	Pipe Stretch-1	Pipe Stretch-2	Total Pipe Length
	mm (in.)	mm (in.)	mm (in.)	mm (in.)
1 in. or 2 in. hard pipe option without adjustable height adaptor (AHA)	25 (1)	2nos x 178.6 (7)	76.2 (3)	433.3 (17.1)
	50 (2)	2nos x 216.1 (8.5)	82.6 (3.25)	514.7 (20.3)
1 in. or 2 in. hard pipe option with adjustable height adaptor (AHA)	25 (1)	246.3 (9.7)	76.2 (3)	322.5 (12.7)
	50 (2)	326.9 (12.9)	82.6 (3.25)	409.5 (16.1)

For 3 in. manifold check valve installations, install a union adaptor between the 3 in. check valve and vertical pipe. The radial adjustment and height adjustment are inbuilt within the 3 in. check valve and adaptor assembly. For the 3 in. check valve, an approximate pipe length of 318 mm (12.5 in.) shall be considered for the installation and design calculation.

Refer to Figure 6-7 for 3 in. discharge check valve installation with hard pipe option with a union adaptor and 3 in. flared adaptor (threaded):

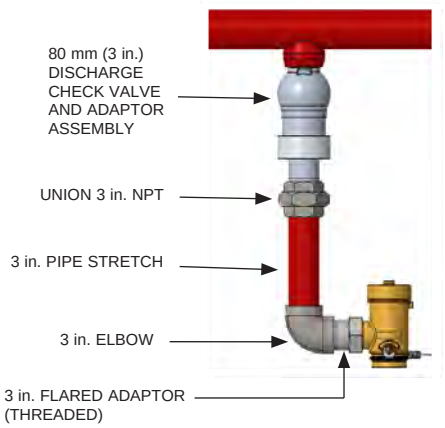


FIGURE 6-7
3 IN. DISCHARGE CHECK VALVE INSTALLATION WITH HARD PIPE OPTIONS WITH UNION ADAPTOR AND 3 IN. FLARED ADAPTOR (THREADED)
E001515

8. For safety, remove the discharge hose and replace the outlet safety caps while the pipe network is installed.

When installing manifold brackets with an adjustable height adaptor (AHA), see the following table for mounting heights.

INSTALLING THE MANIFOLD BRACKETS (Continued)

TABLE 6-6: MANIFOLD BRACKET MOUNTING HEIGHTS

Container Type	Nominal Volume (L)	Manifold Bracket Height without AHA mm (in.)	Manifold Bracket Height with AHA mm (in.)
Seamless containers			
TPED	15	1151 (45.3)	1308 (51.5)
TPED	30	1466 (57.7)	1623 (63.9)
TPED	45	1566 (61.7)	1723 (67.8)
TPED	60	2008 (79.1)	2180 (85.8)
TPED	120	2123 (83.6)	2295 (90.4)
TPED	150	2473 (97.4)	2645 (104.1)
TPED	180	2323 (91.5)	2495 (98.2)
DOT/TPED	15	1151 (45.3)	1308 (51.5)
DOT/TPED	30	1466 (57.7)	1623 (63.9)
DOT/TPED	45	1566 (61.7)	1723 (67.8)
DOT/TPED	60	2008 (79.1)	2180 (85.8)
DOT/TPED	120	2123 (83.6)	2295 (90.4)
DOT/TPED	150	2473 (97.4)	2645 (104.1)
DOT/TPED	180	2323 (91.5)	2495 (98.2)
PESO	34	1321 (52.0)	1478 (58.2)
PESO	80	2372 (93.4)	2544 (100.2)
PESO	120	1897 (74.7)	2069 (81.5)
PESO	140	2072 (81.6)	2244 (88.3)
PESO	180	2417 (95.2)	2589 (101.9)
Welded containers			
DOT	4.5	727 (28.6)	884 (34.8)
DOT	8	750 (29.5)	907 (35.7)
DOT	16	949 (37.4)	1106 (43.5)
DOT	32	1289 (50.7)	1446 (56.9)
DOT	52	1133 (44.6)	1305 (51.4)
DOT	106	1601 (63.0)	1773 (69.8)
DOT	147	1931 (76.0)	2103 (82.8)
DOT	180	2210 (87.0)	2382 (93.8)
DOT	343	2274 (89.5)	–

Note: For some markets (Europe, Middle East, Africa, and Asia), manifold bracket assemblies are available. Refer to the local price list for availability.

INSTALLING THE PIPEWORK

Install the pipework to the installation drawings provided, and follow these points:

- The installation should begin at the valve union adaptor, flexible discharge hose, or manifold union adaptor and progress along to the discharge nozzles.
- The piping material must comply with *FIA Guidance - Pipe Work for Gaseous Fixed Fire Fighting Systems* or *FSSA Pipe Design Handbook - 2nd edition - PDH-01,* or *NFPA 2001.*

CAUTION

- Do not allow tape to overlap the pipe opening. This could cause the agent to block.
- Before assembling the pipe and fittings, ensure all ends are carefully reamed and blown clear of chips, debris, and scale. The inside of pipe and fittings must be free of oil and dirt
- Thread sealant or compound must not be used.

General Piping Requirements (including Manifolds)

When installing the distribution piping, follow these points:

- Use the pipe type as specified in the hydraulic flow calculation report. Fittings must be a minimum of class 300, in accordance with the working pressure.
- Pipe unions are acceptable.
- Reducing bushings and reducing fittings are allowed when reducing pipe size.
- Cast iron pipe and fittings are not acceptable.
- PTFE (TEFLON) tape is an acceptable pipe sealant and must be applied to male threads only.

NOTICE

Do not allow tape to overlap the pipe opening, as this could cause the agent to block. Thread sealant or compound must not be used.

- Before assembling the pipe and fittings, make certain all ends are carefully reamed and blown clear of chips and scale. The inside of the pipe and fittings must be free of oil and dirt.
- All pipe lengths are measured center to center of fittings.
- For systems designed in accordance with *ISO 14520* or *EN 15004*, hangers must be placed within 100 mm (4 in.) of the nozzle. For pipe sizes larger than 25 mm (1 in.), hangers must be placed within 250 mm (10 in.) of the nozzle (*ISO 14520 / EN 15004)*.
- For systems designed and installed in accordance with NFPA 2001, pipe hangers must be mounted to a structure capable of supporting the weight of the pipe and agent and placed within 305 mm (12 in.) of the discharge nozzle.
- All dirt trap maximum lengths are 10 times the nominal pipe diameter and minimum lengths are not less than 50 mm (2 in.).
- Vertical drops on the end of the line are acceptable.

INSTALLING THE PIPEWORK (Continued)

General Piping Requirements (including manifolds) (Continued)

The following tables list the pipe requirements based on *FIA Guidance - Pipe Work for Gaseous Fixed Fire Fighting Systems. FSSA* charts may also be used as acceptable guidance for piping.

The following conditions state the maximum developed
pressure in a system based on temperature and maximum fill density. These values can be used to select pipe type, size, and schedule based on the pressure ratings of the pipe listed in Table 6-7 and 6-8.

- Maximum system temperature of 54 ºC or 130 ºF (fill density 1.00 kg/L) results in maximum system pressure of 34 bar (493 psi).

TABLE 6-7: PRESSURE RATING FOR API GRADE B SEAMLESS PIPE

API Grade B Seamless												
	Schedule 40						Schedule 80					
Nominal Size	NPT Screwed		BSPT Screwed		Welded		NPT Screwed		BSPT Screwed		Welded	
mm (in.)	bar	(psi)	bar	(psi)	bar	(psi)	bar	(psi)	bar	(psi)	bar	(psi)
15 (1/2)	117	(1697)	150	(2176)	285	(4134)	208	(3017)	241	(3495)	376	(5453)
20 (3/4)	101	(1465)	128	(1856)	236	(3423)	182	(2640)	209	(3031)	317	(4598)
25 (1)	89	(1291)	111	(1610)	221	(3205)	160	(2321)	182	(2640)	292	(4235)
32 (1 1/4)	81	(1175)	98	(1421)	185	(2683)	147	(2132)	165	(2393)	252	(3655)
40 (1 1/2)	75	(1088)	90	(1305)	166	(2408)	138	(2002)	153	(2219)	229	(3321)
50 (2)	67	(972)	80	(1160)	140	(2031)	125	(1813)	137	(1987)	198	(2872)
65 (2 1/2)	68	(986)	104	(1508)	154	(2234)	122	(1769)	158	(2292)	208	(3017)
80 (3)	63	(914)	93	(1349)	134	(1944)	115	(1668)	144	(2089)	185	(2683)
100 (4)	59	(856)	82	(1189)	114	(1653)	108	(1566)	131	(1900)	163	(2364)
150 (6)	54	(783)	70	(1015)	91	(1320)	104	(1508)	120	(1740)	142	(2060)

TABLE 6-8: PRESSURE RATING FOR ASTM A 106 GRADE B PIPE

ASTM A 106 Grade B												
	Schedule 40						Schedule 80					
Nominal Size	NPT Screwed		BSPT Screwed		Welded		NPT Screwed		BSPT Screwed		Welded	
mm (in.)	bar	(psi)	bar	(psi)	bar	(psi)	bar	(psi)	bar	(psi)	bar	(psi)
15 (1/2)	114	(1653)	148	(2147)	283	(4105)	212	(3075)	246	(3568)	382	(5540)
20 (3/4)	99	(1436)	126	(1827)	234	(3394)	184	(2669)	211	(3060)	319	(4627)
25 (1)	88	(1276)	110	(1595)	220	(3191)	164	(2379)	187	(2712)	297	(4308)
32 (1 1/4)	79	(1146)	97	(1407)	184	(2669)	146	(2118)	163	(2364)	250	(3626)
40 (1 1/2)	74	(1073)	90	(1305)	166	(2408)	137	(1987)	153	(2219)	229	(3321)
50 (2)	68	(986)	80	(1160)	141	(2045)	127	(1842)	139	(2016)	200	(2901)
65 (2 1/2)	67	(972)	104	(1508)	154	(2234)	123	(1784)	159	(2306)	209	(3031)
80 (3)	63	(914)	93	(1349)	135	(1958)	116	(1682)	145	(2103)	187	(2712)
100 (4)	59	(856)	83	(1204)	115	(1668)	108	(1566)	131	(1890)	163	(2364)
150 (6)	54	(783)	70	(1015)	92	(1334)	104	(1508)	120	(1740)	142	(2060)

INSTALLING THE PIPEWORK (Continued)

General Piping Requirements (including manifolds) (Continued)

TABLE 6-9: US FITTINGS

Fitting Description	Nominal Pipe Size
Class 300 malleable or ductile iron	Up to 3 in.
1000-lb or greater rated ductile iron or forged steel Class 300 flanged joints	> 3 in. all

NOTICE

Cautionary information indicating the calculation method has been investigated for specific types of fittings, type of pipe, and pipe inside diameter. When the specified limitations are not maintained, the system may not supply the required quantity of suppression agent. The flow calculation program contains pipe and fitting options together with equivalent length information for pipe and fittings.

Pipe Hangers

- Pipe hangers must be approved by the Authority Having Jurisdiction (AHJ).
- Pipe hangers must be spaced according to the size of pipe. See the following tables.
- Hangers must be placed within 300 mm (12 in.) of the discharge nozzle. See Figure 6-8.
- Hangers must be placed between elbows that are more than 600 mm (24 in.) apart. See Figure 6-9.
- Hangers must be mounted to a structure capable of supporting the pipework.

TABLE 6-10: HANGER SPACING (FIA GUIDANCE)

Pipe Size		Maximum Spacing	
mm	(in.)	m	(ft)
15	1/2	1.5	5.0
20	3/4	1.8	6.0
25	1	2.1	7.0
32	1 1/4	2.4	8.0
40	1 1/2	2.7	9.0
50	2	3.4	11.0
65	2 1/2	3.5	11.5
80	3	3.7	12.0
100	4	4.3	14.0
150	6	5.2	17.0

Note: This table applies to UK markets only. Data is taken from *FIA Guidance - Pipe Work for Gaseous Fixed Fire Fighting Systems*. For other markets, refer to local hanger spacing requirements.

TABLE 6-11: HANGER SPACING (FSSA GUIDANCE)

Pipe Size		Rod Diameter		Distance Between Supports	
mm	(in.)	mm	(in.)	m	(ft)
10	(1/4)	14	(3/8)	2.1	(7)
15	(1/2)	14	(3/8)	2.1	(7)
20	(3/4)	14	(3/8)	2.1	(7)
25	(1)	14	(3/8)	2.1	(7)
32	(1 1/4)	14	(3/8)	2.1	(7)
40	(1 1/2)	14	(3/8)	2.7	(9)
50	(2)	14	(3/8)	3.0	(10)
65	(2 1/2)	15	(1/2)	3.4	(11)
80	(3)	15	(1/2)	3.7	(12)
100	(4)	16	(5/8)	4.3	(14)
125	(5)	16	(5/8)	4.9	(16)
150	(6)	20	(3/4)	5.2	(17)
200	(8)	20	(3/4)	5.8	(19)



FIGURE 6-8
NOZZLE MOUNTING
009715

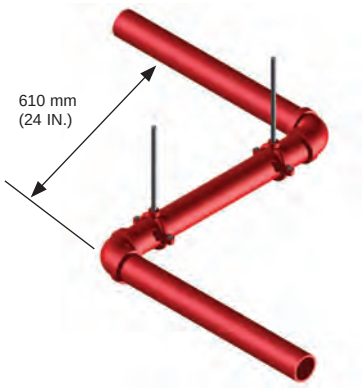


FIGURE 6-9
ELBOW SUPPORT
009716

INSTALLING THE NOZZLES

A false ceiling with loose tiles must have the tiles retained within a 1.22 m (4 ft) radius of the nozzle including all perimeter tiles to help prevent movement during system discharge. Nozzles should be installed a maximum of 300 mm (12 in.) below the ceiling.

Systems designed in accordance with *EN 15004* or *ISO 14520* shall have dirt traps installed at the end of each pipe run. *EN 15004* and *ISO 14520 Section 6.3.6.4* additionally require nozzle filters for nozzles containing an orifice of area less than 7 mm^2 (less than 3 mm dia).

For all other systems where nozzle orifice drill sizes are less than 3 mm (0.12 in.), nozzle filters should be installed. Refer to Figure 6-10 for the correct orientation of the discharge nozzle filter.



FIGURE 6-10
FM-200 NOZZLE FILTER LOCATION
025618

INSTALLING THE ACTUATION COMPONENTS

⚠ CAUTION

Prior to actuation installation steps, ensure all containers are properly secured.

The method of actuation depends on the system configuration which can be broken down as follows:

- Single container actuation
- Multiple container actuation

Single Container Actuation - Electrical Actuator

Install the electrical actuator to the top of the valve assembly as follows:

1. Check the actuator pin to ensure it is in the non-fired position by fully screwing in the reset tool supplied and ensuring the pin is retracted. See Figure 6-11.
2. Remove the dust cap from the top of the valve assembly.
3. Carefully screw the actuator to the valve assembly. See Figure 6-12.

If no other actuators are to be installed to the top of the electrical actuator, ensure the protective cap on the actuator is retained in position.

⚠ CAUTION

The actuator must be hand-tight only. Over-tightening may damage the valve and cause the container to actuate.

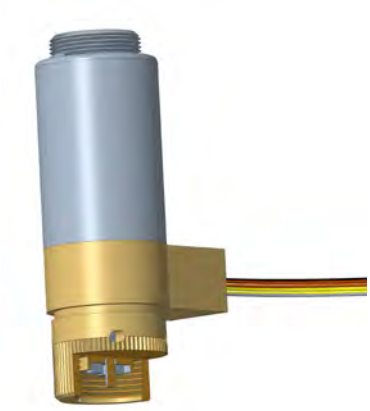


FIGURE 6-11
ACTUATOR PIN NON-FIRED POSITION
E001171



FIGURE 6-12
INSTALLED ELECTRICAL ACTUATOR
E001230

INSTALLING THE ACTUATION COMPONENTS (Continued)

Electrical Actuator - Wiring

⚠ CAUTION

The electrical actuator shall be connected when all other components are completely installed.

For the release circuit, complete the following steps:

1. Using threaded conduit connection on the electrical actuator, pull leads through to a junction box to make connections.
2. Connect Positive from the control panel to either the black or white lead wire. See Figure 6-13.
3. Connect Negative from the control panel to the opposite lead from Step 2.
4. Install the in-line supervisory device on site, if required. (Refer to the control panel instructions).

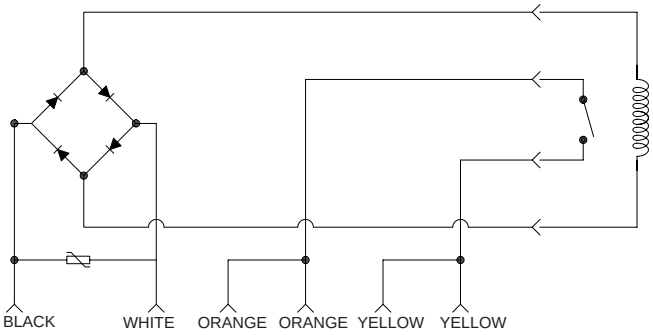


FIGURE 6-13
ELECTRICAL ACTUATOR WIRING DIAGRAM
025555

Before this system is put into operation, the removable solenoid can be checked by actuating the system. To actuate the system, complete the following steps:

1. Remove the electrical actuator from the valve. With power to the actuator, the pin should be firmly in the down position.
2. Ensure that the electrical actuator is reset prior to installing on the container valve.

⚠ CAUTION

Failure to reset the actuator results in potentially hazardous container discharging.

Placement Indicator Switch

The placement indicator switch is integrated within the electrical actuator. See Figure 6-15. Connect the placement indicator switch monitoring to the orange and yellow wires. See Figure 6-14. Activating the placement indicator switch allows a small amount of electric current to pass through the end-of-line (EOL) resistor. This functionality enables the fire control panel to indicate that the electrical actuator is in the correct position for system operation.

If an issue occurs, and the electrical actuator is not in the correct position, the placement indicator switch is **closed**. This means that the switch contacts are closed, and the current now passes through the closed contacts. Once the current passes through the closed contacts, the current does not pass through the EOL resistor, and the fire control panel indicates that the actuator is not in the correct position. This indication results in an audible and visual warning at the associated system fire suppression control panel.

1. Pull the wires into the junction box.
2. Connect positive from the input circuit to either one of the yellow or orange pairs.
3. Connect negative from the input to the opposite lead from Step 2.
4. Of the remaining yellow and orange wires, place the end-of-line resistor (EOL). Refer to the control panel instructions for the appropriate value.



FIGURE 6-14
INTEGRATED PLACEMENT INDICATOR SWITCH
E001172



FIGURE 6-15
INTEGRATED INDICATOR SWITCH INSTALLED
E001230

INSTALLING THE ACTUATION COMPONENTS (Continued)

Manual Actuator

When installing the manual actuator, complete the following steps:

1. Check that the actuation pin is in the non-fired position. See Figure 6-16.
2. Remove the dust cap from the top of the valve.
3. Carefully screw the manual actuator to the top of the electrical actuator or directly onto the master container valve. See Figure 6-17.

⚠ CAUTION

Before installing the manual actuator to the electrical actuator or container valve, ensure the firing pin is retracted and the safety pin is in place. Raising the strike knob **does not** reset the pin. The pin must be **pushed up** manually. Failure to reset the actuator results in potentially hazardous container discharging. The actuator must be hand-tight only. Over-tightening may damage the valve and actuate the container.

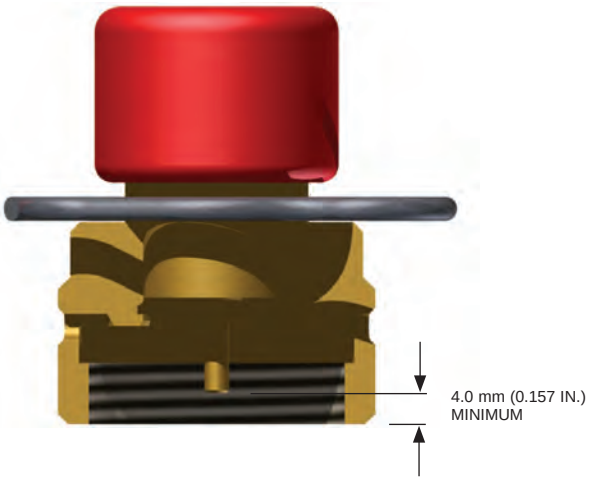


FIGURE 6-16
MANUAL ACTUATOR NON-FIRED POSITION
009721



FIGURE 6-17
MANUAL ACTUATOR INSTALLED
E001231

Pneumatic Actuator

When installing the pneumatic actuator, complete the following steps:

1. Check that the actuation pin is in the non-fired position. See Figure 6-18.
2. Remove the dust cap from the top of the valve.
3. Carefully screw the pneumatic actuator to the top of the subordinate container valve. See Figure 6-19.

⚠ CAUTION

Before installing the pneumatic actuator to the container valve, ensure the firing pin is retracted and the safety pin is in place. The pin must be **pushed up** manually. Failure to reset the actuator results in potentially hazardous container discharging. The actuator must be hand-tight only. Over-tightening may damage the valve and actuate the container.

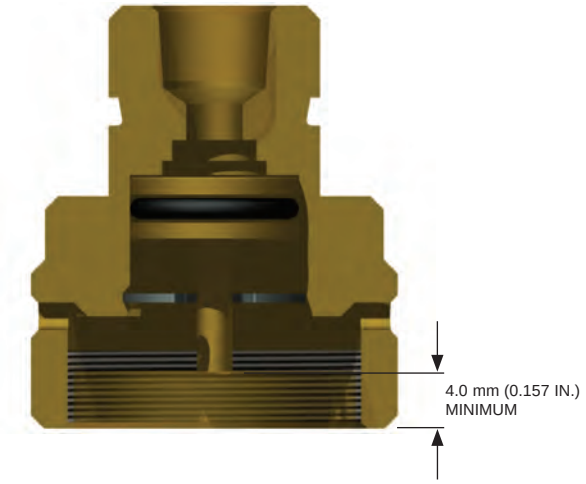


FIGURE 6-18
PNEUMATIC ACTUATOR NON-FIRED POSITION
009723



FIGURE 6-19
PNEUMATIC ACTUATOR INSTALLED
E001232

INSTALLING THE ACTUATION COMPONENTS (Continued)

Manual Pneumatic Actuator

When installing the manual pneumatic actuator, complete the following steps:

1. Check that the actuation pin is in the non-fired position. See Figure 6-20.
2. Remove the dust cap from the top of the valve.
3. Carefully screw the actuator to the top of the electrical actuator or directly onto the master container valve. See Figure 6-21.

⚠ CAUTION

Before installing the manual pneumatic actuator to the electrical actuator or container valve, ensure that the firing pin is retracted and the safety pin is in place. Raising the strike knob **does not** reset the pin. The pin must be **pushed up** manually. Failure to reset the actuator results in potentially hazardous container discharging. The actuator must be hand-tight only. Over-tightening may damage the valve and actuate the container.

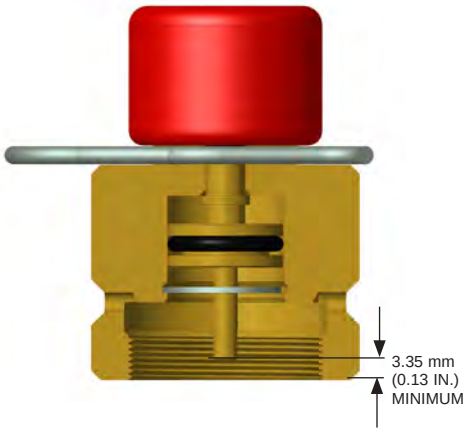


FIGURE 6-20
MANUAL PNEUMATIC ACTUATOR NON-FIRED POSITION
025568



FIGURE 6-21
MANUAL PNEUMATIC ACTUATOR INSTALLED
E001233

INSTALLING THE ACTUATION COMPONENTS (Continued)

Cable Pneumatic Manual (CPM) Actuator

The CPM actuator can be fitted to the top of the electrical actuator or directly onto the valve, after first removing the protective cap. See Figure 6-23.

⚠ CAUTION

Before attaching the CPM actuator to the electrical actuator or valve, ensure that the firing pin is retracted and the safety pin is in place. See Figure 6-22. The actuator must be hand-tight only.

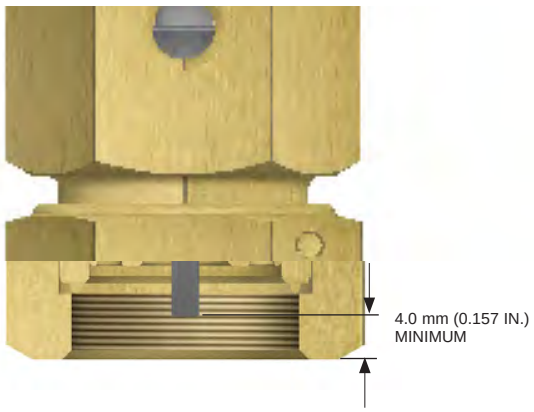


FIGURE 6-22
CPM ACTUATOR NON-FIRE POSITION
025257



FIGURE 6-23
CPM ACTUATOR LOCATION
025256

Note: Example shown is manual only operated system.

CPM Actuator - Pneumatic Limitations

Pneumatic operation of the CPM actuator can be made through a maximum actuation line length of 45.7 m (149.9 ft) using either 6 mm outside diameter pipe with a 1 mm wall thickness or 1/4 in. tubing with a wall thickness of 0.038 in. Table 6-12 to Table 6-15 list maximum actuation line length details.

CPM Actuator - Cable Pull Limitations

Remote cable operation of the CPM actuator can be made through a maximum wire rope run length of 45.7 m (150 ft) protected by 3/8 in. conduit using a maximum of 10 brass watertight pulley elbows. This results in a cable pull force of less than 178 N (40 lb_f).

CPM Actuator - Manual Actuation (Lever Operation)

The CPM actuator requires a pull force of less than 178 N (40 lb_f) in order to actuate by manual mechanical means.

Subordinate Actuation Line

If female actuation hoses are utilized for subordinate container actuation, complete the following steps:

1. Remove the 1/4 in. actuation pressure port plug on the master container valve assembly.
2. Install a 1/4 in. male adaptor (Part No. 309.013.005).
3. Install a male actuation tee (Part No. 309.200.021), on all pneumatic actuators to wrench tight, except the last container in the bank.
4. Install a male actuation elbow (Part No. 309.013.009) on the last pneumatic actuator in the actuation line.

If a pressure switch is connected to the end of the actuation line, complete the followings steps:

1. Install an actuation tee (Part No 309.200.021), instead of the elbow. The actuation line terminates at the pressure switch.
2. Connect one end of the actuation hose (Part No. 306.205.003) to the adaptor on the master container and one end to the actuation line tee on the pneumatic actuator.
3. Connect an actuation hose between the actuation line tees on all pneumatic actuators.

Note: For installations utilizing actuation pipe (copper tube or steel pipe), see Table 6-12, for pipe length limitations. Additionally, see Actuation Line Configurations in Section 9 - Appendix.

INSTALLING THE ACTUATION COMPONENTS (Continued)

Actuation Line - Decompression Screw

Install the decompression screw in the pneumatic actuation line as a means to relieve trapped pressure after system actuation when using pilot containers as a means of actuation.

Actuation line using pipe or tubing

1. Connect the stud coupling (Part No. 30880063 or 441547) to the pipe or tubing.
2. Install the 1/4 in. Dowty seal (Part No. 31199816) to the decompression screw (Part No. 30027301).
3. Thread the decompression screw into the stud coupling and tighten securely.

Actuation line using pilot hoses

1. Connect the female adaptor (Part No. 309013050) to the tee (Part No. 309.200.021).
2. Install the 1/4 in. Dowty seal (Part No. 31199816) to the decompression screw (Part No. 30027301).
3. Thread the decompression screw into the female adaptor and tighten securely.

Note: See recharge instructions for details on using the decompression screw for trapped pressure release.

INSTALLING THE PILOT CONTAINER COMPONENTS

Determine the Actuation Container Requirements

Pilot actuation line limitations: The volume of gas in the pilot container limits the pilot actuation system, along with the requirement to actuate the last container, within one second of the first. The volume of gas determines the number of actuation components, selector valves, and the length of tubing allowed when designing a system.

Master Container Actuation: When you manually or electrically actuate the master container, the remaining subordinate containers pneumatically actuate.

Pilot with Sub-Master: The pilot container pneumatically actuates the Sub-Master container in the container bank. The Sub-Master container then pneumatically actuates the subordinate containers.

Pilot without Sub-Master: The pilot container pneumatically actuates all containers in the container bank.

AUTOMAN Release with Sub-Master: The AUTOMAN release device pneumatically actuates the master container in the container bank. The master container then pneumatically actuates the subordinate containers.

AUTOMAN Release without Sub-Master: The AUTOMAN release device pneumatically actuates all containers in the container bank.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determine the Actuation Container Requirements (Continued)

TABLE 6-12: MAXIMUM ACTUATION LINE LENGTH

Actuation source	Maximum Actuation Line for 6 mm copper pipe m	(ft)	Maximum Actuation Line for 1/4 in. copper tube m	(ft)	Maximum Actuation Line for 1/4 in. steel pipe m	(ft)
Master container 15 L to 180 L	30	(98)	23	(75.5)	6	(19.5)
Pilot container 3 L (without sub-master container)	60	(196)	46	(151)	11	(36)
Pilot container 3 L (with sub-master container)	90 (pilot to sub-master)	(295)	70 (pilot to sub-master)	(230)	17 (pilot to sub-master)	(56)
Pilot container 13 L (without sub-master container)	60	(196)	46	(151)	11	(36)
Pilot container 13 L (with sub-master container)	390 (pilot to sub-master)	(1279)	301 (pilot to sub-master)	(988)	73 (pilot to sub-master)	(240)
Pilot container 50 L (without sub-master container)	60	(196)	46	(151)	11	(36)
Pilot container 50 L (with sub-master container)	1500 (pilot to sub-master)	(4921)	1159 (pilot to sub-master)	(3802)	282 (pilot to sub-master)	(925)
AUTOMAN II-C release (without sub-master container)	60	(196)	46	(151)	11	(36)
AUTOMAN II-C release (with sub-master container)	90 (AUTOMAN II-C to sub-master) + 30 (sub-master to last subordinate)	(295) + (98)	70 (AUTOMAN II-C to sub-master) + 23 (sub-master to last subordinate)	(230) + (75.5)	17 (AUTOMAN II-C to sub-master) + 6 (sub-master to last subordinate)	(56) + (19.5)

The following calculation determines the total equivalent actuation (EL_{Total}) line length, which is used to calculate the required pilot container size for proper actuation.

EL_{Total} = (A/B/C) Number of Actuator Tees and Actuation Line Tees x EQ
+ (D/E/F) Number of Flexible Hose x EQ
+ (G/H) Number of Stud Couplings x EQ
+ Total Length of Actuation Line (6 mm copper pipe, 1/4 in. copper tubing, 1/4 in. steel pipe)

Where EQ = Equivalent Length value for each item.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determine the Actuation Container Requirements (Continued)

Tables 6-12 to 6-14 list the equivalent length for each actuation component that is needed to calculate the total equivalent length for the actuation line. The sum of the equivalent length for the actuation line must be less than the limit from Table 6-12.

TABLE 6-13: EQUIVALENT LENGTH OF ACTUATION COMPONENTS USING 6 mm COPPER PIPE

Component	Equivalent length (EQ) m	(ft)
A. Pneumatic Actuator and Tee for Flexible Hose	0.30	(0.98)
B. Pneumatic Actuator and Tee for Copper Pipe (6 mm)	0.23	(0.75)
C. Pneumatic Actuator and Tee for Copper Tube (1/4 in.)	0.23	(0.75)
D. 710 mm Flexible Hose	1.70	(5.58)
E. 812 mm Flexible Hose	2.00	(6.56)
F. 1070 mm Flexible Hose	2.60	(8.53)
G. Stud Coupling for Copper Pipe (6 mm)	0.02	(0.07)
H. Stud Coupling for Copper Tube (1/4 in.)	0.02	(0.07)

TABLE 6-14: EQUIVALENT LENGTH OF ACTUATION COMPONENTS USING 1/4 in. COPPER TUBE

Component	Equivalent length (EQ) m	(ft)
A. Pneumatic Actuator and Tee for Flexible Hose	0.23	(0.75)
B. Pneumatic Actuator and Tee for Copper Pipe (6 mm)	0.18	(0.59)
C. Pneumatic Actuator and Tee for Copper Tube (1/4 in.)	0.18	(0.59)
D. 710 mm Flexible Hose	1.31	(4.30)
E. 812 mm Flexible Hose	1.55	(5.09)
F. 1070 mm Flexible Hose	2.01	(6.59)
G. Stud Coupling for Copper Pipe (6 mm)	0.02	(0.07)
H. Stud Coupling for Copper Tube (1/4 in.)	0.02	(0.07)

TABLE 6-15: EQUIVALENT LENGTH OF ACTUATION COMPONENTS USING 1/4 in. STEEL PIPE

Component	Equivalent length (EQ) m	(ft)
A. Pneumatic Actuator and Tee for Flexible Hose	0.06	(0.2)
B. Pneumatic Actuator and Tee for Copper Pipe (6 mm)	0.04	(0.13)
C. Pneumatic Actuator and Tee for Copper Tube (1/4 in.)	0.04	(0.13)
D. 710 mm Flexible Hose	0.32	(1.05)
E. 812 mm Flexible Hose	0.38	(1.25)
F. 1070 mm Flexible Hose	0.49	(1.61)
G. Stud Coupling for Copper Pipe (6 mm)	0.004	(0.013)
H. Stud Coupling for Copper Tube (1/4 in.)	0.004	(0.013)

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determine the Actuation Container Requirements (Continued)

Example 1a: Single Hazard Systems - Metric*

The system shown in Figure 6-24a includes six FM-200 containers with one protected hazard. The equivalent length of actuation hardware required to discharge containers into the hazard must be determined to select the appropriate actuation source for the system.

HAZARD

The hazard is protected with six FM-200 containers. The length of actuation tubing (Dia 6 mm copper pipe) from the actuation source (A) to the first container (B) is 2.0 m. There is a single 1/4 in. Flex hose dedicated to the discharge pressure switch. The tubing between the containers is made of Dia 6 mm copper pipe.

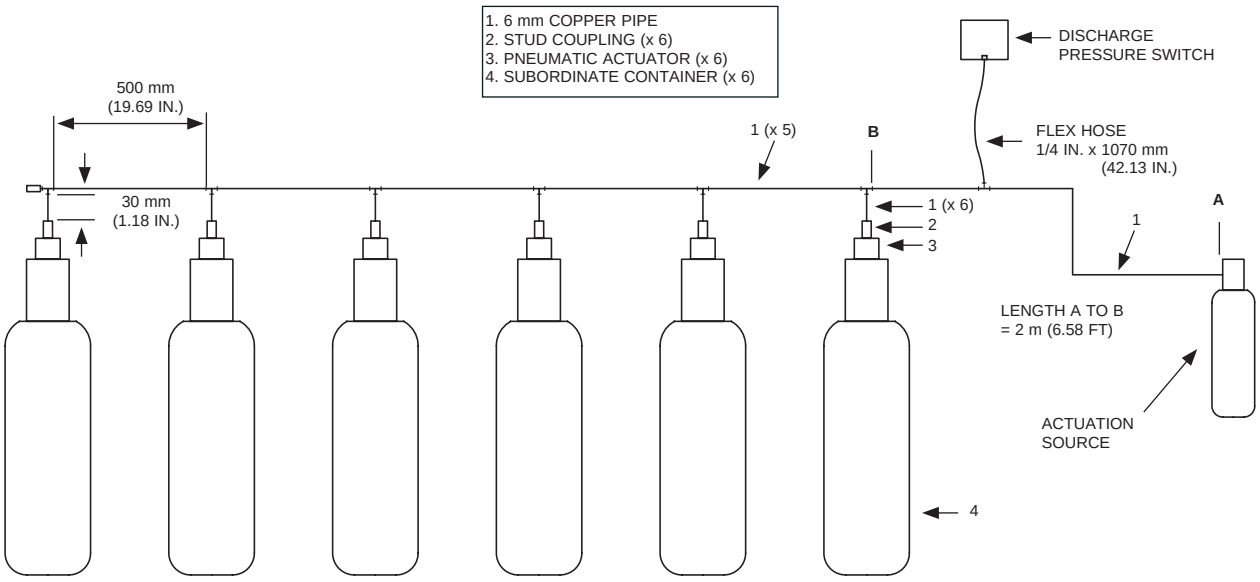


FIGURE 6-24a
METRIC EXAMPLE 1a - SINGLE HAZARD SYSTEM
010776

Calculate the total equivalent length (EL_{Total}) of the pilot actuation line, see Table 6-16a. Use the calculation on page 6-18.

TABLE 6-16a: EQUIVALENT LENGTH OF PILOT ACTUATION LINE: EXAMPLE 1a – METRIC

Component	EQ (m)	Quantity	Total (m)
Length of 6 mm Copper Pipe (5 x 500 mm) + (6 x 30 mm) + 2 m = 4.68 m	N/A	4.68	4.68
Pneumatic Actuator and Tee for Flexible Hose	0.30	–	–
Pneumatic Actuator and Tee for Copper Pipe (6 mm)	0.23	6	1.38
Pneumatic Actuator and Tee for Copper Tube (1/4 in.)	0.23	–	–
Flexible Hose 1/4 in. x 710 mm	1.70	–	–
Flexible Hose 1/4 in. x 815 mm	2.00	–	–
Flexible Hose 1/4 in. x 1070 mm	2.60	1	2.60
Stud Coupling for Copper Pipe (6 mm)	0.02	6	0.12
Stud Coupling for Copper Tube (1/4 in.)	0.02	–	–
		EL_{Total}	**8.78**

*Imperial Example 1b starts on page 6-22.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determine the Actuation Container Requirements (Continued)

Example 1a: Single Hazard Systems - Metric (Continued)

The equivalent length is calculated by summing the total equivalent length for each component within the system.

Total $Length_{6mmCopperPipe}$ = 4.68 m

Total $EQ_{PneuAct6mm}$ = 0.23 x 6 = 1.38 m

Total $EQ_{1070mmFlex\ hose}$ = 2.60 x 1 = 2.60 m

Total $EQ_{StudCoupling6mm}$ = 0.02 x 6 = 0.12 m

EL_{Total} = 4.68 + 1.38 + 2.60 + 0.12 = 8.78 m

RESULT

Based on Table 6-12, the 3 L pilot container is the appropriate minimum pilot container size.

Options per the calculated equivalent length: a 13 L or 50 L pilot container or AUTOMAN II-C release.

SUMMARY

Based on the limitations from Table 6-12, any actuation sources can be used because EL_{Total} is less than the maximum actuation length for all sources.

Note: If the total equivalent length for this system had totaled to 66 m, a 3 L pilot container with a sub-master container would be required.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determine the Actuation Container Requirements (Continued)

Example 1b: Single Hazard Systems - Imperial

The system shown in Figure 6-24b includes six FM-200 containers with one protected hazard. The equivalent length of actuation hardware required to discharge containers into the hazard must be determined to select the appropriate actuation source for the system.

HAZARD

The hazard is protected with six FM-200 containers. The length of actuation tubing (1/4 in. copper tube) from the actuation source (A) to the first container (B) is 6.5 ft. There is a single 1/4 in. Flex hose dedicated to the discharge pressure switch. The tubing between the containers is 1/4 in. copper tube.

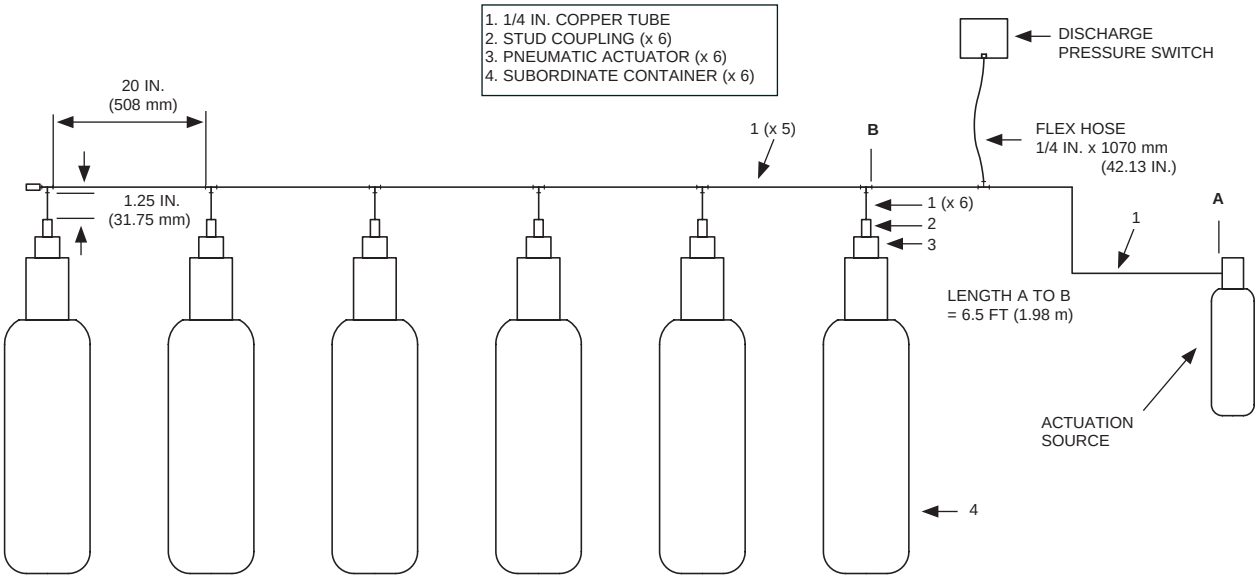


FIGURE 6-24b
IMPERIAL EXAMPLE 1b - SINGLE HAZARD SYSTEM
010776

Calculate the total equivalent length (EL_{Total}) of the pilot actuation line, see Table 6-16b. Use the calculation on page 6-18.

TABLE 6-16b: EQUIVALENT LENGTH OF PILOT ACTUATION LINE: EXAMPLE 1b – IMPERIAL

Component	EQ (ft)	Quantity	Total (ft)
Length of 1/4 in. copper tube (5 x 20 in.) + (6 x 1.25 in.) + 6.5 ft = 15.46 ft	N/A	15.46	15.46
Pneumatic Actuator and Tee for Flexible Hose	0.75	–	–
Pneumatic Actuator and Tee for Copper Pipe (6 mm)	0.59	–	–
Pneumatic Actuator and Tee for Copper Tube (1/4 in.)	0.59	6	3.54
Flexible Hose 1/4 in. x 710 mm (27.95 in.)	4.30	–	–
Flexible Hose 1/4 in. x 812 mm (32.08 in.)	5.09	–	–
Flexible Hose 1/4 in. x 1070 mm (42.13 in.)	6.59	1	6.59
Stud Coupling for Copper Pipe (6 mm)	0.07	–	–
Stud Coupling for Copper Tube (1/4 in.)	0.07	6	0.42
		EL_{Total}	**26.01**

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determine the Actuation Container Requirements (Continued)

Example 1b: Single Hazard Systems - Imperial (Continued)

The equivalent length is calculated by summing the total equivalent length for each component within the system.

Total $Length_{1/4in.CopperTube}$ = 15.46 ft

Total $EQ_{PneuAct1/4in.}$ = 0.59 x 6 = 3.54 ft

Total $EQ_{42.13in.Flex\ hose}$ = 6.59 x 1 = 6.59 ft

Total $EQ_{StudCoupling1/4in.}$ = 0.07 x 6 = 0.42 ft

EL_{Total} = 15.46 + 3.54 + 6.59 + 0.42 = 26.01 ft

RESULT

Based on Table 6-12, the 3 L pilot container is the appropriate minimum pilot container size.

Options per the calculated equivalent length: a 13 L or 50 L pilot container or AUTOMAN II-C release.

SUMMARY

Based on the limitations from Table 6-12, any actuation sources can be used because EL_{Total} is less than the maximum actuation length for all sources.

Note: If the total equivalent length for this system had totaled to 216.5 ft, a 3 L pilot container with a sub-master container would be required.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determine the Actuation Container Requirements (Continued)

Example 2a: Single Hazard Systems - Metric*

The system shown in Figure 6-25a is made up of six FM-200 containers with one protected hazard and includes a sub-master container. The highest total equivalent length of actuation hardware required to discharge containers into the hazard must be determined to select the appropriate actuation source for the system.

HAZARD

The hazard is protected with six FM-200 containers. The length of actuation tubing (Dia 6 mm copper pipe) from the actuation source (A) to the first container (B) is 3.0 m. One 1/4 in. Flex hose is dedicated to the discharge pressure switch. Tubing between the containers is 1/4 in. Flex hose.

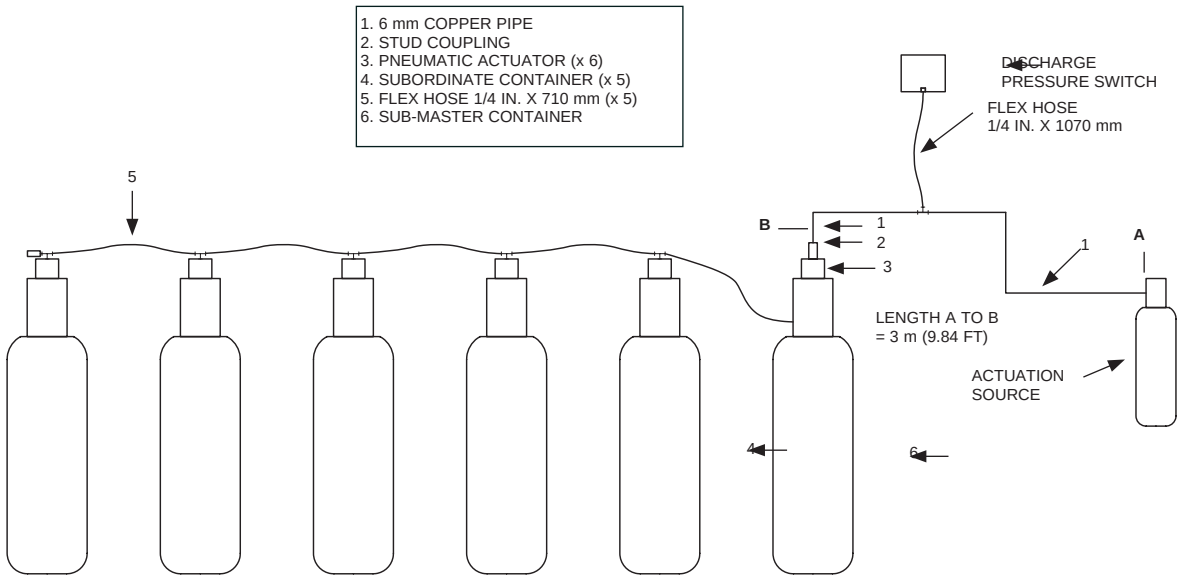


FIGURE 6-25a
METRIC EXAMPLE 2a - SINGLE HAZARD SYSTEM
010777

Calculate the total equivalent length (EL_{Total}) of the pilot actuation line, see Table 6-17a. Use the calculation on page 6-18.

TABLE 6-17a: EQUIVALENT LENGTH OF PILOT ACTUATION LINE: EXAMPLE 2a – METRIC

Component	EQ (m)	Quantity	Total (m)
Length of 6 mm Copper Pipe	N/A	3	3.00
Pneumatic Actuator and Tee for Flexible Hose	0.30	6	1.80
Pneumatic Actuator and Tee for Copper Pipe (6 mm)	0.23	–	–
Pneumatic Actuator and Tee for Copper Tube (1/4 in.)	0.23	–	–
Flexible Hose 1/4 in. x 710 mm	1.70	5	8.50
Flexible Hose 1/4 in. x 815 mm	2.00	–	–
Flexible Hose 1/4 in. x 1070 mm	2.60	1	2.60
Stud Coupling for Copper Pipe (6 mm)	0.02	1	0.02
Stud Coupling for Copper Tube (1/4 in.)	0.02	–	–
		EL_{Total}	**15.92**

* Imperial Example 2b starts on page 6-26.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determine the Actuation Container Requirements (Continued)

Example 2a: Single Hazard Systems - Metric (Continued)

The equivalent length is calculated by summing the total equivalent length for each component within the system.

Total $Length_{6mmCopperPipe}$ = 3.00 m

Total $EQ_{PneuAct6mm}$ = 0.30 x 6 = 1.80 m

Total $EQ_{700mmFlexHose}$ = 1.70 x 5 = 8.50 m

Total $EQ_{1070mmFlexHose}$ = 2.60 x 1 = 2.60 m

Total $EQ_{StudCoupling6mm}$ = 0.02 x 1 = 0.02 m

EL_{Total} = 3.00 + 1.80 + 8.50 + 2.60 + 0.02 = 15.92 m

RESULT

Based on Table 6-12, the 3 L pilot container is the appropriate minimum pilot container size.

Options per the calculated equivalent length: a 13 L or 50 L pilot container or AUTOMAN II-C release could be used.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determine the Actuation Container Requirements (Continued)

Example 2b: Single Hazard Systems - Imperial

The system shown in Figure 6-25b is made up of six FM-200 containers with one protected hazard and includes a sub-master container. The highest total equivalent length of actuation hardware required to discharge containers into the hazard must be determined to select the appropriate actuation source for the system.

HAZARD

The hazard is protected with six FM-200 containers. The length of actuation tubing (1/4 in. copper tube) from the actuation source (A) to the first container (B) is 10 ft. One 1/4 in. Flex hose is dedicated to the discharge pressure switch. Tubing between the containers is 1/4 in. Flex hose.

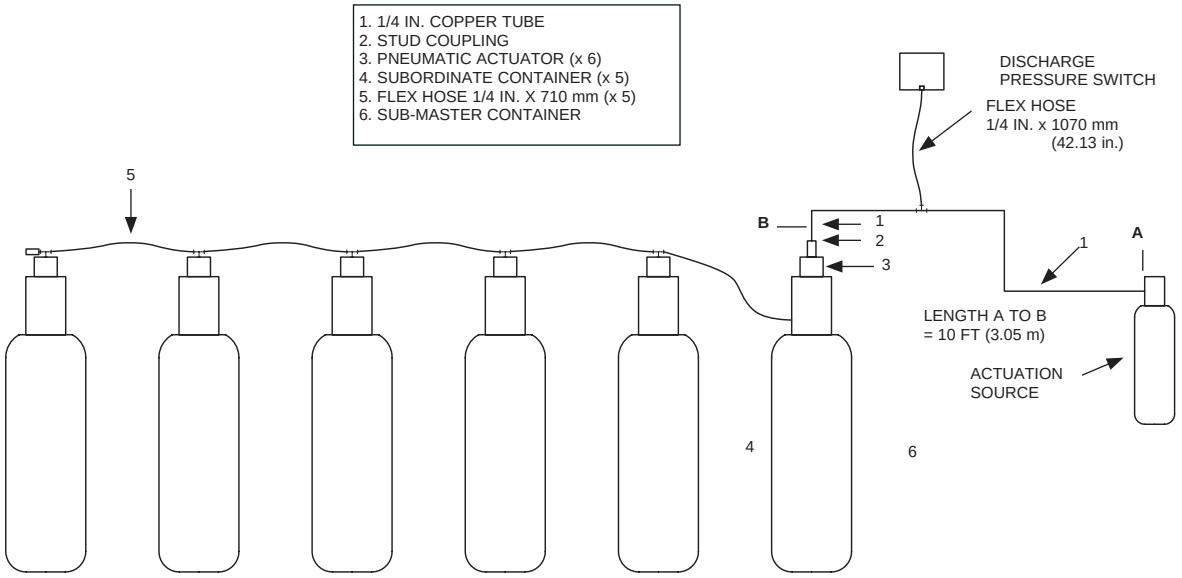


FIGURE 6-25b
IMPERIAL EXAMPLE 2b - SINGLE HAZARD SYSTEM
010777

Calculate the total equivalent length (EL_{Total}) of the pilot actuation line, see Table 6-17b. Use the calculation on page 6-18.

TABLE 6-17b: EQUIVALENT LENGTH OF PILOT ACTUATION LINE: EXAMPLE 2b – IMPERIAL

Component	EQ (ft)	Quantity	Total (ft)
Length of 1/4 in. copper tube	N/A	10	10
Pneumatic Actuator and Tee for Flexible Hose	0.75	5	3.75
Pneumatic Actuator and Tee for Copper Pipe (6 mm)	0.59	–	–
Pneumatic Actuator and Tee for Copper Tube (1/4 in.)	0.59	1	0.59
Flexible Hose 1/4 in. x 710 mm (27.95 in.)	4.30	5	21.5
Flexible Hose 1/4 in. x 812 mm (32.08 in.)	5.09	–	–
Flexible Hose 1/4 in. x 1070 mm (42.13 in.)	6.59	1	6.59
Stud Coupling for Copper Pipe (6 mm)	0.07	–	–
Stud Coupling for Copper Tube (1/4 in.)	0.07	1	0.07
		EL_{Total}	**42.50**

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determine the Actuation Container Requirements (Continued)

Example 2b: Single Hazard Systems - Imperial (Continued)

The equivalent length is calculated by summing the total equivalent length for each component within the system.

Total $Length_{1/4in.CopperTube}$ = 10.0 ft

Total $EQ_{PneuActFlexHose}$ = 0.75 x 5 = 3.75 ft

Total $EQ_{PneuAct1/4in.}$ = 0.59 x 1 = 0.59 ft

Total $EQ_{27.95in.FlexHose}$ = 4.3 x 5 = 21.5 ft

Total $EQ_{42.13in.FlexHose}$ = 6.59 x 1 = 6.59 ft

Total $EQ_{StudCoupling1/4in.}$ = 0.07 x 6 = 0.07 ft

EL_{Total} = 10 + 3.75 + 0.59 + 21.50 + 6.59 + 0.07 = 42.50 ft

RESULT

Based on Table 6-12, the 3 L pilot container is the appropriate minimum pilot container size.

Options per the calculated equivalent length: a 13 L or 50 L pilot container or AUTOMAN II-C release could be used.

ANCILLARY EQUIPMENT

Discharge Pressure Switch - Single Container Systems

On single container installations, the discharge pressure switch shall be located close to the valve assembly and connected with an actuation hose from the pressure port outlet on the valve to the connector on the discharge pressure switch. See Figure 6-26.



FIGURE 6-26
DISCHARGE PRESSURE SWITCH INSTALLATION
SINGLE CONTAINER SYSTEM
025514

Discharge Pressure Switch - Multiple Container Systems

On multi-container installations the discharge pressure switch must be located close to the last subordinate container and can be connected by an actuation hose or appropriate copper pipe or tube. See Figure 6-27. Refer to Actuation Components in Section 2 - System Components for details on the copper pipe or tube.

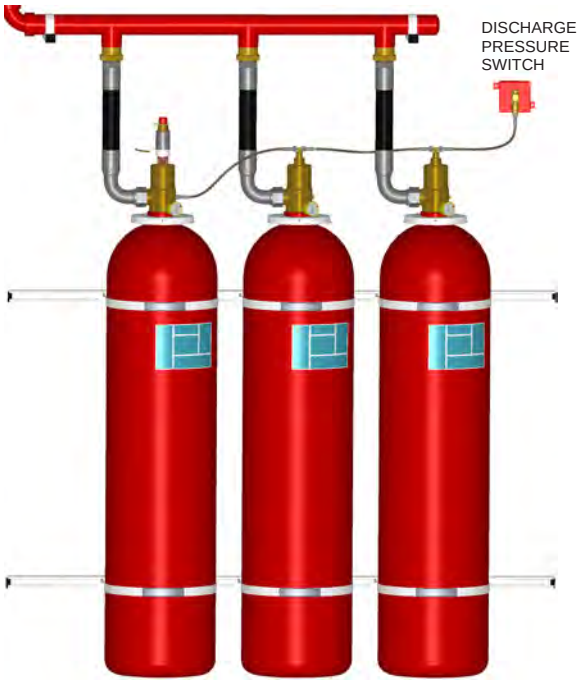


FIGURE 6-27
DISCHARGE PRESSURE SWITCH INSTALLATION
MULTIPLE CONTAINER SYSTEM
025515

Discharge Pressure Switch Installation

The discharge pressure switch mounts on any suitable flat surface near the FM-200 agent containers using the two mounting tabs provided.

Ensure that the container is bracketed securely before connecting the switch. For single container systems, complete the following steps:

1. Remove the plug from the pilot port.
2. Fit the appropriate adaptors in the valve assembly and pressure switch.
3. Connect the switch to the pilot port on the master valve using either pneumatic tubing or an actuation hose.

ANCILLARY EQUIPMENT (Continued)

Discharge Pressure Switch Installation (Continued)

For multiple container systems, complete the following steps:

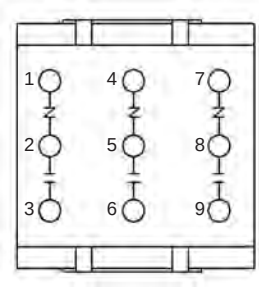
1. Fit the appropriate adaptors in the valve assembly and pressure switch.
2. Connect the switch to the tee on the final subordinate container valve using either pneumatic tubing or an actuation hose.

For electrical installation, complete the following steps:

⚠ WARNING

To ensure the discharge pressure switch maintains its listed IP rating, proper conduit seals must be used when connecting the conduit system to the discharge pressure switch enclosure. Failure to do so may result in premature discharge pressure switch failure, resulting in a potentially hazardous condition that could cause serious injury or death.

1. Remove the cover plate to access the wiring terminals.
2. Connections can be made either normally open or normally closed. For further details, see Figure 6-28. The end-of-line resistor must be installed to suit the control panel.



PRESSURE SWITCH CONTACTS
1: Pole 1, Normally-Closed (NC_1)
2: Pole 1, Common (COM_1)
3: Pole 1, Normally-Open (NO_1)
4: Pole 2, Normally-Closed (NC_2)
5: Pole 2, Common (COM_2)
6: Pole 2, Normally-Open (NO_2)
7: Pole 3, Normally-Closed (NC_3)
8: Pole 3, Common (COM_3)
9: Pole 3, Normally-Open (NO_3)

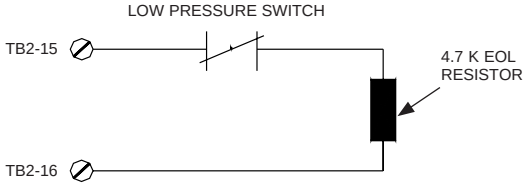
FIGURE 6-28
PRESSURE SWITCH CONTACTS
008922

Bleed Valve (Vent Valve)

The bleed valve (Part No. 302.200.076) relieves a gradual pressure build-up in the actuation line. Thread the bleed valve onto the pneumatic actuator tee of the last subordinate container in manifolded systems. If using the actuation tee, female adaptor (Part No. 309.013.048) is needed. If using 6 mm copper tubing, the 6 mm stud coupling adaptor (Part No. 30880061) is required.

Low Pressure Switch

DOT welded container valves are **factory fitted** with low pressure warning switches. Voltage input can be applied to either terminal.



Note: Programme output circuit 4 as a supervisory input circuit.

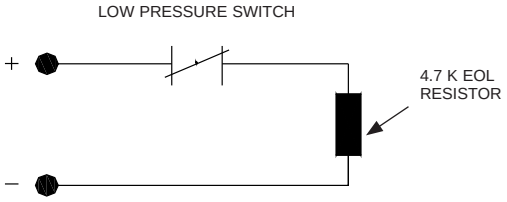


FIGURE 6-29
LOW PRESSURE SWITCH TO CONTROL PANEL
E001294

Note: Programme the addressable module as supervisory. When the pressure switch is connected to a standard supervisory input circuit, there is no distinction between a wiring fault and device actuation. This device is to be utilised only when accepted by the authority having jurisdiction.

Contacted Pressure Gauge (UL/FM) - Pilot Container Assembly

All pilot container valves are fitted with a CPG. The CPG's are connected in series with an end of line (EOL) device. The CPG contacts are normally closed at 100 bar (1450 psi) nominal charge pressure. The contacts open on fall of pressure at 88 bar (1276 psi). The required voltage range is 18 to 30 VDC. Figure 6-30 illustrates the wiring diagram.

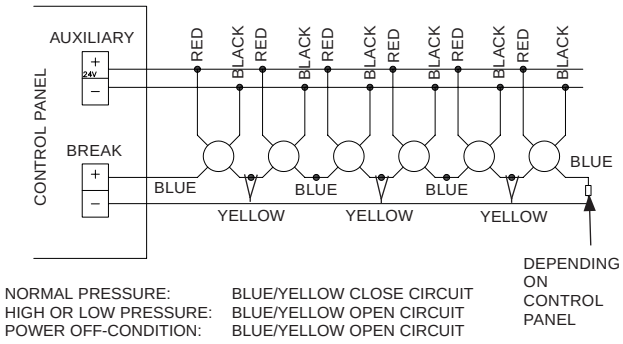
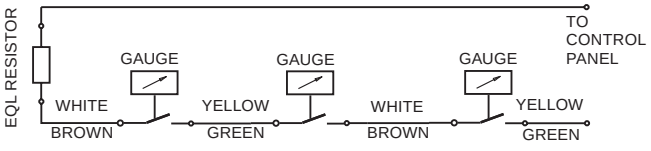


FIGURE 6-30
CPG (UL/FM) PILOT CONTAINER ELECTRICAL CONNECTION
025635

Contacted Pressure Gauge (CE) – Pilot Container Assembly

All pilot container valves are fitted with a CPG. The CPG's are connected in series with an end of line (EOL) device. The CPG contacts are normally closed at 100 bar (1450 psi) nominal charge pressure. The contacts open on fall of pressure at 90 bar (1305 psi). The required voltage range is 4.5 to 24 VDC. Figure 6-31 illustrates the wiring diagram.

SERIES CONNECTION
PRESSURE GAUGE NORMALLY OPEN (CONTACT BREAKS ON FALLING PRESSURE)



GAUGE CONTACTS SHOWN IN OPEN POSITION (ALARM CONDITION)

FIGURE 6-31
CPG (CE) PILOT CONTAINER ELECTRICAL CONNECTION
025538

INSTALLING THE PLACEMENT INDICATOR SWITCH - PILOT CONTAINER

These installation instructions are intended for use with the Electric Actuator Placement Indicator Switch Assembly Kit (Part No. 441872).

Personnel responsible for the installation, recharge, or maintenance must read and fully understand these instructions prior to attempting to install the Placement Indicator Switch.

⚠ CAUTION

The Placement Indicator Switch does not function correctly if not properly installed. Read and follow all instructions carefully. Ensure the placement indicator switch properly communicates with the fire control panel before leaving the location.

Description

The placement indicator switch (see Figure 6-32) is a monitoring device to indicate proper placement of the system electric actuator. The switch mounts directly to the actuator, and is active when the sensor switch is depressed, allowing a small electric current to pass through the end-of-line (EOL) resistor. Passing current through the EOL resistor enables the fire control panel to indicate the actuator is in the proper position for system operation.

If the electric actuator is not in the proper position, the placement indicator switch is closed (not active). The current does not pass through the EOL resistor, and therefore the fire control panel indicates the actuator is not in the proper position.

Note: Refer to fire control panel for correct EOL resistor value.

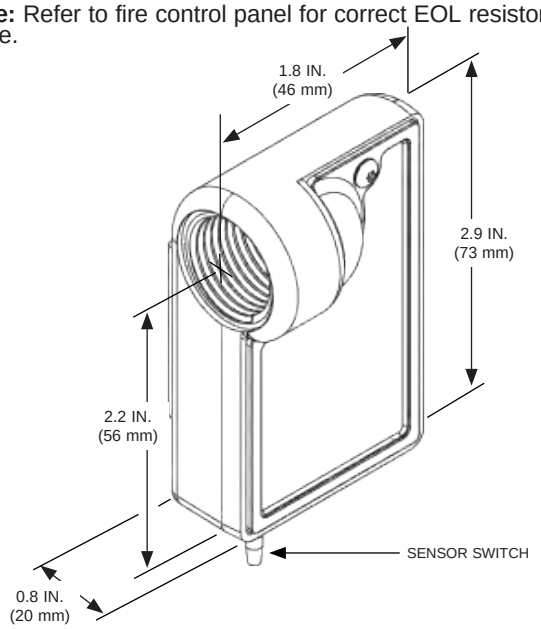


FIGURE 6-32
PLACEMENT INDICATOR SWITCH
009586

Technical Information

Housing:	Molded plastic (nylon)
Current Rating:	0.4 A
Rated Voltage:	24 VDC
Fasteners:	Stainless steel

Installation

To install the placement indicator switch, complete the following steps:

1. Remove the gauge shroud from the valve assembly. Shroud removal can be done by hand. See Figure 6-33.

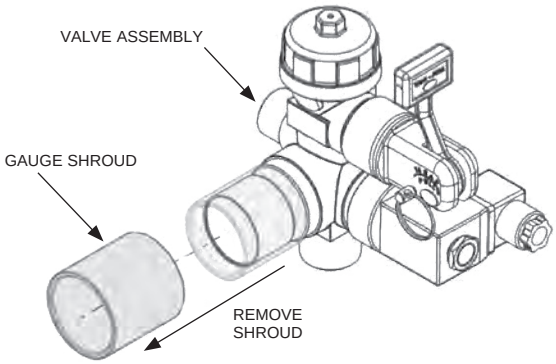


FIGURE 6-33
GAUGE SHROUD REMOVAL
009594

2. Install the placement indicator mounting bracket. See Figure 6-34 and Figure 6-35.

Note: Ensure the finger tabs are positioned on each side of the square base on the underside of the valve and are correctly aligned. Finger tabs should fit snugly over the valve assembly. See Figure 6-34 for finger tab location.

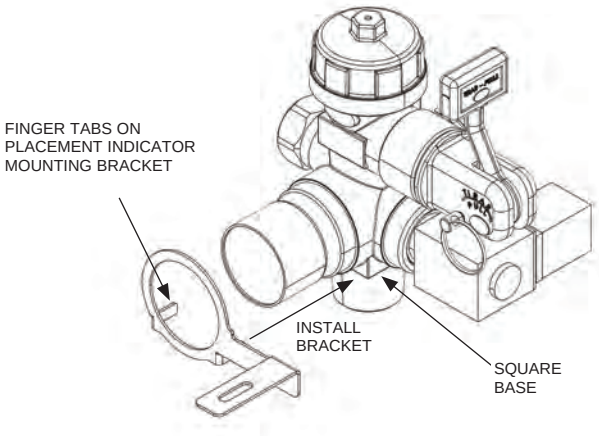


FIGURE 6-34
PLACEMENT INDICATOR MOUNTING BRACKET INSTALLATION
009622

INSTALLING THE PLACEMENT INDICATOR SWITCH - PILOT CONTAINER (Continued)

Installation (Continued)

3. Reinstall the gauge shroud that was removed in Step 1. See Figure 6-35 and Figure 6-36.

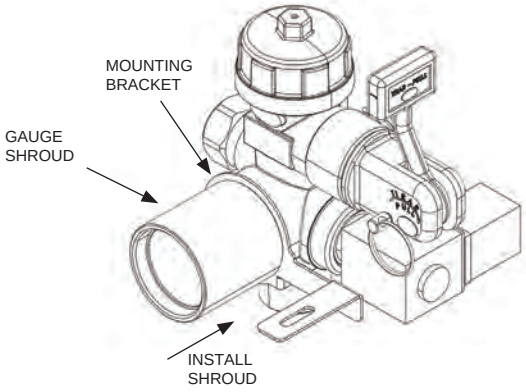


FIGURE 6-35
REINSTALL GAUGE SHROUD
009623

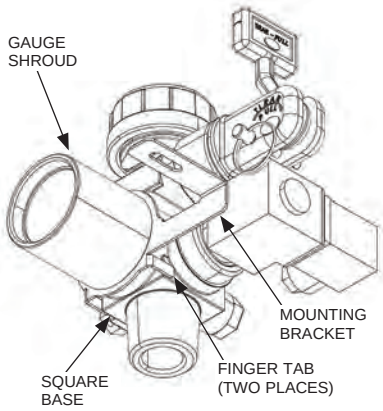


FIGURE 6-36
UNDERSIDE OF VALVE WITH GAUGE SHROUD AND MOUNTING BRACKET ASSEMBLED
009624

Note: Ensure the finger tabs are positioned toward the bottom of the valve and correctly aligned. See Figure 6-36.

4. Secure the mounting bracket to the placement indicator switch housing using the nut provided. See Figure 6-37. The nut secures to the integral bolt on the placement indicator switch. See Figure 6-38. Leave the nut slightly loose for adjustment later.
5. Adjust the horizontal position to ensure the sensor switch is fully depressed. See Figure 6-37, Detail A.

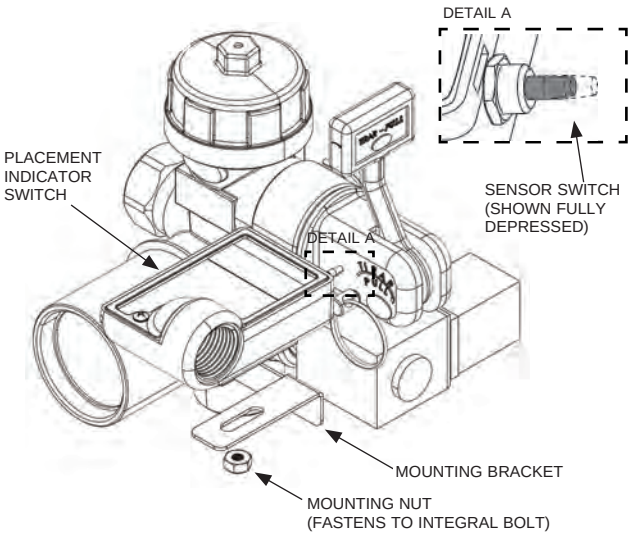


FIGURE 6-37
PLACEMENT INDICATOR SWITCH MOUNTING BRACKET
009625

6. Secure the placement indicator switch horizontal position by snugging the mounting nut tight.

⚠ CAUTION

Do not over-tighten the mounting nut to the placement indicator switch housing.

7. Locate the cable gland found in the Placement Indicator Switch Installation Kit.
   a. Remove the cover of the placement indicator switch using the appropriate screwdriver. See Figure 6-38. **Note**: Do not remove the connector retainer cover.

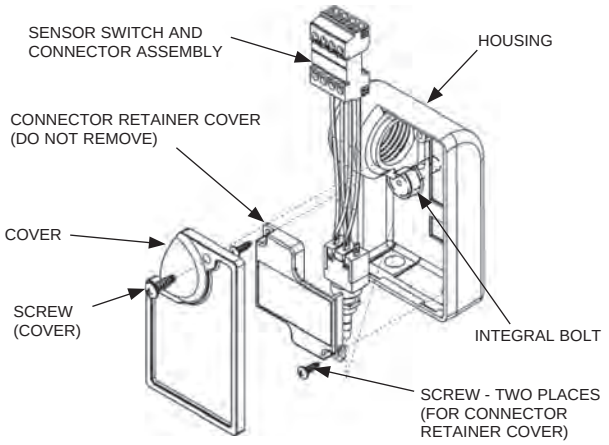


FIGURE 6-38
PLACEMENT INDICATOR SWITCH INTERNAL COMPONENTS
009592

INSTALLING THE PLACEMENT INDICATOR SWITCH - PILOT CONTAINER (Continued)

Installation (Continued)

Step 7 (Continued)

b. Run a 16-18 AWG, 2 conductor power-limited cable through the cable gland and continue into the placement indicator switch. See Figure 6-39.

c. Hand-tighten the cable gland to the placement indicator switch housing. See Figure 6-39. At this time, do not tighten the cable gland to the wire.

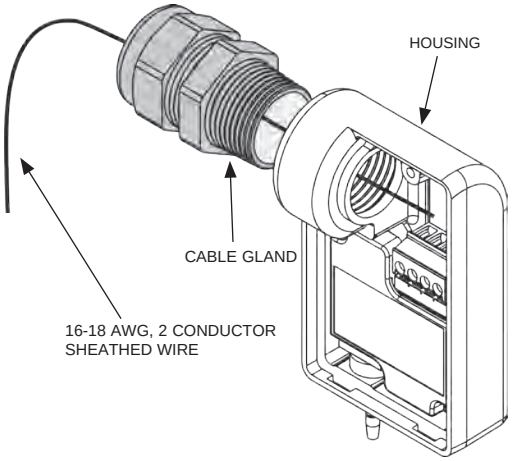


FIGURE 6-39
INSERT WIRE AND CABLE GLAND
009591

8. Disconnect the upper switch connector from the lower switch connector by pulling the upper connector apart from the assembly with your fingers. See Figure 6-40.

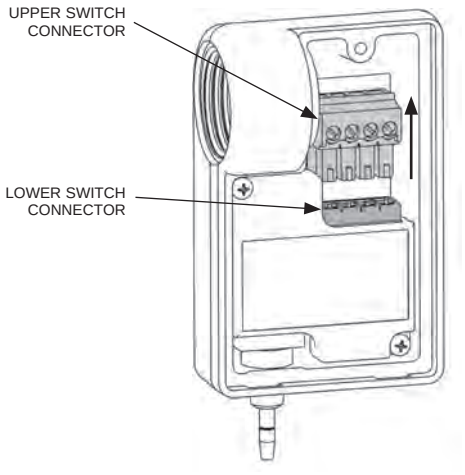


FIGURE 6-40
SEPARATE UPPER SWITCH CONNECTOR
009615

9. Separate the two conductor wire, strip the wire covering, remove the covering from the ends, and install it into the upper switch connector per the wiring diagram. Reference the AUTOPULSE fire control panel documentation for the correct EOL resistor value and install the correct EOL resistor from the wiring diagram. See Figure 6-41.

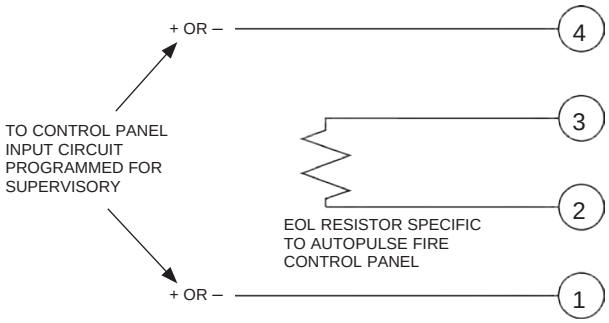


FIGURE 6-41
EOL RESISTOR ELECTRICAL DIAGRAM
009621

10. Reconnect the upper and lower connectors that were disconnected in Step 8 ensuring complete insertion.

11. Arrange the wiring within the placement indicator switch housing.

12. Tighten the cable gland to the wire. Tightening the nut to cable gland will compress the cable gland grommet, and bind the grommet to the wire.

13. Re-assemble the cover to the housing using the appropriate screw driver.

14. Once in place, run the other end of the wire to the wall mounted junction box that will be wired through conduit to the fire control panel.

15. Ensure all other electrical connections are complete, and ensure the placement indicator switch is indicating proper position at the fire control panel.

SOLENOID VALVE

The solenoid valve is supplied factory fitted to the pilot container. Do not electrically connect the unit until the system is ready for commissioning.

⚠WARNING

In the event of a fault with the solenoid valve, return the complete pilot container to Johnson Controls. Do not attempt to remove the solenoid base from the pilot container on site.

Ensure the electrical power supply is disconnected during electrical connections and that the top cap is removed. Connect the solenoid valve as shown in Figure 6-42.

Once connected, place the top cap back on the pilot valve.

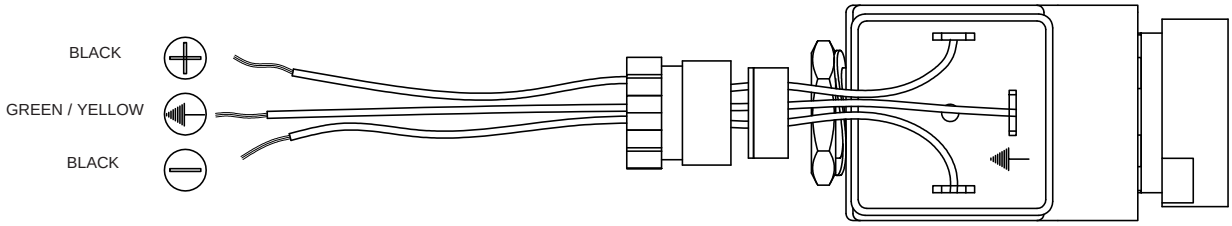


FIGURE 6-42
SOLENOID VALVE ELECTRICAL INSTALLATION
025337

ELECTRICAL INSTALLATION

Once the pneumatic actuation line is complete, connect the various electrical components. Remove the top cap on the pilot container valve while carrying out the electrical installation. If the electrical solenoid operates accidentally, the pilot container does not operate if the top cap is removed.

ACCESSORIES

Door Notices / Door Warning Signs

Warning notices are required at all exits and entrances to the protected area, ideally mounted on the door. Plates may be mounted with fasteners or attached using suitable adhesive.

Manual Release Notices / Nameplates

Manual release notices are required at all manual actuators, remote manual actuators, and call points. Plates may be mounted with fasteners or attached using suitable adhesive.

Installing the Detection System

All detection and control design and installation requirements are located in the *AUTOPULSE Detection and Control Systems Manuals*. These include component sheets.

See Section 5 - System Design for information on electrical actuation requirements.

SYSTEM VERIFICATION

When the installation process is complete, and before making the final connections, the mechanical, electrical, and pneumatic checks should be made:

Mechanical Checks

Inspect the protected area closely for conformance to original risk specifications and for unclosable openings or sources of agent loss which may have been overlooked in the original specification.

Building work should be thoroughly checked to ensure that enclosures are properly constructed, and voids in floors and above suspended ceilings are sealed.

In addition, the following mechanical checks shall be made:

- All back channels are secured firmly to the wall or bulk head.
- Containers are securely held within the brackets.
- Piping is securely mounted within the hangers.
- All pipe connections are tight.
- Nozzles are the proper type, correctly placed, and properly oriented. Ensure that the nozzles are not covered with dirt, grease, or paint, and there is nothing structural blocking the discharge. Ensure that the nozzles are additionally supported to protect against the reaction force of a system discharge.
- Check the model and weight markings on the container nameplates to verify that the correct containers and charges have been installed as required.
- Verify that all warning and instruction plates are mounted where required.
- Check all manual pull stations to confirm that they have not been tampered with and are not blocked from use.
- Check all alarm devices for damage, dirt, and corrosion.
- Visually inspect all components for signs of damage, such as disconnected or loose parts, corrosion, or twisted and dented components.
- Check each container gauge to confirm that the container pressure is in the operable range.

Electrical Checks

The electrical systems may include interfaces with many other systems for alarm, indication, actuation, and shutdown, for example. For complex electrical systems, the scope and operating requirements will be described in other documents. The following electrical checks for a basic system using electrical actuation of the container valve should be made:

1. Check detectors to ensure they are in place, not damaged, or coated with dirt, grease, paint, or any other contaminating substance.
2. Remove all electrical actuators from the valves. Confirm that each electrical actuator is activated when the system triggers.
3. During detection system actuation, verify that the following functions operate:
   a. All apertures in the hazard enclosure are closed by dampers or other suitable methods.
   b. Electrical equipment in the protected area is tripped and isolated.

Before replacing the electrical actuator, manual actuator, pneumatic actuator, manual pneumatic actuator or CPM, ensure that all pins are fully reset. After reinstalling the electrical actuators, reconnect the actuation hoses to the master container valve adaptors if they have been removed.

Pneumatic Checks

The subordinate actuators on manifolded systems are fired by agent discharge. The following pneumatic checks must be adhered to:

1. Remove all pneumatic actuators from container valves.
2. Disconnect the actuation hose from the master container valve adaptor.
3. Provide 5.2 bar (75.4 psi) pressure to the master container valve actuation hose.
4. Verify all pneumatic actuator pistons are in the fired position.
5. Provide 117 bar (1696 psi) pressure to the master container valve actuation hose.
6. Check for leaks. There must be less than 10% pressure loss within one minute.

Before replacing the pneumatic actuators, complete the following step:

- Ensure that all pistons are fully reset.

After reinstalling the pneumatic actuators, complete the following step:

- Reconnect the actuation hose to the master container valve adaptor.

For a sample commissioning checklist, see Section 9 - Appendix.

FINAL CONNECTIONS

NOTICE

Confirm all pre-checks and visual inspections on the previous page are complete.

Discharge Piping

The final connection of the discharge piping occurs at the container valve assembly. For single container systems, the valve outlet safety cap can be removed and the discharge pipe connected to the container outlet. For multi-container systems, the valve outlet safety caps can be removed and all discharge hoses fitted.

Resetting the Discharge Pressure Switch

The discharge pressure switch plunger is designed so that, once installed, the switch cover does not have to be removed to test the switch functionality.

To test the switch, complete the following steps:

1. Insert a flat-blade screwdriver or a similar instrument into the groove on the side of the plunger.
2. Pull up on the plunger until an audible click is heard. The discharge pressure switch contacts will transfer.
3. Verify that the switch produced the desired system response.
4. Depress the plunger, returning it to the **set** position, to reset the switch contacts.

To reset the discharge pressure switch after a system discharge, perform the following steps:

1. Remove the pressure from the actuation line of the discharge pressure switch, if not already completed.
2. Depress the plunger on top of the switch until the top of the plunger is flush with the top of the pressure port. An audible click should be heard.

Hand-Over Procedures

The entire system shall be thoroughly inspected to make sure that it is complete and that all tests required during installation have been properly carried out. In addition, the following items are important:

1. Refill or replace a container when it shows a loss in agent quantity of more than 5% or a loss in pressure of more than 10% when adjusted for temperature (25 bar at 20 °C (360 psi at 70 °F)). Refer to the Temperature Correction table in Section 8 - Recharging for pressures at other container temperatures.
2. Check the container weight information label against system requirements. If there is any doubt, or if there has been a loss of weight, the container must be weighed.
3. Ensure that the system is armed and the actuating systems are operational.
4. Ensure that adequate escape routes with directional signs are provided. Issue of the appropriate documentation shall constitute completion of the Hand-over procedure.

Appropriate records shall be issued by fire and insurance authorities as to the suitability, acceptability, and availability of the system for the hazard area.

Completion Procedures

For ease of reference, completion procedures may be subdivided into the following sections:

- Pre-checks and visual inspections
- Final connections
- Hand over procedures

⚠CAUTION

The completion of the installation system, commissioning tests, and hand over may occur before the area is ready for use. In the event of a delay between the hand over and the risk area being available for protection, the system must be left in a **safe** condition (isolation of actuation system) to avoid accidental discharge. The system must only be made operative once the area for protection has been completed and is operational.

INSPECTION, SERVICE, AND MAINTENANCE

Systems shall be thoroughly inspected and tested for proper operation by an Authorized Johnson Controls Distributor in accordance with *NFPA 2001, ISO14520, EN15004*, and any other standard accepted by the Authority Having Jurisdiction. Before any checks are carried out, complete the following steps:

1. Ensure that the suppression system is isolated electrically and mechanically.
2. Remove all electrical and pneumatic actuators.

No maintenance work should be carried out without obtaining approval from the responsible person and advising any personnel within the hazard area. The following program should be carried out in addition to the user's program of inspection. The user shall be provided with a signed and dated report of the inspection advising any rectification carried out or needed.

SIX MONTH INSPECTION

Check the condition of all actuators by completing the following steps:

1. Remove all actuators from the container valves.
2. Check the manual, pneumatic, manual-pneumatic, and CPM actuator by completing the following steps:
   a. Check the condition of each actuator ensuring that they operate freely.
   b. Reset the actuator ensuring the pin is in the non-fired position.
3. Check the electric actuators by completing the following steps:
   a. Make certain that all wires are properly connected.
   b. Test-fire the actuator and ensure that the pin operates freely.
   c. Reset the actuator ensuring that the pin is in the non-fired position.
4. Test and service all electrical detection and alarm systems as recommended by the relevant NFPA standards and any other standard accepted by the Authority Having Jurisdiction.
5. Externally inspect containers for signs of damage or unauthorized modifications.
6. Check that the container labels are securely mounted and legible.
7. Check all container brackets and fittings.
8. Examine the container pressure gauge reading and refer to the temperature correction table. If the container pressure, after adjusting for temperature, is below 10% of the stated pressure, the container shall be recharged or replaced.
9. Verify the FM-200 fill weight in the containers through either liquid level detection or container weighing. If containers exceed an agent loss of more than 5%, the container shall be refilled or replaced.
10. Check the condition of the piping to make certain it is properly secured in the hangers and all fittings are connected tightly. Look for signs of damage or corrosion. Repair the pipework, if necessary.
11. Inspect the nozzles by completing the following steps:
    a. Inspect for dust and debris. Clean out where necessary.
    b. Ensure that the correct distribution pattern, nozzle orifice code, and orientation are maintained.
12. Carry out a full visual check of the enclosure and confirm that the dimensions and the configuration of the hazard match the latest approved drawings. If the drawings are not available, dimensions and calculations should be made as per Section 5 - System Design.
13. Check all warning signs throughout the area ensuring that they are in place, mounted securely, are readable, and are not damaged.
14. Check the condition of the control panel for tampering, corrosion, or damage. To test the panel, complete the following step:
    • Refer to the appropriate control system manual, for example, an *AUTOPULSE control system* manual.
15. Check that all detectors are in accordance with *NFPA 72* and complete the following steps:
    a. Make certain they are in place, clean, and not damaged.
    b. Check the sensitivity of each detector per the instruction of the detector manufacturer, if required. See the appropriate *Control System* manual for detailed instructions.
16. While checking the detectors and electric pull station, inspect each alarm device by completing the following steps:
    a. Check the condition of the alarm.
    b. Verify that the alarm operates correctly when energized.
    c. Reset the alarm circuit after each test.
17. Check all manual release stations by completing the following steps:
    a. Make certain that the stations are in place and are not blocked or damaged.
    b. Operate each manual release station to confirm that the control panel operates correctly.
    c. Reset each manual release station.
18. Examine all system hoses for damage. If visual examination shows any deficiency, the hose shall be replaced.

CONTAINER WEIGHING

To determine the level of agent in the FM-200 containers, they must be weighed. The weighing procedure is as follows:

1. Remove all actuation devices and pneumatic actuation pipe or tubing and flexible electrical connectors.
2. Disconnect and remove the discharge piping and hoses from the container valves.
3. Install outlet safety caps onto the container valves.
4. Remove the containers from the bracketing and weigh the containers. If the weight loss exceeds 5% of the weight of charge, the container requires recharging by a qualified recharge fill station.
5. Record the weight of the container on a record tag.
6. Replace the containers in the bracketing and remove the outlet safety caps.
7. Reconnect discharge piping / discharge hoses and all actuation devices. Reconnect pneumatic actuation pipe or tubing and flexible electric connectors.

MEASURING LIQUID LEVELS WITH PORTABLE DEVICES

As an alternative to container weighing, agent containers can be liquid leveled using, for example, a hand held ultrasonic device to determine the liquid level height of the FM-200 agent within the container for a given temperature. This data, together with the internal container dimensions and the physical properties of the FM-200 agent, can then be used to calculate the FM-200 agent weight. Contact Johnson Controls Technical Services for further information on this methodology.

Note: This methodology is not UL / FM Approved.

MEASURING LIQUID LEVELS WITH AN INBUILT MECHANICAL DEVICE (106 L, 147 L, 180 L, AND 343 L WELDED CONTAINERS ONLY)

Use the liquid level measuring device to determine the liquid FM-200 level in 106 L, 147 L, 180 L, and 343 L container assemblies. During a maintenance examination, a service representative can use the measuring device to convert a linear measurement to agent weight in order to determine if the tank has any weight loss. This measurement is accomplished without removing the container from the fire suppression system.

To measure the liquid FM-200 level:

1. Remove the protective cap from the measuring device housing.
2. Lift the measuring tape to the end (or approximately 75 mm (3 in.) above the expected level). Slowly lower the tape until a magnetic interlock is felt (see Figure 7-1).

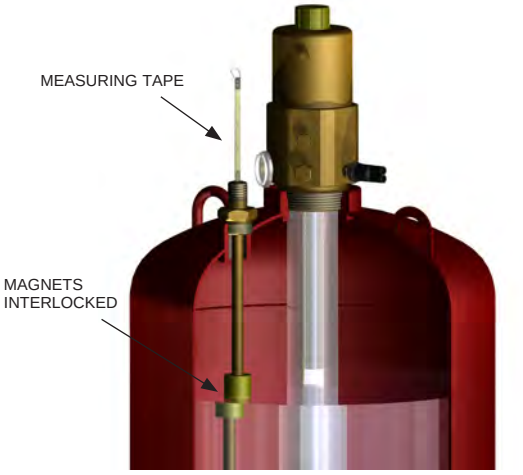


FIGURE 7-1
LIQUID LEVEL MEASURING DEVICE
E001145

3. Read the measurement on the tape directly at the top of the plastic sleeve in the measuring device housing (see Figure 7-2). Record this measurement and note the temperature of the container module.

NOTICE

The container module temperature can be determined by measuring the ambient temperature at the container location. The container must be stored at this temperature for at least 24 hours to obtain an accurate liquid level reading.

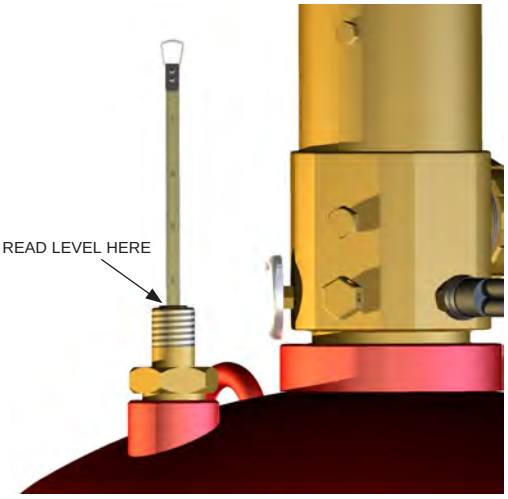


FIGURE 7-2
READING THE LIQUID LEVEL
E001146

4. To reinstall tape, quickly pull on the tape to disengage the magnetic interlock. Then slide the tape into the housing and replace the protective cap.

MEASURING LIQUID LEVELS WITH AN INBUILT MECHANICAL DEVICE (106 L, 147 L, 180 L, AND 343 L WELDED CONTAINERS ONLY) (Continued)

5. Using the Weight Conversion Table located in Section 9 - Appendix, determine the FM-200 weight of charge as follows:
   a. Find the liquid level reading along the left hand vertical line of the table.
   b. From that point, follow the horizontal line to the point where it intersects with the temperature column (using the FM-200 tank temperature noted in Step 3).
   c. Read the weight of FM-200 at the level / temperature column intersection.
6. Compare the weight from the table to the weight of charge stamped on the container nameplate. If the measurement shows a net weight loss of more than 5%, the tank must be weighed to verify the liquid level measurement. If the weight loss still exceeds 5% of the weight of charge, the container requires recharging.

Example: Using the Container Weight Conversion Table

A semi-annual weight check is being performed on a 180 L (450 lb) FM-200 tank filled with 137 kg (301 lb) of FM-200. The temperature of the container is 16 °C (60 °F). The liquid level measuring device reading is 36.2 cm. (14.25 in.).

Find the 36.2 cm (14.25 in.) line on the left side of the 180 L (450 lb) container table and read horizontally across the table to the 16 °C (60 °F) column. Then, by reading the weight of FM-200 at the level/temperature column intersection, it is determined that the weight of FM-200 is 136 kg (299.2 lb).

To determine if this is within the 5% weight loss tolerance, multiply the weight of charge (taken from the container nameplate) by 0.95 to determine the minimum weight of FM-200 required in this container:

137 kg x 0.95 = 130 kg (301 lb x 0.95 = 286 lb)

Because the measured weight of FM-200, 136 kg (299.2 lb) is more than the minimum required FM-200 weight of 130 kg (286 lb), the weight of FM-200 is within the 5% weight loss tolerance.

If the measured weight had been less than the 5% weight loss tolerance, the container should be weighed to verify the liquid level measurement. If the weight loss still exceeds 5% of the weight of charge, the container must be recharged.

INTEGRITY TEST

For integrity testing, refer to *EN 15004, NFPA 2001, and ISO 14520.* These references state the following information:

EN 15004, 9.2.4.1: At least every 12 months, it shall be determined whether boundary penetration or other changes to the protected enclosure have occurred that could affect leakage and fire suppression agent performance. If this cannot be visually determined, it shall be positively established by repeating the test for enclosure integrity in accordance with *Annex E*.

NFPA 2001 7.4: Enclosure Inspection. Other than as identified in *NFPA 2001 7.4.1,* the enclosure protected by the clean agent shall be inspected at least every 12 months to determine if penetrations have occurred that could lead to agent leakage, and if other changes have occurred that could change the volume of the hazard, or both.

Where the inspection indicates conditions that could result in the inability of the enclosure to maintain the clean agent concentration, the conditions shall be corrected. If uncertainty still exists, the enclosure shall be retested in accordance with the relevant standard.

FIVE YEAR INSPECTION

Hoses shall be tested every five years. Refer to the relevant standards and national regulations for detailed testing requirements.

25 YEAR ELECTRICAL ACTUATOR LIFESPAN

The removable electrical actuator has a life span of 25 years from manufacture, which is indicated on the label, and should be replaced before this date is reached.

PERIODIC CONTAINER HYDROTESTING

Refer to the Authority Having Jurisdiction (AHJ) or national regulations for requirements.

PERSONNEL TRAINING

All persons who may be expected to inspect, test, maintain, or operate the fire suppression system shall be kept adequately trained in the functions they are expected to perform. Personnel working in an enclosure protected by a gaseous suppressant shall receive training in the operation and use of the system and safety issues.

FINAL INSPECTION

When carrying out a final visual inspection of the system and the protected area, complete the following steps:

1. Ensure that all equipment has been reinstalled and reconnected properly.
2. Ensure any associated control panel is displaying normal operation.
3. Complete the site log book, recording work carried out and parts used.
4. Inform the responsible person the work is complete and the system is back online.

NOTES:

RECHARGING

Decompression Screw

Following a discharge, follow these steps to release the Nitrogen trapped in the pneumatic actuation line:

1. Remove the cap.
2. Using a flat screwdriver, remove the internal cap.
3. Reverse the internal cap and reinstall in the decompression screw. The hexagon faces outwards. Fit the cap back onto the unit and begin to tighten using a 6 mm Allen wrench. As you tighten, pressure escapes from the pneumatic actuation line.
4. When all internal pressure has been vented, unscrew the cap, remove the internal cap, and reinstall in its original orientation.
5. Refit the cap checking that its o-ring retains in its groove.

Removing Containers

⚠ CAUTION

Make certain that the containers contain no pressure before removing valves. If a container contains pressure, removing a valve could cause violent container movement, causing personnel injury or property damage.

Remove the empty FM-200 fire suppression agent containers from the system installation by removing the actuators, either electrical or pneumatic, removing piping and the discharge hose from the valve outlet and removing empty containers from brackets. Transport the containers to an authorized fill station. Valve refurbishment and refilling are conducted as described below.

Rebuilding the valve

In order to maintain Factory Mutual approval, use factory filled SAPPHIRE fire suppression agent containers or refill at Factory Mutual approved FM facility. To rebuild the valves, complete the following steps:

1. Container valves must be rebuilt. All o-rings and the valve core must be replaced before recharging the containers.
2. Refurbish the valves. The o-ring and valve core kit (Item 3) is a mandatory part number. Items 1, 2, 4, 5, and 6 in Table 8-1 are optional components. See Figure 8-1.

Refurbishing the valve

For refurbishment of the 25 mm (1 in.), 50 mm (2 in.), and 80 mm (3 in.) container valves, follow these steps:

1. Remove the valve and siphon tube assembly from the container.
2. Remove the siphon tube locking screw to allow removal of the siphon tube from the valve for containers up to 180 L. For 343 L containers, remove the siphon tube and adaptor assembly using an adaptor wrench.
3. Remove the hex head cap screw that holds the recoil cap chain to the valve body.
4. Remove the bonnet locking screw from the same port as the socket head cap screw removed in Step 3. The 80 mm (3 in.) valve does not use a locking grubscrew. Unscrew the bonnet assembly for 25 mm (1 in.) and 50 mm (2 in.) valves. Use a wrench (Part No. 21891 (570574). Remove and discard the o-ring from the bonnet assembly. Unscrew the top cap for the 80 mm (3 in.) valve. Remove and discard the body o-ring.
5. Remove the piston assembly by pushing up on it from the bottom of the valve.
6. Visually inspect the main seal on the bottom of the piston assembly for damage. If necessary, replace with a new piston assembly. If there is no visual damage, the piston can be reused with a new upper o-ring.
7. Remove and discard the collar o-ring and siphon tube o-ring. The siphon tube o-ring is only for 25 mm (1 in.) and 50 mm (2 in.) valves.
8. Clean all internal valve surfaces. Use caution not to cause any scratching to surfaces.
9. Use an o-ring kit or a piston assembly kit to replace with all new o-rings, bonnet, collar, and siphon tube. Apply PTFE silicone lubrication to all a-rings before installing the components. Spray a small quantity of PTFE silicone to the bore of the valve. Lubricate the top cap o-ring with PTFE silicone and install into the upper groove on the 80 mm (3 in.) valve.
10. Install the piston assembly.

TABLE 8-1: VALVE REBUILDING COMPONENTS

Item	Component	25 mm (1 in.) Part No.	50 mm (2 in.) Part No.	80 mm (3 in.) Part No.
1.	Bonnet	20818	20822	570298
2a.	Piston assembly	16855	19490	570885
2b.	Piston assembly o-ring and valve core kit	309.209.127	309.209.128	309.209.129 (570880)
3.	O-ring and valve core kit	309.209.133	309.209.134	309.209.135 (570373)
4.	Outlet safety cap	21170	21171	68701 (570600)
5.	Burst disc	26108 **or** 21981		15330 (570300)
6.	Pressure gauge	302.205.026 **or** 302.202.025 **or** 30220032		302.202.025 **or** 30220032
7.	Valve refurbishment kit	309.209.125	309.209.126	309.209.124

RECHARGING (Continued)

Refurbishing the valve (Continued)

11. Install the bonnet assembly and tighten with a spanner or wrench for 25 mm (1 in.) and 50 mm (2 in.) valves. Install the top cap on the 80 mm (3 in.) valve body and hand tighten.
12. Install a valve core into the bonnet/top cap using a torque wrench. For the ALLIGATOR valve core (Part No. 20672), use a torque of 0.25 to 0.56 N•m (0.184 to 0.413 ft-lb). For an alternative SCHRADER valve core (Part No. 12625) use a torque of 0.4 to 0.8 N•m (0.295 to 0.590 ft-lb). The torque wrench (Part No. 20933) supplied in the valve refurbishment tool kit is calibrated to 0.45 N•m (0.332 ft-lb) for use with both the ALLIGATOR and SCHRADER valve core.
13. For 25 mm and 50 mm valves, install and tighten the bonnet locking screw. Using the socket head cap screw and washer and fasten the chain to the container valve body.
14. Do not install the valve into the container until Step 9 in Recharging Instructions on page 8-4.
15. The valve is now ready for a functional and leak test.
16. Refer to halocarbon refill procedures for detailed steps on valve refurbishment.

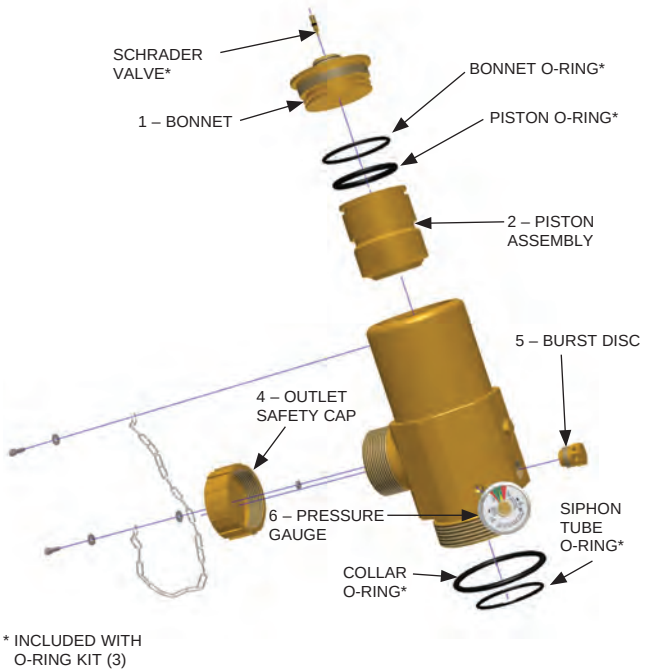


FIGURE 8-1
25 mm / 50 mm (1 IN. / 2 IN.) CONTAINER VALVE
009706

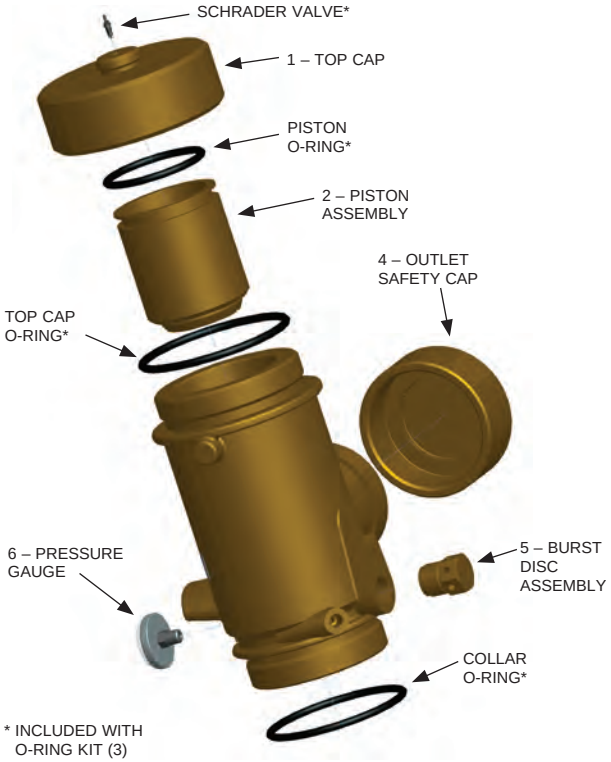


FIGURE 8-2
80 mm (3 IN.) CONTAINER VALVE
009707

*ALLIGATOR is a trademark of its respective owner.

VALVE TESTING

On completion of valve rebuilding, the valve assembly requires two tests; a function test and a leak test.

The tests must be conducted using a nitrogen source, a test bottom cap, close down adaptor, and an outlet filling adaptor assembly.

TABLE 8-2: VALVE TESTING COMPONENTS

Filling valve size	Bottom Test Cap Part No.	Top Closing Adaptor Part No.	Outlet Filling Adaptor Part No.
25 mm (1 in.)	12058 (570272)	300.209.200	300.209.013
50 mm (2 in.)	12062 (570276)	300.209.200	300.209.011
80 mm (3 in.)	570374	300.209.200	300.209.018

The valve assembly is assembled to the test bottom cap. The outlet filling adaptor assembly is assembled to the valve outlet. Attach the nitrogen line and ensure the vent valve on the outlet filling adaptor assembly is closed.

Function Test Procedure

To carry out a function test, complete the following steps:

1. Fit the closing down adaptor to the top cap / bonnet valve assembly.
2. Set the nitrogen regulator to 25 bar (360 psi) and slowly allow pressure through needle valve to the valve through the bottom cap until nominal charge pressure is achieved.
3. Close needle valve 1.
4. Set the nitrogen regulator to 40 bar (580 psi).
5. Open and close the ball valve twice to close the valve piston.
6. Slowly open the filling adaptor vent valve to release pressure trapped between the closed piston and outlet.
7. Verify that 25 bar (360 psi) pressure is maintained on the pressure gauge. Hold this pressure for one minute to ensure that there is no drop in pressure.
8. Set the nitrogen regulator to 34 bar (493 psi) and slowly allow pressure through the needle valve to the valve through the bottom cap until maximum charge pressure is achieved.

Leak Test Procedure

To carry out a leak test, apply water and soap solution or leak detection spray to all leak paths.

Note: Leak test the bonnet valve core prior to removing the outlet filling adaptor assembly when checking for leaks at the valve outlet. If a leak is detected, it must be rectified and retested. If the leak persists, reject the valve assembly.

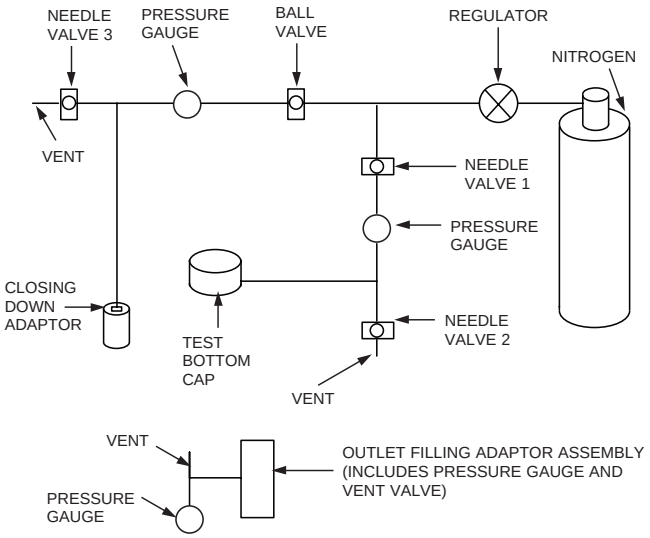


FIGURE 8-3
TESTING STATION CONFIGURATION
009742

RECHARGING INSTRUCTIONS

Figure 8-4 illustrates a typical recharge station configuration; a closed system arrangement to minimize the risk of moisture contamination.

⚠ WARNING

Use the appropriate high pressure regulator.

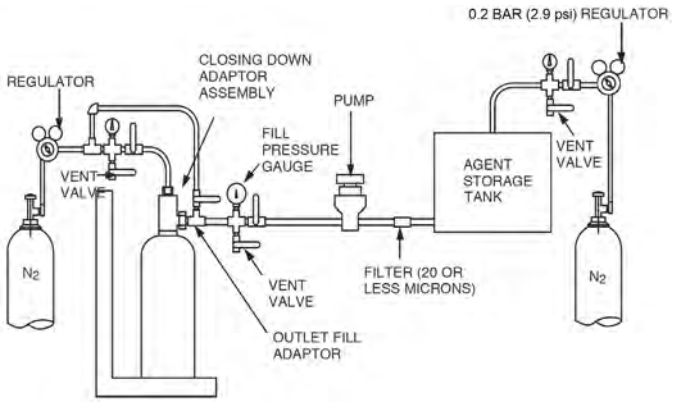


FIGURE 8-4
FILLING CONNECTIONS
E001522

To recharge, complete the followings steps:

1. The outlet of the agent storage container requires an inline filter of 20 micron or smaller. The agent must be pumped into the container.
2. Visually inspect the inside of the container. It must be clean inside.
3. Rebuild the valve. See Rebuilding the Valve and Valve Testing on pages 8-1 to 8-3.
4. Fit the siphon tube into the base of the valve and rotate until the locking screw hole in the siphon tube is aligned with the siphon tube locking screw hole in the valve base. Install the siphon tube locking screw for containers up to 180 L.
5. Purge the container with dry nitrogen until a relative humidity (RH) of 4% or below is achieved. Use a Nitrogen purging kit, Part No. 300.209.032.
6. For 343 L containers, refit the siphon tube and adaptor assembly using an adaptor wrench with a torque to 68 N•m (50.2 ft-lb) and reinstall the valve assembly. For containers up to 180 L reinstall the valve and siphon assembly.
7. Tighten the container valve to a torque of between 65 N•m to 100 N•m (47.9 ft-lb to 73.7 ft-lb) for all container types using a torque kit.

TABLE 8-3: TORQUE KIT DETAILS

Torque kit Part No.	Valve Size	Container Type
300209037	25 mm (1 in.)	Seamless / Welded / PESO
300209038	50 mm (2 in.)	Seamless / Welded / PESO
300.209.004	80 mm (3 in.)	Welded

Note: Adjust the torque wrench to the required torque value. For 25 mm (1 in.) and 50 mm (2 in.) valve kits, a calibrated torque wrench is provided. For the 80 mm (3 in.) valve torque kit, locally source a standard torque wrench and adjust to the required torque setting.

8. Fill the container with the correct amount of agent by weight and nitrogen by pressure. See the nameplate for this information and refer to Table 8-4 for tolerances.
9. Pressure verification must be achieved through a calibrated pressure gauge. Pressure verification using the pressure indicator mounted on the valve is not permissible.
10. Close the fill adaptor ball valve.
11. Vent the fill line and disconnect it. Agitate the container for 60 cycles. Reconnect the fill line, pressurize to the target pressure and open the fill adaptor ball valve to verify the correct pressure.
12. Close the container valve by using the Closing Down Adaptor Assembly (Part No. 300.209.200) as follows:
    a. Set the regulator to 40 bar (580 psi).
    b. Pressurize the closing down adaptor assembly by opening and closing the valve twice in rapid succession to close the piston.
13. Vent pressure from the container valve outlet.
14. Remove the closing down adaptor assembly. Leak check the valve core with water and soap solution or leak detection spray. Install a safety cap on the valve outlet.
15. Let the container assembly stand for 12 hours.
16. Check the container valve for leaks using one of the procedures listed on page 8-8.
17. Check the container gauge pressure based on Table 8-5 and the SAPPHIRE developed pressure chart in Section 9 - Appendix.
18. Replace the recharged containers in the bracket and follow the **Installation** procedures to put the system back in service.
19. Inform the appropriate personnel that the system is back in service.

RECHARGING INSTRUCTIONS (Continued)

TABLE 8-4: FILL TOLERANCES

Container Size	Fill Tolerance Weight	Tolerance Pressure
Seamless containers		
15 L	-0, +0.100 kg (-0, +0.22 lb)	-0 bar, +0.75 bar, (3% of nominal charge pressure) (-0 psi, +11 psi,)
30 L	-0, +0.150 kg (-0, +0.33 lb)	
34 L	-0, +0.170 kg (-0, +0.37 lb)	
45 L	-0, +0.225 kg (-0, +0.50 lb)	
60 L	-0, +0.300 kg (-0, +0.66 lb)	
80 L	-0, +0.400 kg (-0, +0.88 lb)	
120 L	-0, +0.600 kg (-0, +1.32 lb)	
140 L	-0, +0.700 kg (-0, +1.54 lb)	
150 L	-0, +0.750 kg (-0, +1.65 lb)	
180 L	-0, +0.900 kg (-0, +1.98 lb)	
Welded containers		
4.5 L*	-0, +0.100 kg (-0, +0.22 lb)	-0 bar, +0.75 bar, (3% of nominal charge pressure) (-0 psi, +11 psi,)
8 L	-0, +0.100 kg (-0, +0.22 lb)	
16 L	-0, +0.100 kg (-0, +0.22 lb)	
32 L	-0, +0.160 kg (-0, +0.35 lb)	
52 L	-0, +0.260 kg (-0, +0.57 lb)	
106 L	-0, +0.530 kg (-0, +1.17 lb)	
140 L	-0, +0.700 kg (-0, +1.54 lb)	
147 L	-0, +0.740 kg (-0, +1.63 lb)	
180 L	-0, +0.900 kg (-0, +1.98 lb)	
343 L	-0, +1.720 kg (-0, +3.79 lb)	

Note: *For 4.5 L minimum fill of 2.5 kg, ensure the targeted fill is 2.5 kg +0.05 to 0.1 kg.

RECHARGING INSTRUCTIONS (Continued)

TABLE 8-5: TEMPERATURE CORRECTION TABLE (METRIC)

Temp. (ºC)	Fill density: 1.0 kg/L 25 bar at 20 ºC (bar)
-20	15.4
-19	15.6
-18	15.9
-17	16.1
-16	16.3
-15	16.6
-14	16.8
-13	17.1
-12	17.3
-11	17.5
-10	17.8
-9	18.0
-8	18.3
-7	18.5
-6	18.7
-5	19.0
-4	19.2
-3	19.5
-2	19.7
-1	19.9
0	20.2
1	20.4
2	20.7
3	20.9
4	21.2
5	21.4
6	21.6
7	21.9
8	22.1
9	22.4
10	22.6
11	22.8
12	23.1
13	23.3
14	23.6
15	23.8
16	24.0
17	24.3
18	24.5
19	24.8
20	**25.0**
21	25.2
22	25.5
23	25.7
24	26.0
25	26.2
26	26.4
27	26.7
28	26.9
29	27.2
30	27.4
31	27.6
32	27.9
33	28.1
34	28.4
35	28.6
36	28.8
37	29.1
38	29.3
39	29.8
40	30.2
41	30.5
42	30.8
43	31.2
44	31.5
45	31.8
46	32.2
47	32.5
48	32.8
49	33.1
50	33.5
51	33.8
52	34.1
53	34.5
54	34.8
55	35.1

RECHARGING INSTRUCTIONS (Continued)

TABLE 8-6: TEMPERATURE CORRECTION TABLE (IMPERIAL)

Temp. (°F)	Fill Density: 1.0 kg/L 360 psi at 70 °F
-4	216.72
-3	218.65
-2	220.59
-1	222.53
0	224.46
1	226.40
2	228.33
3	230.27
4	232.21
5	234.14
6	236.08
7	238.02
8	239.95
9	241.89
10	243.82
11	245.76
12	247.70
13	249.63
14	251.57
15	253.51
16	255.44
17	257.38
18	259.31
19	261.25
20	263.19
21	265.12
22	267.06
23	269.00
24	270.93
25	272.87
26	274.80
27	276.74
28	278.68
29	280.61
30	282.55
31	284.49
32	286.42
33	288.36
34	290.29
35	292.23
36	294.17

Temp. (°F)	Fill Density: 1.0 kg/L 360 psi at 70 °F
36	294.17
37	296.10
38	298.04
39	299.98
40	301.91
41	303.85
42	305.78
43	307.72
44	309.66
45	311.59
46	313.53
47	315.47
48	317.40
49	319.34
50	321.27
51	323.21
52	325.15
53	327.08
54	329.02
55	330.96
56	332.89
57	334.83
58	336.76
59	338.70
60	340.64
61	342.57
62	344.51
63	346.45
64	348.38
65	350.32
66	352.25
67	354.19
68	356.13
69	358.06
70	**360.00**
71	361.94
72	363.87
73	365.81
74	367.74
75	369.68
76	371.62
77	373.55

Temp. (°F)	Fill Density: 1.0 kg/L 360 psi at 70 °F
78	375.49
79	377.43
80	379.36
81	381.30
82	383.23
83	385.17
84	387.11
85	389.04
86	390.98
87	392.92
88	394.85
89	396.79
90	398.72
91	400.66
92	402.60
93	404.53
94	406.47
95	408.41
96	410.34
97	412.28
98	414.21
99	416.15
100	418.09
101	423.30
102	425.96
103	428.63
104	431.29
105	433.95
106	436.61
107	439.27
108	441.93
109	444.59
110	447.25
111	449.91
112	452.57
113	455.23
114	457.89
115	460.55
116	463.21
117	465.87
118	468.53
119	471.20

Temp. (°F)	Fill Density: 1.0 kg/L 360 psi at 70 °F
120	473.86
121	476.52
122	479.18
123	481.84
124	484.50
125	487.16
126	489.82
127	492.48
128	495.14
129	497.80
130	500.46
131	503.12

CONTAINER AND VALVE ASSEMBLY LEAKAGE TEST

A leakage test is required for all filled FM-200 system valves and container assemblies after being left to stand in a bonded area for at least 12 hours. Two test options are available. The first test option includes a leak detector and calibration gas. The second test option utilizes a submerged water bath leak test.

Mass Spectrometer Leak Test

HALOCARBON LEAK DETECTOR TEST

Conduct testing in an area free of agent contamination. When conducting a halocarbon leak detector test, complete the following steps:

1. After 12 hours standing, check the valve pressure gauge for pressure loss. Refer to the temperature correction chart to adjust for temperature change.
2. Check the container and valve assembly for a leakage using the halocarbon leak detector unit.
3. Take the halocarbon leak detector unit and calibration gas and within the agent free environment, calibrate the unit.
4. Conduct a stability check by leaving the halocarbon leak detector for approximately three minutes in a clean air environment. If the detector remains in the **no alarm state**, proceed to the repeatability check.

   If the stability check is inconclusive, repeat the stability check in an alternative clean environment. If stability problems persist, contact Johnson Controls Technical Services for instruction.
5. A leak standard (Part No. 315.205.010), from Great Yarmouth, UK only, of 0.13 oz per year should be conditioned to a temperature of 20 °C ± 5 °C (68 °F ± 9 °F) for at least 24 hours.
6. Conduct a **calibration repeatability test**.
7. Remove the cap from the leak standard, screw the calibration nozzle into the outlet of the bottle and open the hand valve fully.
8. Place the halocarbon leak detector probe into the calibration nozzle. Within 5 seconds the detector registers an alarm.
9. Remove the probe from the nozzle and position the halocarbon leak detector unit away from the gas source. The detector should revert back to the original no alarm state within 15 seconds.
10. Repeat the test two more times. If the repeatability test indicates that the unit is functioning within the set parameters, proceed to the **container leak test**.

    If the repeatability check is inconclusive, repeat the check in an alternative clean environment. If repeatability problems persist, contact the Johnson Controls Technical Services for instructions. Close the hand valve of the leak standard after use.

CONTAINER LEAK TEST

When conducting a container leak test, complete the following steps:

Carefully probe the container / valve assembly at all probes and openings. Ensure that the probe is not brought into direct contact with any objects as this can lead to spurious results. Ensure the dwell time of the probe is sufficiently long, more than 5 seconds, to ensure any leak is detected. Any significant and repeatable **alarm state** should be taken as an indication of a leak and the container and valve assembly should be rejected.

Once the leakage source has been rectified, the container and valve assembly should be subjected to another leak test using the halocarbon leak detector unit.

A **calibration repeatability test** of the electronic leak detector should be conducted after every five units or each 30 minute period.

The leak standard is supplied with a calibration certificate valid for 12 months from the date of filling subject to the minimum charge pressure not being exceeded. When ordering from Great Yarmouth, UK, the refill and recalibration of an empty FM-200 leak standard can be achieved by returning the empty leak standard under part number 315.205.011 in accordance with normal ordering procedures.

Submerged Leak Test

The second option is a water bath test. The charged samples are placed in a water bath for a period of no less than one hour. A transparent collection apparatus is placed over each sample to collect any escaping agent or nitrogen gas. The one hour period begins after all air bubbles appearing in the device at the start of the test have been removed and the water bath is at the required temperature.

COMMISSIONING SCHEDULE (EXAMPLE)

Client:	
Commissioned by:	
Address:	
Date:	
Project:	
Project reference:	
Address:	
Protected area:	

General instructions			
Step		**Complete**	**Notes**
1	Advise all personnel working in or near the protected area of audible or visual alarms.		
2	Advise the client of any equipment which will be switched off during the tests.		
3	Remeasure the protected area and confirm that the quantity of agent supplied is adequate for the measured volume.		
4	Check that the system is installed in accordance with the drawings or note any changes to the system against the drawings.		
5	Before carrying out any further checks, ensure the suppression system is isolated electrically and mechanically. Remove all pneumatic actuators, if fitted.		

Electrical checklist - Systems with main and reserve containers			
Step		**Complete**	**Notes**
1	Carry out the checks described on pages 9-2 to 9-3 for the **main** container bank.		
2	Carry out the checks described on pages 9-2 to 9-3 for the **reserve** container bank.		

Electrical checklist - Systems with automatic electrical detection (coincidence operation)			
Step		**Complete**	**Notes**
1	Place the system in automatic mode and check lamps are amber on control panel and all status units.		
2	Operate one detection zone.		
3	Check fire alarm sounds.		
4	Check suppressant release solenoid does not operate.		
5	Switch system to manual mode and check lamps are green on control panel and all status/indicator units.		
6	Operate second detection zone.		
7	Check suppressant release solenoid does not operate.		
8	Switch system to automatic mode with two detection zones still in alarm.		
9	Check evacuation alarm sounds.		
10	Check A/C shutdowns.		
11	Check that the suppressant release solenoid operates after preset time delay.		
12	Check the operation of the ‘suppressant released’ pressure switch. Upon operation, check that red lamps are lit on the control panel and all status units.		
13	Reset the pressure switch and then reset the fire alarm system.		
14	Check the operation of each electrical manual release unit in turn.		
15	Check the fire alarm and evacuation alarm sounds.		
16	Check that the suppressant release solenoid operates after preset time delay.		

COMMISSIONING SCHEDULE (Continued)

Electrical checklist - Systems with automatic electrical detection (coincidence operation)			
Step		**Complete**	**Notes**
17	Reset the system. Ensure frangible washers are refitted to the manual release units.		
18	If system is in compliance with *NFPA 2001*, fire detection components shall be approved in accordance with the relevant part of *UL 2166* and *FM 5600*, whichever applies.		
19	If system is in compliance with *NFPA 2001*, manual operating devices shall be approved in accordance with *UL 2166* and *FM 5600*.		
20	If system is in compliance with *NFPA 2001*, electrical automatic control and delay devices shall be approved in accordance with *UL 2166* and *FM 5600*.		

Electrical checklist - Systems with automatic electrical detection (single zone operation)			
Step		**Complete**	**Notes**
1	Place the system in manual mode and check that lamps are green on the control panel and all status units.		
2	Operate the detection system.		
3	Check that the fire alarm sounds.		
4	Check that the suppressant release solenoid does not operate.		
5	Switch the system to automatic mode with the detection system still in alarm and the check lamps are amber on the control panel and all status units.		
6	Check evacuation alarm sounds.		
7	Check A/C shutdowns.		
8	Check that the suppressant release solenoid operates after the preset time delay.		
9	Check the operation of the ‘suppressant released’ pressure switch. Upon operation, check that the red lamps are lit on the control panel and all status / indicator units.		
10	Reset the pressure switch and then reset the fire alarm system.		
11	Check the operation of each electrical manual release unit in turn.		
12	Check that the fire alarm and evacuation alarm sound.		
13	Check that the suppressant release solenoid operates after the preset time delay.		
14	Reset the system.		

Electrical checklist - Systems with electrical manual release only			
Step		**Complete**	**Notes**
1	Operate each electrical manual release unit in turn.		
2	Check fire alarm and evacuation alarm sounds.		
3	Check all A/C shutdowns.		
4	Check that the suppressant release solenoid operates after the preset time delay.		
5	Check the operation of the ‘suppressant released’ pressure switch. Upon operation, check that the red lamps are lit on the control panel, if applicable, and all status / indicator units.		
6	Reset the pressure switch and then reset the fire alarm system. Ensure frangible washers are refitted to the manual release units.		

COMMISSIONING SCHEDULE (Continued)

Electrical checklist - Systems with hold switches			
Step		**Complete**	**Notes**
1	With the system in an inactive state, depress the hold switch. Check that a system fault generates.		
2	Initiate the suppressant release sequence and during the delay period, depress the hold switch. Check that the release sequence is interrupted and the solenoid does not operate.		
3	Release the hold switch and check that the preset time delay restarts from zero and after the preset time delay solenoid operates.		
4	If the system is in compliance with *NFPA 2001,* electrical automatic control and delay devices shall be approved in accordance with *UL* and *FM.*		

Electrical checklist - Systems with abort switches			
Step		**Complete**	**Notes**
1	With system in an inactive state, depress the abort switch. Check that a system fault generates.		
2	With the system in automatic mode, initiate the suppressant release sequence and during the delay period, depress the abort switch. Check that the release sequence is interrupted and the solenoid does not operate.		
3	Check that the system status reverts to manual mode after the operation of the abort switch.		
4	If the system is in compliance with *NFPA 2001*, stop devices shall be approved in accordance with *UL 2166* and *FM 5600.*		

Other items			
Step		**Complete**	**Notes**
1	Detach the solenoid flexible lead and check that the system fault is generated.		
2	Check that the adequate and appropriate visual and audible warning devices are incorporated into the system.		
3	Record the time delay. This should not normally exceed 30 seconds but must be adequate for safe exiting from the protected area.		
4	Confirm that all A/C systems link into the suppression system to shutdown prior to or upon release of gas and these have been checked.		

COMMISSIONING SCHEDULE (Continued)

Mechanical checklist - Pipework and nozzles			
Step		**Complete**	**Notes**
1	Check that pipes and fittings are to the correct standard.		
2	Check that pipework supports have been fitted at the correct intervals and are adequate for the purpose.		
3	Check that all nozzles are fitted in accordance with the design requirements and are aimed in the correct alignment away from obstructions or barriers that could prevent adequate distribution or mixing of the gas.		
4	Check that all pipes and nozzles are adequately braced against the reaction to discharge.		
5	Check that the pipework has been painted and is properly identified.		
6	Purge the pipework to confirm it is continuous and free from debris.		
7	Remove the nozzles to check they are free of debris following the purge.		
8	Conduct a pressure test of the pipework in accordance with the requirements of the applicable design standard.		
9	Steps 6 to 8 may be omitted from the commissioning procedure if written evidence is available that the pipework was purged and pressure tested at an appropriate stage during installation.		
10	Check that dust caps are fitted, if required.		
11	If the nozzle drill size is 3 mm or less, ensure that the nozzle filter is included.		

Mechanical checklist - Containers			
Step		**Complete**	**Notes**
1	Check that the containers are safe from mechanical damage, corrosion, or unauthorised interference.		
2	Check that the container brackets are fitted and all bolts are tightened.		
3	Check that all containers are fitted with instruction plates properly completed.		

Record agent container details here:

Area protected	**Containers**		**FM-200 Quantity**		**Pressure (bar)**	**Temperature (°C)**	**Corrections required (Yes / No)**
	Size (L)	**Serial number**	**Design (kg)**	**Actual (kg)**			

COMMISSIONING SCHEDULE (Continued)

Record pilot container details here:

Area Protected	Containers		Pilot gas	Pressure (bar)	Temperature °C	Corrections required (Yes / No)
	Size	Serial number				

Ancillary equipment			
Step		**Complete**	**Notes**
1	Check that all 'suppressant released' pressure switches are fitted and are securely fixed to wall.		
2	Check that all pressure trips are fitted in the correct plane and are securely fixed.		
3	Check that the pneumatic actuation tubing is firmly fixed.		
4	Check that all pneumatic actuation tubing connections are tight.		
5	Check all pneumatic actuators, pressure switches and pressure trips operate at 5.2 bar (75.4 psi) or lower using the pneumatic test kit (Part No. 300.203.004).		
6	Check the integrity of the pilot line, actuators, pressure switches, and pressure trips by testing at 117 bar (1697 psi) with the pneumatic test kit.		
7	Check that any dampers close and fibreglass curtains drop correctly to fully cover the openings.		
8	Check that supervisory pressure switches are fitted to the agent containers, if required.		
9	Check that supervisory pressure switches are fitted to the pilot containers.		
10	Check that the solenoid flexible lead is correctly fitted and secured using a fixing screw.		
11	Upon completion of all checks, ensure the solenoid is reset and fit the solenoid to the master container. Ensure it is tightened correctly.		
12	On systems utilising a local manual actuator, check that the safety pin is fitted.		
13	Ensure the local manual actuator is reset and fit to the master container. Ensure it is tightened correctly.		
14	Ensure pneumatic actuators are reset and fit to containers as required and ensure are correctly tightened.		
15	Check that door caution plates are fitted at all doors into the protected areas.		
16	Check that manual release caution plates are fitted at all manual control points.		

Enclosure integrity			
Step		**Complete**	**Notes**
1	Record whether a Room Integrity Test has been performed on the protected area.		
2	If not, visually inspect the perimeter of the area and record any leakage areas.		
3	If so, record whether a satisfactory retention time was obtained.		
4	If a Room Integrity Test has not been performed, this must be brought to the customer's attention.		

Completion			
Step		**Complete**	**Notes**
1	On completion, ensure the client is informed of any outstanding actions on their part and confirm these actions in writing.		
2	Obtain the signature of the client's representative on the handover certificate and leave a copy for the client.		

SERVICING AND MAINTENANCE SCHEDULE (EXAMPLE)

Client:	
Serviced by:	
Address:	
Date:	
Project:	
Project reference:	
Address:	
Protected area:	

General instructions			
Steps		**Complete**	**Notes**
1	Advise all personnel working in or near to the protected area of possible audible or visual alarms.		
2	Advise the client of any equipment to be switched off during the tests.		
3	Check that the character of the hazard has not altered. If in doubt, contact the Suppression Design Engineer.		
4	Before carrying out any further checks, ensure the suppression system is isolated electrically and mechanically. Remove all electrical or pneumatic actuators, if fitted.		

Electrical checklist - Systems with main and reserve containers			
Steps		**Complete**	**Notes**
1	Carry out checks described in pages 9-7 to 9-8 for the **main** container bank.		
2	Carry out checks described in pages 9-7 to 9-8 for the **reserve** container bank.		

Electrical checklist - Systems with automatic electrical detection (coincidence operation)			
Steps		**Complete**	**Notes**
1	Place the system in automatic mode and that the check lamps are amber on the control panel and all status units.		
2	Operate one detection zone.		
3	Check that the fire alarm sounds.		
4	Check that the suppressant release solenoid does not operate.		
5	Switch the system to manual mode and check that the lamps are green on the control panel and all status units.		
6	Operate the second detection zone.		
7	Check that the suppressant release solenoid does not operate.		
8	Switch the system to automatic mode with two detection zones still in alarm.		
9	Check that the evacuation alarm sounds.		
10	Check the A/C shutdowns.		
11	Check that the suppressant release solenoid operates after the preset time delay.		
12	Check the operation of the ‘suppressant released’ pressure switch. Upon operation, check that the red lamps are lit on the control panel and on all status units.		
13	Reset the pressure switch and then reset the fire alarm system.		
14	Check the operation of each electrical manual release unit in turn.		

SERVICING AND MAINTENANCE SCHEDULE (Continued)

Electrical checklist - Systems with automatic electrical detection (coincidence operation)			
Steps		**Complete**	**Notes**
15	Check fire alarm and evacuation alarm sounds.		
16	Check that the suppressant release solenoid operates after preset time delay.		
17	Reset the system. Ensure frangible washers are refitted to the manual release units.		

Electrical checklist - Systems with automatic electrical detection (single zone operation)			
Steps		**Complete**	**Notes**
1	Place the system in manual mode and check that the lamps are green on the control panel and on all status units.		
2	Operate the detection system.		
3	Check that the fire alarm sounds.		
4	Check that the suppressant release solenoid does not operate.		
5	Switch the system to automatic mode with the detection system still in alarm and check that the lamps are amber on the control panel and on all status units.		
6	Check that the evacuation alarm sounds.		
7	Check that the A/C shutdowns.		
8	Check that the suppressant release solenoid operates after the preset time delay.		
9	Check the operation of the ‘suppressant released’ pressure switch. Upon operation, check that the red lamps are lit on the control panel and all status and indicator units.		
10	Reset the pressure switch and then reset the fire alarm system.		
11	Check the operation of each electrical manual release unit in turn.		
12	Check that the fire alarm and evacuation alarm sounds.		
13	Check that the suppressant release solenoid operates after the preset time delay.		
14	Reset the system. Ensure that the seals are refitted to the manual release units.		

Electrical checklist - Systems with electrical manual release only			
Steps		**Complete**	**Notes**
1	Operate each electrical manual release unit in turn.		
2	Check that the fire alarm and evacuation alarm sounds.		
3	Check all A/C shutdowns.		
4	Check that the suppressant release solenoid operates after the preset time delay.		
5	Check the operation of the suppressant released pressure switch. Upon operation, check that the red lamps are lit on the control panel, if applicable, and on all status units.		
6	Reset the pressure switch and then reset the fire alarm system. Ensure frangible washers are refitted to the manual release units.		

SERVICING AND MAINTENANCE SCHEDULE (Continued)

Electrical checklist - Systems with hold switches			
Steps		**Complete**	**Notes**
1	With systems in an inactive state, depress the hold switch. Check that a system fault generates.		
2	Initiate the suppressant release sequence and during the delay period, depress the hold switch, check that the release sequence is interrupted and the solenoid does not operate.		
3	Release the hold switch and check that the preset time delay restarts from zero and after the preset time delay, the solenoid operates.		

Electrical checklist - Systems with abort switches			
Steps		**Complete**	**Notes**
1	With system in an inactive state, depress the abort switch. Check that a system fault generates.		
2	With the system in automatic mode, initiate the suppressant release sequence and during the delay period, depress the abort switch. Check that the release sequence is interrupted and the solenoid does not operate.		
3	Check that the system status reverts to manual mode after the operation of the abort switch.		

Other items			
Steps		**Complete**	**Notes**
1	Detach the solenoid flexible lead and check that a system fault generates.		
2	Check that adequate and appropriate visual and audible warning devices are incorporated into the system.		
3	Record the time delay. This should not normally exceed 30 seconds but must be adequate for safe exiting from the protected area.		
4	Confirm that all A/C systems are linked into the suppression system to shutdown prior to, or upon release of gas and these have been checked.		

SERVICING AND MAINTENANCE SCHEDULE (Continued)

Mechanical checklist - Pipework and nozzles			
Steps		**Complete**	**Notes**
1	Check that the pipework has not been altered or tampered with since the last visit.		
2	Check that pipework supports have been fitted at the correct intervals and are adequate for the purpose.		
3	Check that all nozzles are fitted in accordance with the design requirements and are aimed in the correct alignment away from obstructions or barriers that could prevent adequate distribution or mixing of the gas.		
4	Check that all pipes and nozzles are adequately braced against the reaction to discharge.		
5	Check that the pipework has been painted and properly identified.		
6	If any doubt exists concerning the integrity of the pipework, arrange for it to be purged. Remove the nozzles and check they are free of debris following the purge.		
7	Check that dust caps are fitted, if required. If not, check the nozzles for blockages. If in doubt, purge the system.		

Mechanical checklist - Containers			
Steps		**Complete**	**Notes**
1	Check that containers are safe from mechanical damage, corrosion, or unauthorised interference.		
2	Check that container brackets are fitted and that all bolts are tightened.		
3	Check that all containers are fitted with instruction plates properly completed.		
4	Note any containers requiring a hydrostatic test.		

Record agent container details here:

	Containers		**FM-200 Quantity**				
Area protected	**Size (L)**	**Serial number**	**Design (kg)**	**Actual (kg)**	**Pressure (bar)**	**Temperature (°C)**	**Corrections required (Yes / No)**

SERVICING AND MAINTENANCE SCHEDULE (Continued)

Record pilot container details here:

Area protected	Containers		Pilot gas	Pressure (bar)	Temp °C	Corrections required (Yes / No)
	Size (L)	Serial number				

Ancillary equipment			
Steps		**Complete**	**Notes**
1	Check that all 'suppressant released' pressure switches are fitted and are securely fixed to the wall.		
2	Check that all pressure trips are fitted in the correct plane and are securely fixed.		
3	Check that the pneumatic actuation tubing is firmly fixed.		
4	Check that all pneumatic actuation tubing connections are tight.		
5	Check all pneumatic actuators, pressure switches and pressure trips operate at 5.2 bar (75.4 psi) or lower using Pneumatic Test Kit (Part No. 300.203.004).		
6	Check that any dampers close and that fibreglass curtains drop correctly to fully cover the openings.		
7	Check that the solenoid flexible lead is correctly fitted and secured using a fixing screw.		
8	Upon completion of all checks, ensure that the solenoid is reset and fit solenoid to master container. Ensure it is tightened correctly.		
9	Check that the safety pin is fitted to the local manual actuator.		
10	Ensure that the local manual actuator is reset and fits to the master container. Ensure it is tightened correctly.		
11	On systems utilising a local manual actuator, check that the safety pin is fitted.		
12	Ensure the pneumatic actuators are reset and fit to the containers, as required, and ensure they are tightened correctly.		
13	Check that door caution plates are fitted at all doors into the protected areas.		
14	Check that manual release caution plates are fitted at all manual control points.		

SERVICING AND MAINTENANCE SCHEDULE (Continued)

Enclosure integrity			
Step		**Complete**	**Notes**
1	Record whether a Room Integrity Test has been performed on the protected area.		
2	If not, visually inspect the perimeter of the area and record any leakage areas.		
3	If so, record whether a satisfactory retention time was obtained.		

Completion			
Step		**Complete**	**Notes**
1	On completion of the visit, ensure the client is informed of any equipment or deficiencies requiring attention and that details are recorded on the docket.		
2	Obtain the signature of the client's representative on the docket and leave a copy for the client.		

NOTES:

FM-200 FIRE SUPPRESSION AGENT SAFETY DATA SHEET (SDS)

The SDS document in this section is a sample reference only. Technically, SDS information is country and language specific. Refer to the link below for the most recent and applicable version:

www.FireProductsds.com

Note: To find the SDS, enter the part number of a product containing agent.

(FOR REFERENCE ONLY)

Safety Data Sheet

This safety data sheet complies with the requirements of: Regulation (EC) No. 1907/2006

Product name FM-200 Fire Protection Fluid (HFC -227ea)

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product Identifier

Product code 303205300
Product name FM-200 Fire Protection Fluid (HFC -227ea)

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended use No information available

Uses advised against No information available

1.3. Details of the supplier of the safety data sheet

Company Name
Macron Safety Systems (UK) Ltd.
Burlingham House, Hewett Road
Gapton Hall Industrial Estate, Great Yarmouth
United Kingdom NR31 0NN
Telephone: +44 (0) 1493 417600

For further information, please contact

psra@tycofp.com

1.4. Emergency telephone number

CHEMTREC 001-800-424-9300 or 001-703-527-3887

National Poisons Information Centre (NPIC)
+353-1809 2566

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

(FOR REFERENCE ONLY)

Regulation (EC) No 1272/2008
Gases Under Pressure - Compressed Gas - (H280)

2.2. Label Elements



Signal Word
WARNING

Hazard Statements
H280 - Contains gas under pressure; may explode if heated

Precautionary Statements
P410 + P403 - Protect from sunlight. Store in a well-ventilated place

2.3. Other Hazards
The components in this formulation do not meet the criteria for classification as PBT or vPvB.

SECTION 3: Composition/information on ingredients

3.1 Substances

Not Applicable

3.2 Mixture

Chemical name	Index No	EC No	CAS No	weight-%	Classification according to Regulation (EC) No. 1272/2008 [CLP]	REACH registration number
Heptafluoropropane		207-079-2	431-89-0	90 - 100%	Press. Gas (H280)	no data available

Full text of H- and EUH-phrases: see section 16

SECTION 4: First aid measures

4.1. Description of first aid measures

Inhalation Remove to fresh air. If breathing is difficult, give oxygen. (Get medical attention immediately if symptoms occur.).

Skin contact Wash skin with soap and water. Get medical attention if irritation develops and persists.

Eye Contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a doctor.

Ingestion Rinse mouth. Do not induce vomiting without medical advice. If swallowed, call a poison control centre or physician immediately.

4.2. Most important symptoms and effects, both acute and delayed

(FOR REFERENCE ONLY)

Symptoms Unconsciousness.

4.3. Indication of any immediate medical attention and special treatment needed

Note to doctors Treat symptomatically.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable Extinguishing Media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable Extinguishing Media
None

5.2. Special hazards arising from the substance or mixture

None known.

Hazardous Combustion Products Carbon oxides. Fluorinated oxides.

5.3. Advice for firefighters

Wear self-contained breathing apparatus and protective suit. Use personal protective equipment as required.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

Ensure adequate ventilation, especially in confined areas.

Use personal protection recommended in Section 8.

6.2. Environmental precautions

Prevent further leakage or spillage if safe to do so. Prevent entry into waterways, sewers, basements or confined areas. See Section 12 for additional Ecological Information.

6.3. Methods and material for containment and cleaning up

Methods for Containment Prevent further leakage or spillage if safe to do so.

Methods for Cleaning Up Pick up and transfer to properly labelled containers.

6.4. Reference to other sections

See section 8 for more information. See section 13 for more information.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Advice on safe handling

(FOR REFERENCE ONLY)

Avoid contact with skin and eyes. Handle in accordance with good industrial hygiene and safety practice.

General hygiene considerations
Do not eat, drink or smoke when using this product. Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities

Storage Conditions
Keep containers tightly closed in a dry, cool and well-ventilated place.

7.3. Specific end use(s)

Specific Use(s)
Fire extinguishing agent.

Risk Management Methods (RMM)
The information required is contained in this Safety Data Sheet.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Exposure Limits .

Chemical name	Czech Republic	Russia	Hungary	Greece	Sweden
Heptafluoropropane 431-89-0		MAC: 3000 mg/m^3			

Derived No Effect Level (DNEL) No information available.

Predicted No Effect Concentration (PNEC) No information available.

8.2. Exposure controls

Engineering controls Ensure adequate ventilation, especially in confined areas.

Personal Protective Equipment

Eye/Face Protection Avoid contact with eyes. Tight sealing safety goggles.

Hand protection Wear protective natural rubber, nitrile rubber, Neoprene™ or PVC gloves. Gloves must conform to standard EN 374.

Skin and Body Protection Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.

Respiratory Protection In case of insufficient ventilation, wear suitable respiratory equipment. Wear a respirator conforming to EN 140 with Type A filter or better.

Environmental exposure controls No information available.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical State Compressed liquefied gas
Odour Characteristic **Colour** Colourless
Odour Threshold No data available

(FOR REFERENCE ONLY)

Property	Values	Remarks • Method
pH		No data available
Melting Point / Freezing Point		No data available
Boiling point / boiling range	-2 °C	
Flash Point		No data available
Evaporation Rate		No data available
Flammability (solid, gas)		No data available
Flammability limit in air		
Upper flammability limit:		No data available
Lower flammability limit:		No data available
Vapour Pressure		No data available
Vapour Density		No data available
Specific gravity		No data available
Water Solubility		No data available
solubility(ies)		No data available
Partition coefficient		No data available
Autoignition Temperature		No data available
Decomposition Temperature		No data available
Kinematic viscosity		No data available
Dynamic viscosity		No data available
Explosive Properties	No data available	
Oxidising Properties	No data available	

SECTION 10: Stability and reactivity

10.1. Reactivity

No data available.

10.2. Chemical stability

Stable under recommended storage conditions.

10.3. Possibility of hazardous reactions

None under normal processing.

Hazardous Polymerisation
Hazardous polymerisation does not occur.

10.4. Conditions to avoid

Extremes of temperature and direct sunlight.

10.5. Incompatible materials

Strong oxidising agents. Strong acids. Strong bases.

10.6. Hazardous decomposition products

Carbon oxides. Fluorinated oxides.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute Toxicity

(FOR REFERENCE ONLY)

Product information

.

Inhalation	In high concentration the gas may cause a suffocation. Victim may not be aware of asphyxiation. In confined or poorly ventilated areas, vapours can readily accumulate and can cause unconsciousness and death.
Eye Contact	Contact with product may cause frostbite.
Skin contact	Contact with product may cause frostbite.
Ingestion	Not an expected route of exposure.

Skin Corrosion/Irritation	No information available.
Serious eye damage/eye irritation	No information available.
Sensitisation	No information available.
Germ Cell Mutagenicity	No information available.
Carcinogenicity	No information available.

Reproductive Toxicity	Lack of oxygen during pregnancy has produced developmental abnormalities in humans and experimental animals.
STOT - Single Exposure	No information available.
STOT - Repeated Exposure	No information available.
Symptoms	Unconsciousness.
Aspiration Hazard	No information available.

SECTION 12: Ecological information

12.1. Toxicity

12.2. Persistence and degradability

No information available.

12.3. Bioaccumulative potential

No information available.

12.4. Mobility in soil

No information available.

12.5. Results of PBT and vPvB assessment

The components in this formulation do not meet the criteria for classification as PBT or vPvB.

12.6. Other adverse effects

No information available

(FOR REFERENCE ONLY)

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste from Residues/Unused Products	Disposal should be in accordance with applicable regional, national and local laws and regulations.
Contaminated Packaging	Do not re-use container.

SECTION 14: Transport information

IMDG

14.1 UN/ID no	UN3296
14.2	
Proper Shipping Name	Heptafluoropropane
14.3 Hazard class	2.2
14.4 Packing group	NOT REGULATED
Description	UN3296, Heptafluoropropane, 2.2
14.5	
14.6 Special Provisions	None
EmS-No	F-C, S-V
14.7 Transport in Bulk According to Annex II of MARPOL 73/78 and the IBC CODE	No information available

RID

14.1 UN/ID no	UN3296
14.2	
Proper Shipping Name	Heptafluoropropane
14.3 Hazard class	2.2
14.4 Packing group	NOT REGULATED
Description	UN3296, Heptafluoropropane, 2.2
14.5 Environmental Hazard	Not Applicable
Classification Code	2A
14.6 Special Provisions	None

ADR

14.1 UN/ID no	UN3296
14.2	
Proper Shipping Name	Heptafluoropropane
14.3 Hazard class	2.2
Labels	2.2
14.4 Packing group	NOT REGULATED
Description	UN3296, Heptafluoropropane, 2.2, (C/E)
14.5 Environmental Hazard	Not Applicable
14.6 Special Provisions	None
Classification Code	2A
Tunnel restriction code	(C/E)

ICAO (air)

14.1 UN/ID no	UN3296
14.2	
Proper Shipping Name	Heptafluoropropane
14.3 Hazard class	2.2
14.4 Packing group	NOT REGULATED

(FOR REFERENCE ONLY)

Description	UN3296, Heptafluoropropane, 2.2
14.5 Environmental Hazard	Not Applicable
14.6 Special Provisions	None

IATA

14.1 UN/ID no	UN3296
14.2	
Proper Shipping Name	Heptafluoropropane
14.3 Hazard class	2.2
14.4 Packing group	NOT REGULATED
Description	UN3296, Heptafluoropropane, 2.2
14.5 Environmental Hazard	Not Applicable
14.6 Special Provisions	None
ERG Code	2L

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

Germany
Water hazard class (WGK) slightly hazardous to water (WGK 1)

European Union

Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work

Authorisations and/or restrictions on use:
This product does not contain substances subject to authorisation (Regulation (EC) No. 1907/2006 (REACH), Annex XIV) This product does not contain substances subject to restriction (Regulation (EC) No. 1907/2006 (REACH), Annex XVII)

Persistent Organic Pollutants
Not Applicable

Ozone-depleting substances (ODS) regulation (EC) 1005/2009 Not Applicable

International Inventories

TSCA	Complies
DSL/NDSL	Complies
ENCS	Complies
IECSC	Complies
KECL	Does not comply
PICCS	Complies
AICS	Complies

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances

15.2. Chemical safety assessment

Chemical safety assessments for substances in this mixture were not carried out.

SECTION 16: Other information

Key or legend to abbreviations and acronyms used in the safety data sheet

Legend
SVHC: Substances of Very High Concern for Authorisation:

Legend SECTION 8: Exposure controls/personal protection

TWA	TWA (time-weighted average)	STEL	STEL (Short Term Exposure Limit)
Ceiling	Maximum limit value	*	Skin designation

Revision date 03-Sep-2020

Revision note Not Applicable.

This material safety data sheet complies with the requirements of Regulation (EC) No. 1907/2006

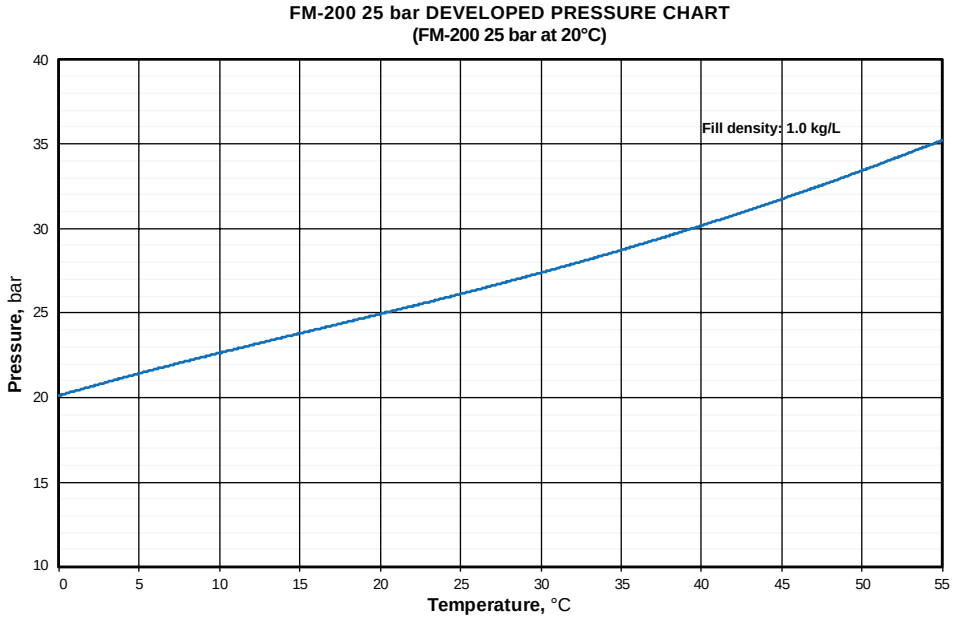
Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

End of Safety Data Sheet

NOTES:

DEVELOPED PRESSURE CHART

Use this chart in accordance with Table 8-5 (metric) or 8-6 (imperial) in Section 8 - Recharging Procedure.



ACTUATION LINE LENGTH LIMITATIONS

Refer to Tables 9-1 to 9-3 for the additional actuation line length limitations for modular, manifolded, and selector valve system configurations.

Pipe Conversion Factor

If one system uses different types of actuation lines, use the pipe conversion factor to determine the maximum total actuation line length. The basis is the maximum length for 6 mm copper tube.

Example:

- Manifolded system, AUTOMAN II-C release, 1 x agent master + 7 x subordinates. Connection between AUTOMAN II-C release and agent master with 1/4 in. copper tube, master to all subordinates with 1/4 in. flexible hose.
- Connection master to 7 subordinates requires 7 flexible hoses =
  7 × 0.71 m = 4.97 m (7 × 2.3 ft = 16.1 ft)
  Converted length = 4.97 m × 2.3 (conversion factor) = 11.4 m
  16.1 ft × 2.3 (conversion factor) = 37.0 ft
- Total maximum length of 6 mm copper tube = 60 m (196.8 ft)
- Remaining length of 6 mm copper tubing =
  60 m - 11.4 m = 48.6 m
  (196.8 ft - 37.4 ft = 159.4 ft)
- 48.6 m (159.4 ft) of 6 mm copper tubing has an equivalent length of 48.6 m / 1.3 (conversion factor 1/4 in. copper tube) = 37.38 m (122.6 ft) of 1/4 in. copper tube.
- 37.38 m (122.6 ft) of 1/4 in. copper tube is the maximum length between the AUTOMAN II-C release and the master container.

Notes:

1. If different types of actuation lines are used in one system, the pipe type with the shortest maximum length determines the maximum total actuation line length.
2. Selector valve systems generally actuate with a pilot container.
3. For systems with more than 12 agent containers or other system configurations, contact Johnson Controls regional Technical Services.

ACTUATION LINE LENGTH LIMITATIONS (Continued)

TABLE 9-1: MODULAR (NO MANIFOLD) SYSTEM CONFIGURATION

Actuation Source	Maximum Number of Agent Containers	Type of Actuation Line	Actuation Line Dimensions	Maximum Length of Actuation Line		Pipe Conversion Factor	Comment
Master	1 x master + 9 x subordinates	Dia 6 mm copper pipe	6 mm x 1 mm (0.24 in. x 0.04 in.)	30.0 m	98.0 ft	1	Total length of actuation line from master container to all subordinate containers including discharge pressure switch connection, if installed.
		Dia 1/4 in. copper tube	6.35 mm x 0.9 mm (0.25 in. x 0.04 in.)	23.1 m	75.8 ft	1.3	
		Dia 1/4 in. steel pipe	13.7 mm x 2.24 mm (0.54 in. x 0.09 in.)	30.5 m	100.0 ft	–	
Pilot Container	11 x subordinates	Dia 6 mm copper pipe	6 mm x 1 mm (0.24 in. x 0.04 in.)	60.0 m	197.0 ft	1	Total length of actuation line from pilot container to all subordinate containers including discharge pressure switch connection, if installed.
		Dia 1/4 in. copper tube	6.35 mm x 0.9 mm (0.25 in. x 0.04 in.)	46.4 m	152.0 ft	1.3	
		Dia 1/4 in. steel pipe	13.7 mm x 2.24 mm (0.54 in. x 0.09 in.)	36.6 m	120.0 ft	–	
	1 x sub-master + 9 x subordinates	Dia 6 mm copper pipe + DN1/4 in. flexible hose (Part No. 306.205.003)	6 mm x 1 mm (0.24 in. x 0.04 in.) + DN1/4 in. hose x 710 mm (27.9 in.)	60.0 m + 13.0 m	197.0 ft + 42.7 ft	1.0 and 2.3	Total length of actuation line from pilot container to sub-master container and from sub-master container to all subordinate containers including discharge pressure switch connection, if installed.
		Dia 1/4 in. copper tube + DN1/4 in. flexible hose (Part No. 306.205.003)	6.35 mm x 0.9 mm (0.25 in. x 0.04 in.) + DN1/4 in. hose x 710 mm (27.9 in.)	46.4 m + 13.0 m	152.0 ft + 42.7 ft	1.3 and 2.3	
		Dia 1/4 in. steel pipe + DN1/4 in. flexible hose (Part No. 306.205.003)	13.7 mm x 2.24 mm (0.54 in. x 0.09 in.) + DN1/4 in. hose x 710 mm (27.9 in.)	36.6 m + 13.0 m	120.0 ft + 42.7 ft	–	
AUTOMAN II-C release	11 x subordinates	Dia 6 mm copper pipe	6 mm x 1 mm (0.24 in. x 0.04 in.)	60.0 m	197.0 ft	1	Total length of actuation line from AUTOMAN II-C release to all subordinate containers including discharge pressure switch connection, if installed.
		Dia 1/4 in. copper tube	6.35 mm x 0.9 mm (0.25 in. x 0.04 in.)	46.4 m	152.0 ft	1.3	
		Dia 1/4 in. steel pipe	13.7 mm x 2.24 mm (0.54 in. x 0.09 in.)	36.6 m	120.0 ft	–	

ACTUATION LINE LENGTH LIMITATIONS (Continued)

TABLE 9-1: MODULAR (NO MANIFOLD) SYSTEM CONFIGURATION (Continued)

Actuation Source	Maximum Number of Agent Containers	Type of Actuation Line	Actuation Line Dimensions	Maximum Length of Actuation Line		Pipe Conversion Factor	Comment
AUTOMAN II-C release	1 x sub-master + 9 x subordinates	Dia 6 mm copper pipe + DN1/4 in. flexible hose (Part No. 306.205.003)	6 mm x 1 mm (0.24 in. x 0.04 in.) + DN1/4 in. hose x 710 mm (27.9 in.)	60.0 m + 13.0 m	197.0 ft + 42.7 ft	1 and 2.3	Total length of actuation line from AUTOMAN II-C release to sub-master container and from sub-master container to all subordinate containers including discharge pressure switch connection, if installed.
		Dia 1/4 in. copper tube + DN1/4 in. flexible hose (Part No. 306.205.003)	6.35 mm x 0.9 mm (0.25 in. x 0.04 in.) + DN1/4 in. hose x 710 mm (27.9 in.)	46.4 m + 13.0 m	152.0 ft + 42.7 ft	1.3 and 2.3	
		Dia 1/4 in. steel pipe + DN1/4 in. flexible hose (Part No. 306.205.003)	13.7 mm x 2.24 mm (0.54 in. x 0.09 in.) + DN1/4 in. hose x 710 mm (27.9 in.)	36.6 m + 13.0 m	120.0 ft + 42.7 ft	–	

ACTUATION LINE LENGTH LIMITATIONS (Continued)

TABLE 9-2: MANIFOLDED SYSTEM CONFIGURATION

Actuation Source	Maximum Number of Agent Containers	Type of Actuation Line	Actuation Line Dimensions	Maximum Length of Actuation Line		Pipe Conversion Factor	Comment
Master	1 x master + 9 x subordinates	Dia 6 mm copper pipe	6 mm x 1 mm (0.24 in. x 0.04 in.)	30.0 m	98.0 ft	1	Total length of actuation line from master container to all subordinate containers including discharge pressure switch connection, if installed.
		Dia 1/4 in. copper tube	6.35 mm x 0.9 mm (0.25 in. x 0.04 in.)	23.1 m	75.8 ft	1.3	
		Dia 1/4 in. steel pipe	13.7 mm x 2.24 mm (0.54 in. x 0.09 in.)	30.5 m	100.0 ft	–	
		DN1/4 in. flexible hose (Part No. 306.205.003)	DN1/4 in. hose x 710 mm (27.9 in.)	13.0 m	42.7 ft	2.3	
Pilot Container	11 x subordinates	Dia 6 mm copper pipe	6 mm x 1 mm (0.24 in. x 0.04 in.)	60.0 m	197.0 ft	1	Total length of actuation line from pilot container to all subordinate containers including discharge pressure switch connection, if installed.
		Dia 1/4 in. copper tube	6.35 mm x 0.9 mm (0.25 in. x 0.04 in.)	46.4 m	152.0 ft	1.3	
		Dia 1/4 in. steel pipe	13.7 mm x 2.24 mm (0.54 in. x 0.09 in.)	36.6 m	120.0 ft	–	
		DN1/4 in. flexible hose (Part No. 306.205.003)	DN1/4 in. hose x 710 mm (27.9 in.)	26.1 m	86.0 ft	2.3	
	1 x sub-master + 9 x subordinates	Dia 6 mm copper pipe + DN1/4 in. flexible hose (Part No. 306.205.003)	6 mm x 1 mm (0.24 in. x 0.04 in.) + DN1/4 in. hose x 710 mm (27.9 in.)	60.0 m + 13.0 m	197.0 ft + 42.7 ft	1 and 2.3	Total length of actuation line from pilot container to sub-master container and from sub-master container to all subordinate containers including discharge pressure switch connection, if installed.
		Dia 1/4 in. copper tube + DN1/4 in. flexible hose (Part No. 306.205.003)	6.35 mm x 0.9 mm (0.25 in. x 0.04 in.) + DN1/4 in. hose x 710 mm (27.9 in.)	46.4 m + 13.0 m	152.0 ft + 42.7 ft	1.3 and 2.3	
		Dia 1/4 in. steel pipe + DN1/4 in. flexible hose (Part No. 306.205.003)	13.7 mm x 2.24 mm (0.54 in. x 0.09 in.) + DN1/4 in. hose x 710 mm (27.9 in.)	36.6 m + 13.0 m	120.0 ft + 42.7 ft	–	
AUTOMAN II-C release	11 x subordinates	Dia 6 mm copper pipe	6 mm x 1 mm (0.24 in. x 0.04 in.)	60.0 m	197.0 ft	1	Total length of actuation line from AUTOMAN II-C release to all subordinate containers including discharge pressure switch connection, if installed.
		Dia 1/4 in. copper tube	6.35 mm x 0.9 mm (0.25 in. x 0.04 in.)	46.4 m	152.0 ft	1.3	
		Dia 1/4 in. steel pipe	13.7 mm x 2.24 mm (0.54 in. x 0.09 in.)	36.6 m	120.0 ft	–	

ACTUATION LINE LENGTH LIMITATIONS (Continued)

TABLE 9-2: MANIFOLDED SYSTEM CONFIGURATION (Continued)

Actuation Source	Maximum Number of Agent Containers	Type of Actuation Line	Actuation Line Dimensions	Maximum Length of Actuation Line		Pipe Conversion Factor	Comment
AUTOMAN II-C release	1 x sub-master + 9 x subordinates	Dia 6 mm copper pipe + DN1/4 in. flexible hose (Part No. 306.205.003)	6 mm x 1 mm (0.24 in. x 0.04 in.) + DN1/4 in. hose x 710 mm (27.9 in.)	60.0 m + 13.0 m	197.0 ft + 42.7 ft	1 and 2.3	Total length of actuation line from AUTOMAN II-C release to sub-master container and from sub-master container to all subordinate containers including discharge pressure switch connection, if installed.
		Dia 1/4 in. copper tube + DN1/4 in. flexible hose (Part No. 306.205.003)	6.35 mm x 0.9 mm (0.25 in. x 0.04 in.) + DN1/4 in. hose x 710 mm (27.9 in.)	46.4 m + 13.0 m	152.0 ft + 42.7 ft	1.3 and 2.3	
		Dia 1/4 in. steel pipe + DN1/4 in. flexible hose (Part No. 306.205.003)	13.7 mm x 2.24 mm (0.54 in. x 0.09 in.) + DN1/4 in. hose x 710 mm (27.9 in.)	36.6 m + 13.0 m	120.0 ft + 42.7 ft	–	

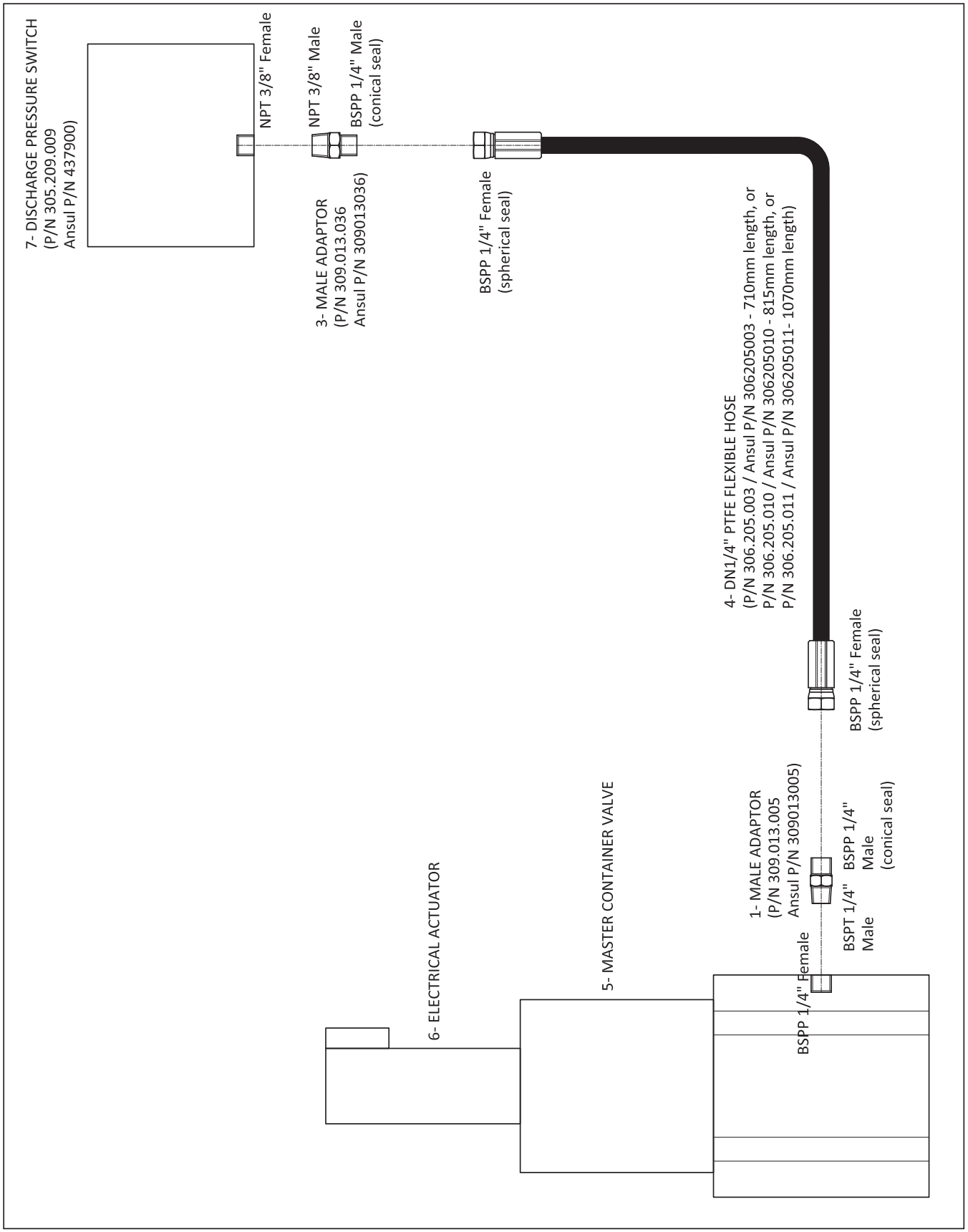
TABLE 9-3: SELECTOR VALVE SYSTEM CONFIGURATION

Actuation Source	Maximum Number of Agent Containers	Type of Actuation Line	Actuation Line Dimensions	Actuation Line Maximum Length		Pipe Conversion Factor	Comment
Pilot container	11 x subordinates	Dia 6 mm copper pipe	6 mm × 1 mm (0.24 in. × 0.04 in.)	28.0 m	92.0 ft	1.0	Total length of actuation line from pilot container to selector valve actuator, and from selector valve actuator to selector valve, and from selector valve to all assigned subordinate containers.
		Dia 1/4 in. copper tube	6.35 mm × 0.9 mm (0.25 in. × 0.04 in.)	21.6 m	71.0 ft	1.3	

ACTUATION LINE SCHEMATICS

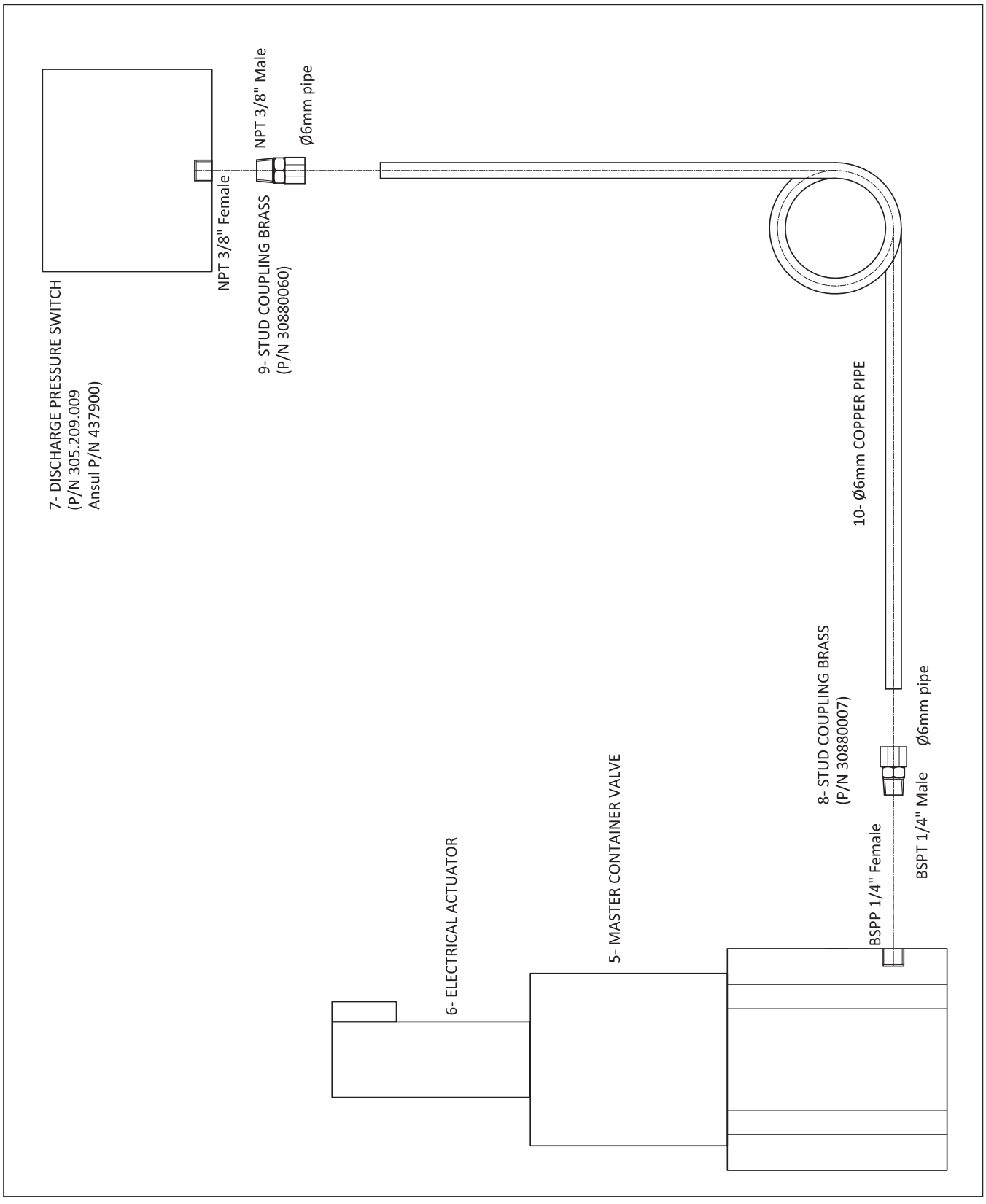
SCHEMATIC	PAGE
Single Container - Single Hazard Dia 1/4 in. PTFE Flexible Hose	9-28
Single Container - Single Hazard Dia 6 mm Copper Pipe	9-29
Single Container - Single Hazard Dia 1/4 in. Copper Tube	9-30
Multiple Container - Single Hazard Master / Subordinate Container DN 1/4 in. Flexible Hose	9-31
DN 1/4 in. PTFE Flexible Hose - Option	9-32
Multiple Container - Single Hazard Master / Subordinate Container Dia 6 mm Copper Pipe	9-33
Multiple Container - Single Hazard Master / Subordinate Container Dia 1/4 in. Copper Tube	9-34
Multiple Container - Single Hazard Pilot Container DN 1/4 in. PTFE Flexible Hose	9-35
Multiple Container - Single Hazard Pilot Container with Sub-Master Container Dia 6 mm Copper Pipe / PTFE Flexible Hose	9-36
Multiple Container - Single Hazard Pilot Container with Sub-Master Container Dia 1/4 in. Copper Tube / DN 1/4 in. PTFE Flexible Hose	9-37
Multiple Container - Single Hazard Pilot Container Dia 6 mm Copper Pipe	9-38
Multiple Container - Single Hazard Pilot Container Dia 1/4 in. Copper Tube	9-39
Multiple Container - Single Hazard AUTOMAN II-C release Dia 6 mm Copper Pipe	9-40
Multiple Container - Single Hazard AUTOMAN II-C release Dia 1/4 in. Copper Tube	9-41
Multiple Container - Single Hazard AUTOMAN II-C release with Sub-Master Container Dia 6 mm Copper Pipe / DN 1/4 in. PTFE Flexible Hose	9-42
Multiple Container - Single Hazard AUTOMAN II-C release with Sub-Master Container Dia 1/4 in. Copper Tube / DN 1/4 in. PTFE Flexible Hose	9-43

SINGLE CONTAINER - SINGLE HAZARD DN 1/4 in. PTFE Flexible Hose (SCSH14FH_REV.00)



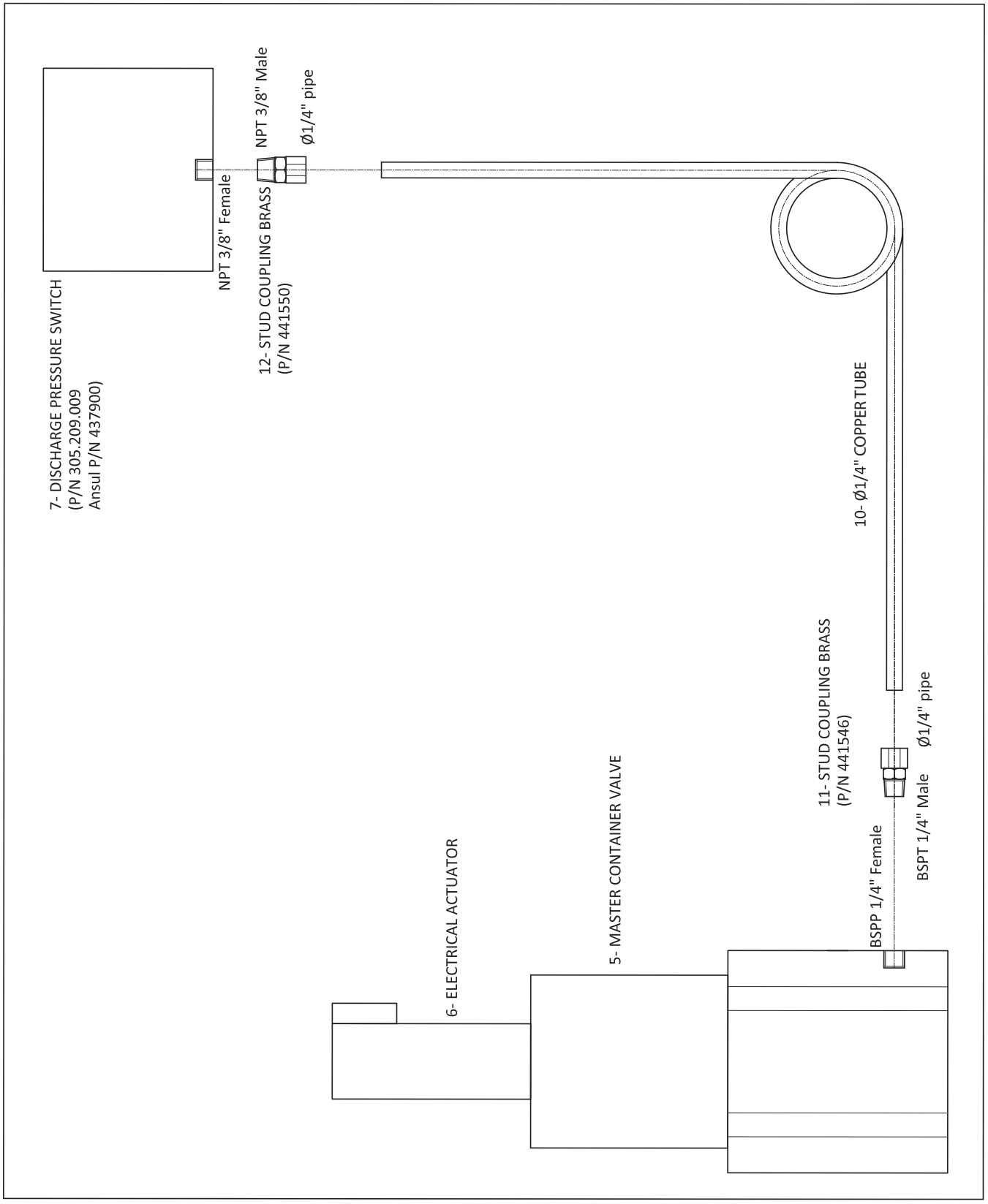
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SINGLE CONTAINER - SINGLE HAZARD Dia 6 mm Copper Pipe
(SCSH6CU_REV.05)



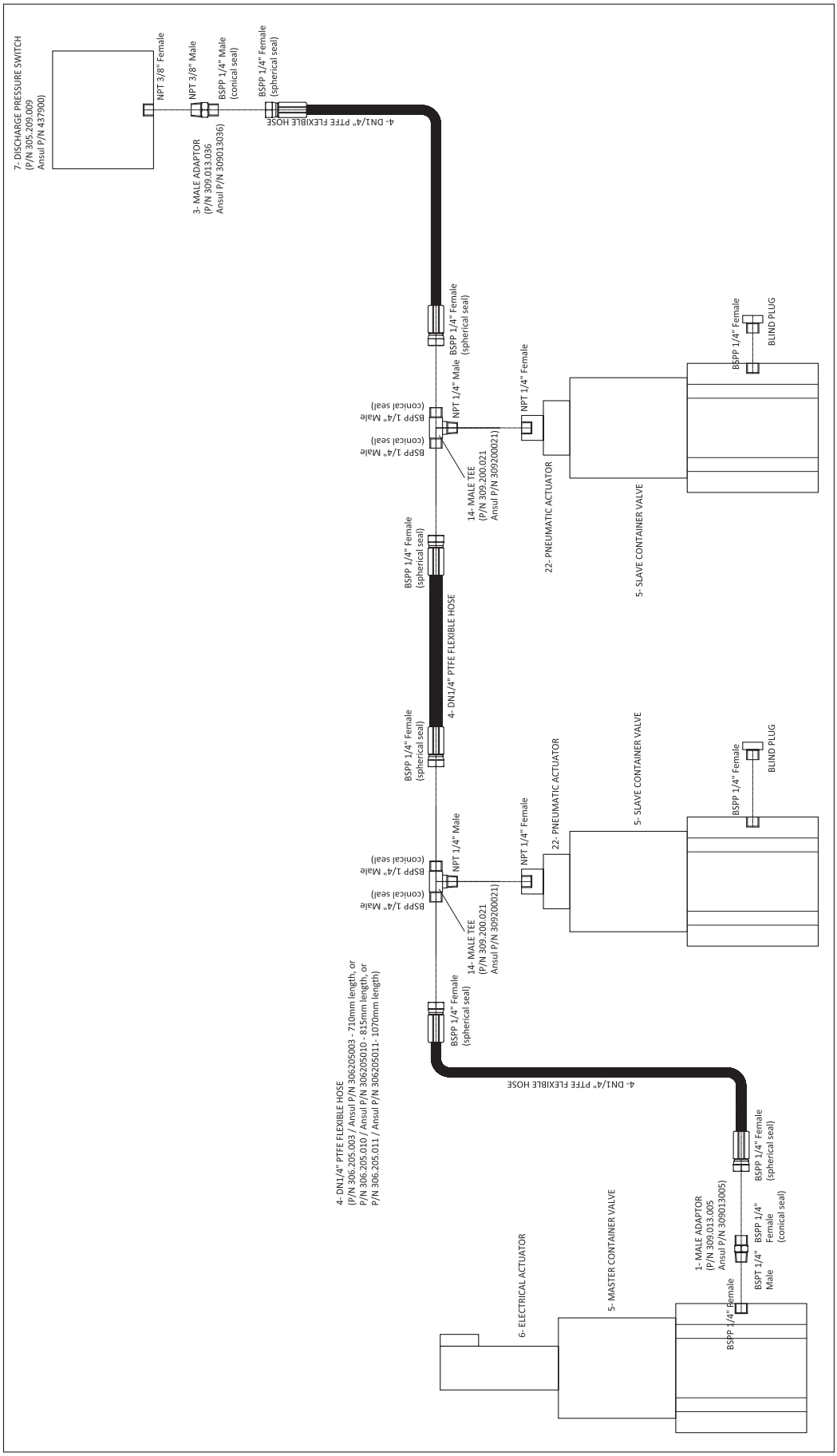
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SINGLE CONTAINER - SINGLE HAZARD Dia 1/4 in. Copper Tube
(SCSH14CU_REV.00)



025700

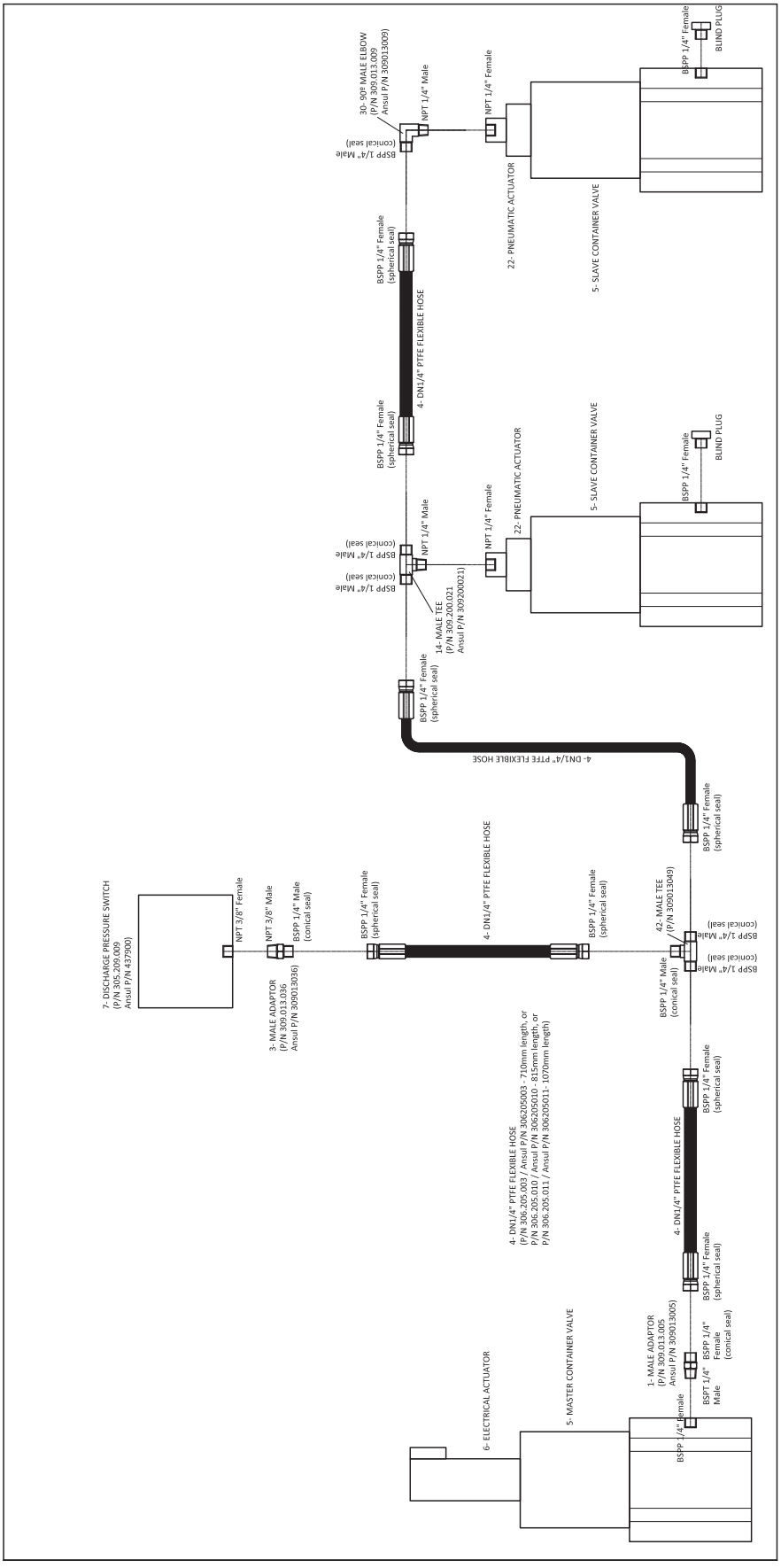
MULTIPLE CONTAINER - SINGLE HAZARD MASTER / SUBORDINATE CONTAINER
DN 1/4 in. PTFE Flexible Hose (MCSHMS14FH_REV.04)



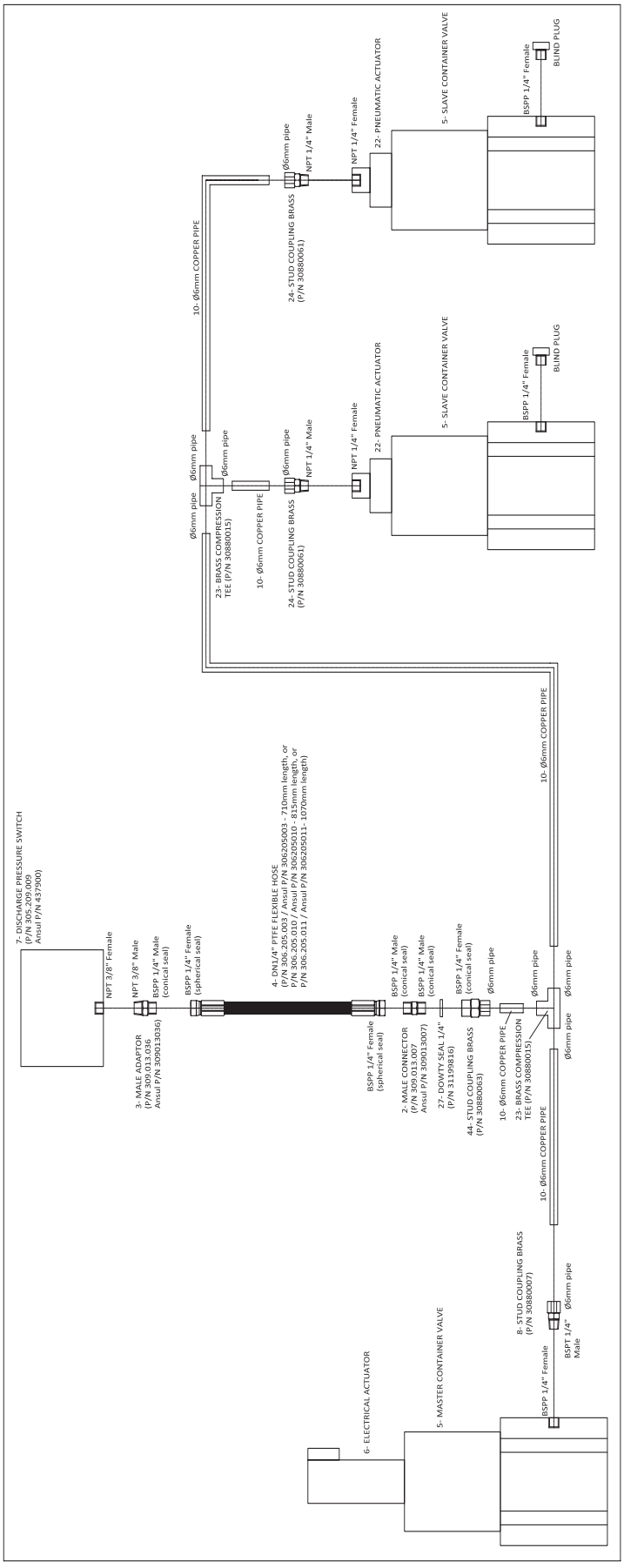
E000668

MULTIPLE CONTAINER - SINGLE HAZARD MASTER / SUBORDINATE CONTAINER (Continued)

DN 1/4 in. PTFE Flexible Hose - Option
(MCSHMS14FH_REV.03)

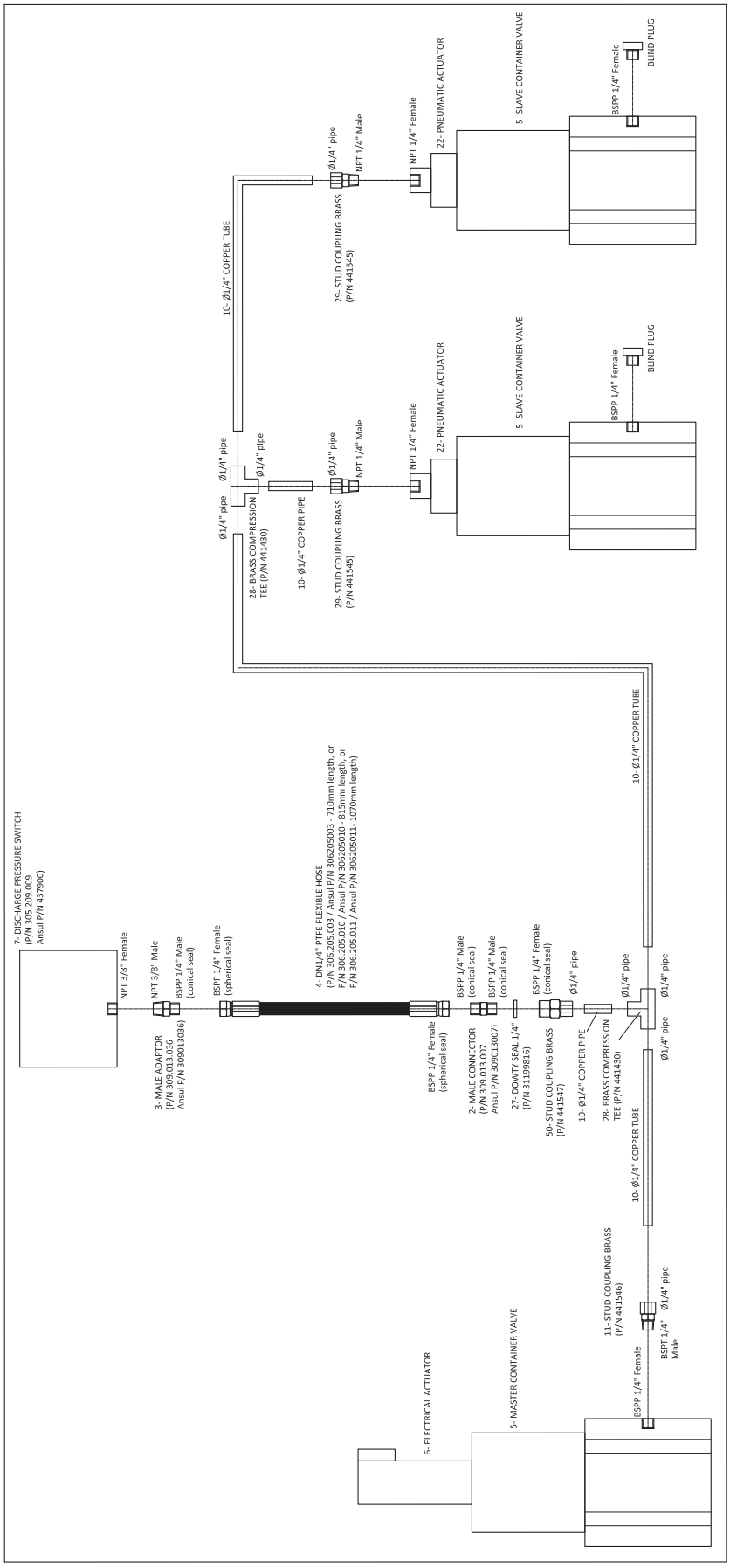


MULTIPLE CONTAINER - SINGLE HAZARD MASTER / SUBORDINATE CONTAINER
Dia 6 mm Copper Pipe (MCSHMS6CU_REV.06)



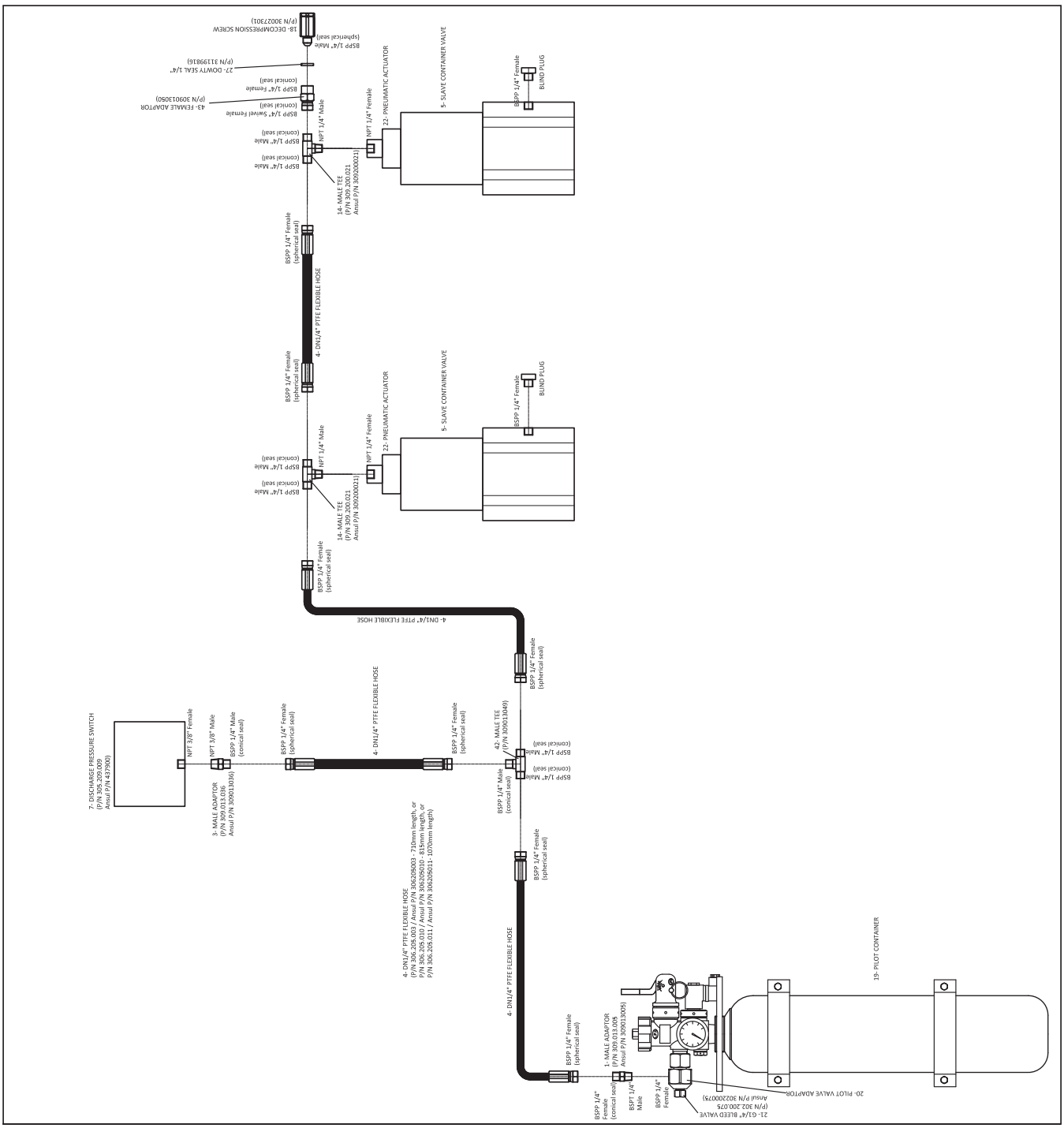
E000669

MULTIPLE CONTAINER - SINGLE HAZARD MASTER / SUBORDINATE CONTAINER
Dia 1/4 in. Copper Tube (MCSHMS14CU_REV.00)



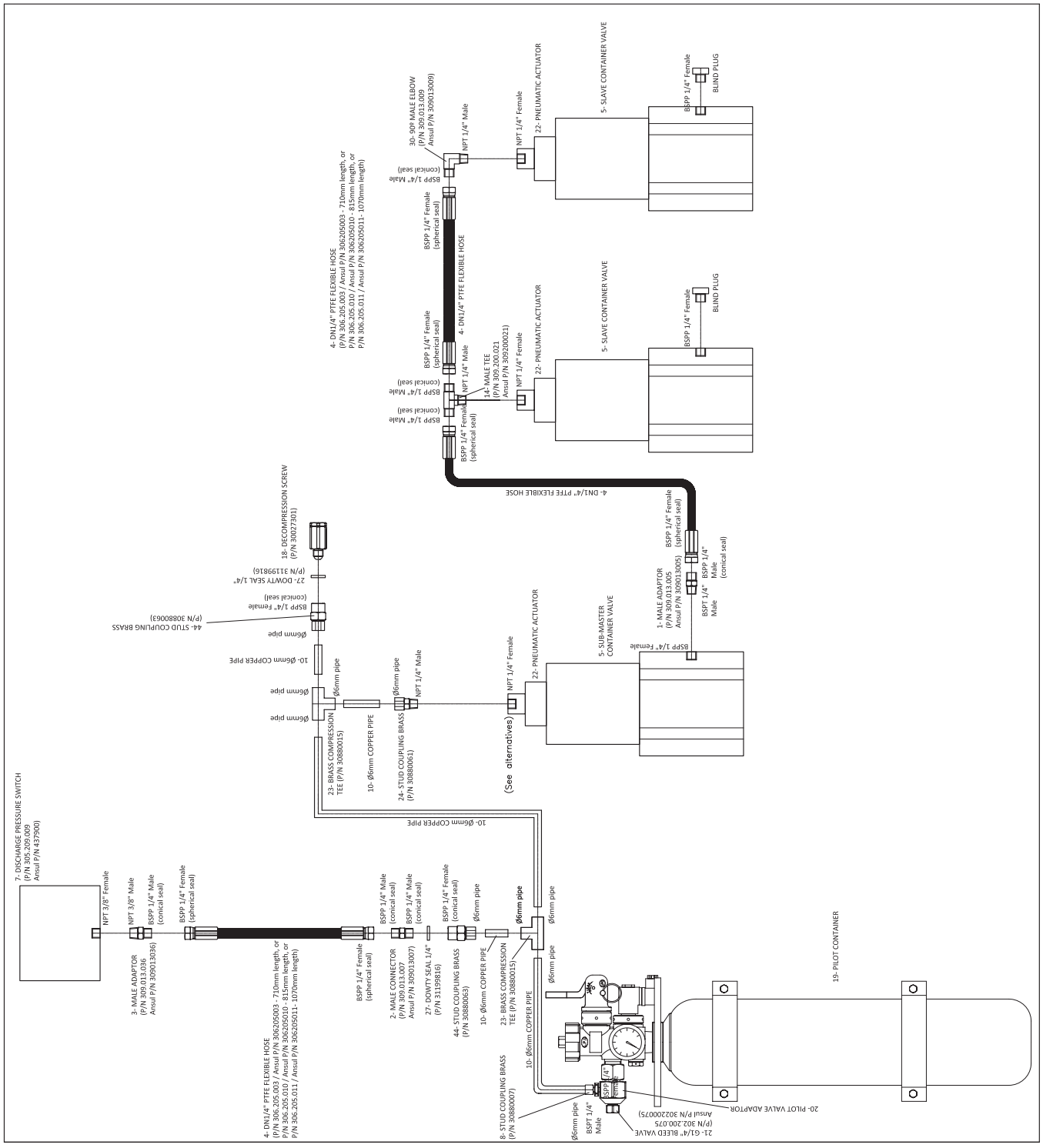
025703

MULTIPLE CONTAINER - SINGLE HAZARD PILOT CONTAINER
DN 1/4 in. PTFE Flexible Hose (MCSHPC14FH_REV.03)



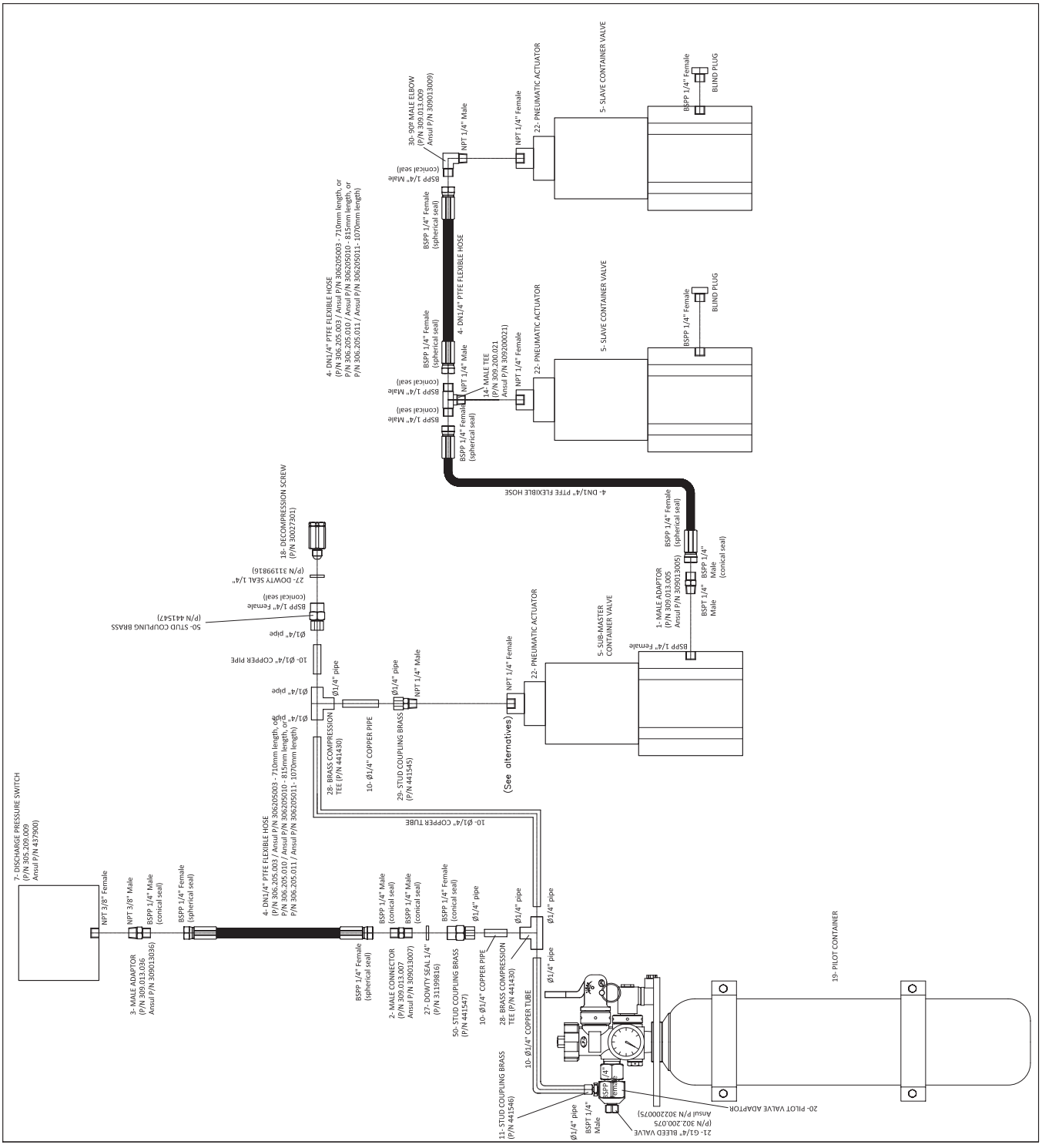
025704

MULTIPLE CONTAINER - SINGLE HAZARD PILOT CONTAINER WITH SUB-MASTER CONTAINER
Dia 6 mm Copper Pipe / DN 1/4 in. PTFE Flexible Hose (MCSHPCSUB6CU14FH_REV.02)



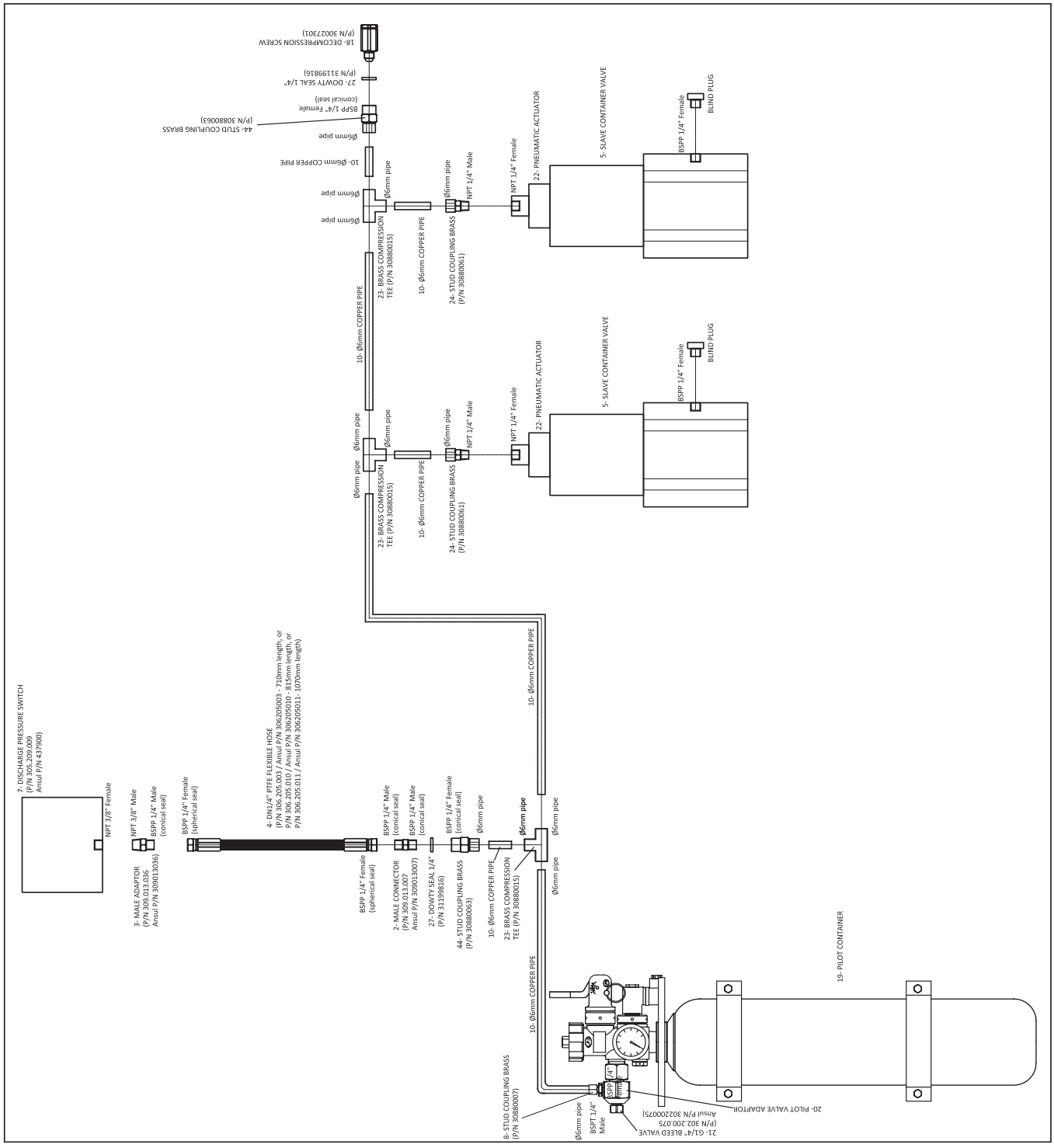
E000670

MULTIPLE CONTAINER - SINGLE HAZARD PILOT CONTAINER WITH SUB-MASTER CONTAINER
Dia 1/4 in. Copper Tube / DN 1/4 in. PTFE Flexible Hose (MCSHPCSUB14CU14FH_REV.01)



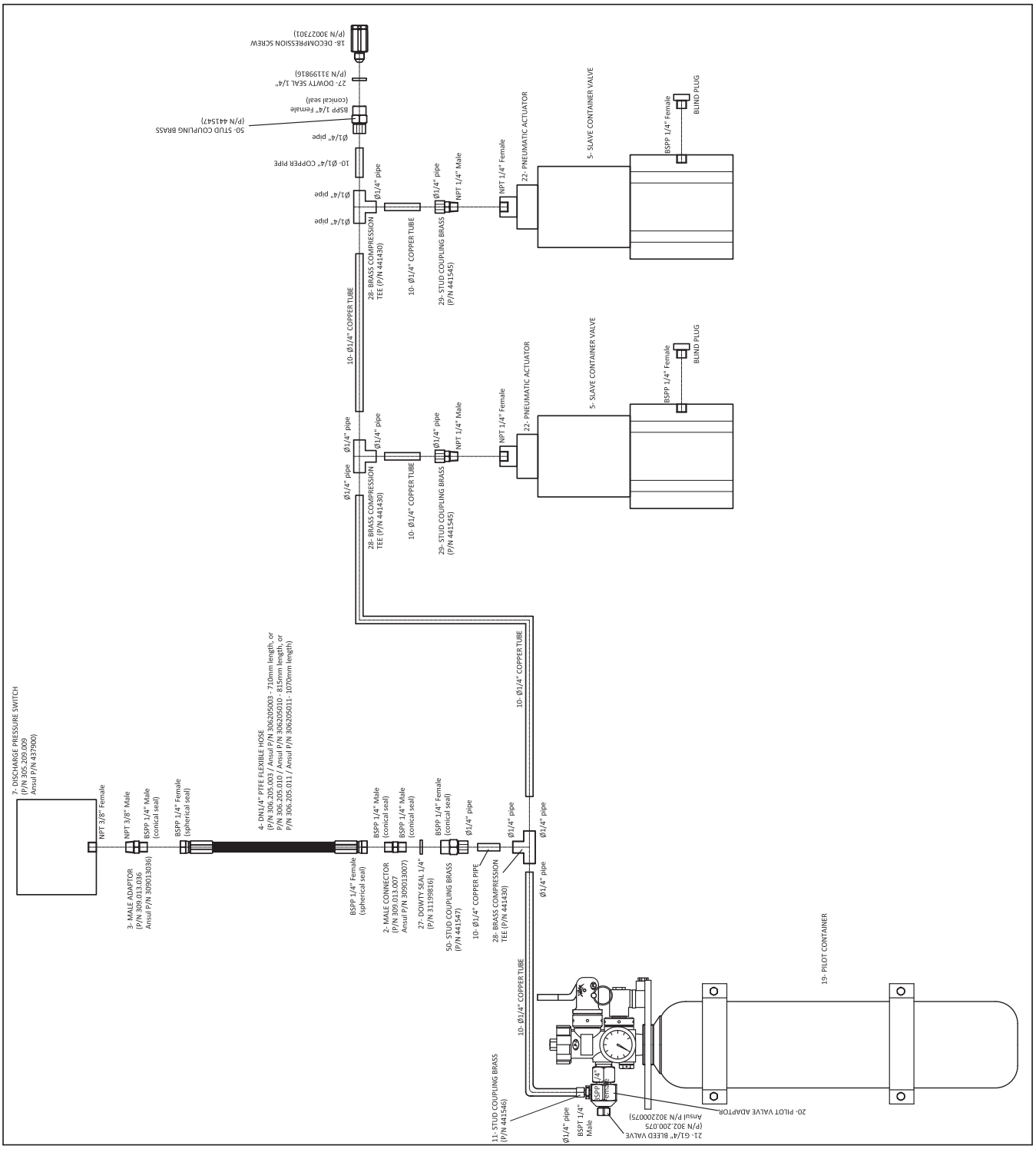
E000671

MULTIPLE CONTAINER - SINGLE HAZARD PILOT CONTAINER
Dia 6 mm Copper Pipe (MCSHPC6CU_REV.06)



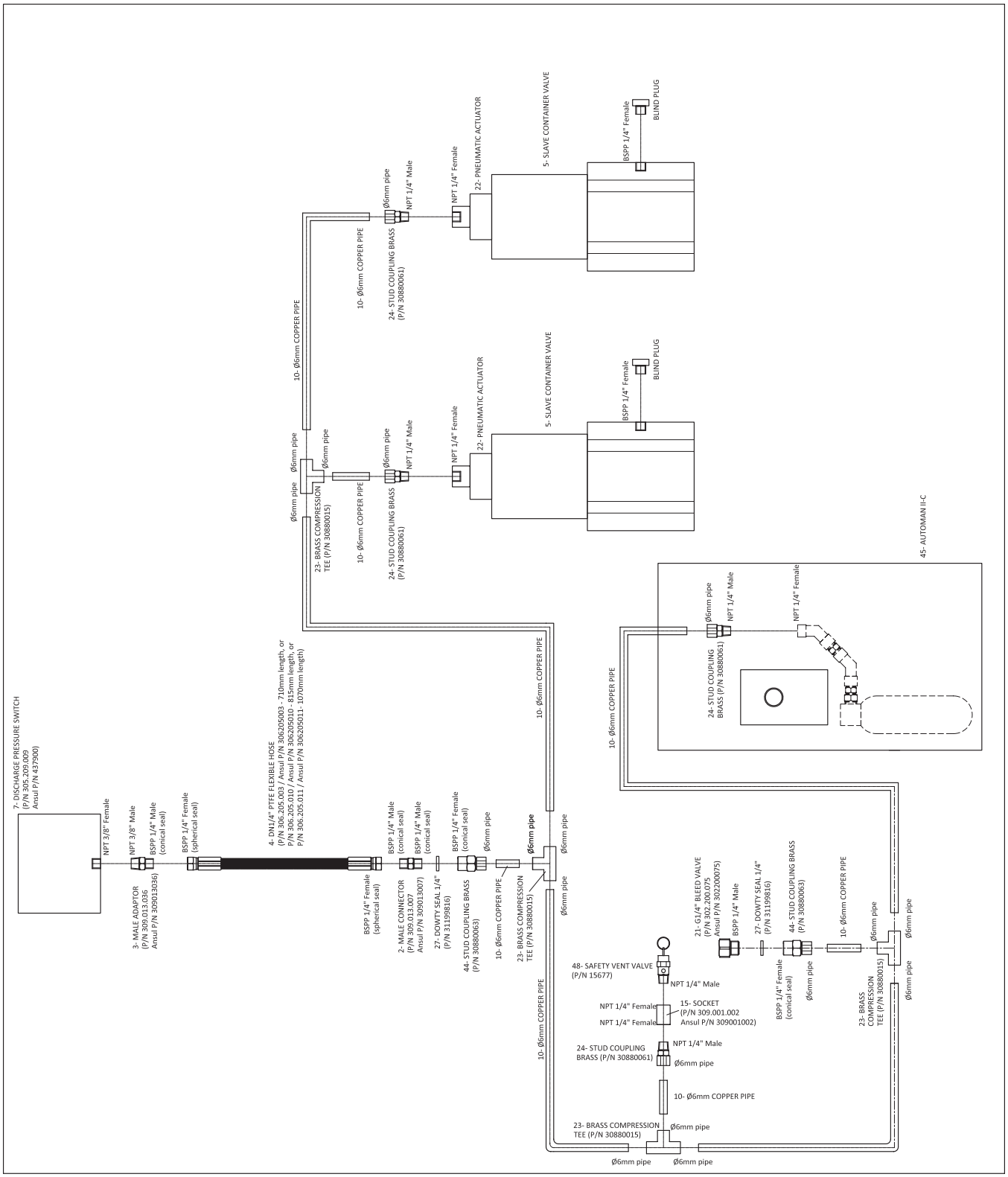
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MULTIPLE CONTAINER - SINGLE HAZARD PILOT CONTAINER
Dia 1/4 in. Copper Tube (MCSHPC14CU_REV.00)



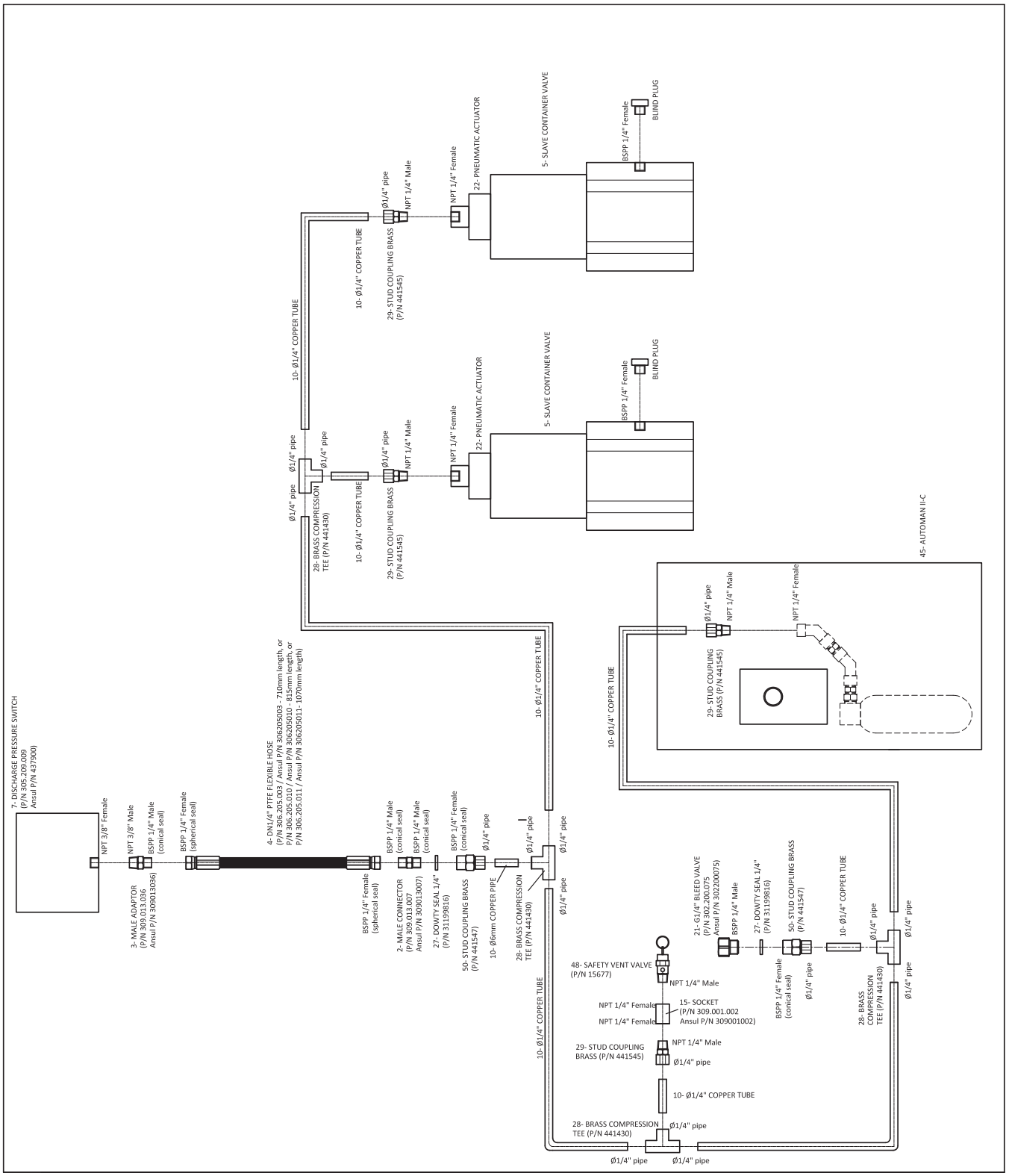
025708

MULTIPLE CONTAINER - SINGLE HAZARD AUTOMAN II-C RELEASE
Dia 6 mm Copper Pipe (MCSHAM6CU_REV.04)



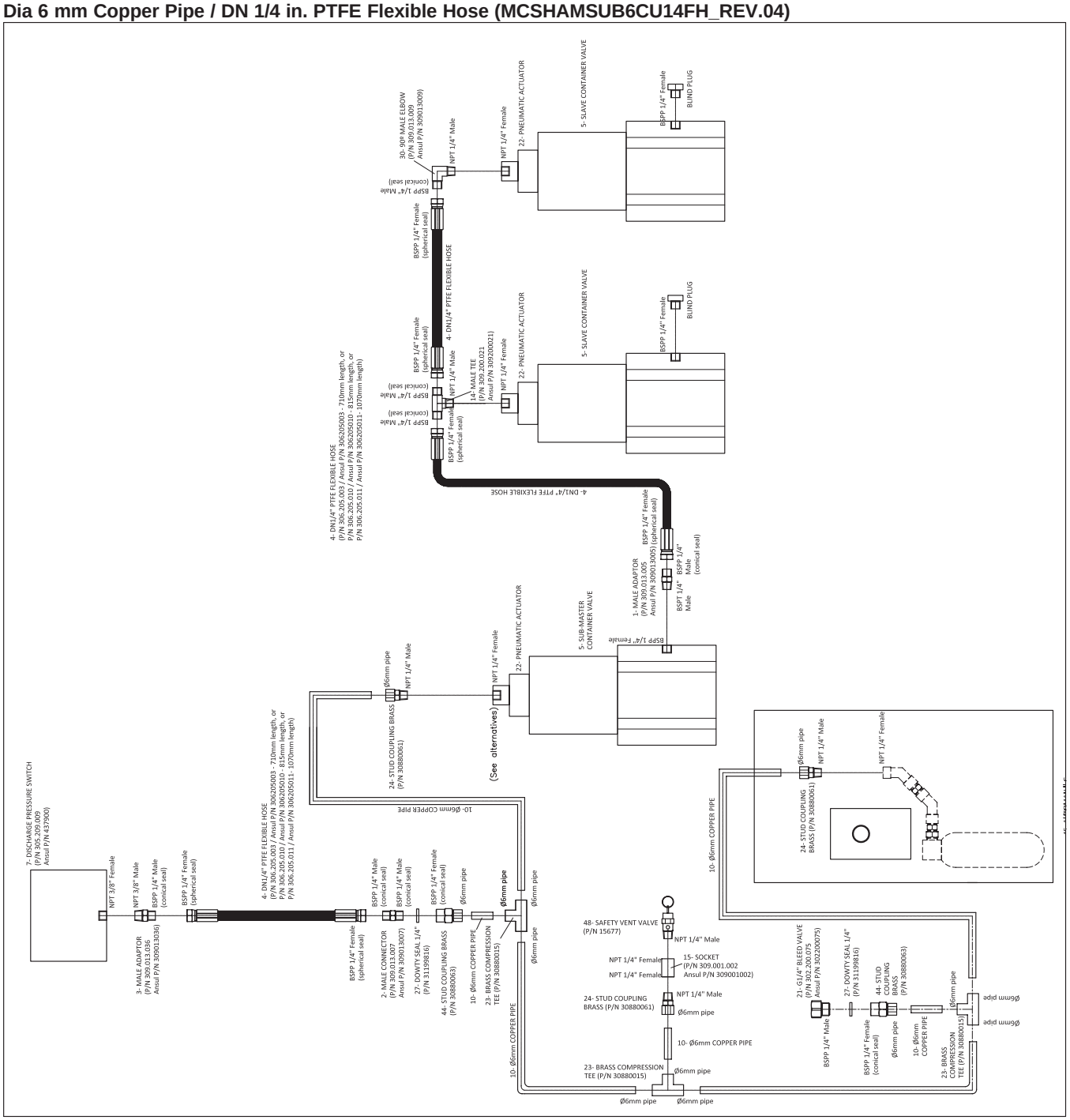
E000673

MULTIPLE CONTAINER - SINGLE HAZARD AUTOMAN II-C RELEASE
Dia 1/4 in. Copper Tube (MCSHAM14CU_REV.01)



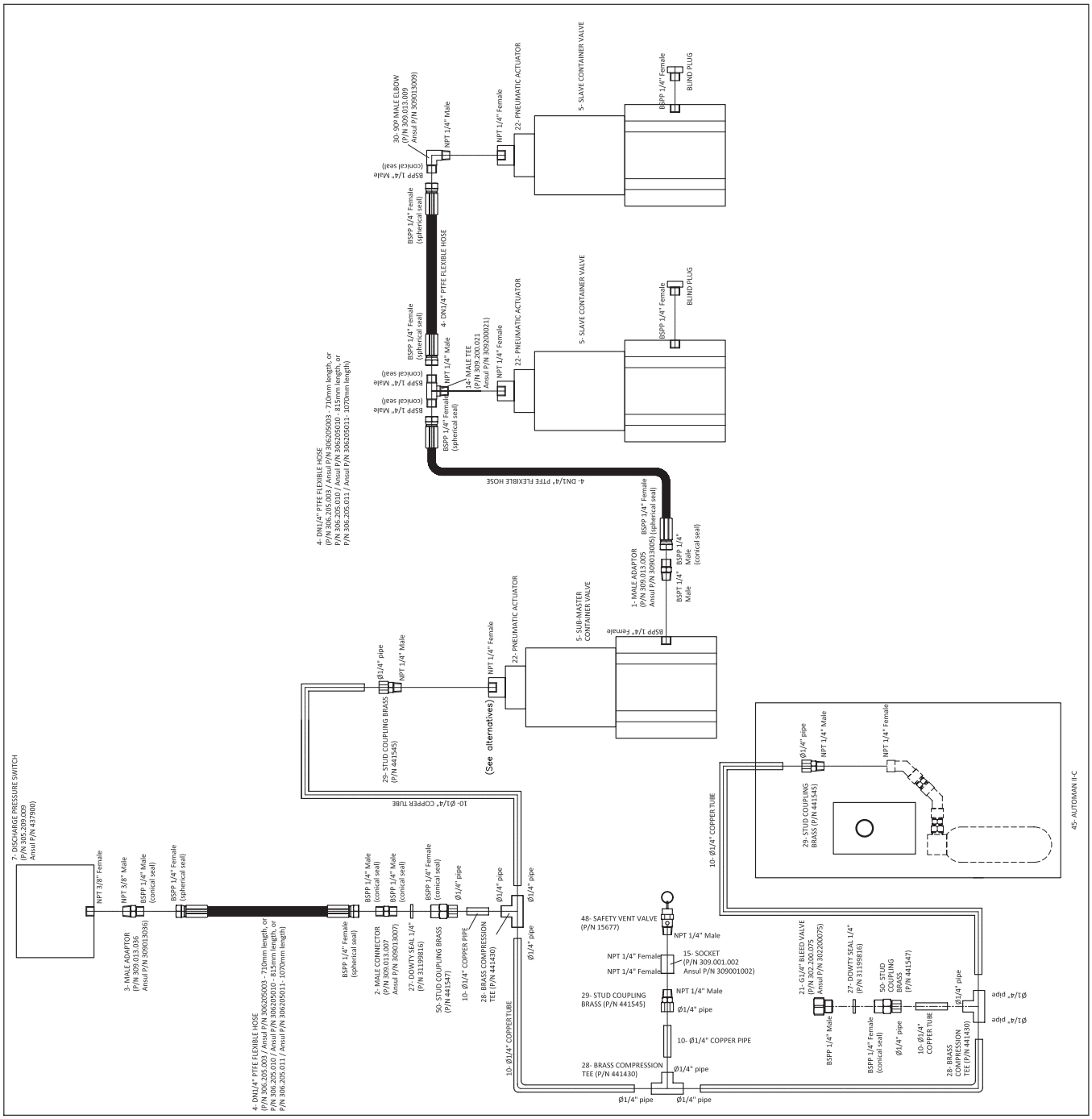
025710

MULTIPLE CONTAINER - SINGLE HAZARD AUTOMAN II-C RELEASE WITH SUB-MASTER CONTAINER
Dia 6 mm Copper Pipe / DN 1/4 in. PTFE Flexible Hose (MCSHAMSUB6CU14FH_REV.04)



E000674

MULTIPLE CONTAINER - SINGLE HAZARD AUTOMAN II-C RELEASE WITH SUB-MASTER CONTAINER
Dia 1/4 in. Copper Tube / DN 1/4 in. PTFE Flexible Hose (MCSHAMSUB14CU14FH_REV.02)



E000675

FM-200 FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (IMPERIAL)

Tyco Clean Agent System Flow Calculation Software v4.00 (FM-200 - UL/FM)
EX15488 / Component of FM Approved System

File Name: Test_Manual.FC4

Consolidated Report

Customer Information

Company Name: Johnson Controls
Address: 2700 Industrial Parkway S
Marinette WI, 54143

Phone: 715-735-7411
Contact:
Title:

Project Data

Project Name: Design Section Example Problem
Designer:
Number:
Account:
Location:
Description:

Enclosure Report

Elevation: 4000 ft (relative to sea level)
Atmospheric Correction Factor: 0,86

Enclosure 1 Computer Room

Enclosure Temperature:
Minimum: 80 F
Maximum: 90 F
Max. Concentration: 7,39 %

Design Concentration:
Adjusted: 7,26 %
Minimum: 7,17 %
Min. Agent Required: 271,3 lb

Number of Nozzles: 1

Width: 20,0 ft
Length: 46,0 ft
Height: 10,0 ft
Volume: 9200,0 ft ³
Non-permeable: 0,0 ft ³
Total Volume: 9200,0 ft ³

Calculation Date/Time: lunes, 11 de mayo de 2020, 13:00:56
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Key ID: 252570117

FM-200 FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (IMPERIAL)

Consolidated Report

Adjusted Agent Required: 274,8 lb
Concentration Profile: UL/FM Class A, (7,17 %)

Enclosure 2 Sorage Room

Enclosure Temperature:
Minimum: 60 F
Maximum: 80 F
Max. Concentration: 7,56 %

Design Concentration:
Adjusted: 7,27 %
Minimum: 7,17 %
Min. Agent Required: 69,2 lb
Adjusted Agent Required: 70,2 lb
Concentration Profile: UL/FM Class A, (7,17 %)

Number of Nozzles: 1

Width: 15,0 ft
Length: 15,0 ft
Height: 10,0 ft
Volume: 2250,0 ft ³
Non-permeable: 0,0 ft ³
Total Volume: 2250,0 ft ³

Agent Source Report

Agent: FM-200 / Propellant N2
(FM-200 is a Trademark of DuPont.)
Container Name: 180L DOT Container Assy
Container Part Number: 303.205.021
Agent Per Container: 345,0 lb
Fill Density: 54,3 lbs / cubic ft
Number of Main Containers: 1
Number of Reserve Containers: 0

Container Empty Weight: 233,2 lb
Weight, All Containers + Agent: 578,2 lb
Floor Area Per Container: 1,40 ft ²
Floor Loading Per Container: 414 lbs / ft ²

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FM-200 FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (IMPERIAL)

Consolidated Report

Parts Report

Total Agent Required: 345,0 lb

Container Name: 180L DOT Container Assy (Part: 303.205.021)

Number of Containers: 1

Nozzle	Type	Nozzle Diameter	Drill Size	Nozzle Area	Part Number
E1-N1	360-BR (NPT)	2 in	14.5 mm	2,0476 in ²	310.205.228
E2-N1	360-BR (NPT)	1-1/4 in	8.7 mm	0,7371 in ²	310.205.224

Nozzle	Drill Diameter	Drill Size
E1-N1	0,5709 inches	14.5 mm
E2-N1	0,3425 inches	8.7 mm

Pipe & Fittings	Type	Diameter	Length	Elbows (90)	Elbows (45)	Tees	Unions
	US80BTS	1-1/4 in	6,00 ft	1	0	0	0
	US80BTS	2 in	20,00 ft	3	0	1	0

Other Objects	Name	Quantity	Part Number
	2 in Swivel Union Adaptor	1	309.002.012

System Acceptance Report

System Discharge Time:	9,4 seconds
Percent Agent In Pipe:	15,1%
Percent Agent Before First Tee:	10,1%
Dead Volume:	0,0% (0,0 lb)
Enclosure Number:	1
Enclosure Name:	Computer Room
Minimum Design Concentration:	7,17%
Adjusted Design Concentration:	7,26%
Predicted Concentration:	7,19%

Calculation Date/Time: lunes, 11 de mayo de 2020, 13:00:56

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Key ID: 252570117

FM-200 FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (IMPERIAL)

Consolidated Report

Maximum Expected Agent Concentration: 7,32% (At 90 F)
Concentration Profile: UL/FM Class A, (7,17 %)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Average Nozzle Pressure
E1-N1	271,3 lb	274,8 lb	272,0 lb	105 psig

Enclosure Number: 2
Enclosure Name: Sorage Room
Minimum Design Concentration: 7,17%
Adjusted Design Concentration: 7,27%
Predicted Concentration: 7,54%
Maximum Expected Agent Concentration: 7,84% (At 80 F)
Concentration Profile: UL/FM Class A, (7,17 %)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Average Nozzle Pressure
E2-N1	69,2 lb	70,2 lb	73,0 lb	105 psig

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Key ID: 252570117

FM-200 FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (METRIC)

Tyco Clean Agent System Flow Calculation Software v4.00 (FM-200 - EU)

File Name: Test_Manual_Metric.FC4.FC4

Consolidated Report

Customer Information

Company Name: Johnson Controls
Address: 2700 Industrial Parkway S
Marinette WI, 54143

Phone: 715-735-7411
Contact:
Title:

Project Data

Project Name:
Designer:
Number:
Account:
Location:
Description:

Enclosure Report

Elevation: 1200 m (relative to sea level)
Atmospheric Correction Factor: 0,89

Enclosure 1 Computer Room

Enclosure Temperature:
Minimum: 15,0 C
Maximum: 25,0 C
Max. Concentration: 8,94 %

Design Concentration:
Adjusted: 8,65 %
Minimum: 8,50 %
Min. Agent Required: 112,58 kg

Number of Nozzles: 1

Width: 6,00 m
Length: 10,00 m
Height: 3,05 m
Volume: 183,00 m ³
Non-permeable: 0,00 m ³
Total Volume: 183,00 m ³

Calculation Date/Time: lunes, 11 de mayo de 2020, 13:15:25
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FM-200 FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (METRIC)

Consolidated Report

Adjusted Agent Required: 114,75 kg
Concentration Profile: EN15004/ISO14520 Class A Higher Hazard, (8,5 %)

Enclosure 2 Storage Room

Enclosure Temperature:
Minimum: 15,0 C
Maximum: 25,0 C
Max. Concentration: 8,31 %

Design Concentration:
Adjusted: 8,04 %
Minimum: 7,90 %
Min. Agent Required: 27,72 kg

Number of Nozzles: 1

Width: 4,00 m
Length: 4,00 m
Height: 3,05 m
Volume: 48,80 m ³
Non-permeable: 0,00 m ³
Total Volume: 48,80 m ³

Adjusted Agent Required: 28,25 kg
Concentration Profile: EN15004/ISO14520 Class A, (7,9 %)

Agent Source Report

Agent: FM-200 / Propellant N2
(FM-200 is a Trademark of DuPont)
Container Name: 147L TPED Container Assy
Container Part Number: 303.205.014
Agent Per Container: 143,00 kg
Fill Density: 0,973 kg / l
Number of Main Containers: 1
Number of Reserve Containers: 0

Container Empty Weight: 103,70 kg
Weight, All Containers + Agent: 246,70 kg
Floor Area Per Container: 0,13 m ²
Floor Loading Per Container: 1906 kg /m ²

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Key ID: 252570117

FM-200 FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (METRIC)

Consolidated Report

Parts Report

Total Agent Required: 143,00 kg

Container Name: 147L TPED Container Assy (Part: 303.205.014)

Number of Containers: 1

Nozzle	Type	Nozzle Diameter	Drill Size	Nozzle Area	Part Number
E1-N1	360-BR (BSP)	50 mm	15.5 mm	1509,54 mm ²	310.205.214
E2-N1	360-BR (BSP)	32 mm	8.6 mm	464,70 mm ²	310.205.210

Nozzle	Drill Diameter	Drill Size
E1-N1	15,5000 mm	15.5 mm
E2-N1	8,6000 mm	8.6 mm

Pipe & Fittings	Type	Diameter	Length	Elbows (90)	Elbows (45)	Tees	Unions
	UK80GTS	32 mm	3,15 m	1	0	0	0
	UK80GTS	50 mm	10,15 m	3	0	1	0

Other Objects	Name	Quantity	Part Number
	50 mm Swivel Union Adaptor	1	309.002.012

System Acceptance Report

System Discharge Time:	9,4 seconds
Percent Agent In Pipe:	26,5%
Percent Agent Before First Tee:	13,2%
Dead Volume:	0,0% (0,00 kg)
Enclosure Number:	1
Enclosure Name:	Computer Room
Minimum Design Concentration:	8,50%
Adjusted Design Concentration:	8,65%
Predicted Concentration:	8,58%

Calculation Date/Time: lunes, 11 de mayo de 2020, 13:15:25

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FM-200 FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (METRIC)

Consolidated Report

Maximum Expected Agent Concentration: 8,88% (At 25,0 C)
Concentration Profile: EN15004/ISO14520 Class A Higher Hazard, (8,5 %)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Average Nozzle Pressure
E1-N1	112,58 kg	114,75 kg	113,79 kg	4,935 bar

Enclosure Number: 2
Enclosure Name: Storage Room
Minimum Design Concentration: 7,90%
Adjusted Design Concentration: 8,04%
Predicted Concentration: 8,29%
Maximum Expected Agent Concentration: 8,57% (At 25,0 C)
Concentration Profile: EN15004/ISO14520 Class A, (7,9 %)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Average Nozzle Pressure
E2-N1	27,72 kg	28,25 kg	29,21 kg	5,387 bar

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Key ID: 252570117

FM-200
LIQUID LEVEL INDICATOR CHART
(16 PAGES)

106L Tank LLI	"Temperature, Degrees F"									
Inches	32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
7.5										
7.75	110.9	110.4	109.8							
8	113.2	112.8	112.2	110.9	109.7					
8.25	115.6	115.1	114.5	113.2	112.0	111.2	110.4			
8.5	118.0	117.5	116.8	115.5	114.2	113.4	112.5	111.7	110.8	
8.75	120.4	119.8	119.1	117.8	116.5	115.6	114.7	113.8	112.9	
9	122.8	122.2	121.4	120.1	118.7	117.8	116.9	115.9	114.9	112.0
9.25	125.1	124.5	123.7	122.4	121.0	120.0	119.0	118.0	116.9	114.0
9.5	127.5	126.9	126.1	124.6	123.2	122.2	121.2	120.1	119.0	116.0
9.75	129.9	129.2	128.4	126.9	125.5	124.4	123.4	122.2	121.0	118.0
10	132.3	131.6	130.7	129.2	127.7	126.6	125.5	124.3	123.0	120.0
10.25	134.7	133.9	133.0	131.5	130.0	128.9	127.7	126.4	125.1	122.0
10.5	137.1	136.3	135.3	133.8	132.3	131.1	129.9	128.5	127.1	124.0
10.75	139.4	138.6	137.6	136.1	134.5	133.3	132.0	130.6	129.1	126.0
11	141.8	141.0	140.0	138.4	136.8	135.5	134.2	132.7	131.2	128.0
11.25	144.2	143.3	142.3	140.6	139.0	137.7	136.4	134.8	133.2	130.0
11.5	146.6	145.7	144.6	142.9	141.3	139.9	138.5	136.9	135.3	132.0
11.75	149.0	148.1	146.9	145.2	143.5	142.1	140.7	139.0	137.3	134.1
12	151.4	150.4	149.2	147.5	145.8	144.3	142.9	141.1	139.3	136.1
12.25	153.7	152.8	151.5	149.8	148.0	146.5	145.0	143.2	141.4	138.1
12.5	156.1	155.1	153.8	152.1	150.3	148.7	147.2	145.3	143.4	140.1
12.75	158.5	157.5	156.2	154.4	152.6	151.0	149.4	147.4	145.4	142.1
13	160.9	159.8	158.5	156.6	154.8	153.2	151.5	149.5	147.5	144.1
13.25	163.3	162.2	160.8	158.9	157.1	155.4	153.7	151.6	149.5	146.1
13.5	165.7	164.5	163.1	161.2	159.3	157.6	155.9	153.7	151.5	148.1
13.75	168.0	166.9	165.4	163.5	161.6	159.8	158.0	155.8	153.6	150.1
14	170.4	169.2	167.7	165.8	163.8	162.0	160.2	157.9	155.6	152.1
14.25	172.8	171.6	170.1	168.1	166.1	164.2	162.4	160.0	157.6	154.1
14.5	175.2	173.9	172.4	170.4	168.3	166.4	164.5	162.1	159.7	156.1
14.75	177.6	176.3	174.7	172.6	170.6	168.6	166.7	164.2	161.7	158.1
15	179.9	178.6	177.0	174.9	172.9	170.9	168.9	166.3	163.7	160.1
15.25	182.2	180.9	179.2	177.2	175.1	173.1	171.0	168.4	165.8	162.1
15.5	184.6	183.2	181.5	179.4	177.4	175.3	173.2	170.5	167.8	164.2
15.75	186.9	185.5	183.7	181.6	179.6	177.5	175.4	172.6	169.8	166.2
16	189.3	187.8	185.9	183.8	181.8	179.6	177.5	174.7	171.9	168.2
16.25	191.6	190.1	188.2	186.1	184.0	181.8	179.7	176.8	173.9	170.2
16.5	194.0	192.4	190.4	188.3	186.2	184.0	181.8	178.9	175.9	172.2
16.75	196.3	194.7	192.6	190.5	188.4	186.2	184.0	181.0	178.0	174.2
17	198.6	197.0	194.8	192.7	190.6	188.3	186.1	183.0	180.0	176.2
17.25	201.0	199.2	197.1	194.9	192.8	190.5	188.3	185.1	182.0	178.2
17.5	203.3	201.5	199.3	197.1	195.0	192.7	190.4	187.2	184.0	180.2
17.75	205.7	203.8	201.5	199.3	197.2	194.9	192.6	189.3	186.0	182.3
18	208.0	206.1	203.8	201.6	199.4	197.0	194.7	191.4	188.1	184.3
18.25	210.4	208.4	206.0	203.8	201.6	199.2	196.8	193.5	190.1	186.3
18.5	212.7	210.7	208.2	206.0	203.8	201.4	199.0	195.5	192.1	188.4
18.75	215.0	213.0	210.5	208.2	206.0	203.6	201.1	197.6	194.1	190.4
19	217.4	215.3	212.7	210.4	208.2	205.7	203.3	199.7	196.1	192.4
19.25	219.7	217.6	214.9	212.6	210.4	207.9	205.4	201.8	198.1	194.4
19.5	222.1	219.9	217.2	214.9	212.6	210.1	207.6	203.9	200.2	196.5
19.75	224.4	222.2	219.4	217.1	214.8	212.2	209.7	206.0	202.2	198.5
20	226.8	224.5	221.6	219.3	217.0	214.4	211.9	208.0	204.2	200.5
20.25	229.1	226.8	223.8	221.5	219.2	216.6	214.0	210.1	206.2	202.6
20.5	231.4	229.1	226.1	223.7	221.4	218.8	216.2	212.2	208.2	204.6
20.75	233.8	231.3	228.3	225.9	223.6	220.9	218.3	214.3	210.2	206.6
21	236.1	233.6	230.5	228.1	225.8	223.1	220.5	216.4	212.3	208.6
21.25	238.5	235.9	232.8	230.4	228.0	225.3	222.6	218.4	214.3	210.7
21.5	240.8	238.2	235.0	232.6	230.2	227.5	224.8	220.5	216.3	212.7
21.75			237.2	234.8	232.4	229.6	226.9	222.6	218.3	214.7
22			239.5	237.0	234.6	231.8	229.1	224.7	220.3	216.7
22.25					236.8	234.0	231.2	226.8	222.3	218.8
22.5					239.0	236.2	233.4	228.9	224.4	220.8
22.75							235.5	230.9	226.4	222.8
23							237.7	233.0	228.4	224.9
23.25							239.8	235.1	230.4	226.9
23.5							242.0	237.2	232.4	228.9
23.75									234.4	230.9
24									236.5	233.0
24.25									235.0	
24.5									237.0	

147L Tank

LLI	"Temperature, Degrees F"									
Inches	32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
10										
10.25	154.2	153.8	153.3							
10.5	156.7	156.3	155.8	154.4	153.0					
10.75	159.2	158.7	158.2	156.7	155.3	154.2	153.0			
11	161.7	161.2	160.6	159.1	157.6	156.4	155.2	153.2	151.2	
11.25	164.2	163.7	163.0	161.5	159.9	158.7	157.4	155.4	153.4	
11.5	166.7	166.1	165.4	163.8	162.3	161.0	159.7	157.6	155.5	
11.75	169.2	168.6	167.8	166.2	164.6	163.2	161.9	159.7	157.6	
12	171.7	171.1	170.2	168.6	166.9	165.5	164.1	161.9	159.8	153.3
12.25	174.2	173.5	172.7	170.9	169.2	167.7	166.3	164.1	161.9	155.4
12.5	176.7	176.0	175.1	173.3	171.6	170.0	168.5	166.2	164.0	157.6
12.75	179.2	178.5	177.5	175.7	173.9	172.3	170.7	168.4	166.2	159.7
13	181.7	180.9	179.9	178.1	176.2	174.5	172.9	170.6	168.3	161.9
13.25	184.2	183.4	182.3	180.4	178.5	176.8	175.1	172.7	170.4	164.0
13.5	186.7	185.8	184.7	182.8	180.9	179.1	177.3	174.9	172.5	166.2
13.75	189.2	188.3	187.2	185.2	183.2	181.3	179.5	177.1	174.7	168.3
14	191.7	190.8	189.6	187.5	185.5	183.6	181.7	179.2	176.8	170.5
14.25	194.2	193.2	192.0	189.9	187.8	185.9	183.9	181.4	178.9	172.6
14.5	196.7	195.7	194.4	192.3	190.2	188.1	186.1	183.6	181.1	174.8
14.75	199.2	198.2	196.8	194.7	192.5	190.4	188.3	185.8	183.2	176.9
15	201.7	200.6	199.2	197.0	194.8	192.7	190.5	187.9	185.3	179.0
15.25	204.3	203.1	201.7	199.4	197.1	194.9	192.7	190.1	187.5	181.2
15.5	206.8	205.6	204.1	201.8	199.5	197.2	194.9	192.3	189.6	183.3
15.75	209.3	208.0	206.5	204.1	201.8	199.4	197.1	194.4	191.7	185.5
16	211.8	210.5	208.9	206.5	204.1	201.7	199.3	196.6	193.9	187.6
16.25	214.3	213.0	211.3	208.9	206.4	204.0	201.5	198.8	196.0	189.8
16.5	216.8	215.4	213.7	211.3	208.8	206.2	203.7	200.9	198.1	191.9
16.75	219.3	217.9	216.2	213.6	211.1	208.5	205.9	203.1	200.3	194.1
17	221.8	220.4	218.6	216.0	213.4	210.8	208.1	205.3	202.4	196.2
17.25	224.3	222.8	221.0	218.4	215.7	213.0	210.3	207.4	204.5	198.4
17.5	226.8	225.3	223.4	220.7	218.1	215.3	212.5	209.6	206.7	200.5
17.75	229.3	227.7	225.8	223.1	220.4	217.6	214.7	211.8	208.8	202.6
18	231.8	230.2	228.2	225.5	222.7	219.8	216.9	213.9	210.9	204.8
18.25	234.3	232.7	230.7	227.8	225.0	222.1	219.1	216.1	213.0	206.9
18.5	236.8	235.1	233.1	230.2	227.4	224.4	221.3	218.3	215.2	209.1
18.75	239.3	237.6	235.5	232.6	229.7	226.6	223.6	220.4	217.3	211.2
19	241.8	240.1	237.9	235.0	232.0	228.9	225.8	222.6	219.4	213.4
19.25	244.3	242.5	240.3	237.3	234.3	231.1	228.0	224.8	221.6	215.5
19.5	246.6	244.9	242.7	239.7	236.7	233.4	230.2	226.9	223.7	217.7
19.75	249.0	247.3	245.1	242.0	239.0	235.7	232.4	229.1	225.8	219.8
20	251.4	249.6	247.3	244.3	241.3	237.9	234.6	231.3	228.0	221.9
20.25	253.7	251.9	249.6	246.6	243.6	240.2	236.8	233.4	230.1	224.1
20.5	256.1	254.2	251.8	248.8	245.8	242.4	239.0	235.6	232.2	226.2
20.75	258.5	256.5	254.1	251.1	248.0	244.6	241.2	237.8	234.4	228.4
21	260.8	258.8	256.3	253.3	250.2	246.8	243.4	239.9	236.5	230.5
21.25	263.2	261.2	258.6	255.5	252.4	249.0	245.5	242.1	238.6	232.7
21.5	265.6	263.5	260.8	257.7	254.6	251.1	247.6	244.2	240.8	234.8
21.75	267.9	265.8	263.1	260.0	256.8	253.3	249.8	246.3	242.9	237.0
22	270.3	268.1	265.3	262.2	259.0	255.5	251.9	248.4	245.0	239.1
22.25	272.7	270.4	267.6	264.4	261.2	257.6	254.0	250.5	247.0	241.3
22.5	275.0	272.7	269.8	266.6	263.4	259.8	256.1	252.6	249.1	243.4
22.75	277.4	275.0	272.1	268.9	265.6	261.9	258.2	254.7	251.1	245.5
23	279.8	277.4	274.3	271.1	267.8	264.1	260.4	256.7	253.1	247.6
23.25	282.1	279.7	276.6	273.3	270.0	266.3	262.5	258.8	255.2	249.6
23.5	284.5	282.0	278.8	275.5	272.2	268.4	264.6	260.9	257.2	251.7
23.75	286.9	284.3	281.1	277.8	274.4	270.6	266.7	263.0	259.2	253.7
24	289.2	286.6	283.3	280.0	276.6	272.7	268.8	265.1	261.3	255.8
24.25	291.6	288.9	285.6	282.2	278.8	274.9	270.9	267.1	263.3	257.9
24.5	294.0	291.2	287.8	284.4	281.0	277.0	273.1	269.2	265.4	259.9
24.75	296.3	293.6	290.1	286.7	283.2	279.2	275.2	271.3	267.4	262.0
25	298.7	295.9	292.3	288.9	285.4	281.4	277.3	273.4	269.4	264.1
25.25	301.1	298.2	294.6	291.1	287.6	283.5	279.4	275.4	271.5	266.1
25.5	303.4	300.5	296.8	293.3	289.8	285.7	281.5	277.5	273.5	268.2
25.75	305.8	302.8	299.1	295.5	292.0	287.8	283.7	279.6	275.5	270.3
26	308.2	305.1	301.3	297.8	294.2	290.0	285.8	281.7	277.6	272.3
26.25	310.5	307.4	303.6	300.0	296.4	292.2	287.9	283.7	279.6	274.4
26.5	312.9	309.8	305.8	302.2	298.6	294.3	290.0	285.8	281.6	276.4
26.75	315.3	312.1	308.1	304.4	300.8	296.5	292.1	287.9	283.7	278.5
27	317.6	314.4	310.3	306.7	303.0	298.6	294.2	290.0	285.7	280.6
27.25	320.0	316.7	312.6	308.9	305.2	300.8	296.4	292.1	287.8	282.6
27.5	322.4	319.0	314.8	311.1	307.4	302.9	298.5	294.1	289.8	284.7
27.75	324.7	321.3	317.1	313.3	309.6	305.1	300.6	296.2	291.8	286.8

147L Tank (Continued)

LLI	"Temperature, Degrees F"									
Inches	32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
28	327.1	323.6	319.3	315.6	311.8	307.3	302.7	298.3	293.9	288.8
28.25	329.4	326.0	321.6	317.8	314.0	309.4	304.8	300.4	295.9	290.9
28.5			323.8	320.0	316.2	311.6	307.0	302.4	297.9	293.0
28.75			326.1	322.2	318.4	313.7	309.1	304.5	300.0	295.0
29			328.3	324.5	320.6	315.9	311.2	306.6	302.0	297.1
29.25			330.6	326.7	322.8	318.1	313.3	308.7	304.1	299.2
29.5					325.0	320.2	315.4	310.8	306.1	301.2
29.75					327.2	322.4	317.5	312.8	308.1	303.3
30					329.4	324.5	319.7	314.9	310.2	305.3
30.25					331.6	326.7	321.8	317.0	312.2	307.4
30.5							323.9	319.1	314.2	309.5
30.75							326.0	321.1	316.3	311.5
31							328.1	323.2	318.3	313.6
31.25							330.3	325.3	320.4	315.7
31.5									322.4	317.7
31.75									324.4	319.8
32									326.5	321.9
32.25										323.9
32.5										326.0

180L Tank

LLI	"Temperature, Degrees F"									
Inches	32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
2.5	189.9	188.9	187.5							
2.75	192.4	191.3	190.0	188.7	187.4					
3	195.0	193.8	192.4	191.1	189.7	189.2	188.7			
3.25	197.5	196.3	194.9	193.5	192.1	191.5	190.9			
3.5	200.0	198.8	197.3	195.9	194.5	193.8	193.1	189.5	185.9	
3.75	202.5	201.3	199.7	198.3	196.8	196.1	195.4	191.7	188.0	
4	205.0	203.8	202.2	200.7	199.2	198.4	197.6	193.9	190.2	
4.25	207.5	206.2	204.6	203.1	201.6	200.7	199.8	196.1	192.4	
4.5	210.1	208.7	207.0	205.5	203.9	203.0	202.1	198.3	194.5	
4.75	212.6	211.2	209.5	207.9	206.3	205.3	204.3	200.5	196.7	190.4
5	215.1	213.7	211.9	210.3	208.7	207.6	206.5	202.7	198.8	192.5
5.25	217.6	216.2	214.4	212.7	211.0	209.9	208.8	204.9	201.0	194.7
5.5	220.1	218.7	216.8	215.1	213.4	212.2	211.0	207.1	203.2	196.8
5.75	222.7	221.1	219.2	217.5	215.8	214.5	213.2	209.3	205.3	198.9
6	225.2	223.6	221.7	219.9	218.1	216.8	215.5	211.5	207.5	201.0
6.25	227.7	226.1	224.1	222.3	220.5	219.1	217.7	213.7	209.6	203.1
6.5	230.2	228.6	226.6	224.7	222.9	221.4	219.9	215.9	211.8	205.2
6.75	232.7	231.1	229.0	227.1	225.2	223.7	222.2	218.1	214.0	207.3
7	235.2	233.6	231.4	229.5	227.6	226.0	224.4	220.3	216.1	209.5
7.25	237.8	236.0	233.9	231.9	230.0	228.3	226.6	222.5	218.3	211.6
7.5	240.3	238.5	236.3	234.3	232.3	230.6	228.9	224.7	220.4	213.7
7.75	242.8	241.0	238.8	236.7	234.7	232.9	231.1	226.9	222.6	215.8
8	245.3	243.5	241.2	239.1	237.1	235.2	233.4	229.1	224.8	217.9
8.25	247.8	246.0	243.6	241.5	239.4	237.5	235.6	231.3	226.9	220.0
8.5	250.3	248.4	246.1	243.9	241.8	239.8	237.8	233.5	229.1	222.2
8.75	252.9	250.9	248.5	246.3	244.2	242.1	240.1	235.7	231.3	224.3
9	255.4	253.4	251.0	248.8	246.5	244.4	242.3	237.8	233.4	226.4
9.25	257.9	255.9	253.4	251.2	248.9	246.7	244.5	240.0	235.6	228.5
9.5	260.4	258.4	255.8	253.6	251.3	249.0	246.8	242.2	237.7	230.6
9.75	262.9	260.9	258.3	256.0	253.7	251.3	249.0	244.4	239.9	232.7
10	265.5	263.3	260.7	258.4	256.0	253.6	251.2	246.6	242.1	234.8
10.25	268.0	265.8	263.1	260.8	258.4	255.9	253.5	248.8	244.2	237.0
10.5	270.5	268.3	265.6	263.2	260.8	258.2	255.7	251.0	246.4	239.1
10.75	273.0	270.8	268.0	265.6	263.1	260.5	257.9	253.2	248.5	241.2
11	275.5	273.3	270.5	268.0	265.5	262.8	260.2	255.4	250.7	243.3
11.25	278.0	275.8	272.9	270.4	267.9	265.1	262.4	257.6	252.9	245.4
11.5	280.6	278.2	275.3	272.8	270.2	267.4	264.6	259.8	255.0	247.5
11.75	283.1	280.7	277.8	275.2	272.6	269.7	266.9	262.0	257.2	249.6
12	285.6	283.2	280.2	277.6	275.0	272.0	269.1	264.2	259.3	251.8
12.25	288.1	285.7	282.7	280.0	277.3	274.3	271.3	266.4	261.5	253.9
12.5	290.6	288.2	285.1	282.4	279.7	276.6	273.6	268.6	263.7	256.0
12.75	293.1	290.7	287.5	284.8	282.1	278.9	275.8	270.8	265.8	258.1
13	295.7	293.1	290.0	287.2	284.4	281.2	278.0	273.0	268.0	260.2
13.25	298.2	295.6	292.4	289.6	286.8	283.5	280.3	275.2	270.1	262.3
13.5	300.7	298.1	294.9	292.0	289.2	285.8	282.5	277.4	272.3	264.5
13.75	303.1	300.5	297.3	294.4	291.5	288.1	284.7	279.6	274.5	266.6
14	305.4	302.9	299.7	296.8	293.9	290.4	287.0	281.8	276.6	268.7

180L Tank (Continued)

LLI	"Temperature, Degrees F"									
Inches	32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
14.25	307.7	305.2	302.1	299.2	296.3	292.7	289.2	284.0	278.8	270.8
14.5	310.1	307.6	304.4	301.5	298.6	295.0	291.4	286.2	280.9	272.9
14.75	312.4	309.9	306.7	303.9	301.0	297.3	293.7	288.4	283.1	275.0
15	314.8	312.2	309.0	306.1	303.2	299.5	295.9	290.6	285.3	277.1
15.25	317.1	314.5	311.3	308.3	305.4	301.7	298.1	292.8	287.4	279.3
15.5	319.4	316.8	313.6	310.6	307.5	304.0	300.4	295.0	289.6	281.4
15.75	321.8	319.2	315.9	312.8	309.7	306.1	302.5	297.1	291.8	283.5
16	324.1	321.5	318.2	315.0	311.9	308.2	304.6	299.2	293.9	285.6
16.25	326.4	323.8	320.5	317.3	314.1	310.4	306.7	301.4	296.1	287.7
16.5	328.8	326.1	322.8	319.5	316.2	312.5	308.8	303.5	298.2	289.8
16.75	331.1	328.4	325.1	321.8	318.4	314.6	310.8	305.6	300.4	291.9
17	333.5	330.8	327.4	324.0	320.6	316.8	312.9	307.7	302.5	294.1
17.25	335.8	333.1	329.7	326.2	322.8	318.9	315.0	309.7	304.5	296.2
17.5	338.1	335.4	332.0	328.5	325.0	321.0	317.1	311.8	306.5	298.3
17.75	340.5	337.7	334.3	330.7	327.1	323.1	319.2	313.8	308.5	300.4
18	342.8	340.1	336.6	333.0	329.3	325.3	321.3	315.9	310.5	302.5
18.25	345.2	342.4	338.9	335.2	331.5	327.4	323.3	317.9	312.6	304.5
18.5	347.5	344.7	341.2	337.4	333.7	329.5	325.4	320.0	314.6	306.5
18.75	349.8	347.0	343.5	339.7	335.8	331.7	327.5	322.1	316.6	308.6
19	352.2	349.3	345.8	341.9	338.0	333.8	329.6	324.1	318.6	310.6
19.25	354.5	351.7	348.1	344.2	340.2	335.9	331.7	326.2	320.6	312.6
19.5	356.8	354.0	350.4	346.4	342.4	338.1	333.8	328.2	322.7	314.7
19.75	359.2	356.3	352.7	348.6	344.6	340.2	335.8	330.3	324.7	316.7
20	361.5	358.6	355.0	350.9	346.7	342.3	337.9	332.3	326.7	318.8
20.25	363.9	360.9	357.3	353.1	348.9	344.5	340.0	334.4	328.7	320.8
20.5	366.2	363.3	359.6	355.3	351.1	346.6	342.1	336.4	330.7	322.8
20.75	368.5	365.6	361.9	357.6	353.3	348.7	344.2	338.5	332.8	324.9
21	370.9	367.9	364.2	359.8	355.4	350.8	346.3	340.5	334.8	326.9
21.25	373.2	370.2	366.5	362.1	357.6	353.0	348.3	342.6	336.8	328.9
21.5	375.6	372.6	368.8	364.3	359.8	355.1	350.4	344.6	338.8	331.0
21.75	377.9	374.9	371.1	366.5	362.0	357.2	352.5	346.7	340.9	333.0
22	380.2	377.2	373.4	368.8	364.2	359.4	354.6	348.7	342.9	335.0
22.25	382.6	379.5	375.7	371.0	366.3	361.5	356.7	350.8	344.9	337.1
22.5	384.9	381.8	378.0	373.3	368.5	363.6	358.8	352.8	346.9	339.1
22.75	387.2	384.2	380.3	375.5	370.7	365.8	360.8	354.9	348.9	341.1
23	389.6	386.5	382.6	377.7	372.9	367.9	362.9	356.9	351.0	343.2
23.25	391.9	388.8	384.9	380.0	375.0	370.0	365.0	359.0	353.0	345.2
23.5	394.3	391.1	387.2	382.2	377.2	372.2	367.1	361.0	355.0	347.3
23.75	396.6	393.4	389.5	384.4	379.4	374.3	369.2	363.1	357.0	349.3
24	398.9	395.8	391.8	386.7	381.6	376.4	371.3	365.1	359.0	351.3
24.25	401.3	398.1	394.1	388.9	383.8	378.5	373.3	367.2	361.1	353.4
24.5	403.6	400.4	396.4	391.2	385.9	380.7	375.4	369.3	363.1	355.4
24.75	406.0	402.7	398.7	393.4	388.1	382.8	377.5	371.3	365.1	357.4
25	408.3	405.1	401.0	395.6	390.3	384.9	379.6	373.4	367.1	359.5
25.25			403.3	397.9	392.5	387.1	381.7	375.4	369.1	361.5
25.5			405.6	400.1	394.6	389.2	383.8	377.5	371.2	363.5
25.75			407.9	402.4	396.8	391.3	385.8	379.5	373.2	365.6
26					399.0	393.5	387.9	381.6	375.2	367.6
26.25					401.2	395.6	390.0	383.6	377.2	369.6
26.5					403.4	397.7	392.1	385.7	379.3	371.7
26.75					405.5	399.8	394.2	387.7	381.3	373.7
27					407.7	402.0	396.3	389.8	383.3	375.8
27.25							398.3	391.8	385.3	377.8
27.5							400.4	393.9	387.3	379.8
27.75							402.5	395.9	389.4	381.9
28							404.6	398.0	391.4	383.9
28.25							406.7	400.0	393.4	385.9
28.5							408.8	402.1	395.4	388.0
28.75									397.4	390.0
29									399.5	392.0
29.25									401.5	394.1
29.5										396.1
29.75										398.1
30										400.2
30.25										402.2

343L Tank LLI	"Temperature, Degrees F"									
Inches	32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
7.75	356.4	354.7	352.4	350.2	347.9					
8	362.1	360.2	357.8	355.5	353.1					
8.25	367.7	365.7	363.3	360.8	358.3					
8.5	373.4	371.3	368.7	366.1	363.5					
8.75	379.0	376.8	374.1	371.4	368.6	361.4	354.1	346.8	339.5	332.2
9	384.6	382.4	379.5	376.7	373.8	366.5	359.2	351.8	344.5	337.2
9.25	390.3	387.9	384.9	382.0	379.0	371.6	364.2	356.8	349.5	342.1
9.5	395.9	393.4	390.4	387.3	384.2	376.7	369.3	361.9	354.4	347.0
9.75	401.6	399.0	395.8	392.6	389.4	381.9	374.4	366.9	359.4	351.9
10	407.2	404.5	401.2	397.9	394.5	387.0	379.4	371.9	364.3	356.8
10.25	412.8	410.1	406.6	403.2	399.7	392.1	384.5	376.9	369.3	361.7
10.5	418.5	415.6	412.0	408.5	404.9	397.2	389.6	381.9	374.3	366.6
10.75	424.1	421.1	417.4	413.8	410.1	402.3	394.6	386.9	379.2	371.5
11	429.7	426.7	422.9	419.0	415.2	407.5	399.7	392.0	384.2	376.4
11.25	435.4	432.2	428.3	424.3	420.4	412.6	404.8	397.0	389.2	381.4
11.5	441.0	437.8	433.7	429.6	425.6	417.7	409.9	402.0	394.1	386.3
11.75	446.7	443.3	439.1	434.9	430.8	422.8	414.9	407.0	399.1	391.2
12	452.3	448.9	444.5	440.2	435.9	428.0	420.0	412.0	404.1	396.1
12.25	457.9	454.4	450.0	445.5	441.1	433.1	425.1	417.0	409.0	401.0
12.5	463.6	459.9	455.4	450.8	446.3	438.2	430.1	422.1	414.0	405.9
12.75	469.2	465.5	460.8	456.1	451.5	443.3	435.2	427.1	419.0	410.8
13	474.9	471.0	466.2	461.4	456.6	448.5	440.3	432.1	423.9	415.7
13.25	480.5	476.6	471.6	466.7	461.8	453.6	445.3	437.1	428.9	420.7
13.5	486.1	482.1	477.1	472.0	467.0	458.7	450.4	442.1	433.8	425.6
13.75	491.8	487.6	482.5	477.3	472.2	463.8	455.5	447.1	438.8	430.5
14	497.4	493.2	487.9	482.6	477.3	468.9	460.6	452.2	443.8	435.4
14.25	503.0	498.7	493.3	487.9	482.5	474.1	465.6	457.2	448.7	440.3
14.5	508.7	504.3	498.7	493.2	487.7	479.2	470.7	462.2	453.7	445.2
14.75	514.3	509.8	504.2	498.5	492.9	484.3	475.8	467.2	458.7	450.1
15	520.0	515.3	509.6	503.8	498.0	489.4	480.8	472.2	463.6	455.0
15.25	525.6	520.9	515.0	509.1	503.2	494.6	485.9	477.2	468.6	459.9
15.5	531.2	526.4	520.4	514.4	508.4	499.7	491.0	482.3	473.6	464.9
15.75	536.9	532.0	525.8	519.7	513.6	504.8	496.0	487.3	478.5	469.8
16	542.5	537.5	531.2	525.0	518.7	509.9	501.1	492.3	483.5	474.7
16.25	548.2	543.0	536.7	530.3	523.9	515.0	506.2	497.3	488.5	479.6
16.5	553.8	548.6	542.1	535.6	529.1	520.2	511.3	502.3	493.4	484.5
16.75	559.4	554.1	547.5	540.9	534.3	525.3	516.3	507.4	498.4	489.4
17	565.1	559.7	552.9	546.2	539.4	530.4	521.4	512.4	503.3	494.3
17.25	570.6	565.1	558.3	551.4	544.6	535.5	526.5	517.4	508.3	499.2
17.5	576.0	570.5	563.6	556.7	549.8	540.7	531.5	522.4	513.3	504.1
17.75	581.4	575.8	568.9	561.9	555.0	545.8	536.6	527.4	518.2	509.1
18	586.8	581.2	574.2	567.1	560.1	550.9	541.7	532.4	523.2	514.0
18.25	592.2	586.5	579.5	572.4	565.3	556.0	546.7	537.5	528.2	518.9
18.5	597.6	591.9	584.7	577.6	570.4	561.1	551.8	542.4	533.1	523.8
18.75	603.0	597.2	590.0	582.7	575.5	566.1	556.8	547.4	538.1	528.7
19	608.4	602.5	595.2	587.8	580.5	571.1	561.8	552.4	543.0	533.6
19.25	613.8	607.8	600.4	593.0	585.5	576.1	566.7	557.3	547.9	538.5
19.5	619.2	613.2	605.6	598.1	590.6	581.2	571.7	562.3	552.9	543.4
19.75	624.6	618.5	610.9	603.3	595.6	586.2	576.7	567.3	557.8	548.4
20	630.0	623.8	616.1	608.4	600.7	591.2	581.7	572.2	562.7	553.3
20.25	635.4	629.1	621.3	613.5	605.7	596.2	586.7	577.2	567.7	558.2
20.5	640.8	634.5	626.6	618.7	610.8	601.2	591.7	582.2	572.6	563.1
20.75	646.2	639.8	631.8	623.8	615.8	606.2	596.7	587.1	577.6	568.0
21	651.6	645.1	637.0	628.9	620.8	611.1	601.4	591.7	582.0	572.2
21.25	657.0	650.4	642.3	634.1	625.9	616.0	606.1	596.3	586.4	576.5
21.5	662.4	655.8	647.5	639.2	630.9	620.9	610.9	600.8	590.8	580.7
21.75	667.8	661.1	652.7	644.3	636.0	625.8	615.6	605.4	595.2	585.0
22	673.2	666.4	658.0	649.5	641.0	630.7	620.3	609.9	599.6	589.2
22.25	678.6	671.7	663.2	654.6	646.1	635.5	625.0	614.5	604.0	593.5
22.5	684.0	677.1	668.4	659.8	651.1	640.4	629.7	619.1	608.4	597.7
22.75	689.4	682.4	673.6	664.9	656.1	645.3	634.5	623.6	612.8	602.0
23	694.8	687.7	678.9	670.0	661.2	650.2	639.2	628.2	617.2	606.2
23.25	700.2	693.0	684.1	675.2	666.2	655.1	643.9	632.8	621.6	610.5
23.5	705.6	698.4	689.3	680.3	671.3	660.0	648.6	637.3	626.0	614.7
23.75	711.0	703.7	694.6	685.4	676.3	664.8	653.4	641.9	630.4	618.9
24	716.4	709.0	699.8	690.6	681.4	669.7	658.1	646.5	634.8	623.2
24.25	721.8	714.3	705.0	695.7	686.4	674.6	662.8	651.0	639.2	627.4
24.5	727.2	719.7	710.3	700.9	691.4	679.5	667.5	655.6	643.6	631.7
24.75	732.6	725.0	715.5	706.0	696.5	684.4	672.3	660.1	648.0	635.9
25	738.0	730.3	720.7	711.1	701.5	689.3	677.0	664.7	652.4	640.2
25.25	743.4	735.6	726.0	716.3	706.6	694.1	681.7	669.3	656.8	644.4
25.5	748.8	741.0	731.2	721.4	711.6	699.0	686.4	673.8	661.3	648.7

343L Tank (Continued)

LLI	"Temperature, Degrees F"									
Inches	32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
25.75	754.2	746.3	736.4	726.5	716.7	703.9	691.2	678.4	665.7	652.9
26	759.6	751.6	741.6	731.7	721.7	708.8	695.9	683.0	670.1	657.2
26.25	765.0	756.9	746.9	736.8	726.7	713.7	700.6	687.5	674.5	661.4
26.5	770.4	762.3	752.1	741.9	731.8	718.6	705.3	692.1	678.9	665.6
26.75	775.8	767.6	757.3	747.1	736.8	723.4	710.1	696.7	683.3	669.9
27	781.2	772.9	762.6	752.2	741.9	728.3	714.8	701.2	687.7	674.1
27.25	786.6	778.2	767.8	757.4	746.9	733.2	719.5	705.8	692.1	678.4
27.5					752.0	738.1	724.2	710.4	696.5	682.6
27.75					757.0	743.0	728.9	714.9	700.9	686.9
28					762.0	747.9	733.7	719.5	705.3	691.1
28.25					767.1	752.7	738.4	724.0	709.7	695.4
28.5					772.1	757.6	743.1	728.6	714.1	699.6
28.75					777.2	762.5	747.8	733.2	718.5	703.8
29					782.2	767.4	752.6	737.7	722.9	708.1
29.25					787.3	772.3	757.3	742.3	727.3	712.3
29.5					792.3	777.2	762.0	746.9	731.7	716.6
29.75					797.3	782.0	766.7	751.4	736.1	720.8
30					802.4	786.9	771.5	756.0	740.5	725.1
30.25					807.4	791.8	776.2	760.6	744.9	729.3
30.5					812.5	796.7	780.9	765.1	749.3	733.6
30.75					817.5	801.6	785.6	769.7	753.8	737.8
31					822.6	806.5	790.4	774.3	758.2	742.1
31.25										746.3
31.5										750.5
31.75										754.8
32										759.0

106L Tank

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
19.5											
20	50.8	50.6	50.3								
20.5	51.6	51.4	51.1	50.6	50.1						
21	52.5	52.2	52.0	51.5	50.9	50.6	50.3				
21.5	53.3	53.1	52.8	52.3	51.7	51.4	51.0	50.7	50.3		
22	54.2	53.9	53.6	53.1	52.6	52.2	51.8	51.4	51.0	50.3	50.8
22.5	55.1	54.8	54.5	53.9	53.4	53.0	52.6	52.2	51.8	51.0	51.5
23	55.9	55.6	55.3	54.7	54.2	53.8	53.4	53.0	52.5	51.8	52.2
23.5	56.8	56.4	56.1	55.5	55.0	54.5	54.2	53.7	53.2	52.5	52.9
24	57.6	57.3	56.9	56.4	55.8	55.3	54.9	54.5	54.0	53.2	53.7
24.5	58.5	58.1	57.8	57.2	56.6	56.1	55.7	55.2	54.7	53.9	54.4
25	59.3	59.0	58.6	58.0	57.4	56.9	56.5	56.0	55.5	54.6	55.1
25.5	60.2	59.8	59.4	58.8	58.2	57.7	57.3	56.8	56.2	55.4	55.8
26	61.0	60.6	60.3	59.6	59.0	58.5	58.1	57.5	56.9	56.1	56.5
26.5	61.9	61.5	61.1	60.5	59.8	59.3	58.8	58.3	57.7	56.8	57.2
27	62.7	62.3	61.9	61.3	60.6	60.1	59.6	59.0	58.4	57.5	57.9
27.5	63.6	63.2	62.7	62.1	61.5	60.9	60.4	59.8	59.1	58.3	58.6
28	64.4	64.0	63.6	62.9	62.3	61.7	61.2	60.6	59.9	59.0	59.3
28.5	65.3	64.8	64.4	63.7	63.1	62.5	62.0	61.3	60.6	59.7	60.0
29	66.1	65.7	65.2	64.6	63.9	63.3	62.7	62.1	61.4	60.4	60.7
29.5	67.0	66.5	66.1	65.4	64.7	64.1	63.5	62.9	62.1	61.2	61.4
30	67.8	67.4	66.9	66.2	65.5	64.9	64.3	63.6	62.8	61.9	62.1
30.5	68.7	68.2	67.7	67.0	66.3	65.7	65.1	64.4	63.6	62.6	62.8
31	69.5	69.0	68.5	67.8	67.1	66.5	65.9	65.1	64.3	63.3	63.5
31.5	70.4	69.9	69.4	68.6	67.9	67.3	66.6	65.9	65.1	64.1	64.2
32	71.2	70.7	70.2	69.5	68.7	68.1	67.4	66.7	65.8	64.8	65.0
32.5	72.1	71.6	71.0	70.3	69.5	68.9	68.2	67.4	66.5	65.5	65.7
33	73.0	72.4	71.9	71.1	70.4	69.7	69.0	68.2	67.3	66.2	66.4
33.5	73.8	73.2	72.7	71.9	71.2	70.5	69.8	68.9	68.0	67.0	67.1
34	74.7	74.1	73.5	72.7	72.0	71.3	70.5	69.7	68.7	67.7	67.8
34.5	75.5	74.9	74.3	73.6	72.8	72.0	71.3	70.5	69.5	68.4	68.5
35	76.4	75.8	75.2	74.4	73.6	72.8	72.1	71.2	70.2	69.1	69.2
35.5	77.2	76.6	76.0	75.2	74.4	73.6	72.9	72.0	71.0	69.8	69.9
36	78.1	77.4	76.8	76.0	75.2	74.4	73.7	72.8	71.7	70.6	70.6
36.5	78.9	78.3	77.6	76.8	76.0	75.2	74.5	73.5	72.4	71.3	71.3
37	79.8	79.1	78.5	77.6	76.8	76.0	75.2	74.3	73.2	72.0	72.0
37.5	80.6	80.0	79.3	78.5	77.6	76.8	76.0	75.0	73.9	72.7	72.7
38	81.5	80.8	80.1	79.3	78.4	77.6	76.8	75.8	74.7	73.5	73.4
38.5	82.3	81.6	80.9	80.1	79.2	78.4	77.6	76.6	75.4	74.2	74.1
39	83.1	82.4	81.7	80.9	80.1	79.2	78.4	77.3	76.1	74.9	74.8
39.5	84.0	83.2	82.5	81.7	80.8	80.0	79.1	78.1	76.9	75.6	75.5

106L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
40	84.8	84.1	83.3	82.5	81.6	80.8	79.9	78.8	77.6	76.4	76.3
40.5	85.6	84.9	84.1	83.3	82.4	81.6	80.7	79.6	78.4	77.1	77.0
41	86.5	85.7	84.9	84.1	83.2	82.3	81.5	80.4	79.1	77.8	77.7
41.5	87.3	86.5	85.7	84.9	84.0	83.1	82.2	81.1	79.8	78.5	78.4
42	88.1	87.3	86.5	85.6	84.8	83.9	83.0	81.9	80.6	79.3	79.1
42.5	89.0	88.1	87.3	86.4	85.6	84.7	83.8	82.6	81.3	80.0	79.9
43	89.8	89.0	88.1	87.2	86.4	85.5	84.5	83.4	82.0	80.7	80.6
43.5	90.6	89.8	88.9	88.0	87.1	86.2	85.3	84.1	82.8	81.4	81.3
44	91.5	90.6	89.7	88.8	87.9	87.0	86.1	84.9	83.5	82.1	82.0
44.5	92.3	91.4	90.5	89.6	88.7	87.8	86.9	85.6	84.2	82.9	82.8
45	93.2	92.2	91.3	90.4	89.5	88.6	87.6	86.4	85.0	83.6	83.5
45.5	94.0	93.0	92.1	91.2	90.3	89.4	88.4	87.2	85.7	84.3	84.2
46	94.8	93.9	92.9	92.0	91.1	90.1	89.2	87.9	86.4	85.0	84.9
46.5	95.7	94.7	93.7	92.8	91.9	90.9	89.9	88.7	87.1	85.7	85.7
47	96.5	95.5	94.5	93.6	92.7	91.7	90.7	89.4	87.9	86.5	86.4
47.5	97.3	96.3	95.3	94.4	93.4	92.5	91.5	90.2	88.6	87.2	87.1
48	98.2	97.1	96.1	95.1	94.2	93.3	92.3	90.9	89.3	87.9	87.9
48.5	99.0	97.9	96.9	95.9	95.0	94.0	93.0	91.7	90.1	88.6	88.6
49	99.8	98.8	97.7	96.7	95.8	94.8	93.8	92.4	90.8	89.4	89.3
49.5	100.7	99.6	98.5	97.5	96.6	95.6	94.6	93.2	91.5	90.1	90.0
50	101.5	100.4	99.3	98.3	97.4	96.4	95.3	93.9	92.3	90.8	90.8
50.5	102.4	101.2	100.1	99.1	98.2	97.1	96.1	94.7	93.0	91.5	91.5
51	103.2	102.0	100.8	99.9	99.0	97.9	96.9	95.5	93.7	92.2	92.2
51.5	104.0	102.8	101.6	100.7	99.7	98.7	97.7	96.2	94.5	93.0	93.0
52	104.9	103.7	102.4	101.5	100.5	99.5	98.4	97.0	95.2	93.7	93.7
52.5	105.7	104.5	103.2	102.3	101.3	100.3	99.2	97.7	95.9	94.4	94.4
53	106.5	105.3	104.0	103.1	102.1	101.0	100.0	98.5	96.6	95.1	95.1
53.5	107.4	106.1	104.8	103.9	102.9	101.8	100.7	99.2	97.4	95.8	95.9
54	108.2	106.9	105.6	104.7	103.7	102.6	101.5	100.0	98.1	96.6	96.6
54.5	109.0	107.7	106.4	105.4	104.5	103.4	102.3	100.7	98.8	97.3	97.3
55	109.9	108.5	107.2	106.2	105.2	104.2	103.1	101.5	99.6	98.0	98.1
55.5	110.7	109.4	108.0	107.0	106.0	104.9	103.8	102.2	100.3	98.7	98.8
56	111.5	110.2	108.8	107.8	106.8	105.7	104.6	103.0	101.0	99.5	99.5
56.5						106.5	105.4	103.8	101.8	100.2	100.2
57						107.3	106.1	104.5	102.5	100.9	101.0
57.5							106.9	105.3	103.2	101.6	101.7
58								106.0	104.0	102.3	102.4
58.5								106.8	104.7	103.1	103.1
59									105.4	103.8	103.9
59.5									106.2	104.5	104.6
60									106.9	105.2	105.3
60.5										106.0	106.1
61										106.7	106.8
61.5										107.4	
62											
62.5											
63											

147L Tank

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
26											
26.5	70.8	70.6	70.4	69.8							
27	71.7	71.5	71.3	70.7	70.1	69.6					
27.5	72.6	72.4	72.1	71.5	70.9	70.5	70.0				
28	73.5	73.3	73.0	72.4	71.8	71.3	70.8	70.1			
28.5	74.4	74.1	73.9	73.2	72.6	72.1	71.6	70.9	69.9		
29	75.3	75.0	74.7	74.1	73.5	72.9	72.4	71.6	70.7		
29.5	76.2	75.9	75.6	74.9	74.3	73.7	73.2	72.4	71.5	69.8	
30	77.1	76.8	76.5	75.8	75.1	74.6	74.0	73.2	72.2	70.6	
30.5	78.0	77.7	77.3	76.6	76.0	75.4	74.8	74.0	73.0	71.4	
31	78.9	78.6	78.2	77.5	76.8	76.2	75.6	74.8	73.8	72.1	70.0
31.5	79.8	79.4	79.1	78.4	77.6	77.0	76.4	75.6	74.6	72.9	70.8
32	80.7	80.3	79.9	79.2	78.5	77.8	77.2	76.3	75.3	73.7	71.6
32.5	81.6	81.2	80.8	80.1	79.3	78.6	78.0	77.1	76.1	74.4	72.4
33	82.5	82.1	81.7	80.9	80.2	79.5	78.8	77.9	76.9	75.2	73.1
33.5	83.4	83.0	82.5	81.8	81.0	80.3	79.6	78.7	77.6	76.0	73.9
34	84.3	83.8	83.4	82.6	81.8	81.1	80.4	79.5	78.4	76.7	74.7
34.5	85.2	84.7	84.3	83.5	82.7	81.9	81.2	80.3	79.2	77.5	75.5
35	86.1	85.6	85.1	84.3	83.5	82.7	82.0	81.0	80.0	78.3	76.2

147L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
35.5	87.0	86.5	86.0	85.2	84.3	83.6	82.8	81.8	80.7	79.0	77.0
36	87.9	87.4	86.9	86.0	85.2	84.4	83.6	82.6	81.5	79.8	77.8
36.5	88.8	88.3	87.7	86.9	86.0	85.2	84.4	83.4	82.3	80.6	78.6
37	89.7	89.1	88.6	87.7	86.9	86.0	85.2	84.2	83.0	81.3	79.3
37.5	90.6	90.0	89.5	88.6	87.7	86.8	86.0	85.0	83.8	82.1	80.1
38	91.5	90.9	90.3	89.4	88.5	87.6	86.8	85.7	84.6	82.9	80.9
38.5	92.4	91.8	91.2	90.3	89.4	88.5	87.6	86.5	85.3	83.6	81.7
39	93.3	92.7	92.1	91.1	90.2	89.3	88.4	87.3	86.1	84.4	82.4
39.5	94.2	93.6	92.9	92.0	91.0	90.1	89.2	88.1	86.9	85.2	83.2
40	95.1	94.4	93.8	92.8	91.9	90.9	90.0	88.9	87.7	85.9	84.0
40.5	96.0	95.3	94.7	93.7	92.7	91.7	90.8	89.7	88.4	86.7	84.8
41	96.9	96.2	95.5	94.5	93.5	92.6	91.6	90.4	89.2	87.5	85.5
41.5	97.8	97.1	96.4	95.4	94.4	93.4	92.4	91.2	90.0	88.2	86.3
42	98.7	98.0	97.3	96.3	95.2	94.2	93.2	92.0	90.7	89.0	87.1
42.5	99.6	98.9	98.1	97.1	96.1	95.0	94.0	92.8	91.5	89.8	87.9
43	100.4	99.7	99.0	98.0	96.9	95.8	94.8	93.6	92.3	90.5	88.6
43.5	101.3	100.6	99.9	98.8	97.7	96.6	95.6	94.4	93.1	91.3	89.4
44	102.2	101.5	100.8	99.7	98.6	97.5	96.4	95.1	93.8	92.1	90.2
44.5	103.1	102.4	101.6	100.5	99.4	98.3	97.2	95.9	94.6	92.8	91.0
45	104.0	103.3	102.5	101.4	100.2	99.1	98.0	96.7	95.4	93.6	91.7
45.5	104.9	104.1	103.4	102.2	101.1	99.9	98.8	97.5	96.1	94.4	92.5
46	105.8	105.0	104.2	103.1	101.9	100.7	99.5	98.3	96.9	95.1	93.3
46.5	106.7	105.9	105.1	103.9	102.8	101.6	100.3	99.0	97.7	95.9	94.1
47	107.6	106.8	106.0	104.8	103.6	102.4	101.1	99.8	98.4	96.7	94.8
47.5	108.5	107.7	106.8	105.6	104.4	103.2	101.9	100.6	99.2	97.4	95.6
48	109.4	108.6	107.7	106.5	105.3	104.0	102.7	101.4	100.0	98.2	96.4
48.5	110.3	109.4	108.6	107.3	106.1	104.8	103.5	102.2	100.8	99.0	97.2
49	111.2	110.3	109.4	108.2	106.9	105.6	104.3	103.0	101.5	99.7	97.9
49.5	112.1	111.2	110.3	109.0	107.8	106.5	105.1	103.7	102.3	100.5	98.7
50	112.9	112.0	111.1	109.9	108.6	107.3	105.9	104.5	103.1	101.3	99.5
50.5	113.7	112.8	111.9	110.7	109.4	108.1	106.7	105.3	103.8	102.0	100.3
51	114.6	113.7	112.8	111.5	110.3	108.9	107.5	106.1	104.6	102.8	101.0
51.5	115.4	114.5	113.6	112.3	111.1	109.7	108.3	106.9	105.4	103.6	101.8
52	116.3	115.3	114.4	113.1	111.9	110.5	109.1	107.7	106.2	104.3	102.6
52.5	117.1	116.1	115.2	113.9	112.7	111.3	109.9	108.4	106.9	105.1	103.3
53	118.0	117.0	116.0	114.7	113.5	112.1	110.7	109.2	107.7	105.9	104.1
53.5	118.8	117.8	116.8	115.5	114.3	112.9	111.5	110.0	108.5	106.6	104.9
54	119.7	118.6	117.6	116.3	115.1	113.7	112.3	110.8	109.2	107.4	105.7
54.5	120.5	119.5	118.4	117.1	115.8	114.4	113.0	111.5	110.0	108.2	106.5
55	121.4	120.3	119.2	117.9	116.6	115.2	113.8	112.3	110.8	108.9	107.3
55.5	122.2	121.1	120.0	118.7	117.4	116.0	114.5	113.1	111.5	109.7	108.1
56	123.1	121.9	120.8	119.5	118.2	116.8	115.3	113.8	112.3	110.4	108.9
56.5	123.9	122.8	121.6	120.3	119.0	117.6	116.1	114.6	113.0	111.2	109.6
57	124.7	123.6	122.4	121.1	119.8	118.3	116.8	115.3	113.7	111.9	110.4
57.5	125.6	124.4	123.2	121.9	120.6	119.1	117.6	116.1	114.5	112.7	111.1
58	126.4	125.2	124.0	122.7	121.4	119.9	118.4	116.8	115.2	113.4	111.9
58.5	127.3	126.1	124.8	123.5	122.1	120.7	119.1	117.6	115.9	114.1	112.6
59	128.1	126.9	125.6	124.3	122.9	121.4	119.9	118.3	116.7	114.9	113.4
59.5	129.0	127.7	126.4	125.1	123.7	122.2	120.7	119.1	117.4	115.6	114.2
60	129.8	128.5	127.2	125.9	124.5	123.0	121.4	119.8	118.1	116.3	114.9
60.5	130.7	129.4	128.0	126.7	125.3	123.8	122.2	120.6	118.9	117.1	115.7
61	131.5	130.2	128.8	127.5	126.1	124.5	122.9	121.3	119.6	117.8	116.4
61.5	132.4	131.0	129.7	128.3	126.9	125.3	123.7	122.1	120.3	118.5	117.2
62	133.2	131.8	130.5	129.1	127.7	126.1	124.5	122.8	121.1	119.3	117.9
62.5	134.1	132.7	131.3	129.9	128.5	126.9	125.2	123.6	121.8	120.0	118.7
63	134.9	133.5	132.1	130.7	129.2	127.7	126.0	124.3	122.6	120.7	119.4
63.5	135.7	134.3	132.9	131.5	130.0	128.4	126.8	125.1	123.3	121.5	120.2
64	136.6	135.1	133.7	132.2	130.8	129.2	127.5	125.8	124.0	122.2	120.9
64.5	137.4	136.0	134.5	133.0	131.6	130.0	128.3	126.6	124.8	122.9	121.7
65	138.3	136.8	135.3	133.8	132.4	130.8	129.1	127.3	125.5	123.7	122.4
65.5	139.1	137.6	136.1	134.6	133.2	131.5	129.8	128.1	126.2	124.4	123.2
66	140.0	138.4	136.9	135.4	134.0	132.3	130.6	128.8	127.0	125.1	123.9
66.5	140.8	139.3	137.7	136.2	134.8	133.1	131.4	129.6	127.7	125.9	124.7
67	141.7	140.1	138.5	137.0	135.6	133.9	132.1	130.3	128.4	126.6	125.4
67.5	142.5	140.9	139.3	137.8	136.3	134.6	132.9	131.1	129.2	127.3	126.2
68	143.4	141.7	140.1	138.6	137.1	135.4	133.6	131.8	129.9	128.1	126.9
68.5	144.2	142.6	140.9	139.4	137.9	136.2	134.4	132.6	130.6	128.8	127.7
69	145.1	143.4	141.7	140.2	138.7	137.0	135.2	133.3	131.4	129.5	128.4
69.5	145.9	144.2	142.5	141.0	139.5	137.7	135.9	134.1	132.1	130.3	129.2
70	146.8	145.0	143.3	141.8	140.3	138.5	136.7	134.8	132.8	131.0	129.9
70.5	147.6	145.9	144.1	142.6	141.1	139.3	137.5	135.6	133.6	131.7	130.7
71	148.4	146.7	144.9	143.4	141.9	140.1	138.2	136.3	134.3	132.5	131.4

147L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
71.5	149.3	147.5	145.8	144.2	142.6	140.9	139.0	137.1	135.1	133.2	132.2
72	150.1	148.3	146.6	145.0	143.4	141.6	139.8	137.8	135.8	133.9	132.9
72.5	151.0	149.2	147.4	145.8	144.2	142.4	140.5	138.6	136.5	134.7	133.7
73	151.8	150.0	148.2	146.6	145.0	143.2	141.3	139.3	137.3	135.4	134.4
73.5	152.7	150.8	149.0	147.4	145.8	144.0	142.0	140.1	138.0	136.1	135.2
74	153.5	151.6	149.8	148.2	146.6	144.7	142.8	140.8	138.7	136.9	135.9
74.5	154.4	152.5	150.6	149.0	147.4	145.5	143.6	141.6	139.5	137.6	136.7
75						146.3	144.3	142.3	140.2	138.3	137.4
75.5						147.1	145.1	143.1	140.9	139.1	138.2
76						147.8	145.9	143.8	141.7	139.8	138.9
76.5							146.6	144.6	142.4	140.5	139.7
77							147.4	145.3	143.1	141.3	140.4
77.5								146.1	143.9	142.0	141.2
78								146.8	144.6	142.7	141.9
78.5								147.6	145.3	143.5	142.7
79									146.1	144.2	143.5
79.5									146.8	144.9	144.2
80									147.6	145.7	145.0
80.5										146.4	145.7
81										147.1	146.5
81.5										147.8	147.2
82											
82.5											
83											
83.5											

180L Tank

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
6											
6.5	86.5										
7	87.4	86.9	86.3								
7.5	88.3	87.8	87.2	86.6							
8	89.2	88.6	88.0	87.5	86.9	86.6	86.4				
8.5	90.1	89.5	88.9	88.4	87.8	87.5	87.2	86.2			
9	91.0	90.4	89.8	89.2	88.6	88.3	88.0	87.0			
9.5	91.9	91.3	90.7	90.1	89.5	89.1	88.8	87.8			
10	92.9	92.2	91.5	90.9	90.3	90.0	89.6	88.6	86.9		
10.5	93.8	93.1	92.4	91.8	91.2	90.8	90.4	89.4	87.7		
11	94.7	94.0	93.3	92.7	92.0	91.6	91.3	90.2	88.5	86.5	
11.5	95.6	94.9	94.2	93.5	92.9	92.5	92.1	90.9	89.2	87.3	
12	96.5	95.7	95.0	94.4	93.7	93.3	92.9	91.7	90.0	88.1	
12.5	97.4	96.6	95.9	95.3	94.6	94.1	93.7	92.5	90.8	88.8	86.8
13	98.3	97.5	96.8	96.1	95.5	94.9	94.5	93.3	91.6	89.6	87.5
13.5	99.2	98.4	97.7	97.0	96.3	95.8	95.3	94.1	92.4	90.4	88.2
14	100.1	99.3	98.5	97.8	97.2	96.6	96.1	94.9	93.1	91.1	89.0
14.5	101.0	100.2	99.4	98.7	98.0	97.4	96.9	95.7	93.9	91.9	89.7
15	101.9	101.1	100.3	99.6	98.9	98.3	97.7	96.5	94.7	92.7	90.5
15.5	102.8	102.0	101.2	100.4	99.7	99.1	98.5	97.3	95.5	93.4	91.2
16	103.7	102.9	102.0	101.3	100.6	99.9	99.4	98.1	96.3	94.2	91.9
16.5	104.6	103.7	102.9	102.2	101.4	100.8	100.2	98.9	97.0	95.0	92.7
17	105.5	104.6	103.8	103.0	102.3	101.6	101.0	99.7	97.8	95.7	93.4
17.5	106.4	105.5	104.7	103.9	103.1	102.4	101.8	100.5	98.6	96.5	94.2
18	107.3	106.4	105.5	104.7	104.0	103.3	102.6	101.3	99.4	97.3	94.9
18.5	108.2	107.3	106.4	105.6	104.8	104.1	103.4	102.1	100.2	98.0	95.6
19	109.1	108.2	107.3	106.5	105.7	104.9	104.2	102.8	100.9	98.8	96.4
19.5	110.0	109.1	108.2	107.3	106.5	105.8	105.0	103.6	101.7	99.6	97.1
20	110.9	110.0	109.0	108.2	107.4	106.6	105.8	104.4	102.5	100.4	97.8
20.5	111.8	110.8	109.9	109.1	108.2	107.4	106.6	105.2	103.3	101.1	98.6
21	112.7	111.7	110.8	109.9	109.1	108.3	107.5	106.0	104.1	101.9	99.3
21.5	113.6	112.6	111.6	110.8	109.9	109.1	108.3	106.8	104.9	102.7	100.1
22	114.5	113.5	112.5	111.6	110.8	109.9	109.1	107.6	105.6	103.4	100.8
22.5	115.4	114.4	113.4	112.5	111.6	110.7	109.9	108.4	106.4	104.2	101.5
23	116.3	115.3	114.3	113.4	112.5	111.6	110.7	109.2	107.2	105.0	102.3
23.5	117.2	116.2	115.1	114.2	113.3	112.4	111.5	110.0	108.0	105.7	103.0
24	118.1	117.1	116.0	115.1	114.2	113.2	112.3	110.8	108.8	106.5	103.8
24.5	119.0	117.9	116.9	116.0	115.0	114.1	113.1	111.6	109.5	107.3	104.5
25	119.9	118.8	117.8	116.8	115.9	114.9	113.9	112.4	110.3	108.0	105.2
25.5	120.8	119.7	118.6	117.7	116.7	115.7	114.7	113.2	111.1	108.8	106.0
26	121.7	120.6	119.5	118.5	117.6	116.6	115.6	114.0	111.9	109.6	106.7

180L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
26.5	122.6	121.5	120.4	119.4	118.4	117.4	116.4	114.7	112.7	110.3	107.4
27	123.5	122.4	121.3	120.3	119.3	118.2	117.2	115.5	113.4	111.1	108.2
27.5	124.4	123.3	122.1	121.1	120.1	119.1	118.0	116.3	114.2	111.9	108.9
28	125.3	124.2	123.0	122.0	121.0	119.9	118.8	117.1	115.0	112.6	109.7
28.5	126.2	125.0	123.9	122.8	121.8	120.7	119.6	117.9	115.8	113.4	110.4
29	127.1	125.9	124.8	123.7	122.7	121.6	120.4	118.7	116.6	114.2	111.1
29.5	128.0	126.8	125.6	124.6	123.5	122.4	121.2	119.5	117.3	114.9	111.9
30	128.9	127.7	126.5	125.4	124.4	123.2	122.0	120.3	118.1	115.7	112.6
30.5	129.8	128.6	127.4	126.3	125.2	124.0	122.8	121.1	118.9	116.5	113.4
31	130.7	129.5	128.3	127.2	126.1	124.9	123.7	121.9	119.7	117.2	114.1
31.5	131.6	130.4	129.1	128.0	126.9	125.7	124.5	122.7	120.5	118.0	114.8
32	132.5	131.3	130.0	128.9	127.8	126.5	125.3	123.5	121.2	118.8	115.6
32.5	133.4	132.2	130.9	129.7	128.6	127.4	126.1	124.3	122.0	119.5	116.3
33	134.3	133.0	131.7	130.6	129.5	128.2	126.9	125.1	122.8	120.3	117.0
33.5	135.2	133.9	132.6	131.5	130.3	129.0	127.7	125.9	123.6	121.1	117.8
34	136.1	134.8	133.5	132.3	131.2	129.9	128.5	126.6	124.4	121.8	118.5
34.5	137.0	135.7	134.4	133.2	132.0	130.7	129.3	127.4	125.1	122.6	119.3
35	137.9	136.5	135.2	134.1	132.9	131.5	130.1	128.2	125.9	123.4	120.0
35.5	138.7	137.4	136.1	134.9	133.7	132.4	130.9	129.0	126.7	124.1	120.7
36	139.5	138.3	137.0	135.8	134.6	133.2	131.8	129.8	127.5	124.9	121.5
36.5	140.4	139.1	137.8	136.6	135.4	134.0	132.6	130.6	128.3	125.7	122.2
37	141.2	139.9	138.6	137.4	136.3	134.9	133.4	131.4	129.0	126.5	123.0
37.5	142.0	140.7	139.4	138.3	137.1	135.7	134.2	132.2	129.8	127.2	123.7
38	142.9	141.6	140.3	139.1	137.9	136.5	135.0	133.0	130.6	128.0	124.4
38.5	143.7	142.4	141.1	139.9	138.7	137.3	135.8	133.8	131.4	128.8	125.2
39	144.5	143.2	141.9	140.7	139.5	138.0	136.6	134.6	132.2	129.5	125.9
39.5	145.4	144.1	142.7	141.5	140.2	138.8	137.4	135.4	132.9	130.3	126.6
40	146.2	144.9	143.6	142.3	141.0	139.6	138.1	136.1	133.7	131.1	127.4
40.5	147.1	145.7	144.4	143.1	141.8	140.4	138.9	136.9	134.5	131.8	128.1
41	147.9	146.5	145.2	143.9	142.6	141.1	139.6	137.6	135.2	132.6	128.9
41.5	148.7	147.4	146.0	144.7	143.4	141.9	140.4	138.4	136.0	133.4	129.7
42	149.6	148.2	146.8	145.5	144.2	142.7	141.1	139.1	136.8	134.1	130.5
42.5	150.4	149.0	147.7	146.3	144.9	143.4	141.9	139.9	137.6	134.9	131.3
43	151.2	149.9	148.5	147.1	145.7	144.2	142.6	140.6	138.3	135.6	132.1
43.5	152.1	150.7	149.3	147.9	146.5	145.0	143.4	141.4	139.0	136.4	132.9
44	152.9	151.5	150.1	148.7	147.3	145.7	144.1	142.1	139.8	137.1	133.6
44.5	153.7	152.3	151.0	149.5	148.1	146.5	144.9	142.9	140.5	137.9	134.3
45	154.6	153.2	151.8	150.3	148.9	147.3	145.6	143.6	141.2	138.6	135.1
45.5	155.4	154.0	152.6	151.1	149.6	148.0	146.4	144.3	141.9	139.3	135.8
46	156.2	154.8	153.4	151.9	150.4	148.8	147.1	145.1	142.7	140.0	136.5
46.5	157.1	155.7	154.2	152.7	151.2	149.6	147.9	145.8	143.4	140.8	137.3
47	157.9	156.5	155.1	153.5	152.0	150.3	148.6	146.5	144.1	141.5	138.0
47.5	158.8	157.3	155.9	154.3	152.8	151.1	149.4	147.3	144.8	142.2	138.7
48	159.6	158.2	156.7	155.1	153.6	151.9	150.1	148.0	145.6	142.9	139.5
48.5	160.4	159.0	157.5	155.9	154.3	152.6	150.9	148.8	146.3	143.7	140.2
49	161.3	159.8	158.4	156.7	155.1	153.4	151.7	149.5	147.0	144.4	140.9
49.5	162.1	160.6	159.2	157.5	155.9	154.2	152.4	150.2	147.8	145.1	141.7
50	162.9	161.5	160.0	158.3	156.7	154.9	153.2	151.0	148.5	145.8	142.4
50.5	163.8	162.3	160.8	159.1	157.5	155.7	153.9	151.7	149.2	146.6	143.1
51	164.6	163.1	161.6	159.9	158.2	156.5	154.7	152.5	149.9	147.3	143.9
51.5	165.4	164.0	162.5	160.8	159.0	157.2	155.4	153.2	150.7	148.0	144.6
52	166.3	164.8	163.3	161.6	159.8	158.0	156.2	153.9	151.4	148.7	145.3
52.5	167.1	165.6	164.1	162.4	160.6	158.8	156.9	154.7	152.1	149.5	146.1
53	168.0	166.4	164.9	163.2	161.4	159.5	157.7	155.4	152.8	150.2	146.8
53.5	168.8	167.3	165.8	164.0	162.2	160.3	158.4	156.1	153.6	150.9	147.5
54	169.6	168.1	166.6	164.8	162.9	161.1	159.2	156.9	154.3	151.6	148.3
54.5	170.5	168.9	167.4	165.6	163.7	161.8	159.9	157.6	155.0	152.4	149.0
55	171.3	169.8	168.2	166.4	164.5	162.6	160.7	158.4	155.8	153.1	149.7
55.5	172.1	170.6	169.0	167.2	165.3	163.4	161.4	159.1	156.5	153.8	150.5
56	173.0	171.4	169.9	168.0	166.1	164.1	162.2	159.8	157.2	154.5	151.2
56.5	173.8	172.2	170.7	168.8	166.9	164.9	162.9	160.6	157.9	155.3	151.9
57	174.6	173.1	171.5	169.6	167.6	165.7	163.7	161.3	158.7	156.0	152.7
57.5	175.5	173.9	172.3	170.4	168.4	166.4	164.4	162.1	159.4	156.7	153.4
58	176.3	174.7	173.2	171.2	169.2	167.2	165.2	162.8	160.1	157.4	154.1
58.5	177.1	175.6	174.0	172.0	170.0	168.0	165.9	163.5	160.9	158.2	154.9
59	178.0	176.4	174.8	172.8	170.8	168.7	166.7	164.3	161.6	158.9	155.6
59.5	178.8	177.2	175.6	173.6	171.6	169.5	167.4	165.0	162.3	159.6	156.4
60	179.7	178.1	176.4	174.4	172.3	170.3	168.2	165.8	163.0	160.3	157.1
60.5	180.5	178.9	177.3	175.2	173.1	171.0	168.9	166.5	163.8	161.1	157.8
61	181.3	179.7	178.1	176.0	173.9	171.8	169.7	167.2	164.5	161.8	158.6
61.5	182.2	180.5	178.9	176.8	174.7	172.6	170.4	168.0	165.2	162.5	159.3
62	183.0	181.4	179.7	177.6	175.5	173.3	171.2	168.7	165.9	163.2	160.0

180L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
62.5	183.8	182.2	180.6	178.4	176.3	174.1	171.9	169.4	166.7	164.0	160.8
63	184.7	183.0	181.4	179.2	177.0	174.9	172.7	170.2	167.4	164.7	161.5
63.5	185.5	183.9	182.2	180.0	177.8	175.6	173.4	170.9	168.1	165.4	162.2
64	186.3	184.7	183.0	180.8	178.6	176.4	174.2	171.7	168.9	166.1	163.0
64.5	187.2	185.5	183.8	181.6	179.4	177.2	174.9	172.4	169.6	166.9	163.7
65	188.0	186.3	184.7	182.4	180.2	177.9	175.7	173.1	170.3	167.6	164.4
65.5	188.9	187.2	185.5	183.2	181.0	178.7	176.5	173.9	171.0	168.3	165.2
66	189.7	188.0	186.3	184.0	181.7	179.5	177.2	174.6	171.8	169.0	165.9
66.5	190.5	188.8	187.1	184.8	182.5	180.2	178.0	175.4	172.5	169.8	166.6
67						181.0	178.7	176.1	173.2	170.5	167.4
67.5						181.8	179.5	176.8	173.9	171.2	168.1
68						182.5	180.2	177.6	174.7	171.9	168.8
68.5							181.0	178.3	175.4	172.7	169.6
69							181.7	179.0	176.1	173.4	170.3
69.5							182.5	179.8	176.9	174.1	171.0
70								180.5	177.6	174.8	171.8
70.5								181.3	178.3	175.6	172.5
71								182.0	179.0	176.3	173.2
71.5								182.7	179.8	177.0	174.0
72									180.5	177.7	174.7
72.5									181.2	178.5	175.4
73									182.0	179.2	176.2
73.5									182.7	179.9	176.9
74										180.6	177.6
74.5										181.4	178.4
75										182.1	179.1
75.5										182.8	179.8
76											180.6
76.5											181.3
77											182.0
77.5											182.8
78											
78.5											
79											
79.5											

343L Tank

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
15											
15.5											
16											
16.5											
17											
17.5											
18											
18.5											
19											
19.5											
20											
20.5	165.2	164.2	163.3	162.3							
21	167.2	166.2	165.2	164.2	163.2						
21.5	169.3	168.2	167.1	166.1	165.0	162.5					
22	171.3	170.2	169.1	168.0	166.9	164.3					
22.5	173.3	172.2	171.0	169.9	168.7	166.2	163.2				
23	175.3	174.1	173.0	171.8	170.6	168.0	165.0	162.0			
23.5	177.3	176.1	174.9	173.7	172.5	169.9	166.8	163.8			
24	179.3	178.1	176.8	175.6	174.3	171.7	168.7	165.6	162.6		163.6
24.5	181.4	180.1	178.8	177.5	176.2	173.5	170.5	167.4	164.4		165.3
25	183.4	182.1	180.7	179.4	178.1	175.4	172.3	169.3	166.2	163.1	167.1
25.5	185.4	184.0	182.7	181.3	179.9	177.2	174.1	171.1	168.0	164.9	168.8
26	187.4	186.0	184.6	183.2	181.8	179.1	176.0	172.9	169.8	166.7	170.6
26.5	189.4	188.0	186.5	185.1	183.6	180.9	177.8	174.7	171.6	168.4	172.3
27	191.5	190.0	188.5	187.0	185.5	182.7	179.6	176.5	173.3	170.2	174.1
27.5	193.5	192.0	190.4	188.9	187.4	184.6	181.4	178.3	175.1	172.0	175.8
28	195.5	193.9	192.4	190.8	189.2	186.4	183.3	180.1	176.9	173.8	177.6
28.5	197.5	195.9	194.3	192.7	191.1	188.3	185.1	181.9	178.7	175.5	179.3
29	199.5	197.9	196.2	194.6	193.0	190.1	186.9	183.7	180.5	177.3	181.1
29.5	201.6	199.9	198.2	196.5	194.8	191.9	188.7	185.5	182.3	179.1	182.9
30	203.6	201.9	200.1	198.4	196.7	193.8	190.5	187.3	184.1	180.8	184.6

343L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
30.5	205.6	203.8	202.1	200.3	198.5	195.6	192.4	189.1	185.9	182.6	186.4
31	207.6	205.8	204.0	202.2	200.4	197.5	194.2	190.9	187.6	184.4	188.1
31.5	209.6	207.8	206.0	204.1	202.3	199.3	196.0	192.7	189.4	186.1	189.9
32	211.7	209.8	207.9	206.0	204.1	201.1	197.8	194.5	191.2	187.9	191.6
32.5	213.7	211.8	209.8	207.9	206.0	203.0	199.7	196.3	193.0	189.7	193.4
33	215.7	213.7	211.8	209.8	207.9	204.8	201.5	198.1	194.8	191.5	195.1
33.5	217.7	215.7	213.7	211.7	209.7	206.7	203.3	199.9	196.6	193.2	196.9
34	219.7	217.7	215.7	213.6	211.6	208.5	205.1	201.7	198.4	195.0	198.6
34.5	221.8	219.7	217.6	215.5	213.4	210.3	206.9	203.6	200.2	196.8	200.4
35	223.8	221.7	219.5	217.4	215.3	212.2	208.8	205.4	201.9	198.5	202.1
35.5	225.8	223.6	221.5	219.3	217.2	214.0	210.6	207.2	203.7	200.3	203.9
36	227.8	225.6	223.4	221.2	219.0	215.9	212.4	209.0	205.5	202.1	205.6
36.5	229.8	227.6	225.4	223.1	220.9	217.7	214.2	210.8	207.3	203.8	207.4
37	231.8	229.6	227.3	225.0	222.8	219.5	216.1	212.6	209.1	205.6	209.1
37.5	233.9	231.6	229.2	226.9	224.6	221.4	217.9	214.4	210.9	207.4	210.9
38	235.9	233.5	231.2	228.8	226.5	223.2	219.7	216.2	212.7	209.2	212.6
38.5	237.9	235.5	233.1	230.7	228.3	225.1	221.5	218.0	214.5	210.9	214.4
39	239.9	237.5	235.1	232.6	230.2	226.9	223.3	219.8	216.2	212.7	216.2
39.5	241.9	239.5	237.0	234.5	232.1	228.7	225.2	221.6	218.0	214.5	217.9
40	244.0	241.5	238.9	236.4	233.9	230.6	227.0	223.4	219.8	216.2	219.7
40.5	246.0	243.4	240.9	238.3	235.8	232.4	228.8	225.2	221.6	218.0	221.4
41	248.0	245.4	242.8	240.2	237.7	234.3	230.6	227.0	223.4	219.8	223.2
41.5	250.0	247.4	244.8	242.1	239.5	236.1	232.5	228.8	225.2	221.5	224.9
42	252.0	249.4	246.7	244.0	241.4	237.9	234.3	230.6	227.0	223.3	226.7
42.5	254.1	251.4	248.7	245.9	243.2	239.8	236.1	232.4	228.8	225.1	228.4
43	256.1	253.3	250.6	247.8	245.1	241.6	237.9	234.2	230.5	226.9	230.2
43.5	258.1	255.3	252.5	249.7	247.0	243.5	239.8	236.0	232.3	228.6	231.9
44	260.0	257.2	254.4	251.6	248.8	245.3	241.6	237.9	234.1	230.4	233.7
44.5	262.0	259.1	256.3	253.5	250.7	247.1	243.4	239.7	235.9	232.2	235.4
45	263.9	261.1	258.2	255.4	252.5	249.0	245.2	241.5	237.7	233.9	237.2
45.5	265.8	263.0	260.1	257.3	254.4	250.8	247.0	243.3	239.5	235.7	238.9
46	267.8	264.9	262.0	259.1	256.3	252.7	248.9	245.1	241.3	237.5	240.7
46.5	269.7	266.8	263.9	261.0	258.1	254.5	250.7	246.9	243.1	239.2	242.5
47	271.6	268.7	265.8	262.9	259.9	256.3	252.5	248.7	244.8	241.0	244.2
47.5	273.6	270.6	267.7	264.7	261.7	258.1	254.3	250.4	246.6	242.8	246.0
48	275.5	272.5	269.5	266.5	263.6	259.9	256.1	252.2	248.4	244.5	247.7
48.5	277.4	274.4	271.4	268.4	265.4	261.7	257.9	254.0	250.2	246.3	249.5
49	279.4	276.3	273.3	270.2	267.2	263.5	259.6	255.8	251.9	248.1	251.2
49.5	281.3	278.2	275.1	272.1	269.0	265.3	261.4	257.6	253.7	249.8	253.0
50	283.2	280.1	277.0	273.9	270.8	267.1	263.2	259.3	255.5	251.6	254.7
50.5	285.2	282.0	278.9	275.7	272.6	268.9	265.0	261.1	257.2	253.4	256.5
51	287.1	283.9	280.8	277.6	274.4	270.7	266.8	262.9	259.0	255.1	258.1
51.5	289.0	285.8	282.6	279.4	276.2	272.5	268.6	264.7	260.8	256.9	259.6
52	291.0	287.7	284.5	281.3	278.0	274.3	270.4	266.5	262.6	258.6	261.1
52.5	292.9	289.6	286.4	283.1	279.8	276.1	272.2	268.2	264.3	260.4	262.6
53	294.8	291.5	288.2	285.0	281.7	277.9	273.9	270.0	266.0	262.1	264.1
53.5	296.8	293.4	290.1	286.8	283.5	279.6	275.6	271.6	267.6	263.6	265.7
54	298.7	295.3	292.0	288.6	285.3	281.4	277.3	273.3	269.2	265.2	267.2
54.5	300.6	297.2	293.9	290.5	287.1	283.1	279.0	274.9	270.8	266.7	268.7
55	302.6	299.1	295.7	292.3	288.9	284.9	280.8	276.6	272.4	268.3	270.2
55.5	304.5	301.0	297.6	294.2	290.7	286.7	282.5	278.3	274.1	269.9	271.7
56	306.4	302.9	299.5	296.0	292.5	288.4	284.2	279.9	275.7	271.4	273.2
56.5	308.4	304.8	301.3	297.8	294.3	290.2	285.9	281.6	277.3	273.0	274.7
57	310.3	306.8	303.2	299.7	296.1	292.0	287.6	283.2	278.9	274.5	276.2
57.5	312.2	308.7	305.1	301.5	297.9	293.7	289.3	284.9	280.5	276.1	277.7
58	314.2	310.6	307.0	303.4	299.8	295.5	291.0	286.6	282.1	277.7	279.2
58.5	316.1	312.5	308.8	305.2	301.6	297.3	292.7	288.2	283.7	279.2	280.7
59	318.0	314.4	310.7	307.0	303.4	299.0	294.5	289.9	285.3	280.8	282.2
59.5	320.0	316.3	312.6	308.9	305.2	300.8	296.2	291.6	286.9	282.3	283.8
60	321.9	318.2	314.4	310.7	307.0	302.5	297.9	293.2	288.6	283.9	285.3
60.5	323.8	320.1	316.3	312.6	308.8	304.3	299.6	294.9	290.2	285.5	286.8
61	325.8	322.0	318.2	314.4	310.6	306.1	301.3	296.5	291.8	287.0	288.3
61.5	327.7	323.9	320.1	316.2	312.4	307.8	303.0	298.2	293.4	288.6	289.8
62	329.6	325.8	321.9	318.1	314.2	309.6	304.7	299.9	295.0	290.1	291.3
62.5	331.6	327.7	323.8	319.9	316.0	311.4	306.4	301.5	296.6	291.7	292.8
63	333.5	329.6	325.7	321.8	317.9	313.1	308.2	303.2	298.2	293.3	294.3
63.5	335.4	331.5	327.5	323.6	319.7	314.9	309.9	304.9	299.8	294.8	295.8
64	337.4	333.4	329.4	325.4	321.5	316.7	311.6	306.5	301.4	296.4	297.3
64.5	339.3	335.3	331.3	327.3	323.3	318.4	313.3	308.2	303.1	297.9	298.8
65	341.2	337.2	333.2	329.1	325.1	320.2	315.0	309.8	304.7	299.5	300.4
65.5	343.1	339.1	335.0	331.0	326.9	321.9	316.7	311.5	306.3	301.1	301.9
66	345.1	341.0	336.9	332.8	328.7	323.7	318.4	313.2	307.9	302.6	303.4

343L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
66.5	347.0	342.9	338.8	334.6	330.5	325.5	320.1	314.8	309.5	304.2	304.9
67	348.9	344.8	340.6	336.5	332.3	327.2	321.9	316.5	311.1	305.7	306.4
67.5	350.9	346.7	342.5	338.3	334.1	329.0	323.6	318.1	312.7	307.3	307.9
68	352.8	348.6	344.4	340.2	336.0	330.8	325.3	319.8	314.3	308.9	309.4
68.5	354.7	350.5	346.3	342.0	337.8	332.5	327.0	321.5	315.9	310.4	310.9
69	356.7	352.4	348.1	343.9	339.6	334.3	328.7	323.1	317.6	312.0	312.4
69.5	358.6	354.3	350.0	345.7	341.4	336.1	330.4	324.8	319.2	313.5	313.9
70	360.5	356.2	351.9	347.5	343.2	337.8	332.1	326.5	320.8	315.1	315.4
70.5						339.6	333.8	328.1	322.4	316.7	317.0
71						341.3	335.6	329.8	324.0	318.2	318.5
71.5						343.1	337.3	331.4	325.6	319.8	320.0
72						344.9	339.0	333.1	327.2	321.3	321.5
72.5							340.7	334.8	328.8	322.9	323.0
73							342.4	336.4	330.4	324.5	324.5
73.5							344.1	338.1	332.0	326.0	326.0
74								339.7	333.7	327.6	327.5
74.5								341.4	335.3	329.1	329.0
75								343.1	336.9	330.7	330.5
75.5								344.7	338.5	332.3	332.0
76									340.1	333.8	333.6
76.5									341.7	335.4	335.1
77									343.3	336.9	336.6
77.5									344.9	338.5	338.1
78										340.1	339.6
78.5										341.6	341.1
79										343.2	342.6
79.5										344.7	344.1
80											
80.5											
81											
81.5											

NOTES:

REMOVABLE ELECTRICAL ACTUATOR (SUPPRESSION DIODE)

The removable electrical actuator locates to the top of the container valve. 24 v dc is required for solenoid operation. Provision is made for the connection of a manual actuator to the top of the actuator assembly. The suppression diode electrical actuator must be wired up correctly with the positive supply from the control panel connected to terminal 1, and the negative supply connected to terminal 2.

The removable electrical actuator has a life span of 10 years from manufacture, which is indicated on the label.



FIGURE 9-1
ELECTRICAL ACTUATOR - SUPPRESSION DIODE
(PART NO. 304.205.010)
E001151

Technical information

Body:	Mild steel and dull nickel
Swivel nut:	Brass CZ121
Actuation pin:	Stainless steel
Actuation type:	Latching
Reset requirement:	Manually with reset tool supplied
Connection:	1 in. BSPP brass
Nominal voltage:	24 VDC
Nominal current:	0.25 A
Max. monitoring current:	25 mA
Manual actuation force:	50 N (11.24 lbf)
Nominal pin travel:	4.4 mm (0.17 in.)
Electrical connection:	3-pin plug connector
Back EMF protection:	Suppression diode
Certification:	UL Recognised
Overall size:	104 mm (L) x 44 mm (Dia) (4.09 in. (L) x 1.73 in. (Dia))
Weight:	0.95 kg (2.09 lb)

REMOVABLE ELECTRICAL ACTUATOR (BRIDGE RECTIFIER)

The removable electrical actuator locates to the top of the container valve. 24 v dc is required for solenoid operation. Provision is made for the connection of a manual actuator to the top of the actuator assembly. Due to the design of the bridge rectifier it will operate regardless of how it is wired up; the positive supply from control panel can be connected to either terminal 1 or 2 with the reverse for the negative supply.

The removable electrical actuator has a life span of 10 years from manufacture, which is indicated on the label.



FIGURE 9-2
ELECTRICAL ACTUATOR - BRIDGE RECTIFIER
(PART NO. 304.209.001)
E001151

Technical Information

Body:	Mild steel and dull nickel
Swivel nut:	Brass CZ121
Actuation pin:	Stainless steel
Actuation type:	Latching
Reset requirement:	Manually with reset tool supplied
Connection:	1 in. BSPP brass
Nominal voltage:	24 VDC
Nominal current:	0.25 A
Max. monitoring current:	25 mA
Manual actuation force:	50 N (11.24 lbf)
Nominal pin travel:	4.4 mm (0.17 in.)
Electrical connection:	3-pin plug connector
Back EMF protection:	Bridge rectifier
Certification:	UL Recognised
Overall size:	104 mm (L) x 44 mm (Dia) (4.09 in. (L) x 1.73 in. (Dia))
Weight:	0.95 kg (2.09 lb)

INSTALLING THE ELECTRICAL ACTUATOR - SUPPRESSION DIODE

The electrical signal from the detection and/or control equipment is connected in accordance with the wiring diagram detailed in Figure 9-3 when all other installations have been completed. This electrical actuator is fitted with a suppression diode in parallel to the coil as indicated.

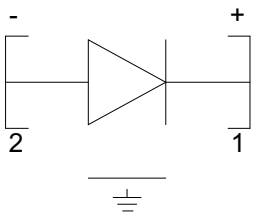


FIGURE 9-3
ELECTRICAL ACTUATOR WIRING DIAGRAM - SUPPRESSION DIODE

1. Connect +ve from control panel to terminal 1 and -ve from control panel to terminal 2, on the plug connector. The end-of-line monitoring device (if required) is fitted on-site.
2. Before putting this system into operation, the removable solenoid can be checked by firing the system. To do this, **remove the electrical actuator from the valve.** With power to the actuator, the pin should be firmly in the down position. Ensure that the electrical actuator is reset prior to fitting on to the conatainer valve.

⚠ DANGER

Failure to reset the actuator results in the potentially hazardous discharge of the container.

INSTALLING THE ELECTRICAL ACTUATOR - BRIDGE RECTIFIER

Connect the electrical signal from the detection or control equipment in accordance with the wiring diagram detailed in Figure 9-4 when all other installations are complete. This electrical actuator is fitted with a bridge rectifier as indicated.

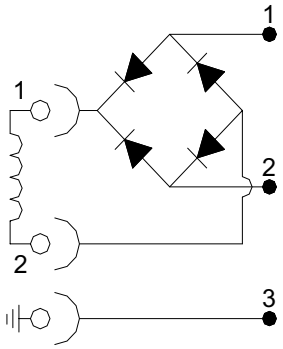


FIGURE 9-4
ELECTRICAL ACTUATOR WIRING DIAGRAM - BRIDGE RECTIFIER
E001149

1. Connect +ve from the control panel to either terminal 1 or 2 with the reverse for the -ve supply from control panel, on the plug connector. The end-of-line monitoring device (if required) is fitted on-site.
2. Before putting this system into operation, the removable solenoid can be checked by firing the system. To do this, **remove the electrical actuator from the valve.** With power to the actuator, the pin should be firmly in the down position. Ensure that the electrical actuator is reset prior to fitting on to the conatainer valve.

⚠ DANGER

Failure to reset the actuator results in the potentially hazardous discharge of the container.

CONTAINER LABELS

TABLE 9-4: LEGACY CONTAINER LABEL DETAILS

Part No.	Agent	Brand	Agent	Type	Manual Reference	Manual Reference China
314.205.045	FM-200 container label HYGOOD (UL) 32/106/147/180/343 L	HYGOOD	FM-200	UL	14A-07H	14A-07H/CH
314.205.046	FM-200 container label HYGOOD (UL) 4.5/8/16/52 L	HYGOOD	FM-200	UL	14A-07H	14A-07H/CH
314.205.021	FM-200 container label HYGOOD (UL/FM) 32/106/147/180/343 L	HYGOOD	FM-200	UL/FM	14A-07H	
314.205.022	FM-200 container label HYGOOD (UL/FM) 8/16/52 L	HYGOOD	FM-200	UL/FM	14A-07H	

NOTES: