SAPPHIRE® TOTAL FLOOD FIRE SUPPRESSION SYSTEM

HYGOOD

DESIGN, INSTALLATION, AND MAINTENANCE MANUAL



UL FM APPROVED

E000211

Burlingham House, Hewett Road, Gapton Hall Industrial Estate, Great Yarmouth, NR31 0NN | +44 (0)1 493 417600
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Johnson Controls

This manual is intended for use with the HYGOOD® SAPPHIRE® Clean Agent Total Flood Fire Suppression System, engineered for use with FK-5-1-12 agent. 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 a SAPPHIRE system training program with training to plan, install, and maintain the SAPPHIRE system shall install and maintain the SAPPHIRE 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 SAPPHIRE 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.

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All instructions contained herein relate to a typical installation.

Part No.: 14A-53H-01

Date: 2024-JUN-11

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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
2024-JUN-11	–	Full manual: formatting, grammar, and vocabulary updates applied across the document to improve style consistency. Capitalization in headings and tables changed to sentence style. Cross references updated, where applicable. Standardized the name of the female actuation hose (DN 1/4 in. PTFE) to flexible female actuation hose. Removed references to PESO throughout the document.
	1-2	Added a reference to EN 12094 for CE and UKCA manufactured systems.
	1-3	Updated the list of typical areas protected by SAPPHIRE fire protection systems.
	1-4	Added new entries to the agent physical properties table include the requirements from *NFPA 2001, ISO 14520-5,* and *EN15004-2*. Added the g/mol unit symbol to the molecular weight row.
	2-1 to 2-72	Standardized the specification wordings for approvals, listings, and certifications, conformity, and system working temperature range. Updated or added CE and UKCA marking details, where required.
	2-1 to 2-2	Added a new bulk filling details table and specifications. Extended the entry to two pages.
	2-3	Added a note for ordering parts from Enschede beneath the manifold system drawing and added a manual actuator part number to item 7.
	2-4	Added text to the TPED and DOT/TPED seamless container section for Canada and USA regulatory requirements.
	2-7	Added a note on use to the certification column for Part No. 452334 and 452329.
	2-9	Added TPED and TPE certification numbers.
	2-12	Added a legacy design bracket assembly image and clarified the use of single brackets for 8 L containers.
	2-13	Various additions made to the electrical actuator specification.
2024-JUN-11	2-14	Explosion-proof electrical actuator conformity and hazard location specifications updated.
	2-15	Added a new page for the manual actuator (Part No. A1638150HY).
	2-20	Re-phrased some entries in the approvals column in the AUTOMAN II-C releasing device parts table.
	2-24 to 2-25	Added o-ring details to the flexible discharge hose pages.
	2-30	Merged the manifold components into one table.
	2-35	Updated the hose volume and length columns in the flexible female actuation hose table.
	2-45	Updated the note beneath the specification to include LPCB Redbook listing information. Rephrased the location on system section.
	2-47	Updated the pressure port material, element, and marking requirements for the GEMS low pressure switch. Updated the marking requirements and method of marking for the NASON low pressure switch.
	2-48	Updated the conformity and hazard location specifications for the explosion-proof low pressure switch.
	2-49	Added factory ID to the discharge nozzle marking requirements.
	2-60	Changed the opening sentence in the pilot container introduction and edited the list of components in the second paragraph. Added pressure gauge type to the pilot container table. Updated the CPG switch point to 88 bar (1276 psi).
	2-68	Added a statement that the pilot valve adaptor is included in the pilot container assembly.
	2-69	Added a dimensions column to the pilot container bracket table.
	2-71	Revised the final paragraph of the liquid level measuring device introduction.
	3-1	Updated the second paragraph in the second column to clarify that FK-5-1-12 suppresses fires through its cooling effect.
	3-3	Removed the opening paragraph in the fully automatic system section.
	5-1	Added a section on sub-master container actuation.

Date	Page	Description
2024-JUN-11	5-3	Reformatted Table 5-1. Added a statement to the LOAEL section on the use of a pre-discharge alarm and time delay. Added a note on the use of an additional safety factor from the AHJ for manual only operated systems. Added UL Class B minimum design concentrations to the Class B fires (commercial grade heptane) paragraph. Added UL Class C minimum design concentrations to the Class C fires (UL Listed and FM Approved systems) paragraph.
	5-4	Reformatted Table 5-2.
	5-5	Removed duplicate text from the nozzle selection and location section.
	5-10	Updated the maximum number of subordinate containers per pilot or AUTOMAN II-C releasing device to 11.
	5-12	Updated Class C UL and FM design concentration to 4.52% and 4.74%.
	5-21	Added bullet points to Step 18 to confirm the details of the system. Rounded up the imperial conversion beneath the altitude correction factors table and added a reference to NFPA 2001.
	6-1	Added a statement after the list in the general information section for positioning SAPPHIRE containers indoors.
	6-2	Reworded the installing the SAPPHIRE container valves section.
	6-3	Changed the column title in the bracket mounting heights table to *Welded containers* and updated the note beneath the table.
	6-6	Reworded Step 2 in installing multiple containers. Reworded Step 2 under installing the manifold brackets and moved the manifold bracket mounting heights table to this page.
	6-14	Added a new electrical actuator wiring diagram. Added a statement beneath the wiring diagram to test the electrical actuator before putting the system into operation.
	6-15	Added new installation steps for the manual actuator (Part No. A1638150HY).
2024-JUN-11	6-16 to 6-18	Added part numbers beneath the actuator subtitles.
	6-34	Added a note beneath Step 3 for installing the discharge pressure switch in the distribution piping as a pressure tap for controlling ancillary devices.
	6-35	Reworded the low pressure switch installation section and added a new note beneath the voltage diagram. Removed the instructions for the CE pilot container contacted pressure gauge as this component has been removed from the manual. Added steps for installing the low pressure switch (Part No. 305.209.007 and 570585).
	6-36	Added installation instructions for the explosion-proof low pressure switch.
	8-2 to 8-4	Added callout tables to Figures 8-1 to 8-4.
	8-5	Revised the fill tolerance weights and tolerance pressures in the fill tolerances table.
	9-1 to 9-98	Added Appendix 1, 2, and so on to the appendix titles.
	9-13	Updated MSDS added.

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ABOUT THIS MANUAL

This manual is a comprehensive guide containing the necessary information to design, install, and maintain the SAPPHIRE engineered fire suppression system. The manual does not include information relating to fire detection.

Refer to the following standards:

- *NFPA 2001 - Standard on Clean Agent Fire Extinguishing Systems*
- *NFPA 72 - National Fire Alarm and Signaling Code*
- *NFPA 70 - National Electrical Code*
- *EN 15004 - Fixed firefighting systems. Gas extinguishing systems (BS EN 15004 in the UK)*
- *ISO 14520 - Gaseous fire-extinguishing systems*

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.

NOTICE

When ordering parts from Enschede, remove the dots (.) from the part numbers.

DEFINITIONS

SAPPHIRE SAPPHIRE is a trademark name for the Johnson Controls system that uses FK-5-1-12 agent.

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, or suitability of the protection, 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:

Macron Safety Systems (UK) Ltd.
Burlingham House
Hewett Road
Gapton Hall Ind. Estate
Great Yarmouth
NR31 0NN
UK
Phone No. +44(0)1493 417600

INTRODUCTION

FK-5-1-12 agent 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, FK-5-1-12 agent is an alternative to HFCs, HCFCs, and PFCs in special hazard, high value applications. However, FK-5-1-12 agent 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 the minimum design concentration. Contact Johnson Controls Technical Services for specific fuel design concentrations.

The US Environmental Protection Agency (EPA) accepts this suppressant in normally occupied areas where the concentration does not exceed 10%. 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 SAPPHIRE 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 FK-5-1-12 agent have comprehensive approvals and listings providing further support to the overall product.

FK-5-1-12 agent

Approvals and listings include, but are not limited to:

- Factory Mutual (FM)
- Underwriters Laboratories Inc. (UL) Recognized Component

Manufactured systems

Approvals and listings include, but are not limited to:

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

FK-5-1-12 agent 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 SAPPHIRE 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.

FK-5-1-12 agent suppresses primarily through heat absorption, and does not significantly deplete oxygen levels. Exposure to FK-5-1-12 agent at a concentration of up to 10.0% 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.

FK-5-1-12 agent 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 FK-5-1-12 agent 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 within the protected area to move paper and light objects.

Direct contact with the vaporizing liquid discharged from an FK-5-1-12 agent 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. 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

FK-5-1-12 AGENT

FK-5-1-12 agent is a clean agent containing no particles or oily residues. It is produced under *ISO 9002* guidelines to strict manufacturing specifications ensuring product purity. FK-5-1-12 agent leaves no residue or oily deposits on delicate electronic equipment, and can be removed from the protected space by ventilation.

FK-5-1-12 agent 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 five days. The US EPA SNAP does not consider FK-5-1-12 agent as a long-lived substance when discharged, and as such has placed no restrictions on its use. Refer to the *Environmental Protection Agency's Significant New Alternatives Program*.

Typical areas protected by a SAPPHIRE fire suppression system include the following examples:

- Aviation facilities
- Computer and electronic control rooms
- Data processing centers
- Medical facilities
- Museums
- Libraries
- Power generation plants
- Telecommunication sites
- Transformer and switch rooms
- Flammable liquid stores

The present understanding of the functioning of FK-5-1-12 agent is that its fire fighting effectiveness is primarily achieved through heat absorption. Complete suppression using FK-5-1-12 agent 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.

FK-5-1-12 agent is stored as a liquid and discharges into the protected area as a vapor. It is stored in approved TPED, DOT/TPED, or DOT welded containers and super-pressurized with dry nitrogen to 25 bar at 20 °C (360 psi at 70 °F).

⚠ WARNING

FK-5-1-12 agent 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 auto-thermal decomposition, such as certain organic peroxidase and hydrazine.
- Deep seated fires.

AGENT PHYSICAL PROPERTIES AND SPECIFICATIONS

Table 1-1, Table 1-2, and Table 1-3 list the physical properties and specifications of FK-5-1-12 agent and nitrogen.

TABLE 1-1: FK-5-1-12 AGENT PHYSICAL PROPERTIES AND SPECIFICATIONS

Agent physical properties and specifications	
Chemical structure	$CF_3CF_2C(O)CF(CF_3)_2$
Chemical name	Dodecafluoro-2-methylpentan-3-one (FK-5-1-12)
Molecular weight	316.04 g/mol
Boiling point	49.0 °C (120.2 °F)
Freezing point	-108.0 °C (-162.4 °F)
Critical temperature	168.7 °C (335.6 °F)
Critical pressure	1865 kPa (270.4 psi)
Critical volume	494.5 cc / mole (0.0251 lbm / ft³)
Critical density	639.1 kg/m³ (39.9 lbm / ft³)
Purity	99.0% (mol/mol) minimum
Moisture content	10 ppmw maximum
Acidity	3.0 ppmw maximum (hydrochloric acid [HCl] equivalent)
Non-volatile residue	0.03% by maximum mass
Suspended matter or sediment	None visible
Kinetic dimers of HFP	2850 ppm maximum
Thermodynamic dimer of HFP + HF adduct	95 ppm maximum
This specification is a combination of the requirements of *NFPA 2001*, *ISO 14520-5*, and *EN15004-2* standards.	

TABLE 1-2: NITROGEN PHYSICAL PROPERTIES AND SPECIFICATIONS

Agent physical properties and specifications	
Chemical structure	N_2
Chemical name	Nitrogen
Molecular weight	28 g/mol
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 (493.1 psi)

TABLE 1-3: FK-5-1-12 AGENT ENVIRONMENTAL TOXICOLOGY

Environmental	
Ozone depletion potential (ODP)	0
Atmospheric lifetime	0.014 years (5 days)
Toxicology	
Acute exposure LC50	>10.0%
Cardiac sensitization No observable adverse effect level (NOAEL)	10.0%
Lowest observable adverse effect level (LOAEL)	>10.0%
Reference: *NFPA 2001*	

BULK FILLING CONTAINER

Where alternate manufacturing locations order empty container assemblies for initial filling, FK-5-1-12 agent is supplied in either 300 kg (661 lb) drums or 1100 kg (2425 lb)* totes. The drums are disposed of after use. The tote is reusable. The tote comes complete with forklift pockets and connections located on top and can subsequently be hoisted. The 2 in. camlock located on the front of the tote connects to the agent fill pump. The 1 in. NPT fill head connects to the nitrogen pad through a micromatic valve.

For the drum, the 2 in. BSPP connection connects to the agent fill pump. The 3/4 in. BSPP connection connects to the nitrogen pad through a two-stage regulator.

For both bulk container types, pressure relief set at 0.2 bar (3 psi) and a nitrogen pad using a 2-stage regulator set at 0.14 bar (2 psi) is available and ordered separately as part of the fill station equipment hardware package.



FIGURE 2-1
SAPPHIRE TOTES
E001483 / E001484



FIGURE 2-2
METAL DRUMS
E001526

TABLE 2-1: BULK FILLING CONTAINER DETAILS

Part No.	Description	Agent weight kg (lb)
452011	FK-5-1-12 agent (4.52% Class C) in kg	–
452013	FK-5-1-12 agent (4.74% Class C) in kg	–
452012	FK-5-1-12 agent drum 300 kg (4.52% Class C)	300 (661)
452014	FK-5-1-12 agent drum 300 kg (4.74% Class C)	300 (661)
452029	Empty FK-5-1-12 agent tote deposit (4.52% Class C)	1100 (2425)*
452030	Empty FK-5-1-12 agent tote deposit (4.74% Class C)	1100 (2425)*

Note: 1. When ordering a filled SAPPHIRE tote, order the empty SAPPHIRE tote deposit and 1100 kg (2425 lb)* of FK-5-1-12 agent as separate line items.

2. The design concentration for Class C in this table is in accordance with NFPA 2001.

*The actual tote agent fill weight may vary based on the tote supplier.

BULK FILLING CONTAINER (Continued)

Technical specification – SAPPHIRE drum

Part No.:	452012	452014
NFPA 2001 Class C design concentration:	4.52%	4.74%
Nominal fill:	300 kg (661 lb)	300 kg (661 lb)
Nominal capacity:	216 L (57.1 gal) or 210 L (55.5 gal)	216.5 (52.8 gal)
Nominal tare weight:	23.5 kg (51.8 lb) or 23 kg (50.7 lb)	23.5 kg (51.8 lb)
Nominal dimensions (Dia x L):	590 mm x 890 mm (23.2 in. x 35.0 in.) or 585 mm x 895 mm (23.0 in. x 35.3 in.)	590 mm x 890 mm (23.2 in. x 35.0 in.)
Nitrogen pad:	3/4 in. BSPP 1/4 in.	3/4 in. BSPP 1/4 in.
Working pressure:	0.3 bar (4.4 psi) or 0.2 bar (2.9 psi)	0.2 bar (2.9 psi)
Test pressure:	1.0 bar (14.5 psi)	1.0 bar (14.5 psi)
Bulk container type:	Drum	Drum
Liquid port:	2 in. BSPP	2 in. BSPP
Nitrogen pad:	3/4 in. BSPP	3/4 in. BSPP
2-stage regulator:	0.14 bar (2 psi)	0.14 bar (2 psi)
Pressure relief:	0.2 bar (3 psi)	0.2 bar (3 psi)

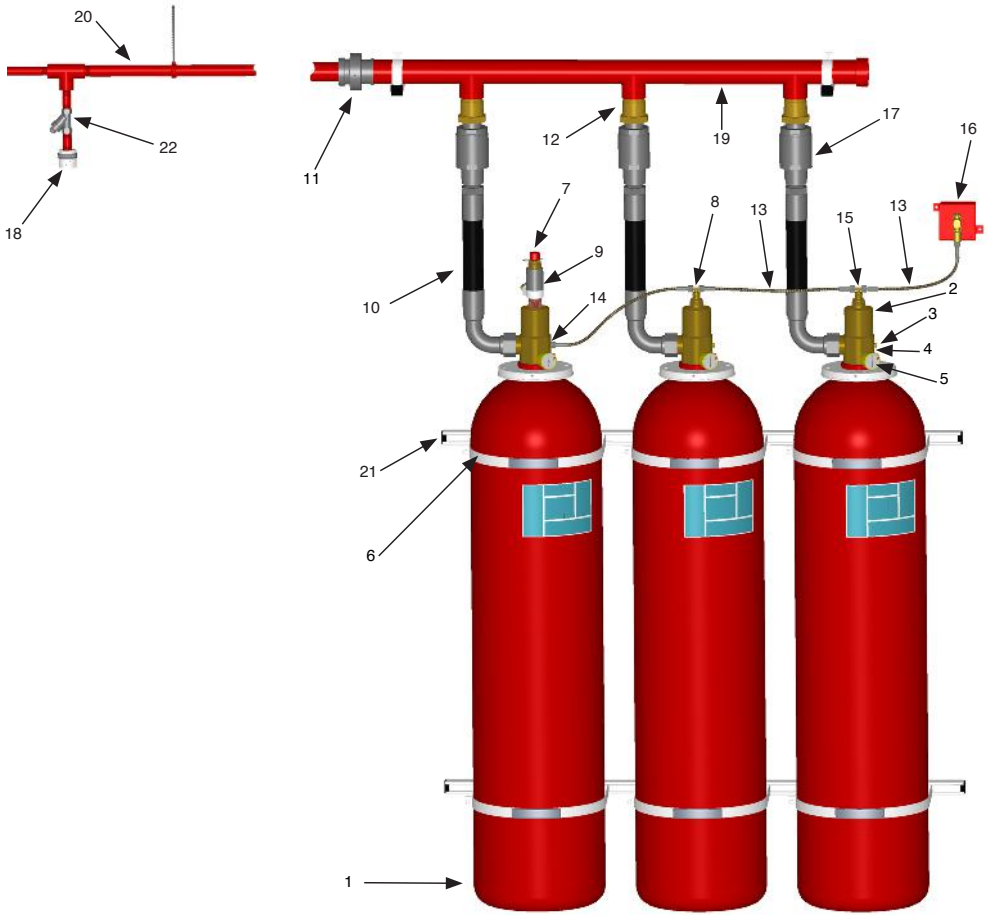
Technical specification – empty SAPPHIRE tote deposit

Part No.:	452029	452030
NFPA 2001 Class-C design concentration:	4.52%	4.74%
Nominal capacity:	757 L (200 gal)	757 L (200 gal)
Nominal fill:	1100 kg (2425 lb) *	1100 kg (2425 lb) *
Bulk container type:	Intermediate bulk container (IBC)	Intermediate bulk container (IBC)
Material:	High-density polyethylene (HDPE)	High-density polyethylene (HDPE)
Working pressure:	0.4 bar (5.8 psi)	0.4 bar (5.8 psi)
Test pressure:	1.0 bar (14.5 psi)	1.0 bar (14.5 psi)
Liquid port:	2 in. camlock	2 in. camlock
Nitrogen pad port:	1 in. NPT fill head through micromatic valve	1 in. NPT fill head through micromatic valve
Nominal tare weight:	178 kg (392 lb)	178 kg (392 lb)
Dimensions (W x D x H):	1.15 m x 1.15 m x 1.5 m (3.77 ft x 3.77 ft x 4.92 ft)	1.15 m x 1.15 m x 1.5 m (3.77 ft x 3.77 ft x 4.92 ft)
Pressure relief:	0.2 bar (3 psi)	0.2 bar (3 psi)

Note: *The actual tote agent fill weight may vary based on the tote supplier.

MANIFOLD SYSTEM EXAMPLE

The following figure illustrates a 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 2-5	2-5
2	Container valve	302.209.001 or 570535 302.209.002 or 570536	2-8
3	Burst disc	26108 and 21981	2-10
4	Low pressure switch	304.205.006 305.209.005 305.209.007 or 570585	2-46
5	Pressure gauge	302207020 302207021 302207022	2-11
6	Mounting brackets	See Table 2-8	2-12
7	Manual actuator	A1638150HY 304.209.002	2-15
8	Pneumatic actuator	304.209.004	2-17
9	Electrical actuator	304205030 304205040	2-13
10	Flexible discharge hose	306.207.002 306.207.003	2-24
11	Manifold union adaptor	See Table 2-18	2-33

Item	Description	Part No.	Page
12	Manifold check valve	302.209.004 302.209.005	2-29
13	Female actuation hose	306.205.003 306205010 306205011	2-35
14	Male adaptor	309.013.005	2-36
15	Male actuation tee	309.200.021	2-36
16	Discharge pressure switch and adaptor	437900 305.209.009	2-45
17	Adjustable height adaptor	306700003 306700004	2-28
18	Discharge nozzle	See Table 2-22	2-51
19	Manifold	See Table 2-16	2-31
20	Pipe and fittings	—	6-10
21	Back channel (included with the bracket assembly)	—	6-3
22	Discharge nozzle filter	See Table 2-25	2-54

Note: When ordering parts from Enschede, remove the dots from the part numbers.

FIGURE 2-3
MANIFOLD SYSTEM
E000882

AGENT CONTAINER AND VALVE ASSEMBLY (Part No., see the tables on pages 2-5 to 2-6)

The container assembly consists of a container fitted with a valve and internal siphon tube, factory filled with FK-5-1-12 agent, and super-pressurized with dry nitrogen to 25 bar at 20 °C (360 psi at 70 °F). TPED, DOT/TPED, 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 comes factory installed on the valve and must be specified at the time of order. The low pressure switch is optional and must be specified when ordering. A liquid level indicator is optional on DOT welded containers and must be specified at the time of order.

Container and valve assembly technical specification

Nominal working pressure:	25 bar at 20 °C (360 psi at 70 °F)
Maximum system pressure:	29.1 bar at 54 °C (422 psi at 130 °F)
Maximum fill density:	1.20 kg/L (74.9 lb/ft^3)
Minimum fill density:	0.5 kg/L (31.2 lb/ft^3)
Temperature rating:	-18 °C to 54 °C (0 °F to 130 °F) Standard coverage (UL and FM)
	0 °C to 54 °C (32 °F to 130 °F) Extended coverage (UL and FM)
Specific container information:	See Tables 2-3 to 2-5

Note: The temperature rating difference is based on the nozzle coverage area and how it applies during the configuration and ordering processes.

TABLE 2-2: PAINT SPECIFICATION

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

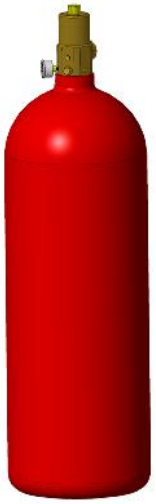


FIGURE 2-4
SEAMLESS CONTAINER AND VALVE ASSEMBLY
E001690

TPED and DOT/TPED seamless container technical specification

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 Pi and Rho for TPED, and Pi and UN USA for DOT approval.

Canada and the United States (USA) mutually recognize the regulatory approvals for UN ISO pressure receptacles. This means that UN ISO pressure receptacles manufactured in accordance with 49 CFR marked with USA as the country of approval or manufactured in accordance with CSA B431 marked CAN as the country of approval, can be used seamlessly and interchangeably in the USA and Canada. UN ISO containers manufactured in accordance with US Department of Transportation's Hazardous Materials Regulations; 49CFR, are commonly referred to as DOT specification containers and are marked with USA.

Hydraulic test pressure:	200 bar (2,900 psi)
Maximum working pressure:	120 bar (1,740 psi)
Material:	Alloy steel

DOT welded container technical specification

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 (1,000 psi)
Maximum working pressure:	34.5 bar (500 psi)

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, FM, AND EN) AT -18 °C TO 54 °C (0 °F TO 130 °F)

Part No.	Container size L	Pressure gauge type	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)
303207300	15	PG	0.5 (31.2)	1.2 (74.9)	7.5 (17)	18 (39)	25 (1.0)	695 (27.4)	204 (8.0)	29.3 (64.6)	47.3 (104.3)
303207301	30	PG	0.5 (31.2)	1.2 (74.9)	15 (33)	36 (79)	25 (1.0)	1010 (39.8)	229 (9.0)	38.8 (85.5)	74.8 (164.9)
303207302	45	PG	0.5 (31.2)	1.2 (74.9)	22.5 (50)	54.0 (119)	25 (1.0)	1110 (43.7)	267 (10.5)	60.4 (133.2)	114.4 (252.2)
303207303	60	PG	0.5 (31.2)	1.2 (74.9)	30 (67)	72 (158)	50 (2.0)	1428 (56.2)	267 (10.5)	80.1 (176.6)	152.1 (335.3)
303207304	120	PG	0.5 (31.2)	1.2 (74.9)	60 (133)	144 (317)	50 (2.0)	1543 (60.7)	360 (14.2)	140.6 (310.0)	284.6 (627.4)
303207305	150	PG	0.5 (31.2)	1.2 (74.9)	75 (166)	180 (396)	50 (2.0)	1893 (74.5)	360 (14.2)	166.6 (367.3)	346.6 (764.1)
303207306	180	PG	0.5 (31.2)	1.2 (74.9)	90 (199)	216 (476)	50 (2.0)	1743 (68.6)	406 (16.0)	214.8 (473.6)	430.8 (949.8)

Note: When ordering containers, the pressure gauge, low pressure switch, fill weight, operating temperature range, and container label must be specified at the time of shipment.

DOT/TPED container assemblies

TABLE 2-4: DOT/TPED SEAMLESS CONTAINER ASSEMBLY (UL, FM, AND EN) AT -18 °C TO 54 °C (0 °F TO 130 °F)

Part No.	Container size L	Pressure gauge type	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)
303207310	15	PG	0.5 (31.2)	1.2 (74.9)	7.5 (17)	18 (39)	25 (1.0)	695 (27.4)	204 (8.0)	29.3 (64.6)	47.3 (104.3)
303207311	30	PG	0.5 (31.2)	1.2 (74.9)	15 (33)	36 (79)	25 (1.0)	1010 (39.8)	229 (9.0)	38.8 (85.5)	74.8 (164.9)
303207312	45	PG	0.5 (31.2)	1.2 (74.9)	22.5 (50)	54 (119)	25 (1.0)	1110 (43.7)	267 (10.5)	60.4 (133.2)	114.4 (252.2)
303207313	60	PG	0.5 (31.2)	1.2 (74.9)	30 (67)	72 (158)	50 (2.0)	1428 (56.2)	267 (10.5)	80.1 (176.6)	152.1 (335.3)
303207314	120	PG	0.5 (31.2)	1.2 (74.9)	60 (133)	144 (317)	50 (2.0)	1543 (60.7)	360 (14.2)	140.6 (310.0)	284.6 (627.4)
303207315	150	PG	0.5 (31.2)	1.2 (74.9)	75 (166)	180 (396)	50 (2.0)	1893 (74.5)	360 (14.2)	166.6 (367.3)	346.6 (764.1)

Notes: 1. The DOT/TPED 25 bar seamless container assemblies are not approved for transportation in North America.

2. When ordering containers, the pressure gauge, low pressure switch, fill weight, operating temperature range, and container label must be specified at the time of shipment.

AGENT CONTAINER AND VALVE ASSEMBLY (Continued)

DOT welded container assemblies

TABLE 2-5: DOT WELDED CONTAINER ASSEMBLY AT -18 °C TO 54 °C (0 °F TO 130 °F)

Part No.	Container size L	Pressure gauge type	Fill density Min. kg/L (lb/ft^3)	Fill density Max. kg/L (lb/ft^3)	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)
303.207.010	4.5	PG	0.5 (31.2)	1.2 (74.9)	2.5 (5.5)	5 (11)	25 (1.0)	324 (12.8)	178 (7)	7.7 (17)	12.7 (28.0)
303.207.001	8	PG	0.5 (31.2)	1.2 (74.9)	4.0 (9)	9.5 (21)	25 (1.0)	305 (12.0)	254 (10)	14.8 (32.6)	24.3 (53.6)
303.207.002	16	PG	0.5 (31.2)	1.2 (74.9)	8.0 (18)	19 (42)	25 (1.0)	504 (19.8)	254 (10)	18.4 (40.6)	37.4 (82.5)
303.207.003	32	PG	0.5 (31.2)	1.2 (74.9)	16.0 (36)	38 (84)	25 (1.0)	836 (32.9)	254 (10)	26.1 (57.5)	64.1 (141.3)
303.207.004	52	PG	0.5 (31.2)	1.2 (74.9)	26.0 (58)	62 (137)	50 (2.0)	595 (23.4)	406 (16)	49.1 (108.3)	111.1 (244.9)
303.207.005	106	PG	0.5 (31.2)	1.2 (74.9)	53.0 (117)	127 (280)	50 (2.0)	1022 (40.2)	406 (16)	71.8 (158.3)	198.8 (438.3)
303.207.006	147	PG	0.5 (31.2)	1.2 (74.9)	73.5 (163)	176 (388)	50 (2.0)	1356 (53.4)	406 (16)	89.9 (198.2)	265.9 (586.2)
303.207.007	180	PG	0.5 (31.2)	1.2 (74.9)	90.0 (199)	208 (459)	50 (2.0)	1635 (64.4)	406 (16)	105.8 (233.2)	313.8 (691.8)
303.207.008	343	PG	0.5 (31.2)	1.2 (74.9)	171.5 (379)	386 (851)	80 (3.0)	1466 (57.7)	610 (24)	207.0 (456.0)	593.0 (1307.3)

Notes: 1. The 4.5 L DOT welded container is not available from Marinette.

2. When ordering containers, the pressure gauge, low pressure switch, fill weight, operating temperature range, container label, and liquid level indicator must be specified at the time of shipment.

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. The label should be ordered separately for orders from Great Yarmouth.

Technical specification

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

TABLE 2-6: LABEL DETAILS

Part No.	Nominal charge pressure	Language	Certification	Label size	Where used
314207321	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, 45 L, 60 L, 120 L, 140 L, 150 L, and 180 L **Welded container:** 32 L, 106 L, 147 L, 180 L, and 343 L
314207322	25 bar (360 psi)	English	UL	241.3 mm × 165.1 mm (9.5 in. × 6.5 in.)	
314207323	25 bar (360 psi)	English	EU	241.3 mm × 165.1 mm (9.5 in. × 6.5 in.)	
314207208	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
314207209	25 bar (360 psi)	English	UL	558.8 mm × 50.8 mm (22 in. x 2 in.)	
314207210	25 bar (360 psi)	English	EU	558.8 mm × 50.8 mm (22 in. x 2 in.)	
452221	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
452334	25 bar (360 psi)	English	None (used if the original label needs replacing after a refill or hydrotest)	558.8 mm × 50.8 mm (22 in. x 2 in.)	**Welded container:** 4.5 L, 8 L, 16 L, and 52 L
452329	25 bar (360 psi)	English	None (used if the original label needs replacing after a refill or hydrotest)	241.3 mm × 165.1 mm (9.5 in. × 6.5 in.)	**Seamless container:** 15 L, 30 L, 45 L, 60 L, 120 L, 140 L, 150 L, and 180 L **Welded container:** 32 L, 106 L, 147 L, 180 L, and 343 L

Note: *For UL or UL and FM container assemblies sold in the EU, label part number 452221 must be additionally attached to the container.

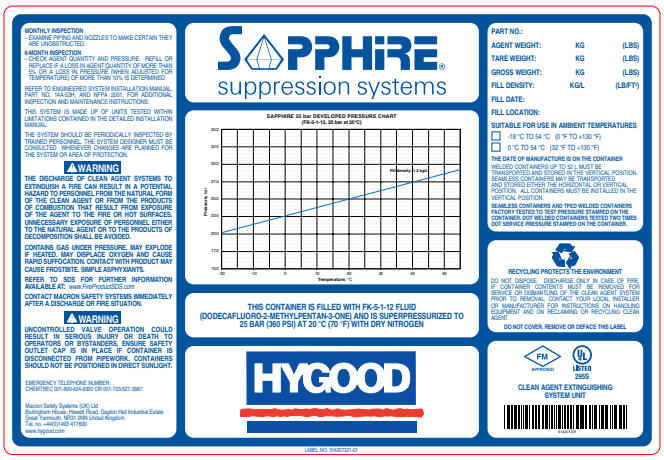


FIGURE 2-5
CONTAINER LABEL (PART NO. 314207321)
E002079

VALVE ASSEMBLY

The valve assembly is factory-fitted to the container assembly and is 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. 302207020 [WIKA], 302207021 [MIJA], or 302207022 [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.

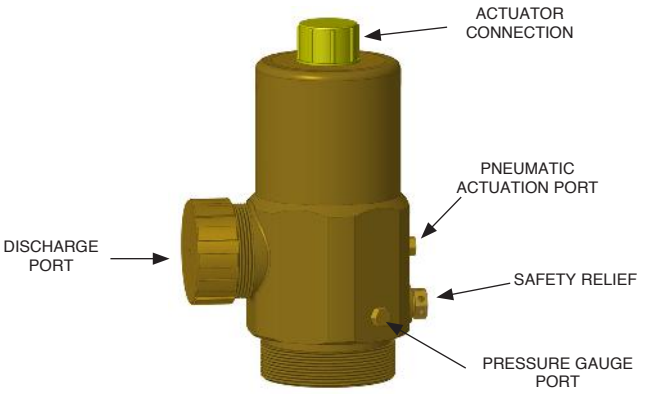


FIGURE 2-6
VALVE ASSEMBLY
E001691

Technical specification

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 CW617N (CZ122)	Brass CW617N (CZ122)
Thread type:	2 in. 8UN	3 1/4 in. 8UN
Outlet connection:	1 in. BSPP	2 in. BSPP
Outlet safety cap material:	Brass CW614N (CZ121)	Brass CW617N (CZ122)
Maximum working pressure:	28.6 bar (415 psi) CE 34 bar (493 psi) UL and FM	28.6 bar (415 psi) CE 34 bar (493 psi) UL and FM
Test pressure:	51 bar (740 psi)	51 bar (740 psi)
Free flow cross sectional area:	507 mm^2 (0.78 $in.^2$)	1810 mm^2 (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 maximum working pressure	26 N (5.8 lbf) at maximum working pressure
Burst disc rating:	53.4 bar ± 5% (50.7 to 56.1 bar) at 50 °C (775 psi ± 5% [736 to 814 psi] at 122 °F)	53.4 bar± 5% (50.7 to 56.1 bar) at 50 °C (775 psi ± 5% [736 to 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
System 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	-20 °C to 50 °C (-4 °F to 122 °F) CE -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, listings, and certifications:	UL and FM	UL and FM
Conformity:	EN 12094-4	EN 12094-4
CE certification number:	2831-CPR-S0093	2831-CPR-S0093
UKCA certification number:	0832-UKCA-CPR-S5102	0832-UKCA-CPR-S5102
TPED certification number:	2880-335-2203	2880-335-2203
TPE certification number:	1266-335-2204	1266-335-2204
Marking requirements:	Manufacturer's mark, Part No., DN25, Serial No., CE_{2831}, π2880, ρ1266 and $UKCA_{0832}$	Manufacturer's mark, Part No., DN25, Serial No., CE_{2831}, π2880, ρ1266 and $UKCA_{0832}$
Part number marked on component:	302.209.001	302.209.002
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.)

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

VALVE ASSEMBLY (Continued)

Technical specification

Valve size:	80 mm (3 in.) valve
Part No.:	**445977** (Valve assembly with plug and no pressure gauge) **450074** (Valve assembly with plug, no pressure gauge, and individually packaged)
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 to 56.1) at 50 °C (775 psi ± 5% [736 to 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
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F) UL and FM
Weight:	18.82 kg (41.5 lb)
Approvals, listings, and certifications:	UL and FM
Valve type:	Type 2
Overall size:	252 mm x 174 mm (9.94 in. x 6.85 in.)

Notes: *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.

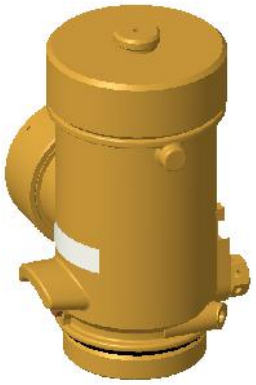


FIGURE 2-7
80 mm (3 in.) VALVE ASSEMBLY
E001462

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 2-7: BURST DISC DETAILS

Part No.	Description	Where used
26108 442781	M18 53.4 bar burst disc (WEHBERG*)	25 mm and 50 mm valve
21981 570793	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

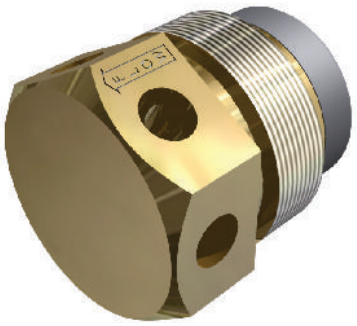


FIGURE 2-8
BURST DISC
E001692

Technical specification

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 or 570793	26108	15330 or 570300
Manufacturer trademark:	MATRIX	WEHBERG	MATRIX
Body material:	Brass	Brass	Brass
Rating:	53.4 bar ± 5% (50.7 to 56.1) at 50 °C	53.4 bar ± 5% (50.7 to 56.1) at 50 °C	53.4 bar ± 5% (50.7 to 56.1) at 50 °C
	(775 psi ± 5% [736 to 814] at 122 °F)	(775 psi ± 5% [736 to 814] at 122 °F)	(775 psi ± 5% [736 to 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)
System 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)
Conformity:	CE	CE	–
Approvals, listings, and certifications:	UL and FM	UL and FM	UL and FM
Marking requirements:	Manufacturer's mark, rating in bar, part number, CE_{2820}, lot number, serial number	Manufacturer's mark, rating in bar, part number, CE_{0045}, lot number, serial number	Rating in psi
Part number marked on component:	21981	26108	None

* WEHBERG and MATRIX are trademarks of their respective owners.

PRESSURE GAUGE (UL, FM, AND EN) (Part No. 302207020)

The pressure gauge is factory fitted to the valve. The device continually monitors the container pressure and is field-replaceable. Additionally, the device is dual-approved for CE and UL or FM applications.



FIGURE 2-9
PRESSURE GAUGE
E002197

Technical specification

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
System working temperature range:	-20 °C to 50 °C (-4 °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, listings, and certifications:	UL, FM, and EN
Conformity:	EN 12094-10 and EN 837-1
CE certification number:	2831-CPR-S0054
UKCA certification number:	0832-UKCA-CPR-S5021
Agent marked on component:	FK-5-1-12
Method of marking:	Part of gauge artwork
Marking requirements:	Manufacturer's mark, bar (psi), CL1.6, EN837-1, CE_{2831} and $UKCA_{0832}$
Part number marked on component:	302207020
Weight:	0.12 kg (0.27 lb)

PRESSURE GAUGE (UL AND FM) (Part No. 302207021 and 302207022)

The pressure gauge is factory fitted to the valve. The device continually monitors the container pressure and is field-replaceable.



FIGURE 2-10
PRESSURE GAUGE
E001391

Technical specification

Part No.:	302207021 (MIJA) 302207022 (MILJOCO)
Type:	Bourdon tube pressure gauge
Entry:	Back axial
Body material:	Stainless steel
Connection material:	Brass
Nominal size:	Dia 41 mm x 27 mm (1.6 in. x 1.1 in.)
Units of outer scale:	psi (MIJA), bar (MILJOCO)
Units of inner scale:	bar (MIJA), psi (MILJOCO)
Connection:	1/8 in. NPT
Language:	English
System 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)
Agent marked on component:	FK-5-1-12
Method of marking:	Part of gauge artwork
Approvals, listings, and certifications:	UL and FM (MIJA) UL (MILJOCO)
Weight:	0.022 kg (0.049 lb)

Note: For all UL and FM approved pressure gauges, if a system design requires a minimum temperature of -18 °C (0 °F), the pressure gauge reading is outside the green zone limit, as the pressure gauge artwork is based on 0 °C to 54 °C (32 °F to 130 °F).

MOUNTING BRACKETS

The bracket assembly consists of a nut and bolt with two bracket straps and a 41 mm x 41 mm (1.6 in. x 1.6 in.) back channel 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 correct 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). Two bracket assemblies must be ordered when using individual container brackets, except for the 8 L container which uses a single bracket assembly. When ordering multi-container brackets, all required hardware is included for double bracketing. Table 2-8 lists the mounting bracket details.

Technical specification

Material: Stainless steel 316

Mounting: Back channel



FIGURE 2-11
LEGACY DESIGN CONTAINER BRACKET ASSEMBLY
E002202



FIGURE 2-12
CONTAINER BRACKET ASSEMBLY
E002339

TABLE 2-8: MOUNTING BRACKET DETAILS

Part No.	Container type	Container size L	Description	Container diameter mm (in.)	Channel length mm (in.)	Weight kg (lb)
311700002	Seamless	15	Container bracket assembly with back channel	204 (8.0)	400 (15.75)	1.67 (3.68)
311700003		30		229 (9.0)	400 (15.75)	1.72 (3.79)
311700004		45 and 60		267 (10.5)	400 (15.75)	1.78 (3.92)
311700005		120 and 150		360 (14.2)	600 (23.62)	2.43 (5.36)
311700006	Seamless	180		406 (16.0)	600 (23.62)	2.50 (5.51)
	Welded	52, 106, 147, and 180		406 (16.0)	600 (23.62)	2.50 (5.51)
311700013	Welded	4.5		178 (7.0)	400 (15.75)	1.47 (3.24)
311700014		8, 16, and 32		254 (10.0)	400 (15.75)	1.63 (3.59)
311.205.019		343		610 (24.0)	900 (35.43)	3.59 (7.91)
311700007	Seamless	120 and 150	Multi-container bracket assembly with back channel x 4 containers	360 (14.2)	1200 (47.24)	9.62 (21.2)
311700008			Multi-container bracket assembly with back channel x 6 containers	360 (14.2)	1700 (66.93)	13.66 (30.12)
311700009			Multi-container bracket assembly with back channel x 8 containers	360 (14.2)	2200 (86.61)	17.78 (39.20)
311700010	Seamless	180	Multi-container bracket assembly with back channel x 4 containers	406 (16.0)	1200 (47.24)	9.85 (21.72)
311700011			Multi-container bracket assembly with back channel x 6 containers	406 (16.0)	1700 (66.93)	14.11 (31.11)
311700012			Multi-container bracket assembly with back channel x 8 containers	406 (16.0)	2200 (86.61)	18.19 (40.10)

Note: Part No. 311.205.019 is the legacy container bracket assembly design.

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

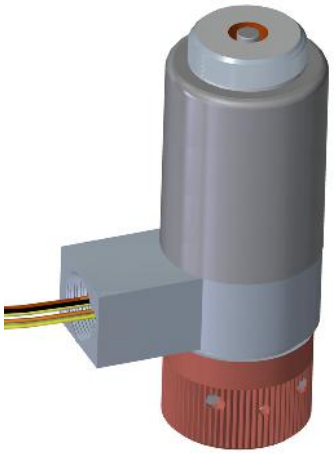


FIGURE 2-13
ELECTRICAL ACTUATOR
E001130

Technical specification

Country of origin:	US (304205030) China (304205040)
Body:	Mild steel
Body finish:	Electroless nickel plate (0.023mm to 0.028mm (0.0009 in. to 0.0011 in.)
Actuation pin:	Stainless steel
Loose nut:	Brass CW603N (CZ124)
Nose and JB:	Brass CW603N (CZ124)
Actuation type:	Latching
Reset requirement:	Manually with reset tool supplied
Connection:	1 in. BSPP (loose nut and manual actuator)
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:	0.50 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
Placement switch:	Integral to unit
Vent area:	31.76 mm² (0.049 in²)
Maximum humidity:	80% to 90% (non-condesning)
System 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
Factory testing:	100% check on start / finish position
Field testing of actuator:	Possible
Maximum humidity:	80% to 90% RH non-condensing
Ingress Protection class:	IP54
Approvals, listings, and certifications:	UL, FM, and CE
Conformity:	EN 12094-4 and UL 864A
CE certification number:	2831-CPR-S0093
UKCA Certification No.:	0832-UKCA-CPR-S5102
Marking requirements:	Manufacturer's mark, Part No., Serial No., 24 VDC, 0.5 A, CE_{2831} and $UKCA_{0832}$
Part number marked on component:	304205030 (US) 304205040 (China)
Method of marking:	Laser or engraved
Overall size:	132 mm (L) x 73 mm (W) (5.19 in. x 2.87 in.)
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

EXPLOSION-PROOF ELECTRICAL ACTUATOR (Part No. 453978)

The explosion-proof electrical actuator electrically operates a total flooding fire suppression system container. A voltage signal from the control panel activates the explosion-proof electrical actuator. The voltage signal de-energizes the permanent magnet, allowing the spring to push and latch the actuator pin into the fire position. The electrical actuator can be reset using the supplied reset tool when the voltage signal terminates.

The explosion-proof electrical actuator connects to the top of the container discharge valve, between the valve and the manual actuator.

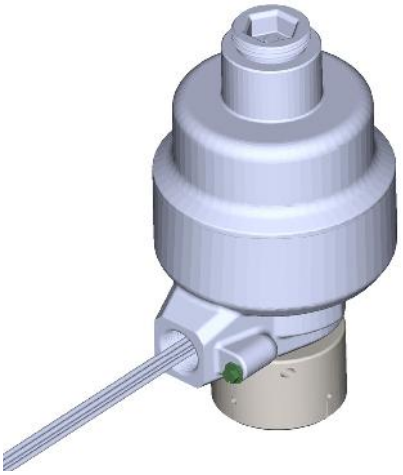


FIGURE 2-14
EXPLOSION-PROOF ELECTRICAL ACTUATOR
E002118

Technical specification

Body:	316 or 304 stainless steel, no painted surfaces
Actuation pin:	304 stainless steel
Loose nut (threaded swivel):	304 stainless steel
Actuation type:	Latching
Reset requirement:	Manually through a reset tool
Connection:	1 in. BSPP male
Nominal voltage:	24 VDC
Current supply:	0.5 A
Monitoring current:	<30 mA
Electrical connection:	1/2 in. NPT female conduit with inbuilt bridge rectifier
Back EMF protection:	Bridge rectifier
Placement switch:	Integral to unit
Lead wire:	Thermoplastic flexible fixture nylon (TFFN) 6000 V, 90 °C temperature
Minimum duration of trigger signal:	1 s
Duty:	Continuous
Nominal Pin Travel:	5 mm (0.2 in.)
Firing force:	Minimum 180 N at 1.5 mm stroke or 7.10 mm pin position (minimum 40.45 lb at 0.059 in. stroke or 0.280 in. pin position)
Manual actuation force:	50 N (11.24 lb) minimum.
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F) UL
Life span:	25 years
Testing:	100% check on start / finish position
Maximum humidity:	80% to 90% RH, non-condensing
Enclosure type:	Type 4X
Ingress Protection class:	IP66
Approvals, listings, and certifications:	UL, ATEX, and IECEx
Conformity:	EN IEC 60079-0: 2018 and EN 60079-1: 2014 (ATEX) IEC 60079-0:2017 and IEC 60079-1:2014-06 (IECEx)
Hazard locations:	ATEX/IECEx Haz-loc: II 2 G Ex db IIC T5 Gb UL Haz-loc: Class I Division I Groups A, B, C and D, T5 Class I Zone 1 AEx db IIC T5 Gb
Method of marking:	Laser or engraved
Marking details:	Manufacturer details, PA0546, serial number, UL haz loc ratings, CE_{0539}, ATEX, and IECEx ratings
Part number marked on component:	PA0546
Overall size:	182.8 mm (L) x 101.6 mm (Dia) (7.20 in. x 4.0 in.)
Weight:	5.5 kg (12 lb)

MANUAL ACTUATOR (Part No. A1638150HY)

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.

Location on system

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

Note: In accordance with NFPA 2001, the discharge pressure switch must be utilized if using manual actuation (NFPA 2001).

Technical specification

Body:	Brass CDA 360 or C3604
Knob:	Phenolic (color – red)
Safety pin:	Stainless steel 304
Actuator pin:	Stainless steel 303/304
Vent area:	31.76 mm^2 (0.049 $in.^2$)
Nominal stroke:	3.9 mm (0.154 in.)
Weight:	0.27 kg (0.595 lb)
System 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
Field testing of actuator:	Possible
Approvals, listings, and certifications:	UL and FM
Conformity:	EN12094-4
CE certification number:	2831-CPR-S0093
UKCA certification number:	0832-UKCA-CPR-S5102
Marking requirements:	Manufacturer's mark, part number, CE_{2831}, $UKCA_{0832}$, and serial number
Part number marked on component:	A1638150HY
Method of marking:	Laser or engraved
Overall size (L x Dia):	60.6 mm x 41.0 mm (2.4 in. x 1.61 in.)



FIGURE 2-15
MANUAL ACTUATOR (ALTERNATE)
E002505

MANUAL ACTUATOR (ALTERNATE) (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.

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 specification

Body:	Brass CW614N (CZ121)
Knob:	PVC (color - red)
Safety pin:	Stainless steel 303
Actuation pin:	Brass CW614N (CZ121)
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)
System 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
Field testing of actuator:	Possible
Approvals, listings, and certifications:	UL, FM, and CE
Conformity:	EN 12094-4
CE certification number:	2831-CPR-S0093
UKCA certification number:	0832-UKCA-CPR-S5102
Marking requirements:	Manufacturer's mark, part number, serial number, CE$_{2831}$ and UKCA$_{0832}$
Part number marked on component:	304.209.002
Method of marking:	Laser or engraved
Overall size:	52 mm (L) x 41.0 mm (Dia) (2.05 in. [L] x 1.61 in. [Dia])

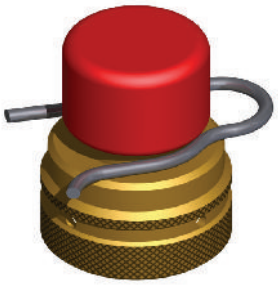


FIGURE 2-16
MANUAL ACTUATOR
E001695

PNEUMATIC ACTUATOR (Part No. 304.209.004)

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



FIGURE 2-17
PNEUMATIC ACTUATOR
E001696

Location on system

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

Technical specification

Body:	Brass CW614N (CZ121)
Actuator pin:	Brass CW614N (CZ121)
Pipe connection:	1/4 in. NPT female
Maximum working pressure:	120 bar (1,740 psi)
Test pressure:	180 bar (2,610 psi)
Vent area:	31.77 mm² (0.049 in.^{2})
Stroke:	3.7 mm (0.15 in.)
Minimum trigger pressure:	4 bar (58 psi)
Nominal trigger pressure:	Dependent on actuation source (Master or AUTOMAN II-C release)
Maximum trigger pressure:	120 bar (1,740 psi)
Minimum duration of trigger pressure:	1 s
Weight	0.23 kg (0.50 lb)
System 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
Field testing of actuator:	Possible
Approvals, listings, and certifications:	UL, FM, and CE
Conformity:	EN 12094-4
CE certification number:	2831-CPR-S0093
UKCA certification number:	0832-UKCA-CPR-S5102
Marking requirements:	Manufacturer's mark, part number, serial number, WP-120 bar, CE_{2831} and $UKCA_{0832}$
Part number marked on component:	304.209.004
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.

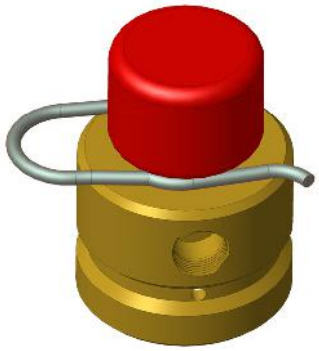


FIGURE 2-18
MANUAL PNEUMATIC ACTUATOR
E001697

Technical specification

Body:	Brass CW614N (CZ121)
Actuation pin:	Brass CW614N (CZ121)
Knob:	PVC (color - red)
Safety pin:	Stainless steel 303
Pipe connection:	1/4 in. NPT female
Maximum working pressure:	120 bar (1,740 psi)
Test pressure:	180 bar (2,610 psi)
Vent area:	31.77 mm² (0.049 $in.^2$)
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 release)
Maximum trigger pressure:	120 bar (1,740 psi)
Minimum duration of trigger pressure:	1 s
Weight:	0.4 kg (0.88 lb)
System 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
Field testing of actuator:	Possible
Approvals, listings, and certifications:	UL, FM, and CE
Conformity:	EN 12094-4
CE certification number:	2831-CPR-S0093
UKCA certification number:	0832-UKCA-CPR-S5102
Marking requirements:	Manufacturer's mark, part number, serial number, WP-120 bar, CE_{2831} and $UKCA_{0832}$
Part number marked on component:	304700003
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])

CPM ACTUATOR
(Part No. 304.209.013 and 436796)

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 in the EU.



FIGURE 2-19
CPM ACTUATOR
E001698

Technical specification

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
Field testing of actuator:	Possible
Minimum actuation pressure:	6.9 bar (100 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 (1,740 psi)
Test pressure:	180 bar (2,611 psi)
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F) UL and FM
Overall size (L x H x D):	180 mm x 137 mm x 79 mm (7.09 in. x 5.39 in. x 3.11 in.)
Part number marked on component:	436796
Weight:	1.20 kg (2.65 lb)
Approvals, listings, and certifications:	UL and FM
Method of marking:	Laser or engraving



FIGURE 2-20
CPM ACTUATOR (MANUALLY ACTUATED POSITION)
E001700

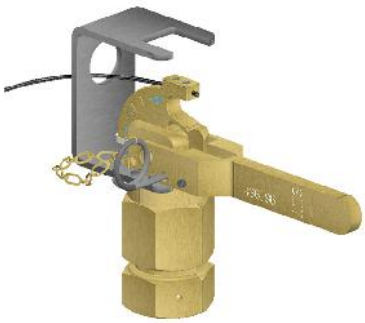


FIGURE 2-21
CPM ACTUATOR (CABLE ACTUATED POSITION)
E001699

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 SAPPHIRE 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.



FIGURE 2-22
AUTOMAN II-C RELEASING DEVICE
E001701

Technical specification

Cartridge body:	Steel
Cartridge volume:	0.692 L (0.18 gal)
Gas type:	Nitrogen
Cartridge pressure:	144.8 bar (2,100 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 the latest revisions of the AUTOMAN II-C release manuals (Part No. 17788 [standard] or or Part No. 31496 [explosion-proof]).

TABLE 2-9: AUTOMAN II-C RELEASING DEVICE PART DETAILS

Part No.	Description	Approvals	Explosion-proof classification
5373	LT-30-R nitrogen cartridge (ordered separately)	–	–
26310	Cocking lever (ordered separately)	–	–
17728	AUTOMAN II-C releasing device, 24 VDC	UL Listed for use in non-hazardous locations: UL File R5998 Approved for use with FM Approved systems	–
35620	AUTOMAN II-C releasing device, weather-proof, 24 VDC	–	–
31492	AUTOMAN II-C releasing device, explosion-proof, 24 VDC	UL Listed for use in hazardous locations: UL file E62842	Class I, Groups C and D
		Approved for use with FM Approved systems	Not approved for use in hazardous locations for FM Approved systems
35623	AUTOMAN II-C releasing device, explosion and weather-proof, 24 VDC	UL Listed for use in hazardous locations: UL file E62842	Class I, Groups C and D
		Approved for use with FM Approved systems	Not approved for use in hazardous locations for FM Approved systems

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 in 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 2-23
AUTOPULSE RELEASE CONTROL PANEL GROUP
E001703



FIGURE 2-24
AUTOPULSE Z-20 AGENT RELEASE CONTROL SYSTEM
E001702

VALVE UNION ADAPTOR

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

TABLE 2-10: 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
309.002.013 570363	3 in. valve union adaptors
309.002.014 69470	
309.002.015 69471	

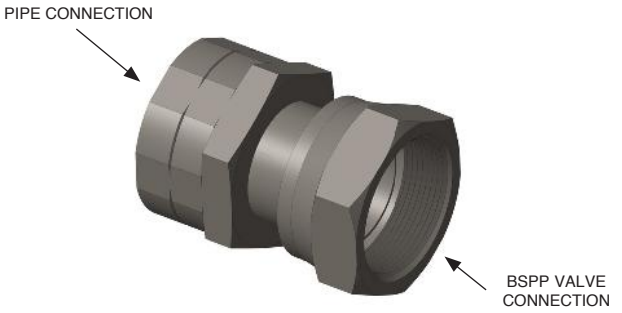


FIGURE 2-25
VALVE UNION ADAPTOR
E001704

Technical specification

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:	1 in. BSPP swivel cone (hydraulic) x 1 in. NPT fixed female (Part No. 309002016) or 1 in. BSPT fixed female (Part No. 309002018)	2 in. BSPP swivel cone (hydraulic) x 2 in. NPT fixed female (Part No. 309002017) or 2 in. BSPT fixed female (Part No. 309002019)
Overall size:	75 mm (2.95 in.) L in extended position x 41 mm (1.61 in.) A/F	100 mm (3.94 in.) L in extended position x 70 mm (2.76 in.) A/F
System working temperature range:	-20 °C to 50 °C (-4 °F to 122 °F) LPCB	-20 °C to 50 °C (-4 °F to 122 °F) LPCB
	-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
Maximum working pressure:	120 bar (1,740 psi)	120 bar (1,740 psi)
Equivalent length:	1.27 m (4.17 ft)	1.45 m (4.76 ft)
Test pressure:	180 bar (2,611 psi)	180 bar (2,611 psi)
Weight:	0.38 kg (0.84 lb)	1.18 kg (2.60 lb)
Approvals, listings, and certifications:	UL and FM	UL and FM
Part number marked on component:	309002016 (NPT) 309002018 (BSPT)	309002017 (NPT) 309002019 (BSPT)

* 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.

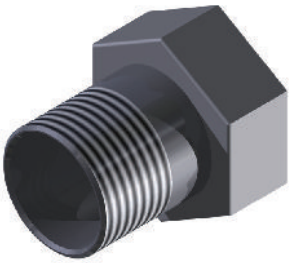


FIGURE 2-26
80 mm (3 in.) VALVE CONTAINER ADAPTOR
E001705

Technical specification

Body:	Brass
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F)
Approvals, listings, and certifications:	UL and FM

3 in. flared to 3 in. BSPT

Part No.:	309.002.013 570363
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)

3 in. flared to 3 in. NPT

Part No.:	309.002.014 69470
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)

3 in. flared to 3 in. grooved

Part No.:	309.002.015 69471
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)

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

SAPPHIRE 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 and an o-ring fitted to the sealing face.

TABLE 2-11: 25 mm (1 in.) FLEXIBLE DISCHARGE HOSE

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

Technical specification

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.)
O-ring:	21.95 mm x 1.78 mm (0.86 in. x 0.07 in.)
Maximum working pressure:	49 bar (711 psi) (according to EN 12094-8)
Test pressure:	88 bar (1,276 psi)
Minimum burst pressure:	350 bar (5,076 psi)
System 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
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, listings, and certifications:	UL, FM, and CE
Conformity:	EN 12094-8
CE certification number:	2831-CPR-S2040
UKCA certification number:	0832-UKCA-CPR-S5010
Marking requirements:	Manufacturer's mark, Part No., Batch No., WP-49 bar, hose type 1, CE_{2831} and $UKCA_{0832}$
Part number marked on component:	306.207.002
Method of marking:	Laser

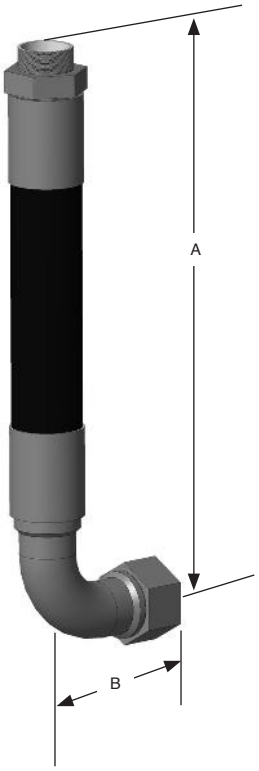


FIGURE 2-27
FLEXIBLE DISCHARGE HOSE
E001684

Location on system

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

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

The following table lists the 50 mm (2 in.) flexible discharge hose details. The flexible discharge hose has a swivel fitting at the inlet and an o-ring fitted to the sealing face.

TABLE 2-12: 50 mm (2 in.) FLEXIBLE DISCHARGE HOSE

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

Technical specification

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.)
O-ring:	47.35 mm x 1.78 mm (1.86 in. x 0.07 in.)
Maximum working pressure:	49 bar (711 psi) according to EN 12094-8
Test pressure:	80 bar (1,160 psi)
Minimum burst pressure:	320 bar (4,641 psi)
System 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
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, listings, and certifications:	UL, FM, and CE
Conformity:	EN 12094-8
CE certification number:	2831-CPR-S2040
UKCA certification number:	0832-UKCA-CPR-S5010
Marking requirements:	Manufacturer's mark, Part No., Batch No., WP-49 bar, hose type 1, CE_{2831} and $UKCA_{0832}$
Part number marked on component:	306.207.003
Method of marking:	Laser

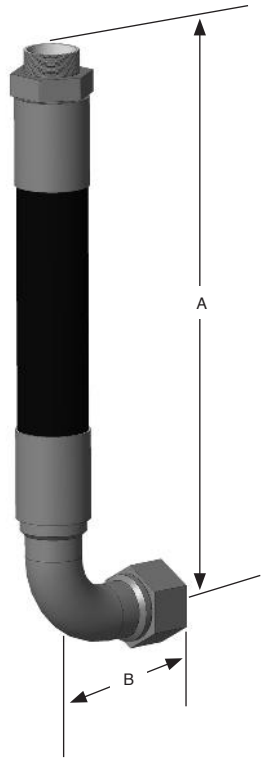


FIGURE 2-28
FLEXIBLE DISCHARGE HOSE
E001684

Location on system

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

FLEXIBLE DISCHARGE HOSE - 80 mm (3 in.) HOSE / CHECK VALVE ASSEMBLY (Part No. 306.205.006 / 69841)

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 32 mm (1 1/4 in.) height adjustment.



FIGURE 2-29
80 mm (3 in.) FLEXIBLE DISCHARGE HOSE
E001120

Technical specification

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 (hose):	51.7 bar (750 psi)
Minimum burst pressure (hose):	137.9 bar (2,000 psi)
Equivalent length:	15.85 m (52 ft)
System working temperature range:	-18 °C to 54 °C (0 °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)
Approvals, listings, and certifications:	UL and FM

Note: This hose and check valve assembly is not certified in accordance with EN12094-8 and EN12094-13 and cannot be installed in the UK and EU.

FLEXIBLE DISCHARGE HOSE - 80 mm (3 in.) HOSE (Part No. 306.205.005 / 69990)

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 2-30
80 mm (3 in.) FLEXIBLE DISCHARGE HOSE
E001121

Technical specification

Hose construction:	Double braid stainless steel
Maximum working pressure:	34.5 bar (500 psi)
Test pressure:	51.7 bar (750 psi)
Minimum burst pressure:	137.9 bar (2,000 psi)
Minimum bend radius:	460 mm (18 in.)
Equivalent length:	2.7 m (8.8 ft)
System working temperature range:	-18 °C to 54 °C (0 °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)
Approvals, listings, and certifications:	UL and FM

Note: This hose is not certified in accordance with EN12094-8 and EN12094-13 and cannot be installed in 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 32 mm (1 1/4 in.) height adjustment.

Technical specification

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)
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F) UL and FM
Overall size:	350 mm (L) x 157 mm (Dia) (13.78 in. [L] x 6.18 in. [Dia])
Weight:	Approximately 16.25 kg (35.82 lb)
Equivalent length:	13.15 m (43.143 ft)
Approvals, listings, and certifications:	UL and FM

Note: This check valve is not certified in accordance with EN12094-13 and cannot be installed in the UK and EU.

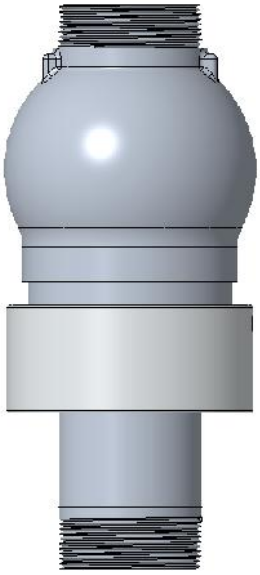


FIGURE 2-31
80 mm (3 in.) DISCHARGE CHECK VALVE AND ADAPTOR ASSEMBLY
E001516

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 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 2-13: ADJUSTABLE HEIGHT ADAPTOR

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



FIGURE 2-32
ADJUSTABLE HEIGHT ADAPTOR
E001719

Technical specification

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
System 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
Maximum working pressure:	120 bar (1,740 psi)	120 bar (1,740 psi)
Equivalent length:	0.44 m (1.44 ft)	0.96 m (3.15 ft)
Test pressure:	180 bar (2,611 psi)	180 bar (2,611 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, listings, and certifications:	UL, FM, and CE	UL, FM, and CE
Conformity:	EN 12094-8	EN 12094-8
CE certification number:	2831-CPR-S0071	2831-CPR-S0071
UKCA certification number:	0832-UKCA-CPR-S5023	0832-UKCA-CPR-S5023
Marking requirements:	Manufacturer's mark, Part No., Batch No., WP, size, connector type, CE_{2831} and $UKCA_{0832}$	Manufacturer's mark, Part No., Batch No., WP, size, connector type, CE_{2831} and $UKCA_{0832}$
Part number marked on component:	306700003	306700004
Method of marking:	Laser	Laser
Connector type:	Type 5	Type 5

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 2-14: 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

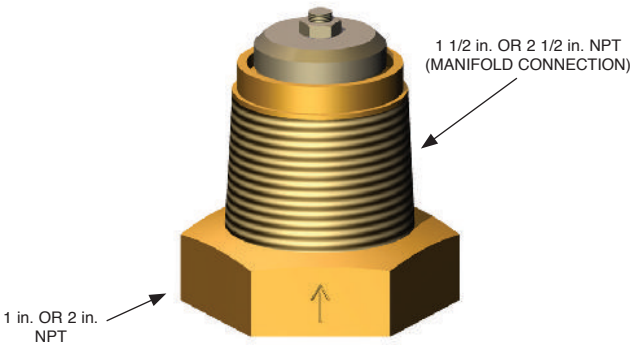


FIGURE 2-33
MANIFOLD CHECK VALVE
E001706

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 specification

Check valve:	25 mm (1 in.)	50 mm (2 in.)
Body material:	Brass CW617N (CZ122)	Brass CW617N (CZ122)
Stem material:	Stainless steel	Stainless steel
Spring material:	Stainless steel	Stainless steel
Top plate material:	Stainless steel	Stainless steel
Bottom plate material:	Brass CW614N (CZ121)	Brass CW614N (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 (1,740 psi)	120 bar (1,740 psi)
Test pressure:	180 bar (2,611 psi)	180 bar (2,611 psi)
System 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
Approvals, listings, and certifications:	UL, FM, and CE	UL, FM, and CE
Conformity:	EN 12094-13	EN 12094-13
CE certification number:	2831-CPR-S0070	2831-CPR-S0070
UKCA certification number:	0832-UKCA-CPR-S5022	0832-UKCA-CPR-S5022
Marking requirements:	Manufacturer's mark, part number, DN25 or DN50, WP-120 bar, vertical, ↑, serial number, CE_{2831} and $UKCA_{0832}$	Manufacturer's mark, part number, DN50, WP-120 bar, vertical, ↑, serial number, CE_{2831} and $UKCA_{0832}$
Part number marked on component:	302.209.004	302.209.005
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. 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 2-16 lists the manifold part details.

The following list specifies the manifolding requirements:

- Follow local pipe guidance such as FIA, FSSA, and NFPA for pipe schedule, size, and material requirements.
- 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 in conjunction with manifold reducing bushings can be utilized for connecting to the discharge pressure switch. Alternatively, manifold blind caps or a combination of sockets, reducing bushings, and plugs 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 2-15 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.

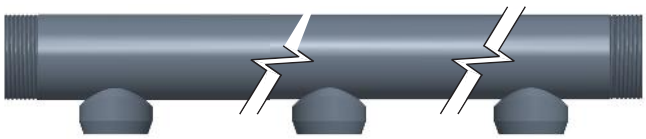


FIGURE 2-34
MANIFOLD ASSEMBLY
E001686

Technical specification

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 (1,740 psi) - threaded 50 bar (725 psi) - flanged
Test pressure:	180 bar (2,611 psi) - threaded 75 bar (1,088 psi) - flanged
Finish:	Primed and ready to paint on-site

TABLE 2-15: MANIFOLD COMPONENTS

Part No.	Description
Manifold reducing bushings	
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
NPT sockets for manifold ends	
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
Manifold reducing bushing plugs	
309.007.003	1/2 in. NPT plug galvanized 3000 lb
309.007.013	1/2 in. BSPT plug galvanized 3000 lb
Manifold blind caps	
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 2-16: 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 specification

Material:	Carbon steel per ASTM A105 / ASTM A350 LF2
Dimensions:	Per ANSI B16.11 / BS3799
Pressure rating:	3,000 lb



FIGURE 2-35
THREADED INLET FOR MANIFOLDS
E001707

TABLE 2-17: 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, and 45	4.5, 8, 16, and 32	75 (2.95)	1 1/2 in. NPT	44 (1.73)	0.71 (1.57)
451634							
17037	80 (3)	60, 120, 150, and 180	52, 106, 147, and 180	100 (3.94)	2 1/2 in. NPT	63 (2.48)	1.20 (2.65)
451635							
17038	100 (4)	60, 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)
451636							
17467	150 (6)	60, 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)
451637							

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 2-18: MANIFOLD UNION ADAPTORS

Connector size mm (in.)	Part No. NPT to NPT (Female)	Part No. 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)

Note: *Special orders only.

Spare o-rings

Spare o-rings are available for the union adaptors, should they become lost or damaged.

TABLE 2-19: SPARE O-RINGS

Connector size mm (in.)	Part No.
25 (1)	22000524
40 (1 1/2)	22000527
50 (2)	22000528
65 (2 1/2)	22000529
80 (3)	22000530
100 (4)	22000531



FIGURE 2-36
MANIFOLD UNION ADAPTOR
E001708

Technical specification

Material:	Zinc plated steel (nut) Nitrile (o-ring)
Maximum working pressure:	240 bar (3,481 psi)
Test pressure:	360 bar (5,221 psi)
System working temperature range:	-20 °C to 50 °C (-4 °F to 122 °F) LPCB -18 °C to 54 °C (0 °F to 130 °F) UL and FM
Marking requirements:	Part number, nominal size, flow direction, and serial number

MANIFOLD BRACKET ASSEMBLY

A manifold bracket assembly consists of two lengths of back channel mounted vertically on a wall or bulk head to enable the height adjustment of the manifold assembly. Cantilever brackets are fastened to the back channel and are held in position using a long spring nut, washer, and hex head screw. The 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. When a container bank is multiple rows deep, the manifold bracketing must be constructed and installed to local code requirements taking the manifold weight and wall specifications into consideration.

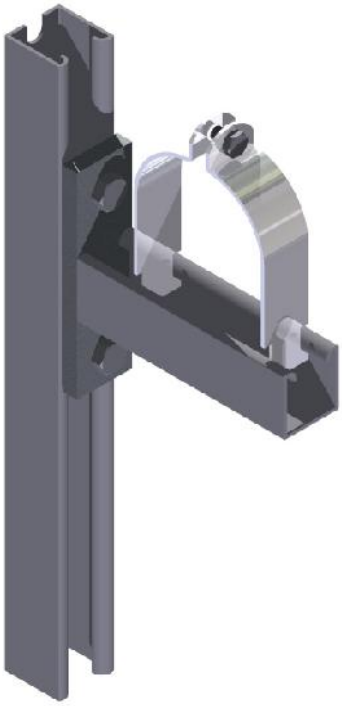


FIGURE 2-37
MANIFOLD BRACKET
E001709

Technical specification

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.)
Back 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)

FLEXIBLE 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 specification

Hose construction:	Stainless steel wire braid PTFE liner to ISO 12086 Part 1
Connection:	Zinc passivated mild steel, two 1/4 in. BSP straight female swivel unions
Plating specification:	ZINKLAD 1000 (Hexavalent Chromium-Free)
Nominal hose internal diameter:	6 mm (1/4 in.)
Connection inner diameter:	4 mm (1/8 in.)
Maximum working pressure:	120 bar (1,740 psi)
Test pressure:	180 bar (2,611 psi)
Minimum burst pressure:	724 bar (10,500 psi)
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F) UL and FM -20 °C to 50 °C (-4 °F to 122 °F) CE
Bend angle:	360°
Minimum bend radius:	60 mm at 0 °C (2 3/8 in. at 32 °F) according to EN 12094-8
Approvals, listings, and certifications:	UL, FM, and CE
Conformity:	EN 12094-8
CE certification number:	2831-CPR-S0071
UKCA certification number:	0832-UKCA-CPR-S5023
Marking requirements:	Manufacturer's mark, part number, batch number, WP-120 bar, hose type 3, CE_{2831} and $UKCA_{0832}$
Part number marked on component:	306.205.003 (710 mm) 306205010 (815 mm) 306205011 (1070 mm)
Method of marking:	Laser (onto identification collar)
Hose type:	Type 3
Overall size:	See Table 2-20
Weight:	See Table 2-20



FIGURE 2-38
FLEXIBLE FEMALE ACTUATION HOSE
E001710

TABLE 2-20: FLEXIBLE FEMALE ACTUATION HOSES

Part No.	Length of DN 1/4 in. PTFE flexible female actuation hose	Hose volume	Weight
		cm^3 ($in.^3$)	kg (lb)
306.205.003	710 mm (27 7/8 in.)	20.07 cm^3 (1 1/4 $in.^3$)	0.15 (0.33)
306205010	815 mm (32 1/8 in.)	23.5 cm^3 (1 7/16 $in.^3$)	0.17 (0.37)
306205011	1070 mm (42 1/8 in.)	31.2 cm^3 (1 29/32 $in.^3$)	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 specification	
309.013.005	The male adaptor connects the pilot hose to the 25 mm (1 in.) and 50 mm (2 in.) container valve assembly.	 E001712	Material:	Steel 230 M07 Pb, zinc passivated
			Connection:	1/4 in. BSPT x 1/4 in. BSPP
			Maximum working pressure:	350 bar (5,076 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

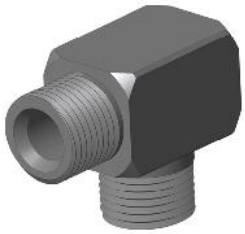
Part No.	Description	Picture	Technical specification	
309.013.006	The male adaptor connects the female actuation hose to the discharge pressure switch.	 E001711	Material:	Steel 230 M07 Pb, zinc passivated
			Connection:	1/4 in. NPT x 1/4 in. BSPP
			Maximum working pressure:	350 bar (5,076 psi)
			Overall 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 specification	
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.	 E001713	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 (6,527 psi)
			Overall size:	42.3 mm x 33.3 mm (1.67 in. x 1.31 in.)
			Weight:	0.075 kg (0.165 lb)

ACTUATION COMPONENTS (Continued)

Male actuation elbow

Part No.	Description	Picture	Technical specification	
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.	 E001717	Material:	Steel 230 M07 Pb, zinc passivated
			Connection:	1/4 in. BSPP x 1/4 in. NPT
			Maximum working pressure:	450 bar (6,527 psi)
			Overall size:	33.9 mm x 33.0 mm (1.33 in. x 1.30 in.)
			Weight:	0.05 kg (0.11 lb)

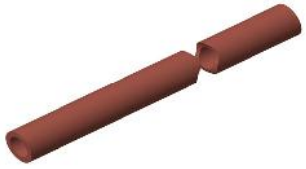
Male pilot hose connector

Part No.	Description	Picture	Technical specification	
309.013.007	The male connector connects the two female actuation hoses together, or actuation hose to the non-return valve.	 E001716	Material:	Steel 230 M07 Pb, zinc passivated
			Connection:	1/4 in. BSPP x 1/4 in. BSPP
			Maximum working pressure:	350 bar (5,076 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

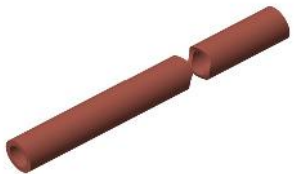
Part No.	Description	Picture	Technical specification	
309.013.036	The male adaptor connects the pilot hose to the discharge pressure switch (Part No. 305.209.009). This adaptor is supplied with the standard pressure switch.	 E001715	Material:	Steel 230 M07 Pb, zinc passivated
			Connection:	3/8 in. NPT x 1/4 in. BSPP
			Maximum working pressure:	350 bar (5,076 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

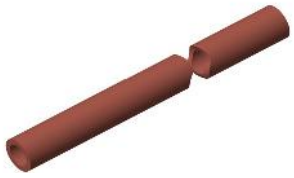
Part No.	Description	Picture	Technical specification	
308.002.001	The copper nickel pipe connects pressure activated devices to the system, for example, a subordinate container or a pressure switch. The pipe is supplied per meter (foot) and is suitable for bending.	 E001714	Material:	Copper nickel alloy
			Specification:	CN102
			Maximum working pressure:	149.5 bar (2,168 psi)
			Supplied length:	Ordered per meter (foot)
			Diameter:	6 mm OD x 4.4 mm ID (0.24 in. x 0.17 in.)
			Weight:	0.078 kg/m (0.052 lb/ft)

ACTUATION COMPONENTS (Continued)

6 mm half hard pipe

Part No.	Description	Picture	Technical specification	
308.002.002	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.	 E001682	Material:	Phosphorous deoxidized copper
			Specification:	BS6017 grade Cu-DHP
			Maximum working pressure:	149.5 bar (2,168 psi)
			Supplied length:	3.0 m (9.83 ft)
			Diameter:	6 mm OD x 4 mm ID (0.24 in. x 0.16 in.)
			Weight:	0.078 kg/m (0.052 lb/ft)

1/4 in. copper tubing

Part No.	Description	Picture	Technical specification	
447609	Where extensive actuation runs are required, a 50 ft coil of 1/4 in. copper tubing can be used. The tubing is suitable for bending.	 E001682	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 (1,450 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 specification	
30880015	The 6 mm compression tee primarily connects pilot lines from one subordinate container to the next.	 E001718	Material:	Brass
			Connection:	6 mm DIN 2353 compression fittings
			Maximum working pressure:	150 bar (2,176 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 specification	
441430	The 1/4 in. compression tee primarily connects pilot lines from one subordinate container to the next.	 E001720	Material:	Brass
			Connection:	1/4 in. compression fittings
			Maximum working pressure:	150 bar (2,176 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 specification	
30880020	The 6 mm straight coupling connects the 6 mm copper pipe.	 E001721	Material:	Brass
			Connection:	6 mm DIN 2353
			Maximum working pressure:	150 bar (2,176 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 specification	
441544	The 1/4 in. straight coupling connects the 1/4 in. copper tubing.	 E001722	Material:	Brass
			Connection:	1/4 in. compression fittings
			Maximum working pressure:	150 bar (2,176 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 specification	
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) and must be ordered separately with the alternative discharge pressure switch (Part No. 437900).	 E001723	Material:	Brass
			Connection:	3/8 in. NPT x 6 mm stud coupling
			Maximum working pressure:	150 bar (2,176 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 specification	
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 437900). The stud coupling must be ordered separately.	 E001724	Material:	Brass
			Connection:	3/8 in. NPT x 1/4 in. stud coupling
			Maximum working pressure:	150 bar (2,176 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 specification	
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).	 E001725	Material:	Brass
			Connection:	1/4 in. NPT x 6 mm stud coupling
			Maximum working pressure:	150 bar (2,176 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 specification	
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).	 E001726	Material:	Brass
			Connection:	1/4 in. NPT x 1/4 in. stud coupling
			Maximum working pressure:	150 bar (2,176 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 specification	
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).	 E001727	Material:	Brass
			Connection:	1/4 in. BSPT male x 6 mm stud coupling
			Maximum working pressure:	150 bar (2,176 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 specification	
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).	 E001728	Material:	Brass
			Connection:	1/4 in. BSPT x 1/4 in. stud coupling
			Maximum working pressure:	150 bar (2,176 psi)
			Overall size:	1.02 in. x 0.55 in. hex A/F
			Weight:	0.024 kg (0.053 lb)

ACTUATION COMPONENTS (Continued)

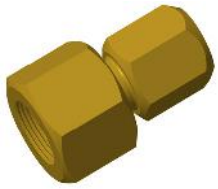
6 mm stud coupling

Part No.	Description	Picture	Technical specification	
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).	 E001729	Material:	Brass
			Connection:	1/4 in. BSPP male x 6 mm stud coupling
			Maximum working pressure:	200 bar (2,901 psi)
			Overall size:	18.95 mm hex A/F x 31.5 mm
			Weight:	0.030 kg (0.066 lb)

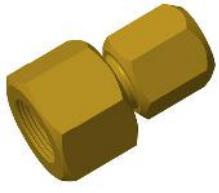
1/4 in. stud coupling

Part No.	Description	Picture	Technical specification	
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).	 E001730	Material:	Brass
			Connection:	1/4 in. BSPP male x 1/4 in. stud coupling
			Maximum working pressure:	150 bar (2,176 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 specification	
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.	 E001685	Material:	Brass
			Connection:	1/4 in. BSPP female x 6 mm stud coupling
			Maximum working pressure:	150 bar (2,176 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 specification	
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.	 E001685	Material:	Brass
			Connection:	1/4 in. BSPP female x 1/4 in. stud coupling
			Maximum working pressure:	150 bar (2,176 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 specification	
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.	 E001731	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 (3,046 psi)

Bleed valve

Part No.	Description	Picture	Technical specification	
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 limit. It connects into the outlet adaptor on the pilot container assembly and is supplied within the DOT and TPED pilot container assemblies.	 E001732	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 (5,366 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 specification	
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.	 E001733	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 (1,740 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 specification	
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).	 E001734	Material:	Steel 11SMnPb37, passivated
			Connection:	1/4 in. NPT male x 1/4 in. BSPP swivel female
			Maximum working pressure:	350 bar (5,076 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 specification	
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.	 E001735	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 specification	
309013049	The 1/4 in. BSPP equal male tee connects the female actuation hoses.	 E001736	Material:	Steel 230 MO7 Pb, zinc passivated
			Connection:	1/4 in. BSPP male
			Maximum working pressure:	450 bar (6,527 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 specification	
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.	 E001737	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 (6,527 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 and 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 No. 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 No. 305.209.009 consists of Part No. 437900 and two additional adaptors, 3/8 in. NPT male x 1/4 in. BSPP male and 3/8 in. NPT male x 6 mm stud adaptor.

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

Technical specification

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 (2,900 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
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F) UL and FM -20 °C to 50 °C (-4 °F to 122 °F) LPCB
Conformity:	EN 12094-10*
Marking requirements:	Manufacturer's mark, part number, maximum working pressure, CE*
Part number marked on component:	437900 305.209.009
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, listings, and certifications:	LPCB (Part No. 305.209.009) UL and FM (Part No. 437900)



FIGURE 2-39
DISCHARGE PRESSURE SWITCH
E001745

Note: * The CE mark on the component relates to the electrical switch mechanism (not for the constructions product regulation [CPR] as the discharge pressure switch is not covered by EN12094-10). Additionally, the discharge pressure switch has been tested in accordance with EN12094-10 for LPCB redbook listing.

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, to the pneumatic actuation line, or onto the distribution piping as a pressure tap.

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

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 signaled to a control unit.

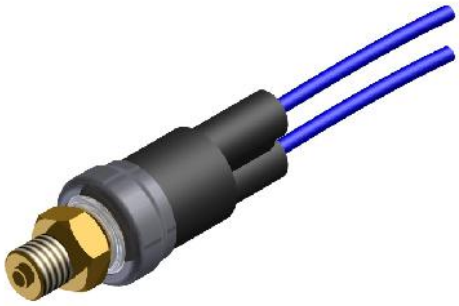


FIGURE 2-40
LOW PRESSURE SWITCH (STANDARD OPEN ON FALL)
E001293

Technical specification

Standard - open on fall	(Part No. 304.205.006)
Body:	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)
System 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
Maximum working pressure:	33.5 bar (485.9 psi)
Proof pressure:	345 bar (5,003 psi)
Electrical connection:	0.9 m (3 ft) x 2 core cable
Maximum current:	2.9 A
Voltage range:	5 VDC to 28 VDC
Weight:	0.087 kg (0.192 lb)
Approvals, listings, and certifications:	UL, FM, and CE
Conformity:	EN 12094-10
CE certification number:	2831-CPR-S2048
UKCA certification number:	0832-UKCA-CPR-S5014
Marking requirements:	Manufacturer's mark, PS80-K2-1949 (designation), Serial No., 290-350 (set point and switch point), CE_{2831} and $UKCA_{0832}$
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 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 signaled to a control unit.

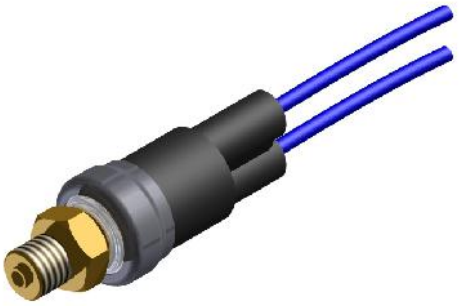


FIGURE 2-41
LOW PRESSURE SWITCH (SPECIAL CLOSE ON FALL)
E001293

Technical specification

Special - close on fall	(Part No. 305.209.005)
Body:	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)
System 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
Maximum working pressure:	33.5 bar (485.9 psi)
Proof pressure:	345 bar (5,003 psi)
Electrical connection:	0.9 m (3 ft) x 2 core cable
Maximum current:	2.9 A
Voltage range:	5 VDC to 28 VDC
Weight:	0.087 kg (0.192 lb)
Approvals, listings, and certifications:	UL, FM, and CE
Conformity:	EN 12094-10
CE certification number:	2831-CPR-S2048
UKCA certification number:	0832-UKCA-CPR-S5014
Marking requirements:	Manufacturer's mark, PS80-K1-1949 (designation), Serial No., 290-350 (set point and switch point), CE_{2831} and $UKCA_{0832}$
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 / 570585)

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. Review the installation instructions for this device if field installed. The 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 2-42
LOW PRESSURE SWITCH OPTION 1 – GEMS (ALTERNATE – TRANSFER ON FALL)
E001295

Technical specification

Pressure port material:	Zinc plated steel
Element:	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)
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F) UL and FM
Maximum working pressure:	33.5 bar (485.9 psi)
Proof pressure:	206.8 bar (3,000 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
Conformity:	–
Approvals, listings, and certifications:	UL and FM
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)
Marking requirements:	Manufacturer's mark, PS71, Part No., and Serial No., 294F (set point)
Part number marked on component:	570585
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 / 570585)

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. Review the installation instructions for this device if field installed. The 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 2-43
LOW PRESSURE SWITCH OPTION 2 – NASON (ALTERNATE – TRANSFER ON FALL)
E001296

Technical specification

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)
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F) UL and FM
Maximum working pressure:	33.5 bar (485.9 psi)
Proof pressure:	413.7 bar (6,000 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
Conformity:	–
Approvals, listings, and certifications:	UL and FM
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)
Marking requirements:	Manufacturer's mark, FVC CD 234, Part No., and Serial No., 294F (set point)
Method of marking:	Pin stamped

EXPLOSION-PROOF LOW PRESSURE SWITCH (25 BAR) (Part No. 453979)

The explosion-proof low pressure switch continuously monitors the pressure of a container in a total flood fire suppression system. The explosion-proof low pressure switch fits opposite the outlet of the container valve assembly. If the container pressure falls below 20 bar (290 psi), the switch operates though an electrical signal. Order the low pressure switch separate from the container.

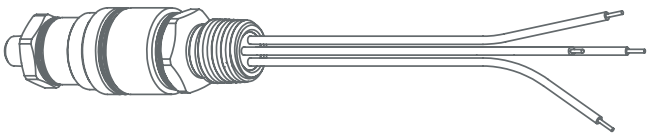


FIGURE 2-44
EXPLOSION-PROOF LOW PRESSURE SWITCH
E002096

Location on system

The low pressure switch is fitted opposite the outlet of the container valve assembly.

Technical specification

Body:	316L stainless steel
Piston:	Stainless steel with viton o-ring
Switch point:	20 bar (290 psi, falling)
Switch point tolerance:	± 2.75 bar (±40 psi)
Set point:	Factory set
Enclosure rating:	NEMA 4X
Mechanical life piston design:	$>10^6$ operations
Ingress Protection rating:	IP67
Pressure connection:	1/8 in. NPT male
Electrical connection:	1/2 in. NPT male
Electrical rating:	5 A at 28 VDC maximum
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F)
Approvals, listings, and certifications:	UL, ATEX, and IECEx
Conformity:	EN 60079-0: 2012/A11:2013 and EN 60079-1: 2014 (ATEX) IEC 60079-0:2011, IEC 60079-31:2013 and IEC 60079-1:2014-06 (IECEx)
Hazard locations:	ATEX/IECEx Haz-loc: II 2GD Ex d IIC T6/T5 Gb Ex tb IIIC T85°C/100°C Db T5 or T6 UL Haz-loc: Class I Division 1 Groups A, B, C, and D Class II Division 1 Groups E, F, and G T5 or T6
Marking details:	Manufacturer details, CE_{0518}, UL haz loc ratings, ATEX and IECEx ratings, model, range, serial number, electrical ratings, setpoint, DB and proof
Part number marked on component:	–
Overall size:	Dia. 28.6 mm x 97.4 mm (L) excluding wires (Dia. 1.13 in. x 3.83 in. [L])
Weight:	0.25 kg (0.55 lb)

DISCHARGE NOZZLES
(Part No., see Table 2-22)

FK-5-1-12 agent 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 brass or stainless steel NPT or BSPT threads. Table 2-22 lists the discharge nozzle details.

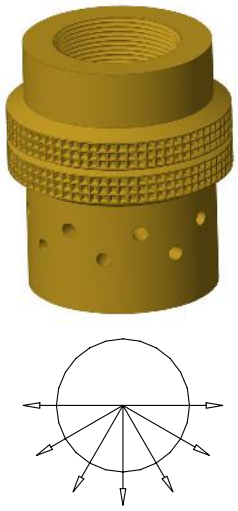
Location on system

At the end of the discharge pipework.

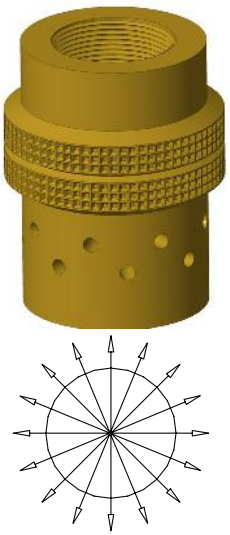
Technical specification

Material:	Brass or stainless steel
Thread type:	BSPT or NPT female (NPT thread is denoted by v-groove around knurling)
Sizes:	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:	16 port (360°) or 7 port (180°)
Nozzle coverage radius:	See Table 2-21
Maximum protection height:	4.3 m (14.1 ft)
Minimum protection height:	0.3 m (1.0 ft)
Maximum distance from ceiling:	0.3 m (1.0 ft)
Minimum and maximum distance from wall to center of 180° nozzle:	0.05 m to 0.3 m (0.2 ft to 1.0 ft)
Maximum coverage area per nozzle:	See Table 2-21
Minimum nozzle pressure:	5.0 bar (72.5 psi)
System working temperature range:	-20 °C to 50 °C (-4 °F to 122 °F) (EU standard coverage area)
	-18 °C to 54 °C (0 °F to 130 °F) (UL and FM standard coverage area)
	0 °C to 50 °C (32 °F to 122 °F) (EU extended coverage area)
	0 °C to 54 °C (32 °F to 130 °F) (UL and FM extended coverage area)
Orientation:	Pendant or upright
Approvals, listings, and certifications:	UL and FM
Marking requirements:	Manufacturer's mark, serial number, factory ID, part number, drill size in mm

Note: The nozzles are drilled and marked in metric (mm) only.



180° nozzle pattern (7 ports)



360° nozzle pattern (16 ports)

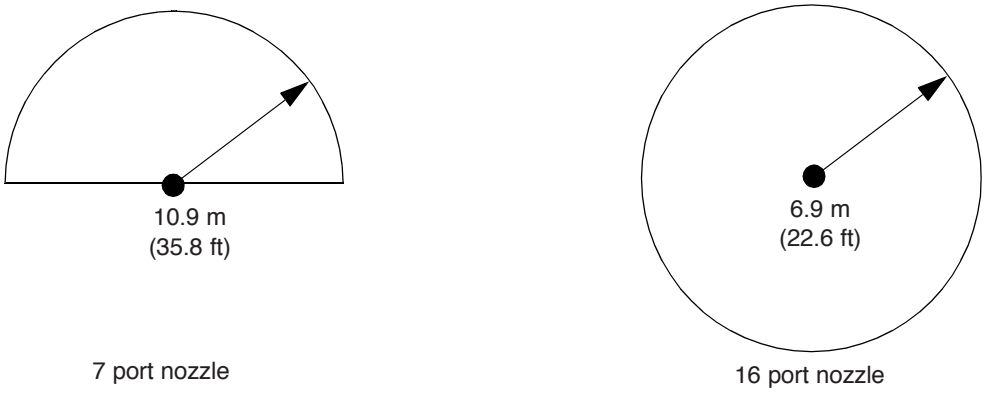
FIGURE 2-45
7 AND 16 PORT NOZZLES BRASS CONFIGURATION
E001744, E001756, E001758, and E001759

DISCHARGE NOZZLES (Continued)

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

TABLE 2-21: NOZZLE COVERAGE DETAILS

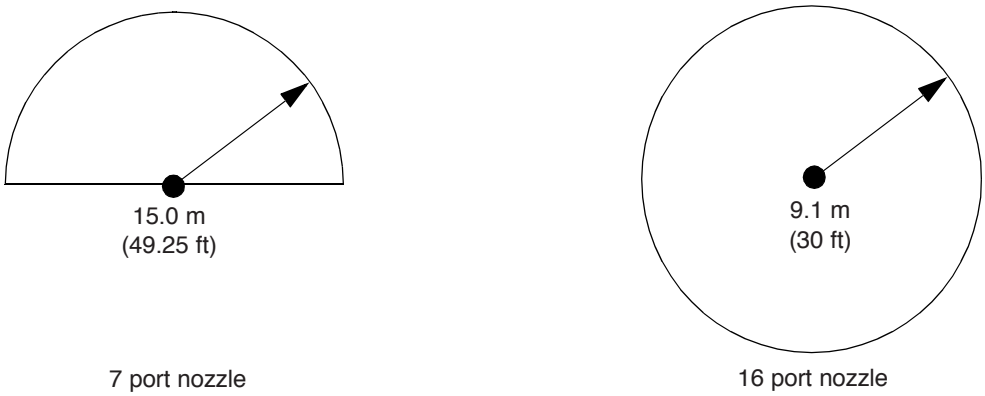
Nozzle coverage	Temperature range	Approvals, listings, and certifications	Maximum nozzle radius	
			7 port (180°)	16 port (360°)
Standard area coverage	-20 °C to 50 °C (-4 °F to 122 °F)	UL and FM (in the EU)	10.9 m (35.8 ft)	6.9 m (22.6 ft)
Maximum: 96 m^2 (1033 ft^2)	-18 °C to 54 °C (0 °F to 130 °F)	UL and FM (outside EU)		
Extended area coverage	0 °C to 50 °C (32 °F to 122 °F)	UL and FM (in the EU)	15.0 m (49.25 ft)	9.1 m (30 ft)
Maximum: 167.2 m^2 (1800 ft^2)	0 °C to 54 °C (32 °F to 130 °F)	UL and FM (outside EU)		



7 port nozzle

16 port nozzle

FIGURE 2-46
STANDARD AREA COVERAGE
E001748



7 port nozzle

16 port nozzle

FIGURE 2-47
EXTENDED AREA COVERAGE
E001748

DISCHARGE NOZZLES (Continued)

The drill size for a nozzle must be indicated at the time of order and should come from the hydraulic calculation report. The drill size for the nozzle is the individual hole size for either 7 or 16 ports.

TABLE 2-22: DISCHARGE NOZZLES

Brass – NPT

	Nozzle size		Nozzle	Length		Diameter		Weight		Min. drill size Sch 40	Max. drill size Sch 40
Part No.	mm	(in.)	type	mm	(in.)	mm	(in.)	kg	(lb)	mm	mm
310.207.213	15	(1/2)	7 port	41.0	(1 5/8)	47.6	(1 7/8)	0.47	(1.04)	1.9	5.3
310.207.215	20	(3/4)	7 port	47.0	(1 7/8)	53.1	(2 1/8)	0.64	(1.41)	3.6	7.0
310.207.217	25	(1)	7 port	52.0	(2 1/16)	58.9	(2 3/8)	0.83	(1.84)	4.6	9.0
310.207.219	32	(1 1/4)	7 port	63.1	(2 1/2)	66.5	(2 5/8)	1.18	(2.59)	6.0	11.8
310.207.221	40	(1 1/2)	7 port	68.0	(2 5/8)	72.9	(2 7/8)	1.47	(3.24)	7.0	13.8
310.207.223	50	(2)	7 port	89.0	(3 1/2)	88.9	(3 1/2)	2.55	(5.62)	8.9	17.7
310.207.214	15	(1/2)	16 port	41.0	(1 5/8)	47.6	(1 7/8)	0.47	(1.04)	1.3	3.4
310.207.216	20	(3/4)	16 port	47.0	(1 7/8)	53.1	(2 1/8)	0.64	(1.41)	2.4	4.6
310.207.218	25	(1)	16 port	52.0	(2 1/16)	58.9	(2 3/8)	0.83	(1.84)	3.0	5.9
310.207.220	32	(1 1/4)	16 port	63.1	(2 1/2)	66.5	(2 5/8)	1.18	(2.59)	4.0	7.8
310.207.222	40	(1 1/2)	16 port	68.0	(2 5/8)	72.9	(2 7/8)	1.47	(3.24)	4.6	9.1
310.207.224	50	(2)	16 port	89.0	(3 1/2)	88.9	(3 1/2)	2.55	(5.62)	5.9	11.7

Stainless steel – NPT

	Nozzle size		Nozzle	Length		Diameter		Weight		Min. drill size Sch 40	Max. drill size Sch 40
Part No.	mm	(in.)	type	mm	(in.)	mm	(in.)	kg	(lb)	mm	mm
310.207.313	15	(1/2)	7 port	41.0	(1 5/8)	47.6	(1 7/8)	0.44	(0.97)	1.9	5.3
310.207.315	20	(3/4)	7 port	47.0	(1 7/8)	53.1	(2 1/8)	0.6	(1.31)	3.6	7.0
310.207.317	25	(1)	7 port	52.0	(2 1/16)	58.9	(2 3/8)	0.79	(1.75)	4.6	9.0
310.207.319	32	(1 1/4)	7 port	63.1	(2 1/2)	66.5	(2 5/8)	1.11	(2.45)	6.0	11.8
310.207.321	40	(1 1/2)	7 port	68.0	(2 5/8)	72.9	(2 7/8)	1.38	(3.04)	7.0	13.8
310.207.323	50	(2)	7 port	89.0	(3 1/2)	88.9	(3 1/2)	2.41	(5.32)	8.9	17.7
310.207.314	15	(1/2)	16 port	41.0	(1 5/8)	47.6	(1 7/8)	0.44	(0.97)	1.3	3.4
310.207.316	20	(3/4)	16 port	47.0	(1 7/8)	53.1	(2 1/8)	0.6	(1.31)	2.4	4.6
310.207.318	25	(1)	16 port	52.0	(2 1/16)	58.9	(2 3/8)	0.79	(1.75)	3.0	5.9
310.207.320	32	(1 1/4)	16 port	63.1	(2 1/2)	66.5	(2 5/8)	1.11	(2.45)	4.0	7.8
310.207.322	40	(1 1/2)	16 port	68.0	(2 5/8)	72.9	(2 7/8)	1.38	(3.04)	4.6	9.1
310.207.324	50	(2)	16 port	89.0	(3 1/2)	88.9	(3 1/2)	2.41	(5.32)	5.9	11.7

DISCHARGE NOZZLES (Continued)

The drill size for a nozzle must be indicated at the time of order and should come from the hydraulic calculation report. The drill size for the nozzle is the individual hole size for either 7 or 16 ports.

TABLE 2-23: DISCHARGE NOZZLES (Continued)

Brass - BSPT

	Nozzle size		Nozzle	Length		Diameter		Weight		Min. drill size Sch 40	Max. drill size Sch 40
Part No.	mm	(in.)	type	mm	(in.)	mm	(in.)	kg	(lb)	mm	mm
310.207.201	15	(1/2)	7 port	41.0	(1 5/8)	47.6	(1 7/8)	0.47	(1.04)	1.9	5.3
310.207.203	20	(3/4)	7 port	47.0	(1 7/8)	53.1	(2 1/8)	0.64	(1.41)	3.6	7.0
310.207.205	25	(1)	7 port	52.0	(2 1/16)	58.9	(2 3/8)	0.83	(1.84)	4.6	9.0
310.207.207	32	(1 1/4)	7 port	63.1	(2 1/2)	66.5	(2 5/8)	1.18	(2.59)	6.0	11.8
310.207.209	40	(1 1/2)	7 port	68.0	(2 5/8)	72.9	(2 7/8)	1.47	(3.24)	7.0	13.8
310.207.211	50	(2)	7 port	89.0	(3 1/2)	88.9	(3 1/2)	2.55	(5.62)	8.9	17.7
310.207.202	15	(1/2)	16 port	41.0	(1 5/8)	47.6	(1 7/8)	0.47	(1.04)	1.3	3.4
310.207.204	20	(3/4)	16 port	47.0	(1 7/8)	53.1	(2 1/8)	0.64	(1.41)	2.4	4.6
310.207.206	25	(1)	16 port	52.0	(2 1/16)	58.9	(2 3/8)	0.83	(1.84)	3.0	5.9
310.207.208	32	(1 1/4)	16 port	63.1	(2 1/2)	66.5	(2 5/8)	1.18	(2.59)	4.0	7.8
310.207.210	40	(1 1/2)	16 port	68.0	(2 5/8)	72.9	(2 7/8)	1.47	(3.24)	4.6	9.1
310.207.212	50	(2)	16 port	89.0	(3 1/2)	88.9	(3 1/2)	2.55	(5.62)	5.9	11.7

Stainless steel - BSPT

	Nozzle size		Nozzle	Length		Diameter		Weight		Min. drill size Sch 40	Max. drill size Sch 40
Part No.	mm	(in.)	type	mm	(in.)	mm	(in.)	kg	(lb)	mm	mm
310.207.301	15	(1/2)	7 port	41.0	(1 5/8)	47.6	(1 7/8)	0.44	(0.97)	1.9	5.3
310.207.303	20	(3/4)	7 port	47.0	(1 7/8)	53.1	(2 1/8)	0.60	(1.31)	3.6	7.0
310.207.305	25	(1)	7 port	52.0	(2 1/16)	58.9	(2 3/8)	0.79	(1.75)	4.6	9.0
310.207.307	32	(1 1/4)	7 port	63.1	(2 1/2)	66.5	(2 5/8)	1.11	(2.45)	6.0	11.8
310.207.309	40	(1 1/2)	7 port	68.0	(2 5/8)	72.9	(2 7/8)	1.38	(3.04)	7.0	13.8
310.207.311	50	(2)	7 port	89.0	(3 1/2)	88.9	(3 1/2)	2.41	(5.32)	8.9	17.7
310.207.302	15	(1/2)	16 port	41.0	(1 5/8)	47.6	(1 7/8)	0.44	(0.97)	1.3	3.4
310.207.304	20	(3/4)	16 port	47.0	(1 7/8)	53.1	(2 1/8)	0.60	(1.31)	2.4	4.6
310.207.306	25	(1)	16 port	52.0	(2 1/16)	58.9	(2 3/8)	0.79	(1.75)	3.0	5.9
310.207.308	32	(1 1/4)	16 port	63.1	(2 1/2)	66.5	(2 5/8)	1.11	(2.45)	4.0	7.8
310.207.310	40	(1 1/2)	16 port	68.0	(2 5/8)	72.9	(2 7/8)	1.38	(3.04)	4.6	9.1
310.207.312	50	(2)	16 port	89.0	(3 1/2)	88.9	(3 1/2)	2.41	(5.32)	5.9	11.7

ROSETTE

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.

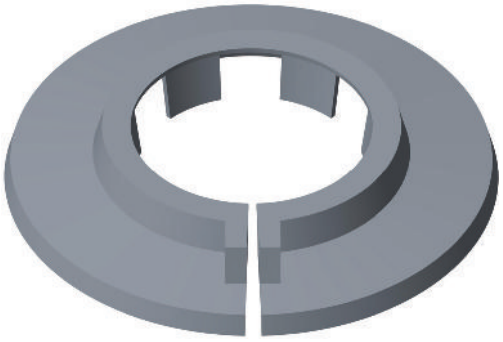


FIGURE 2-48
ROSETTE
009752

TABLE 2-24: ROSETTE DETAILS

Part No.	Nozzle size mm (in.)	Diameter mm (in.)
570172	15 (1/2)	60 (2.39)
12036		
570174	20 (3/4)	71 (2.80)
12037		
570175	25 (1)	76 (3.00)
12038		
570176	32 (1 1/4)	90 (3.54)
12039		
570178	40 (1 1/2)	97 (3.80)
12040		
570179	50 (2)	110 (4.32)
12041		

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.

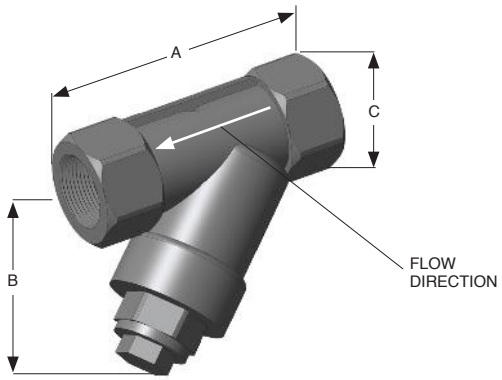


FIGURE 2-49
DISCHARGE NOZZLE FILTER
E001740

TABLE 2-25: 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)	52.0 (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)	52.0 (2.0)	3/4 in. NPT

Technical specification

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
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F) UL and FM
	-20 °C to 50 °C (-4 °F to 122 °F) LPCB

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). For further details, see the Actuation Line Schematics in Section 9 - Appendix.

NOTICE

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

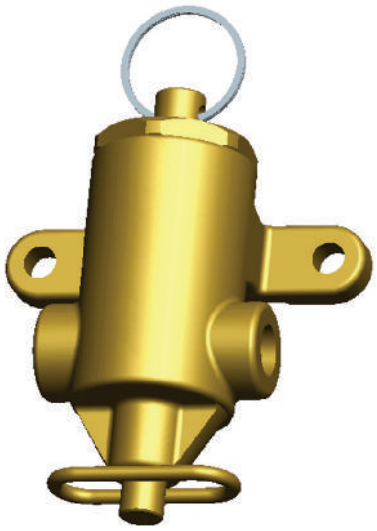


FIGURE 2-50
PRESSURE TRIP
E001746

Technical specification

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 (2,100.1 psi)
Maximum load at 5.2 bar (75.4 psi):	31.7 kg (69.9 lb)
System working temperature range:	-20 °C to 54 °C (-4 °F to 130 °F)
Approvals, listings, and certifications:	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)
Part number marked on component:	5156

Note: The link and pull ring are not fitted to the pressure trip assembly and should be fitted during the installation of the pressure trip.

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 specification

Body:	Brass
Spring:	Stainless steel
Pull ring:	Stainless steel
Inlet:	1/4 in. male
Connection:	1/4 in. NPT
Set point:	18.3 bar (265 psi)
Maximum installation torque:	27 N•m (20 ft-lb)
System working temperature range:	-20 °C to 54 °C (-4 °F to 130 °F)
Approvals, listings, and certifications:	UL and FM
Overall size:	50.8 mm (L) x 17.5 mm (W) (2.00 in. [L] x 0.69 in. [W])
Weight:	0.046 kg (0.101 lb)



FIGURE 2-51
SAFETY VENT VALVE
E001747

MANUAL PULL BOX - LATCHED DOOR TYPE (Part No. 304.207.008 / 45062)

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 / 41542) are supplied in a pack with two legs, two screws, and two nuts to allow connection to the pull box.



FIGURE 2-52
LATCH DOOR TYPE PULL BOX
E001749

Technical specification

Latch door type pull box (Part No. 304.207.008 / 45062)

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 / 41542)

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 2-53
1.6 mm (1/16 in.) CABLE WITH SWAGED END FITTING
E001750

TABLE 2-26: CABLE PART DETAILS

Part No.	Description
304.207.010	15.2 m (50 ft) cable
42104	
304.207.011	30.5 m (100 ft) cable
42109	
304.207.012	45.7 m (150 ft) cable
42113	

Technical specification

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])
Weight (304.207.010 / 42104):	0.178 kg (0.39 lb)
Weight (304.207.011 / 42109):	0.341 kg (0.75 lb)
Weight (304.207.012 / 42113):	0.519 kg (1.14 lb)

CABLE CLAMP
(Part No. 304.207.013 / 45333)

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

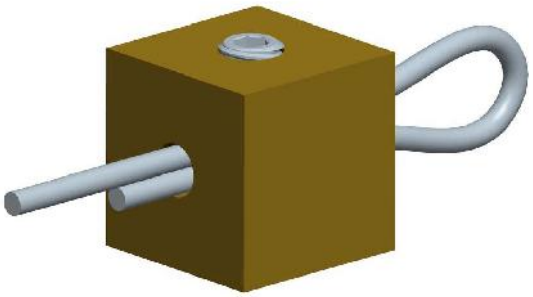


FIGURE 2-54
CABLE CLAMP
E001751

Technical specification

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 / 40060)

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.

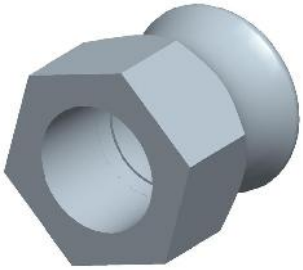


FIGURE 2-55
FLARED END FITTING
E001743

Technical specification

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 / 45515 and 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 / 45515) 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 2-56
CORNER PULLEY - SHEAVE TYPE
E001757

Technical specification - 304.207.015 / 45515

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.)
Location:	Use in the hazard area or outside
Weight:	0.46 kg (1.01 lb)

Technical specification - 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.)
Location:	Only use outside the hazard area
Weight:	0.09 kg (0.2 lb)

THREAD ADAPTOR
(Part No. 304.207.016 / 40696)

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 2-57
THREAD ADAPTOR
E001741

Technical specification

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

Pilot containers are available depending on market requirements (TPED and DOT). These pilot containers pneumatically operate a SAPPHIRE system. Table 2-28 lists the maximum number of SAPPHIRE containers operated by these actuation containers. The maximum actuation line tubing lengths are detailed in Table 6-11.

The pilot container is supplied with a solenoid, manual actuator, contacted pressure gauge, outlet adaptor, pipe and hose adaptors, bleed valve complete with Dowty seal, and brackets. The contacted pressure gauge has a switch point that is factory set to 88 bar (1,276 psi).

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

TABLE 2-27: PILOT CONTAINER BRACKETS

Bracket (see page 2-69)	Part No.
3 L Bracket assembly - DOT 13 L Bracket assembly - TPED	30621310
3 L Bracket assembly - TPED	30620310
13 L Bracket assembly - DOT	441408
50 L Bracket assembly - DOT and TPED	30625010

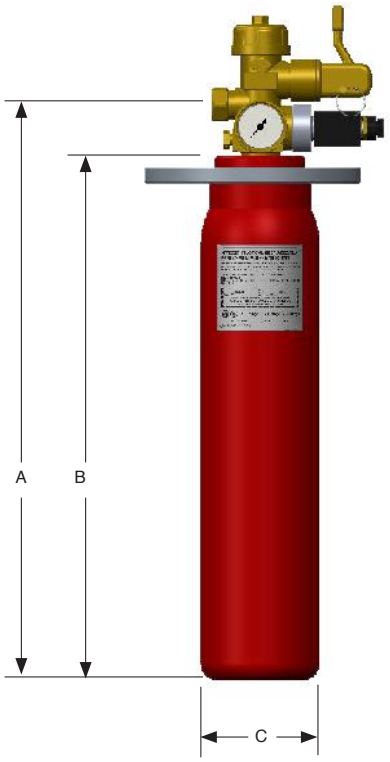


FIGURE 2-58
PILOT CONTAINER DETAILS (3 L SHOWN)
E001754

TABLE 2-28: PILOT CONTAINER DETAILS

Part No.	Nom. size (L)	Water capacity (L)	Pressure gauge type	Height A mm (in.)	Height B mm (in.)	Dia C mm (in.)	Maximum number of containers operated	Weight kg (lb)	Approvals, listings, and certifications
304700009 (TPED 50 ºC)	3	3.0	CPG	542 (21 3/8)	495 (19 1/2)	100 (3 7/8)	12	10.6 (23.4)	UL and FM
304700010 (DOT 50 ºC)	3	3.4	CPG	403 (15 7/8)	355.6 (14)	133 (5 1/4)	12	11.3 (24.9)	UL and FM
304700017 (TPED 50 ºC)	13	13.4	CPG	1111 (43 3/4)	1064 (41 7/8)	140 (5 1/2)	12	21.2 (46.7)	UL and FM
304700019 (DOT 50 ºC)	13	14.2	CPG	695 (27 3/8)	648 (25 1/2)	188 (7 3/8)	12	23.5 (51.8)	UL and FM
304700022 (TPED 50 ºC)	50	50.0	CPG	1527 (60 1/4)	1481 (58 1/4)	229 (9)	12	51.2 (112.9)	UL and FM
304700024 (DOT 50 ºC)	50	50.0	CPG	1482 (58 3/8)	1435 (56 1/2)	236 (9 1/4)	12	67.0 (147.7)	UL and FM

PILOT CONTAINER - STANDARD (Continued)

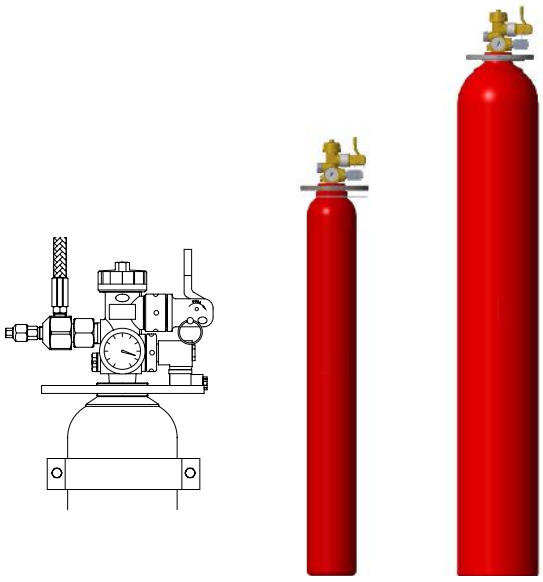


FIGURE 2-59
VALVE CONNECTIONS, 13 L AND 50 L PILOT CONTAINERS
E000967

Technical specification

Valve body:	Brass CZ121
TPED container thread type:	DIN477 (W28.8)
DOT container thread type:	1 in. NGT
Valve outlet:	DIN477 (W21.7)
Valve outlet adaptor connection:	1/4 in. BSPP
Container volume:	See Table 2-28
Gas type:	Nitrogen
Container:	Carbon steel
Container pressure:	100 bar at 15 °C (1,450 psi at 59 °F)
Container test pressure (TPED):	300 bar (4,351 psi)
Container test pressure (DOT):	207 bar (3,000 psi)
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F)
Approvals, listings, and certifications:	UL and FM
Actuation method:	Manual and electrical
Bracket type:	Wall mounted (3 L)
Weight:	See Table 2-28

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

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

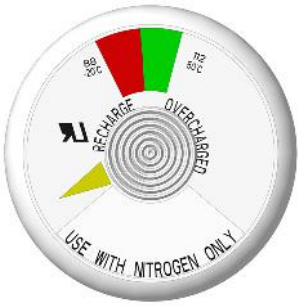


FIGURE 2-60
MIJA CONTACTED PRESSURE GAUGE (TPED AND DOT PILOT CONTAINER)
E001761

Technical specification

Type:	Bourdon tube pressure gauge
Entry:	Back axial
Measurement system:	Copper alloy
Movement:	Copper alloy
Case:	Stainless steel
Window:	Polycarbonate
Restrictor:	Brass Dia 0.5 mm
Nominal size:	DN40 (1.6 in.)
Units of outer scale:	bar
Units of inner scale:	psi
Connection:	M10 x 1 DIN13
Ingress Protection Class:	IP54
Language:	English
Pressure range:	0 bar to 134 bar (0 psi to 1,944 psi)
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F)
Nominal charge pressure:	100 bar (1,450 psi)
Setpoint:	88 bar (1,276 psi)
Accuracy:	± 4% at charge ± 8% at upper and lower limits
Wire specification:	18 gauge SXL, 280 mm
Voltage:	18 VDC to 30 VDC
Current:	5 mA to 100 mA
Maximum consumption:	3 W
Weight:	0.06 kg (0.13 lb)
Approvals, listings, and certifications:	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 specification

Valve size:	12 mm (0.47 in.)
Disc Part No.:	29999911 (violet color)
Plug Part No.:	22000001
Body material:	Copper/nickel (disc) Brass CW614N (plug)
Rating:	160 bar to 180 bar at 20 °C (2,321 psi to 2,611 psi at 68 °F)
	152 bar to 172 bar at 55 °C (2,205 psi to 2,495 psi at 131 °F)
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °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)

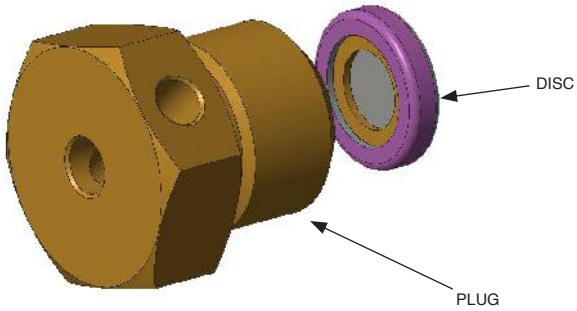


FIGURE 2-61
PILOT CONTAINER SAFETY BURST DISC
E001760

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

The pilot container valve includes a factory-fitted solenoid.

Technical specification

Actuation type:	Solenoid
Reset method:	Automatic
Connection:	Factory-fitted
Voltage:	24 VDC (21.6 VDC to 27.6 VDC)
Maximum working pressure:	115 bar (1,668 psi)
Consumption:	13 W
Maximum current:	0.56 A
Minimum duration of trigger signal:	Continuous duty
Electrical connection:	DIN plug
Protection:	IP65
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F) UL and FM -20 °C to 50 °C (-4 °F to 122 °F) CE
Weight:	0.25 kg (0.55 lb)
Approvals, listings, and certifications:	CE, UL, and FM
Conformity:	EN 12094
CE Certification No.:	0786-CPR-30062
UKCA Certification No.:	0086-CPR-771058
Marking requirements:	Manufacturer's mark, Part No., working pressure, Batch No., nominal voltage, current, CE_{0786} and $UKCA_{0086}$



FIGURE 2-62
PILOT CONTAINER SOLENOID VALVE
E001683

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

The placement indicator switch assembly consists of a monitoring device (Part No. 441857) and a mounting bracket (Part No. 441883). It indicates the correct 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 that 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 correct 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 correct position.

Technical specification

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
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F)
Approvals, listings, and certifications:	UL and FM
Part number marked on component:	441857
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 2-63
PLACEMENT INDICATOR SWITCH KIT
E001752



FIGURE 2-64
PLACEMENT INDICATOR MOUNT BRACKET
E001739

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 before fitting it onto the container valve results in the immediate operation of the container valve and a potentially hazardous discharge of the container.



FIGURE 2-65
MANUAL ACTUATOR
E001764

Location on system

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

Technical specification

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)
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F) UL and FM -20 °C to 50 °C (-4 °F to 122 °F) CE
Overall size:	82.0 mm x 72.0 mm (3.2 in. x 2.8 in.)
Approvals, listings, and certifications:	UL and FM
Conformity:	EN 12094-4
CE certification number:	0786-CPR-30062
UKCA certification number:	0086-CPR-771058
Marking requirements:	Manufacturer's mark, part number, batch number, CE_{0786} and $UKCA_{0086}$
Part number marked on component:	31009401

PILOT CONTAINER ACTUATION BURST DISC

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

Technical specification

Part No.:	20938000 (orange color)
Material:	Copper nickel
Burst pressure:	285 bar to 315 bar at 20 °C (4,134 psi to 4,569 psi at 68 °F)
Overall size:	Dia 14.0 mm x 2.2 mm (Dia 0.55 in. x 0.09 mm)
Weight:	0.2 kg (0.4 lb)

PILOT CONTAINER VALVE
(Part No., see Table 2-29)

⚠ 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 2-66
PILOT CONTAINER VALVE
E001742

Technical specification

Body material:	Brass CZ121
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 (2,408 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 (2,465 psi ± 145 psi)
Burst disc port:	M12 x 1.5
Gauge port:	M10 x 1
System working temperature range:	-20 °C to 50 °C (-4 °F to 122 °F) Valve Part No. 20012128 and 441400
Weight:	1.95 kg (4.3 lb)
Approvals, listings, and certifications:	UL and FM (Valve Part No. 20012128 and 441400)
Conformity:	EN 12094-4
Valve certification number:	0786-CPR-30062 (CE) 0086-CPR-771058 (UKCA) 2880-335-2203 (TPED) 1266-335-2204 (TPE)
Marking requirements 128-90UL:	Manufacturers mark, 128-90UL, 20012128, batch number, 140 bar, VdS, CE_{0786}, $UKCA_{0086}$, π2880 and ρ1266
Marking requirements 128-97:	Manufacturers mark, 128-97, 21114008, batch number, 140 bar, VdS, CE_{0786}, $UKCA_{0086}$, π2880 and ρ1266
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 2-29: PILOT CONTAINER VALVE DETAILS

Valve Part No.	Thread type	Components included with the valve part number	Where used
441400	1 in. NGT	· 128-97 valve (Part No. 21114008) · 50 °C MIJA contacted pressure gauge 0 bar to 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)
20012128	28.8 DIN 477	· 128-90 UL valve including 50 °C MIJA contacted pressure gauge 0 bar to 134 bar, normally closed under pressure (Part No. 30213401) The pilot container assembly includes a 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)
Note: For valve part number 20012128, 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). The pilot valve adaptor is included in the pilot container assembly.

Technical specification

Body:	Steel (zinc coated)
Connection:	1/4 in. BSPP
Working pressure:	100 bar (1,450 psi)
Overall size:	53.5 mm x 39 mm (2.1 in x 1.5 in)
Weight:	0.26 kg (0.6 lb)

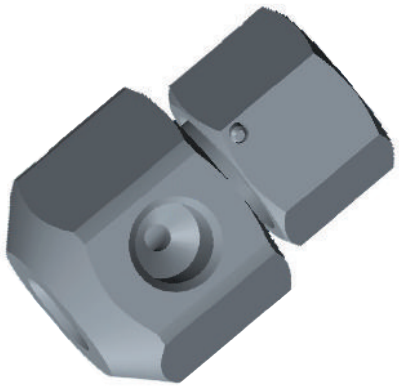


FIGURE 2-67
PILOT VALVE ADAPTOR
E001755

PILOT CONTAINER BRACKETS

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

Note: 3 L DOT pilot containers only require one bracket assembly.

TABLE 2-30: BRACKET DETAILS

Part No.	Bracket	Dimensions (width x height)
30621310	3 L bracket assembly - DOT 13 L bracket assembly - TPED	208 mm x 164 mm (8.2 in. x 6.5 in.)
30620310	3 L bracket assembly - TPED	160 mm x 143 mm (6.3 in. x 5.6 in.)
441408	13 L bracket assembly - DOT	292 mm x 203 mm (11.5 in. x 8.0 in.)
30625010	50 L bracket assembly - DOT and TPED	303 mm x 273 mm (11.9 in. x 10.7 in.)

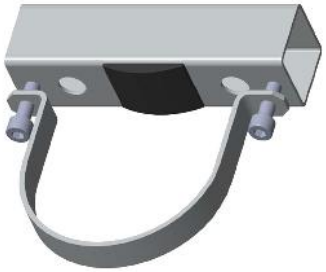
Container mounting type:

Wall mounted – 3 L

Floor mounted – 13 L and 50 L



3 L (DOT) and 13 L (TPED) pilot container bracket (Part No. 30621310)
E000994



3 L (TPED) pilot container bracket (Part No. 30620310)
E000995



50 L (DOT and TPED) pilot container bracket (Part No. 30625010)
E000996



13 L (DOT) pilot container bracket (Part No. 441408)
E001054

FIGURE 2-68
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 2-69
DECOMPRESSION SCREW
E001738

Technical specification

Body:	Brass
Internal parts:	Nitrile
Connection:	1/4 in. BSPP
Test pressure:	420 bar (6,092 psi)
Maximum working pressure:	140 bar (2,031 psi)
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F) UL and FM
	-20 °C to 50 °C (-4 °F to 122 °F) EU
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 requirements:	Manufacturer, part number, UL, serial number, and working pressure
Part number marked on component:	30027301
Method of marking:	Engraving
Approvals, listings, and certifications:	UL and FM

LIQUID LEVEL MEASURING DEVICE
(Part No., see technical specification)

The measuring device is used to measure the level of liquid FK-5-1-12 agent in 106 L, 147 L, 180 L, and 343 L welded containers. The weight of the FK-5-1-12 agent in the container is determined by converting the level measurement into a weight measurement using the weight conversion tables. The operating temperature range for the liquid level measuring device is -18 °C to 54 °C (0 °F to 130 °F).

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. This measurement is accomplished without removing the tank from the fire suppression system.

The device must be installed in an empty welded container assembly before filling. The liquid level measuring device must be ordered as a separate line item or specified at the time of order entry to be included in the assembly of the container.



FIGURE 2-70
LIQUID LEVEL MEASURING DEVICE
E001420

Technical specification

106 L liquid level:	Part No. 300.015.127 / 570277
147 L and 343 L liquid level:	Part No. 300.015.128 / 570278
180 L liquid level:	Part No. 300.015.129 / 570589
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 / 570277
	1170 mm (46.0 in.) - Part No. 300.015.128 / 570278
	1480 mm (58.3 in.) - Part No. 300.015.129 / 570589
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F)
Weight:	0.53 kg (1.17 lb) - Part No. 300.015.127 / 570277
	0.61 kg (1.34 lb) - Part No. 300.015.128 / 570278
	0.70 kg (1.54 lb) - Part No. 300.015.129 / 570589
Approvals, listings, and certifications:	UL and FM

DOOR NOTICES

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

TABLE 2-31: DOOR NOTICE DETAILS

Part No.	Description
314207102	Greater than NOAEL. For use in unoccupied spaces only.
314207101	Less than NOAEL.



FIGURE 2-71
DOOR NOTICE (GREATER THAN NOAEL)
E001398



FIGURE 2-72
DOOR NOTICE (LESS THAN NOAEL)
E001397

Technical specification

Material: 0.65 mm (0.03 in.) PVC

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. 314207103)

A notice shall be located at each manual release position.



FIGURE 2-73
MANUAL RELEASE SIGN
E001399

Technical specification

Material: 0.65 mm (0.03 in.) PVC

Finish: Gloss, scratch-resistant

Overall size: 212 mm (L) x 75 mm (W)
(8.25 in. [L] x 3.00 in. [W])

INTRODUCTION

FK-5-1-12 agent is a clean, safe, and effective fire fighting agent for use in total flooding automatic suppression systems.

SAPPHIRE 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 SAPPHIRE equipment should only be conducted by persons trained in dealing with this type of equipment.

FK-5-1-12 agent 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 heat absorption. It removes heat energy from the fire and flame zone. The agent decomposes in temperatures in excess of 500 ºC (932 ºF). It is important to avoid applications involving hazards where continuously hot surfaces are involved. Upon exposure to the flame, the agent will decompose to form halogen acids. A sharp, easily detectable acidic odor acts as a warning and safeguard to personnel.

The primary objective of a SAPPHIRE 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 by-products of combustion to the atmosphere using appropriate ventilation devices.

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*.

FK-5-1-12 agent suppresses fires through its cooling effect, not through the displacement of oxygen. The agent therefore provides the ability to utilize a SAPPHIRE system in occupied areas.

Exposure to the agent at the design concentration of up to 10.0% 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 SAPPHIRE SYSTEMS

SAPPHIRE systems are designed to suppress fires in Class A, B, and C hazards.

⚠ CAUTION

FK-5-1-12 agent 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)

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 FK-5-1-12 agent gives the appearance of a fog that may reduce visibility. This normally clears rapidly and should not obstruct the ability of personnel to safely exit the protected area.

SAPPHIRE 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 SAPPHIRE 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 SAPPHIRE 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 inside 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 and pneumatic actuators on the containers.

TYPES OF DETECTION

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

Electronic control panel

Electric actuation of the SAPPHIRE 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 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 the correct response if a fire situation occurs.

For SAPPHIRE 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 SAPPHIRE 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 by-products of combustion to the atmosphere using appropriate ventilation devices.

FULLY AUTOMATIC SYSTEM

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.

Before a 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 SAPPHIRE 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 SAPPHIRE Total Flooding Fire Suppression System.

OPERATING THE SYSTEM COMPONENTS

Follow the operating guidelines for the SAPPHIRE 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 that 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 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 container valve operates with the CPM actuator or pneumatically with pressure from the master container, pilot container, or AUTOMAN II-C release. To manually operate the CPM actuator, remove the safety pin and apply the required force to move the lever 90° in an upward direction. When the CPM pneumatically operates through a cable, a pull station is utilized to apply force on the actuation wire. After operation, the CPM remains in the fire position and requires manual resetting before refitting the discharge valve or electrical actuator.

AUTOMAN II-C releasing device

The AUTOMAN II-C actuator operates automatically through an electrical signal from thermal detectors, fusible links, or 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.

Discharge pressure switch

The discharge pressure switch works within the predetermined system operating conditions. After pressure has been relieved from the actuation or discharge line, the discharge pressure switch must be manually reset. To do this, depress the plunger at the top of the brass housing.

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.

INTRODUCTION

Planning for the design and installation of a SAPPHIRE system must start when the customer is first contacted in regards to protecting a hazard with FK-5-1-12 agent. 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 SAPPHIRE 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 a SAPPHIRE 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 a SAPPHIRE 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 a SAPPHIRE 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 a SAPPHIRE 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, visible, or both?
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 a SAPPHIRE 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 a SAPPHIRE 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 FK-5-1-12 agent 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 a SAPPHIRE 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 305 mm (12 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 305 mm (12 in.) below the ceiling to avoid discharging the agent against obstructions, such as beams. If nozzles are installed more than 305 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 305 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*. SAPPHIRE systems are manufactured in accordance with *ISO 9001* and FK-5-1-12 agent 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 or sub-master container, and the other containers are **subordinate** containers. The master container can be actuated electrically or manually. The sub-master container can be actuated pneumatically through a pilot container or AUTOMAN II-C releasing device, or it can be actuated manually. The subordinate containers are actuated pneumatically by the action of the master container or sub-master container discharging.

Master container actuation

The maximum number of subordinate actuated containers is 10, for a total of 11 containers, including one master and 10 subordinates. After every 11 containers, another master container must be created, using an electrical actuator. All master electrical actuators must operate simultaneously to help ensure the correct discharge time.

Sub-master container actuation

The maximum number of subordinate actuated containers is 10, for a total of 11 containers, including one sub-master and 10 subordinates. After every 11 containers, another sub-master container must be created, using a pneumatic actuator (pilot or AUTOMAN II-C releasing device). All sub-master pneumatic actuators must operate simultaneously to help ensure the correct discharge time.

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

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 and the *Actuation Line Schematics* in Section 9 – Appendix.

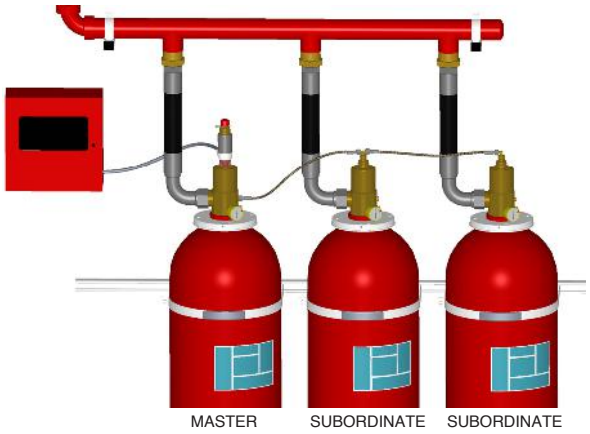


FIGURE 5-1
MASTER AND SUBORDINATE ELECTRICAL ACTUATION WITH AN AUTOPULSE PANEL
E001766

AUTOMAN II-C releasing device – pneumatic (sub-master)

The sub-master container actuates pneumatically through the AUTOMAN II-C releasing device. Additional subordinate containers pneumatically actuate from the master container valve actuation port. See Figure 5-2 and 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.

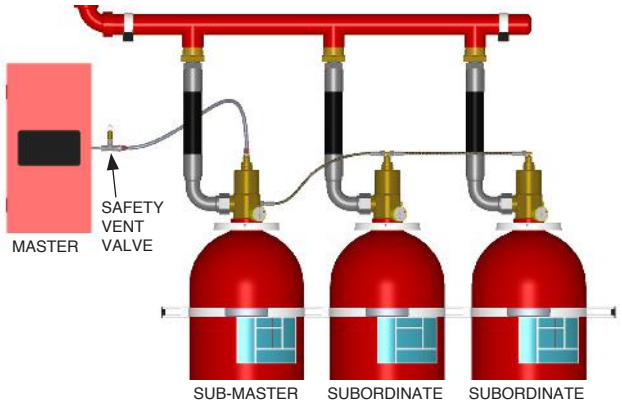


FIGURE 5-2
SUB-MASTER AND SUBORDINATE ACTUATION WITH AN AUTOMAN II-C RELEASING DEVICE
E001767

RELEASE OPTIONS (Continued)

AUTOMAN II-C releasing device – pneumatic (without sub-master)

All containers actuate pneumatically using the AUTOMAN II-C releasing device. See Figure 5-3 and and 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 releasing device.

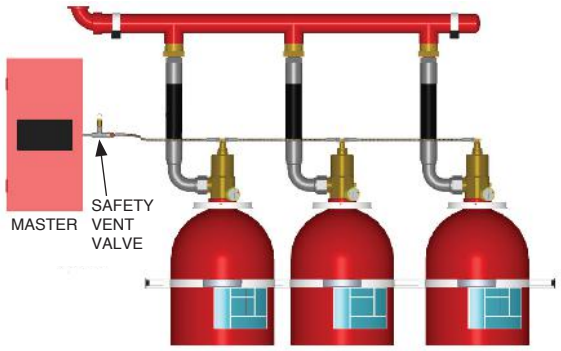


FIGURE 5-3
ACTUATION OF CONTAINERS WITH AN AUTOMAN II-C RELEASING DEVICE (WITHOUT SUB-MASTER ACTUATION)
E001767

ROOM INTEGRITY

The room integrity is the ability of the hazard enclosure to retain the discharged FK-5-1-12 agent. 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. FK-5-1-12 agent 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

SAPPHIRE 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 and FM
Class A	4.50%
Class B	Contact Johnson Controls Technical Services
Class C	4.52% or 4.74%*
Note: * Dependant on the FK-5-1-12 agent manufacturer.	

FK-5-1-12 agent 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) = ≤10%

LOAEL (Lowest Observable Adverse Effect Level) = >10%

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. A pre-discharge alarm and time delay shall be provided to allow personnel sufficient time to evacuate before a discharge.

Calculations to determine the 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 = 3.3%

The agent cup burner value is 4.5% for commercial grade Heptane, as defined in *NFPA 2001*. Actual distribution test concentration is 4.5%. Therefore:

$$\text{Nozzle efficiency factor} = \frac{4.5\%}{4.5\%} = 1.00$$

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

Class A fires (UL Listed and 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
= 3.3% x 1.2 x 1.00 = **3.96%** (minimum = **4.5%**).

NFPA 2001 states that the design concentration should not be less than the heptane cup burner value of 4.5%.

Therefore, Class A minimum design concentration is 4.5% for UL Listed and FM Approved systems.

Class B fires (commercial grade heptane)

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

FM Class B minimum design concentration (commercial grade heptane)
= 4.5% x 1.3 x 1.00 = **5.85%** rounded up to **5.9%**.

UL Class B minimum design concentration (commercial grade heptane) when using FK-5-1-12 agent 4.52 Class C

= 4.5% x 1.3 x 1.00 = **5.85%** rounded up to **5.9%**

UL Class B minimum design concentration (commercial grade heptane) when using FK-5-1-12 agent 4.74 Class C

= 4.53% x 1.3 x 1.00 = **5.89%** rounded up to **5.9%**

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

Class C fires (UL Listed and 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).

FM Class C minimum design concentration
= 3.35% x 1.35 x 1.00 = **4.52%**

UL Class C minimum design concentration when using FK-5-1-12 agent 4.52 Class C = 3.35% x 1.35 x 1.00 = **4.52%**

UL Class C minimum design concentration when using SAPPHIRE FK-5-1-12 4.74 Class C
= 3.51% x 1.35 x 1.00 = **4.74%**

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 **4.5%** for UL Listed and FM Approved systems.

DESIGN CONCENTRATION (Continued)

Design concentrations - ISO 14520 / EN 15004

SAPPHIRE 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	5.30%
Class A Higher Hazards	5.60%
Class B	Contact Johnson Controls Technical Services
Class C	N/A
Note: *Dependant on the FK-5-1-12 agent manufacturer.	

FK-5-1-12 agent 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) = ≤10%

LOAEL (Lowest Observable Adverse Effect Level) = >10%

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 4.1%.

The agent cup burner value is 4.5% for commercial grade Heptane, as defined in *ISO 14520* and *EN15004.* Actual distribution test concentration is 4.5%. Therefore:

$$\text{Nozzle efficiency factor} = \frac{4.5\%}{4.5\%} = 1.00 \text{ for Class B fires}$$

(Not applicable for Class A fires)

Note: Manual only operated systems require a safety factor, as determined by the AHJ.

Class A fires (*ISO 14520 and EN15004*)

ISO 14520 and *EN15004* state that the minimum design concentration is the highest fire test value of wood crib, PMMA, PP, or ABS extinguishing concentration multiplied by 1.3 safety factor.

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

= 4.1% x 1.3 x 1.00

= 5.33% rounded to one decimal place = **5.3%**

Therefore, Class A minimum design concentration is **5.3%**.

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).

= 5.3 **or** 0.95 x 5.85

= 5.56% rounded to one decimal place = **5.6%**

Therefore, Class A higher hazard minimum design concentration is 5.6%.

Class B fires (commercial grade heptane)

Class B minimum design concentration

= fire test concentration x safety factor x nozzle efficiency factor

= 4.5% x 1.3 x 1.00

= 5.85% rounded to one decimal place = **5.9%**

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 Johnson Controls 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.

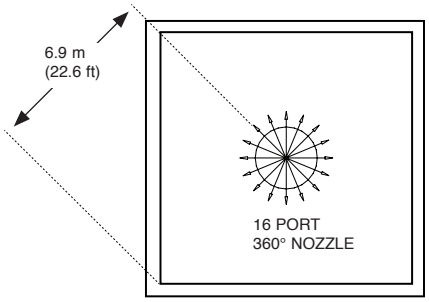
Nozzle selection and location

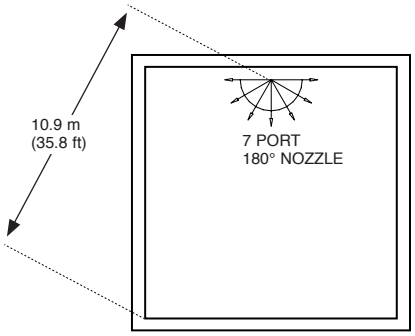
The number of nozzles required is based on the hazard size and configuration and the coverage provided by the nozzle (see Figures 5-4 to 5-6). Nozzles are available in 7 port or 16 port versions to provide 180° or 360° discharge patterns respectively. See Tables 5-3 to 5-5 for further details. When considering the optimum nozzle location, take the following factors into account:

- The shape of the hazard area affects the nozzle location.
- The maximum coverage area is 96 m^2 (1033 ft^2) for standard area coverage and 167.2 m^2 (1800 ft^2) for extended area coverage and must be within nozzle radius limits.
- Nozzle orifices must not be placed where they may discharge into nearby objects.
- Nozzles can be installed up to a maximum of 0.3 m (1.0 ft) below the ceiling.
- Maximum nozzle height above floor level for a single row of nozzles is 4.3 m (14 ft). For ceiling heights above 4.3 m (14 ft) additional rows of nozzles may be added.
- 180° nozzles must be mounted within 0.05 m to 0.3 m (0.2 ft to 1.0 ft) of the wall and point at the center of the hazard.
- The minimum ceiling height, for subfloors, false ceilings, plenums, for example, is 0.3 m (1.0 ft).
- 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 5-7.
- The maximum elevation difference between the highest horizontal pipe runs or discharge nozzles shall not exceed 9.1 m (30 ft), see Figure 5-8.
- 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.

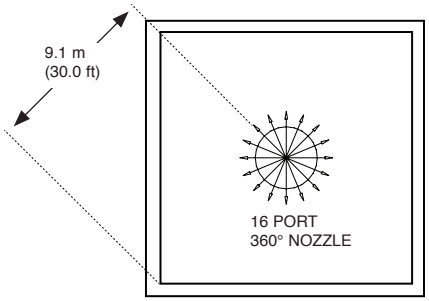
Note: If a system breaks any of the above limits, the system design must be modified to comply with all of the limitations.

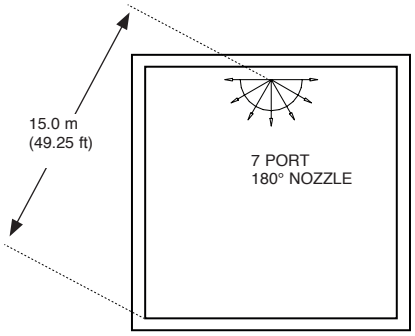
Standard area coverage max. radial distance per nozzle*





Extended area coverage max. radial distance per nozzle*





* Distance from the nozzle to the farthest point of the protected area.

FIGURE 5-4
NOZZLE DISCHARGE RADIUS
025533

SYSTEM LIMITATIONS (Continued)

Nozzle selection and location (Continued)

TABLE 5-3: NOZZLE COVERAGE DETAILS

Nozzle coverage	Temperature range	Approvals and listings	Maximum nozzle radius	
			7 port (180°)	16 port (360°)
Standard area coverage	-20 °C to 50 °C (-4 °F to 122 °F)	UL and FM (within EU)	10.9 m (35.8 ft)	6.9 m (22.6 ft)
Maximum: 96 m^2 (1033 ft^2)	-18 °C to 54 °C (0 °F to 130 °F)	UL and FM (outside EU)		
Extended area coverage	0 °C to 50 °C (32 °F to 122 °F)	UL and FM (within EU)	15.0 m (49.25 ft)	9.1 m (30 ft)
Maximum: 167.2 m^2 (1800 ft^2)	0 °C to 54 °C (32 °F to 130 °F)	UL and FM (outside EU)		

TABLE 5-4: 360° NOZZLE AREA COVERAGE - MAX. 167.2 m^2 (1800 ft^2)

m		(ft)		m		(ft)	
A	B	A	B	A	B	A	B
1.83	18.29	(6)	(60)	9.45	15.54	(31)	(51)
2.13	18.29	(7)	(60)	9.75	15.54	(32)	(51)
2.44	17.98	(8)	(59)	10.06	15.24	(33)	(50)
2.74	17.98	(9)	(59)	10.36	14.94	(34)	(49)
3.05	17.98	(10)	(59)	10.67	14.94	(35)	(49)
3.35	17.98	(11)	(59)	10.97	14.63	(36)	(48)
3.66	17.98	(12)	(59)	11.28	14.33	(37)	(47)
3.96	17.98	(13)	(59)	11.58	14.02	(38)	(46)
4.27	17.68	(14)	(58)	11.89	14.02	(39)	(46)
4.57	17.68	(15)	(58)	12.19	13.72	(40)	(45)
4.88	17.68	(16)	(58)	13.72	12.19	(45)	(40)
5.18	17.68	(17)	(58)	14.02	11.89	(46)	(39)
5.49	17.37	(18)	(57)	14.33	11.28	(47)	(37)
5.79	17.37	(19)	(57)	14.63	10.97	(48)	(36)
6.10	17.37	(20)	(57)	14.94	10.67	(49)	(35)
6.40	17.07	(21)	(56)	15.24	10.06	(50)	(33)
6.71	17.07	(22)	(56)	15.54	9.75	(51)	(32)
7.01	16.76	(23)	(55)	15.85	9.14	(52)	(30)
7.32	16.76	(24)	(55)	16.15	8.53	(53)	(28)
7.62	16.76	(25)	(55)	16.46	7.92	(54)	(26)
7.92	16.46	(26)	(54)	16.76	7.32	(55)	(24)
8.23	16.46	(27)	(54)	17.07	6.71	(56)	(22)
8.53	16.15	(28)	(53)	17.37	5.79	(57)	(19)
8.84	16.15	(29)	(53)	17.68	4.57	(58)	(15)
9.14	15.85	(30)	(52)	17.98	3.35	(59)	(11)

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

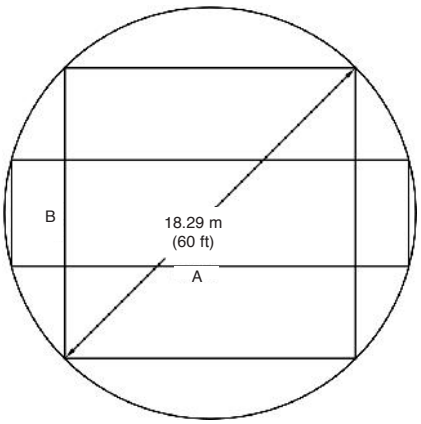


FIGURE 5-5
DIMENSIONS FOR 360° NOZZLE (EXTENDED AREA COVERAGE)
008629

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. 167.2 m^2 (1800 ft^2)

m		(ft)		m		(ft)	
A	B	A	B	A	B	A	B
11.28	14.63	(37)	(48)	21.03	7.92	(69)	(26)
11.58	14.33	(38)	(47)	21.34	7.62	(70)	(25)
11.89	13.72	(39)	(45)	21.64	7.62	(71)	(25)
12.19	13.72	(40)	(45)	21.95	7.62	(72)	(25)
12.50	13.11	(41)	(43)	22.25	7.32	(73)	(24)
12.80	12.80	(42)	(42)	22.56	7.32	(74)	(24)
13.11	12.50	(43)	(41)	22.86	7.32	(75)	(24)
13.41	12.19	(44)	(40)	23.16	7.01	(76)	(23)
13.72	12.19	(45)	(40)	23.47	7.01	(77)	(23)
14.02	11.89	(46)	(39)	23.77	7.01	(78)	(23)
14.33	11.58	(47)	(38)	24.08	6.71	(79)	(22)
14.63	11.28	(48)	(37)	24.38	6.71	(80)	(22)
14.94	10.97	(49)	(36)	24.69	6.71	(81)	(22)
15.24	10.97	(50)	(36)	24.99	6.40	(82)	(21)
15.54	10.67	(51)	(35)	25.30	6.40	(83)	(21)
15.85	10.36	(52)	(34)	25.60	6.40	(84)	(21)
16.15	10.06	(53)	(33)	25.91	6.40	(85)	(21)
16.46	10.06	(54)	(33)	26.21	6.10	(86)	(20)
16.76	9.75	(55)	(32)	26.52	6.10	(87)	(20)
17.07	9.75	(56)	(32)	26.82	6.10	(88)	(20)
17.37	9.45	(57)	(31)	27.13	6.10	(89)	(20)
17.68	9.45	(58)	(31)	27.43	6.10	(90)	(20)
17.98	9.14	(59)	(30)	27.74	5.79	(91)	(19)
18.29	9.14	(60)	(30)	28.04	5.18	(92)	(17)
18.59	8.84	(61)	(29)	28.35	4.88	(93)	(16)
18.90	8.84	(62)	(29)	28.65	4.27	(94)	(14)
19.20	8.53	(63)	(28)	28.96	3.96	(95)	(13)
19.51	8.53	(64)	(28)	29.26	3.35	(96)	(11)
19.81	8.23	(65)	(27)	29.26	3.05	(96)	(10)
20.12	8.23	(66)	(27)	29.57	2.44	(97)	(8)
20.42	7.92	(67)	(26)	29.57	1.83	(97)	(6)
20.73	7.92	(68)	(26)	29.87	1.22	(98)	(4)

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

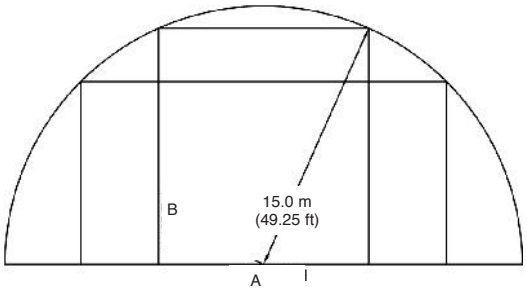


FIGURE 5-6
DIMENSIONS FOR 180° NOZZLE (EXTENDED AREA COVERAGE)
008630

SYSTEM LIMITATIONS (Continued)

Nozzle selection and location (continued)

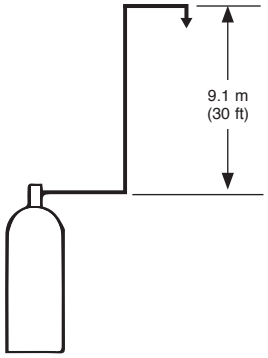


FIGURE 5-7
MAXIMUM ELEVATION BETWEEN NOZZLES AND CONTAINER OUTLET
009744

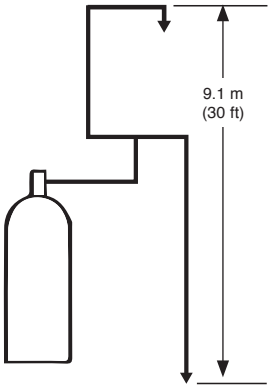


FIGURE 5-8
MAXIMUM ELEVATION BETWEEN HORIZONTAL PIPE RUNS AND NOZZLES
009745

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.
- When using factory built manifolds, locate the agent containers in a single row and space them according to the Inlet to Inlet Distance column in Table 6-3 (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 SAPPHIRE systems, a side tee and a bull tee. Both have limitations on the minimum and maximum allowable flow splits. See Figures 5-9 to 5-12.

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 35%. The bull tee splits shall be between 30% to 70%. All tee outlets must be in the same horizontal plane.

EXAMPLES: TEE SPLIT DESIGNS

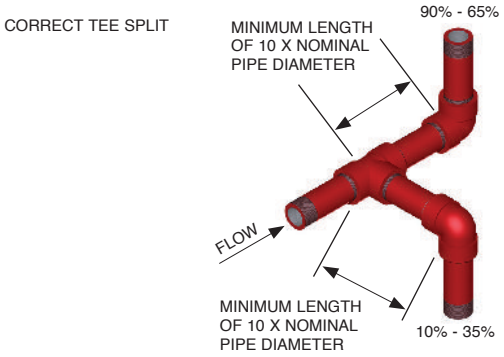


FIGURE 5-9
SIDE TEE SPLIT LIMITS
009746



FIGURE 5-10
INCORRECT SIDE TEE ORIENTATION
009747

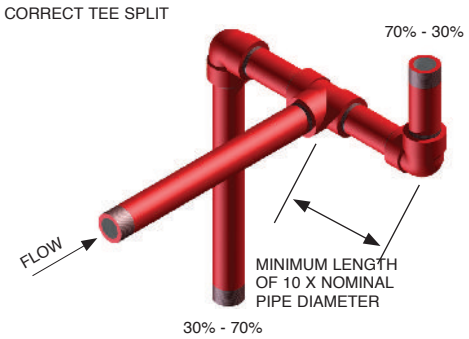


FIGURE 5-11
BULL TEE SPLIT LIMITS
009748



FIGURE 5-12
INCORRECT BULL TEE ORIENTATION
009749

SYSTEM LIMITATIONS (Continued)

SAPPHIRE system flow calculation program

The SAPPHIRE 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. SAPPHIRE software is currently under development in the SDC. A technical bulletin will be released on completion and certification by UL and FM. Until this time, continue to use the JENSEN HUGHES stand-alone software for SAPPHIRE hydraulic software calculations.

For further information on the flow calculation program, refer to the user guide or video tutorials within the Suppression Design Center.

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: 5.0 bar (73 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 35%) Through tee (90% to 65%)
- Bull tee split limit: 30% to 70%, 50% to 50%
- Minimum fill density: 0.5 kg/L (31.2 lb/ft^3)
- Maximum fill density: 1.2 kg/L (74.9 lb/ft^3)
- Discharge time: 6 s to 10 s
- Maximum number of nozzles per enclosure: 20
- Maximum number of subordinate containers per pilot or AUTOMAN II-C releasing device: 11
- Maximum number of subordinate containers per master or sub-master: 10 (total of 11 containers)
- 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)
- Minimum distance between major fittings (tees and elbows): 10 x internal pipe diameter
- 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 0.20 (20%) and a maximum of 0.80 (80%). For 15 mm nozzles, the minimum is 0.10 (10%).

TABLE 5-6: ESTIMATED SAPPHIRE 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)
15	(1/2)	40	15.8	(0.587)	0.45	(1)	1.36	(3)
20	(3/4)	40	20.9	(0.803)	0.91	(2)	2.50	(5.5)
25	(1)	40	26.6	(1.012)	1.59	(3.5)	3.86	(8.5)
32	(1 1/4)	40	35.1	(1.354)	2.72	(6)	5.67	(12.5)
40	(1 1/2)	40	40.9	(1.587)	4.08	(9)	9.07	(20)
50	(2)	40	52.5	(2.019)	6.35	(14)	13.61	(30)
65	(2 1/2)	40	62.7	(2.468)	9.07	(20)	24.95	(55)
80	(3)	40	77.9	(3.068)	13.61	(30)	44.82	(99)
100	(4)	40	102.3	(3.824)	24.95	(55)	56.70	(125)
125	(5)	40	128.2	(4.813)	40.82	(90)	90.72	(200)
150	(6)	40	154.1	(5.762)	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 SAPPHIRE system:

1. Determine the hazard volumes.
2. Calculate the reduced volume.
3. Determine the minimum design concentration.
4. Determine the minimum quantity of FK-5-1-12 agent 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 SAPPHIRE 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 5-13):

- 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**)

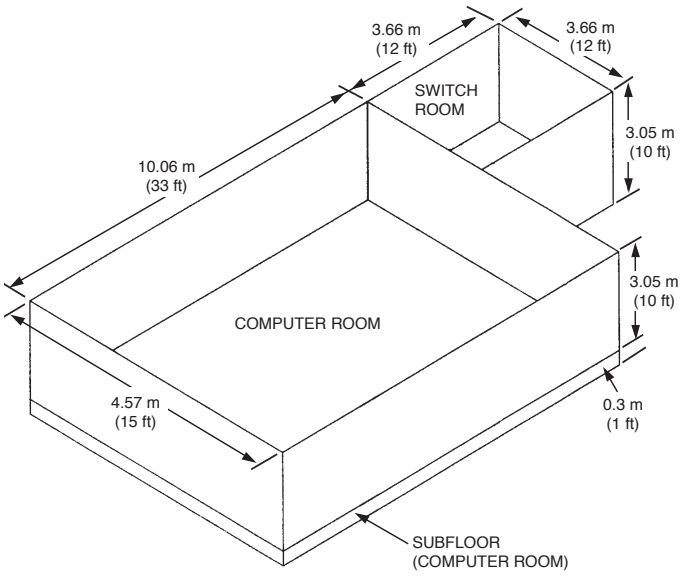


FIGURE 5-13
HAZARD AREA
007400

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

Fire class	UL and FM (NFPA 2001)	ISO 14520 and EN 15004
Class A	4.5%	5.3%
Class A higher hazard	Non applicable	5.6%
Class B	Refer to Johnson Controls Technical Services	
Class C	4.52% and 4.74%	Non applicable

For design concentrations for Class B flammable liquids, consult Johnson Controls Technical Services. The minimum design concentration for flammable liquids is 5.9% based on commercial grade heptane. Class A, B, and C hazards are UL Listed and FM Approved for SAPPHIRE 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 **4.5%** was selected.

SYSTEM DESIGN PROCEDURE (Continued)

Step 4: Determine the minimum quantity of FK-5-1-12 agent required

This step determines the minimum amount of FK-5-1-12 agent 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 = 0.0664 + 0.000274T m^3/kg

(where S = 0.9856 + 0.002441T 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 = 0.0664 + (0.000274 x 21 °C) = 0.07215 m^3/kg

- Computer room:
  4.5% required design concentration example only.

$$W = \frac{140.22\ m^3}{0.072154\ m^3/kg} \times \left(\frac{4.5\%}{100 - 4.5\%}\right) = 91.57\ kg$$

- Subfloor:
  4.5% required design concentration example only.

$$W = \frac{13.79\ m^3}{0.072154\ m^3/kg} \times \left(\frac{4.5\%}{100 - 4.5\%}\right) = 9.01\ kg$$

- Switch room:
  4.5% required design concentration example only.

$$W = \frac{40.86\ m^3}{0.072154\ m^3/kg} \times \left(\frac{4.5\%}{100 - 4.5\%}\right) = 26.68\ kg$$

English example using NFPA 2001 formula

S = 0.9856 + (0.002441 x 70 °F) = 1.15647 ft^3/lb

- Computer room:
  4.5% required design concentration example only.

$$W = \frac{4950\ ft^3}{1.15647\ ft^3/lb} \times \left(\frac{4.5\%}{100 - 4.5\%}\right) = 201.69\ lb$$

- Subfloor:
  4.5% required design concentration example only.

$$W = \frac{495\ ft^3}{1.15647\ ft^3/lb} \times \left(\frac{4.5\%}{100 - 4.5\%}\right) = 20.17\ lb$$

- Switch room:
  4.5% required design concentration example only.

$$W = \frac{1440\ ft^3}{1.15647\ ft^3/lb} \times \left(\frac{4.5\%}{100 - 4.5\%}\right) = 58.67\ lb$$

The second option for calculating the required quantity of agent is to use the Flooding Factors Table 5-10 or 5-11, (pages 5-22 and 5-23) 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 = 21 °C (70 °F)

Minimum design concentration = 4.5%

Flooding factor = 0.6531 kg/m^3 (0.0407 lb/ft^3)

- Computer room

  140.22 m^3 x 0.6531 kg/m^3 = 91.58 kg of agent
  (4950 ft^3 x 0.0407 lb/ft^3 = 201.47 lb of agent)

- Subfloor

  13.79 m^3 x 0.6531 kg/m^3 = 9.01 kg of agent
  (495 ft^3 x 0.0407 lb/ft^3 = 20.15 lb of agent)

- Switch room

  40.86 m^3 x 0.6531 kg/m^3 = 26.69 kg of agent
  (1440 ft^3 x 0.0407 lb/ft^3 = 58.61 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 FK-5-1-12 agent 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 FK-5-1-12 agent quantities.

Example – continue using *NFPA 2001* formula values.

- Computer room

  91.58 kg of agent x 1.00 = 91.58 kg of agent
  (201.47 lb of agent x 1.00 = 201.47 lb of agent)

- Subfloor

  9.01 kg of agent x 1.00 = 9.01 kg of agent
  (20.15 lb of agent x 1.00 = 20.15 lb of agent)

- Switch room

  26.69 kg of agent x 1.00 = 26.69 kg of agent
  (58.61 lb of agent x 1.00 = 58.61 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 FK-5-1-12 agent that may be retained in part of the pipework, known as the **dead volume** (see Figure 5-14). 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 FK-5-1-12 agent at 20 °C (68 °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 5-14.

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 FK-5-1-12 agent, 1600 kg/m^3 (99.9 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 5-14 as an example.

Manifold dead volume length: 0.6 m (2 ft)

Internal diameter 85.3 mm (3.36 in.) converts to:
0.0853 m (0.28 ft)

Therefore, r= 0.0853 m / 2 = 0.426 m
(0.28 ft / 2 = 0.14 ft)

$\pi = 3.1416$

r = 0.426 m (0.14 ft)

L = 0.6 m (2 ft)

$V = 3.1416 \times (0.426^2) \times 0.6 = 3.1416 \times 0.018147 \times 0.6 = 0.342\ m^3$

$(V = 3.1416 \times (0.14^2) \times 2 = 3.1416 \times 0.0196 \times 2 = 0.1232\ ft^3)$

Dead volume quantity= 0.342 m^3 x 1600 kg/m^3 = 5.58 kg
(0.1232 ft^3 x 99.9 lb/ft^3= 12.31 lb)

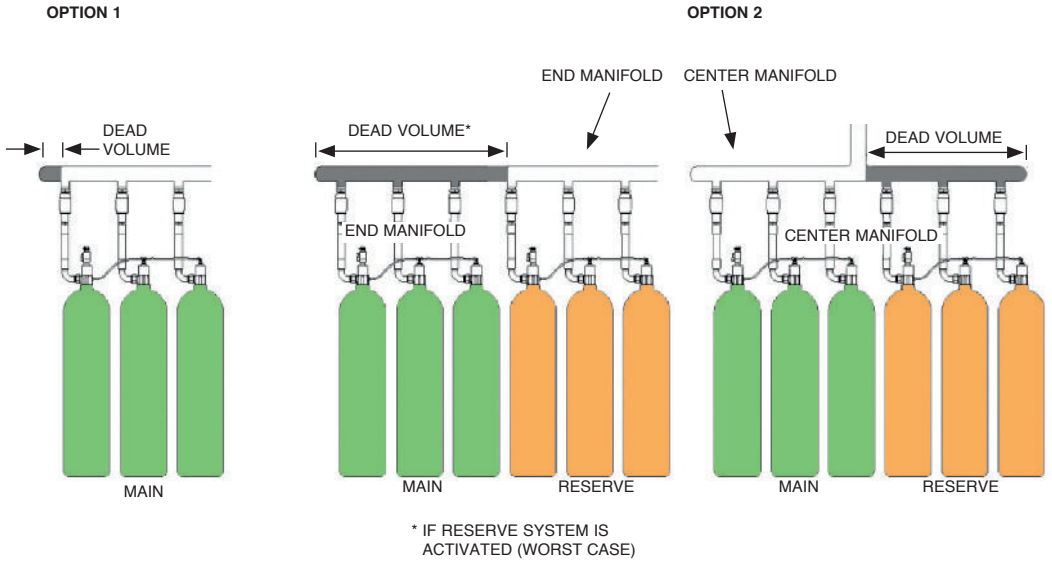
This quantity needs to be added to the design quantity when selecting the container size, but remains trapped in the pipe network at discharge. It is not added into the room concentration calculation.

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	0.66 (1.46)	1.02 (2.25)	1.78 (3.92)	4.03 (8.88)
Quantity for each reserve container manifold section	1.52 (3.35)	3.41 (7.52)	5.90 (13.01)	13.46 (29.67)



Note: Option 2 dead volume can be mitigated with the use of an appropriate manifold ball valve or shuttle valve.

FIGURE 5-14
DEAD VOLUME AREAS
E001768

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:

91.58 kg + 9.01 kg + 26.69 kg = 127.28 kg
rounded up to **127.5 kg** of agent

(201.47 lb + 20.15 lb + 58.61 lb = 280.23 lb
rounded up to **281 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 2-5, minimum and maximum fills (weight) columns.

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:

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

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

  91.58 kg + 26.69 kg = 118.27 kg rounded up to 118.5 kg
  (201.47 lb + 58.61 lb = 260.08 lb rounded up to 261 lb)

- Subfloor

  9.01 kg rounded up to 9.5 kg
  (20.15 lb rounded up to 21 lb)

Final quantity required after rounding up:

- Computer room = 118.5 kg x 0.7744 = **91.77 kg**
  (261 lb x 0.7746 = **202.17 lb**)
- Switch room = 118.5 kg x 0.2256 = **26.73 kg**
  (261 lb x 0.2254 = **58.83 lb**)
- Subfloor = 9.5 kg x 1.0 = **9.5 kg**
  (21 lb x 1.0 = **21 lb**)

It is estimated that a 120 L or 180 L (370 lb or 560 lb) container may be used for the computer room and switch room and a 15 L or 30 L (50 lb or 100 lb) container may be used for the Subfloor.

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

Confirm that the NOAEL and LOAEL concentrations and requirements of NFPA are not exceeded. See page 5-3.

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 = 0.0664 + 0.000274T m^3/kg

(where S = 0.9856 + 0.002441T 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 (continued)

Example:

• Computer room

$$C = \frac{100\ (91.77\ kg)}{\frac{140.22\ m^3}{0.073716\ m^3/kg} + 91.77\ kg}$$

C= 4.60 where s = 0.07372

$$\left(C = \frac{100\ (202.17\ lb)}{\frac{4950\ ft^3}{1.18088\ ft^3/lb} + 202.17\ lb} \right)$$

C = 4.60 where s = 1.18088

Design concentration at maximum temperature
= 4.6% (4.6%) ÷ 1.00 (altitude correction factor)
= 4.6% (4.6%)

• Switch room

$$C = \frac{100\ (26.73\ kg)}{\frac{40.86\ m^3}{0.073716\ m^3/kg} + 26.73\ kg}$$

C = 4.60 where s = 0.07372

$$\left(C = \frac{100\ (58.83\ lb)}{\frac{1440\ ft^3}{1.18088\ ft^3/lb} + 58.83\ lb} \right)$$

C = 4.60 where s = 1.18088

Design concentration at maximum temperature
= 4.6% (4.6%) ÷ 1.00 (altitude correction factor)
= 4.6% (4.6%)

• Subfloor

$$C = \frac{100\ (9.5\ kg)}{\frac{13.79\ m^3}{0.073716\ m^3/kg} + 9.5\ kg}$$

C = 4.83 where s = 0.07372

$$\left(C = \frac{100\ (21\ lb)}{\frac{495\ ft^3}{1.18088\ ft^3/lb} + 21\ lb} \right)$$

C = 4.77 where s = 1.18088

Design concentration at maximum temperature
= 4.83% (4.77%) ÷ 1.00 (altitude correction factor)
= 4.83% (4.77%)

When completing this step, adhere to the following point:

• Verify that the actual agent concentration is within the design concentration range of 4.5% to 10.0%. 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 4.6%. This is between 4.5% to 10.0%. 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.

Note: See Table 5-3: Nozzle Coverage Details (page 5-6) to confirm that the minimum and maximum operating temperatures are maintained in the protected area.

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 96 m^2 (1033 ft^2) for standard area coverage and 167.2 m^2 (1800 ft^2) for extended area coverage 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 ÷ 167.2 m^2 = **1 nozzle**
  (33 ft x 15 ft = 495 ft^2)
  (495 ft^2 ÷ 1800 ft^2 = **1 nozzle**)

- Switch room
  3.66 m x 3.66 m = 13.40 m^2
  13.40 m^2 ÷ 167.2 m^2 = **1 nozzle**
  (12 ft x 12 ft = 144 ft^2)
  (144 ft^2 ÷ 1800 ft^2 = **1 nozzle**)

- Subfloor
  10.06 m x 4.97 m = 45.97 m^2
  45.97 m^2 ÷ 167.2 m^2 = **1 nozzle**
  (33 ft x 15 ft = 495 ft^2)
  (495 ft^2 ÷ 1800 ft^2 = **1 nozzle**)

Ensure that the radial coverage for the nozzle is within the distance defined in Figure 5-4, page 5-5. 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
  91.77 kg ÷ 10 seconds = 9.18 kg/s
  (202.17 lb ÷ 10 seconds = 20.22 lb/s)
- Switch room
  26.73 kg ÷ 10 seconds = 2.67 kg/s
  (58.83 lb ÷ 10 seconds = 5.88 lb/s)
- Subfloor
  9.5 kg ÷ 10 seconds = 0.95 kg/s
  (21 lb ÷ 10 seconds = 2.1 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 each area (Step 11) 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 eacg area (Step 11) 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
  9.18 kg/s ÷ 1 nozzle = 9.18 kg/s per nozzle
  (20.22 lb/s ÷ 1 nozzle = 20.22 lb/s per nozzle)
- Switch room
  2.67 kg/s ÷ 1 nozzle = 2.67 kg/s per nozzle
  (5.88 lb/s ÷ 1 nozzle = 5.88 lb/s per nozzle)
- Subfloor
  0.95 kg/s ÷ 1 nozzle = 0.95 kg/s per nozzle
  (2.1 lb/s ÷ 1 nozzle = 2.1 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 SAPPHIRE 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

  9.18 kg/s per nozzle = 50 mm pipe
  (20.22 lb/s per nozzle = 2 in. pipe)

- Switch room

  2.67 kg/s per nozzle = 25 mm pipe
  (5.88 lb/s per nozzle = 1 in. pipe)

- Subfloor

  0.95 kg/s per nozzle = 15 mm pipe
  (2.1 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 SAPPHIRE 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 SAPPHIRE *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 details of the system should be organized and confirmed including:

- Hazard volume
- Hazard leakage verified
- Vent requirements
- Design concentration
- Quantity of FK-5-1-12 agent
- Number of containers and the container location
- Actuation type
- Nozzle quantity and location
- Sketch of the piping layout
- Flow calculations verified

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 a SAPPHIRE 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 FK-5-1-12 agent in accordance with *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: According to *NFPA 2001,* on systems between – 914 m and +914 m (– 3,000 ft and + 3,000 ft), use of the altitude correction factor is optional.

SYSTEM DESIGN TABLES (Continued)

TABLE 5-10: FK-5-1-12 AGENT FLOODING FACTORS (kg FLUID / m^3 ENCLOSURE VOLUME) – METRIC

Temp. (2)	Specific vapor vol. (3)	Weight requirements of hazard volume, W/v (kg/m^3) (1) Minimum design concentration (% by volume) (4)												
(°C)	(m^3/kg)	4.0	4.5	4.7	5.0	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0
-20	0.0609	0.6840	0.7736	0.8096	0.8640	0.9005	0.9188	0.9371	0.9555	0.9739	0.9923	1.0108	1.0293	1.0479
-15	0.0623	0.6688	0.7563	0.7916	0.8448	0.8805	0.8983	0.9163	0.9342	0.9522	0.9702	0.9883	1.0064	1.0246
-10	0.0637	0.6545	0.7402	0.7747	0.8268	0.8617	0.8792	0.8967	0.9143	0.9319	0.9495	0.9672	0.9850	1.0027
-5	0.0650	0.6407	0.7246	0.7584	0.8094	0.8435	0.8606	0.8778	0.8950	0.9122	0.9295	0.9468	0.9642	0.9816
0	0.0664	0.6275	0.7096	0.7427	0.7926	0.8261	0.8429	0.8597	0.8765	0.8934	0.9103	0.9273	0.9443	0.9613
5	0.0678	0.6148	0.6953	0.7277	0.7766	0.8094	0.8258	0.8423	0.8588	0.8753	0.8919	0.9085	0.9252	0.9418
10	0.0691	0.6026	0.6815	0.7133	0.7612	0.7933	0.8094	0.8256	0.8417	0.8580	0.8742	0.8905	0.9068	0.9232
15	0.0705	0.5909	0.6682	0.6994	0.7464	0.7779	0.7937	0.8095	0.8254	0.8413	0.8572	0.8732	0.8892	0.9052
20	0.0719	0.5796	0.6555	0.6861	0.7322	0.7630	0.7785	0.7941	0.8096	0.8252	0.8409	0.8565	0.8722	0.8879
25	0.0733	0.5688	0.6432	0.6732	0.7184	0.7488	0.7640	0.7792	0.7945	0.8098	0.8251	0.8405	0.8559	0.8713
30	0.0746	0.5583	0.6314	0.6608	0.7052	0.7350	0.7499	0.7649	0.7799	0.7949	0.8099	0.8250	0.8401	0.8553
35	0.0760	0.5482	0.6200	0.6489	0.6925	0.7217	0.7364	0.7511	0.7658	0.7805	0.7953	0.8101	0.8250	0.8399
40	0.0774	0.5385	0.6090	0.6374	0.6802	0.7089	0.7233	0.7378	0.7522	0.7667	0.7812	0.7958	0.8104	0.8250
45	0.0787	0.5291	0.5984	0.6263	0.6684	0.6966	0.7107	0.7249	0.7391	0.7534	0.7676	0.7819	0.7962	0.8106
50	0.0801	0.5201	0.5882	0.6156	0.6570	0.6847	0.6986	0.7125	0.7265	0.7405	0.7545	0.7685	0.7826	0.7967
55	0.0815	0.5113	0.5783	0.6052	0.6459	0.6731	0.6868	0.7005	0.7142	0.7280	0.7418	0.7556	0.7694	0.7833
60	0.0829	0.5029	0.5687	0.5952	0.6352	0.6620	0.6754	0.6889	0.7024	0.7159	0.7295	0.7431	0.7567	0.7704
65	0.0842	0.4947	0.5594	0.5855	0.6249	0.6512	0.6644	0.6777	0.6910	0.7043	0.7176	0.7310	0.7444	0.7578

TABLE 5-10 (Continued)

(°C)	(m^3/kg)	6.5	7.00	8.0	9.0	10.0
-20	0.0609	1.1413	1.2357	1.4275	1.6236	1.8241
-15	0.0623	1.1159	1.2082	1.3958	1.5875	1.7835
-10	0.0637	1.0921	1.1824	1.3660	1.5537	1.7455
-5	0.0650	1.0690	1.1575	1.3372	1.5209	1.7087
0	0.0664	1.0470	1.1336	1.3096	1.4895	1.6734
5	0.0678	1.0258	1.1106	1.2831	1.4593	1.6395
10	0.0691	1.0054	1.0886	1.2576	1.4304	1.6070
15	0.0705	0.9859	1.0674	1.2332	1.4026	1.5757
20	0.0719	0.9671	1.0471	1.2096	1.3758	1.5457
25	0.0733	0.9490	1.0275	1.1870	1.3500	1.5167
30	0.0746	0.9315	1.0086	1.1652	1.3252	1.4888
35	0.0760	0.9147	0.9904	1.1442	1.3013	1.4620
40	0.0774	0.8985	0.9728	1.1239	1.2783	1.4361
45	0.0787	0.8829	0.9559	1.1043	1.2560	1.4111
50	0.0801	0.8677	0.9395	1.0854	1.2345	1.3869
55	0.0815	0.8531	0.9237	1.0671	1.2137	1.3636
60	0.0829	0.8390	0.9084	1.0495	1.1936	1.3410
65	0.0842	0.8253	0.8936	1.0324	1.1742	1.3191

NOTES:

The flooding factors listed in Table 5-10 are based on the following calculations:

1. W/V (Agent Weight Requirements [kg/m^3]) = kilograms of agent required per cubic meter of protected volume to produce the indicated concentration at the temperature specified.

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

2. T (Temperature [°C]) – The design temperature in the hazard area.
3. S (specific vapor volume [m^3/kg]) of superheated FK-5-1-12 agent vapor can be approximated by the formula:
   $S = 0.0664 + 0.000274T$
   where T is the temperature in °C
4. C (Concentration [%]) – Volumetric concentration of FK-5-1-12 agent in air at the design temperature indicated.

SYSTEM DESIGN TABLES (Continued)

TABLE 5-11: FK-5-1-12 AGENT FLOODING FACTORS (lb FLUID / ft^3 ENCLOSURE VOLUME) – IMPERIAL

Temp. (2)	Specific vapor vol. (3)	Weight requirements of hazard volume, W/V (lb/ft^3) (1) Minimum design concentration (% by volume) (4)												
(°F)	(ft^3/lb)	4.0	4.5	4.7	5.0	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0
-20	0.9368	0.0445	0.0503	0.0526	0.0562	0.0586	0.0597	0.0609	0.0621	0.0633	0.0645	0.0657	0.0669	0.0681
-10	0.9612	0.0433	0.0490	0.0513	0.0548	0.0571	0.0582	0.0594	0.0606	0.0617	0.0629	0.0641	0.0652	0.0664
0	0.9856	0.0423	0.0478	0.0500	0.0534	0.0557	0.0568	0.0579	0.0591	0.0602	0.0613	0.0625	0.0636	0.0648
10	1.0100	0.0413	0.0467	0.0488	0.0521	0.0543	0.0554	0.0565	0.0576	0.0587	0.0598	0.0610	0.0621	0.0632
20	1.0344	0.0403	0.0456	0.0477	0.0509	0.0530	0.0541	0.0552	0.0563	0.0573	0.0584	0.0595	0.0606	0.0617
30	1.0588	0.0394	0.0445	0.0466	0.0497	0.0518	0.0529	0.0539	0.0550	0.0560	0.0571	0.0582	0.0592	0.0603
40	1.0832	0.0385	0.0435	0.0455	0.0486	0.0506	0.0517	0.0527	0.0537	0.0548	0.0558	0.0568	0.0579	0.0589
50	1.1077	0.0376	0.0425	0.0445	0.0475	0.0495	0.0505	0.0515	0.0525	0.0536	0.0546	0.0556	0.0566	0.0576
60	1.1321	0.0368	0.0416	0.0436	0.0465	0.0485	0.0494	0.0504	0.0514	0.0524	0.0534	0.0544	0.0554	0.0564
70	1.1565	0.0360	0.0407	0.0426	0.0455	0.0474	0.0484	0.0494	0.0503	0.0513	0.0523	0.0532	0.0542	0.0552
80	1.1809	0.0353	0.0399	0.0418	0.0446	0.0465	0.0474	0.0483	0.0493	0.0502	0.0512	0.0521	0.0531	0.0541
90	1.2053	0.0346	0.0391	0.0409	0.0437	0.0455	0.0464	0.0474	0.0483	0.0492	0.0502	0.0511	0.0520	0.0530
100	1.2297	0.0339	0.0383	0.0401	0.0428	0.0446	0.0455	0.0464	0.0473	0.0482	0.0492	0.0501	0.0510	0.0519
110	1.2541	0.0332	0.0376	0.0393	0.0420	0.0437	0.0446	0.0455	0.0464	0.0473	0.0482	0.0491	0.0500	0.0509
120	1.2785	0.0326	0.0369	0.0386	0.0412	0.0429	0.0438	0.0446	0.0455	0.0464	0.0473	0.0482	0.0490	0.0499
130	1.3029	0.0320	0.0362	0.0379	0.0404	0.0421	0.0430	0.0438	0.0447	0.0455	0.0464	0.0473	0.0481	0.0490
140	1.3273	0.0314	0.0355	0.0372	0.0397	0.0413	0.0422	0.0430	0.0438	0.0447	0.0455	0.0464	0.0472	0.0481
150	1.3518	0.0308	0.0349	0.0365	0.0389	0.0406	0.0414	0.0422	0.0431	0.0439	0.0447	0.0455	0.0464	0.0472

TABLE 5-11 (Continued)

(°F)	(ft^3/lb)	6.5	7.00	8.0	9.0	10.0
-20	0.9368	0.0742	0.0803	0.0928	0.1056	0.1186
-10	0.9612	0.0723	0.0783	0.0905	0.1029	0.1156
0	0.9856	0.0705	0.0764	0.0882	0.1003	0.1127
10	1.0100	0.0688	0.0745	0.0861	0.0979	0.1100
20	1.0344	0.0672	0.0728	0.0841	0.0956	0.1074
30	1.0588	0.0657	0.0711	0.0821	0.0934	0.1049
40	1.0832	0.0642	0.0695	0.0803	0.0913	0.1026
50	1.1077	0.0628	0.0680	0.0785	0.0893	0.1003
60	1.1321	0.0614	0.0665	0.0768	0.0874	0.0981
70	1.1565	0.0601	0.0651	0.0752	0.0855	0.0961
80	1.1809	0.0589	0.0637	0.0736	0.0838	0.0941
90	1.2053	0.0577	0.0624	0.0721	0.0821	0.0922
100	1.2297	0.0565	0.0612	0.0707	0.0804	0.0904
110	1.2541	0.0554	0.0600	0.0693	0.0789	0.0886
120	1.2785	0.0544	0.0589	0.0680	0.0774	0.0869
130	1.3029	0.0534	0.0578	0.0667	0.0759	0.0853
140	1.3273	0.0524	0.0567	0.0655	0.0745	0.0837
150	1.3518	0.0514	0.0557	0.0643	0.0732	0.0822

NOTES:

The flooding factors listed in Table 5-11 are based on the following calculations:

1. W/V (Agent Weight Requirements [lb/ft^3]) = pounds of agent required per cubic feet of protected volume to produce indicated concentration at temperature specified.

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

2. T (Temperature [°F]) – The design temperature in the hazard area.
3. S (specific vapor volume [ft^3/lb]) of superheated FK-5-1-12 agent vapor can be approximated by the formula:
   $S = 0.9856 + 0.002441T$
   where T is the temperature in °F
4. C (Concentration [%]) – Volumetric concentration of FK-5-1-12 agent in air at the design temperature indicated.

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 on 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 (35.1)
	445977 / 450074	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)	2.70 (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 (43.14)
Flexible 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 (52.0)
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 (1.80)
	309.002.015 (69471)	80 (3) flared to grooved	0.55 (1.80)
	309.002.013 (570363)	80 (3) flared to BSP	0.55 (1.80)

Note: 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)	3.90 (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:_____

SAPPHIRE SYSTEM
DESIGN CALCULATION WORKSHEET

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 TEMP.:					
DESIGN CONCENTRATION:					
FLOODING FACTOR:					
(From Table)					
INITIAL AGENT QUANTITY CALC.:					
Quantity (lb)					

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

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

ACTUAL AGENT QUANTITY (lb):					
(Initial Agent Quantity x Altitude Correction Factor)					

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

SAPPHIRE SYSTEM
DESIGN CALCULATION WORKSHEET

SAPPHIRE SYSTEM DESIGN CALCULATION WORKSHEET (Continued)

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 Qty ÷ Total Agent Qty.) x Agent Supplied]

ACTUAL AGENT FLOODING FACTOR:					

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

CONCENTRATION RANGE CHECK:

(Design concentration must be between 6.7% to 10.5% for occupied spaces)

Room Maximum Ambient Temperature:					
Design Concentration at Max. Temperature:					

(Locate Actual Agent Conc. at Maximum Temperature on Table, or use the Calculation in the Design Manual)

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

(Locate Actual Agent Conc. at Ambient Temperature on Table, or use the Calculation in the Design Manual)

Nozzle Quantity:					

[Area ÷ 1026 (rounded to the next highest whole number) then verify the 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 SAPPHIRE *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

SAPPHIRE container assemblies should be positioned indoors either within or outside of the protected enclosure. The containers should not be positioned in direct sunlight.

The SAPPHIRE 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 use the Temperature Correction tables in Section 8 - Recharging Procedure, 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 SAPPHIRE CONTAINER VALVES

The discharge valve is supplied factory-fitted to the container. Before connecting to the pipework or discharge hose, ensure that the container is secured with the appropriate container brackets.

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 6-10.
8. Reconnect the pipe to the container after completing the pipework system and the discharge nozzles are installed.

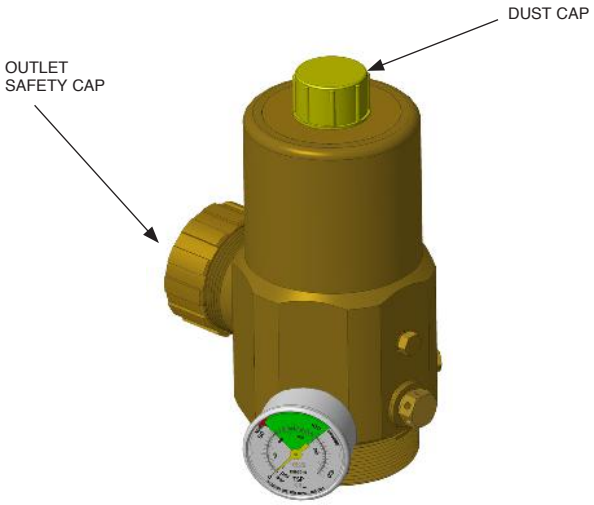


FIGURE 6-1
OUTLET SAFETY AND DUST CAPS
E001776

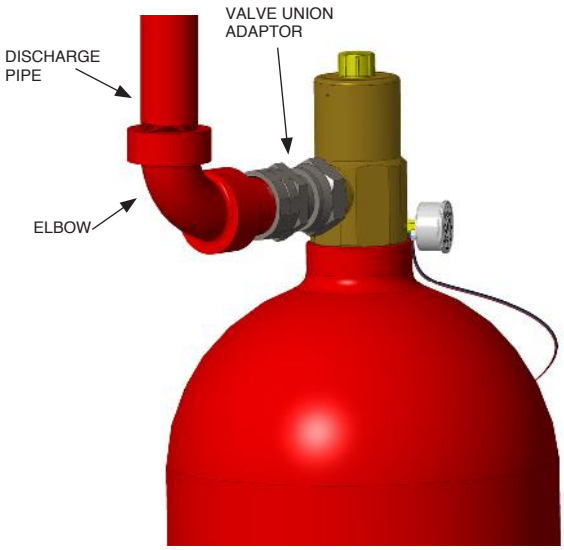


FIGURE 6-2
DISCHARGE OUTLET CONNECTIONS
E001777

INSTALLING A SINGLE CONTAINER (Continued)

TABLE 6-2: BRACKET MOUNTING HEIGHTS

Container size L	Diameter mm (in.)	Number of back channels	Height from floor to bracket (A) mm (in.)	Height from floor to bracket (B) mm (in.)
Seamless containers				
15	204 (8)	2	130 (5 1/8)	450 (17 3/4)
30	229 (9)	2	300 (11 3/4)	710 (28)
45	267 (10 1/2)	2	300 (11 3/4)	820 (32 1/4)
60	267 (10 1/2)	2	300 (11 3/4)	1130 (44 1/2)
120	360 (14 1/4)	2	300 (11 3/4)	1190 (46 7/8)
150	360 (14 1/4)	2	300 (11 3/4)	1530 (60 1/4)
180	406 (16)	2	300 (11 3/4)	1370 (53 7/8)
Welded containers				
4.5	178 (7)	1	–	170 (6 3/4)
8	254 (10)	1	100 (3 7/8)	–
16	254 (10)	2	150 (6)	320 (12 5/8)
32	254 (10)	2	170 (6 3/4)	620 (24 3/8)
52	406 (16)	2	190 (7 1/2)	380 (15)
106	406 (16)	2	260 (10 1/4)	740 (29 1/8)
147	406 (16)	2	260 (10 1/4)	1070 (42 1/8)
180	406 (16)	2	260 (10 1/4)	1350 (53 1/8)
343	610 (24)	2	310 (12 1/4)	1100 (43 1/4)

Note: The containers listed in this table require two sets of brackets where the height (B) of the upper bracket is positioned a nominal 90 mm (3 1/2 in.) below the start of the curved shoulder of the container. The 4.5 L and 8 L containers only require one set of brackets and are to be installed at the height indicated in the table.

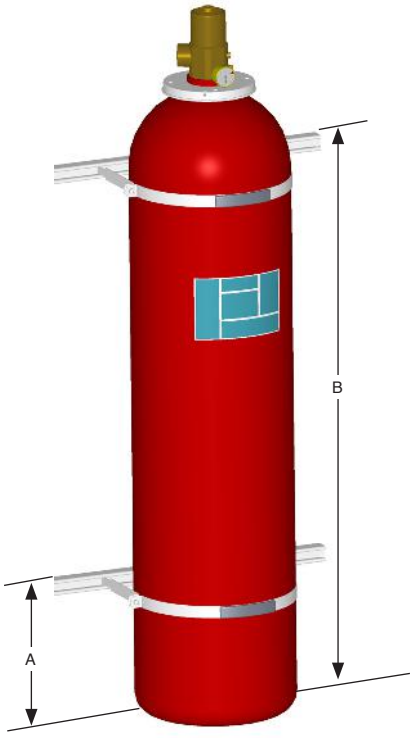


FIGURE 6-3
CONTAINER STRAP LOCATION
E001773

INSTALLING MANIFOLDS

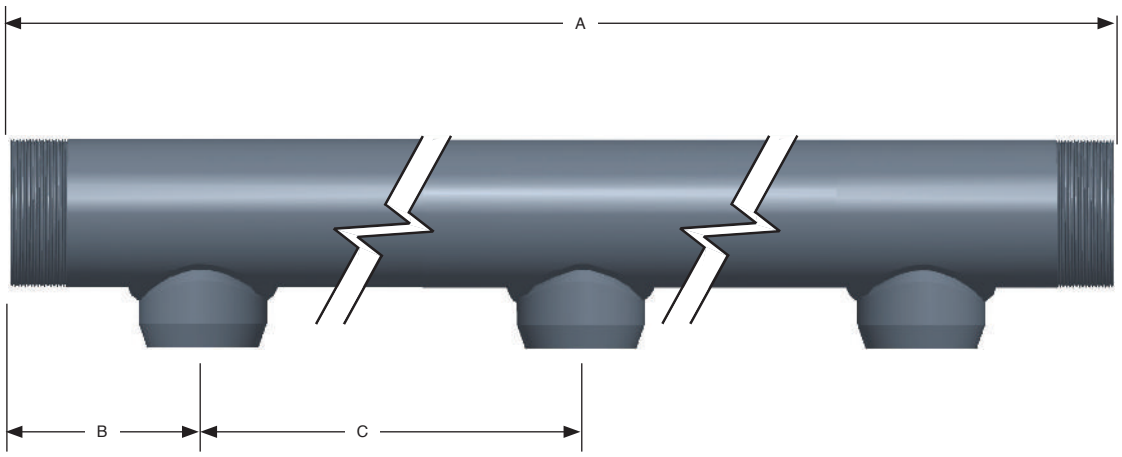
NOTICE

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.



Note: See the following table for dimensions A, B, and C.

FIGURE 6-4
THREADED MANIFOLD ASSEMBLY
009712

INSTALLING MANIFOLDS (Continued)

TABLE 6-3: 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 (C) mm (in.)	Inlet to end connection distance (B) mm (in.)	Container size L	Overall length (A) mm (in.)	Weight kg (lb)
307.209.001	2	2 1/2 in. NPT	65 (2 1/2)	145 (5 3/4)	350 (13 3/4)	145 (5 3/4)	15 to 45 and 4.5 to 32	640 (25 1/4)	8.06 (17 3/4)
307.209.002	3	2 1/2 in. NPT	65 (2 1/2)	145 (5 3/4)	350 (13 3/4)	145 (5 3/4)		990 (39)	12.44 (27 3/8)
307.209.003	4	2 1/2 in. NPT	65 (2 1/2)	145 (5 3/4)	350 (13 3/4)	145 (5 3/4)		1340 (52 3/4)	19.79 (43 5/8)
307700004	2	3 in. NPT	80 (3)	216 (8 1/2)	500 (20)	216 (8 1/2)	60 to 180 and 52 to 180	932 (36 3/4)	12.57 (27 3/4)
307700005	3	3 in. NPT	80 (3)	216 (8 1/2)	500 (20)	216 (8 1/2))		1432 (56 3/8)	19.20 (42 1/4)
307700006	4	3 in. NPT	80 (3)	216 (8 1/2)	500 (20)	216 (8 1/2)		1932 (76)	25.84 (57)
307700007	5	3 in. NPT	80 (3)	216 (8 1/2)	500 (20)	216 (8 1/2)		2432 (95 3/4)	32.47 (71 5/8)
307700008	6	3 in. NPT	80 (3)	216 (8 1/2)	500 (20)	216 (8 1/2)		2932 (115 3/8)	39.10 (86 1/4)
307700009	2	4 in. NPT	100 (4)	216 (8 1/2)	500 (20)	216 (8 1/2)	60 to 180 and 52 to 180	932 (36 3/4)	21.85 (48 1/4)
307700010	3	4 in. NPT	100 (4)	216 (8 1/2)	500 (20)	216 (8 1/2)		1432 (56 3/8)	33.55 (74)
307700011	4	4 in. NPT	100 (4)	216 (8 1/2)	500 (20)	216 (8 1/2)		1932 (76)	45.24 (99 3/4)
307700012	5	4 in. NPT	100 (4)	216 (8 1/2)	500 (20)	216 (8 1/2)		2432 (95 3/4)	56.93 (125 1/2)
307700013	6	4 in. NPT	100 (4)	216 (8 1/2)	500 (20)	216 (8 1/2)		2932 (115 3/8)	68.62 (151 1/4)
307209050	3	6 in. flange	150 (6)	200 (7 7/8)	500 (20)	200 (7 7/8)	52 to 180	1400 (55 1/8)	85.0 (187 3/8)
307209051	4	6 in. flange	150 (6)	200 (7 7/8)	500 (20)	200 (7 7/8)		1900 (74 3/4)	136.8 (301 5/8)
307209052	5	6 in. flange	150 (6)	200 (7 7/8)	500 (20)	200 (7 7/8)		2400 (94 1/2)	160.4 (353 5/8)
307209053	6	6 in. flange	150 (6)	200 (7 7/8)	500 (20)	200 (7 7/8)		2900 (114 1/4)	184.0 (405 3/4)
307209054	7	6 in. flange	150 (6)	200 (7 7/8)	500 (20)	200 (7 7/8)		3400 (133 7/8)	207.5 (457 1/2)
307209055	8	6 in. flange	150 (6)	200 (7 7/8)	500 (20)	200 (7 7/8)		3900 (153 1/2)	231.1 (509 1/2)
307209056	9	6 in. flange	150 (6)	200 (7 7/8)	500 (20)	200 (7 7/8)		4400 (173 1/4)	282.9 (623 3/4)
307209057	10	6 in. flange	150 (6)	200 (7 7/8)	500 (20)	200 (7 7/8)		4900 (192 7/8)	278.3 (613 1/2)
307.209.035	2	4 in. NPT	100 (4)	150 (6)	711 (28)	150 (6)	343	1011 (39 3/4)	26.9 (59 1/4)
307.209.036	3	4 in. NPT	100 (4)	150 (6)	711 (28)	150 (6)		1722 (67 3/4)	45.0 (99 1/4)
307.209.037	4	4 in. NPT	100 (4)	150 (6)	711 (28)	150 (6)		2433 (95 3/4)	63.1 (139 1/8)
307.209.041	2	6 in. flange	150 (6)	150 (6)	711 (28)	200 (7 7/8)		1111 (43 3/4)	66.2 (145 7/8)
307.209.042	3	6 in. flange	150 (6)	150 (6)	711 (28)	200 (7 7/8)		1822 (71 3/4)	98.9 (218)
307.209.043	4	6 in. flange	150 (6)	150 (6)	711 (28)	200 (7 7/8)		2533 (99 3/4)	159.0 (350 1/2)
307.209.044	5	6 in. flange	150 (6)	150 (6)	711 (28)	200 (7 7/8)		3244 (127 3/4)	191.7 (422 5/8)
307.209.045	6	6 in. flange	150 (6)	150 (6)	711 (28)	200 (7 7/8)		3955 (155 3/4)	224.4 (494 3/4)
307.209.046	7	6 in. flange	150 (6)	150 (6)	711 (28)	200 (7 7/8)		4666 (183 3/4)	256.2 (564 3/4)
307.209.047	8	6 in. flange	150 (6)	150 (6)	711 (28)	200 (7 7/8)		5377 (211 3/4)	288.9 (636 7/8)
307.209.048	9	6 in. flange	150 (6)	150 (6)	711 (28)	200 (7 7/8)		6088 (239 3/4)	349.8 (771 1/4)
307.209.049	10	6 in. flange	150 (6)	150 (6)	711 (28)	200 (7 7/8)		6799 (267 3/4)	353.5 (779 1/4)

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. Ensure that the containers are spaced appropriately for manifold port spacing.
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 6-4.
2. Locate and secure the cantilever brackets to each channel using an M10 x 40 mm (3/8 UNC x 1 1/2 in.) hex head screw and a 10 mm (3/8 in.) long spring. 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 the 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.

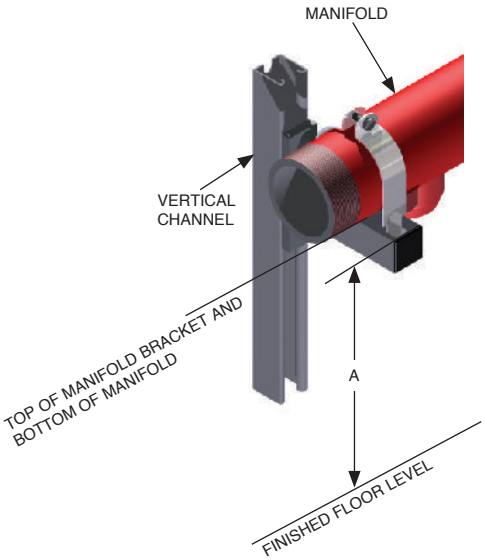


FIGURE 6-5
MANIFOLD ASSEMBLY
009714

When installing manifold brackets with an adjustable height adaptor (AHA), see the following table for mounting heights.

Installation heights with and without the AHA include the required height for the flexible discharge hose and check valve.

TABLE 6-4: 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 1/4)	1308 (51 1/2)
TPED	30	1466 (57 3/4)	1623 (63 7/8)
TPED	45	1566 (61 3/4)	1723 (67 3/4)
TPED	60	2008 (79 1/8)	2180 (85 3/4)
TPED	120	2123 (83 5/8)	2295 (90 3/8)
TPED	150	2473 (97 3/8)	2645 (104 1/8)
TPED	180	2323 (91 1/2)	2495 (98 1/4)
DOT/TPED	15	1151 (45 1/4)	1308 (51 1/2)
DOT/TPED	30	1466 (57 3/4)	1623 (63 7/8)
DOT/TPED	45	1566 (61 3/4)	1723 (67 3/4)
DOT/TPED	60	2008 (79 1/8)	2180 (85 3/4)
DOT/TPED	120	2123 (83 5/8)	2295 (90 3/8)
DOT/TPED	150	2473 (97 3/8)	2645 (104 1/8)
DOT/TPED	180	2323 (91 1/2)	2495 (98 1/4)
Welded containers			
DOT	4.5	727 (28 5/8)	884 (34 3/4)
DOT	8	750 (29 1/2)	907 (35 3/4)
DOT	16	949 (37 3/8)	1106 (43 1/2)
DOT	32	1289 (50 3/4)	1446 (56 7/8)
DOT	52	1133 (44 5/8)	1305 (51 3/8)
DOT	106	1601 (63)	1773 (69 3/4)
DOT	147	1931 (76)	2103 (82 3/4)
DOT	180	2210 (87)	2382 (93 3/4)
DOT	343	2274 (89 1/2)	–

Note: For some markets (Europe, Middle East, Africa, and Asia), manifold bracket assemblies are available. Refer to the local price list for availability.

CONNECTING THE DISCHARGE HOSE FROM THE VALVE TO THE MANIFOLD

1. Remove the container valve outlet safety cap.
2. Attach the discharge hose between the valve outlet and the adjustable height adaptor or manifold check valve.
3. Where the adjustable height adaptor is utilized and to allow for a variation in the container height, adjust each adjustable height adaptor.

CONNECTING HARD PIPE FROM THE VALVE TO THE MANIFOLD

1. Remove the container valve outlet safety cap.
2. For the 25 mm (1 in.) and 50 mm (2 in.) valve, install hard pipe sections between the valve outlet through the valve union adaptor and a 90° elbow, and from the 90° elbow to the adjustable height adaptor, if utilized, or manifold check valve.
3. For the 80 mm (3 in.) valve, install hard pipe sections between the valve outlet through the flared adaptor and a 90° elbow, and from the 90° elbow to the adjustable height adaptor, if utilized, or manifold check valve.
4. Ensure that the vertical height alignment with the valve outlet is correct.

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 the check valve. This enables a radial adjustment to achieve the correct alignment with the valve outlet.
- Where the adjustable height adaptor **is** utilized, fix each adjustable height adaptor to allow a variation in the container height. See the approximate pipe stretch length from Table 6-5.
- See Figure 6-6 and 6-7 for 1 in. and 2 in. manifold check valve installations, hard pipe options with or without the AHA.

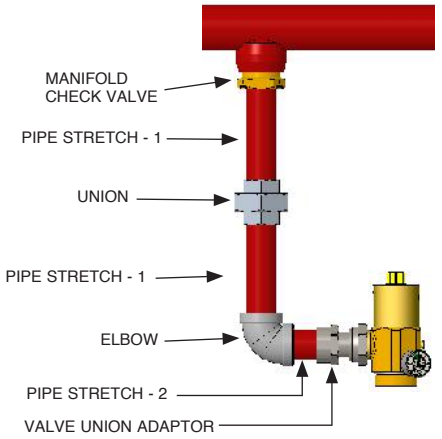


FIGURE 6-6
1 in. OR 2 in. DISCHARGE OUTLET CONNECTION – HARD PIPE OPTION WITHOUT AN AHA
E001518

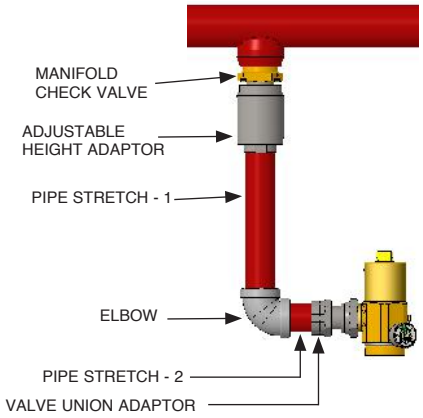


FIGURE 6-7
1 in. OR 2 in. DISCHARGE OUTLET CONNECTION – HARD PIPE OPTION WITH AN AHA
E0015189

TABLE 6-5: PIPE STRETCH LENGTH DETAILS FOR INSTALLATION AND DESIGN CALCULATION

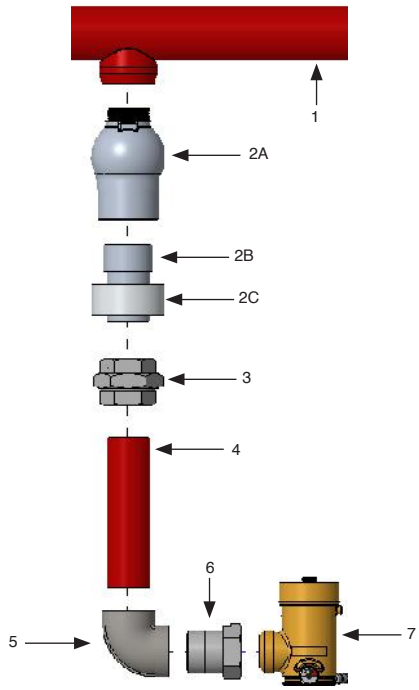
Pipe lengths allow for the manifold height and container placement to match the flexible discharge hose length for:

25 mm (1 in.)
405 mm (16 in.) and 50 mm (2 in.)
520 mm (20 1/2 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)	Qty. 2 at 178.6 (7)	76.2 (3)	433.3 (17 1/8)
	50 (2)	Qty. 2 at 216.1 (8 1/2)	82.6 (3 1/4)	514.7 (20 1/4)
1 in. or 2 in. hard pipe option **with** adjustable height adaptor (AHA)	25 (1)	246.3 (9 3/4)	76.2 (3)	322.5 (12 3/4)
	50 (2)	326.9 (12 7/8)	82.6 (3 1/4)	409.5 (16 1/8)
3 in. hard pipe option with manifold check valve	80 (3)	318 (12 1/2)	n/a	318 (12 1/2)

Note: The pipe stretch length includes threads at both ends.

CONNECTING THE HARD PIPE ASSEMBLY USING A 3 in. THREADED ADAPTOR AND A 3 in. UNION ADAPTOR



Item	Description
1	Manifold assembly
2A	3 in. check valve assembly
2B	3 in. check valve – 3 in. NPT adaptor
2C	3 in. check valve – swivel nut
3	3 in. NPT threaded union
4	Pipe stretch – 1 Threaded on both ends Nominal length 318 mm (12 1/2 in.)
5	3 in. threaded elbow
6	3 in. flared adaptor
7	3 in. discharge valve

FIGURE 6-8
HARD PIPE ASSEMBLY USING A 3 in. THREADED ADAPTOR AND A 3 in. UNION ADAPTOR
E002147

1. Install the 3 in. check valve (2a) into the manifold (1).

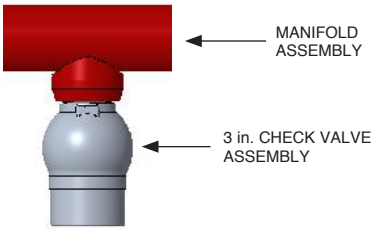


FIGURE 6-9
E002148

2. Install the 3 in. NPT threaded adaptor (2b) with swivel nut (2c) to the 3 in. union head (3) and tighten securely.

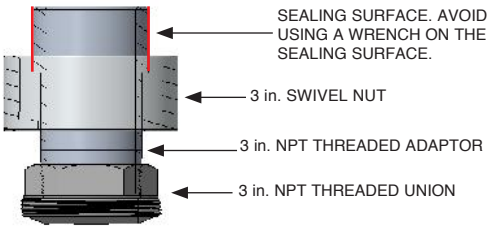


FIGURE 6-10
E002149

3. Install the 3 in. pipe stretch-1 (4) to the 3 in. union tail (3) and tighten securely.

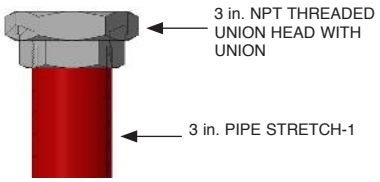


FIGURE 6-11
E002150

4. Install the 3 in. 90° threaded elbow (5) to the valve flared adaptor end NPT (6) and tighten securely.

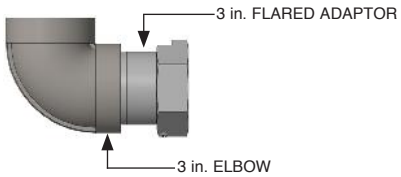


FIGURE 6-12
E002151

CONNECTING THE HARD PIPE ASSEMBLY USING A 3 in. THREADED ADAPTOR AND A 3 in. UNION ADAPTOR (Continued)

5. Install the 3 in. pipe stretch and union tail assembly to the open end of the 3 in. 90° elbow and tighten securely.

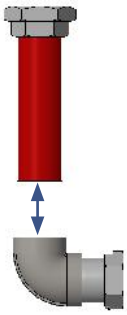


FIGURE 6-13
E002152

6. Remove the outlet safety cap from the valve outlet and install the valve flared adaptor (6) end to the valve outlet (7) and tighten securely.

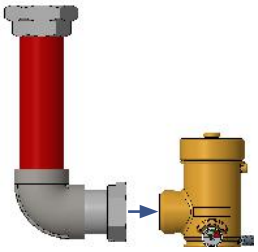


FIGURE 6-14
E002153

⚠ CAUTION

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

7. Verify that the o-ring is inside the check valve body (2a). Slide the 3 in. threaded adaptor (2b) into the check valve body at the o-ring end to full depth. Hand-tighten the swivel nut (2c) to the check valve body. Do not tighten the grub screw in the swivel nut at this step.

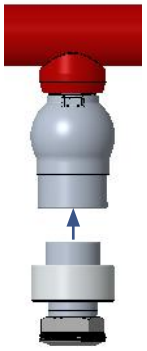


FIGURE 6-15
E002154

8. To ensure vertical alignment, align the ends of the 3 in. threaded adaptor with union head and the 3 in. pipe stretch – 1 with union tail by moving the container manually.

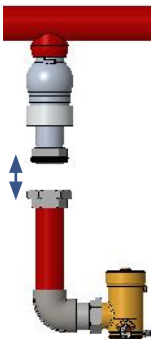


FIGURE 6-16
E002155

9. When you achieve vertical alignment, loosen the swivel nut (2c) to slide down the threaded adaptor and then securely tighten the threaded union.



FIGURE 6-17
E002156

10.a Tighten the swivel nut (2c) over the check valve body. Using a grub screw, lock the swivel nut.

b. For adequate thread engagement, ensure a minimum of eight full rotations of the swivel nut on the check valve body (minimum 17.1 mm [0.67 in.] thread engagement length).

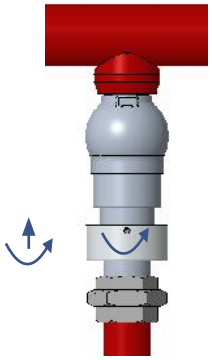


FIGURE 6-18
E002157

⚠ CAUTION

For safety, remove the discharge hose and replace the outlet safety caps while installing the pipe network.

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* - current edition 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 conditions state the maximum developed pressure in a system based on maximum temperature and fill density. These values can be used to select pipe type, size, and schedule based on the pressure ratings of the pipe listed in Tables 6-6 and 6-7. The information in these tables is based on the pipe requirements in the *FIA Guidance – Pipe Work for Gaseous Fixed Fire Fighting Systems*. When designing systems in accordance with NFPA and FSSA pipe requirements, follow the acceptable reductions of the maximum developed pressure before selecting the appropriate size and schedule.

- A maximum system temperature of 54 ºC (130 ºF) at a fill density of 1.20 kg/L (74.9 lb/ft^3) results in a maximum system pressure of 29.1 bar (418.4 psi).

TABLE 6-6: 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	(1,697)	150	(2,176)	285	(4,134)	208	(3,017)	241	(3,495)	376	(5,453)
20 (3/4)	101	(1,465)	128	(1,856)	236	(3,423)	182	(2,640)	209	(3,031)	317	(4,598)
25 (1)	89	(1,291)	111	(1,610)	221	(3,205)	160	(2,321)	182	(2,640)	292	(4,235)
32 (1 1/4)	81	(1,175)	98	(1,421)	185	(2,683)	147	(2,132)	165	(2,393)	252	(3,655)
40 (1 1/2)	75	(1,088)	90	(1,305)	166	(2,408)	138	(2,002)	153	(2,219)	229	(3,321)
50 (2)	67	(972)	80	(1,160)	140	(2,031)	125	(1,813)	137	(1,987)	198	(2,872)
65 (2 1/2)	68	(986)	104	(1,508)	154	(2,234)	122	(1,769)	158	(2,292)	208	(3,017)
80 (3)	63	(914)	93	(1,349)	134	(1,944)	115	(1,668)	144	(2,089)	185	(2,683)
100 (4)	59	(856)	82	(1,189)	114	(1,653)	108	(1,566)	131	(1,900)	163	(2,364)
150 (6)	54	(783)	70	(1,015)	91	(1,320)	104	(1,508)	120	(1,740)	142	(2,060)

TABLE 6-7: 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	(1,653)	148	(2,147)	283	(4,105)	212	(3,075)	246	(3,568)	382	(5,540)
20 (3/4)	99	(1,436)	126	(1,827)	234	(3,394)	184	(2,669)	211	(3,060)	319	(4,627)
25 (1)	88	(1,276)	110	(1,595)	220	(3,191)	164	(2,379)	187	(2,712)	297	(4,308)
32 (1 1/4)	79	(1,146)	97	(1,407)	184	(2,669)	146	(2,118)	163	(2,364)	250	(3,626)
40 (1 1/2)	74	(1,073)	90	(1,305)	166	(2,408)	137	(1,987)	153	(2,219)	229	(3,321)
50 (2)	68	(986)	80	(1,160)	141	(2,045)	127	(1,842)	139	(2,016)	200	(2,901)
65 (2 1/2)	67	(972)	104	(1,508)	154	(2,234)	123	(1,784)	159	(2,306)	209	(3,031)
80 (3)	63	(914)	93	(1,349)	135	(1,958)	116	(1,682)	145	(2,103)	187	(2,712)
100 (4)	59	(856)	83	(1,204)	115	(1,668)	108	(1,566)	131	(1,890)	163	(2,364)
150 (6)	54	(783)	70	(1,015)	92	(1,334)	104	(1,508)	120	(1,740)	142	(2,060)

INSTALLING THE PIPEWORK (Continued)

General piping requirements, including manifolds (Continued)

TABLE 6-8: 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 305 mm (12 in.) of the discharge nozzle. See Figure 6-19.
- Hangers must be placed between elbows that are more than 610 mm (24 in.) apart. See Figure 6-20.
- Hangers must be mounted to a structure capable of supporting the pipework.

TABLE 6-9: 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 6-10: 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)

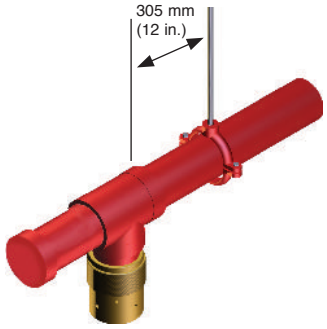


FIGURE 6-19
NOZZLE MOUNTING
009715

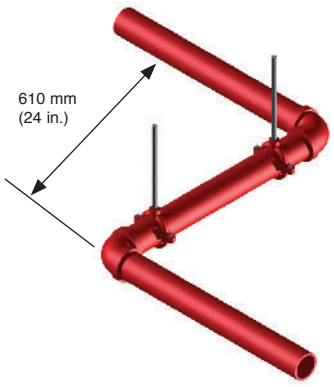


FIGURE 6-20
ELBOW SUPPORT
009716

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 a system discharge. Nozzles should be installed a maximum of 0.3 m (1.0 ft) below the ceiling.

⚠ CAUTION

For 180° nozzles, ensure that they are correctly oriented to achieve the correct area coverage. Ensure that all nozzles are adequately supported to prevent movement and to protect against the reaction force of a system discharge.

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. See Figure 6-21 for the correct orientation of the discharge nozzle filter.



FIGURE 6-21
FK-5-1-12 AGENT NOZZLE FILTER LOCATION
E001779

INSTALLING THE ACTUATION COMPONENTS

⚠ CAUTION

Before completing the actuation installation steps, ensure that all containers are correctly secured.

Installing the electrical actuator (Part No. 304205030 and 304205040)

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 6-22.
2. Remove the dust cap from the top of the valve assembly.
3. Carefully screw the actuator to the valve assembly. See Figure 6-23.

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 6-22
ACTUATOR PIN NON-FIRED POSITION
E001171



FIGURE 6-23
INSTALLED ELECTRICAL ACTUATOR
E001230

INSTALLING THE ACTUATION COMPONENTS (Continued)

Wiring the electrical actuator

⚠ CAUTION

The electrical actuator shall be connected when all other components are completely installed.

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 the following wiring diagram.
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).

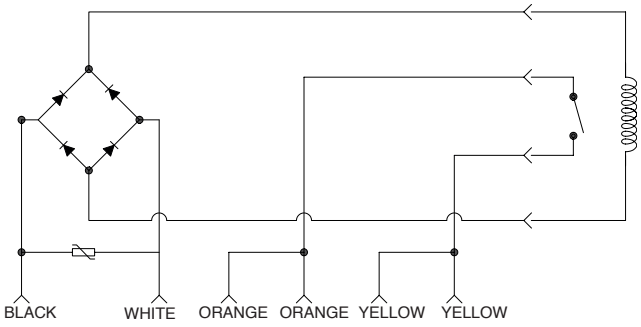


FIGURE 6-24
ELECTRICAL ACTUATOR WIRING DIAGRAM
E002160

Before putting the system into operation, test the electrical actuator. 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.

Installing the placement indicator switch

The placement indicator switch is integrated within the electrical actuator. See Figure 6-25. Connect the placement indicator switch monitoring to the orange and yellow wires. See Figure 6-24. 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.

To wire the placement indicator switch, complete the following steps:

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.

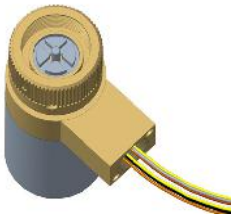


FIGURE 6-25
INTEGRATED PLACEMENT INDICATOR SWITCH (ORANGE AND YELLOW WIRES)
E001172



FIGURE 6-26
INTEGRATED INDICATOR SWITCH INSTALLED (ORANGE AND YELLOW WIRES)
E001230

INSTALLING THE ACTUATION COMPONENTS (Continued)

Installing the explosion-proof electrical actuator (Part No. 453978)

Mechanical installation: Before installing the electrical actuator onto the discharge valve, ensure that the unit is reset in the non-fire position at a distance from the end of the pin to the actuator base of 4.02 mm to 4.78 mm (0158 in. to 0.188 in.). Place the electrical actuator onto the discharge valve and install it until hand-tight.

Electrical installation: The electrical actuator is supplied with a 1/2 in. NPT conduit connection. Due to the design of the bridge rectifier, the positive supply from the control panel can be connected to either terminal 1 or 2 with the reverse for the negative supply. The nominal supply is 24 VDC with a maximum monitoring current of 30 mA.

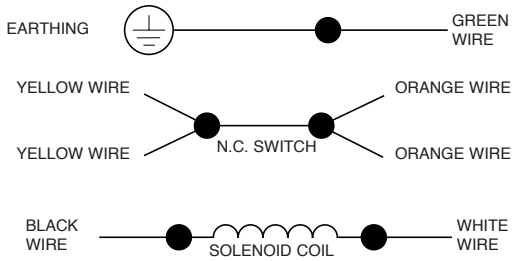


FIGURE 6-27
WIRING DIAGRAM
E002119

Operating instructions

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 a manual reset. Remove the unit from the valve and insert or screw in the reset tool.

Note: The explosion-proof electrical actuator is a purchased item and does not fall under any works instructions used in the manufacturing.

Maintenance instructions

1. Remove the actuator from the valve assembly.
2. Apply 24 VDC and observe the correct functionality. The energized pin position is 0.6 mm to 1.01 mm (0.023 in. to 0.040 in.) from the base of the actuator.
3. Terminate the supply voltage and reset the electrical actuator by fitting (screwing in) the reset tool into the base.
4. When reset, remove the reset tool, and reinstall it onto the valve assembly.

In case of faults or suspected faults contact Johnson Controls customer services to organize a replacement part.

Installing the manual actuator (Part No. A1638150HY)

1. Check that the actuation pin is in the non-fired position. See Figure 6-28.
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.

⚠ CAUTION

Before installing the manual actuator to the electrical actuator or container valve, ensure tthat 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. Overtightening may damage the valve and actuate the container.

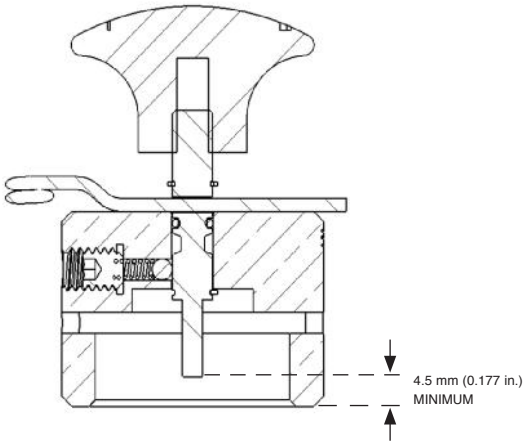


FIGURE 6-28
MANUAL ACTUATOR NON-FIRED POSITION
E001231

Operating instructions

1. Remove the safety pin and apply pressure to the red knob.
2. Ensure that the knob is fully depressed and hold for one second. The local manual actuator latches in the fire position and requires manual resetting before you refit it to the discharge valve or top-mounted electrical actuator.
3. When resetting the local manual actuator, pull while twisting the red knob in a clockwise direction to ease the process.

INSTALLING THE ACTUATION COMPONENTS (Continued)

Maintenance instructions

1. Remove the local manual actuator assembly from the discharge valve.
2. Remove the safety pin and depress the red knob.
3. Verify the correct functionality of the actuator. The knob latches and the nominal fire position of the pin from the base is 0.6 mm (0.024 in.).
3. Reset the actuation pin and refit the safety pin. The nominal non-fire position of the pin from the base is 4.5 mm (7/8 in.).
4. Reinstall the local manual actuator onto the discharge valve.

In case of faults or suspected faults contact customer services to organize a replacement part.

Installing the alternate manual actuator (Part No. 304.209.002)

1. Check that the actuation pin is in the non-fired position. See Figure 6-29.
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 6-30.

⚠ 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.

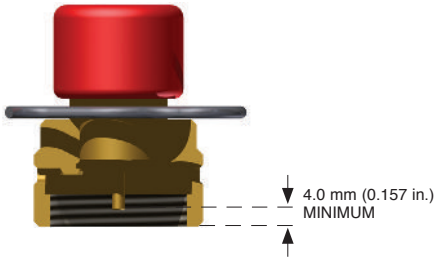


FIGURE 6-29
ALTERNATE MANUAL ACTUATOR NON-FIRED POSITION
009721



FIGURE 6-30
MANUAL ACTUATOR INSTALLED
E001231

INSTALLING THE ACTUATION COMPONENTS (Continued)

Installing the pneumatic actuator (Part No. 304.209.004)

1. Check that the actuation pin is in the non-fired position. See Figure 6-31.
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 6-32.

⚠ CAUTION

Before installing the pneumatic actuator to the container valve, ensure that the firing pin is retracted. 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.

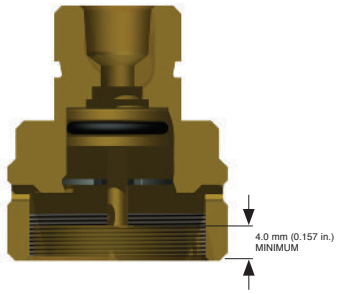


FIGURE 6-31
PNEUMATIC ACTUATOR NON-FIRED POSITION
009723



FIGURE 6-32
PNEUMATIC ACTUATOR INSTALLED
E001232

Installing the manual pneumatic actuator (Part No. 304700003)

1. Check that the actuation pin is in the non-fired position. See Figure 6-33.
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 6-34.

⚠ 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.

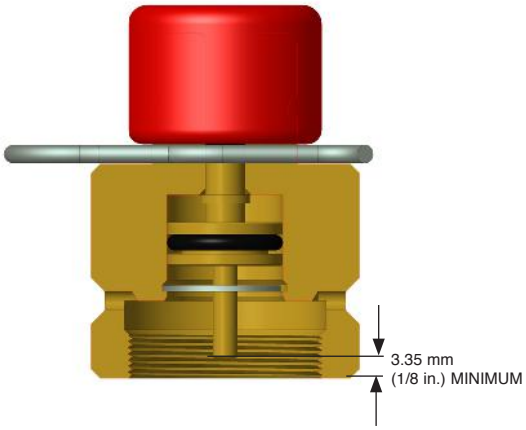


FIGURE 6-33
MANUAL PNEUMATIC ACTUATOR NON-FIRED POSITION
E001778



FIGURE 6-34
MANUAL PNEUMATIC ACTUATOR INSTALLED
E001233

INSTALLING THE ACTUATION COMPONENTS (Continued)

Installing the cable pneumatic manual (CPM) actuator (Part No. 304.209.013 and 436796)

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 6-35.

⚠ 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 6-35. The actuator must be hand-tight only.

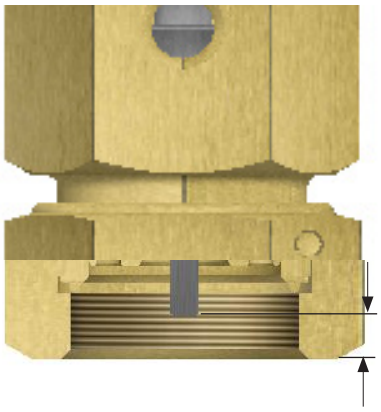


FIGURE 6-35
CPM ACTUATOR NON-FIRE POSITION
E001769



FIGURE 6-36
CPM ACTUATOR LOCATION
E001770

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 6-11 to Table 6-14 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 6-11, for pipe length limitations. Additionally, see the 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

Determining 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 II-C release with sub-master: The AUTOMAN II-C release device pneumatically actuates the sub-master container in the container bank. The sub-master container then pneumatically actuates the subordinate containers.

AUTOMAN II-C release without sub-master: The AUTOMAN II-C release device pneumatically actuates all containers in the container bank.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determining the actuation container requirements (Continued)

TABLE 6-11: MAXIMUM ACTUATION LINE LENGTH

	Maximum actuation line for 6 mm copper pipe 6 mm (OD)x 1 mm (Thickness) (0.24 in. [OD] x 0.04 in. [Thickness])		**Maximum actuation line for 1/4 in. copper tube 6.35 mm (OD) x 0.9 mm (Thickness) (0.25 in. [OD] x 0.04 in. [Thickness])**		**Maximum actuation line for 1/4 in. steel pipe 13.7 mm (OD) x 2.24 mm (Thickness) (0.54 in. [OD] x 0.09 in. [Thickness])**	
Actuation source	**m**	**(ft)**	**m**	**(ft)**	**m**	**(ft)**
Master container (all sizes)	30	(98)	23	(75.5)	30.5	(100)
Pilot container 3 L (without sub-master container)	60	(196)	46	(151)	36.6	(120)
Pilot container 3 L (with sub-master container)	90	(295)	70	(230)	36.6	(120)
	(Pilot to sub-master)		Pilot to sub-master		Pilot to sub-master	
	+30	(+98)	+23	(+75.5)	+30.5	(+100)
	(Sub-master to last subordinate)		(Sub-master to last subordinate)		(Sub-master to last subordinate)	
Pilot container 13 L (without sub-master container)	60	(196)	46	(151)	36.6	(120)
Pilot container 13 L (with sub-master container)	390	(1279)	301	(988)	73	(240)
	Pilot to sub-master		Pilot to sub-master		Pilot to sub-master	
	+30	(+98)	+23	(+75.5)	+30.5	(+100)
	(Sub-master to last subordinate)		(Sub-master to last subordinate)		(Sub-master to last subordinate)	
Pilot container 50 L (without sub-master container)	60	(196)	46	(151)	36.6	(120)
Pilot container 50 L (with sub-master container)	1500	(4921)	1159	(3802)	282	(925)
	Pilot to sub-master		Pilot to sub-master		Pilot to sub-master	
	+30	(+98)	+23	(+75.5)	+30.5	(+100)
	(Sub-master to last subordinate)		(Sub-master to last subordinate)		(Sub-master to last subordinate)	
AUTOMAN II-C release (without sub-master container)	60	(196)	46	(151)	36.6	(120)
AUTOMAN II-C release (with sub-master container)	90	(295)	70	(230)	36.6	(120)
	Pilot to sub-master		Pilot to sub-master		AUTOMAN II-C to sub-master	
	+30	(+98)	+23	(+75.5)	+30.5	(+100)
	(Sub-master to last subordinate)		(Sub-master to last subordinate)		(Sub-master to last subordinate)	

The following calculation determines the total equivalent actuation (EL_{Total}) line length, which is used to calculate the required pilot container size for correct actuation.

EL_{Total} = (A/B/C) Number of actuator tees and actuation line tees x EQ
+ (D/E/F) Number of flexible female actuation hoses 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)

Determining 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 6-11.

TABLE 6-12: 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. Flexible hose 1/4 in. x 710 mm (27.9 in.)	1.70	(5.58)
E. Flexible hose 1/4 in. x 815 mm (32.1 in.)	2.00	(6.56)
F. Flexible hose 1/4 in. x 1070 mm (42.1 in.)	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 6-13: 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. Flexible hose 1/4 in. x 710 mm (27.9 in.)	1.31	(4.30)
E. Flexible hose 1/4 in. x 815 mm (32.1 in.)	1.55	(5.09)
F. Flexible hose 1/4 in. x 1070 mm (42.1 in.)	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 6-14: 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. Flexible hose 1/4 in. x 710 mm (27.9 in.)	0.32	(1.05)
E. Flexible hose 1/4 in. x 815 mm (32.1 in.)	0.38	(1.25)
F. Flexible hose 1/4 in. x 1070 mm (42.1 in.)	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)

Determining the actuation container requirements (Continued)

Example 1a: Single hazard system - master container actuation (metric)*

The system shown in Figure 6-37 includes three SAPPHIRE 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 three SAPPHIRE containers. The lengths of actuation piping (Dia 6 mm copper pipe) is indicated in Figure 6-37. There is a single flexible female actuation hose (flexible hose) dedicated to the discharge pressure switch. The piping between the containers is made of Dia 6 mm copper pipe. See Table 6-15 for the total equivalent length.

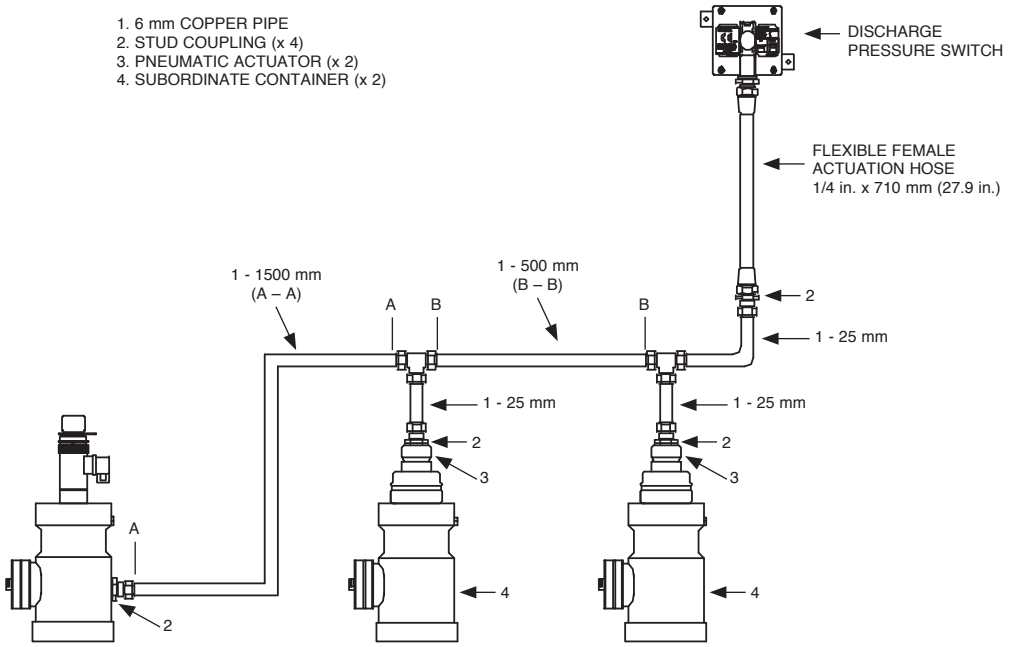


FIGURE 6-37
METRIC EXAMPLE 1a - SINGLE HAZARD SYSTEM
011538

Calculate the total equivalent length (EL_{Total}) of the pilot actuation line, see Table 6-15. Use the calculation on page 6-20.

TABLE 6-15: EQUIVALENT LENGTH OF PILOT ACTUATION LINE (EXAMPLE 1a – METRIC)

Component	EQ (m)	Quantity	Total (m)
Length of 6 mm copper pipe: 1,500 mm + 500 mm + (3 x 25 mm)	n/a	2.075 m	2.075
Pneumatic actuator and tee for flexible hose	0.30	–	–
Pneumatic actuator and tee for copper pipe (6 mm)	0.23	2	0.46
Pneumatic actuator and tee for copper tube (1/4 in.)	0.23	–	–
Flexible hose 1/4 in. x 710 mm (27.9 in.)	1.70	1	1.70
Flexible hose 1/4 in. x 815 mm (32.1 in.)	2.00	–	–
Flexible hose 1/4 in. x 1070 mm (42.1 in.)	2.60	–	–
Stud coupling for copper pipe (6 mm)	0.02	4	0.08
Stud coupling for copper tube (1/4 in.)	0.02	–	–
		EL_{Total}	**4.315**

*Imperial Example 1b starts on page 6-24.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determining the actuation container requirements (Continued)

Example 1a: Single hazard system - master container actuation (metric, continued)

The equivalent length is calculated by summing the total equivalent length for each component within the system.

Total $Length_{6mmCopperPipe}$ = 2.075 m

Total $EQ_{PneuAct6mm}$ = 0.23 x 2 = 0.46 m

Total $EQ_{710mmFlexHose}$ = 1.70 x 1 = 1.70 m

Total $EQ_{StudCoupling6mm}$ = 0.02 x 4 = 0.08 m

EL_{Total} = 2.075 + 0.46 + 1.70 + 0.08 = 4.315 m

SUMMARY

Table 6-11 states a maximum of 30 m of total EL copper pipe can be used from the master (sub-master) to subordinate containers for actuation. For this example, the total EL of copper pipe used is 4.315 m. This is within the limitations for the configuration, and an additional 25.685 m of EL copper pipe can be used if the configuration required additional pipe and fittings in the field.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determining the actuation container requirements (Continued)

Example 1b: Single hazard system - master container actuation (imperial)

The system shown in Figure 6-38 includes three SAPPHIRE 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 three SAPPHIRE containers. The length of actuation tubing (1/4 in. copper tube) is indicated in Figure 6-38. There is a single flexible female actuation hose (flexible hose) dedicated to the discharge pressure switch. The tubing between the containers is 1/4 in. copper tube. See Table 6-16 for the total equivalent length.

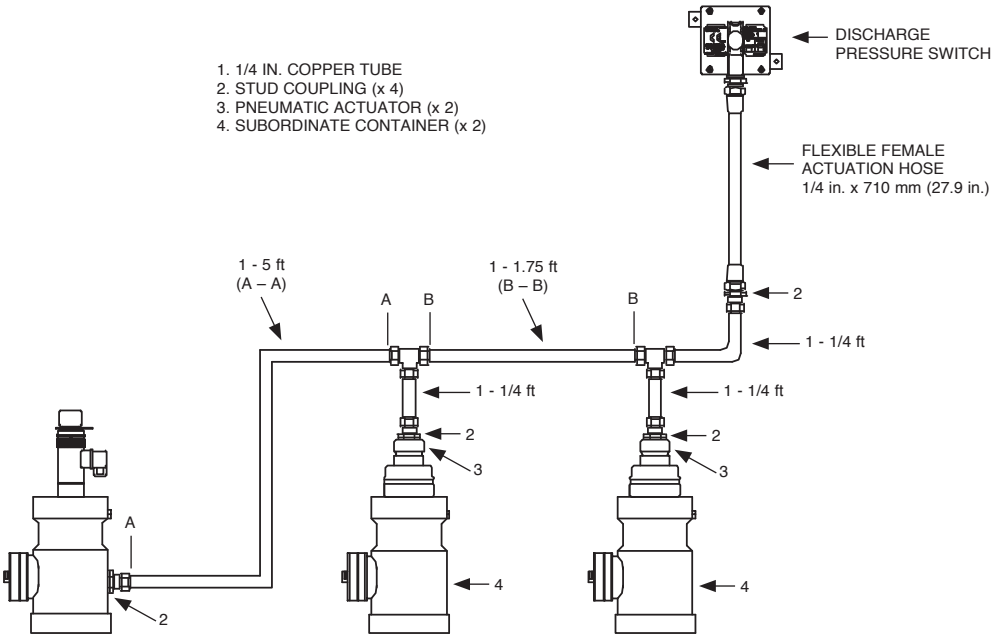


FIGURE 6-38
IMPERIAL EXAMPLE 1b - SINGLE HAZARD SYSTEM
011539

Calculate the total equivalent length (EL_{Total}) of the pilot actuation line, see Table 6-16. Use the calculation on page 6-20.

TABLE 6-16: EQUIVALENT LENGTH OF PILOT ACTUATION LINE (EXAMPLE 1b – IMPERIAL)

Component	EQ (ft)	Quantity	Total (ft)
Length of 1/4 in. copper tube: 5 ft + 1.75 ft + (3 x 0.25 ft)	n/a	7.5 ft	7.5
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	2	1.18
Flexible hose 1/4 in. x 710 mm (27.9 in.)	4.30	1	4.3
Flexible hose 1/4 in. x 815 mm (32.1 in.)	5.09	–	–
Flexible hose 1/4 in. x 1070 mm (42.1 in.)	6.59	–	–
Stud coupling for copper pipe (6 mm)	0.07	–	–
Stud coupling for copper tube (1/4 in.)	0.07	4	0.28
		EL_{Total}	**13.26**

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determining the actuation container requirements (Continued)

Example 1b: Single hazard system - master container actuation (imperial, continued)

The equivalent length is calculated by summing the total equivalent length for each component within the system.

Total $Length_{1/4in.CopperTube}$ = 7.5 ft

Total $EQ_{PneuAct1/4in.}$ = 0.59 x 2 = 1.18 ft

Total $EQ_{27.9in.FlexHose}$ = 4.30 x 1 = 4.30 ft

Total $EQ_{StudCoupling1/4in.}$ = 0.07 x 4 = 0.28 ft

EL_{Total} = 7.5 + 1.18 + 4.3 + 0.28 = 13.26 ft

SUMMARY

Table 6-11 states a maximum of 75.5 ft of total EL copper tube can be used from the master (sub-master) to subordinate containers for actuation. For this example the total EL of copper tube used is 13.26 ft. This is within the limitations for the configuration and an additional 62.24 ft of EL copper tube can be used if the configuration required additional tube and fittings in the field.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determining the actuation container requirements (Continued)

Example 2a: Single hazard system – pilot container without sub-master container (metric)*

The system shown in Figure 6-39 is made up of two SAPPHIRE 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 two SAPPHIRE containers. The length of actuation piping (Dia 6 mm copper pipe) is indicated in Figure 6-39. There is a single flexible female actuation hose (flexible hose) dedicated to the discharge pressure switch. The piping between the containers is 6 mm copper pipe. See Table 6-17 for the total equivalent length.

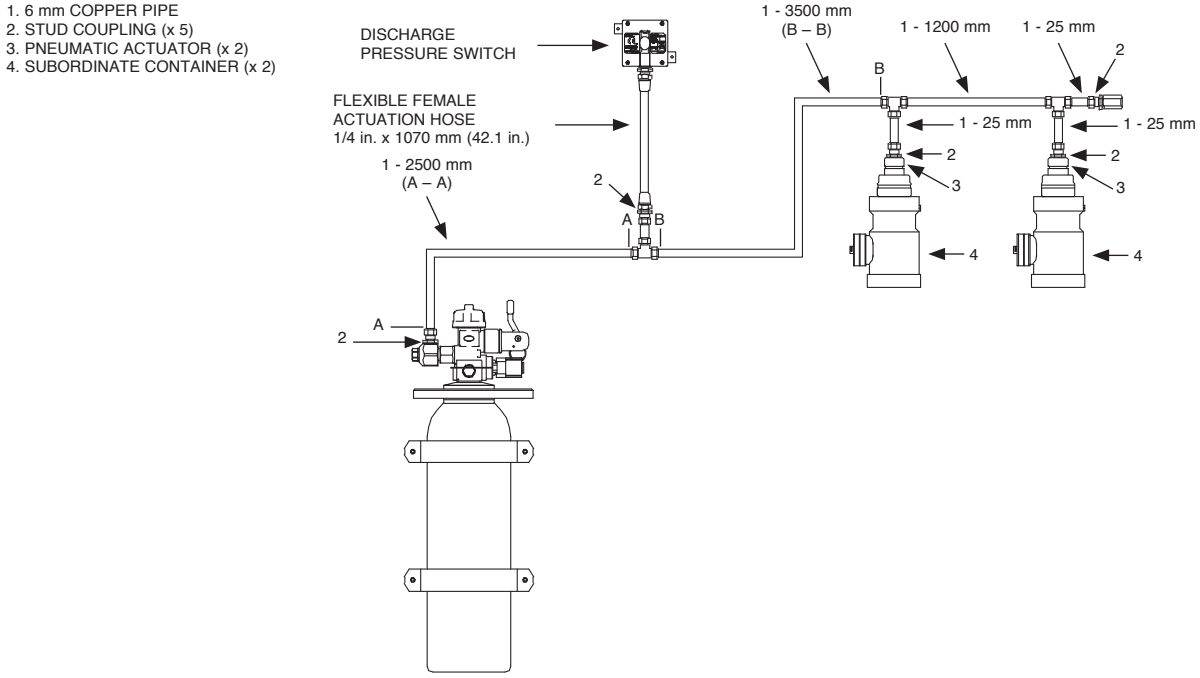


FIGURE 6-39
METRIC EXAMPLE 2a - SINGLE HAZARD SYSTEM
011540

Calculate the total equivalent length (EL_{Total}) of the pilot actuation line, see Table 6-17. Use the calculation on page 6-20.

TABLE 6-17: EQUIVALENT LENGTH OF PILOT ACTUATION LINE (EXAMPLE 2a – METRIC)

Component	EQ (m)	Quantity	Total (m)
Length of 6 mm copper pipe: 2,500 mm + 3,500 mm + 1,200 mm + (3 x 25 mm)	n/a	7.275 m	7.275
Pneumatic actuator and tee for flexible hose	0.30	–	–
Pneumatic actuator and tee for copper pipe (6 mm)	0.23	2	0.46
Pneumatic actuator and tee for copper tube (1/4 in.)	0.23	–	–
Flexible hose 1/4 in. x 710 mm (27.9 in.)	1.70	–	–
Flexible hose 1/4 in. x 815 mm (32.1 in.)	2.00	–	–
Flexible hose 1/4 in. x 1,070 mm (42.1 in.)	2.60	1	2.60
Stud coupling for copper pipe (6 mm)	0.02	5	0.10
Stud coupling for copper tube (1/4 in.)	0.02	–	–
		EL_{Total}	**10.435**

* Imperial Example 2b starts on page 6-28.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determining the actuation container requirements (Continued)

Example 2a: Single hazard system – pilot container without sub-master container (metric, continued)

The equivalent length is calculated by summing the total equivalent length for each component within the system.

Total $Length_{6mmCopperPipe}$ = 7.275 m

Total $EQ_{PneuAct6mm}$ = 0.23 x 2 = 0.46 m

Total $EQ_{1070mmFlexHose}$ = 2.60 x 1 = 2.60 m

Total $EQ_{StudCoupling6mm}$ = 0.02 x 5 = 0.10 m

EL_{Total} = 7.725 + 0.46 + 2.60 + 0.10 = 10.435 m

RESULT

Based on Table 6-11, the 3 L pilot container is the appropriate minimum pilot container size.

SUMMARY

Table 6-11 states a maximum of 60 m of total EL copper pipe can be used from the pilot container to all subordinate containers. For this example the total EL of copper pipe used is 10.435 m. This is within the limitations for the configuration and an additional 49.565 m of EL copper pipe can be used if the configuration required additional pipe and fittings in the field.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determining the actuation container requirements (Continued)

Example 2b: Single hazard system – pilot container without sub-master container (imperial)

The system shown in Figure 6-40 is made up of two SAPPHIRE 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 two SAPPHIRE containers. The length of actuation tubing (1/4 in. copper tube) is indicated in Figure 6-40. There is a single flexible female actuation hose (flexible hose) is dedicated to the discharge pressure switch. The tubing between the containers is 1/4 in. copper tube. See Table 6-18 for the total equivalent length.

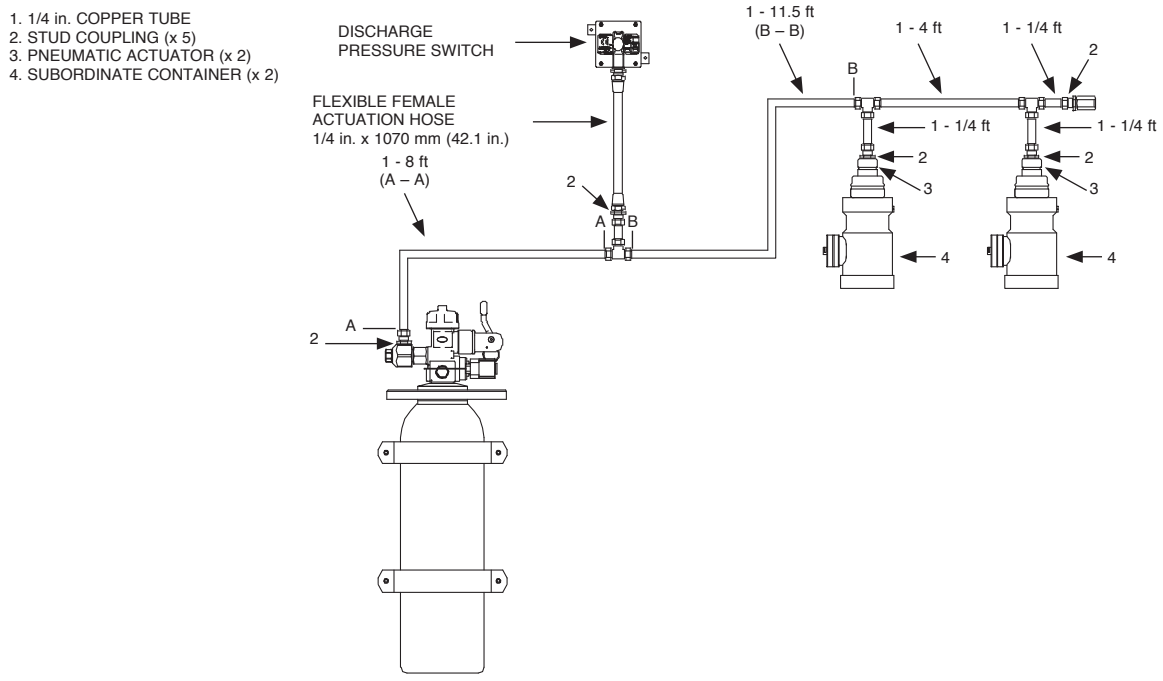


FIGURE 6-40
IMPERIAL EXAMPLE 2b - SINGLE HAZARD SYSTEM
011541

Calculate the total equivalent length (EL_{Total}) of the pilot actuation line, see Table 6-18. Use the calculation on page 6-20.

TABLE 6-18: EQUIVALENT LENGTH OF PILOT ACTUATION LINE (EXAMPLE 2b – IMPERIAL)

Component	EQ (ft)	Quantity	Total (ft)
Length of 1/4 in. copper tube: 8 ft + 11.5 ft + 4 ft + (3 x 0.25 ft)	n/a	24.25 ft	24.25
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	2	1.18
Flexible hose 1/4 in. x 710 mm (27.9 in.)	4.30	–	–
Flexible hose 1/4 in. x 815 mm (32.1 in.)	5.09	–	–
Flexible hose 1/4 in. x 1070 mm (42.1 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	5	0.35
		EL_{Total}	**32.37**

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determining the actuation container requirements (Continued)

Example 2b: Single hazard system – pilot container without sub-master container (imperial, continued)

The equivalent length is calculated by summing the total equivalent length for each component within the system.

Total $Length_{1/4in.CopperTube}$ =	24.25 ft
Total $EQ_{PneuAct1/4in.}$ =	0.59 x 2 = 1.18 ft
Total $EQ_{42.1in.FlexHose}$ =	6.59 x 1 = 6.59 ft
Total $EQ_{StudCoupling1/4in.}$ =	0.07 x 5 = 0.35 ft
EL_{Total} = 24.25 + 1.18 + 6.59 + 0.35 =	**32.37 ft**

RESULT

Based on Table 6-11, the 3 L pilot container is the appropriate minimum pilot container size.

SUMMARY

Table 6-11 states a maximum of 151 ft of total EL copper tube can be used from the pilot container to all subordinate containers. For this example the total EL of copper tube used is 32.37 ft. This is within the limitations for the configuration and an additional 118.63 ft of EL copper tube can be used if the configuration required additional tube and fittings in the field.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determining the actuation container requirements (Continued)

Example 3a: Single hazard system - AUTOMAN II-C release with sub-master container (metric)

The system shown in Figure 6-41 is made up of three SAPPHIRE 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 three SAPPHIRE containers. The lengths of actuation piping are indicated in Figure 6-41. One flexible female actuation hose (flexible hose) is dedicated to the discharge pressure switch. Two flexible female actuation hoses connect the subordinate containers. The piping between the containers is 6 mm copper pipe. See Tables 6-19 and 6-20 for the total equivalent length.

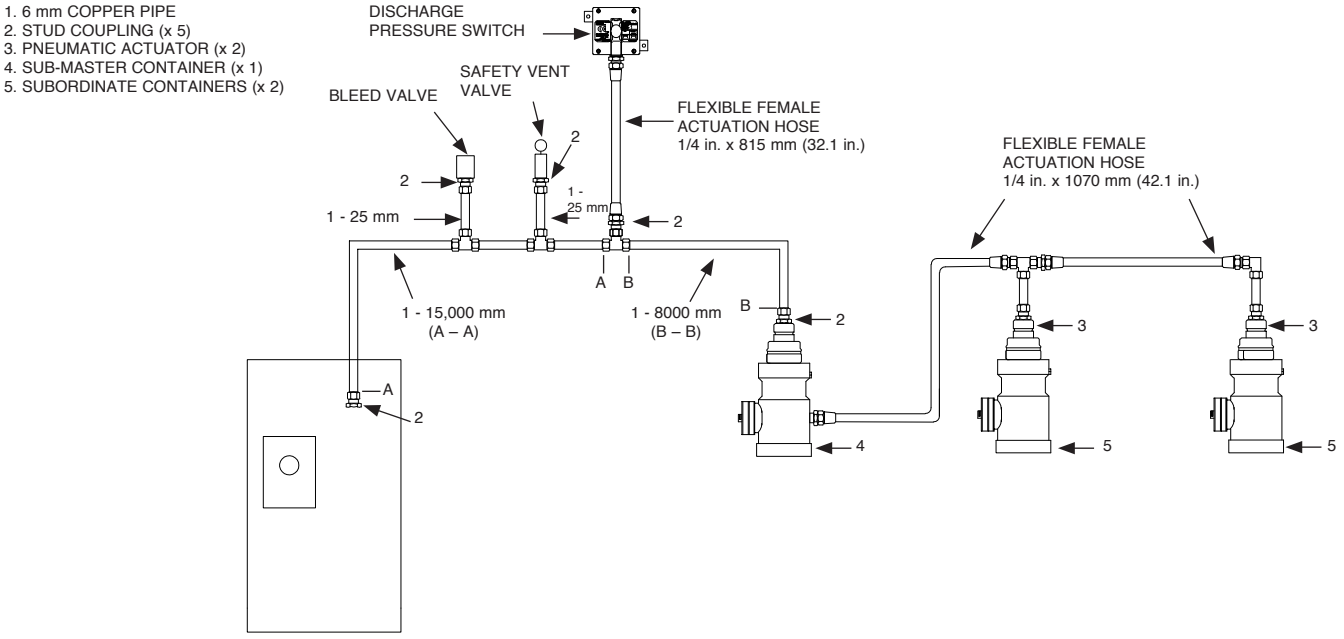


FIGURE 6-41
METRIC EXAMPLE 3a -
AUTOMAN II-C RELEASE TO SUB-MASTER ACTUATION
011542

Calculate the total equivalent length (EL_{Total}) for the AUTOMAN II-C release, see Table 6-19. Use the calculation on page 6-20.

TABLE 6-19: EQUIVALENT LENGTH OF AUTOMAN II-C RELEASE TO SUB-MASTER (EXAMPLE 3a – METRIC)

Component	EQ (m)	Quantity	Total (m)
Length of 6 mm copper pipe: 15,000 mm + 8,000 mm + (2 x 25 mm)	n/a	23.05 m	23.05
Pneumatic actuator and tee for flexible hose	0.30	–	–
Pneumatic actuator and tee for copper pipe (6 mm)	0.23	1	0.23
Pneumatic actuator and tee for copper tube (1/4 in.)	0.23	–	–
Flexible hose 1/4 in. x 710 mm (27.9 in.)	1.70	–	–
Flexible hose 1/4 in. x 815 mm (32.1 in.)	2.00	1	2.00
Flexible hose 1/4 in. x 1,070 mm (42.1 in.)	2.60	–	–
Stud coupling for copper pipe (6 mm)	0.02	5	0.10
Stud coupling for copper tube (1/4 in.)	0.02	–	–
		EL_{Total}	**25.38**

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determining the actuation container requirements (Continued)

Example 3a: Single hazard system - AUTOMAN II-C release with sub-master container (metric, continued)

The equivalent length is calculated by summing the total equivalent length for each component within the system.

Total $Length_{6mmCopperPipe}$ = 23.05 m

Total $EQ_{PneuAct6mm}$ = 0.23 x 1 = 0.23 m

Total $EQ_{815mmFlexHose}$ = 2.00 x 1 = 2.00 m

Total $EQ_{StudCoupling6mm}$ = 0.02 x 5 = 0.10 m

EL_{Total} = 23.05 + 0.23 + 2.00 + 0.10 = 25.38 m

Calculate the total equivalent length (EL_{Total}) of the sub-master container, see Table 6-20. Use the calculation on page 6-20.

TABLE 6-20: EQUIVALENT LENGTH OF SUB-MASTER TO SUBORDINATE CONTAINERS (EXAMPLE 3a – METRIC)

Component	EQ (m)	Quantity	Total (m)
Length of 6 mm copper pipe	n/a	–	–
Pneumatic actuator and tee for flexible hose	0.30	2	0.60
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 (27.9 in.)	1.70	–	–
Flexible hose 1/4 in. x 815 mm (32.1 in.)	2.00	–	–
Flexible hose 1/4 in. x 1,070 mm (42.1 in.)	2.60	2	5.20
Stud coupling for copper pipe (6 mm)	0.02	–	–
Stud coupling for copper tube (1/4 in.)	0.02	–	–
		EL_{Total}	**5.80**

Total$EQ_{PneuActFlexHose}$ = 0.30 x 2 = 0.60 m

Total $EQ_{1070mmFlexHose}$ = 2.60 x 2 = 5.20 m

EL_{Total} = 0.60 + 5.20 = 5.80 m

SUMMARY

Table 6-11 states a maximum of 90 m of total EL copper pipe can be used from the AUTOMAN II-C release to the sub-master container, and 30 m of total EL copper pipe can be used from the sub-master container to the furthest subordinate container. For this example the total EL of copper pipe used from the AUTOMAN II-C release to sub-master container is 25.38 m and 5.80 m from the sub-master to the final subordinate container. This is within the limitations for the configuration. An additional 64.62 m of EL copper pipe can be used from the AUTOMAN II-C release to the sub-master container and 24.2 m from the sub-master container to the final subordinate container if the configuration required additional pipe and fittings in the field.

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determining the actuation container requirements (Continued)

Example 3b: Single hazard system - AUTOMAN II-C release with sub-master container (imperial)

The system shown in Figure 6-42 is made up of three SAPPHIRE 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 three SAPPHIRE containers. The length of actuation tubing is indicated in Figure 6-42. One flexible female actuation hose (flexible hose) is dedicated to the discharge pressure switch. Two flexible female actuation hoses connect the subordinate containers. The tubing between the containers is 1/4 in. copper tube. See Tables 6-21 and 6-22 for the total equivalent length.

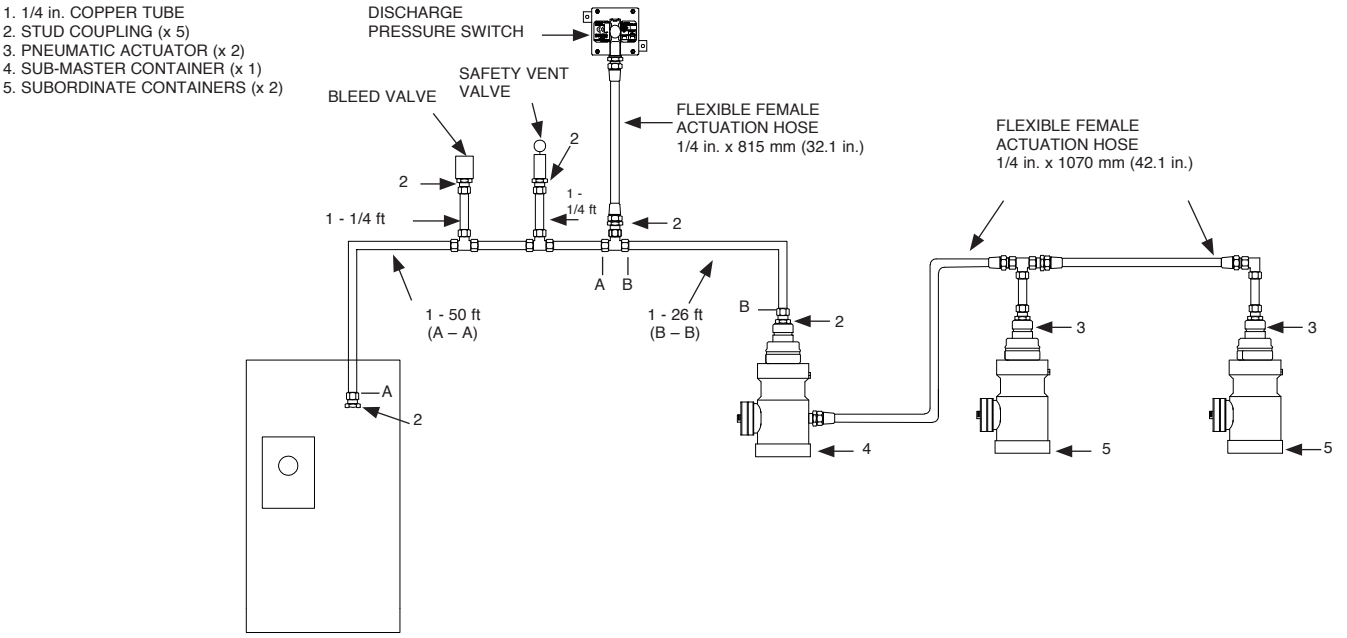


FIGURE 6-42
IMPERIAL EXAMPLE 3b -
AUTOMAN II-C RELEASE TO SUB-MASTER ACTUATION
011542

Calculate the total equivalent length (EL_{Total}) of the AUTOMAN II-C release, see Table 6-21. Use the calculation on page 6-20.

TABLE 6-21: EQUIVALENT LENGTH OF AUTOMAN II-C RELEASE TO SUB-MASTER (EXAMPLE 3b – IMPERIAL)

Component	EQ (ft)	Quantity	Total (ft)
Length of 1/4 in. copper tube: 50 ft + 26 ft + (2 x 0.25 ft)	n/a	76.50 ft	76.50
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	1	0.59
Flexible hose 1/4 in. x 710 mm (27.9 in.)	4.30	–	–
Flexible hose 1/4 in. x 815 mm (32.1 in.)	5.09	1	5.09
Flexible hose 1/4 in. x 1,070 mm (42.1 in.)	6.59	–	–
Stud coupling for copper pipe (6 mm)	0.07	–	–
Stud coupling for copper tube (1/4 in.)	0.07	5	0.35
		EL_{Total}	**82.53**

INSTALLING THE PILOT CONTAINER COMPONENTS (Continued)

Determining the actuation container requirements (Continued)

Example 3b: Single hazard system - AUTOMAN II-C release with sub-master container (imperial, continued)

The equivalent length is calculated by summing the total equivalent length for each component within the system.

Total $Length_{1/4in.CopperTube}$ = 76.50 ft

Total $EQ_{PneuAct1/4in.}$ = 0.59 x 1 = 0.59 ft

Total $EQ_{815mmFlexHose}$ = 5.09 x 1 = 5.09 ft

Total $EQ_{StudCoupling1/4in.}$ = 0.07 x 5 = 0.35 ft

EL_{Total} = 76.50 + 0.59 + 5.09 + 0.35 = 82.53 ft

Calculate the total equivalent length (EL_{Total}) of the sub-master container, see Table 6-22. Use the calculation on page 6-20.

TABLE 6-22: EQUIVALENT LENGTH OF SUB-MASTER TO SUBORDINATE CONTAINERS (EXAMPLE 3b – IMPERIAL)

Component	EQ (ft)	Quantity	Total (ft)
Length of 1/4 in. copper tube	n/a	–	–
Pneumatic actuator and tee for flexible hose	0.75	2	1.50
Pneumatic actuator and tee for copper pipe (6 mm)	0.59	–	–
Pneumatic actuator and tee for copper tube (1/4 in.)	0.59	–	–
Flexible hose 1/4 in. x 710 mm (27.9 in.)	4.30	–	–
Flexible hose 1/4 in. x 815 mm (32.1 in.)	5.09	–	–
Flexible hose 1/4 in. x 1,070 mm (42.1 in.)	6.59	2	13.18
Stud coupling for copper pipe (6 mm)	0.07	–	–
Stud coupling for copper tube (1/4 in.)	0.07	–	–
		EL_{Total}	**14.68**

Total $EQ_{PneuActFlexHose}$ = 0.75 x 2 = 1.50 ft

Total $EQ_{1070mmFlexHose}$ = 6.59 x 2 = 13.18 ft

EL_{Total} = 1.5 + 13.18 = 14.68 ft

SUMMARY

Table 6-11 states a maximum of 230 ft of total EL copper tube can be used from the AUTOMAN II-C release to the sub-master container, and 75.5 ft of total EL copper tube can be used from the sub-master container to the furthest subordinate container. For this example, the total EL of copper tube used from the AUTOMAN II-C release to sub-master container is 82.53 ft and 14.68 ft from the sub-master to the final subordinate container. This is within the limitations for the configuration. An additional 147.47 ft of EL copper tube can be used from the AUTOMAN II-C release to the sub-master container and 60.82 ft from the sub-master container to the final subordinate container if the configuration required additional pipe and fittings in the field.

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 6-43.

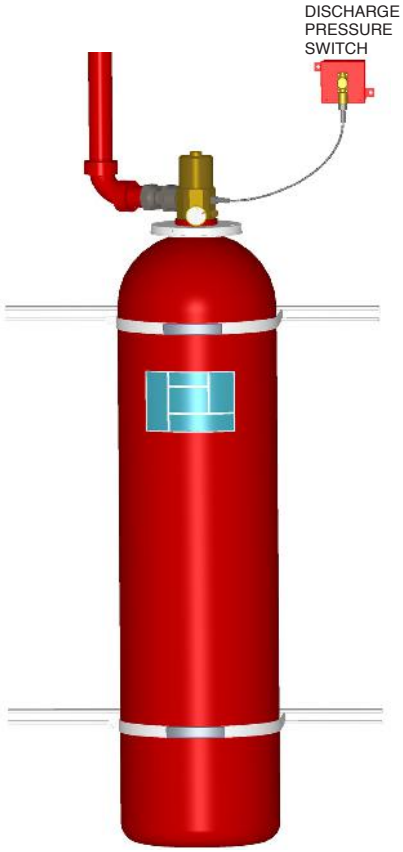


FIGURE 6-43
DISCHARGE PRESSURE SWITCH INSTALLATION
SINGLE CONTAINER SYSTEM
E001774

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 6-44. See *Actuation Components* in Section 2 - System Components for details on the copper pipe or tube.

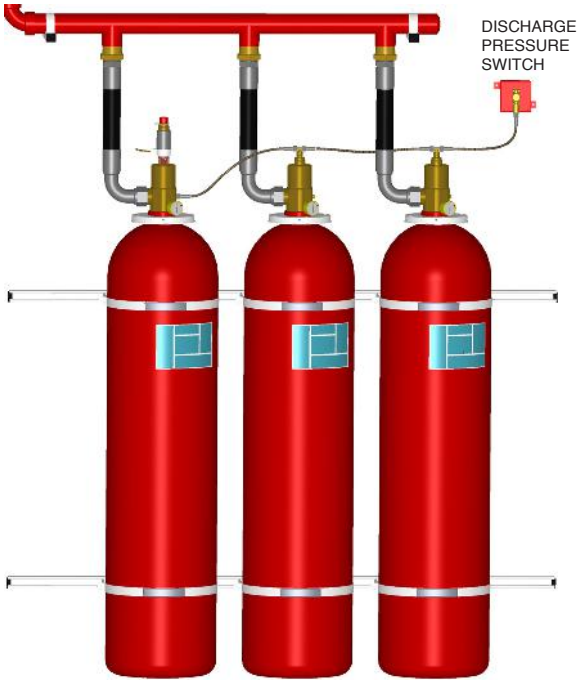


FIGURE 6-44
DISCHARGE PRESSURE SWITCH INSTALLATION
MULTIPLE CONTAINER SYSTEM
E001775

Installing the discharge pressure switch

The discharge pressure switch mounts on any suitable flat surface near the SAPPHIRE 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.

Additionally, the discharge pressure switch can be installed in the distribution piping as a pressure tap for controlling ancillary devices as needed in the system design. This is normally seen on main and reserve configurations.

ANCILLARY EQUIPMENT (Continued)

Installing the discharge pressure switch (Continued)

For multiple container systems, complete the following steps:

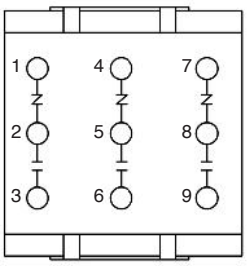
1. Fit the appropriate adaptors in the valve assembly and pressure switch.
2. Connect the switch to the tee on the final subordinate container valve using either pneumatic tubing or an actuation hose.

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 6-45. 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 6-45
PRESSURE SWITCH CONTACTS
008922

Bleed 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 (Part No. 304.205.006 and 305.209.005)

DOT welded container valves can be **factory-fitted** with low pressure warning switches when specified at the time of order. Voltage input can be applied to either terminal.

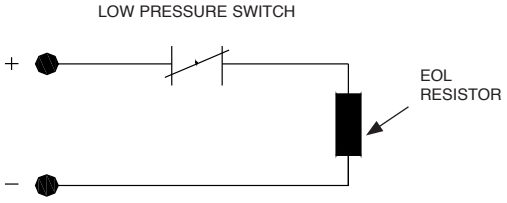


FIGURE 6-46
LOW PRESSURE SWITCH TO CONTROL PANEL
E001294

Note: The low pressure switch is not polarity sensitive and should be programmed to the supervisory input circuit on a conventional panel or program output circuit 4 on an addressable panel as a supervisory input circuit.

Note: Program 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 utilized only when accepted by the authority having jurisdiction.

Low pressure switch (Part No. 305.209.007 and 570585)

DOT welded container valves can be factory-fitted with low pressure warning switches when specified at the time of order. To install the low pressure switch, complete the following steps:

1. Remove the DIN connector to access the wiring terminals. To remove the connector, remove the set-screw from the connector and the terminal block from the DIN housing.
2. Connections can be made either normally open or normally closed as shown in Fig 6-47. The end-of-line resistor must be installed to suit the control unit, typically 4K7.

   1 and 2 **make** contact on pressure decrease (normally open at container nominal system pressure and normally closed at atmospheric pressure).

   1 and 3 **break** contact on pressure decrease (normally closed at container nominal system pressure and normally open at atmospheric pressure).

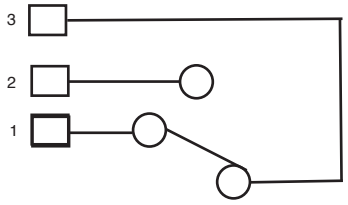


FIGURE 6-47
LOW PRESSURE WIRING

ANCILLARY EQUIPMENT (Continued)

Installing the explosion-proof low pressure switch (Part No. 453979)

The container valve is supplied pre-assembled from Johnson Controls with the low pressure switch installed. The low pressure switch is supplied with a connector and can be wired normally open or normally closed. The terminals from the low pressure switch are not polarity sensitive but require the addition of an end-of-line resistor in series or parallel (typically 4K7) when connecting to the control unit.

Reset instructions

Refer to *Form F-2022046* for the explosion-proof low pressure switch reset procedures.

TABLE 6-23: WIRE DETAILS

Wire color	Switch	Correct container pressure	Low container pressure
Red	SW1	Normally open	Normally closed
White	SW1	Common	Common
Blue	SW1	Normally closed	Normally open
Green	–	Earth	Earth

Operating instructions

The low pressure switch works within the pre-determined system operating conditions in conjunction with an appropriate control unit.

Maintenance instructions

In case of faults or suspected faults, contact Johnson Controls customer services to organise a replacement part.

Contacted pressure gauge (UL and FM) – pilot container assembly (Part No. 30213401)

When pilot container valves are fitted with a CPG, the CPGs 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 following figure illustrates the wiring diagram for the CPG part number 30213401 (50 ºC [122 ºF]).

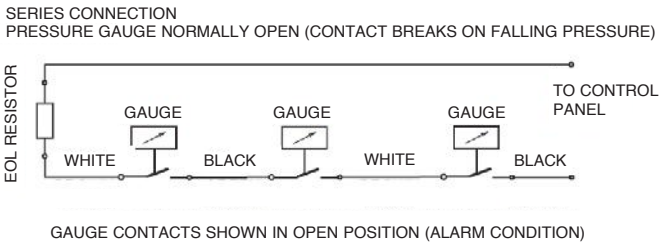


FIGURE 6-48
CPG PILOT CONTAINER ELECTRICAL CONNECTION
E001881

The resistor value may depend upon the panel requirements, but use of 4.7 KΩ resistor is usually required.

Operating instructions

The pressure gauge works within the pre-determined system operating conditions.

Maintenance instructions

If faults or suspected faults arise, contact customer services to organize a replacement part. If the pressure drops to 88 bar (1276 psi) when adjusted for temperature, then refill or replace the container. End users must check the pressure gauges weekly. The pressure gauges are field-replaceable.

INSTALLING THE PLACEMENT INDICATOR SWITCH - PILOT CONTAINER

These installation instructions are intended for use with the electrical 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 correctly installed. Read and follow all instructions carefully. Ensure that the placement indicator switch correctly communicates with the fire control panel before leaving the location.

Description

The placement indicator switch (see Figure 6-49) is a monitoring device to indicate the correct placement of the system's electrical 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 correct position for system operation.

If the electric actuator is not in the correct 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 correct position.

Note: Refer to fire control panel for correct EOL resistor value.

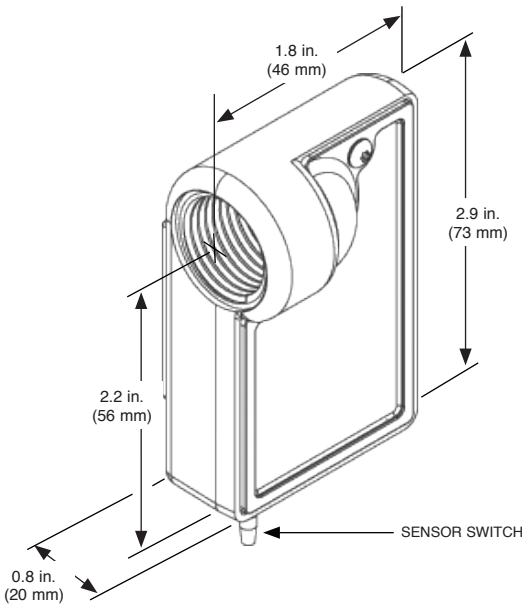


FIGURE 6-49
PLACEMENT INDICATOR SWITCH
009586

Technica specification

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.

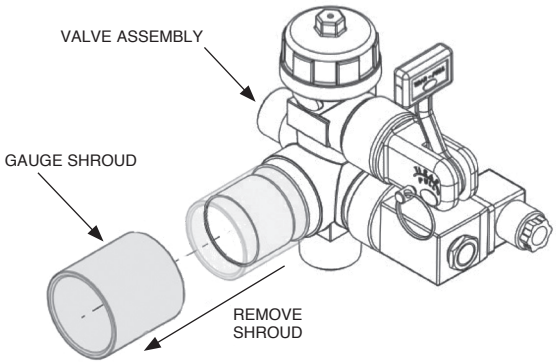


FIGURE 6-50
GAUGE SHROUD REMOVAL
009594

2. Install the placement indicator mounting bracket. See Figure 6-51 and Figure 6-52.

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. For the finger tab location, see the following figure.

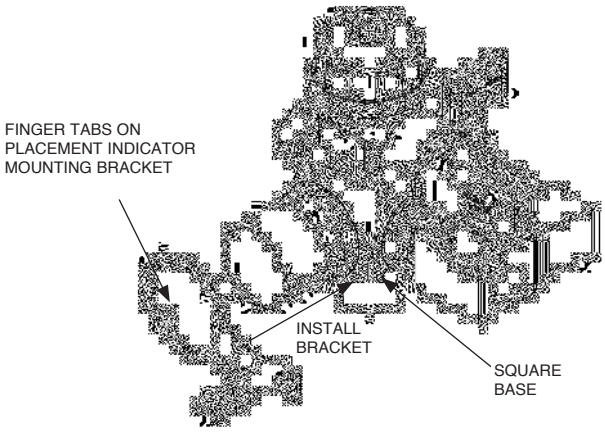


FIGURE 6-51
PLACEMENT INDICATOR MOUNTING BRACKET INSTALLATION
009622

INSTALLING THE PLACEMENT INDICATOR SWITCH - PILOT CONTAINER (Continued)

Installation (Continued)

3. Reinstall the gauge shroud that was removed in Step 1. See Figure 6-52 and Figure 6-53.

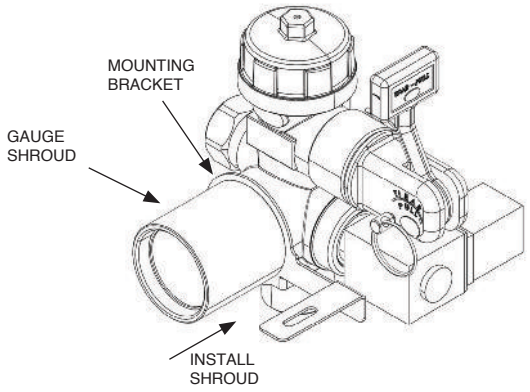


FIGURE 6-52
REINSTALLING THE GAUGE SHROUD
009623

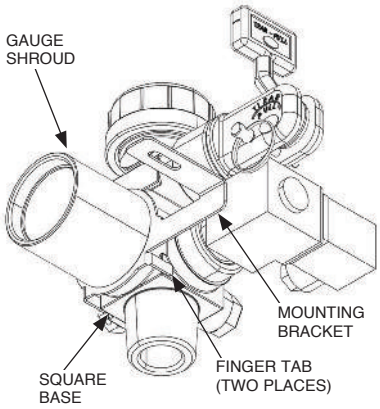


FIGURE 6-53
UNDERSIDE OF THE VALVE WITH THE GAUGE SHROUD AND MOUNTING BRACKET ASSEMBLED
009624

Note: Ensure that the finger tabs are positioned toward the bottom of the valve and align correctly. See Figure 6-53.

4. Secure the mounting bracket to the placement indicator switch housing using the nut provided. See Figure 6-54. The nut secures to the integral bolt on the placement indicator switch. See Figure 6-55. Leave the nut slightly loose for adjustment later.
5. Adjust the horizontal position to ensure the sensor switch is fully depressed. See Figure 6-54, Detail A.

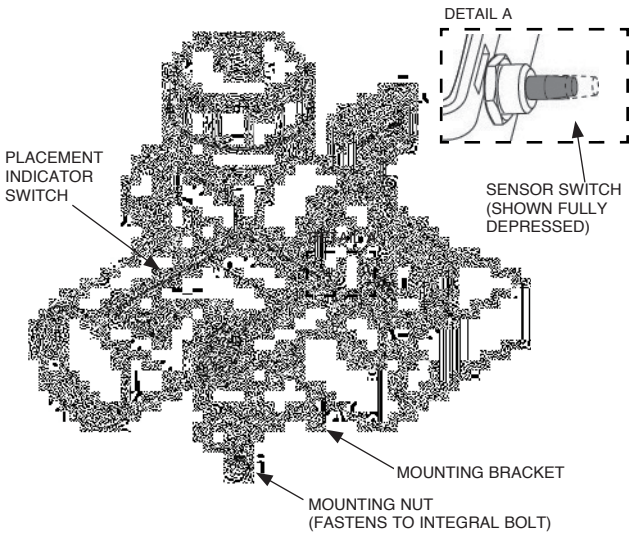


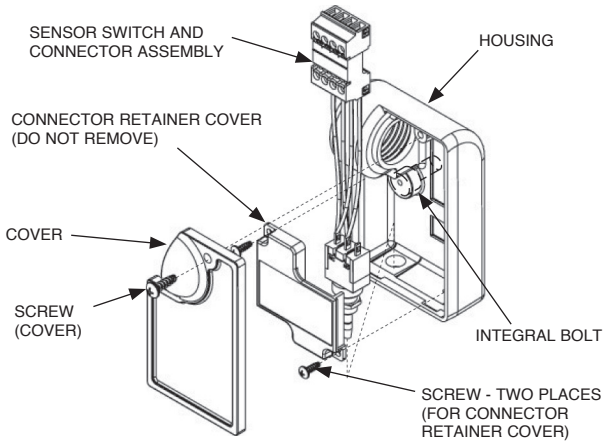
FIGURE 6-54
PLACEMENT INDICATOR SWITCH MOUNTING BRACKET
009625

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 (strain relief), found in the placement indicator switch installation kit.
   a. Remove the cover of the placement indicator switch using the appropriate screwdriver. See the following figure.



Note: Do not remove the connector retainer cover.

FIGURE 6-55
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 6-56.

c. Hand-tighten the cable gland to the placement indicator switch housing. See the following figure. At this time, do not tighten the cable gland to the wire.

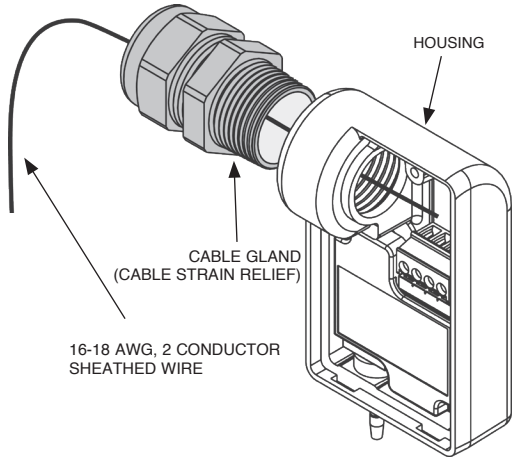


FIGURE 6-56
INSERT WIRE AND CABLE GLAND
009591

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 6-57.

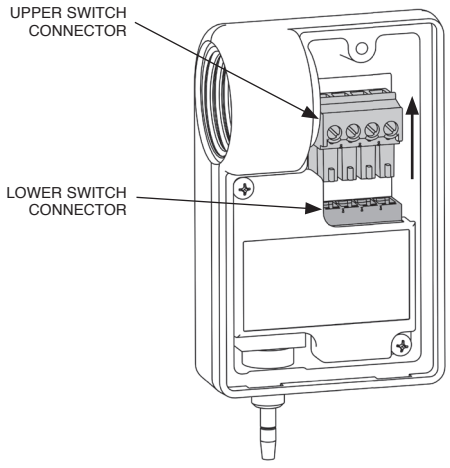


FIGURE 6-57
SEPARATE UPPER SWITCH CONNECTOR
009615

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 the following figure.

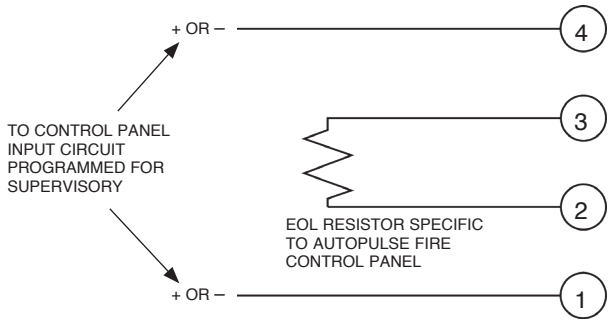


FIGURE 6-58
EOL RESISTOR ELECTRICAL DIAGRAM
009621

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 6-59.

Once connected, place the top cap back on the pilot valve.

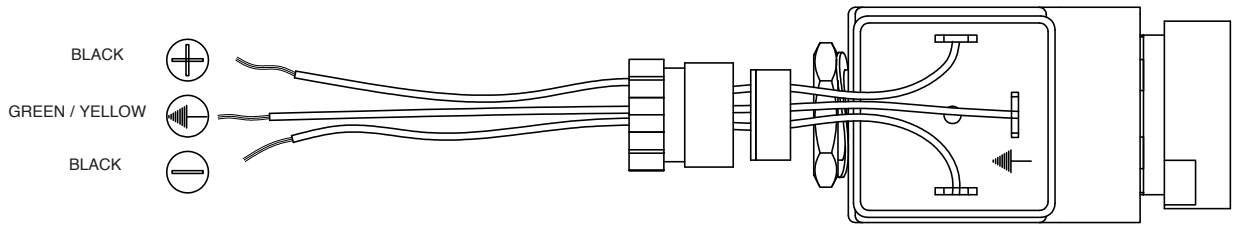


FIGURE 6-59
SOLENOID VALVE ELECTRICAL INSTALLATION
E001772

ELECTRICAL INSTALLATION

When 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 and 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 and 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 actuator, 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 8 bar (116 psi) pressure to the master container valve actuation hose.
4. Verify all pneumatic actuator pistons are in the fired position.
5. Provide 120 bar (1,740 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 steps:

1. Bleed down any trapped pressure through the decompression screw or safety relief valve.
2. 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 [363 psi at 70 °F]). See Tables 8-5 or 8-6 (Temperature Correction) in Section 8 – Recharging Procedure on page 8-6 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.

NOTES:

INSPECTION, SERVICE, AND MAINTENANCE

Systems shall be thoroughly inspected and tested for correct 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 correctly 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 FK-5-1-12 agent 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 correctly 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 a visual examination shows any deficiency, the hose shall be replaced. Every five years, hydrostatically test or replace the flexible discharge hoses. Order replacement hoses from customer services.

CONTAINER WEIGHING

To determine the level of agent in the SAPPHIRE 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 the 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 FK-5-1-12 agent within the container for a given temperature. This data, together with the internal container dimensions and the physical properties of the FK-5-1-12 agent, can then be used to calculate the FK-5-1-12 agent weight. Contact Johnson Controls Technical Services for further information on this methodology.

Note: This methodology is not UL Listed or 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 FK-5-1-12 agent 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 FK-5-1-12 agent level, complete the following steps:

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).

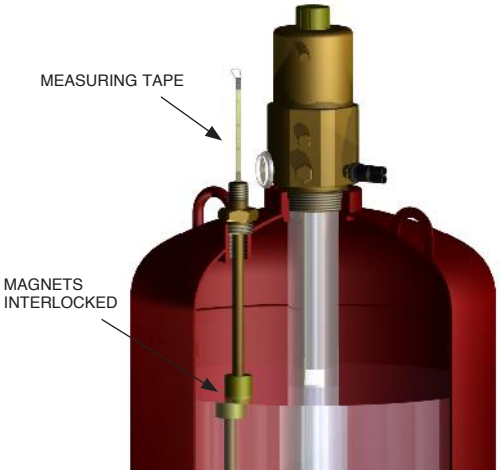


FIGURE 7-1
LIQUID LEVEL MEASURING DEVICE
E001145

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.

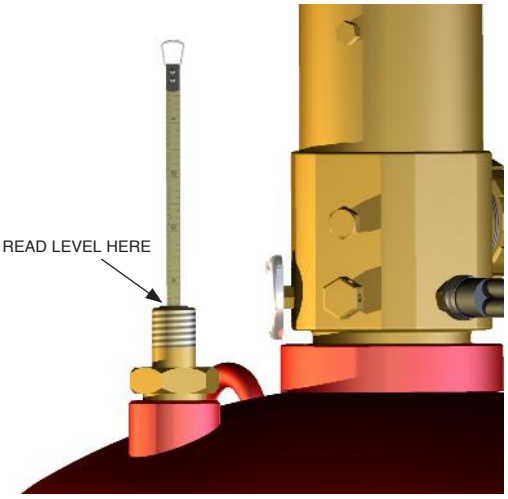


FIGURE 7-2
READING THE LIQUID LEVEL
E001146

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 Liquid Level Indicator Charts located in Section 9 - Appendix, determine the FK-5-1-12 agent weight of charge as follows:
   a. Find the liquid level reading along the left hand vertical line of the chart.
   b. From that point, follow the horizontal line to the point where it intersects with the temperature column (using the FK-5-1-12 agent tank temperature noted in Step 3).
   c. Read the weight of FK-5-1-12 agent at the level and temperature column intersection.
6. Compare the weight from the chart 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 liquid level indicator charts

A semi-annual weight check is being performed on a 180 L (450 lb) SAPPHIRE tank filled with 137 kg (301 lb) of FK-5-1-12 agent. The temperature of the container is 15 °C (59 °F). The liquid level measuring device reading is 52 cm (20.5 in.).

Find the 52 cm line on the left side of the 180 L (450 lb) container chart (see page 9-83) and read horizontally across the table to the 15 °C (59 °F) column. Then, by reading the weight of FK-5-1-12 agent at the level and temperature column intersection, it is determined that the weight of FK-5-1-12 agent is 130.7 kg (288.1 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 FK-5-1-12 agent required in this container:

137 kg x 0.95 = 130 kg (302 lb x 0.95 = 286.9 lb)

Because the measured weight of FK-5-1-12 agent, 130.7 kg, (288.2 lb) is more than the minimum required FK-5-1-12 agent weight of 130 kg (286 lb), the weight of FK-5-1-12 agent 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 correctly.
2. Ensure that any associated control panel displays normal operation.
3. Complete the site logbook, recording work carried out and parts used.
4. Inform the responsible person that the work is complete and the system is back online.

NOTES:

RECHARGING

Releasing trapped nitrogen from the pneumatic actuation line

After 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 the containers

⚠ WARNING

Make certain that the containers contain no pressure before you remove the valves. If a container contains pressure, removing a valve could cause a sudden container movement. A sudden movement of the container could injure personnel or damage property.

To remove the empty SAPPHIRE fire suppression agent containers from the system installation, complete the following steps:

1. Remove the electric or pneumatic actuators.
2. Remove the piping and the discharge hose from the valve outlet.
3. Remove the empty containers from the brackets.
4. Transport the containers to an authorized fill station.
5. Complete the valve refurbishment and refilling procedures in accordance with the steps in this section of the manual.

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. In Table 8-1, item 3 (o-ring and valve core kit) is a mandatory part number. Items 1, 2, 4, 5, and 6 are optional components. See Figures 8-1 and 8-2.

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.

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	302207020 **or** 302207021 **or** 302207022		302207021 **or** 302207022
7	Valve refurbishment kit	309.209.125	309.209.126	309.209.124

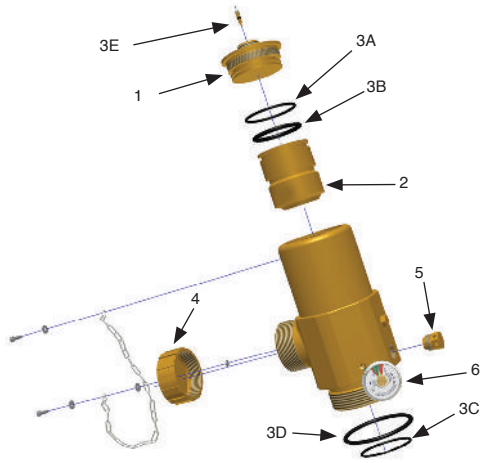
RECHARGING (Continued)

Refurbishing the valve (Continued)

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.
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 using a torque wrench.

    Use the ALLIGATOR valve core (Part No. 20672 / 570730) with a torque of 0.25 N•m to 0.56 N•m (0.184 ft-lb to 0.413 ft-lb) or the Schrader valve core (Part No. 12624) with a torque of 0.34 N•m to 0.56 N•m (0.250 ft-lb to 0.413 ft-lb) or the Schrader valve core (Part No. 12625 / 570043) with a torque of 0.4 N•m to 0.8 N•m (0.30 ft-lb to 0.59 ft-lb).

    The torque wrench (Part No. 20933 [GY] / 570869) supplied in the valve refurbishment toolkit is calibrated to 0.45 N•m (0.332 ft-lb) for use with the any of the valve cores.
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.



Item	Description
1	Bonnet
2	Piston assembly
3a	Bonnet o-ring
3b	Piston o-ring
3c	Siphon tube o-ring
3d	Collar o-ring
3e	Schrader valve
4	Outlet safety cap
5	Burst disc
6	Pressure gauge

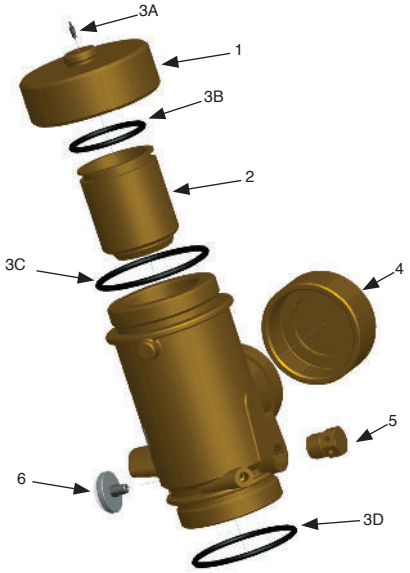
Note: Items 3a to 3e are included with the o-ring kit.

FIGURE 8-1
25 mm AND 50 mm (1 in. AND 2 in.) CONTAINER VALVE
009706

*ALLIGATOR and SCHRADER are trademarks of their respective owners.

RECHARGING (Continued)

Refurbishing the valve (continued)



Item	Description
1	Top cap
2	Piston assembly
3a	Schrader valve
3b	Piston o-ring
3c	Top cap o-ring
3d	Collar o-ring
4	Outlet safety cap
5	Burst disc
6	Pressure gauge

Note: Items 3a to 3d are included with the o-ring kit.

FIGURE 8-2
80 mm (3 in.) CONTAINER VALVE
009707

TESTING THE VALVE

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	Top closing adaptor	Outlet filling adaptor
	Part No.	Part No.	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:

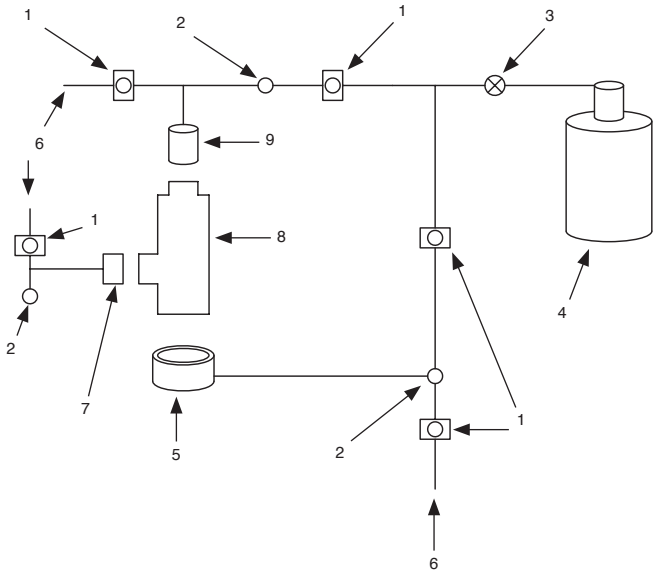
1. Fit the closing down adaptor to the top cap or bonnet valve assembly.
2. Set the nitrogen regulator to 25 bar (360 psi) and slowly allow pressure through needle valve to the valve through the bottom cap until nominal charge pressure is achieved.
3. Close needle valve 1.
4. Set the nitrogen regulator 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.

TESTING THE VALVE (Continued)

Leak test procedure

To carry out a leak test, apply water and soap solution or leak detection spray to all leak paths.

Leak test the bonnet valve core before you remove the outlet filling adaptor assembly when checking for leaks at the valve outlet. If you detect a leak, it must be rectified and retested. If the leak persists, reject the valve assembly.



Item	Description
1	Ball valve
2	Pressure gauge
3	Regulator
4	Nitrogen
5	Bottom test cap
6	Vent
7	Outlet filling adaptor
8	Valve body
9	Top closing adaptor

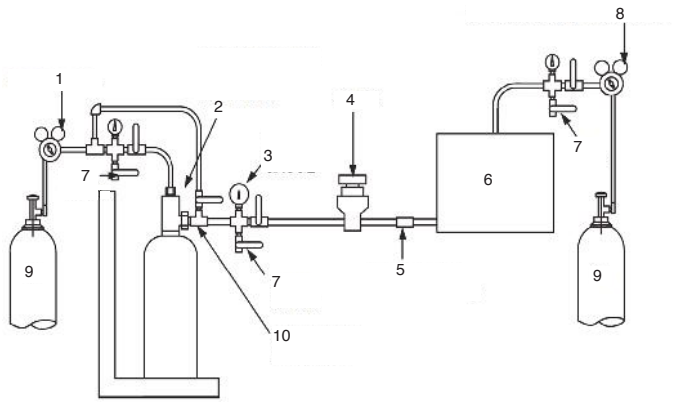
FIGURE 8-3
TESTING STATION CONFIGURATION
011537

RECHARGING INSTRUCTIONS

Figure 8-4 illustrates a standard recharge station configuration. It illustrates a closed system arrangement to minimize the risk of moisture contamination.

⚠ WARNING

Use the appropriate high pressure regulator.



Item	Description
1	Regulator
2	Closing down adaptor assembly
3	Fill pressure gauge
4	Pump
5	Filter (20 microns or less)
6	Agent storage tank
7	Vent valve
8	0.2 bar (2.9 psi) regulator
9	N_2
10	Outlet fill adaptor

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 Testing the Valve 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.

RECHARGING INSTRUCTIONS (Continued)

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 and welded
300209038	50 mm (2 in.)	Seamless and welded
300.209.004 570932	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.

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 (-0 psi, +11 psi) (3% of nominal charge pressure)
30 L	-0, +0.150 kg (-0, +0.33 lb)	
45 L	-0, +0.225 kg (-0, +0.50 lb)	
60 L	-0, +0.300 kg (-0, +0.66 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 (-0 psi, +11 psi) (3% of nominal charge pressure)
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 (5.5 lb), ensure the targeted fill is 2.5 kg +0.05 to 0.1 kg (5.5 lb +0.11 to 0.22 lb).

RECHARGING INSTRUCTIONS (Continued)

TABLE 8-5: TEMPERATURE CORRECTION TABLE (METRIC)

	Fill density: 1.2 kg/L
Temperature (°C)	**25 bar at 20 °C (bar)**
-20	20.2
-19	20.3
-18	20.4
-17	20.5
-16	20.7
-15	20.8
-14	20.9
-13	21.0
-12	21.1
-11	21.3
-10	21.4
-9	21.5
-8	21.6
-7	21.7
-6	21.9
-5	22.0
-4	22.1
-3	22.2
-2	22.3
-1	22.5
0	22.6
1	22.7
2	22.8
3	22.9
4	23.1
5	23.2
6	23.3
7	23.4
8	23.6
9	23.7
10	23.8
11	23.9
12	24.0
13	24.2
14	24.3
15	24.4
16	24.5
17	24.6
18	24.8
19	24.9
20	25.0

	Fill density: 1.2 kg/L
Temperature (°C)	**25 bar at 20 °C (bar)**
21	25.1
22	25.2
23	25.4
24	25.5
25	25.6
26	25.7
27	25.8
28	26.0
29	26.1
30	26.2
31	26.3
32	26.4
33	26.6
34	26.7
35	26.8
36	26.9
37	27.1
38	27.2
39	27.3
40	27.4
41	27.5
42	27.7
43	27.8
44	27.9
45	28.0
46	28.1
47	28.3
48	28.4
49	28.5
50	28.6
51	28.7
52	28.9
53	29.0
54	29.1
55	29.2

RECHARGING INSTRUCTIONS (Continued)

TABLE 8-6: TEMPERATURE CORRECTION TABLE (IMPERIAL)

Temp. (°F)	Fill density: 74.9 lb/ft^3 360 psi at 70 °F (psi)
-4	287.97
-3	288.94
-2	289.91
-1	290.89
0	291.86
1	292.83
2	293.81
3	294.78
4	295.75
5	296.73
6	297.70
7	298.67
8	299.65
9	300.62
10	301.59
11	302.57
12	303.54
13	304.51
14	305.49
15	306.46
16	307.43
17	308.41
18	309.38
19	310.35
20	311.33
21	312.30
22	313.27
23	314.25
24	315.22
25	316.20
26	317.17
27	318.14
28	319.12
29	320.09
30	321.06
31	322.04
32	323.01
33	323.98
34	324.96
35	325.93
36	326.90
37	327.88

Temp. (°F)	Fill density: 74.9 lb/ft^3 360 psi at 70 °F (psi)
38	328.85
39	329.82
40	330.80
41	331.77
42	332.74
43	333.72
44	334.69
45	335.66
46	336.64
47	337.61
48	338.58
49	339.56
50	340.53
51	341.50
52	342.48
53	343.45
54	344.42
55	345.40
56	346.37
57	347.34
58	348.32
59	349.29
60	350.26
61	351.24
62	352.21
63	353.18
64	354.16
65	355.13
66	356.10
67	357.08
68	358.05
69	359.02
70	**360.00**
71	360.97
72	361.94
73	362.92
74	363.89
75	364.87
76	365.84
77	366.81
78	367.79
79	368.76

Temp. (°F)	Fill density: 74.9 lb/ft^3 360 psi at 70 °F (psi)
80	369.73
81	370.71
82	371.68
83	372.65
84	373.63
85	374.60
86	375.57
87	376.55
88	377.52
89	378.49
90	379.47
91	380.44
92	381.41
93	382.39
94	383.36
95	384.33
96	385.31
97	386.28
98	387.25
99	388.23
100	389.20
101	390.17
102	391.15
103	392.12
104	393.09
105	394.07
106	395.04
107	396.01
108	396.99
109	397.96
110	398.93
111	399.91
112	400.88
113	401.85
114	402.83
115	403.80
116	404.77
117	405.75
118	406.72
119	407.69
120	408.67
121	409.64

Temp. (°F)	Fill density: 74.9 lb/ft^3 360 psi at 70 °F (psi)
122	410.61
123	411.59
124	412.56
125	413.54
126	414.51
127	415.48
128	416.46
129	417.43
130	418.40
131	419.38

CONTAINER AND VALVE ASSEMBLY LEAKAGE TEST

A leakage test is required for all filled SAPPHIRE 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 table 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. 315.207.010) 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:

1. Carefully probe the container and valve assembly at all probes and openings. Do not bring the probe into direct contact with any objects as this can lead to spurious results.
2. Ensure that the dwell time of the probe is sufficiently long, more than five seconds, to detect any leak. Take any significant and repeatable **alarm state** as an indication of a leak. In this case, the container and valve assembly should be rejected.
3. When the leakage source has been rectified, subject the container and valve assembly to another leak test using the halocarbon leak detector unit.
4. 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 that is valid for 12 months from the date of filling, subject to the minimum charge pressure not being exceeded. To refill and recalibrate an empty FK-5-1-12 agent leak standard, return the empty leak standard under Part No. 315.207.011 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.

APPENDIX 1: 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 that 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 electrical checklist for the **main** container bank.		
2	Carry out the electrical checklist 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.		

APPENDIX 1: COMMISSIONING SCHEDULE EXAMPLE

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.		

APPENDIX 1: COMMISSIONING SCHEDULE EXAMPLE

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.		

APPENDIX 1: COMMISSIONING SCHEDULE EXAMPLE

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 unauthorized 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:							
	Containers		**FK-5-1-12 agent quantity**				
Area protected	**Size (L)**	**Serial number**	**Design (kg)**	**Actual (kg)**	**Pressure (bar)**	**Temperature (˚C)**	**Corrections required (Yes / No)**

APPENDIX 1: COMMISSIONING SCHEDULE EXAMPLE

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 that all pneumatic actuators, pressure switches and pressure trips operate at 4.0 bar (58.0 psi) or lower using the pneumatic test kit.		
6	Check the integrity of the pilot line, actuators, pressure switches, and pressure trips by testing at 117 bar (1,697 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.		

APPENDIX 2: 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 the electrical checklist for the **main** container bank.		
2	Carry out the electrical checklist 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.		

APPENDIX 2: SERVICING AND MAINTENANCE SCHEDULE EXAMPLE

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.		

APPENDIX 2: SERVICING AND MAINTENANCE SCHEDULE EXAMPLE

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.		

APPENDIX 2: SERVICING AND MAINTENANCE SCHEDULE EXAMPLE

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 unauthorized 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		**FK-5-1-12 agent quantity**				
Area protected	**Size (L)**	**Serial number**	**Design (kg)**	**Actual (kg)**	**Pressure (bar)**	**Temperature (°C)**	**Corrections required (Yes / No)**

APPENDIX 2: SERVICING AND MAINTENANCE SCHEDULE EXAMPLE

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 that all pneumatic actuators, pressure switches, and pressure trips operate at 4.0 bar (58.0 psi) or lower using the pneumatic test kit.		
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.		

APPENDIX 2: SERVICING AND MAINTENANCE SCHEDULE EXAMPLE

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:

APPENDIX 3:
FK-5-1-12 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 following link 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: WHIMS 2015

Product name SAPPHIRE 25bar DOT Agent Container Assembly 8L (Empty or Filled)

1. Identification of the Substance/Preparation and of the Company/Undertaking

Product identifier

Product name SAPPHIRE 25bar DOT Agent Container Assembly 8L (Empty or Filled)

Other means of identification

Product code 303.207.001

UN number or ID number UN1956

Synonyms None

Recommended use of the chemical and restrictions on use

Recommended use Fire extinguishing agent

Uses advised against No information available

Details of the supplier of the safety data sheet

Initial supplier identifier
Johnson Controls
Canadian Distribution Centre
20 Delta Park Blvd
Brampton ON L6T 5E7
Telephone: 1-888-888-7838

Emergency telephone number

Emergency telephone CHEMTREC 001-800-424-9300 or 001-703-527-3887

2. Hazards Identification

Classification

Gases under pressure	Compressed gas
Simple asphyxiants	Category 1

Label elements

Warning

Contains gas under pressure; may explode if heated
May displace oxygen and cause rapid suffocation



Precautionary Statements - Storage
Protect from sunlight. Store in a well-ventilated place

Other information
Harmful to aquatic life with long lasting effects

3. Composition/information on Ingredients

Substance

Not applicable.

Mixture

Chemical name	CAS No	Weight-%	Hazardous Material Information Review Act registry number (HMIRA registry #)	Date HMIRA filed and date exemption granted (if applicable)
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone	756-13-8	90 - 100%	-	-
Nitrogen	7727-37-9	0 - 10%	-	-

4. First aid measures

Description of first aid measures

Inhalation Remove to fresh air.

Eye contact Rinse thoroughly with plenty of water for at least 15 minutes, lifting lower and upper eyelids. Consult a physician.

Skin contact Wash skin with soap and water.

Ingestion Rinse mouth.

Most important symptoms and effects, both acute and delayed

Symptoms No information available.

Indication of any immediate medical attention and special treatment needed

Note to physicians Treat symptomatically.

5. Fire-fighting measures

Suitable Extinguishing Media Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Unsuitable extinguishing media CAUTION: Use of water spray when fighting fire may be inefficient.

Specific hazards arising from the chemical No information available.

Explosion data
Sensitivity to mechanical impact None.
Sensitivity to static discharge None.

Special protective equipment and precautions for fire-fighters Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear. Use personal protection equipment.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

Personal precautions Ensure adequate ventilation.

Environmental precautions

Environmental precautions Prevent entry into waterways, sewers, basements or confined areas. Prevent further leakage or spillage if safe to do so. See Section 12 for additional Ecological Information.

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 labeled containers.

Prevention of secondary hazards Clean contaminated objects and areas thoroughly observing environmental regulations.

7. Handling and Storage

Precautions for safe handling

Advice on safe handling Contents under pressure. Empty containers pose a potential fire and explosion hazard. Do not cut, puncture or weld containers.

FOR REFERENCE ONLY

Conditions for safe storage, including any incompatibilities

Storage Conditions Keep container tightly closed in a dry and well-ventilated place Protect from sunlight

8. Exposure Controls/Personal Protection

Control parameters

Chemical name	Alberta	British Columbia	Ontario	Quebec
Nitrogen 7727-37-9			TWA:	

Appropriate engineering controls

Engineering controls Ensure adequate ventilation, especially in confined areas.

Individual protection measures, such as personal protective equipment

Eye/face protection No special protective equipment required.

Skin and body protection No special protective equipment required.

Respiratory protection No protective equipment is needed under normal use conditions. If exposure limits are exceeded or irritation is experienced, ventilation and evacuation may be required.

Ventilation Use local exhaust or general dilution ventilation to control exposure with applicable limits

General hygiene considerations Handle in accordance with good industrial hygiene and safety practice.

9. Physical and Chemical Properties

Information on basic physical and chemical properties

Physical state	Liquid
Appearance	No information available
Color	colorless
Odor	Characteristic
Odor threshold	No information available

Property	**Values**	**Remarks • Method**
pH	No information available	None known
Melting point / freezing point	No information available	None known
Initial boiling point and boiling range	No information available	49.2 °C
Flash point	No information available	None known
Evaporation rate	No information available	None known
Flammability	No data available	None known
Flammability Limit in Air		No data available
Upper flammability or explosive	No information available	

limits		
Lower flammability or explosive limits	No information available	
Vapor pressure	No information available	None known
Relative vapor density	No information available	None known
Relative density	No data available	None known
Water Solubility	No data available	None known
Solubility in other solvents	No information available	None known
Partition coefficient	No information available	None known
Autoignition temperature	No information available	None known
Hyphen	No data available	None known
Kinematic viscosity	No data available	None known
Dynamic viscosity	No data available	None known

Other information

Softening point	Not applicable
Molecular weight	Not applicable
VOC content	Not applicable
Liquid Density	Not applicable
Bulk density	Not applicable

10. Stability and Reactivity

Reactivity No information available.

Chemical stability Stable under normal conditions.

Possibility of hazardous reactions None under normal processing.

Conditions to avoid Extremes of temperature and direct sunlight.

Incompatible materials Strong oxidizing agents. Strong acids. Strong bases.

Hazardous decomposition products Carbon oxides. Nitrogen oxides (NOx). Fluorinated oxides.

11. Toxicological Information

Information on likely routes of exposure

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, vapors can readily accumulate and can cause unconsciousness and death.

Eye contact Specific test data for the substance or mixture is not available.

Skin contact Specific test data for the substance or mixture is not available.

Ingestion Specific test data for the substance or mixture is not available.

Symptoms related to the physical, chemical and toxicological characteristics

Symptoms No information available.

Numerical measures of toxicity

Acute toxicity

Chemical name	Oral LD50	Dermal LD50	Inhalation LC50
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone 756-13-8	-	> 2000 mg/kg (Rat)	> 1275 mg/L (Rat) 4 h

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation No information available.

Serious eye damage/eye irritation No information available.

Respiratory or skin sensitization 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.

Aspiration hazard No information available.

12. Ecological Information

Ecotoxicity Harmful to aquatic life with long lasting effects.

Chemical name	Algae/aquatic plants	Fish	Toxicity to microorganisms	Crustacea
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone 756-13-8	Pseudokirchneriella subcapitata EC50: 10.6 mg/L (96h)	-	-	-

Persistence and degradability Not readily biodegradable.

Bioaccumulation No information available.

Other adverse effects No information available.

13. Disposal Considerations

Disposal methods

Waste from residues/unused products	Dispose of in accordance with local regulations. Dispose of waste in accordance with environmental legislation.
Contaminated packaging	Do not reuse empty containers.

14. Transport Information

TDG

UN number or ID number	UN1956
UN proper shipping name	Compressed gas, n.o.s.
Transport hazard class(es)	2.2
Special Provisions	16, 148
Description	UN1956, Compressed gas, n.o.s. (Nitrogen Mixture), 2.2

MEX

UN number or ID number	UN1956
UN proper shipping name	Compressed gas, n.o.s.
Transport hazard class(es)	2.2
Special Provisions	274
Description	UN1956, Compressed gas, n.o.s. (Nitrogen Mixture), 2.2

ICAO (air)

UN number or ID number	UN1956
UN proper shipping name	Compressed gas, n.o.s.
Transport hazard class(es)	2.2
Special Provisions	A202
Description	UN1956, Compressed gas, n.o.s. (Nitrogen Mixture), 2.2

IATA

UN number or ID number	UN1956
Transport hazard class(es)	2.2
ERG Code	2L
Special Provisions	A202
Description	UN1956, Compressed gas, n.o.s. (Nitrogen Mixture), 2.2

IMDG

UN number or ID number	UN1956
Transport hazard class(es)	2.2
EmS-No	F-C, S-V
Special Provisions	274, 378, 392
Description	UN1956, Compressed gas, n.o.s.(Nitrogen Mixture), 2.2

RID

UN number or ID number	UN1956
UN proper shipping name	Compressed gas, n.o.s.

FOR REFERENCE ONLY

Transport hazard class(es)	2.2
Classification code	1A
Special Provisions	274, 378, 392, 655, 662
Description	UN1956, Compressed gas, n.o.s.(Nitrogen Mixture), 2.2
Labels	2.2 (+13)

ADR

UN number or ID number	UN1956
UN proper shipping name	Compressed gas, n.o.s.
Transport hazard class(es)	2.2
Classification code	1A
Tunnel restriction code	(E)
Special Provisions	274, 378, 392, 655, 662
Description	UN1956, Compressed gas, n.o.s.(Nitrogen Mixture), 2.2, (E)
Labels	2.2

ADN

UN proper shipping name	Compressed gas, n.o.s.
Transport hazard class(es)	2.2
Classification code	1A
Special Provisions	274, 378, 392, 655, 662
Description	UN1956, Compressed gas, n.o.s.(Nitrogen Mixture), 2.2
Hazard label(s)	2.2
Limited quantity (LQ)	120 ml
Equipment Requirements	PP

15. Regulatory Information

Safety, health and environmental regulations/legislation specific for the substance or mixture

International Regulations

Ozone-depleting substances (ODS)	Not Applicable
The Stockholm Convention on Persistent Organic Pollutants	Not applicable
The Rotterdam Convention	Not applicable

International Inventories

TSCA	Complies
DSL/NDSL	Complies
ENCS	Complies
IECSC	Complies
KECL	Does not comply
PICCS	Does not comply
AIIC	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
AIIC - Australian Inventory of Industrial Chemicals

16. Other information, including date of preparation of the last revision

NFPA	**Health hazards** 0	**Flammability** 0	**Instability** 0	**Special hazards** -
HMIS	**Health hazards** 0	**Flammability** 0	**Physical hazards** 0	**Personal protection** X

Revision date 22-Aug-2023
Revision Note No information available.

End of Safety Data Sheet

NOTES:

APPENDIX 4: FK-5-1-12 AGENT CONCENTRATIONS FOR OTHER FUELS (FROM ISO 1452-5:2019)	
Fuel	**Minimum design concentration (vol%)**
Acetone	5.9
Ethyl alcohol	7.2
Marine diesel	5.9
Methyl alcohol	8.5
Methyl ethyl ketone	5.9
n-heptane	5.9
Technical heptane	5.9

APPENDIX 5: DEVELOPED PRESSURE CHART

Use this chart in accordance with Table 8-5 (metric) or 8-6 (imperial) in Section 8 - Recharging Procedure.

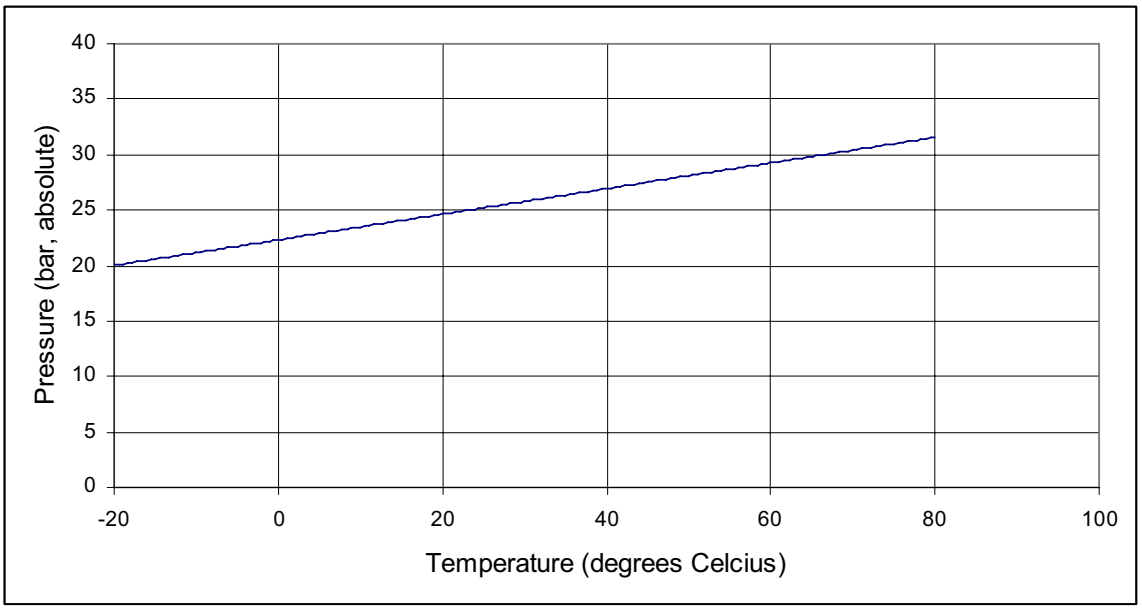


FIGURE 9-1
DEVELOPED PRESSURE CHART

APPENDIX 6: ACTUATION LINE LENGTH LIMITATIONS

Refer to Tables 9-1 to 9-2 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 flexible female actuation hose.
- Connection master to 7 subordinates requires 7 flexible female actuation 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.

APPENDIX 6: ACTUATION LINE LENGTH LIMITATIONS

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 + 10 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 + 10 x subordinates	Dia 6 mm copper pipe + Flexible female actuation 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 + Flexible female actuation 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 + Flexible female actuation 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	–	

APPENDIX 6: ACTUATION LINE LENGTH LIMITATIONS

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 + 10 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	–	

APPENDIX 6: ACTUATION LINE LENGTH LIMITATIONS

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 + 10 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 + 10 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	–	

APPENDIX 6: ACTUATION LINE LENGTH LIMITATIONS

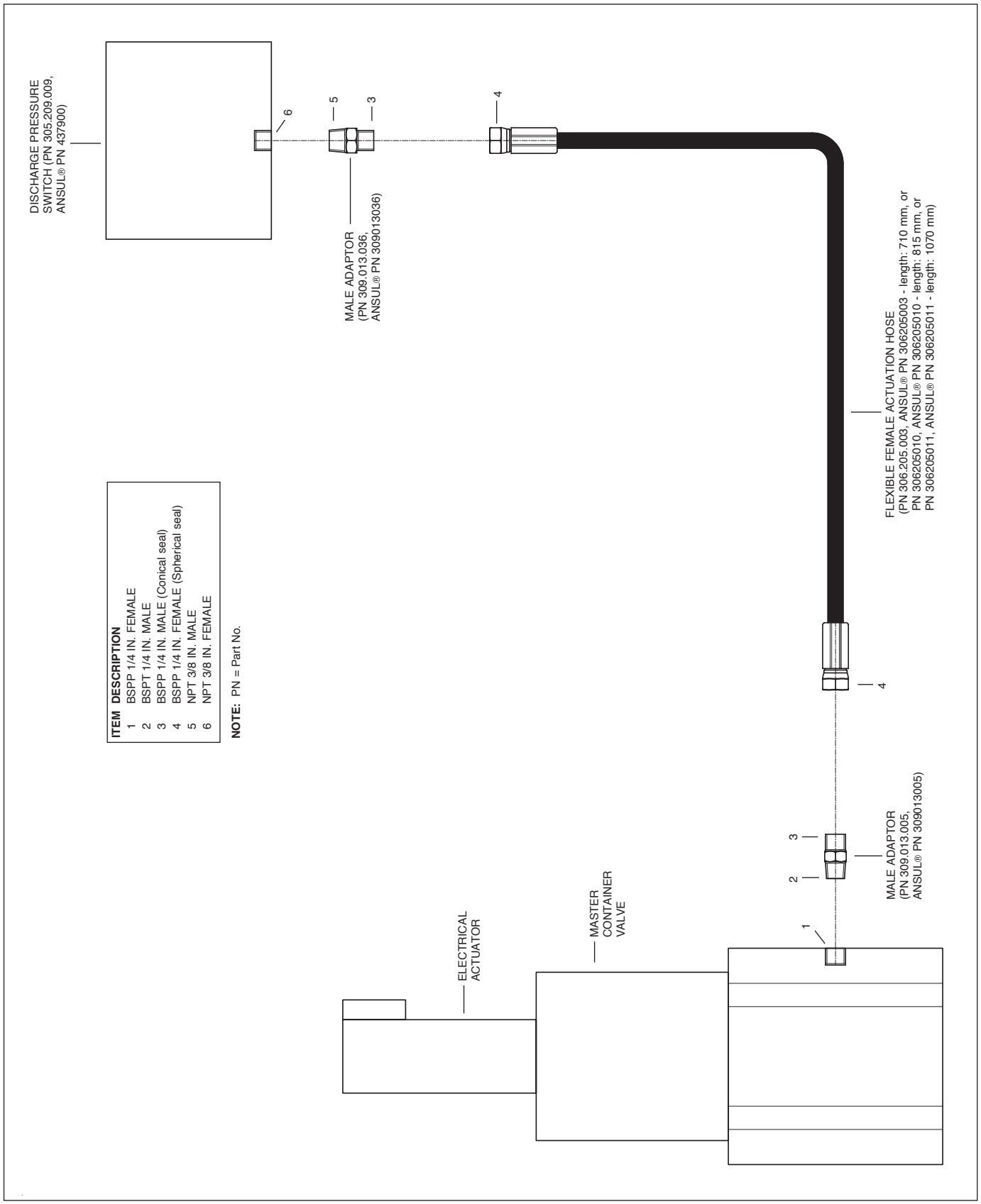
TABLE 9-2: MANIFOLDED SYSTEM CONFIGURATION (Continued)

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 + 10 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	–	

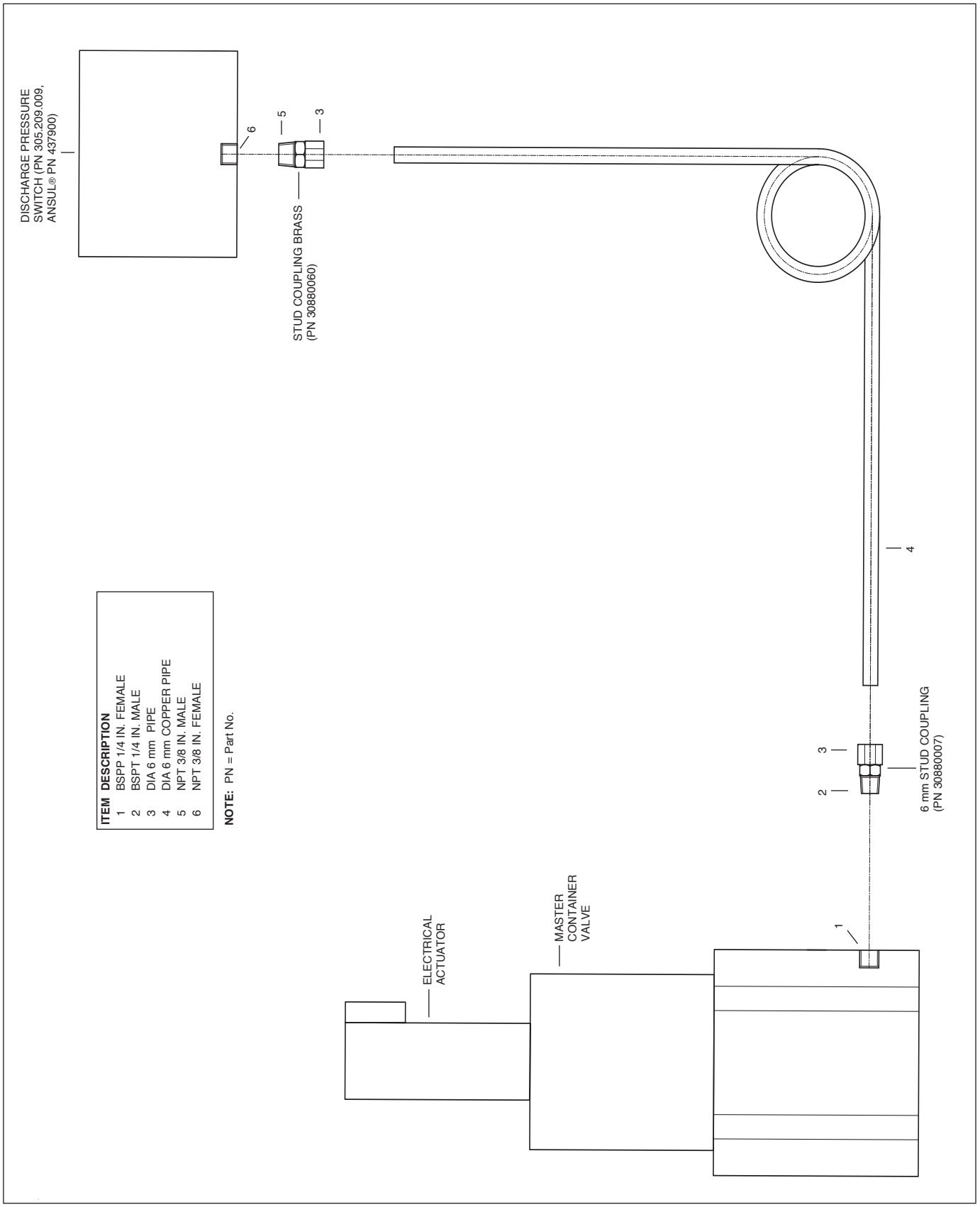
APPENDIX 7: ACTUATION LINE SCHEMATICS

SCHEMATIC	PAGE
Single container - single hazard DN 1/4 in. PTFE flexible hose	9-32
Single container - single hazard Dia 6 mm copper pipe	9-33
Single container - single hazard Dia 1/4 in. copper tube	9-34
Multiple container - single hazard Master / subordinate container DN 1/4 in. flexible hose	9-35
DN 1/4 in. PTFE flexible hose - option	9-36
Multiple container - single hazard Master / subordinate container Dia 6 mm copper pipe	9-37
Multiple container - single hazard Master / subordinate container Dia 1/4 in. copper tube	9-38
Multiple container - single hazard Pilot container DN 1/4 in. PTFE flexible hose	9-39
Multiple container - single hazard Pilot container with sub-master container Dia 6 mm copper pipe / PTFE flexible hose	9-40
Multiple container - single hazard Pilot container with sub-master container Dia 1/4 in. copper tube / DN 1/4 in. PTFE Flexible hose	9-41
Multiple container - single hazard Pilot container Dia 6 mm copper pipe	9-42
Multiple container - single hazard Pilot container Dia 1/4 in. copper tube	9-43
Multiple container - single hazard AUTOMAN II-C release Dia 6 mm copper pipe	9-44
Multiple container - single hazard AUTOMAN II-C release Dia 1/4 in. copper tube	9-45
Multiple container - single hazard AUTOMAN II-C release with sub-master container Dia 6 mm copper pipe / DN 1/4 in. PTFE flexible hose	9-46
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	9-47

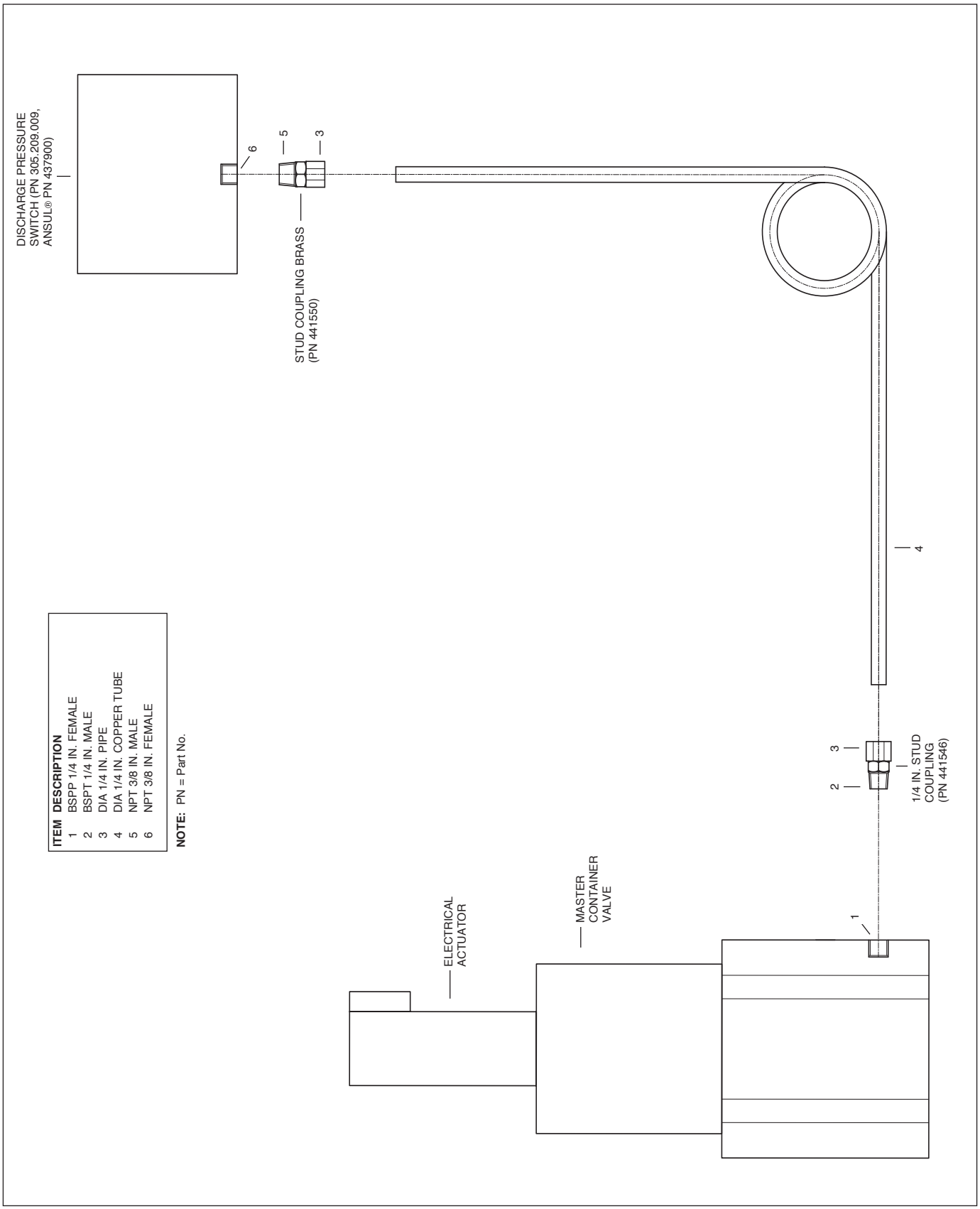
SINGLE CONTAINER - SINGLE HAZARD DN 1/4 in. PTFE FLEXIBLE FEMALE ACTUATION HOSE (SCSH14FH_REV.00)



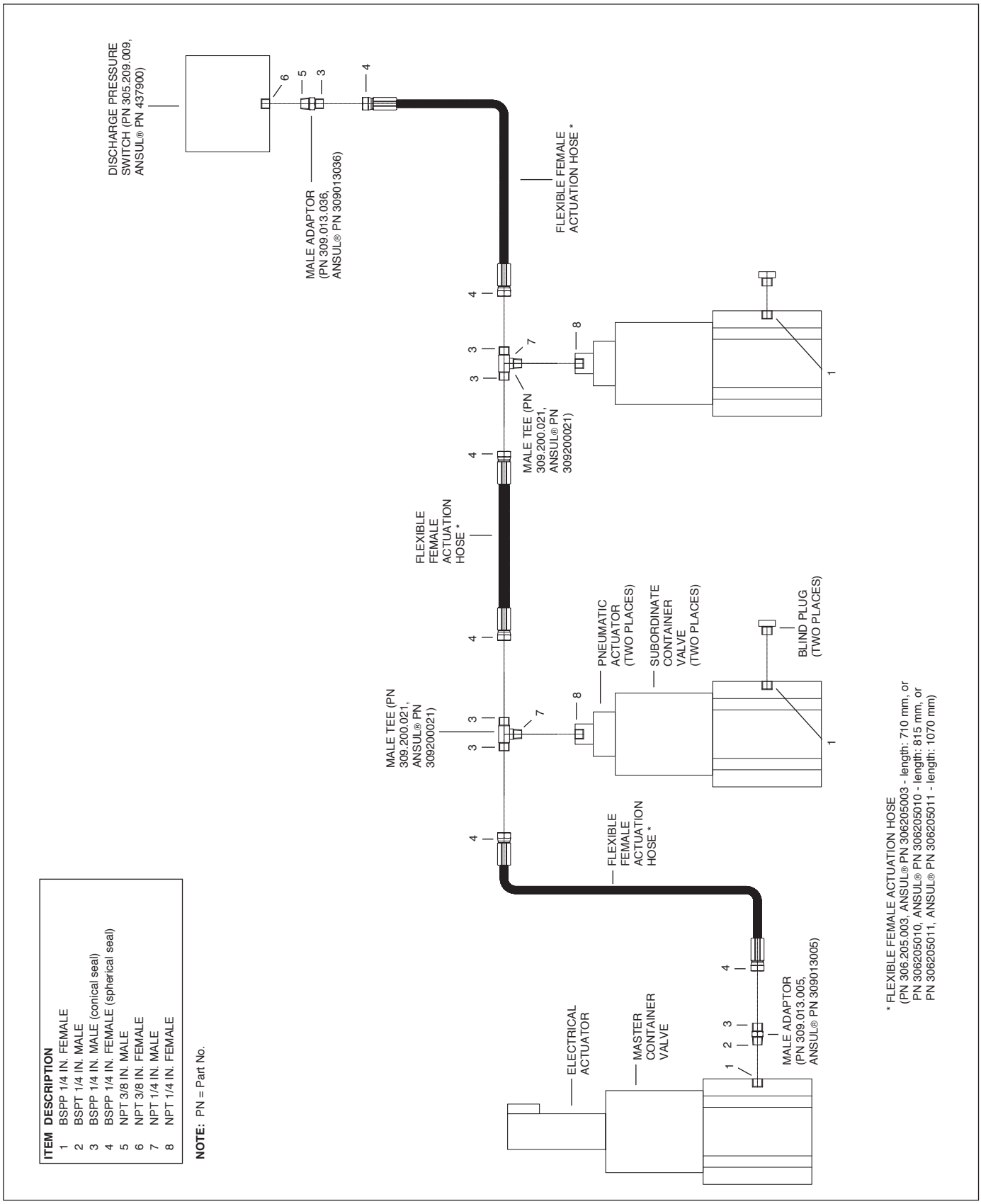
SINGLE CONTAINER - SINGLE HAZARD DIA 6 mm COPPER PIPE
(SCSH6CU_REV.05)



SINGLE CONTAINER - SINGLE HAZARD DIA 1/4 in. COPPER TUBE
(SCSH14CU_REV.00)

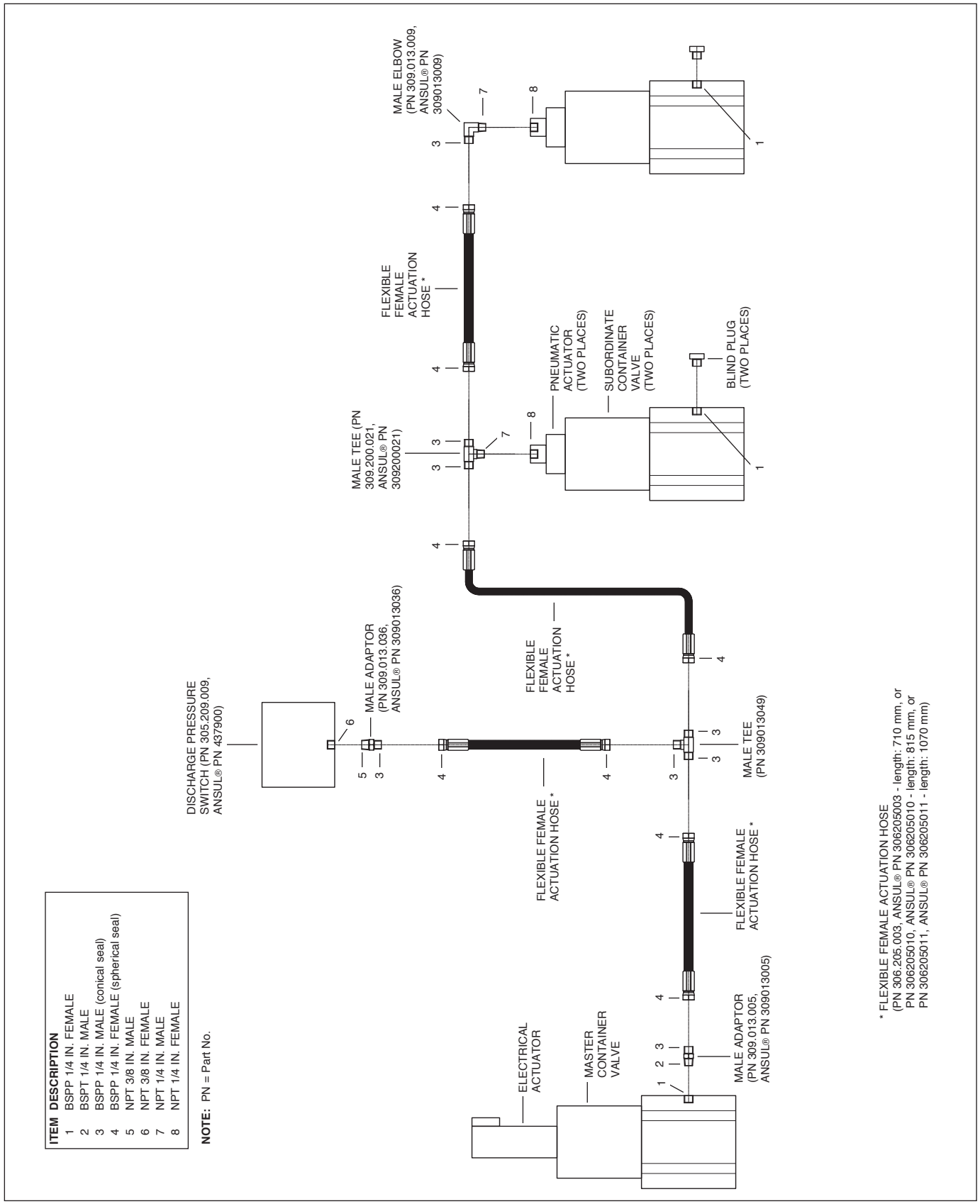


MULTIPLE CONTAINER - SINGLE HAZARD MASTER / SUBORDINATE CONTAINER
DN 1/4 in. PTFE FLEXIBLE FEMALE ACTUATION HOSE (MCSHMS14FH_REV.04)

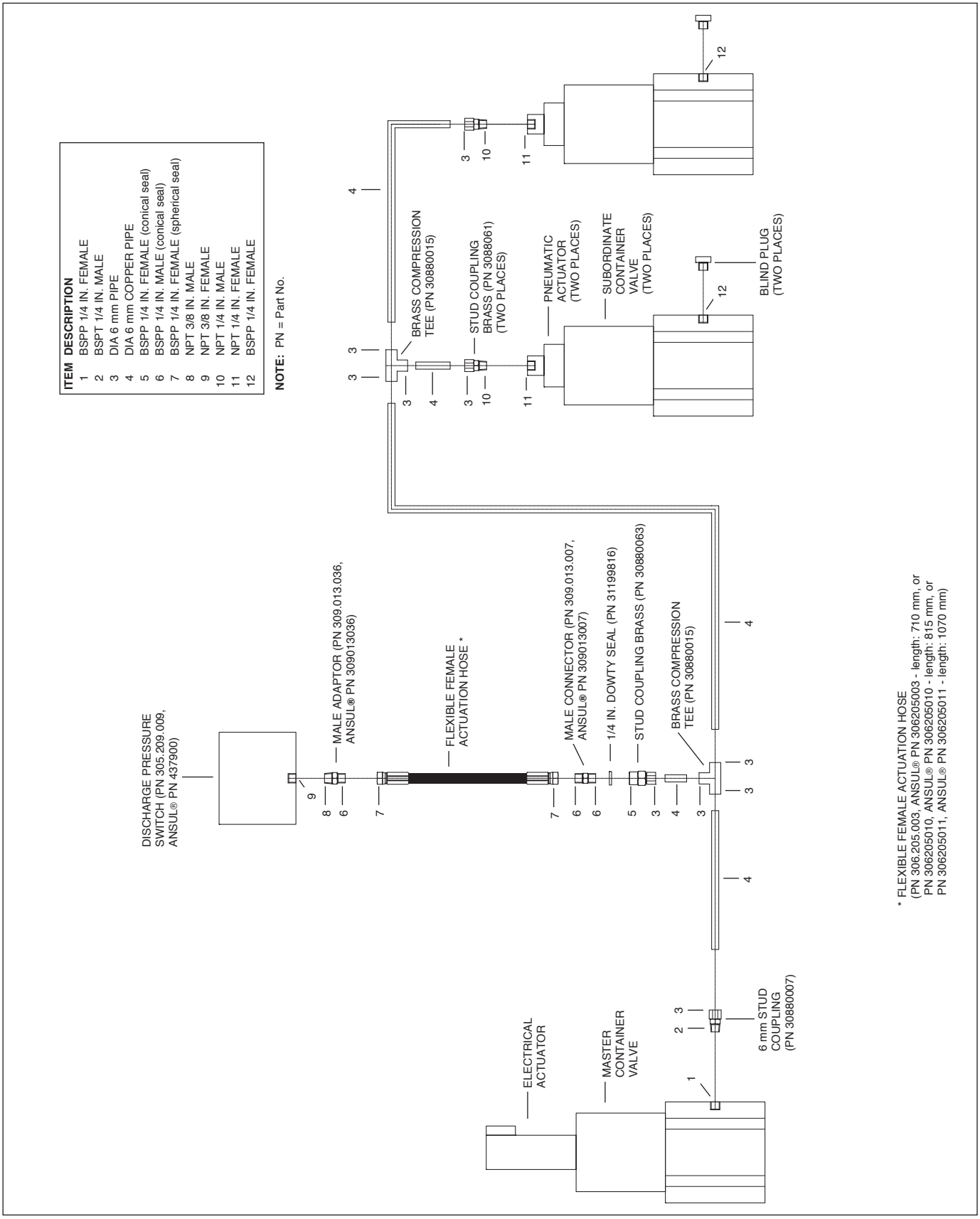


MULTIPLE CONTAINER - SINGLE HAZARD MASTER / SUBORDINATE CONTAINER (Continued)

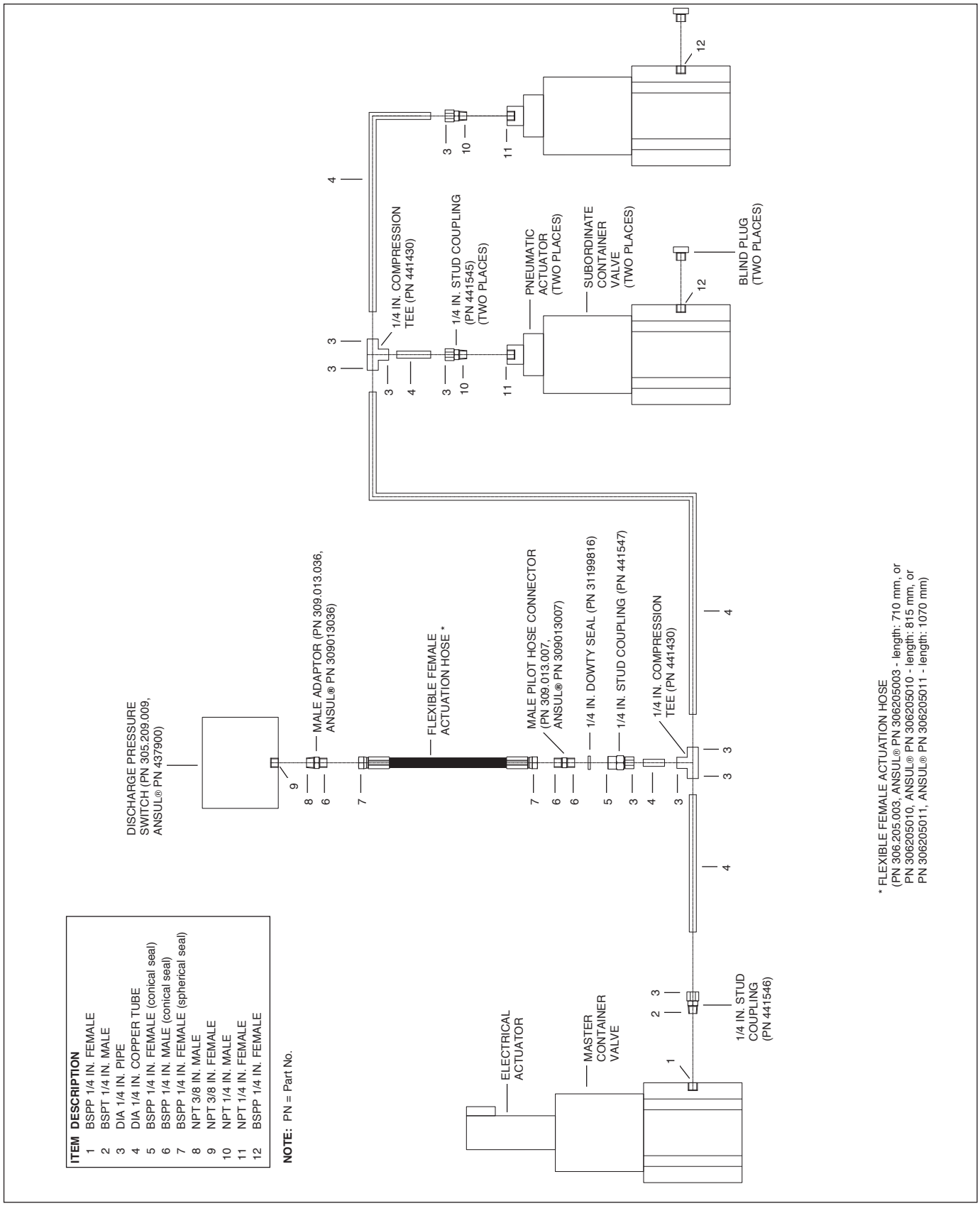
DN 1/4 in. PTFE FLEXIBLE FEMALE ACTUATION HOSE - OPTION (MCSHMS14FH_REV.03)



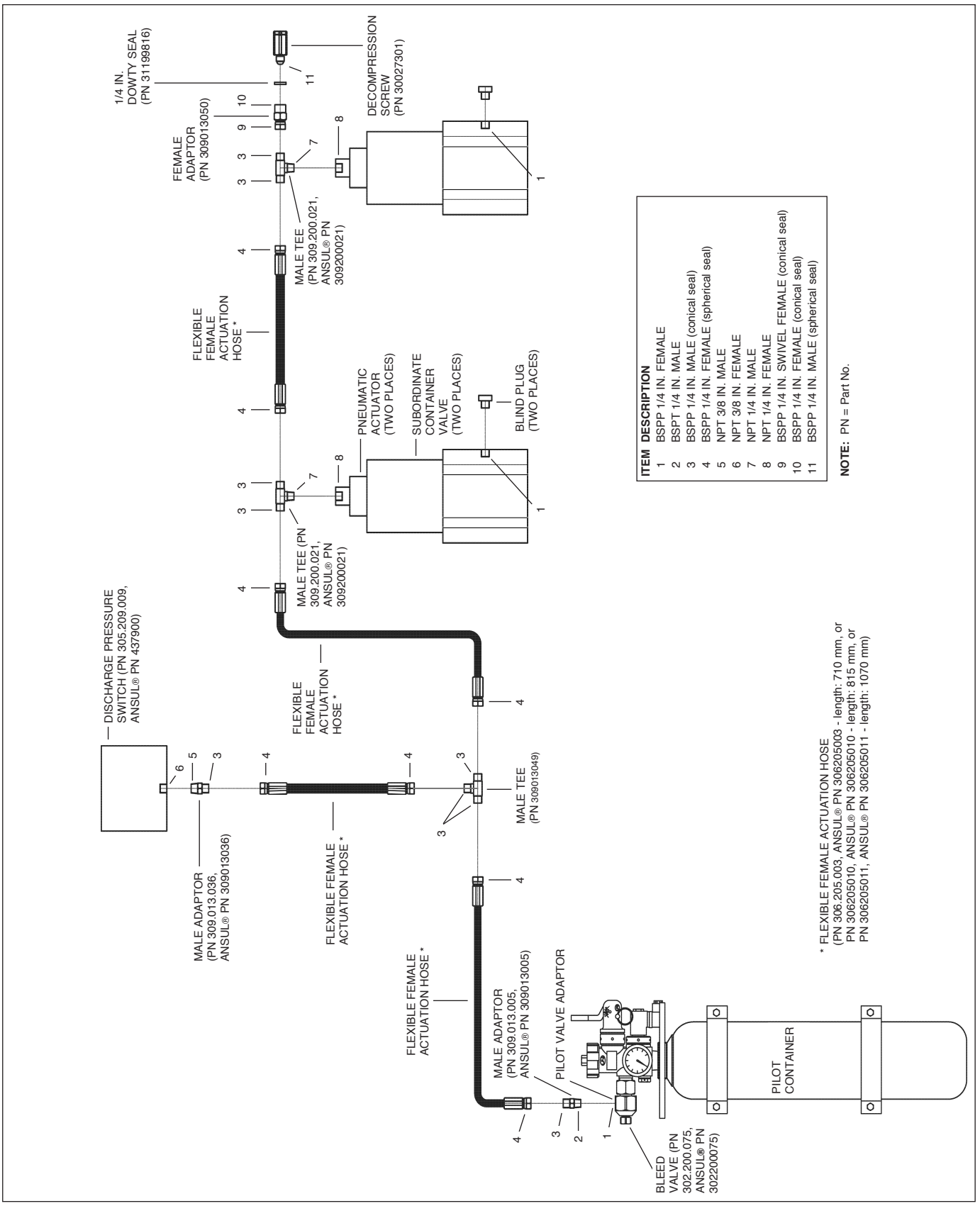
MULTIPLE CONTAINER - SINGLE HAZARD MASTER / SUBORDINATE CONTAINER
Dia 6 mm COPPER PIPE (MCSHMS6CU_REV.06)



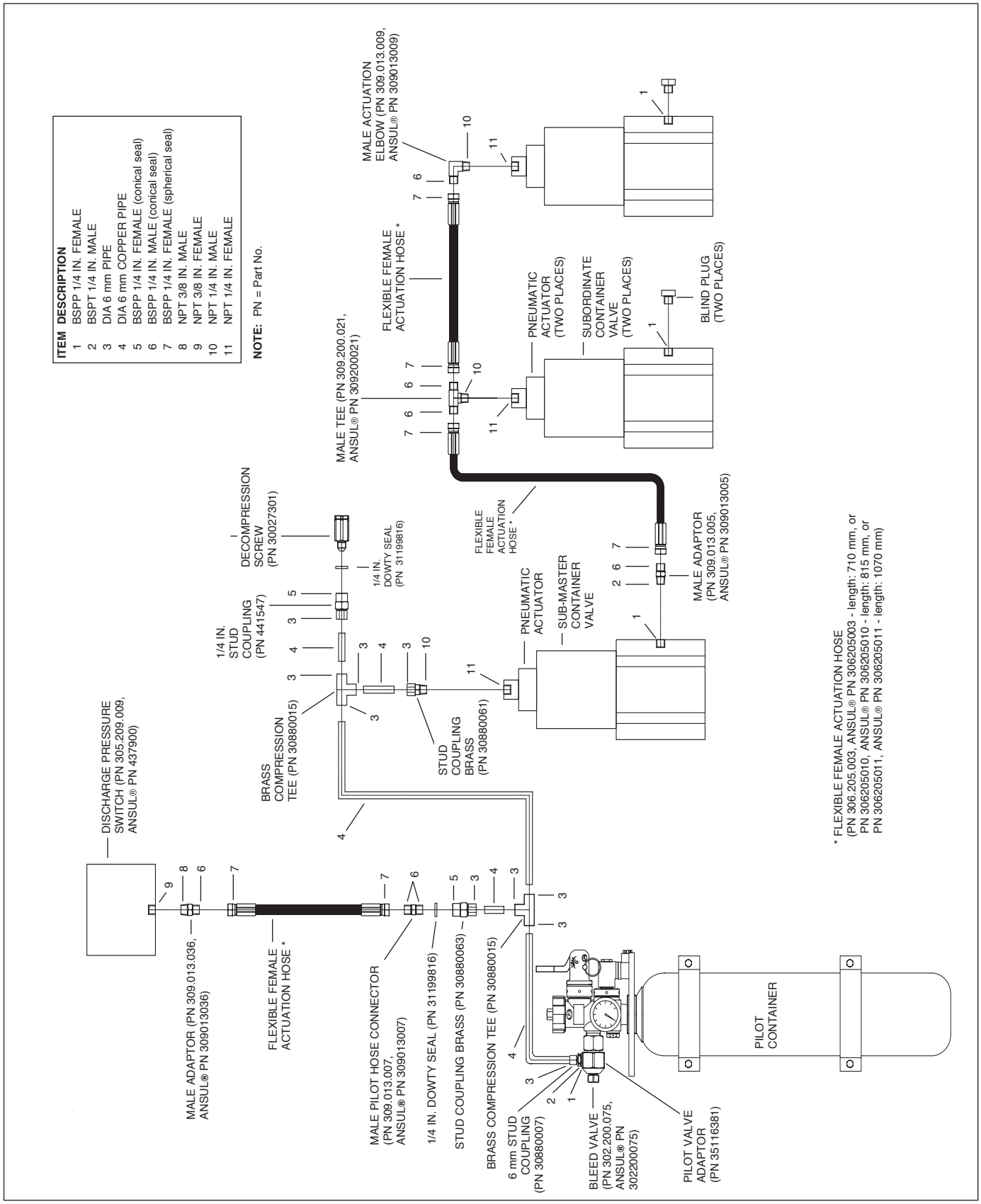
MULTIPLE CONTAINER - SINGLE HAZARD MASTER / SUBORDINATE CONTAINER
DIA 1/4 in. COPPER TUBE (MCSHMS14CU_REV.00)



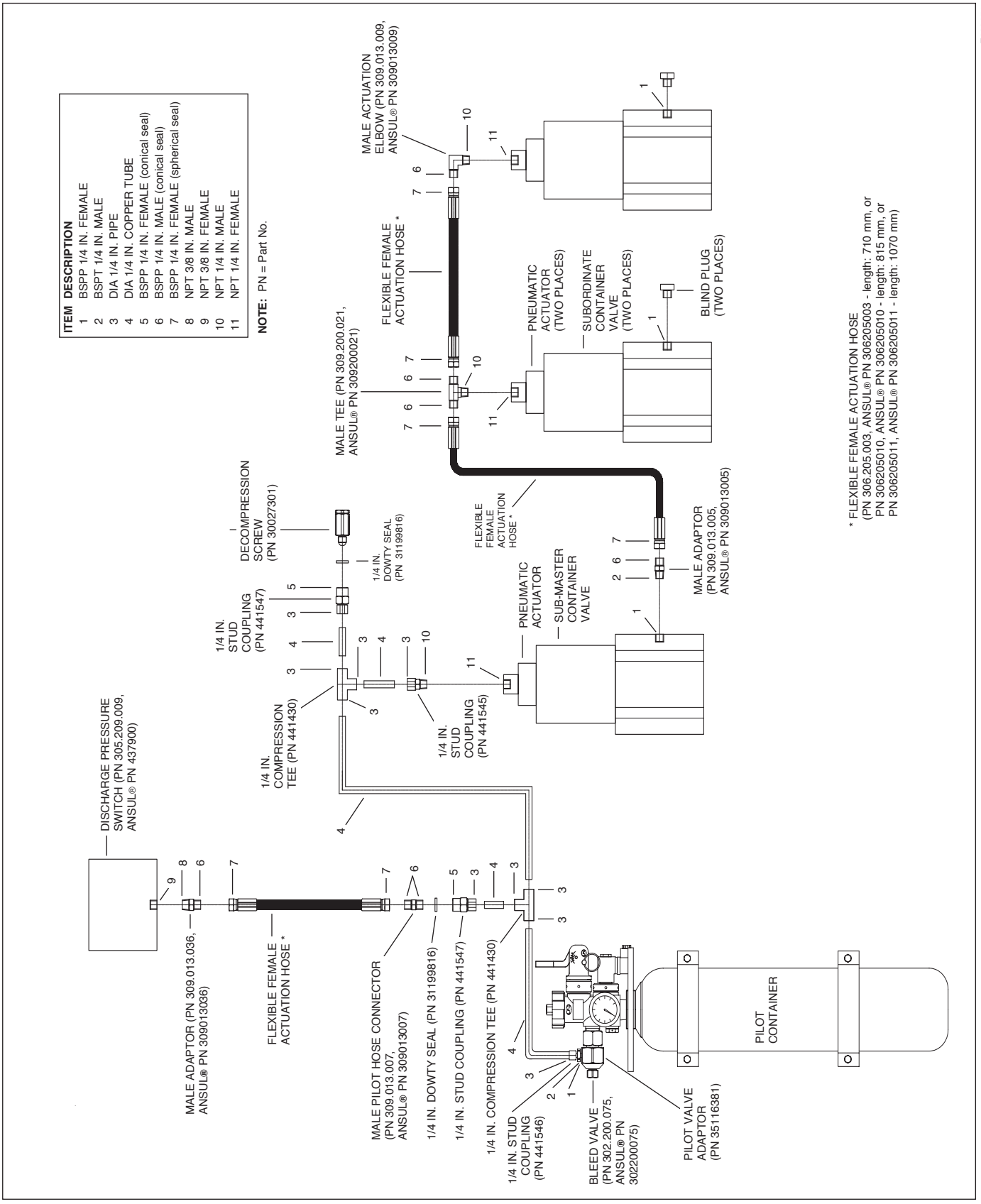
MULTIPLE CONTAINER - SINGLE HAZARD PILOT CONTAINER
DN 1/4 in. PTFE FLEXIBLE FEMALE ACTUATION HOSE (MCSHPC14FH_REV.03)



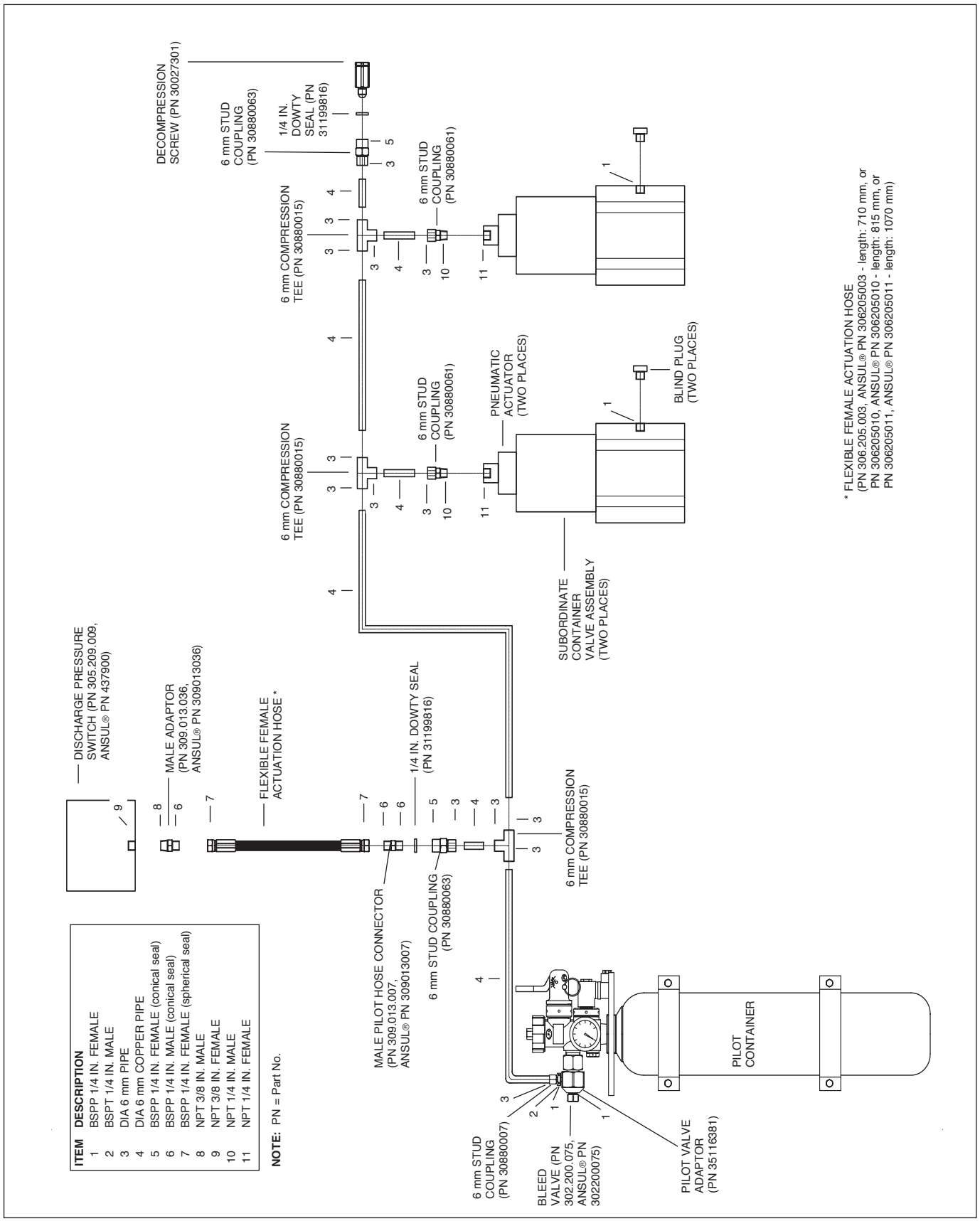
MULTIPLE CONTAINER - SINGLE HAZARD PILOT CONTAINER WITH SUB-MASTER CONTAINER
DIA 6 mm COPPER PIPE / DN 1/4 in. PTFE FLEXIBLE FEMALE ACTUATION HOSE (MCSHPCSUB6CU14FH_REV.02)



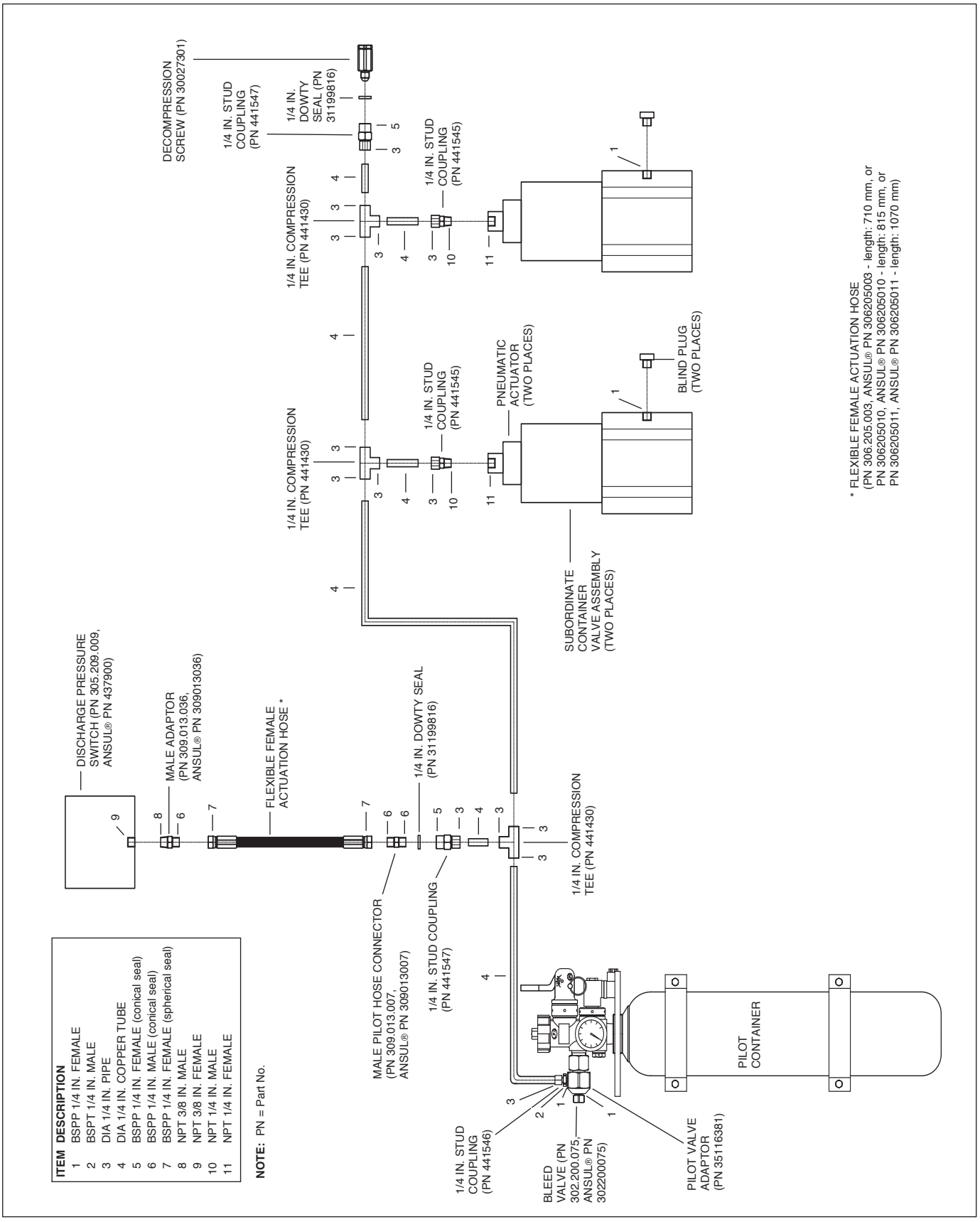
MULTIPLE CONTAINER - SINGLE HAZARD PILOT CONTAINER WITH SUB-MASTER CONTAINER
DIA 1/4 in. COPPER TUBE / DN 1/4 in. PTFE FLEXIBLE FEMALE ACTUATION HOSE (MCSHPCSUB14CU14FH_REV.01)



MULTIPLE CONTAINER - SINGLE HAZARD PILOT CONTAINER
DIA 6 mm COPPER PIPE (MCSHPC6CU_REV.06)



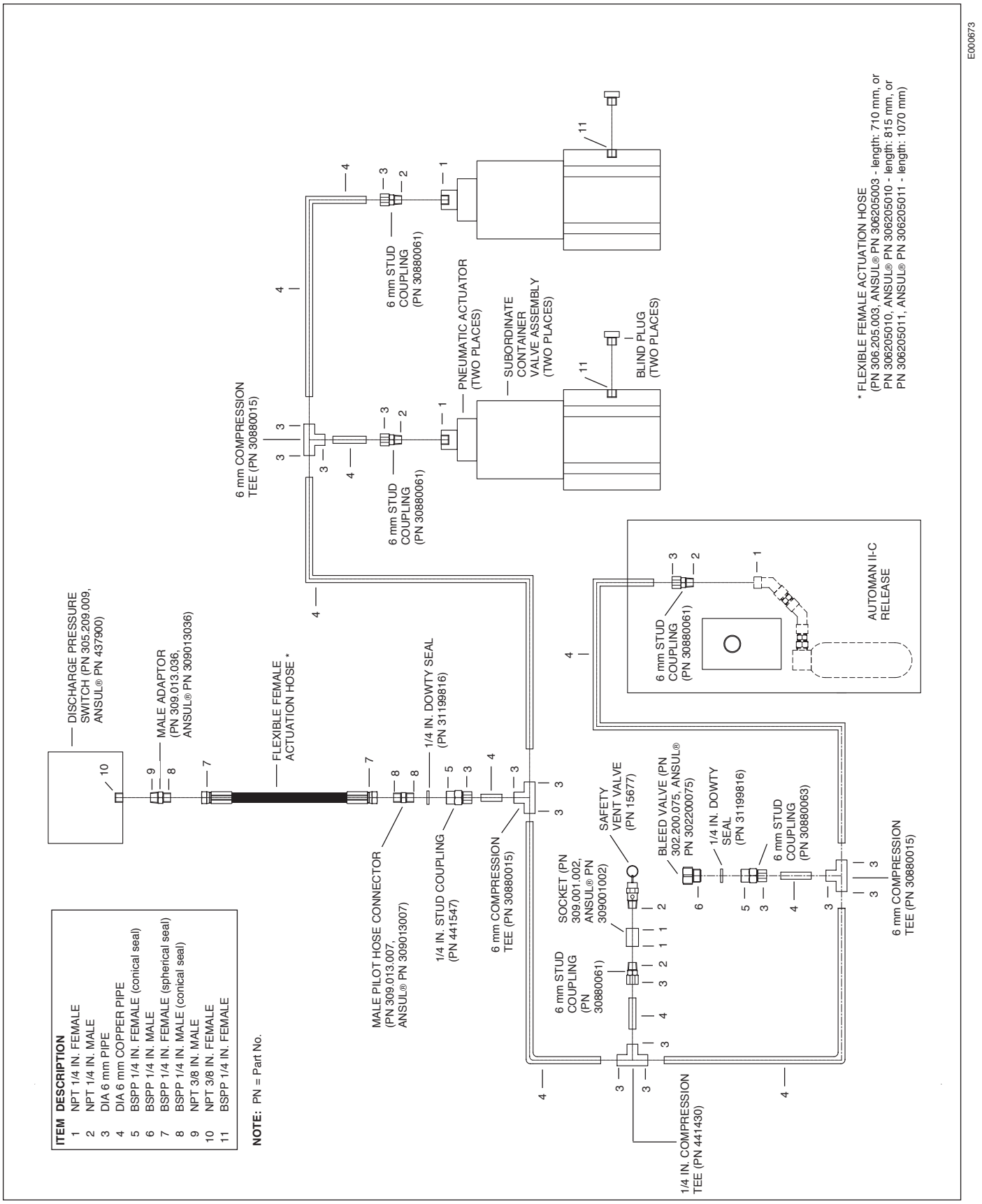
MULTIPLE CONTAINER - SINGLE HAZARD PILOT CONTAINER
DIA 1/4 in. COPPER TUBE (MCSHPC14CU_REV.00)



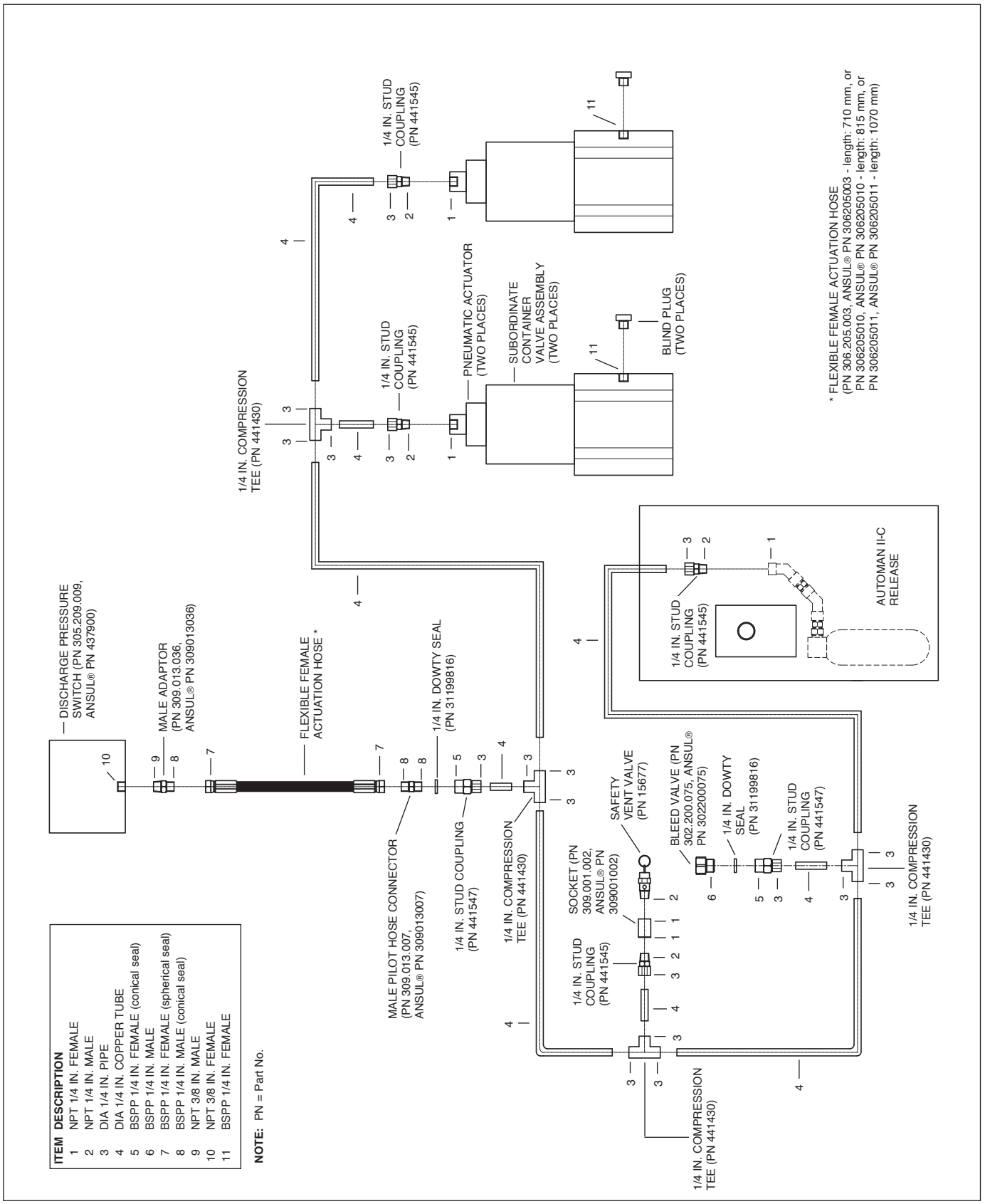
ITEM	DESCRIPTION
1	BSPP 1/4 IN. FEMALE
2	BSPT 1/4 IN. MALE
3	DIA 1/4 IN. PIPE
4	DIA 1/4 IN. COPPER TUBE
5	BSPP 1/4 IN. FEMALE (conical seal)
6	BSPP 1/4 IN. MALE (conical seal)
7	BSPP 1/4 IN. FEMALE (spherical seal)
8	NPT 3/8 IN. MALE
9	NPT 3/8 IN. FEMALE
10	NPT 1/4 IN. MALE
11	NPT 1/4 IN. FEMALE

NOTE: PN = Part No.

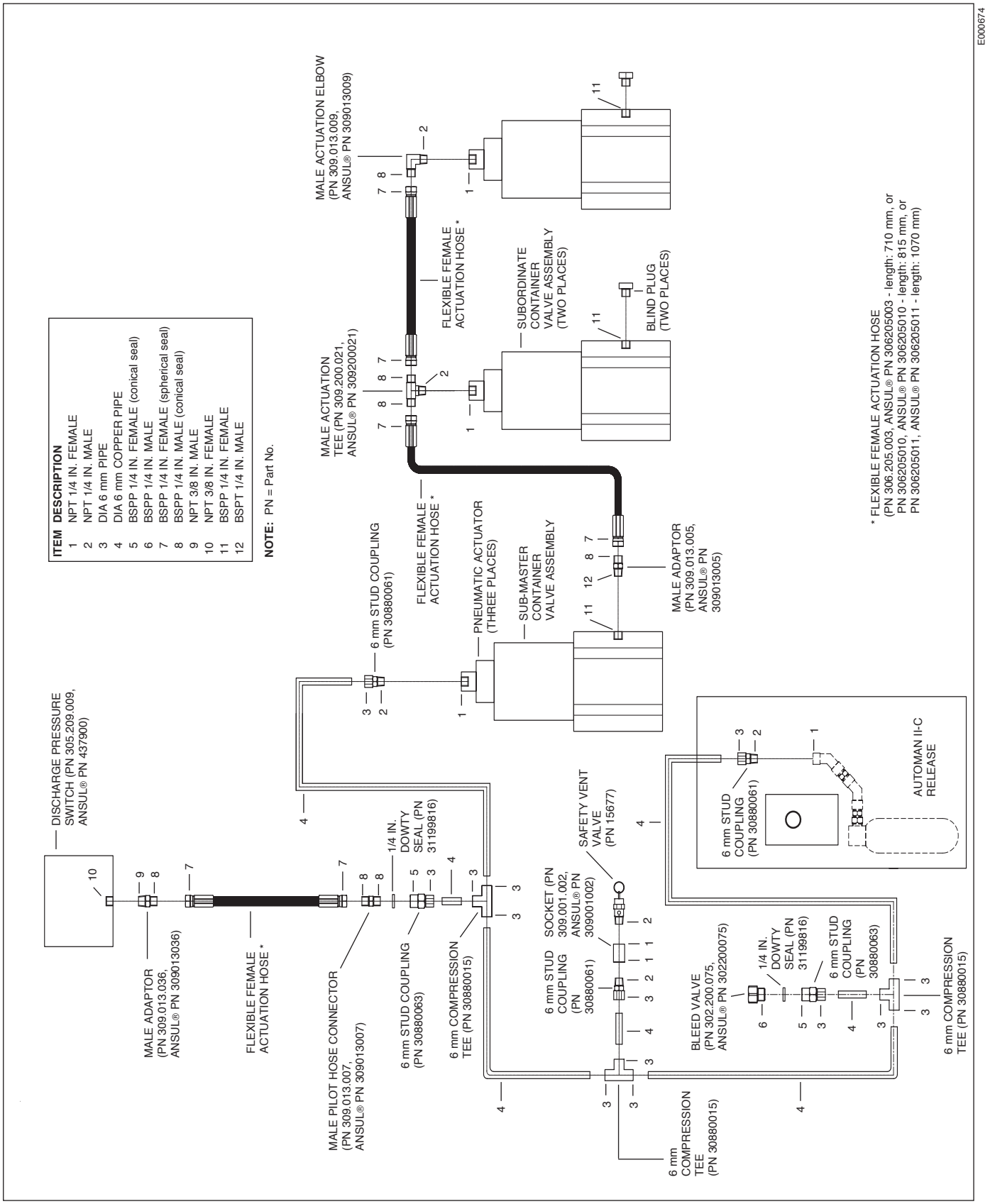
MULTIPLE CONTAINER - SINGLE HAZARD AUTOMAN II-C RELEASE
DIA 6 mm COPPER PIPE (MCSHAM6CU_REV.04)



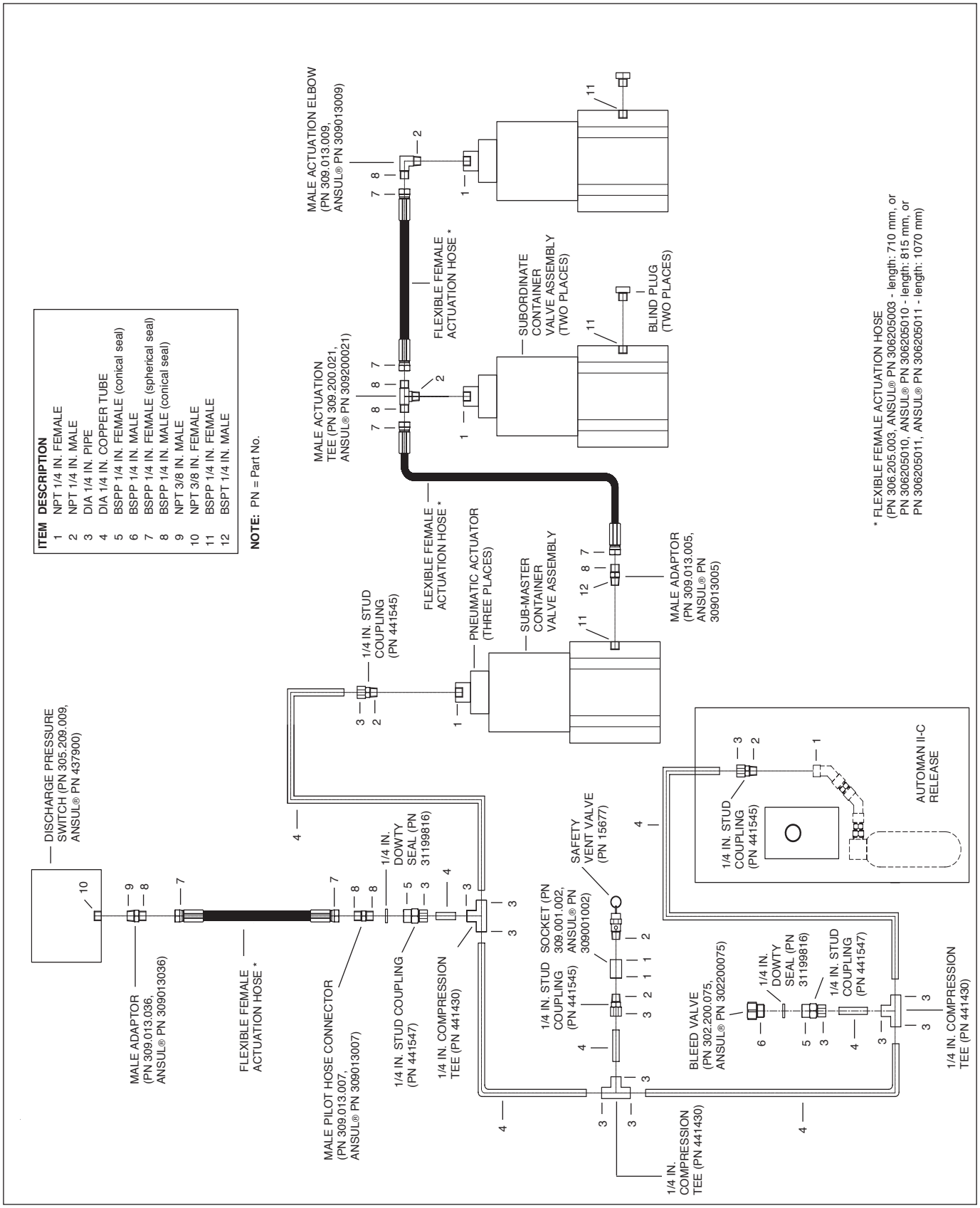
MULTIPLE CONTAINER - SINGLE HAZARD AUTOMAN II-C RELEASE
DIA 1/4 in. COPPER TUBE (MCSHAM14CU_REV.01)



MULTIPLE CONTAINER - SINGLE HAZARD AUTOMAN II-C RELEASE WITH SUB-MASTER CONTAINER
DIA 6 mm COPPER PIPE / DN 1/4 in. PTFE FLEXIBLE FEMALE ACTUATION HOSE (MCSHAMSUB6CU14FH_REV.04)



MULTIPLE CONTAINER - SINGLE HAZARD AUTOMAN II-C RELEASE WITH SUB-MASTER CONTAINER
DIA 1/4 in. COPPER TUBE / DN 1/4 in. PTFE FLEXIBLE FEMALE ACTUATION HOSE (MCSHAMSUB14CU14FH_REV.02)



APPENDIX 8: SAPPHIRE FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (METRIC)

JCI Clean Agent System Flow Calculation Software v4.00 (FK-5-1-12 - UL/FM & EU)
EX5104 / Component of FM Approved System

File Name: Hygood Design Section Sample Metric.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 (NFPA 2001)

Enclosure 1 Computer Room

Enclosure Temperature:
Minimum: 15.0 C
Maximum: 25.0 C
Max. Concentration: 4.66% (At 25.0 C)
Design Concentration:

Number of Nozzles: 1

Width: 6.10 m
Length: 14.20 m
Height: 3.05 m
Volume: 264.19 m³

Calculation Date/Time: Friday, July 8, 2022, 10:05:03 AM
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APPENDIX 8: SAPPHIRE FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (METRIC)

HYGOOD

Consolidated Report

Adjusted:	4.50 %	Non-permeable:	0.00 m ³
Minimum:	4.50 %	Total Volume:	264.19 m ³
Min. Agent Required:	157.13 kg		
Adjusted Agent Required:	157.18 kg		
Concentration Profile:	UL/FM Class A, (4.5 %)		

Enclosure 2 Storage Room

Enclosure Temperature:		Number of Nozzles:	1
Minimum:	15.0 C	Width:	3.66 m
Maximum:	25.0 C	Length:	3.66 m
Max. Concentration:	4.70% (At 25.0 C)	Height:	3.05 m
Design Concentration:		Volume:	40.86 m ³
Adjusted:	4.50 %	Non-permeable:	0.00 m ³
Minimum:	4.50 %	Total Volume:	40.86 m ³
Min. Agent Required:	24.31 kg		
Adjusted Agent Required:	24.32 kg		
Concentration Profile:	UL/FM Class A, (4.5 %)		

Agent Source Report

Agent:	FK-5-1-12
Container Name:	343L DOT Container Assy
Container Part Number:	303.207.008
Agent Per Container:	181.50 kg
Fill Density:	0.529 kg / l
Number of Main Containers:	1
Number of Reserve Containers:	0
Container Empty Weight:	207.00 kg
Weight, All Containers + Agent:	388.50 kg
Floor Area Per Container:	0.29 m ²
Floor Loading Per Container:	1330 kg /m ²

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APPENDIX 8: SAPPHIRE FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (METRIC)

HYGOOD

Consolidated Report

Parts Report

Total Agent Required: 181.50 kg

Container Name: 343L DOT Container Assy (Part: 303.207.008)

Number of Containers: 1

Nozzle	Type	Nozzle Diameter	Nozzle Area	Part Number
E1-N1	360-BR (NPT)	40 mm	865.70 mm ²	310.207.222
E2-N1	360-BR (NPT)	20 mm	120.76 mm ²	310.207.216

Nozzle	Drill Diameter	Drill Size
E1-N1	8.3 mm	8.30 mm
E2-N1	3.1 mm	3.10 mm

Pipe & Fittings	Type	Diameter	Length	Elbows (90)	Elbows (45)	Tees	Unions
	US40BTS	20 mm	4.60 m	2	0	0	0
	US40BTS	40 mm	12.30 m	3	0	1	0

Other Objects	Name	Quantity	Part Number
80 mm Flex. Discharge Hose / Check Valve Assembly		1	306.205.006

System Acceptance Report

System Discharge Time: 8.7 seconds
Percent Agent In Pipe: 25.3%
Percent Agent Before First Tee: 11.9%

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APPENDIX 8: SAPPHIRE FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (METRIC)

Consolidated Report

Dead Volume: 0.0% (0.00 kg)

Enclosure Number:	1
Enclosure Name:	Computer Room
Minimum Design Concentration:	4.50%
Adjusted Design Concentration:	4.50%
Predicted Concentration:	4.50%
Maximum Expected Agent Concentration:	4.66% (At 25.0 C)
Concentration Profile:	UL/FM Class A, (4.5 %)
Maximum Allowed Enclosure Pressure:	20000.00 Pa
Installed Vent Area:	0.00 m^2
Estimated Free Vent Area Required (Negative):	0.00 m^2
Estimated Free Vent Area Required (Positive):	0.00 m^2
Predicted Enclosure Pressure (Negative):	N/A
Predicted Enclosure Pressure (Positive):	N/A

* WARNING - Predicted agent concentration is below minimum design concentration.

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Average Nozzle Pressure
E1-N1	157.13 kg	157.18 kg	157.01 kg	8.702 bar
Total	157.13 kg	157.18 kg	157.01 kg	

Enclosure Number:	2
Enclosure Name:	Storage Room
Minimum Design Concentration:	4.50%
Adjusted Design Concentration:	4.50%
Predicted Concentration:	4.53%
Maximum Expected Agent Concentration:	4.70% (At 25.0 C)
Concentration Profile:	UL/FM Class A, (4.5 %)
Maximum Allowed Enclosure Pressure:	20000.00 Pa
Installed Vent Area:	0.00 m^2
Estimated Free Vent Area Required (Negative):	0.00 m^2
Estimated Free Vent Area Required (Positive):	0.00 m^2
Predicted Enclosure Pressure (Negative):	N/A
Predicted Enclosure Pressure (Positive):	N/A

Calculation Date/Time: Friday, July 8, 2022, 10:05:03 AM

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Key ID: 1346057843

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APPENDIX 8: SAPPHIRE FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (METRIC)

HYGOOD

Consolidated Report

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Average Nozzle Pressure
E2-N1	24.31 kg	24.32 kg	24.49 kg	11.901 bar
Total	24.31 kg	24.32 kg	24.49 kg	

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APPENDIX 8: SAPPHIRE FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (METRIC)

HYGOOD

Consolidated Report

Pipe Network Report

Description	Pipe Section	Start Node	End Node	Pipe Type	Pipe Diameter	Pipe Length	Union	Total Elevation Change	Total Equivalent Length	Nozzle Name	Nozzle Size	Nozzle Type	Nozzle Area
Container - On	Man./End	0	2		80 mm	1.47 m	0	1.47 m	25.91 m				
Flex Check	System	2	3		80 mm	0.81 m	0	0.41 m	15.85 m				
Pipe	System	3	4	US40BTS	40 mm	1.00 m	0	1.00 m	1.00 m				
Elbow (90)	System	4	5	US40BTS	40 mm	------	0	------	1.31 m				
Pipe	System	5	6	US40BTS	40 mm	1.00 m	0	------	1.00 m				
Tee	System	6	7	US40BTS	40 mm	------	0	------	0.82 m				
Pipe	System	7	8	US40BTS	40 mm	3.00 m	0	------	3.00 m				
Elbow (90)	System	8	9	US40BTS	40 mm	------	0	------	1.31 m				
Pipe	System	9	10	US40BTS	40 mm	7.00 m	0	------	7.00 m				
Elbow (90)	System	10	11	US40BTS	40 mm	------	0	------	1.31 m				
Pipe&Nozzle	System	11	12	US40BTS	40 mm	0.30 m	0	-0.30 m	0.30 m	E1-N1	40 mm	360-BR	865.70 mm ^{2}
Tee	System	6	13	US40BTS	20 mm	------	0	------	1.37 m				
Pipe	System	13	14	US40BTS	20 mm	2.30 m	0	------	2.30 m				
Elbow (90)	System	14	15	US40BTS	20 mm	------	0	------	0.67 m				
Pipe	System	15	16	US40BTS	20 mm	2.00 m	0	------	2.00 m				
Elbow (90)	System	16	17	US40BTS	20 mm	------	0	------	0.67 m				
Pipe&Nozzle	System	17	18	US40BTS	20 mm	0.30 m	0	-0.30 m	0.30 m	E2-N1	20 mm	360-BR	120.76 mm ^{2}

Key ID: 1346057843

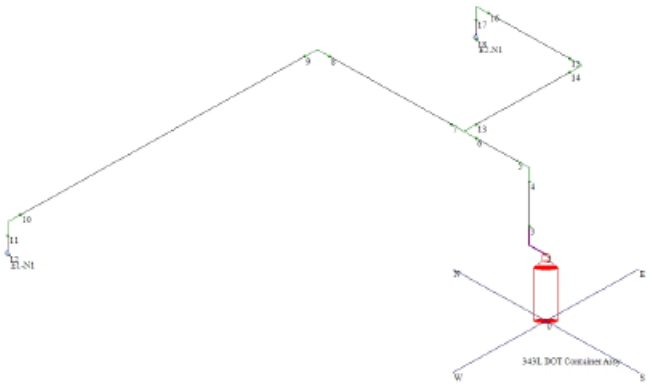
Page: 6 of 7

APPENDIX 8: SAPPHIRE FLOW CALCULATION REPORT FROM JENSEN HUGHES SOFTWARE (METRIC)

HYGOOD

Consolidated Report

View #: 1 - Isometric View-Node



Key ID: 1346057843

Page: 7 of 7

APPENDIX 9: REMOVABLE ELECTRICAL ACTUATOR (SUPPRESSION DIODE)

(Part No. 304.205.010)

The removable electrical actuator locates to the top of the container valve. 24 VDC 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 9-2
ELECTRICAL ACTUATOR - SUPPRESSION DIODE
E001151

Technical specification

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 Recognized
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.

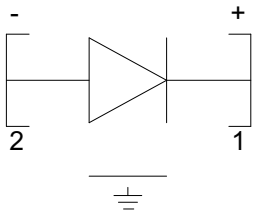


FIGURE 9-3
ELECTRICAL ACTUATOR WIRING DIAGRAM - SUPPRESSION DIODE
E001150

1. Connect positive from the control panel to terminal 1 and negative from the control panel to terminal 2 on the plug connector. The end-of-line monitoring device (if required) is 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 before fitting it onto the conatainer valve.

⚠ DANGER

Failure to reset the actuator results in the potentially hazardous discharge of the container.

APPENDIX 10: REMOVABLE ELECTRICAL ACTUATOR (BRIDGE RECTIFIER)

(Part No. 304.209.001 / 570537)

The removable electrical actuator locates to the top of the container valve. 24 VDC 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 9-4
ELECTRICAL ACTUATOR - BRIDGE RECTIFIER
E001151

Technical specification

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 Recognized
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 – bridge rectifier

Connect the electrical signal from the detection or control equipment in accordance with the wiring diagram detailed in Figure 9-5 when all other installations are complete. This electrical actuator is fitted with a bridge rectifier as indicated.

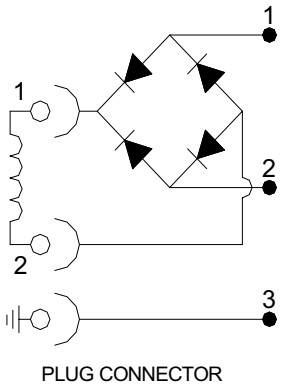


FIGURE 9-5
ELECTRICAL ACTUATOR WIRING DIAGRAM - BRIDGE RECTIFIER
E001149

1. Connect positive from the control panel to either terminal 1 or 2 with the reverse for the negative supply from the 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 before fitting it onto the conatainer valve.

⚠ DANGER

Failure to reset the actuator results in the potentially hazardous discharge of the container.

APPENDIX 11: HALOCARBON ELECTRICAL ACTUATOR PLACEMENT INDICATOR SWITCH ASSEMBLY (Part No. 441871)

The placement indicator switch is a monitoring device designed to help ensure the correct placement of the system electric actuator on the master container. The design of the placement indicator switch allows the device to mount directly onto the electric actuator.

Activating the placement indicator switch allows a small amount of electric current to pass through the end-of-line resistor. This functionality enables the fire control panel to indicate that the 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 the switch contacts are closed and the current now passes through the closed contacts. When 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.

Technical specification

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
System working temperature range:	-18 °C to 54 °C (0 °F to 130 °F)
Approvals, listings, and certifications:	UL and FM
Part number marked on component:	441857
Overall size (W x H x D):	46 mm x 73 mm x 20 mm (1.8 in. x 2.9 in. x 0.8 in.)
Weight:	0.23 kg (0.51 lb)



FIGURE 9-6
PLACEMENT INDICATOR SWITCH KIT
E001752

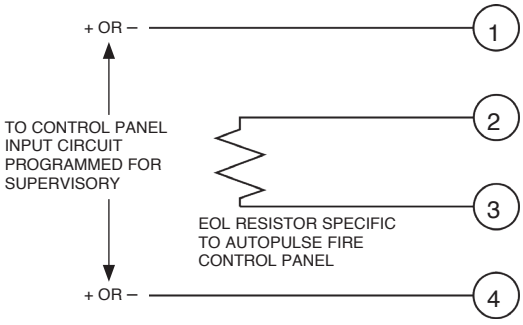


FIGURE 9-7
PLACEMENT INDICATOR SWITCH WIRING DIAGRAM
009621

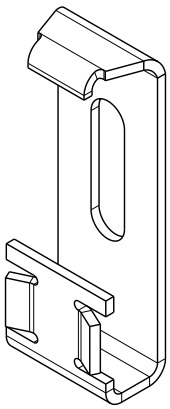


FIGURE 9-8
PLACEMENT INDICATOR MOUNT BRACKET
E002203

APPENDIX 12:
FK-5-1-12 AGENT
LIQUID LEVEL INDICATOR (LLI) CHARTS
(39 PAGES)

CHART	PAGE
106 L container (280 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI in. and temperature °F)	9-59
147 L container (390 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI in. and temperature °F)	9-61
180 L container (450 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI in. and temperature °F)	9-63
343 L container (850 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI in. and temperature °F)	9-65
106 L container (280 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C)	9-67
147 L container (390 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C)	9-69
180 L container (450 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C)	9-72
343 L container (850 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C)	9-75
106 L container (280 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C)	9-78
147 L container (390 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C)	9-80
180 L container (450 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C)	9-83
343 L container (850 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C)	9-86
106 L container (280 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI in. and temperature °F)	9-89
147 L container (390 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI in. and temperature °F)	9-91
180 L container (450 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI in. and temperature °F)	9-93
343 L container (850 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI in. and temperature °F)	9-96

106 L container (280 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI in. and temperature °F)

	Temperature °F (°C)													
LLI	0	10	20	30	40	50	60	70	80	90	100	110	120	130
in.	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.6)	(43.3)	(48.9)	(54.4)
6	110.7	109.1	107.5	105.9	104.3	102.8	101.2	99.6	98	96.3	94.7	93	91.4	89.8
6.25	113.3	111.8	110.2	108.6	107	105.5	103.9	102.3	100.7	99	97.4	95.7	94	92.4
6.5	116	114.4	112.9	111.3	109.8	108.2	106.6	105.1	103.4	101.7	100	98.4	96.7	95
6.75	118.7	117.1	115.6	114	112.5	110.9	109.4	107.8	106.1	104.4	102.7	101	99.3	97.6
7	121.3	119.8	118.2	116.7	115.2	113.6	112.1	110.5	108.8	107.1	105.4	103.7	102	100.3
7.25	124	122.5	120.9	119.4	117.9	116.3	114.8	113.3	111.5	109.8	108.1	106.3	104.6	102.9
7.5	126.7	125.1	123.6	122.1	120.6	119	117.5	116	114.2	112.5	110.8	109	107.3	105.5
7.75	129.3	127.8	126.3	124.8	123.3	121.8	120.2	118.7	117	115.2	113.4	111.7	109.9	108.1
8	132	130.5	129	127.5	126	124.5	123	121.5	119.7	117.9	116.1	114.3	112.5	110.8
8.25	134.7	133.2	131.7	130.2	128.7	127.2	125.7	124.2	122.4	120.6	118.8	117	115.2	113.4
8.5	137.3	135.8	134.4	132.9	131.4	129.9	128.4	126.9	125.1	123.3	121.5	119.6	117.8	116
8.75	140	138.5	137	135.6	134.1	132.6	131.1	129.7	127.8	126	124.1	122.3	120.5	118.6
9	142.7	141.2	139.7	138.3	136.8	135.3	133.9	132.4	130.5	128.7	126.8	125	123.1	121.2
9.25	145.3	143.9	142.4	141	139.5	138	136.6	135.1	133.3	131.4	129.5	127.6	125.7	123.9
9.5	148	146.6	145.1	143.7	142.2	140.8	139.3	137.9	136	134.1	132.2	130.3	128.4	126.5
9.75	150.7	149.2	147.8	146.4	144.9	143.5	142	140.6	138.7	136.8	134.9	132.9	131	129.1
10	153.3	151.9	150.5	149	147.6	146.2	144.8	143.3	141.4	139.5	137.5	135.6	133.7	131.7
10.25	156	154.6	153.2	151.7	150.3	148.9	147.5	146.1	144.1	142.2	140.2	138.3	136.3	134.4
10.5	158.7	157.3	155.8	154.4	153	151.6	150.2	148.8	146.8	144.9	142.9	140.9	139	137
10.75	161.3	159.9	158.5	157.1	155.7	154.3	152.9	151.5	149.5	147.6	145.6	143.6	141.6	139.6
11	164	162.6	161.2	159.8	158.4	157	155.7	154.3	152.3	150.3	148.3	146.2	144.2	142.2
11.25	166.7	165.3	163.9	162.5	161.1	159.8	158.4	157	155	153	150.9	148.9	146.9	144.9
11.5	169.3	168	166.6	165.2	163.8	162.5	161.1	159.7	157.7	155.6	153.6	151.6	149.5	147.5
11.75	172	170.6	169.3	167.9	166.6	165.2	163.8	162.5	160.4	158.3	156.3	154.2	152.2	150.1
12	174.7	173.3	172	170.6	169.3	167.9	166.5	165.2	163.1	161	159	156.9	154.8	152.7
12.25	177.3	176	174.6	173.3	172	170.6	169.3	167.9	165.8	163.7	161.6	159.5	157.5	155.4
12.5	180	178.7	177.3	176	174.7	173.3	172	170.7	168.5	166.4	164.3	162.2	160.1	158
12.75	182.7	181.3	180	178.7	177.4	176	174.7	173.4	171.3	169.1	167	164.9	162.7	160.6
13	185.3	184	182.7	181.4	180.1	178.8	177.4	176.1	174	171.8	169.7	167.5	165.4	163.2
13.25	188	186.7	185.4	184.1	182.8	181.5	180.2	178.9	176.7	174.5	172.4	170.2	168	165.9
13.5	190.7	189.4	188.1	186.8	185.5	184.2	182.9	181.6	179.4	177.2	175	172.9	170.7	168.5
13.75	193.3	192.1	190.8	189.5	188.2	186.9	185.6	184.3	182.1	179.9	177.7	175.5	173.3	171.1
14	196	194.7	193.4	192.2	190.9	189.6	188.3	187.1	184.8	182.6	180.4	178.2	176	173.7
14.25	198.7	197.4	196.1	194.9	193.6	192.3	191.1	189.8	187.6	185.3	183.1	180.8	178.6	176.4
14.5	201.3	200.1	198.8	197.6	196.3	195	193.8	192.5	190.3	188	185.8	183.5	181.2	179
14.75	204	202.8	201.5	200.3	199	197.8	196.5	195.3	193	190.7	188.4	186.2	183.9	181.6
15	206.7	205.4	204.2	203	201.7	200.5	199.2	198	195.7	193.4	191.1	188.8	186.5	184.2
15.25	209.3	208.1	206.9	205.6	204.4	203.2	202	200.7	198.4	196.1	193.8	191.5	189.2	186.8
15.5	212	210.8	209.6	208.3	207.1	205.9	204.7	203.5	201.1	198.8	196.5	194.1	191.8	189.5
15.75	214.7	213.5	212.3	211	209.8	208.6	207.4	206.2	203.8	201.5	199.1	196.8	194.4	192.1
16	217.3	216.1	214.9	213.7	212.5	211.3	210.1	208.9	206.6	204.2	201.8	199.5	197.1	194.7
16.25	220	218.8	217.6	216.4	215.2	214	212.9	211.7	209.3	206.9	204.5	202.1	199.7	197.3
16.5	222.7	221.5	220.3	219.1	217.9	216.8	215.6	214.4	212	209.6	207.2	204.8	202.4	200
16.75	225.3	224.2	223	221.8	220.6	219.5	218.3	217.1	214.7	212.3	209.9	207.4	205	202.6
17	228	226.8	225.7	224.5	223.4	222.2	221	219.9	217.4	215	212.5	210.1	207.7	205.2
17.25	230.7	229.5	228.4	227.2	226.1	224.9	223.7	222.6	220.1	217.7	215.2	212.8	210.3	207.8
17.5	233.3	232.2	231.1	229.9	228.8	227.6	226.5	225.3	222.9	220.4	217.9	215.4	212.9	210.5
17.75	236	234.9	233.7	232.6	231.5	230.3	229.2	228.1	225.6	223.1	220.6	218.1	215.6	213.1
18	238.7	237.5	236.4	235.3	234.2	233	231.9	230.8	228.3	225.8	223.3	220.7	218.2	215.7
18.25	241.3	240.2	239.1	238	236.9	235.8	234.6	233.5	231	228.5	225.9	223.4	220.9	218.3
18.5	244	242.9	241.8	240.7	239.6	238.5	237.4	236.3	233.7	231.2	228.6	226.1	223.5	221
18.75	246.7	245.6	244.5	243.4	242.3	241.2	240.1	239	236.4	233.9	231.3	228.7	226.2	223.6
19	249.3	248.3	247.2	246.1	245	243.9	242.8	241.7	239.1	236.6	234	231.4	228.8	226.2
19.25	252	250.9	249.9	248.8	247.7	246.6	245.5	244.5	241.9	239.3	236.6	234	231.4	228.8
19.5	254.7	253.6	252.5	251.5	250.4	249.3	248.3	247.2	244.6	241.9	239.3	236.7	234.1	231.5
19.75	257.3	256.3	255.2	254.2	253.1	252	251	249.9	247.3	244.6	242	239.4	236.7	234.1
20	260	259	257.9	256.9	255.8	254.8	253.7	252.7	250	247.3	244.7	242	239.4	236.7
20.25	262.7	261.6	260.6	259.6	258.5	257.5	256.4	255.4	252.7	250	247.4	244.7	242	239.3
20.5	265.3	264.3	263.3	262.2	261.2	260.2	259.2	258.1	255.4	252.7	250	247.3	244.6	242
20.75	268	267	266	264.9	263.9	262.9	261.9	260.9	258.1	255.4	252.7	250	247.3	244.6
21	270.7	269.7	268.7	267.6	266.6	265.6	264.6	263.6	260.9	258.1	255.4	252.7	249.9	247.2
21.25	273.3	272.3	271.3	270.3	269.3	268.3	267.3	266.3	263.6	260.8	258.1	255.3	252.6	249.8
21.5	276	275	274	273	272	271	270.1	269.1	266.3	263.5	260.8	258	255.2	252.4
21.75	278.7	277.7	276.7	275.7	274.7	273.8	272.8	271.8	269	266.2	263.4	260.6	257.9	255.1

106 L container (280 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI in. and temperature °F) (Continued)

	Temperature °F (°C)													
LLI	0	10	20	30	40	50	60	70	80	90	100	110	120	130
in.	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.6)	(43.3)	(48.9)	(54.4)
22	281.3	280.4	279.4	278.4	277.4	276.5	275.5	274.5	271.7	268.9	266.1	263.3	260.5	257.7
22.25	284	283	282.1	281.1	280.2	279.2	278.2	277.3	274.4	271.6	268.8	266	263.1	260.3
22.5	286.7	285.7	284.8	283.8	282.9	281.9	280.9	280	277.2	274.3	271.5	268.6	265.8	262.9
22.75	289.3	288.4	287.5	286.5	285.6	284.6	283.7	282.7	279.9	277	274.1	271.3	268.4	265.6
23	292	291.1	290.1	289.2	288.3	287.3	286.4	285.5	282.6	279.7	276.8	273.9	271.1	268.2
23.25	294.7	293.7	292.8	291.9	291	290	289.1	288.2	285.3	282.4	279.5	276.6	273.7	270.8
23.5	297.3	296.4	295.5	294.6	293.7	292.8	291.8	290.9	288	285.1	282.2	279.3	276.4	273.4
23.75	300	299.1	298.2	297.3	296.4	295.5	294.6	293.7	290.7	287.8	284.9	281.9	279	276.1
24	302.7	301.8	300.9	300	299.1	298.2	297.3	296.4	293.4	290.5	287.5	284.6	281.6	278.7
24.25	305.3	304.5	303.6	302.7	301.8	300.9	300	299.1	296.2	293.2	290.2	287.2	284.3	281.3
24.5	308	307.1	306.3	305.4	304.5	303.6	302.7	301.9	298.9	295.9	292.9	289.9	286.9	283.9
24.75	310.7	309.8	308.9	308.1	307.2	306.3	305.5	304.6	301.6	298.6	295.6	292.6	289.6	286.6
25	313.3	312.5	311.6	310.8	309.9	309	308.2	307.3	304.3	301.3	298.3	295.2	292.2	289.2
25.25	316	315.2	314.3	313.5	312.6	311.8	310.9	310.1	307	304	300.9	297.9	294.8	291.8
25.5	318.7	317.8	317	316.2	315.3	314.5	313.6	312.8	309.7	306.7	303.6	300.6	297.5	294.4
25.75	321.3	320.5	319.7	318.8	318	317.2	316.4	315.5	312.4	309.4	306.3	303.2	300.1	297.1
26	324	323.2	322.4	321.5	320.7	319.9	319.1	318.3	315.2	312.1	309	305.9	302.8	299.7

147 L container (390 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI in. and temperature °F)

LLI in.	Temperature °F (°C) 0 (-17.8)	10 (-12.2)	20 (-6.7)	30 (-1.1)	40 (4.4)	50 (10)	60 (15.6)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.6)	110 (43.3)	120 (48.9)	130 (54.4)
7	147.8	146.0	144.2	142.5	140.7	138.9	137.1	135.4	134.5	133.7	132.8	132.0	131.1	130.3
7.25	150.7	148.9	147.1	145.3	143.5	141.7	139.9	138.1	137.2	136.3	135.4	134.6	133.7	132.8
7.5	153.6	151.8	150.0	148.1	146.3	144.4	142.6	140.8	139.9	139.0	138.1	137.2	136.3	135.4
7.75	156.6	154.7	152.8	151.0	149.1	147.2	145.3	143.5	142.5	141.6	140.7	139.8	138.9	137.9
8	159.5	157.6	155.7	153.8	151.9	150.0	148.1	146.2	145.2	144.3	143.3	142.4	141.4	140.5
8.25	162.5	160.5	158.6	156.6	154.7	152.7	150.8	148.9	147.9	146.9	146.0	145.0	144.0	143.1
8.5	165.4	163.4	161.5	159.5	157.5	155.5	153.5	151.6	150.6	149.6	148.6	147.6	146.6	145.6
8.75	168.4	166.3	164.3	162.3	160.3	158.3	156.3	154.3	153.2	152.2	151.2	150.2	149.2	148.2
9	171.3	169.2	167.2	165.2	163.1	161.1	159.0	157.0	155.9	154.9	153.9	152.8	151.8	150.8
9.25	174.2	172.2	170.1	168.0	165.9	163.8	161.7	159.7	158.6	157.5	156.5	155.4	154.4	153.3
9.5	177.2	175.1	172.9	170.8	168.7	166.6	164.5	162.4	161.3	160.2	159.1	158.0	157.0	155.9
9.75	180.1	178.0	175.8	173.7	171.5	169.4	167.2	165.0	163.9	162.8	161.7	160.6	159.5	158.4
10	183.1	180.9	178.7	176.5	174.3	172.1	169.9	167.7	166.6	165.5	164.4	163.2	162.1	161.0
10.25	186.0	183.8	181.6	179.3	177.1	174.9	172.7	170.4	169.3	168.2	167.0	165.9	164.7	163.6
10.5	189.0	186.7	184.4	182.2	179.9	177.7	175.4	173.1	172.0	170.8	169.6	168.5	167.3	166.1
10.75	191.9	189.6	187.3	185.0	182.7	180.4	178.1	175.8	174.6	173.5	172.3	171.1	169.9	168.7
11	194.8	192.5	190.2	187.9	185.5	183.2	180.9	178.5	177.3	176.1	174.9	173.7	172.5	171.2
11.25	197.8	195.4	193.1	190.7	188.3	186.0	183.6	181.2	180.0	178.8	177.5	176.3	175.0	173.8
11.5	200.7	198.3	195.9	193.5	191.1	188.7	186.3	183.9	182.7	181.4	180.2	178.9	177.6	176.4
11.75	203.7	201.2	198.8	196.4	193.9	191.5	189.1	186.6	185.4	184.1	182.8	181.5	180.2	178.9
12	206.6	204.1	201.7	199.2	196.7	194.3	191.8	189.3	188.0	186.7	185.4	184.1	182.8	181.5
12.25	209.5	207.0	204.5	202.0	199.5	197.0	194.5	192.0	190.7	189.4	188.0	186.7	185.4	184.1
12.5	212.5	210.0	207.4	204.9	202.3	199.8	197.3	194.7	193.4	192.0	190.7	189.3	188.0	186.6
12.75	215.4	212.9	210.3	207.7	205.1	202.6	200.0	197.4	196.1	194.7	193.3	191.9	190.6	189.2
13	218.4	215.8	213.2	210.6	207.9	205.3	202.7	200.1	198.7	197.3	195.9	194.5	193.1	191.7
13.25	221.3	218.7	216.0	213.4	210.7	208.1	205.5	202.8	201.4	200.0	198.6	197.1	195.7	194.3
13.5	224.3	221.6	218.9	216.2	213.6	210.9	208.2	205.5	204.1	202.6	201.2	199.7	198.3	196.9
13.75	227.2	224.5	221.8	219.1	216.4	213.6	210.9	208.2	206.8	205.3	203.8	202.4	200.9	199.4
14	230.1	227.4	224.6	221.9	219.2	216.4	213.7	210.9	209.4	207.9	206.5	205.0	203.5	202.0
14.25	233.1	230.3	227.5	224.7	222.0	219.2	216.4	213.6	212.1	210.6	209.1	207.6	206.1	204.5
14.5	236.0	233.2	230.4	227.6	224.8	221.9	219.1	216.3	214.8	213.2	211.7	210.2	208.6	207.1
14.75	239.0	236.1	233.3	230.4	227.6	224.7	221.9	219.0	217.5	215.9	214.3	212.8	211.2	209.7
15	241.9	239.0	236.1	233.3	230.4	227.5	224.6	221.7	220.1	218.6	217.0	215.4	213.8	212.2
15.25	244.8	241.9	239.0	236.1	233.2	230.2	227.3	224.4	222.8	221.2	219.6	218.0	216.4	214.8
15.5	247.8	244.8	241.9	238.9	236.0	233.0	230.1	227.1	225.5	223.9	222.2	220.6	219.0	217.4
15.75	250.7	247.7	244.8	241.8	238.8	235.8	232.8	229.8	228.2	226.5	224.9	223.2	221.6	219.9
16	253.7	250.7	247.6	244.6	241.6	238.6	235.5	232.5	230.8	229.2	227.5	225.8	224.2	222.5
16.25	256.6	253.6	250.5	247.4	244.4	241.3	238.3	235.2	233.5	231.8	230.1	228.4	226.7	225.0
16.5	259.6	256.5	253.4	250.3	247.2	244.1	241.0	237.9	236.2	234.5	232.8	231.0	229.3	227.6
16.75	262.5	259.4	256.2	253.1	250.0	246.9	243.7	240.6	238.9	237.1	235.4	233.6	231.9	230.2
17	265.4	262.3	259.1	256.0	252.8	249.6	246.5	243.3	241.5	239.8	238.0	236.3	234.5	232.7
17.25	268.4	265.2	262.0	258.8	255.6	252.4	249.2	246.0	244.2	242.4	240.6	238.9	237.1	235.3
17.5	271.3	268.1	264.9	261.6	258.4	255.2	251.9	248.7	246.9	245.1	243.3	241.5	239.7	237.9
17.75	274.3	271.0	267.7	264.5	261.2	257.9	254.7	251.4	249.6	247.7	245.9	244.1	242.2	240.4
18	277.2	273.9	270.6	267.3	264.0	260.7	257.4	254.1	252.2	250.4	248.5	246.7	244.8	243.0
18.25	280.2	276.8	273.5	270.1	266.8	263.5	260.1	256.8	254.9	253.0	251.2	249.3	247.4	245.5
18.5	283.1	279.7	276.4	273.0	269.6	266.2	262.9	259.5	257.6	255.7	253.8	251.9	250.0	248.1
18.75	286.0	282.6	279.2	275.8	272.4	269.0	265.6	262.2	260.3	258.3	256.4	254.5	252.6	250.7
19	289.0	285.5	282.1	278.7	275.2	271.8	268.3	264.9	262.9	261.0	259.1	257.1	255.2	253.2
19.25	291.9	288.4	285.0	281.5	278.0	274.5	271.1	267.6	265.6	263.6	261.7	259.7	257.7	255.8
19.5	294.9	291.4	287.8	284.3	280.8	277.3	273.8	270.3	268.3	266.3	264.3	262.3	260.3	258.3
19.75	297.8	294.3	290.7	287.2	283.6	280.1	276.5	273.0	271.0	269.0	266.9	264.9	262.9	260.9
20	300.7	297.2	293.6	290.0	286.4	282.8	279.3	275.7	273.6	271.6	269.6	267.5	265.5	263.5
20.25	303.7	300.1	296.5	292.8	289.2	285.6	282.0	278.4	276.3	274.3	272.2	270.1	268.1	266.0
20.5	306.6	303.0	299.3	295.7	292.0	288.4	284.7	281.1	279.0	276.9	274.8	272.8	270.7	268.6
20.75	309.6	305.9	302.2	298.5	294.8	291.1	287.5	283.8	281.7	279.6	277.5	275.4	273.3	271.2
21	312.5	308.8	305.1	301.4	297.6	293.9	290.2	286.5	284.3	282.2	280.1	278.0	275.8	273.7
21.25	315.5	311.7	307.9	304.2	300.4	296.7	292.9	289.2	287.0	284.9	282.7	280.6	278.4	276.3
21.5	318.4	314.6	310.8	307.0	303.2	299.4	295.7	291.9	289.7	287.5	285.4	283.2	281.0	278.8
21.75	321.3	317.5	313.7	309.9	306.0	302.2	298.4	294.6	292.4	290.2	288.0	285.8	283.6	281.4
22	324.3	320.4	316.6	312.7	308.8	305.0	301.1	297.3	295.0	292.8	290.6	288.4	286.2	284.0
22.25	327.2	323.3	319.4	315.5	311.6	307.8	303.9	300.0	297.7	295.5	293.2	291.0	288.8	286.5
22.5	330.2	326.2	322.3	318.4	314.4	310.5	306.6	302.7	300.4	298.1	295.9	293.6	291.3	289.1
22.75	333.1	329.1	325.2	321.2	317.3	313.3	309.3	305.4	303.1	300.8	298.5	296.2	293.9	291.6

147 L container (390 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI in. and temperature °F) (Continued)

	Temperature °F (°C)													
LLI	0	10	20	30	40	50	60	70	80	90	100	110	120	130
in.	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.6)	(43.3)	(48.9)	(54.4)
23	336.1	332.1	328.1	324.1	320.1	316.1	312.1	308.1	305.7	303.4	301.1	298.8	296.5	294.2
23.25	339.0	335.0	330.9	326.9	322.9	318.8	314.8	310.8	308.4	306.1	303.8	301.4	299.1	296.8
23.5	341.9	337.9	333.8	329.7	325.7	321.6	317.5	313.5	311.1	308.7	306.4	304.0	301.7	299.3
23.75	344.9	340.8	336.7	332.6	328.5	324.4	320.3	316.2	313.8	311.4	309.0	306.6	304.3	301.9
24	347.8	343.7	339.5	335.4	331.3	327.1	323.0	318.8	316.5	314.1	311.7	309.3	306.9	304.5
24.25	350.8	346.6	342.4	338.2	334.1	329.9	325.7	321.5	319.1	316.7	314.3	311.9	309.4	307.0
24.5	353.7	349.5	345.3	341.1	336.9	332.7	328.5	324.2	321.8	319.4	316.9	314.5	312.0	309.6
24.75	356.6	352.4	348.2	343.9	339.7	335.4	331.2	326.9	324.5	322.0	319.5	317.1	314.6	312.1
25	359.6	355.3	351.0	346.8	342.5	338.2	333.9	329.6	327.2	324.7	322.2	319.7	317.2	314.7
25.25	362.5	358.2	353.9	349.6	345.3	341.0	336.7	332.3	329.8	327.3	324.8	322.3	319.8	317.3
25.5	365.5	361.1	356.8	352.4	348.1	343.7	339.4	335.0	332.5	330.0	327.4	324.9	322.4	319.8
25.75	368.4	364.0	359.6	355.3	350.9	346.5	342.1	337.7	335.2	332.6	330.1	327.5	324.9	322.4
26	371.4	366.9	362.5	358.1	353.7	349.3	344.9	340.4	337.9	335.3	332.7	330.1	327.5	325.0
26.25	374.3	369.8	365.4	360.9	356.5	352.0	347.6	343.1	340.5	337.9	335.3	332.7	330.1	327.5
26.5	377.2	372.8	368.3	363.8	359.3	354.8	350.3	345.8	343.2	340.6	338.0	335.3	332.7	330.1
26.75	380.2	375.7	371.1	366.6	362.1	357.6	353.1	348.5	345.9	343.2	340.6	337.9	335.3	332.6
27	383.1	378.6	374.0	369.5	364.9	360.3	355.8	351.2	348.6	345.9	343.2	340.5	337.9	335.2
27.25	386.1	381.5	376.9	372.3	367.7	363.1	358.5	353.9	351.2	348.5	345.8	343.1	340.5	337.8
27.5	389.0	384.4	379.8	375.1	370.5	365.9	361.3	356.6	353.9	351.2	348.5	345.8	343.0	340.3
27.75	391.9	387.3	382.6	378.0	373.3	368.6	364.0	359.3	356.6	353.8	351.1	348.4	345.6	342.9
28	394.9	390.2	385.5	380.8	376.1	371.4	366.7	362.0	359.3	356.5	353.7	351.0	348.2	345.4
28.25	397.8	393.1	388.4	383.6	378.9	374.2	369.4	364.7	361.9	359.1	356.4	353.6	350.8	348.0
28.5	400.8	396.0	391.2	386.5	381.7	376.9	372.2	367.4	364.6	361.8	359.0	356.2	353.4	350.6
28.75	403.7	398.9	394.1	389.3	384.5	379.7	374.9	370.1	367.3	364.5	361.6	358.8	356.0	353.1
29	406.7	401.8	397.0	392.2	387.3	382.5	377.6	372.8	370.0	367.1	364.3	361.4	358.5	355.7
29.25	409.6	404.7	399.9	395.0	390.1	385.3	380.4	375.5	372.6	369.8	366.9	364.0	361.1	358.3
29.5	412.5	407.6	402.7	397.8	392.9	388.0	383.1	378.2	375.3	372.4	369.5	366.6	363.7	360.8
29.75	415.5	410.5	405.6	400.7	395.7	390.8	385.8	380.9	378.0	375.1	372.1	369.2	366.3	363.4
30	418.4	413.5	408.5	403.5	398.5	393.6	388.6	383.6	380.7	377.7	374.8	371.8	368.9	365.9
30.25	421.4	416.4	411.4	406.3	401.3	396.3	391.3	386.3	383.3	380.4	377.4	374.4	371.5	368.5
30.5	424.3	419.3	414.2	409.2	404.1	399.1	394.0	389.0	386.0	383.0	380.0	377.0	374.1	371.1
30.75	427.3	422.2	417.1	412.0	406.9	401.9	396.8	391.7	388.7	385.7	382.7	379.6	376.6	373.6
31	430.2	425.1	420.0	414.9	409.7	404.6	399.5	394.4	391.4	388.3	385.3	382.3	379.2	376.2
31.25	433.1	428.0	422.8	417.7	412.5	407.4	402.2	397.1	394.0	391.0	387.9	384.9	381.8	378.7
31.5	436.1	430.9	425.7	420.5	415.3	410.2	405.0	399.8	396.7	393.6	390.6	387.5	384.4	381.3
31.75	439.0	433.8	428.6	423.4	418.1	412.9	407.7	402.5	399.4	396.3	393.2	390.1	387.0	383.9
32	442.0	436.7	431.5	426.2	421.0	415.7	410.4	405.2	402.1	398.9	395.8	392.7	389.6	386.4
32.25	444.9	439.6	434.3	429.0	423.8	418.5	413.2	407.9	404.7	401.6	398.4	395.3	392.1	389.0
32.5	447.8	442.5	437.2	431.9	426.6	421.2	415.9	410.6	407.4	404.2	401.1	397.9	394.7	391.6
32.75	450.8	445.4	440.1	434.7	429.4	424.0	418.6	413.3	410.1	406.9	403.7	400.5	397.3	394.1
33	453.7	448.3	442.9	437.6	432.2	426.8	421.4	416.0	412.8	409.6	406.3	403.1	399.9	396.7
33.25	456.7	451.2	445.8	440.4	435.0	429.5	424.1	418.7	415.4	412.2	409.0	405.7	402.5	399.2
33.5	459.6	454.2	448.7	443.2	437.8	432.3	426.8	421.4	418.1	414.9	411.6	408.3	405.1	401.8
33.75	462.6	457.1	451.6	446.1	440.6	435.1	429.6	424.1	420.8	417.5	414.2	410.9	407.7	404.4
34	465.5	460.0	454.4	448.9	443.4	437.8	432.3	426.8	423.5	420.2	416.9	413.5	410.2	406.9

180 L container (450 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI in. and temperature °F)

	Temperature °F (°C)													
LLI	0	10	20	30	40	50	60	70	80	90	100	110	120	130
in.	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.6)	(43.3)	(48.9)	(54.4)
10	179.2	177.5	175.8	174.1	172.4	170.6	168.9	167.2	165.3	163.3	161.3	159.4	157.4	155.4
10.25	182.1	180.4	178.7	177	175.2	173.5	171.8	170	168.1	166.1	164.1	162.1	160.1	158.1
10.5	185.1	183.4	181.6	179.9	178.1	176.4	174.6	172.9	170.8	168.8	166.8	164.8	162.8	160.7
10.75	188.1	186.3	184.5	182.8	181	179.2	177.5	175.7	173.6	171.6	169.5	167.5	165.5	163.4
11	191	189.2	187.5	185.7	183.9	182.1	180.3	178.5	176.4	174.4	172.3	170.2	168.1	166.1
11.25	194	192.2	190.4	188.6	186.8	184.9	183.1	181.3	179.2	177.1	175	172.9	170.8	168.7
11.5	197	195.1	193.3	191.5	189.6	187.8	186	184.1	182	179.9	177.8	175.6	173.5	171.4
11.75	199.9	198.1	196.2	194.4	192.5	190.7	188.8	187	184.8	182.7	180.5	178.4	176.2	174
12	202.9	201	199.1	197.3	195.4	193.5	191.6	189.8	187.6	185.4	183.2	181.1	178.9	176.7
12.25	205.9	204	202.1	200.2	198.3	196.4	194.5	192.6	190.4	188.2	186	183.8	181.6	179.4
12.5	208.8	206.9	205	203.1	201.2	199.2	197.3	195.4	193.2	190.9	188.7	186.5	184.3	182
12.75	211.8	209.8	207.9	206	204	202.1	200.2	198.2	196	193.7	191.5	189.2	186.9	184.7
13	214.7	212.8	210.8	208.9	206.9	205	203	201	198.8	196.5	194.2	191.9	189.6	187.4
13.25	217.7	215.7	213.8	211.8	209.8	207.8	205.8	203.9	201.6	199.2	196.9	194.6	192.3	190
13.5	220.7	218.7	216.7	214.7	212.7	210.7	208.7	206.7	204.3	202	199.7	197.3	195	192.7
13.75	223.6	221.6	219.6	217.6	215.6	213.5	211.5	209.5	207.1	204.8	202.4	200.1	197.7	195.3
14	226.6	224.6	222.5	220.5	218.4	216.4	214.4	212.3	209.9	207.5	205.2	202.8	200.4	198
14.25	229.6	227.5	225.4	223.4	221.3	219.3	217.2	215.1	212.7	210.3	207.9	205.5	203.1	200.7
14.5	232.5	230.4	228.4	226.3	224.2	222.1	220	218	215.5	213.1	210.6	208.2	205.8	203.3
14.75	235.5	233.4	231.3	229.2	227.1	225	222.9	220.8	218.3	215.8	213.4	210.9	208.4	206
15	238.5	236.3	234.2	232.1	230	227.8	225.7	223.6	221.1	218.6	216.1	213.6	211.1	208.6
15.25	241.4	239.3	237.1	235	232.8	230.7	228.5	226.4	223.9	221.4	218.9	216.3	213.8	211.3
15.5	244.4	242.2	240.1	237.9	235.7	233.6	231.4	229.2	226.7	224.1	221.6	219	216.5	214
15.75	247.3	245.2	243	240.8	238.6	236.4	234.2	232	229.5	226.9	224.3	221.8	219.2	216.6
16	250.3	248.1	245.9	243.7	241.5	239.3	237.1	234.9	232.3	229.7	227.1	224.5	221.9	219.3
16.25	253.3	251	248.8	246.6	244.4	242.1	239.9	237.7	235.1	232.4	229.8	227.2	224.6	221.9
16.5	256.2	254	251.7	249.5	247.2	245	242.7	240.5	237.8	235.2	232.5	229.9	227.2	224.6
16.75	259.2	256.9	254.7	252.4	250.1	247.9	245.6	243.3	240.6	238	235.3	232.6	229.9	227.3
17	262.2	259.9	257.6	255.3	253	250.7	248.4	246.1	243.4	240.7	238	235.3	232.6	229.9
17.25	265.1	262.8	260.5	258.2	255.9	253.6	251.3	248.9	246.2	243.5	240.8	238	235.3	232.6
17.5	268.1	265.8	263.4	261.1	258.8	256.4	254.1	251.8	249	246.3	243.5	240.7	238	235.2
17.75	271.1	268.7	266.4	264	261.6	259.3	256.9	254.6	251.8	249	246.2	243.5	240.7	237.9
18	274	271.6	269.3	266.9	264.5	262.1	259.8	257.4	254.6	251.8	249	246.2	243.4	240.6
18.25	277	274.6	272.2	269.8	267.4	265	262.6	260.2	257.4	254.6	251.7	248.9	246.1	243.2
18.5	279.9	277.5	275.1	272.7	270.3	267.9	265.5	263	260.2	257.3	254.5	251.6	248.7	245.9
18.75	282.9	280.5	278	275.6	273.2	270.7	268.3	265.9	263	260.1	257.2	254.3	251.4	248.5
19	285.9	283.4	281	278.5	276	273.6	271.1	268.7	265.8	262.8	259.9	257	254.1	251.2
19.25	288.8	286.4	283.9	281.4	278.9	276.4	274	271.5	268.6	265.6	262.7	259.7	256.8	253.9
19.5	291.8	289.3	286.8	284.3	281.8	279.3	276.8	274.3	271.3	268.4	265.4	262.5	259.5	256.5
19.75	294.8	292.2	289.7	287.2	284.7	282.2	279.6	277.1	274.1	271.1	268.2	265.2	262.2	259.2
20	297.7	295.2	292.6	290.1	287.6	285	282.5	279.9	276.9	273.9	270.9	267.9	264.9	261.8
20.25	300.7	298.1	295.6	293	290.4	287.9	285.3	282.8	279.7	276.7	273.6	270.6	267.5	264.5
20.5	303.7	301.1	298.5	295.9	293.3	290.7	288.2	285.6	282.5	279.4	276.4	273.3	270.2	267.2
20.75	306.6	304	301.4	298.8	296.2	293.6	291	288.4	285.3	282.2	279.1	276	272.9	269.8
21	309.6	307	304.3	301.7	299.1	296.5	293.8	291.2	288.1	285	281.9	278.7	275.6	272.5
21.25	312.6	309.9	307.3	304.6	302	299.3	296.7	294	290.9	287.7	284.6	281.4	278.3	275.1
21.5	315.5	312.8	310.2	307.5	304.8	302.2	299.5	296.8	293.7	290.5	287.3	284.2	281	277.8
21.75	318.5	315.8	313.1	310.4	307.7	305	302.4	299.7	296.5	293.3	290.1	286.9	283.7	280.5
22	321.4	318.7	316	313.3	310.6	307.9	305.2	302.5	299.3	296	292.8	289.6	286.4	283.1
22.25	324.4	321.7	318.9	316.2	313.5	310.8	308	305.3	302	298.8	295.5	292.3	289	285.8
22.5	327.4	324.6	321.9	319.1	316.4	313.6	310.9	308.1	304.8	301.6	298.3	295	291.7	288.5
22.75	330.3	327.6	324.8	322	319.2	316.5	313.7	310.9	307.6	304.3	301	297.7	294.4	291.1
23	333.3	330.5	327.7	324.9	322.1	319.3	316.5	313.8	310.4	307.1	303.8	300.4	297.1	293.8
23.25	336.3	333.4	330.6	327.8	325	322.2	319.4	316.6	313.2	309.9	306.5	303.1	299.8	296.4
23.5	339.2	336.4	333.6	330.7	327.9	325.1	322.2	319.4	316	312.6	309.2	305.9	302.5	299.1
23.75	342.2	339.3	336.5	333.6	330.8	327.9	325.1	322.2	318.8	315.4	312	308.6	305.2	301.8
24	345.2	342.3	339.4	336.5	333.7	330.8	327.9	325	321.6	318.2	314.7	311.3	307.8	304.4
24.25	348.1	345.2	342.3	339.4	336.5	333.6	330.7	327.8	324.4	320.9	317.5	314	310.5	307.1
24.5	351.1	348.2	345.2	342.3	339.4	336.5	333.6	330.7	327.2	323.7	320.2	316.7	313.2	309.7
24.75	354	351.1	348.2	345.2	342.3	339.4	336.4	333.5	330	326.5	322.9	319.4	315.9	312.4
25	357	354	351.1	348.1	345.2	342.2	339.3	336.3	332.8	329.2	325.7	322.1	318.6	315.1
25.25	360	357	354	351	348.1	345.1	342.1	339.1	335.5	332	328.4	324.8	321.3	317.7
25.5	362.9	359.9	356.9	353.9	350.9	347.9	344.9	341.9	338.3	334.7	331.2	327.6	324	320.4
25.75	365.9	362.9	359.9	356.8	353.8	350.8	347.8	344.8	341.1	337.5	333.9	330.3	326.7	323
26	368.9	365.8	362.8	359.7	356.7	353.7	350.6	347.6	343.9	340.3	336.6	333	329.3	325.7
26.25	371.8	368.8	365.7	362.6	359.6	356.5	353.4	350.4	346.7	343	339.4	335.7	332	328.4
26.5	374.8	371.7	368.6	365.5	362.5	359.4	356.3	353.2	349.5	345.8	342.1	338.4	334.7	331
26.75	377.8	374.6	371.5	368.4	365.3	362.2	359.1	356	352.3	348.6	344.8	341.1	337.4	333.7
27	380.7	377.6	374.5	371.3	368.2	365.1	362	358.8	355.1	351.3	347.6	343.8	340.1	336.3
27.25	383.7	380.5	377.4	374.2	371.1	367.9	364.8	361.7	357.9	354.1	350.3	346.6	342.8	339
27.5	386.6	383.5	380.3	377.1	374	370.8	367.6	364.5	360.7	356.9	353.1	349.3	345.5	341.7
27.75	389.6	386.4	383.2	380	376.9	373.7	370.5	367.3	363.5	359.6	355.8	352	348.1	344.3

180 L container (450 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI in. and temperature °F) (Continued)

	Temperature °F (°C)													
LLI	0	10	20	30	40	50	60	70	80	90	100	110	120	130
in.	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.6)	(43.3)	(48.9)	(54.4)
28	392.6	389.4	386.2	382.9	379.7	376.5	373.3	370.1	366.3	362.4	358.5	354.7	350.8	347
28.25	395.5	392.3	389.1	385.8	382.6	379.4	376.2	372.9	369	365.2	361.3	357.4	353.5	349.6
28.5	398.5	395.2	392	388.7	385.5	382.2	379	375.7	371.8	367.9	364	360.1	356.2	352.3
28.75	401.5	398.2	394.9	391.6	388.4	385.1	381.8	378.6	374.6	370.7	366.8	362.8	358.9	355
29	404.4	401.1	397.8	394.6	391.3	388	384.7	381.4	377.4	373.5	369.5	365.5	361.6	357.6
29.25	407.4	404.1	400.8	397.5	394.1	390.8	387.5	384.2	380.2	376.2	372.2	368.3	364.3	360.3
29.5	410.4	407	403.7	400.4	397	393.7	390.4	387	383	379	375	371	367	362.9
29.75	413.3	410	406.6	403.3	399.9	396.5	393.2	389.8	385.8	381.8	377.7	373.7	369.6	365.6
30	416.3	412.9	409.5	406.2	402.8	399.4	396	392.7	388.6	384.5	380.5	376.4	372.3	368.3
30.25	419.2	415.8	412.5	409.1	405.7	402.3	398.9	395.5	391.4	387.3	383.2	379.1	375	370.9
30.5	422.2	418.8	415.4	412	408.5	405.1	401.7	398.3	394.2	390.1	385.9	381.8	377.7	373.6
30.75	425.2	421.7	418.3	414.9	411.4	408	404.5	401.1	397	392.8	388.7	384.5	380.4	376.2
31	428.1	424.7	421.2	417.8	414.3	410.8	407.4	403.9	399.8	395.6	391.4	387.2	383.1	378.9
31.25	431.1	427.6	424.1	420.7	417.2	413.7	410.2	406.7	402.5	398.3	394.2	390	385.8	381.6
31.5	434.1	430.6	427.1	423.6	420.1	416.6	413.1	409.6	405.3	401.1	396.9	392.7	388.4	384.2
31.75	437	433.5	430	426.5	422.9	419.4	415.9	412.4	408.1	403.9	399.6	395.4	391.1	386.9
32	440	436.4	432.9	429.4	425.8	422.3	418.7	415.2	410.9	406.6	402.4	398.1	393.8	389.5
32.25	443	439.4	435.8	432.3	428.7	425.1	421.6	418	413.7	409.4	405.1	400.8	396.5	392.2
32.5	445.9	442.3	438.8	435.2	431.6	428	424.4	420.8	416.5	412.2	407.8	403.5	399.2	394.9
32.75	448.9	445.3	441.7	438.1	434.5	430.9	427.3	423.6	419.3	414.9	410.6	406.2	401.9	397.5
33	451.8	448.2	444.6	441	437.3	433.7	430.1	426.5	422.1	417.7	413.3	408.9	404.6	400.2
33.25	454.8	451.2	447.5	443.9	440.2	436.6	432.9	429.3	424.9	420.5	416.1	411.7	407.3	402.9
33.5	457.8	454.1	450.4	446.8	443.1	439.4	435.8	432.1	427.7	423.2	418.8	414.4	409.9	405.5
33.75	460.7	457	453.4	449.7	446	442.3	438.6	434.9	430.5	426	421.5	417.1	412.6	408.2
34	463.7	460	456.3	452.6	448.9	445.2	441.4	437.7	433.3	428.8	424.3	419.8	415.3	410.8
34.25	466.7	462.9	459.2	455.5	451.7	448	444.3	440.6	436	431.5	427	422.5	418	413.5
34.5	469.6	465.9	462.1	458.4	454.6	450.9	447.1	443.4	438.8	434.3	429.8	425.2	420.7	416.2
34.75	472.6	468.8	465	461.3	457.5	453.7	450	446.2	441.6	437.1	432.5	427.9	423.4	418.8
35	475.6	471.8	468	464.2	460.4	456.6	452.8	449	444.4	439.8	435.2	430.7	426.1	421.5
35.25	478.5	474.7	470.9	467.1	463.3	459.5	455.6	451.8	447.2	442.6	438	433.4	428.8	424.1
35.5	481.5	477.6	473.8	470	466.1	462.3	458.5	454.6	450	445.4	440.7	436.1	431.4	426.8
35.75	484.4	480.6	476.7	472.9	469	465.2	461.3	457.5	452.8	448.1	443.5	438.8	434.1	429.5
36	487.4	483.5	479.7	475.8	471.9	468	464.2	460.3	455.6	450.9	446.2	441.5	436.8	432.1
36.25	490.4	486.5	482.6	478.7	474.8	470.9	467	463.1	458.4	453.7	448.9	444.2	439.5	434.8
36.5	493.3	489.4	485.5	481.6	477.7	473.7	469.8	465.9	461.2	456.4	451.7	446.9	442.2	437.4
36.75	496.3	492.4	488.4	484.5	480.5	476.6	472.7	468.7	464	459.2	454.4	449.6	444.9	440.1
37	499.3	495.3	491.3	487.4	483.4	479.5	475.5	471.5	466.8	462	457.2	452.4	447.6	442.8
37.25	502.2	498.3	494.3	490.3	486.3	482.3	478.3	474.4	469.5	464.7	459.9	455.1	450.2	445.4
37.5	505.2	501.2	497.2	493.2	489.2	485.2	481.2	477.2	472.3	467.5	462.6	457.8	452.9	448.1
37.75	508.2	504.1	500.1	496.1	492.1	488	484	480	475.1	470.2	465.4	460.5	455.6	450.7
38	511.1	507.1	503	499	494.9	490.9	486.9	482.8	477.9	473	468.1	463.2	458.3	453.4
38.25	514.1	510	506	501.9	497.8	493.8	489.7	485.6	480.7	475.8	470.8	465.9	461	456.1
38.5	517	513	508.9	504.8	500.7	496.6	492.5	488.5	483.5	478.5	473.6	468.6	463.7	458.7
38.75	520	515.9	511.8	507.7	503.6	499.5	495.4	491.3	486.3	481.3	476.3	471.3	466.4	461.4
39	523	518.9	514.7	510.6	506.5	502.3	498.2	494.1	489.1	484.1	479.1	474.1	469.1	464
39.25	525.9	521.8	517.6	513.5	509.4	505.2	501.1	496.9	491.9	486.8	481.8	476.8	471.7	466.7
39.5	528.9	524.7	520.6	516.4	512.2	508.1	503.9	499.7	494.7	489.6	484.5	479.5	474.4	469.4
39.75	531.9	527.7	523.5	519.3	515.1	510.9	506.7	502.5	497.5	492.4	487.3	482.2	477.1	472
40	534.8	530.6	526.4	522.2	518	513.8	509.6	505.4	500.2	495.1	490	484.9	479.8	474.7
40.25	537.8	533.6	529.3	525.1	520.9	516.6	512.4	508.2	503	497.9	492.8	487.6	482.5	477.3
40.5	540.8	536.5	532.3	528	523.8	519.5	515.2	511	505.8	500.7	495.5	490.3	485.2	480
40.75	543.7	539.5	535.2	530.9	526.6	522.4	518.1	513.8	508.6	503.4	498.2	493	487.9	482.7
41	546.7	542.4	538.1	533.8	529.5	525.2	520.9	516.6	511.4	506.2	501	495.8	490.5	485.3
41.25	549.7	545.3	541	536.7	532.4	528.1	523.8	519.5	514.2	509	503.7	498.5	493.2	488
41.5	552.6	548.3	543.9	539.6	535.3	530.9	526.6	522.3	517	511.7	506.5	501.2	495.9	490.6
41.75	555.6	551.2	546.9	542.5	538.2	533.8	529.4	525.1	519.8	514.5	509.2	503.9	498.6	493.3
42	558.5	554.2	549.8	545.4	541	536.7	532.3	527.9	522.6	517.3	511.9	506.6	501.3	496

343 L container (850 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI in. and temperature °F)

	Temperature °F (°C)													
LLI	0	10	20	30	40	50	60	70	80	90	100	110	120	130
in.	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.6)	(43.3)	(48.9)	(54.4)
5	362.1	358.7	355.3	352	348.6	345.3	341.9	338.6	335.6	332.5	329.5	326.5	323.5	320.5
5.25	368.5	365.1	361.7	358.3	354.9	351.5	348.1	344.7	341.6	338.5	335.4	332.4	329.3	326.2
5.5	375	371.5	368.1	364.6	361.1	357.7	354.2	350.7	347.6	344.5	341.3	338.2	335.1	331.9
5.75	381.5	378	374.4	370.9	367.4	363.8	360.3	356.8	353.6	350.4	347.2	344.1	340.9	337.7
6	388	384.4	380.8	377.2	373.6	370	366.4	362.9	359.6	356.4	353.1	349.9	346.7	343.4
6.25	394.4	390.8	387.1	383.5	379.9	376.2	372.6	368.9	365.6	362.3	359	355.8	352.5	349.2
6.5	400.9	397.2	393.5	389.8	386.1	382.4	378.7	375	371.7	368.3	365	361.6	358.3	354.9
6.75	407.4	403.6	399.9	396.1	392.3	388.6	384.8	381.1	377.7	374.3	370.9	367.5	364	360.6
7	413.9	410	406.2	402.4	398.6	394.8	391	387.1	383.7	380.2	376.8	373.3	369.8	366.4
7.25	420.3	416.5	412.6	408.7	404.8	401	397.1	393.2	389.7	386.2	382.7	379.2	375.6	372.1
7.5	426.8	422.9	418.9	415	411.1	407.1	403.2	399.3	395.7	392.1	388.6	385	381.4	377.9
7.75	433.3	429.3	425.3	421.3	417.3	413.3	409.3	405.3	401.7	398.1	394.5	390.9	387.2	383.6
8	439.8	435.7	431.7	427.6	423.6	419.5	415.5	411.4	407.7	404.1	400.4	396.7	393	389.3
8.25	446.2	442.1	438	433.9	429.8	425.7	421.6	417.5	413.7	410	406.3	402.6	398.8	395.1
8.5	452.7	448.5	444.4	440.2	436	431.9	427.7	423.5	419.8	416	412.2	408.4	404.6	400.8
8.75	459.2	455	450.7	446.5	442.3	438.1	433.8	429.6	425.8	421.9	418.1	414.3	410.4	406.6
9	465.7	461.4	457.1	452.8	448.5	444.2	440	435.7	431.8	427.9	424	420.1	416.2	412.3
9.25	472.1	467.8	463.5	459.1	454.8	450.4	446.1	441.8	437.8	433.9	429.9	426	422	418
9.5	478.6	474.2	469.8	465.4	461	456.6	452.2	447.8	443.8	439.8	435.8	431.8	427.8	423.8
9.75	485.1	480.6	476.2	471.7	467.3	462.8	458.3	453.9	449.8	445.8	441.7	437.7	433.6	429.5
10	491.6	487	482.5	478	473.5	469	464.5	460	455.8	451.7	447.6	443.5	439.4	435.3
10.25	498	493.5	488.9	484.3	479.7	475.2	470.6	466	461.9	457.7	453.5	449.3	445.2	441
10.5	504.5	499.9	495.2	490.6	486	481.4	476.7	472.1	467.9	463.6	459.4	455.2	451	446.8
10.75	511	506.3	501.6	496.9	492.2	487.5	482.9	478.2	473.9	469.6	465.3	461	456.8	452.5
11	517.5	512.7	508	503.2	498.5	493.7	489	484.2	479.9	475.6	471.2	466.9	462.6	458.2
11.25	523.9	519.1	514.3	509.5	504.7	499.9	495.1	490.3	485.9	481.5	477.1	472.7	468.4	464
11.5	530.4	525.5	520.7	515.8	511	506.1	501.2	496.4	491.9	487.5	483	478.6	474.2	469.7
11.75	536.9	532	527	522.1	517.2	512.3	507.4	502.4	497.9	493.4	488.9	484.4	480	475.5
12	543.4	538.4	533.4	528.4	523.4	518.5	513.5	508.5	504	499.4	494.9	490.3	485.7	481.2
12.25	549.8	544.8	539.8	534.7	529.7	524.7	519.6	514.6	510	505.4	500.8	496.1	491.5	486.9
12.5	556.3	551.2	546.1	541	535.9	530.8	525.7	520.6	516	511.3	506.7	502	497.3	492.7
12.75	562.8	557.6	552.5	547.3	542.2	537	531.9	526.7	522	517.3	512.6	507.8	503.1	498.4
13	569.3	564.1	558.8	553.6	548.4	543.2	538	532.8	528	523.2	518.5	513.7	508.9	504.2
13.25	575.7	570.5	565.2	559.9	554.7	549.4	544.1	538.9	534	529.2	524.4	519.5	514.7	509.9
13.5	582.2	576.9	571.6	566.2	560.9	555.6	550.2	544.9	540	535.2	530.3	525.4	520.5	515.6
13.75	588.7	583.3	577.9	572.5	567.1	561.8	556.4	551	546.1	541.1	536.2	531.2	526.3	521.4
14	595.2	589.7	584.3	578.8	573.4	567.9	562.5	557.1	552.1	547.1	542.1	537.1	532.1	527.1
14.25	601.6	596.1	590.6	585.1	579.6	574.1	568.6	563.1	558.1	553	548	542.9	537.9	532.9
14.5	608.1	602.6	597	591.4	585.9	580.3	574.8	569.2	564.1	559	553.9	548.8	543.7	538.6
14.75	614.6	609	603.4	597.7	592.1	586.5	580.9	575.3	570.1	565	559.8	554.6	549.5	544.3
15	621.1	615.4	609.7	604	598.4	592.7	587	581.3	576.1	570.9	565.7	560.5	555.3	550.1
15.25	627.5	621.8	616.1	610.3	604.6	598.9	593.1	587.4	582.1	576.9	571.6	566.3	561.1	555.8
15.5	634	628.2	622.4	616.6	610.8	605.1	599.3	593.5	588.1	582.8	577.5	572.2	566.9	561.6
15.75	640.5	634.6	628.8	622.9	617.1	611.2	605.4	599.5	594.2	588.8	583.4	578	572.7	567.3
16	647	641.1	635.2	629.2	623.3	617.4	611.5	605.6	600.2	594.8	589.3	583.9	578.5	573
16.25	653.4	647.5	641.5	635.5	629.6	623.6	617.6	611.7	606.2	600.7	595.2	589.7	584.3	578.8
16.5	659.9	653.9	647.9	641.8	635.8	629.8	623.8	617.7	612.2	606.7	601.1	595.6	590.1	584.5
16.75	666.4	660.3	654.2	648.1	642.1	636	629.9	623.8	618.2	612.6	607	601.4	595.9	590.3
17	672.9	666.7	660.6	654.4	648.3	642.2	636	629.9	624.2	618.6	612.9	607.3	601.6	596
17.25	679.3	673.1	666.9	660.7	654.5	648.3	642.1	635.9	630.2	624.5	618.8	613.1	607.4	601.7
17.5	685.8	679.6	673.3	667	660.8	654.5	648.3	642	636.3	630.5	624.8	619	613.2	607.5
17.75	692.3	686	679.7	673.4	667	660.7	654.4	648.1	642.3	636.5	630.7	624.8	619	613.2
18	698.8	692.4	686	679.7	673.3	666.9	660.5	654.2	648.3	642.4	636.6	630.7	624.8	619
18.25	705.3	698.8	692.4	686	679.5	673.1	666.7	660.2	654.3	648.4	642.5	636.5	630.6	624.7
18.5	711.7	705.2	698.7	692.3	685.8	679.3	672.8	666.3	660.3	654.3	648.4	642.4	636.4	630.4
18.75	718.2	711.7	705.1	698.6	692	685.5	678.9	672.4	666.3	660.3	654.3	648.2	642.2	636.2
19	724.7	718.1	711.5	704.9	698.2	691.6	685	678.4	672.3	666.3	660.2	654.1	648	641.9
19.25	731.2	724.5	717.8	711.2	704.5	697.8	691.2	684.5	678.4	672.2	666.1	659.9	653.8	647.7
19.5	737.6	730.9	724.2	717.5	710.7	704	697.3	690.6	684.4	678.2	672	665.8	659.6	653.4
19.75	744.1	737.3	730.5	723.8	717	710.2	703.4	696.6	690.4	684.1	677.9	671.6	665.4	659.1
20	750.6	743.7	736.9	730.1	723.2	716.4	709.5	702.7	696.4	690.1	683.8	677.5	671.2	664.9
20.25	757.1	750.2	743.3	736.4	729.5	722.6	715.7	708.8	702.4	696.1	689.7	683.3	677	670.6
20.5	763.5	756.6	749.6	742.7	735.7	728.7	721.8	714.8	708.4	702	695.6	689.2	682.8	676.4
20.75	770	763	756	749	741.9	734.9	727.9	720.9	714.4	708	701.5	695	688.6	682.1

343 L container (850 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI in. and temperature °F) (Continued)

	Temperature °F (°C)													
LLI	0	10	20	30	40	50	60	70	80	90	100	110	120	130
in.	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.6)	(43.3)	(48.9)	(54.4)
21	776.5	769.4	762.3	755.3	748.2	741.1	734	727	720.5	713.9	707.4	700.9	694.4	687.9
21.25	783	775.8	768.7	761.6	754.4	747.3	740.2	733	726.5	719.9	713.3	706.7	700.2	693.6
21.5	789.4	782.2	775.1	767.9	760.7	753.5	746.3	739.1	732.5	725.9	719.2	712.6	706	699.3
21.75	795.9	788.7	781.4	774.2	766.9	759.7	752.4	745.2	738.5	731.8	725.1	718.4	711.8	705.1
22	802.4	795.1	787.8	780.5	773.2	765.9	758.6	751.2	744.5	737.8	731	724.3	717.6	710.8
22.25	808.9	801.5	794.1	786.8	779.4	772	764.7	757.3	750.5	743.7	736.9	730.1	723.3	716.6
22.5	815.3	807.9	800.5	793.1	785.6	778.2	770.8	763.4	756.5	749.7	742.8	736	729.1	722.3
22.75	821.8	814.3	806.9	799.4	791.9	784.4	776.9	769.5	762.6	755.6	748.7	741.8	734.9	728
23	828.3	820.7	813.2	805.7	798.1	790.6	783.1	775.5	768.6	761.6	754.6	747.7	740.7	733.8
23.25	834.8	827.2	819.6	812	804.4	796.8	789.2	781.6	774.6	767.6	760.6	753.5	746.5	739.5
23.5	841.2	833.6	825.9	818.3	810.6	803	795.3	787.7	780.6	773.5	766.5	759.4	752.3	745.3
23.75	847.7	840	832.3	824.6	816.9	809.2	801.4	793.7	786.6	779.5	772.4	765.2	758.1	751
24	854.2	846.4	838.6	830.9	823.1	815.3	807.6	799.8	792.6	785.4	778.3	771.1	763.9	756.7
24.25	860.7	852.8	845	837.2	829.3	821.5	813.7	805.9	798.6	791.4	784.2	776.9	769.7	762.5
24.5	867.1	859.3	851.4	843.5	835.6	827.7	819.8	811.9	804.6	797.4	790.1	782.8	775.5	768.2
24.75	873.6	865.7	857.7	849.8	841.8	833.9	825.9	818	810.7	803.3	796	788.6	781.3	774
25	880.1	872.1	864.1	856.1	848.1	840.1	832.1	824.1	816.7	809.3	801.9	794.5	787.1	779.7
25.25	886.6	878.5	870.4	862.4	854.3	846.3	838.2	830.1	822.7	815.2	807.8	800.3	792.9	785.4
25.5	893	884.9	876.8	868.7	860.6	852.4	844.3	836.2	828.7	821.2	813.7	806.2	798.7	791.2
25.75	899.5	891.3	883.2	875	866.8	858.6	850.5	842.3	834.7	827.2	819.6	812	804.5	796.9
26	906	897.8	889.5	881.3	873.1	864.8	856.6	848.3	840.7	833.1	825.5	817.9	810.3	802.7
26.25	912.5	904.2	895.9	887.6	879.3	871	862.7	854.4	846.7	839.1	831.4	823.7	816.1	808.4
26.5	918.9	910.6	902.2	893.9	885.5	877.2	868.8	860.5	852.8	845	837.3	829.6	821.9	814.1
26.75	925.4	917	908.6	900.2	891.8	883.4	875	866.5	858.8	851	843.2	835.4	827.7	819.9
27	931.9	923.4	915	906.5	898	889.6	881.1	872.6	864.8	857	849.1	841.3	833.5	825.6
27.25	938.4	929.8	921.3	912.8	904.3	895.7	887.2	878.7	870.8	862.9	855	847.1	839.3	831.4
27.5	944.8	936.3	927.7	919.1	910.5	901.9	893.3	884.8	876.8	868.9	860.9	853	845	837.1
27.75	951.3	942.7	934	925.4	916.8	908.1	899.5	890.8	882.8	874.8	866.8	858.8	850.8	842.8
28	957.8	949.1	940.4	931.7	923	914.3	905.6	896.9	888.8	880.8	872.7	864.7	856.6	848.6
28.25	964.3	955.5	946.8	938	929.2	920.5	911.7	903	894.9	886.7	878.6	870.5	862.4	854.3
28.5	970.7	961.9	953.1	944.3	935.5	926.7	917.8	909	900.9	892.7	884.5	876.4	868.2	860.1
28.75	977.2	968.3	959.5	950.6	941.7	932.8	924	915.1	906.9	898.7	890.5	882.2	874	865.8
29	983.7	974.8	965.8	956.9	948	939	930.1	921.2	912.9	904.6	896.4	888.1	879.8	871.5
29.25	990.2	981.2	972.2	963.2	954.2	945.2	936.2	927.2	918.9	910.6	902.3	893.9	885.6	877.3
29.5	996.6	987.6	978.6	969.5	960.5	951.4	942.4	933.3	924.9	916.5	908.2	899.8	891.4	883
29.75	1003.1	994	984.9	975.8	966.7	957.6	948.5	939.4	930.9	922.5	914.1	905.6	897.2	888.8
30	1009.6	1000.4	991.3	982.1	972.9	963.8	954.6	945.4	937	928.5	920	911.5	903	894.5
30.25	1016.1	1006.9	997.6	988.4	979.2	970	960.7	951.5	943	934.4	925.9	917.3	908.8	900.3
30.5	1022.6	1013.3	1004	994.7	985.4	976.1	966.9	957.6	949	940.4	931.8	923.2	914.6	906
30.75	1029	1019.7	1010.3	1001	991.7	982.3	973	963.6	955	946.3	937.7	929	920.4	911.7

106 L container (280 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C)

LLI	Temperature °C (°F)													
cm	-15 (5)	-10 (14)	-5 (23)	0 (32)	5 (41)	10 (50)	15 (59)	20 (68)	25 (77)	30 (86)	35 (95)	40 (104)	45 (113)	50 (122)
15.5	110.9	109.6	108.0	106.7	105.4	103.9	102.5	101.0	99.7	98.1	96.6	95.0	93.7	92.2
16	113.1	111.6	110.3	108.9	107.4	106.1	104.5	103.2	101.7	100.3	98.8	97.2	95.7	94.2
16.5	115.1	113.8	112.5	110.9	109.6	108.3	106.7	105.4	103.9	102.3	100.8	99.4	97.9	96.4
17	117.3	116.0	114.4	113.1	111.8	110.3	108.9	107.6	106.1	104.5	103.0	101.4	99.9	98.3
17.5	119.5	118.0	116.6	115.3	113.8	112.5	111.1	109.6	108.0	106.7	105.2	103.6	102.1	100.5
18	121.5	120.2	118.6	117.3	116.0	114.7	113.1	111.8	110.3	108.7	107.2	105.6	104.1	102.5
18.5	123.7	122.2	120.8	119.5	118.2	116.6	115.3	114.0	112.5	110.9	109.4	107.8	106.3	104.7
19	125.7	124.4	123.0	121.5	120.2	118.8	117.5	116.2	114.7	112.9	111.4	109.8	108.3	106.7
19.5	127.9	126.3	125.0	123.7	122.4	121.1	119.7	118.2	116.6	115.1	113.6	112.0	110.5	108.7
20	129.9	128.6	127.2	125.9	124.6	123.0	121.7	120.4	118.8	117.3	115.8	114.0	112.5	110.9
20.5	132.1	130.8	129.2	127.9	126.6	125.2	123.9	122.6	121.1	119.3	117.7	116.2	114.7	112.9
21	134.1	132.7	131.4	130.1	128.8	127.4	126.1	124.8	123.0	121.5	120.0	118.2	116.6	115.1
21.5	136.3	134.9	133.6	132.3	131.0	129.4	128.1	126.8	125.2	123.7	121.9	120.4	118.6	117.1
22	138.3	136.9	135.6	134.3	133.0	131.6	130.3	129.0	127.4	125.7	124.1	122.4	120.8	119.3
22.5	140.5	139.1	137.8	136.5	135.2	133.8	132.5	131.2	129.7	127.9	126.3	124.6	122.8	121.3
23	142.4	141.1	139.8	138.7	137.4	136.0	134.7	133.4	131.6	130.1	128.3	126.8	125.0	123.3
23.5	144.6	143.3	142.0	140.7	139.4	138.0	136.7	135.4	133.8	132.1	130.5	128.8	127.0	125.5
24	146.9	145.5	144.2	142.9	141.6	140.2	138.9	137.6	136.0	134.3	132.5	131.0	129.2	127.4
24.5	148.8	147.5	146.2	144.9	143.8	142.4	141.1	139.8	138.3	136.5	134.7	133.0	131.2	129.7
25	151.0	149.7	148.4	147.1	145.8	144.4	143.1	142.0	140.2	138.5	136.9	135.2	133.4	131.6
25.5	153.0	151.7	150.6	149.3	148.0	146.6	145.3	144.0	142.4	140.7	138.9	137.2	135.4	133.6
26	155.2	153.9	152.6	151.3	150.2	148.8	147.5	146.2	144.6	142.9	141.1	139.4	137.6	135.8
26.5	157.2	156.1	154.8	153.5	152.1	150.8	149.7	148.4	146.6	144.9	143.1	141.3	139.6	137.8
27	159.4	158.1	156.8	155.7	154.4	153.0	151.7	150.6	148.8	147.1	145.3	143.5	141.8	140.0
27.5	161.4	160.3	159.0	157.7	156.6	155.2	153.9	152.6	151.0	149.3	147.5	145.5	143.8	142.0
28	163.6	162.3	161.2	159.9	158.5	157.2	156.1	154.8	153.2	151.3	149.5	147.7	146.0	144.2
28.5	165.6	164.5	163.2	161.8	160.7	159.4	158.3	157.0	155.2	153.5	151.7	149.9	148.0	146.2
29	167.8	166.5	165.4	164.1	162.9	161.6	160.3	159.2	157.4	155.7	153.7	151.9	150.2	148.2
29.5	170.0	168.7	167.4	166.3	164.9	163.8	162.5	161.2	159.6	157.7	155.9	154.1	152.1	150.4
30	172.0	170.9	169.6	168.2	167.1	165.8	164.7	163.4	161.6	159.9	158.1	156.1	154.4	152.4
30.5	174.2	172.9	171.8	170.4	169.3	168.0	166.7	165.6	163.8	162.1	160.1	158.3	156.3	154.6
31	176.2	175.1	173.8	172.7	171.3	170.2	168.9	167.8	166.0	164.1	162.3	160.3	158.5	156.6
31.5	178.4	177.1	176.0	174.6	173.5	172.2	171.1	169.8	168.2	166.3	164.3	162.5	160.5	158.8
32	180.4	179.3	177.9	176.8	175.7	174.4	173.3	172.0	170.2	168.5	166.5	164.5	162.7	160.7
32.5	182.6	181.3	180.1	179.0	177.7	176.6	175.3	174.2	172.4	170.4	168.7	166.7	164.7	162.7
33	184.6	183.5	182.4	181.0	179.9	178.6	177.5	176.4	174.6	172.7	170.7	168.7	166.9	164.9
33.5	186.8	185.7	184.3	183.2	182.1	180.8	179.7	178.4	176.6	174.9	172.9	170.9	168.9	166.9
34	188.7	187.6	186.5	185.2	184.1	183.0	181.9	180.6	178.8	176.8	174.9	172.9	171.1	169.1
34.5	191.0	189.9	188.5	187.4	186.3	185.2	183.9	182.8	181.0	179.0	177.1	175.1	173.1	171.1
35	192.9	191.8	190.7	189.6	188.3	187.2	186.1	185.0	183.2	181.3	179.3	177.3	175.3	173.3
35.5	195.1	194.0	192.9	191.6	190.5	189.4	188.3	187.2	185.2	183.2	181.3	179.3	177.3	175.3
36	197.3	196.0	194.9	193.8	192.7	191.6	190.3	189.2	187.4	185.4	183.5	181.5	179.3	177.3
36.5	199.3	198.2	197.1	196.0	194.7	193.6	192.5	191.4	189.6	187.6	185.4	183.5	181.5	179.5
37	201.5	200.4	199.1	198.0	196.9	195.8	194.7	193.6	191.6	189.6	187.6	185.7	183.5	181.5
37.5	203.5	202.4	201.3	200.2	199.1	198.0	196.9	195.8	193.8	191.8	189.9	187.6	185.7	183.7
38	205.7	204.6	203.5	202.4	201.1	200.0	198.9	197.8	196.0	193.8	191.8	189.9	187.6	185.7
38.5	207.7	206.6	205.5	204.4	203.3	202.2	201.1	200.0	198.2	196.0	194.0	191.8	189.9	187.9
39	209.9	208.8	207.7	206.6	205.5	204.4	203.3	202.2	200.2	198.2	196.0	194.0	191.8	189.9
39.5	211.9	210.8	209.7	208.6	207.5	206.4	205.5	204.4	202.4	200.2	198.2	196.0	194.0	191.8
40	214.1	213.0	211.9	210.8	209.7	208.6	207.5	206.4	204.6	202.4	200.4	198.2	196.0	194.0
40.5	216.1	215.2	214.1	213.0	211.9	210.8	209.7	208.6	206.6	204.6	202.4	200.4	198.2	196.0
41	218.3	217.2	216.1	215.0	213.9	213.0	211.9	210.8	208.8	206.6	204.6	202.4	200.2	198.2
41.5	220.5	219.4	218.3	217.2	216.1	215.0	213.9	213.0	211.0	208.8	206.6	204.6	202.4	200.2
42	222.5	221.4	220.3	219.4	218.3	217.2	216.1	215.0	213.2	211.0	208.8	206.6	204.4	202.2
42.5	224.7	223.6	222.5	221.4	220.3	219.4	218.3	217.2	215.2	213.0	211.0	208.8	206.6	204.4
43	226.7	225.6	224.7	223.6	222.5	221.4	220.5	219.4	217.4	215.2	213.0	210.8	208.6	206.4
43.5	228.9	227.8	226.7	225.6	224.7	223.6	222.5	221.6	219.6	217.4	215.2	213.0	210.8	208.6
44	230.9	230.0	228.9	227.8	226.7	225.8	224.7	223.6	221.6	219.4	217.2	215.0	212.8	210.6
44.5	233.1	232.0	230.9	230.0	228.9	227.8	226.9	225.8	223.8	221.6	219.4	217.2	215.0	212.8
45	235.1	234.2	233.1	232.0	231.1	230.0	228.9	228.0	226.0	223.8	221.6	219.2	217.0	214.8
45.5	237.3	236.2	235.3	234.2	233.1	232.2	231.1	230.2	228.2	225.8	223.6	221.4	219.2	216.8
46	239.2	238.4	237.3	236.4	235.3	234.2	233.3	232.2	230.2	228.0	225.8	223.4	221.2	219.0
46.5	241.4	240.3	239.5	238.4	237.5	236.4	235.5	234.4	232.4	230.2	227.8	225.6	223.4	220.9
47	243.4	242.6	241.4	240.6	239.5	238.6	237.5	236.6	234.6	232.2	230.0	227.8	225.4	223.1

106 L container (280 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
47.5	245.6	244.8	243.7	242.8	241.7	240.8	239.7	238.8	236.6	234.4	232.2	229.8	227.6	225.1
48	247.8	246.7	245.9	244.8	243.9	242.8	241.9	240.8	238.8	236.6	234.2	232.0	229.5	227.3
48.5	249.8	248.9	247.8	247.0	245.9	245.0	244.1	243.0	241.0	238.6	236.4	234.0	231.7	229.3
49	252.0	250.9	250.0	248.9	248.1	247.2	246.1	245.2	243.2	240.8	238.4	236.2	233.7	231.3
49.5	254.0	253.1	252.0	251.1	250.3	249.2	248.3	247.4	245.2	243.0	240.6	238.1	235.9	233.5
50	256.2	255.1	254.2	253.4	252.3	251.4	250.5	249.4	247.4	245.0	242.8	240.3	237.9	235.5
50.5	258.2	257.3	256.4	255.3	254.5	253.6	252.5	251.6	249.6	247.2	244.8	242.3	239.9	237.7
51	260.4	259.5	258.4	257.5	256.7	255.6	254.7	253.8	251.6	249.4	247.0	244.5	242.1	239.7
51.5	262.4	261.5	260.6	259.7	258.6	257.8	256.9	256.0	253.8	251.4	248.9	246.5	244.1	241.9
52	264.6	263.7	262.6	261.7	260.9	260.0	259.1	258.0	256.0	253.6	251.1	248.7	246.3	243.9
52.5	266.6	265.7	264.8	263.9	263.1	262.2	261.1	260.2	258.2	255.8	253.4	250.7	248.3	245.9
53	268.8	267.9	267.0	266.1	265.0	264.2	263.3	262.4	260.2	257.8	255.3	252.9	250.5	248.1
53.5	271.0	269.9	269.0	268.1	267.2	266.4	265.5	264.6	262.4	260.0	257.5	255.1	252.5	250.0
54	273.0	272.1	271.2	270.3	269.5	268.6	267.7	266.6	264.6	262.2	259.5	257.1	254.7	252.3
54.5	275.2	274.3	273.2	272.3	271.4	270.6	269.7	268.8	266.6	264.2	261.7	259.3	256.7	254.2
55	277.2	276.3	275.4	274.5	273.6	272.8	271.9	271.0	268.8	266.4	263.9	261.3	258.9	256.4
55.5	279.4	278.5	277.6	276.7	275.8	275.0	274.1	273.2	271.0	268.6	265.9	263.5	260.9	258.4
56	281.4	280.5	279.6	278.7	277.8	276.9	276.1	275.2	273.2	270.6	268.1	265.5	263.1	260.4
56.5	283.6	282.7	281.8	280.9	280.0	279.2	278.3	277.4	275.2	272.8	270.1	267.7	265.0	262.6
57	285.5	284.7	284.0	283.1	282.2	281.4	280.5	279.6	277.4	275.0	272.3	269.7	267.2	264.6
57.5	287.8	286.9	286.0	285.1	284.2	283.3	282.7	281.8	279.6	276.9	274.5	271.9	269.2	266.8
58	289.7	289.1	288.2	287.3	286.4	285.5	284.7	283.8	281.8	279.2	276.5	273.9	271.4	268.8
58.5	291.9	291.1	290.2	289.3	288.6	287.8	286.9	286.0	283.8	281.1	278.7	276.1	273.4	270.8
59	293.9	293.3	292.4	291.5	290.6	290.0	289.1	288.2	286.0	283.3	280.7	278.3	275.6	273.0
59.5	296.1	295.2	294.6	293.7	292.8	291.9	291.3	290.4	288.2	285.5	282.9	280.3	277.6	275.0
60	298.3	297.5	296.6	295.7	295.0	294.1	293.3	292.6	290.2	287.5	285.1	282.5	279.8	277.2
60.5	300.3	299.4	298.8	297.9	297.0	296.4	295.5	294.6	292.4	289.7	287.1	284.4	281.8	279.2
61	302.5	301.6	300.8	300.1	299.2	298.3	297.7	296.8	294.6	291.9	289.3	286.7	284.0	281.4
61.5	304.5	303.8	303.0	302.1	301.4	300.5	299.7	299.0	296.8	293.9	291.3	288.6	286.0	283.3
62	306.7	305.8	305.2	304.3	303.4	302.7	301.9	301.2	298.8	296.1	293.5	290.8	288.2	285.3
62.5	308.7	308.0	307.2	306.5	305.6	304.7	304.1	303.2	301.0	298.3	295.7	292.8	290.2	287.5
63	310.9	310.0	309.4	308.5	307.8	306.9	306.3	305.4	303.2	300.3	297.7	295.0	292.4	289.5
63.5	312.9	312.2	311.3	310.7	309.8	309.1	308.3	307.6	305.2	302.5	299.9	297.0	294.4	291.7
64	315.1	314.2	313.6	312.7	312.0	311.1	310.5	309.8	307.4	304.7	301.9	299.2	296.6	293.7
64.5	317.1	316.4	315.8	314.9	314.2	313.3	312.7	311.8	309.6	306.7	304.1	301.2	298.6	295.9
65	319.3	318.6	317.7	317.1	316.2	315.5	314.7	314.0	311.8	308.9	306.3	303.4	300.5	297.9
65.5	321.5	320.6	319.9	319.1	318.4	317.7	316.9	316.2	313.8	311.1	308.3	305.6	302.7	299.9
66	323.5	322.8	321.9	321.3	320.6	319.7	319.1	318.4	316.0	313.1	310.5	307.6	304.7	302.1

147 L container (390 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
17.5	145.5	144.0	142.4	140.9	139.4	137.8	136.1	134.5	133.6	133.0	132.1	131.4	130.5	129.9
18	148.0	146.4	144.6	143.1	141.6	139.8	138.3	136.7	135.8	134.9	134.3	133.4	132.7	131.9
18.5	150.2	148.6	146.9	145.3	143.8	142.0	140.4	138.9	137.8	137.2	136.3	135.4	134.7	133.8
19	152.6	150.8	149.3	147.5	146.0	144.2	142.6	140.9	140.0	139.1	138.3	137.6	136.7	135.8
19.5	154.8	153.2	151.5	149.7	148.2	146.4	144.8	143.1	142.0	141.3	140.5	139.6	138.7	138.0
20	157.2	155.5	153.7	151.9	150.4	148.6	146.9	145.3	144.2	143.3	142.4	141.6	140.9	140.0
20.5	159.4	157.7	155.9	154.4	152.6	150.8	149.1	147.3	146.2	145.5	144.6	143.8	142.9	142.0
21	161.6	160.1	158.3	156.6	154.8	153.0	151.2	149.5	148.4	147.5	146.6	145.8	144.9	144.0
21.5	164.1	162.3	160.5	158.8	157.0	155.2	153.4	151.7	150.6	149.7	148.8	148.0	147.1	146.0
22	166.3	164.5	162.7	161.0	159.2	157.4	155.5	153.7	152.6	151.7	150.8	149.9	149.1	148.2
22.5	168.7	166.9	164.9	163.2	161.4	159.4	157.7	155.9	154.8	153.9	152.8	151.9	151.0	150.2
23	170.9	169.1	167.1	165.4	163.6	161.6	159.8	158.1	156.8	155.9	155.0	154.1	153.0	152.1
23.5	173.3	171.3	169.6	167.6	165.8	163.8	162.0	160.1	159.0	158.1	157.0	156.1	155.2	154.1
24	175.5	173.8	171.8	169.8	168.0	166.0	164.1	162.3	161.0	160.1	159.2	158.1	157.2	156.3
24.5	177.9	176.0	174.0	172.0	170.2	168.2	166.3	164.3	163.2	162.3	161.2	160.3	159.2	158.3
25	180.1	178.2	176.2	174.4	172.4	170.4	168.5	166.5	165.4	164.3	163.4	162.3	161.4	160.3
25.5	182.6	180.6	178.6	176.6	174.6	172.7	170.6	168.7	167.4	166.5	165.4	164.3	163.4	162.3
26	184.8	182.8	180.8	178.8	176.8	174.9	172.8	170.7	169.6	168.5	167.4	166.5	165.4	164.3
26.5	187.0	185.0	183.0	181.0	179.0	176.8	174.9	172.9	171.5	170.7	169.6	168.5	167.4	166.5
27	189.4	187.4	185.2	183.2	181.3	179.0	177.1	175.1	173.8	172.7	171.5	170.4	169.6	168.5
27.5	191.6	189.6	187.4	185.4	183.5	181.3	179.2	177.1	176.0	174.9	173.8	172.7	171.5	170.4
28	194.0	191.8	189.9	187.6	185.7	183.5	181.4	179.3	177.9	176.8	175.7	174.6	173.5	172.4
28.5	196.2	194.3	192.1	189.9	187.9	185.7	183.5	181.5	180.1	179.0	177.9	176.8	175.7	174.4
29	198.7	196.5	194.3	192.1	190.1	187.9	185.7	183.5	182.1	181.0	179.9	178.8	177.7	176.6
29.5	200.9	198.7	196.5	194.5	192.3	190.1	187.9	185.7	184.3	183.2	181.9	180.8	179.7	178.6
30	203.3	201.1	198.9	196.7	194.5	192.3	190.0	187.9	186.3	185.2	184.1	183.0	181.7	180.6
30.5	205.5	203.3	201.1	198.9	196.7	194.5	192.2	189.9	188.5	187.4	186.1	185.0	183.9	182.6
31	207.7	205.5	203.3	201.1	198.9	196.5	194.3	192.1	190.7	189.4	188.3	187.0	185.9	184.8
31.5	210.1	207.9	205.5	203.3	201.1	198.7	196.5	194.3	192.7	191.6	190.3	189.2	187.9	186.8
32	212.3	210.1	207.7	205.5	203.3	200.9	198.6	196.2	194.9	193.6	192.5	191.2	190.1	188.7
32.5	214.8	212.3	210.1	207.7	205.5	203.1	200.8	198.5	196.9	195.8	194.5	193.2	192.1	190.7
33	217.0	214.8	212.3	209.9	207.7	205.3	202.9	200.7	199.1	197.8	196.7	195.4	194.0	192.7
33.5	219.4	217.0	214.5	212.1	209.9	207.5	205.1	202.6	201.3	200.0	198.7	197.3	196.0	194.9
34	221.6	219.2	216.8	214.5	212.1	209.7	207.2	204.8	203.3	202.0	200.7	199.6	198.2	196.9
34.5	224.0	221.6	219.2	216.8	214.3	211.9	209.4	207.0	205.5	204.2	202.9	201.5	200.2	198.9
35	226.2	223.8	221.4	219.0	216.5	214.1	211.6	209.0	207.5	206.2	204.8	203.5	202.2	200.9
35.5	228.4	226.0	223.6	221.2	218.7	216.1	213.7	211.2	209.7	208.4	207.0	205.7	204.4	202.9
36	230.9	228.4	225.8	223.4	220.9	218.3	215.9	213.4	211.7	210.4	209.0	207.7	206.4	205.1
36.5	233.1	230.6	228.0	225.6	223.1	220.5	218.0	215.4	213.9	212.6	211.2	209.7	208.4	207.0
37	235.5	232.8	230.4	227.8	225.4	222.7	220.2	217.6	216.1	214.5	213.2	211.9	210.4	209.0
37.5	237.7	235.3	232.6	230.0	227.6	224.9	222.3	219.8	218.1	216.8	215.2	213.9	212.6	211.0
38	240.1	237.5	234.8	232.2	229.8	227.1	224.5	221.8	220.3	218.7	217.4	215.9	214.5	213.2
38.5	242.3	239.7	237.0	234.4	232.0	229.3	226.7	224.0	222.3	220.9	219.4	218.1	216.5	215.2
39	244.8	242.1	239.5	236.8	234.2	231.5	228.8	226.2	224.5	222.9	221.6	220.1	218.7	217.2
39.5	247.0	244.3	241.7	239.0	236.4	233.7	231.0	228.2	226.5	225.1	223.6	222.0	220.7	219.2
40	249.2	246.5	243.9	241.2	238.6	235.7	233.1	230.4	228.7	227.1	225.8	224.2	222.7	221.2
40.5	251.6	248.9	246.1	243.4	240.8	237.9	235.3	232.6	230.9	229.3	227.8	226.2	224.7	223.4
41	253.8	251.1	248.3	245.6	243.0	240.1	237.4	234.6	232.8	231.3	229.8	228.4	226.9	225.4
41.5	256.2	253.4	250.7	247.8	245.2	242.3	239.6	236.8	235.1	233.5	232.0	230.4	228.9	227.3
42	258.4	255.8	252.9	250.0	247.4	244.5	241.7	239.0	237.0	235.5	234.0	232.4	230.9	229.3
42.5	260.9	258.0	255.1	252.3	249.6	246.7	243.9	241.0	239.2	237.7	236.2	234.6	233.1	231.3
43	263.1	260.2	257.3	254.5	251.8	248.9	246.0	243.2	241.4	239.7	238.1	236.6	235.1	233.5
43.5	265.5	262.6	259.7	256.9	254.0	251.1	248.2	245.4	243.4	241.9	240.3	238.6	237.0	235.5
44	267.7	264.8	262.0	259.1	256.2	253.4	250.4	247.4	245.6	243.9	242.3	240.8	239.0	237.5
44.5	269.9	267.0	264.2	261.3	258.4	255.3	252.5	249.6	247.6	246.1	244.5	242.8	241.2	239.5
45	272.3	269.5	266.4	263.5	260.6	257.5	254.7	251.8	249.8	248.1	246.5	244.8	243.2	241.7
45.5	274.5	271.7	268.6	265.7	262.8	259.7	256.8	253.8	251.8	250.3	248.5	247.0	245.2	243.7
46	276.9	273.9	271.0	267.9	265.0	262.0	259.0	256.0	254.0	252.3	250.7	248.9	247.4	245.6
46.5	279.2	276.3	273.2	270.1	267.2	264.2	261.1	258.2	256.2	254.5	252.7	251.1	249.4	247.6
47	281.6	278.5	275.4	272.3	269.5	266.4	263.3	260.2	258.2	256.4	254.9	253.1	251.4	249.6
47.5	283.8	280.7	277.6	274.5	271.7	268.6	265.4	262.4	260.4	258.6	256.9	255.1	253.4	251.8
48	286.2	283.1	280.0	276.9	273.9	270.8	267.6	264.6	262.4	260.6	259.1	257.3	255.6	253.8
48.5	288.4	285.3	282.2	279.2	276.1	272.8	269.7	266.6	264.6	262.8	261.1	259.3	257.5	255.8
49	290.6	287.5	284.4	281.4	278.3	275.0	271.9	268.8	266.6	264.8	263.1	261.3	259.5	257.8

147 L container (390 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
49.5	293.0	290.0	286.7	283.6	280.5	277.2	274.1	271.0	268.8	267.0	265.3	263.5	261.7	259.7
50	295.2	292.2	288.9	285.8	282.7	279.4	276.2	273.0	271.0	269.0	267.2	265.5	263.7	262.0
50.5	297.7	294.4	291.3	288.0	284.9	281.6	278.4	275.2	273.0	271.2	269.5	267.5	265.7	263.9
51	299.9	296.8	293.5	290.2	287.1	283.8	280.5	277.4	275.2	273.2	271.4	269.7	267.7	265.9
51.5	302.3	299.0	295.7	292.4	289.3	286.0	282.7	279.4	277.2	275.4	273.6	271.7	269.9	267.9
52	304.5	301.2	297.9	294.6	291.5	288.2	284.8	281.6	279.4	277.4	275.6	273.9	271.9	270.1
52.5	306.9	303.6	300.3	297.0	293.7	290.4	287.0	283.8	281.6	279.6	277.6	275.8	273.9	272.1
53	309.1	305.8	302.5	299.2	295.9	292.4	289.1	285.8	283.6	281.8	279.8	277.8	276.1	274.1
53.5	311.3	308.0	304.7	301.4	298.1	294.6	291.3	288.0	285.8	283.8	281.8	280.0	278.1	276.1
54	313.8	310.5	306.9	303.6	300.3	296.8	293.5	290.2	287.8	286.0	284.0	282.0	280.0	278.1
54.5	316.0	312.7	309.1	305.8	302.5	299.0	295.6	292.2	290.0	288.0	286.0	284.0	282.0	280.3
55	318.4	314.9	311.6	308.0	304.7	301.2	297.8	294.4	291.9	290.2	288.2	286.2	284.2	282.2
55.5	320.6	317.3	313.8	310.2	306.9	303.4	299.9	296.6	294.1	292.2	290.2	288.2	286.2	284.2
56	323.0	319.5	316.0	312.4	309.1	305.6	302.1	298.6	296.4	294.4	292.2	290.2	288.2	286.2
56.5	325.2	321.7	318.2	314.7	311.3	307.8	304.2	300.8	298.3	296.4	294.4	292.4	290.4	288.2
57	327.7	324.1	320.6	317.1	313.6	310.0	306.4	303.0	300.5	298.6	296.4	294.4	292.4	290.4
57.5	329.9	326.3	322.8	319.3	315.8	312.0	308.5	305.0	302.5	300.5	298.6	296.4	294.4	292.4
58	332.1	328.5	325.0	321.5	318.0	314.2	310.7	307.2	304.7	302.7	300.5	298.6	296.6	294.4
58.5	334.5	331.0	327.2	323.7	320.2	316.4	312.8	309.4	306.9	304.7	302.7	300.5	298.6	296.4
59	336.7	333.2	329.4	325.9	322.4	318.6	315.0	311.3	308.9	306.9	304.7	302.7	300.5	298.6
59.5	339.1	335.4	331.9	328.1	324.6	320.8	317.2	313.6	311.1	308.9	306.9	304.7	302.5	300.5
60	341.3	337.8	334.1	330.3	326.8	323.0	319.3	315.8	313.1	311.1	308.9	306.7	304.7	302.5
60.5	343.8	340.0	336.3	332.5	329.0	325.2	321.5	317.7	315.3	313.1	310.9	308.9	306.7	304.5
61	346.0	342.2	338.5	334.7	331.2	327.4	323.6	319.9	317.3	315.3	313.1	310.9	308.7	306.5
61.5	348.4	344.6	340.9	337.1	333.4	329.6	325.8	321.9	319.5	317.3	315.1	312.9	310.9	308.7
62	350.6	346.8	343.1	339.3	335.6	331.6	327.9	324.1	321.7	319.5	317.3	315.1	312.9	310.7
62.5	352.8	349.1	345.3	341.6	337.8	333.8	330.1	326.3	323.7	321.5	319.3	317.1	314.9	312.7
63	355.2	351.5	347.5	343.8	340.0	336.0	332.2	328.3	325.9	323.7	321.5	319.1	316.9	314.7
63.5	357.4	353.7	349.7	346.0	342.2	338.2	334.4	330.5	327.9	325.7	323.5	321.3	319.1	316.9
64	359.9	355.9	352.1	348.2	344.4	340.5	336.5	332.7	330.1	327.9	325.5	323.3	321.0	318.8
64.5	362.1	358.3	354.3	350.4	346.6	342.7	338.7	334.7	332.1	329.9	327.7	325.5	323.0	320.8
65	364.5	360.5	356.5	352.6	348.8	344.9	340.9	336.9	334.3	332.1	329.6	327.4	325.2	322.8
65.5	366.7	362.7	358.8	354.8	351.0	347.1	343.0	339.1	336.5	334.1	331.9	329.4	327.2	324.8
66	369.1	365.1	361.2	357.2	353.2	349.1	345.2	341.1	338.5	336.3	333.8	331.6	329.2	327.0
66.5	371.3	367.4	363.4	359.4	355.4	351.3	347.3	343.3	340.7	338.2	336.0	333.6	331.2	329.0
67	373.5	369.6	365.6	361.6	357.7	353.5	349.5	345.5	342.7	340.5	338.0	335.6	333.4	331.0
67.5	376.0	372.0	367.8	363.8	359.9	355.7	351.6	347.5	344.9	342.4	340.0	337.8	335.4	333.0
68	378.2	374.2	370.0	366.0	362.1	357.9	353.8	349.7	347.1	344.6	342.2	339.8	337.4	334.9
68.5	380.6	376.4	372.4	368.2	364.3	360.1	356.0	351.9	349.1	346.6	344.2	341.8	339.6	337.1
69	382.8	378.8	374.6	370.4	366.5	362.3	358.1	353.9	351.3	348.8	346.4	344.0	341.6	339.1
69.5	385.2	381.0	376.8	372.6	368.7	364.5	360.3	356.1	353.2	350.8	348.4	346.0	343.5	341.1
70	387.4	383.2	379.0	374.9	370.9	366.7	362.4	358.3	355.4	353.0	350.6	347.9	345.5	343.1
70.5	389.8	385.7	381.5	377.1	372.9	368.7	364.6	360.3	357.4	355.0	352.6	350.2	347.7	345.3
71	392.0	387.9	383.7	379.5	375.1	370.9	366.7	362.5	359.6	357.2	354.8	352.1	349.7	347.3
71.5	394.3	390.1	385.9	381.7	377.3	373.1	368.9	364.7	361.8	359.2	356.8	354.3	351.7	349.3
72	396.7	392.5	388.1	383.9	379.5	375.3	371.0	366.7	363.8	361.4	358.8	356.3	353.9	351.3
72.5	398.9	394.7	390.3	386.1	381.7	377.5	373.2	368.9	366.0	363.4	361.0	358.3	355.9	353.2
73	401.3	396.9	392.7	388.3	383.9	379.7	375.4	371.1	368.0	365.6	362.9	360.5	357.9	355.4
73.5	403.5	399.3	394.9	390.5	386.1	381.9	377.5	373.1	370.2	367.6	365.1	362.5	359.9	357.4
74	405.9	401.5	397.1	392.7	388.3	384.1	379.7	375.3	372.2	369.8	367.1	364.5	362.1	359.4
74.5	408.1	403.7	399.3	394.9	390.5	386.3	381.8	377.5	374.4	371.8	369.3	366.7	364.0	361.4
75	410.6	406.2	401.8	397.1	392.7	388.3	384.0	379.5	376.6	374.0	371.3	368.7	366.0	363.4
75.5	412.8	408.4	404.0	399.5	394.9	390.5	386.1	381.7	378.6	376.0	373.3	370.7	368.2	365.6
76	415.0	410.6	406.2	401.8	397.1	392.7	388.3	383.9	380.8	378.2	375.5	372.9	370.2	367.6
76.5	417.4	413.0	408.4	404.0	399.3	394.9	390.4	385.9	382.8	380.1	377.5	374.9	372.2	369.6
77	419.6	415.2	410.6	406.2	401.5	397.1	392.6	388.1	385.0	382.3	379.7	377.1	374.2	371.5
77.5	422.0	417.4	413.0	408.4	403.7	399.3	394.7	390.3	387.2	384.3	381.7	379.0	376.4	373.7
78	424.2	419.8	415.2	410.6	405.9	401.5	396.9	392.3	389.2	386.5	383.9	381.0	378.4	375.7
78.5	426.7	422.0	417.4	412.8	408.1	403.7	399.1	394.5	391.4	388.5	385.9	383.2	380.4	377.7
79	428.9	424.2	419.6	415.0	410.4	405.9	401.2	396.7	393.4	390.7	387.9	385.2	382.6	379.7

147 L container (390 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
79.5	431.3	426.7	422.0	417.2	412.6	407.9	403.4	398.7	395.6	392.7	390.1	387.2	384.6	381.7
80	433.5	428.9	424.2	419.6	414.8	410.1	405.5	400.9	397.6	394.9	392.0	389.4	386.5	383.9
80.5	435.9	431.1	426.4	421.8	417.0	412.3	407.7	403.1	399.8	396.9	394.3	391.4	388.5	385.9
81	438.1	433.5	428.7	424.0	419.2	414.5	409.8	405.1	402.0	399.1	396.2	393.4	390.7	387.9
81.5	440.3	435.7	430.9	426.2	421.4	416.7	412.0	407.3	404.0	401.1	398.4	395.6	392.7	389.8
82	442.8	437.9	433.3	428.4	423.6	419.0	414.1	409.5	406.2	403.3	400.4	397.6	394.7	391.8
82.5	445.0	440.3	435.5	430.6	425.8	421.2	416.3	411.5	408.1	405.3	402.6	399.8	396.9	394.0
83	447.4	442.5	437.7	432.8	428.0	423.4	418.4	413.7	410.4	407.5	404.6	401.8	398.9	396.0
83.5	449.6	444.7	439.9	435.0	430.2	425.6	420.6	415.9	412.6	409.5	406.6	403.7	400.9	398.0
84	452.0	447.2	442.3	437.3	432.4	427.5	422.8	417.8	414.5	411.7	408.8	405.9	402.9	400.0
84.5	454.2	449.4	444.5	439.7	434.6	429.8	424.9	420.1	416.7	413.7	410.8	407.9	405.1	402.2
85	456.7	451.6	446.7	441.9	436.8	432.0	427.1	422.3	418.7	415.9	413.0	409.9	407.0	404.2
85.5	458.9	454.0	448.9	444.1	439.0	434.2	429.2	424.2	420.9	417.8	415.0	412.1	409.0	406.2
86	461.1	456.2	451.1	446.3	441.2	436.4	431.4	426.4	422.9	420.1	417.2	414.1	411.2	408.1

180 L container (450 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
25.5	178.8	177.3	175.7	174.2	172.7	171.1	169.6	168.0	166.3	164.5	162.7	161.0	159.2	157.4
26	181.3	179.5	177.9	176.4	174.9	173.3	171.8	170.2	168.5	166.7	164.9	163.2	161.4	159.6
26.5	183.5	181.9	180.4	178.8	177.3	175.7	174.0	172.4	170.7	168.9	167.1	165.4	163.4	161.6
27	185.9	184.1	182.6	181.0	179.5	177.9	176.4	174.6	172.9	171.1	169.3	167.4	165.6	163.8
27.5	188.1	186.5	185.0	183.2	181.7	180.1	178.6	176.8	175.1	173.3	171.5	169.6	167.8	165.8
28	190.5	188.7	187.2	185.7	183.9	182.4	180.8	179.3	177.3	175.5	173.5	171.8	169.8	168.0
28.5	192.7	191.2	189.6	187.9	186.3	184.6	183.0	181.5	179.5	177.7	175.7	174.0	172.0	170.2
29	195.1	193.4	191.8	190.3	188.5	187.0	185.2	183.7	181.7	179.9	177.9	176.0	174.2	172.2
29.5	197.3	195.8	194.0	192.5	190.7	189.2	187.4	185.9	183.9	182.1	180.1	178.2	176.2	174.4
30	199.8	198.0	196.5	194.7	193.2	191.4	189.6	188.1	186.1	184.1	182.4	180.4	178.4	176.4
30.5	202.0	200.4	198.7	197.1	195.4	193.6	192.1	190.3	188.3	186.3	184.6	182.6	180.6	178.6
31	204.4	202.6	201.1	199.3	197.6	195.8	194.3	192.5	190.5	188.5	186.5	184.6	182.6	180.6
31.5	206.8	205.1	203.3	201.5	199.8	198.2	196.5	194.7	192.7	190.7	188.7	186.8	184.8	182.8
32	209.0	207.3	205.5	204.0	202.2	200.4	198.7	196.9	194.9	192.9	191.0	189.0	187.0	185.0
32.5	211.5	209.7	207.9	206.2	204.4	202.6	200.9	199.1	197.1	195.1	193.2	191.2	189.0	187.0
33	213.7	211.9	210.1	208.4	206.6	204.8	203.1	201.3	199.3	197.3	195.4	193.2	191.2	189.2
33.5	216.1	214.3	212.6	210.8	209.0	207.0	205.3	203.5	201.5	199.6	197.6	195.4	193.4	191.2
34	218.3	216.5	214.8	213.0	211.2	209.5	207.7	205.7	203.7	201.8	199.6	197.6	195.4	193.4
34.5	220.7	219.0	217.2	215.2	213.4	211.7	209.9	208.2	205.9	204.0	201.8	199.8	197.6	195.4
35	222.9	221.2	219.4	217.6	215.6	213.9	212.1	210.4	208.2	206.2	204.0	201.8	199.8	197.6
35.5	225.4	223.6	221.6	219.8	218.1	216.1	214.3	212.6	210.4	208.4	206.2	204.0	201.8	199.8
36	227.6	225.8	224.0	222.0	220.3	218.5	216.5	214.8	212.6	210.4	208.4	206.2	204.0	201.8
36.5	230.0	228.2	226.2	224.5	222.5	220.7	218.7	217.0	214.8	212.6	210.4	208.4	206.2	204.0
37	232.4	230.4	228.7	226.7	224.9	222.9	220.9	219.2	217.0	214.8	212.6	210.4	208.2	205.9
37.5	234.6	232.8	230.9	228.9	227.1	225.1	223.4	221.4	219.2	217.0	214.8	212.6	210.4	208.2
38	237.0	235.1	233.1	231.3	229.3	227.3	225.6	223.6	221.4	219.2	217.0	214.8	212.6	210.1
38.5	239.2	237.3	235.5	233.5	231.5	229.8	227.8	225.8	223.6	221.4	219.2	217.0	214.5	212.3
39	241.7	239.7	237.7	235.7	234.0	232.0	230.0	228.0	225.8	223.6	221.4	219.0	216.8	214.5
39.5	243.9	241.9	240.1	238.1	236.2	234.2	232.2	230.2	228.0	225.8	223.4	221.2	219.0	216.5
40	246.3	244.3	242.3	240.3	238.4	236.4	234.4	232.4	230.2	228.0	225.6	223.4	220.9	218.7
40.5	248.5	246.5	244.5	242.6	240.6	238.6	236.6	234.6	232.4	230.2	227.8	225.6	223.1	220.7
41	250.9	248.9	247.0	245.0	243.0	241.0	239.0	237.0	234.6	232.4	230.0	227.6	225.4	222.9
41.5	253.4	251.1	249.2	247.2	245.2	243.2	241.2	239.2	236.8	234.4	232.2	229.8	227.3	225.1
42	255.6	253.6	251.6	249.6	247.4	245.4	243.4	241.4	239.0	236.6	234.4	232.0	229.5	227.1
42.5	258.0	255.8	253.8	251.8	249.8	247.6	245.6	243.7	241.2	238.8	236.4	234.2	231.7	229.3
43	260.2	258.2	256.2	254.0	252.0	250.0	247.8	245.9	243.4	241.0	238.6	236.2	233.7	231.3
43.5	262.6	260.4	258.4	256.4	254.2	252.3	250.0	248.1	245.6	243.2	240.8	238.4	235.9	233.5
44	264.8	262.8	260.6	258.6	256.4	254.5	252.5	250.3	247.8	245.4	243.0	240.6	238.1	235.5
44.5	267.2	265.0	263.1	260.9	258.9	256.7	254.7	252.5	250.0	247.6	245.2	242.6	240.1	237.7
45	269.5	267.5	265.3	263.3	261.1	258.9	256.9	254.7	252.3	249.8	247.4	244.8	242.3	239.9
45.5	271.9	269.7	267.7	265.5	263.3	261.3	259.1	256.9	254.5	252.0	249.4	247.0	244.5	241.9
46	274.1	272.1	269.9	267.7	265.7	263.5	261.3	259.1	256.7	254.2	251.6	249.2	246.5	244.1
46.5	276.5	274.3	272.1	270.1	267.9	265.7	263.5	261.3	258.9	256.4	253.8	251.1	248.7	246.1
47	278.9	276.7	274.5	272.3	270.1	267.9	265.7	263.7	261.1	258.6	256.0	253.4	250.9	248.3
47.5	281.1	278.9	276.7	274.5	272.3	270.1	268.1	265.9	263.3	260.6	258.2	255.6	252.9	250.3
48	283.6	281.4	279.2	276.9	274.7	272.5	270.3	268.1	265.5	262.8	260.4	257.8	255.1	252.5
48.5	285.8	283.6	281.4	279.2	276.9	274.7	272.5	270.3	267.7	265.0	262.4	259.7	257.3	254.7
49	288.2	286.0	283.8	281.4	279.2	276.9	274.7	272.5	269.9	267.2	264.6	262.0	259.3	256.7
49.5	290.4	288.2	286.0	283.8	281.6	279.2	276.9	274.7	272.1	269.5	266.8	264.2	261.5	258.9
50	292.8	290.6	288.2	286.0	283.8	281.6	279.2	276.9	274.3	271.7	269.0	266.4	263.5	260.9
50.5	295.0	292.8	290.6	288.2	286.0	283.8	281.4	279.2	276.5	273.9	271.2	268.3	265.7	263.1
51	297.5	295.2	292.8	290.6	288.2	286.0	283.8	281.4	278.7	276.1	273.4	270.6	267.9	265.0
51.5	299.7	297.5	295.2	292.8	290.6	288.2	286.0	283.6	280.9	278.3	275.4	272.8	269.9	267.2
52	302.1	299.7	297.5	295.0	292.8	290.4	288.2	285.8	283.1	280.5	277.6	275.0	272.1	269.5
52.5	304.5	302.1	299.7	297.5	295.0	292.8	290.4	288.0	285.3	282.7	279.8	276.9	274.3	271.4
53	306.7	304.3	302.1	299.7	297.2	295.0	292.6	290.2	287.5	284.9	282.0	279.2	276.3	273.6
53.5	309.1	306.7	304.3	302.1	299.7	297.2	294.8	292.6	289.7	286.9	284.2	281.4	278.5	275.6
54	311.3	308.9	306.7	304.3	301.9	299.4	297.0	294.8	291.9	289.1	286.4	283.6	280.7	277.8
54.5	313.8	311.3	308.9	306.5	304.1	301.6	299.4	297.0	294.1	291.3	288.4	285.5	282.7	280.0
55	316.0	313.6	311.1	308.9	306.5	304.1	301.6	299.2	296.4	293.5	290.6	287.8	284.9	282.0
55.5	318.4	316.0	313.6	311.1	308.7	306.3	303.8	301.4	298.6	295.7	292.8	290.0	287.1	284.2
56	320.6	318.2	315.8	313.3	310.9	308.5	306.1	303.6	300.8	297.9	295.0	292.2	289.1	286.2
56.5	323.0	320.6	318.2	315.8	313.1	310.7	308.3	305.8	303.0	300.1	297.2	294.1	291.3	288.4
57	325.2	322.8	320.4	318.0	315.5	313.1	310.5	308.0	305.2	302.3	299.4	296.4	293.5	290.4

180 L container (450 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI cm	-15 (5)	-10 (14)	-5 (23)	0 (32)	5 (41)	10 (50)	15 (59)	20 (68)	25 (77)	30 (86)	35 (95)	40 (104)	45 (113)	50 (122)
57.5	327.7	325.2	322.8	320.2	317.7	315.3	312.7	310.2	307.4	304.5	301.4	298.6	295.5	292.6
58	330.1	327.4	325.0	322.6	319.9	317.5	315.1	312.4	309.6	306.7	303.6	300.8	297.7	294.8
58.5	332.3	329.9	327.2	324.8	322.4	319.7	317.3	314.7	311.8	308.9	305.8	302.7	299.9	296.8
59	334.7	332.1	329.6	327.0	324.6	321.9	319.5	316.9	314.0	310.9	308.0	305.0	301.9	299.0
59.5	336.9	334.5	331.9	329.4	326.8	324.4	321.7	319.1	316.2	313.1	310.2	307.2	304.1	301.0
60	339.3	336.7	334.3	331.6	329.0	326.6	323.9	321.5	318.4	315.3	312.2	309.4	306.3	303.2
60.5	341.6	339.1	336.5	333.8	331.4	328.8	326.1	323.7	320.6	317.5	314.4	311.3	308.3	305.2
61	344.0	341.3	338.7	336.3	333.6	331.0	328.3	325.9	322.8	319.7	316.6	313.6	310.5	307.4
61.5	346.2	343.8	341.1	338.5	335.8	333.2	330.8	328.1	325.0	321.9	318.8	315.8	312.7	309.6
62	348.6	346.0	343.3	340.7	338.2	335.6	333.0	330.3	327.2	324.1	321.0	318.0	314.7	311.6
62.5	351.0	348.4	345.7	343.1	340.5	337.8	335.2	332.5	329.4	326.3	323.3	319.9	316.9	313.8
63	353.2	350.6	347.9	345.3	342.7	340.0	337.4	334.7	331.6	328.5	325.2	322.2	319.1	315.8
63.5	355.7	353.0	350.4	347.5	344.9	342.2	339.6	336.9	333.8	330.8	327.4	324.4	321.0	318.0
64	357.9	355.2	352.6	349.9	347.3	344.4	341.8	339.1	336.0	333.0	329.6	326.6	323.3	319.9
64.5	360.3	357.7	354.8	352.1	349.5	346.8	344.0	341.3	338.2	335.2	331.9	328.5	325.5	322.2
65	362.5	359.9	357.2	354.6	351.7	349.1	346.4	343.5	340.5	337.1	334.1	330.8	327.4	324.4
65.5	364.9	362.1	359.4	356.8	353.9	351.3	348.6	345.7	342.7	339.3	336.3	333.0	329.6	326.3
66	367.1	364.5	361.8	359.0	356.3	353.5	350.8	348.2	344.9	341.6	338.2	335.2	331.9	328.5
66.5	369.6	366.7	364.0	361.4	358.5	355.9	353.0	350.4	347.1	343.8	340.5	337.1	333.8	330.5
67	371.8	369.1	366.3	363.6	360.7	358.1	355.2	352.6	349.3	346.0	342.7	339.3	336.0	332.7
67.5	374.2	371.3	368.7	365.8	363.2	360.3	357.4	354.8	351.5	348.2	344.9	341.6	338.2	334.9
68	376.6	373.7	370.9	368.2	365.4	362.5	359.9	357.0	353.7	350.4	347.1	343.8	340.2	336.9
68.5	378.8	376.0	373.3	370.4	367.6	364.7	362.1	359.2	355.9	352.6	349.3	345.7	342.4	339.1
69	381.2	378.4	375.5	372.6	369.8	367.1	364.3	361.4	358.1	354.8	351.3	347.9	344.6	341.1
69.5	383.4	380.6	377.7	375.1	372.2	369.3	366.5	363.6	360.3	357.0	353.5	350.2	346.6	343.3
70	385.9	383.0	380.1	377.3	374.4	371.5	368.7	365.8	362.5	359.2	355.7	352.4	348.8	345.3
70.5	388.1	385.2	382.3	379.5	376.6	373.7	370.9	368.0	364.7	361.4	357.9	354.3	351.0	347.5
71	390.5	387.6	384.8	381.9	379.0	376.0	373.1	370.2	366.9	363.4	360.1	356.5	353.0	349.7
71.5	392.7	389.8	387.0	384.1	381.2	378.4	375.5	372.4	369.1	365.6	362.3	358.8	355.2	351.7
72	395.1	392.3	389.4	386.3	383.4	380.6	377.7	374.6	371.3	367.8	364.3	360.7	357.4	353.9
72.5	397.3	394.5	391.6	388.7	385.7	382.8	379.9	377.1	373.5	370.0	366.5	362.9	359.4	355.9
73	399.8	396.9	393.8	390.9	388.1	385.0	382.1	379.3	375.7	372.2	368.7	365.1	361.6	358.1
73.5	402.2	399.1	396.2	393.2	390.3	387.4	384.3	381.5	377.9	374.4	370.9	367.4	363.8	360.1
74	404.4	401.5	398.4	395.6	392.5	389.6	386.5	383.7	380.1	376.6	373.1	369.3	365.8	362.3
74.5	406.8	403.7	400.9	397.8	394.9	391.8	388.7	385.9	382.3	378.8	375.3	371.5	368.0	364.5
75	409.0	406.2	403.1	400.0	397.1	394.0	391.2	388.1	384.6	381.0	377.3	373.7	370.2	366.5
75.5	411.5	408.4	405.3	402.4	399.3	396.2	393.4	390.3	386.8	383.2	379.5	376.0	372.2	368.7
76	413.7	410.8	407.7	404.6	401.5	398.7	395.6	392.5	389.0	385.4	381.7	377.9	374.4	370.7
76.5	416.1	413.0	409.9	406.8	404.0	400.9	397.8	394.7	391.2	387.4	383.9	380.1	376.6	372.9
77	418.3	415.4	412.3	409.2	406.2	403.1	400.0	396.9	393.4	389.6	386.1	382.3	378.6	374.9
77.5	420.7	417.6	414.5	411.5	408.4	405.3	402.2	399.1	395.6	391.8	388.3	384.6	380.8	377.1
78	423.1	419.8	417.0	413.9	410.6	407.5	404.4	401.3	397.8	394.0	390.3	386.5	383.0	379.3
78.5	425.3	422.3	419.2	416.1	413.0	409.9	406.8	403.5	400.0	396.2	392.5	388.7	385.0	381.2
79	427.8	424.5	421.4	418.3	415.2	412.1	409.0	405.9	402.2	398.4	394.7	390.9	387.2	383.4
79.5	430.0	426.9	423.8	420.7	417.4	414.3	411.2	408.1	404.4	400.6	396.9	393.2	389.2	385.4
80	432.4	429.1	426.0	422.9	419.8	416.5	413.4	410.4	406.6	402.9	399.1	395.1	391.4	387.6
80.5	434.6	431.5	428.4	425.1	422.0	419.0	415.6	412.6	408.8	405.1	401.3	397.3	393.6	389.8
81	437.0	433.7	430.6	427.5	424.2	421.2	417.8	414.8	411.0	407.3	403.3	399.5	395.6	391.8
81.5	439.2	436.1	432.8	429.8	426.4	423.4	420.1	417.0	413.2	409.5	405.5	401.8	397.8	394.0
82	441.7	438.4	435.3	432.0	428.9	425.6	422.5	419.2	415.4	411.7	407.7	403.7	400.0	396.0
82.5	443.9	440.8	437.5	434.4	431.1	427.8	424.7	421.4	417.6	413.7	409.9	405.9	402.0	398.2
83	446.3	443.0	439.9	436.6	433.3	430.2	426.9	423.6	419.8	415.9	412.1	408.1	404.2	400.2
83.5	448.7	445.4	442.1	438.8	435.7	432.4	429.1	425.8	422.0	418.1	414.3	410.4	406.4	402.4
84	450.9	447.6	444.3	441.2	437.9	434.6	431.3	428.0	424.2	420.3	416.3	412.3	408.4	404.6
84.5	453.3	450.0	446.7	443.4	440.1	436.8	433.5	430.2	426.4	422.5	418.5	414.5	410.6	406.6
85	455.6	452.2	448.9	445.6	442.3	439.0	435.7	432.6	428.7	424.7	420.7	416.7	412.8	408.8
85.5	458.0	454.7	451.4	448.1	444.7	441.4	438.1	434.8	430.9	426.9	422.9	419.0	414.8	410.8
86	460.2	456.9	453.6	450.3	447.0	443.6	440.3	437.0	433.1	429.1	425.1	420.9	417.0	413.0
86.5	462.6	459.3	456.0	452.5	449.2	445.9	442.5	439.2	435.3	431.3	427.1	423.1	419.2	415.0
87	464.8	461.5	458.2	454.9	451.6	448.1	444.7	441.4	437.5	433.5	429.3	425.3	421.2	417.2

180 L container (450 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
87.5	467.2	463.9	460.4	457.1	453.8	450.3	447.0	443.6	439.7	435.7	431.5	427.5	423.4	419.4
88	469.4	466.1	462.8	459.3	456.0	452.7	449.2	445.9	441.9	437.7	433.7	429.5	425.6	421.4
88.5	471.9	468.6	465.0	461.7	458.2	454.9	451.6	448.1	444.1	439.9	435.9	431.7	427.5	423.6
89	474.3	470.8	467.5	463.9	460.6	457.1	453.8	450.3	446.3	442.1	438.1	433.9	429.8	425.6
89.5	476.5	473.2	469.7	466.4	462.8	459.3	456.0	452.5	448.5	444.3	440.1	436.1	432.0	427.8
90	478.9	475.4	471.9	468.6	465.0	461.7	458.2	454.7	450.7	446.5	442.3	438.1	433.9	429.8
90.5	481.1	477.8	474.3	470.8	467.2	463.9	460.4	456.9	452.9	448.7	444.5	440.3	436.1	432.0
91	483.6	480.0	476.5	473.2	469.7	466.1	462.6	459.1	455.1	450.9	446.7	442.5	438.4	434.2
91.5	485.8	482.2	478.9	475.4	471.9	468.3	464.8	461.5	457.3	453.1	448.9	444.7	440.3	436.1
92	488.2	484.7	481.1	477.6	474.1	470.5	467.2	463.7	459.5	455.3	451.1	446.7	442.5	438.4
92.5	490.4	486.9	483.6	480.0	476.5	473.0	469.4	465.9	461.7	457.5	453.1	448.9	444.7	440.3
93	492.8	489.3	485.8	482.2	478.7	475.2	471.6	468.1	463.9	459.7	455.3	451.1	446.7	442.5
93.5	495.0	491.5	488.0	484.4	480.9	477.4	473.9	470.3	466.1	461.9	457.5	453.3	448.9	444.7
94	497.4	493.9	490.4	486.9	483.1	479.6	476.1	472.5	468.3	463.9	459.7	455.3	451.1	446.7
94.5	499.9	496.1	492.6	489.1	485.5	481.8	478.3	474.7	470.5	466.1	461.9	457.5	453.1	448.9
95	502.1	498.6	495.0	491.3	487.7	484.2	480.5	476.9	472.8	468.3	464.2	459.7	455.3	450.9
95.5	504.5	500.8	497.2	493.7	490.0	486.4	482.9	479.1	475.0	470.5	466.1	461.9	457.5	453.1
96	506.7	503.2	499.4	495.9	492.4	488.6	485.1	481.4	477.2	472.8	468.3	463.9	459.5	455.1
96.5	509.1	505.4	501.9	498.1	494.6	490.8	487.3	483.6	479.4	475.0	470.5	466.1	461.7	457.3
97	511.3	507.8	504.1	500.5	496.8	493.3	489.5	485.8	481.6	477.2	472.8	468.3	463.9	459.5
97.5	513.8	510.0	506.5	502.7	499.0	495.5	491.7	488.0	483.8	479.4	475.0	470.5	465.9	461.5
98	516.0	512.4	508.7	504.9	501.4	497.7	493.9	490.4	486.0	481.6	477.2	472.5	468.1	463.7
98.5	518.4	514.6	510.9	507.4	503.6	499.9	496.1	492.6	488.2	483.8	479.1	474.7	470.3	465.7
99	520.8	517.1	513.3	509.6	505.8	502.1	498.6	494.8	490.4	486.0	481.4	476.9	472.3	467.9
99.5	523.0	519.3	515.5	511.8	508.3	504.5	500.8	497.0	492.6	488.2	483.6	478.9	474.5	469.9
100	525.5	521.7	518.0	514.2	510.5	506.7	503.0	499.2	494.8	490.2	485.8	481.1	476.7	472.1
100.5	527.7	523.9	520.2	516.4	512.7	508.9	505.2	501.4	497.0	492.4	488.0	483.3	478.7	474.3
101	530.1	526.3	522.6	518.6	514.9	511.1	507.4	503.6	499.2	494.6	490.2	485.5	480.9	476.3
101.5	532.3	528.5	524.8	521.0	517.3	513.3	509.6	505.8	501.4	496.8	492.2	487.5	483.1	478.5
102	534.7	531.0	527.0	523.2	519.5	515.7	511.8	508.0	503.6	499.0	494.4	489.7	485.1	480.5
102.5	536.9	533.2	529.4	525.7	521.7	518.0	514.2	510.2	505.8	501.2	496.6	491.9	487.3	482.7
103	539.3	535.6	531.6	527.9	523.9	520.2	516.4	512.4	508.0	503.4	498.8	494.1	489.5	484.7
103.5	541.5	537.8	534.1	530.1	526.3	522.4	518.6	514.6	510.2	505.6	501.0	496.1	491.5	486.9
104	544.0	540.2	536.3	532.5	528.5	524.8	520.8	517.1	512.4	507.8	503.2	498.3	493.7	489.1
104.5	546.4	542.4	538.5	534.7	530.7	527.0	523.0	519.3	514.6	510.0	505.2	500.5	495.9	491.1
105	548.6	544.6	540.9	536.9	533.2	529.2	525.2	521.5	516.9	512.2	507.4	502.7	497.9	493.3
105.5	551.0	547.1	543.1	539.3	535.4	531.4	527.4	523.7	519.1	514.2	509.6	504.7	500.1	495.2
106	553.2	549.3	545.5	541.5	537.6	533.6	529.9	525.9	521.3	516.4	511.8	506.9	502.3	497.4
106.5	555.7	551.7	547.7	543.8	539.8	536.0	532.1	528.1	523.5	518.6	514.0	509.1	504.3	499.7
107	557.9	553.9	550.1	546.2	542.2	538.2	534.3	530.3	525.7	520.8	516.2	511.3	506.5	501.6

343 L container (850 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
13	363.4	360.5	357.4	354.3	351.3	348.2	345.3	342.2	339.3	336.7	333.8	331.2	328.3	325.7
13.5	368.5	365.4	362.3	359.2	356.1	353.2	350.2	347.1	344.2	341.3	338.5	335.8	333.0	330.3
14	373.5	370.4	367.4	364.3	361.2	358.1	354.8	351.7	348.8	346.0	343.3	340.5	337.6	334.7
14.5	378.6	375.5	372.4	369.1	366.0	362.9	359.6	356.5	353.7	350.8	347.9	345.1	342.2	339.3
15	383.9	380.6	377.3	374.2	370.9	367.8	364.5	361.4	358.3	355.4	352.6	349.7	346.8	344.0
15.5	389.0	385.7	382.3	379.0	376.0	372.6	369.3	366.0	363.2	360.3	357.2	354.3	351.5	348.4
16	394.0	390.7	387.4	384.1	380.8	377.5	374.2	370.9	367.8	364.9	361.8	359.0	355.9	353.0
16.5	399.1	395.8	392.3	389.0	385.7	382.3	379.0	375.7	372.6	369.6	366.7	363.6	360.5	357.7
17	404.2	400.6	397.3	394.0	390.5	387.2	383.9	380.6	377.3	374.4	371.3	368.2	365.1	362.1
17.5	409.2	405.7	402.4	398.9	395.6	392.0	388.7	385.2	382.1	379.0	376.0	372.9	369.8	366.7
18	414.3	410.8	407.3	404.0	400.4	396.9	393.6	390.1	387.0	383.7	380.6	377.5	374.4	371.3
18.5	419.4	415.9	412.3	408.8	405.3	401.8	398.4	394.9	391.6	388.5	385.2	382.1	379.0	375.7
19	424.5	420.9	417.4	413.9	410.4	406.8	403.3	399.5	396.5	393.2	389.8	386.8	383.4	380.4
19.5	429.5	426.0	422.3	418.7	415.2	411.7	407.9	404.4	401.1	397.8	394.7	391.4	388.1	385.0
20	434.6	430.9	427.3	423.6	420.1	416.5	412.8	409.2	405.9	402.6	399.3	396.0	392.7	389.4
20.5	439.7	435.9	432.4	428.7	424.9	421.4	417.6	414.1	410.6	407.3	404.0	400.6	397.3	394.0
21	444.7	441.0	437.3	433.5	430.0	426.2	422.5	418.7	415.4	412.1	408.6	405.3	402.0	398.4
21.5	449.8	446.1	442.3	438.6	434.8	431.1	427.3	423.6	420.1	416.7	413.2	409.9	406.6	403.1
22	454.9	451.1	447.4	443.4	439.7	435.9	432.2	428.4	424.9	421.4	418.1	414.5	411.0	407.7
22.5	460.0	456.2	452.2	448.5	444.5	440.8	437.0	433.1	429.5	426.2	422.7	419.2	415.6	412.1
23	465.0	461.1	457.3	453.3	449.6	445.6	441.9	437.9	434.4	430.9	427.3	423.8	420.3	416.7
23.5	470.1	466.1	462.2	458.4	454.5	450.5	446.7	442.8	439.0	435.5	432.0	428.4	424.9	421.4
24	475.2	471.2	467.2	463.3	459.3	455.3	451.6	447.6	443.9	440.3	436.6	433.1	429.5	425.8
24.5	480.2	476.3	472.3	468.3	464.4	460.2	456.2	452.2	448.7	445.0	441.4	437.7	434.2	430.4
25	485.3	481.4	477.2	473.2	469.2	465.3	461.1	457.1	453.3	449.6	446.1	442.3	438.6	435.0
25.5	490.4	486.4	482.2	478.3	474.1	470.1	465.9	461.9	458.2	454.5	450.7	447.0	443.2	439.5
26	495.5	491.3	487.3	483.1	478.9	475.0	470.8	466.6	462.8	459.1	455.3	451.6	447.8	444.1
26.5	500.5	496.3	492.2	488.2	484.0	479.8	475.6	471.4	467.7	463.7	460.0	456.2	452.5	448.7
27	505.6	501.4	497.2	493.0	488.8	484.7	480.5	476.3	472.3	468.6	464.6	460.8	457.1	453.1
27.5	510.7	506.5	502.3	497.9	493.7	489.5	485.3	481.1	477.2	473.2	469.4	465.5	461.7	457.8
28	515.7	511.6	507.2	503.0	498.6	494.4	490.2	485.8	481.8	478.0	474.1	470.1	466.1	462.4
28.5	520.8	516.6	512.2	507.8	503.6	499.2	495.0	490.6	486.6	482.7	478.7	474.7	470.8	466.8
29	525.9	521.5	517.3	512.9	508.5	504.1	499.9	495.5	491.3	487.3	483.3	479.4	475.4	471.4
29.5	531.0	526.6	522.1	517.7	513.3	508.9	504.5	500.3	496.1	492.2	488.0	484.0	480.0	476.1
30	536.0	531.6	527.2	522.8	518.4	513.8	509.4	504.9	500.8	496.8	492.8	488.6	484.7	480.5
30.5	541.1	536.7	532.3	527.7	523.2	518.8	514.2	509.8	505.6	501.4	497.4	493.3	489.3	485.1
31	546.2	541.8	537.1	532.7	528.1	523.7	519.1	514.6	510.2	506.3	502.1	497.9	493.7	489.7
31.5	551.3	546.8	542.2	537.6	532.9	528.5	523.9	519.3	515.1	510.9	506.7	502.5	498.3	494.1
32	556.3	551.7	547.3	542.7	538.0	533.4	528.8	524.1	519.9	515.5	511.3	507.2	503.0	498.8
32.5	561.4	556.8	552.1	547.5	542.9	538.2	533.6	529.0	524.6	520.4	516.2	511.8	507.6	503.4
33	566.5	561.8	557.2	552.6	547.7	543.1	538.5	533.8	529.4	525.0	520.8	516.4	512.2	507.8
33.5	571.5	566.9	562.1	557.4	552.8	547.9	543.3	538.5	534.1	529.9	525.5	521.0	516.9	512.4
34	576.6	572.0	567.1	562.3	557.6	552.8	548.2	543.3	538.9	534.5	530.1	525.7	521.3	517.1
34.5	581.7	577.0	572.2	567.3	562.5	557.6	553.0	548.2	543.5	539.1	534.7	530.3	525.9	521.5
35	586.8	581.9	577.0	572.2	567.3	562.5	557.6	552.8	548.4	544.0	539.3	534.9	530.5	526.1
35.5	592.0	587.0	582.1	577.3	572.4	567.3	562.5	557.6	553.0	548.6	544.2	539.6	535.2	530.7
36	597.1	592.0	587.2	582.1	577.3	572.4	567.3	562.5	557.9	553.2	548.8	544.2	539.8	535.2
36.5	602.2	597.1	592.0	587.2	582.1	577.3	572.2	567.3	562.5	558.1	553.5	548.8	544.4	539.8
37	607.3	602.2	597.1	592.0	587.0	582.1	577.0	572.0	567.3	562.7	558.1	553.5	548.8	544.4
37.5	612.3	607.3	602.2	597.1	592.0	587.0	581.9	576.8	572.0	567.3	562.7	558.1	553.5	548.8
38	617.4	612.3	607.0	602.0	596.9	591.8	586.8	581.7	576.8	572.2	567.6	562.7	558.1	553.5
38.5	622.5	617.2	612.1	607.0	601.7	596.7	591.6	586.3	581.7	576.8	572.2	567.3	562.7	558.1
39	627.5	622.3	617.2	611.9	606.8	601.5	596.5	591.2	586.3	581.7	576.8	572.0	567.3	562.5
39.5	632.6	627.3	622.0	617.0	611.7	606.4	601.3	596.0	591.2	586.3	581.5	576.6	572.0	567.1
40	637.7	632.4	627.1	621.8	616.5	611.2	605.9	600.9	595.8	590.9	586.1	581.2	576.4	571.8
40.5	642.8	637.5	632.2	626.9	621.4	616.1	610.8	605.5	600.6	595.8	590.7	585.9	581.0	576.2
41	647.8	642.5	637.0	631.7	626.4	620.9	615.6	610.3	605.3	600.4	595.6	590.5	585.6	580.8
41.5	652.9	647.4	642.1	636.6	631.3	626.0	620.5	615.2	610.1	605.1	600.2	595.1	590.3	585.4
42	658.0	652.5	647.2	641.7	636.1	630.9	625.3	619.8	614.8	609.9	604.8	599.8	594.9	589.8
42.5	663.0	657.5	652.0	646.5	641.2	635.7	630.2	624.7	619.6	614.5	609.5	604.4	599.5	594.5
43	668.1	662.6	657.1	651.6	646.1	640.6	635.0	629.5	624.2	619.2	614.1	609.0	603.9	598.9
43.5	673.2	667.7	661.9	656.4	650.9	645.4	639.9	634.4	629.1	624.0	618.9	613.7	608.6	603.5
44	678.3	672.7	667.0	661.5	655.8	650.3	644.7	639.0	633.7	628.6	623.6	618.3	613.2	608.1
44.5	683.3	677.6	672.1	666.4	660.8	655.1	649.6	643.9	638.6	633.5	628.2	622.9	617.8	612.5

343 L container (850 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
45	688.4	682.7	676.9	671.4	665.7	660.0	654.2	648.7	643.4	638.1	632.8	627.5	622.5	617.2
45.5	693.5	687.7	682.0	676.3	670.5	664.8	659.1	653.3	648.0	642.8	637.5	632.2	627.1	621.8
46	698.5	692.8	687.1	681.3	675.4	669.7	663.9	658.2	652.9	647.6	642.3	636.8	631.5	626.2
46.5	703.6	697.9	691.9	686.2	680.5	674.5	668.8	663.0	657.5	652.2	646.9	641.4	636.1	630.9
47	708.7	703.0	697.0	691.3	685.3	679.6	673.6	667.9	662.4	656.9	651.6	646.3	640.8	635.5
47.5	713.8	707.8	702.1	696.1	690.2	684.4	678.5	672.5	667.0	661.7	656.2	650.9	645.4	639.9
48	718.8	712.9	706.9	701.0	695.2	689.3	683.3	677.4	671.9	666.4	660.8	655.5	650.0	644.5
48.5	723.9	717.9	712.0	706.0	700.1	694.1	688.2	682.2	676.5	671.0	665.5	660.2	654.7	649.2
49	729.0	723.0	717.1	710.9	704.9	699.0	693.0	686.9	681.3	675.8	670.3	664.8	659.1	653.6
49.5	734.0	728.1	721.9	716.0	709.8	703.8	697.9	691.7	686.0	680.5	675.0	669.4	663.7	658.2
50	739.1	733.2	727.0	720.8	714.9	708.7	702.7	696.6	690.8	685.3	679.6	674.1	668.3	662.8
50.5	744.2	738.0	732.1	725.9	719.7	713.5	707.4	701.4	695.5	689.9	684.2	678.7	673.0	667.2
51	749.3	743.1	736.9	730.7	724.6	718.4	712.2	706.0	700.3	694.6	688.8	683.3	677.6	671.9
51.5	754.3	748.2	742.0	735.8	729.4	723.2	717.1	710.9	705.2	699.4	693.7	688.0	682.2	676.5
52	759.4	753.2	747.1	740.7	734.5	728.1	721.9	715.7	709.8	704.1	698.3	692.6	686.6	680.9
52.5	764.5	758.3	751.9	745.7	739.3	732.9	726.8	720.4	714.6	708.7	703.0	697.2	691.3	685.5
53	769.5	763.4	757.0	750.6	744.2	738.0	731.6	725.2	719.3	713.5	707.6	701.9	695.9	690.2
53.5	774.6	768.2	762.0	755.7	749.3	742.9	736.5	730.1	724.1	718.2	712.2	706.5	700.5	694.6
54	779.7	773.3	766.9	760.5	754.1	747.7	741.3	734.9	728.8	722.8	717.1	711.1	705.2	699.2
54.5	784.8	778.4	772.0	765.6	759.0	752.6	746.2	739.6	733.6	727.7	721.7	715.7	709.8	703.8
55	789.8	783.4	776.8	770.4	763.8	757.4	751.0	744.4	738.2	732.3	726.3	720.4	714.2	708.2
55.5	794.9	788.5	781.9	775.3	768.9	762.3	755.7	749.3	743.1	736.9	731.0	725.0	718.8	712.9
56	800.0	793.6	787.0	780.3	773.7	767.1	760.5	753.9	747.7	741.8	735.6	729.6	723.5	717.5
56.5	805.3	798.4	791.8	785.2	778.6	772.0	765.4	758.7	752.6	746.4	740.2	734.3	728.1	721.9
57	810.3	803.5	796.9	790.3	783.7	776.8	770.2	763.6	757.2	751.2	745.1	738.9	732.7	726.5
57.5	815.4	808.6	802.0	795.1	788.5	781.7	775.1	768.4	762.0	755.9	749.7	743.5	737.4	731.2
58	820.5	813.6	806.8	800.2	793.4	786.5	779.9	773.1	766.9	760.5	754.3	748.2	741.8	735.6
58.5	825.6	818.7	811.9	805.0	798.2	791.6	784.8	777.9	771.5	765.4	759.0	752.8	746.4	740.2
59	830.6	823.8	817.0	810.1	803.3	796.4	789.6	782.8	776.4	770.0	763.6	757.4	751.0	744.8
59.5	835.7	828.9	821.8	815.0	808.1	801.3	794.5	787.4	781.0	774.6	768.4	762.0	755.7	749.3
60	840.8	833.7	826.9	820.0	813.0	806.1	799.3	792.3	785.9	779.5	773.1	766.7	760.3	753.9
60.5	845.8	838.8	831.9	824.9	817.8	811.0	803.9	797.1	790.5	784.1	777.7	771.3	764.9	758.5
61	850.9	843.9	836.8	830.0	822.9	815.9	808.8	802.0	795.3	788.7	782.3	775.9	769.3	762.9
61.5	856.0	848.9	841.9	834.8	827.8	820.7	813.6	806.6	800.0	793.6	787.0	780.6	774.0	767.6
62	861.1	854.0	846.9	839.7	832.6	825.6	818.5	811.4	804.8	798.2	791.6	785.2	778.6	772.2
62.5	866.1	859.1	851.8	844.7	837.7	830.4	823.3	816.3	809.5	803.1	796.4	789.8	783.2	776.6
63	871.2	863.9	856.9	849.6	842.5	835.3	828.2	820.9	814.3	807.7	801.1	794.5	787.8	781.2
63.5	876.3	869.0	861.9	854.7	847.4	840.1	833.0	825.8	818.9	812.3	805.7	799.1	792.5	785.9
64	881.3	874.1	866.8	859.5	852.2	845.2	837.9	830.6	823.8	817.2	810.3	803.7	796.9	790.3
64.5	886.4	879.1	871.9	864.6	857.3	850.0	842.8	835.5	828.6	821.8	815.0	808.4	801.5	794.9
65	891.5	884.2	876.7	869.4	862.2	854.9	847.6	840.1	833.3	826.4	819.8	813.0	806.1	799.3
65.5	896.6	889.3	881.8	874.5	867.0	859.7	852.2	845.0	838.1	831.3	824.4	817.6	810.8	803.9
66	901.6	894.1	886.9	879.4	871.9	864.6	857.1	849.8	842.8	835.9	829.1	822.2	815.4	808.6
66.5	906.7	899.2	891.7	884.4	876.9	869.4	861.9	854.4	847.6	840.5	833.7	826.9	820.0	813.0
67	911.8	904.3	896.8	889.3	881.8	874.3	866.8	859.3	852.2	845.4	838.3	831.5	824.4	817.6
67.5	916.8	909.3	901.8	894.3	886.6	879.1	871.6	864.1	857.1	850.0	843.2	836.1	829.1	822.2
68	921.9	914.4	906.7	899.2	891.7	884.0	876.5	869.0	861.7	854.9	847.8	840.8	833.7	826.7
68.5	927.0	919.5	911.8	904.3	896.6	888.8	881.3	873.6	866.6	859.5	852.5	845.4	838.3	831.3
69	932.1	924.3	916.8	909.1	901.4	893.7	886.2	878.5	871.2	864.1	857.1	850.0	843.0	835.9
69.5	937.1	929.4	921.7	914.0	906.3	898.8	891.0	883.3	876.0	869.0	861.7	854.7	847.6	840.3
70	942.2	934.5	926.8	919.0	911.3	903.6	895.9	888.0	880.7	873.6	866.3	859.3	852.0	845.0
70.5	947.3	939.6	931.8	923.9	916.2	908.5	900.7	892.8	885.5	878.3	871.2	863.9	856.6	849.6
71	952.3	944.6	936.7	929.0	921.0	913.3	905.4	897.7	890.2	883.1	875.8	868.5	861.3	854.0
71.5	957.4	949.7	941.8	933.8	926.1	918.2	910.2	902.5	895.0	887.7	880.5	873.2	865.9	858.6
72	962.5	954.5	946.8	938.9	931.0	923.0	915.1	907.1	899.9	892.4	885.1	877.8	870.5	863.3
72.5	967.6	959.6	951.7	943.7	935.8	927.9	919.9	912.0	904.5	897.2	889.7	882.4	875.2	867.7
73	972.6	964.7	956.7	948.8	940.7	932.7	924.8	916.8	909.3	901.8	894.6	887.1	879.6	872.3
73.5	977.7	969.8	961.8	953.7	945.7	937.6	929.6	921.5	914.0	906.7	899.2	891.7	884.2	876.9
74	982.8	974.8	966.7	958.7	950.6	942.4	934.5	926.3	918.8	911.3	903.8	896.3	888.8	881.3
74.5	987.8	979.9	971.7	963.6	955.4	947.3	939.3	931.2	923.5	916.0	908.5	901.0	893.5	886.0

343 L container (850 lb tank) – Weight (lb) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI cm	-15 (5)	-10 (14)	-5 (23)	0 (32)	5 (41)	10 (50)	15 (59)	20 (68)	25 (77)	30 (86)	35 (95)	40 (104)	45 (113)	50 (122)
75	992.9	984.8	976.6	968.7	960.3	952.3	944.2	936.0	928.3	920.8	913.1	905.6	898.1	890.6
75.5	998.0	989.8	981.7	973.5	965.3	957.2	949.0	940.7	932.9	925.4	917.9	910.2	902.7	895.0
76	1003.1	994.9	986.7	978.6	970.2	962.0	953.7	945.5	937.8	930.1	922.6	914.9	907.1	899.6
76.5	1008.1	1000.0	991.6	983.4	975.1	966.9	958.5	950.4	942.4	934.9	927.2	919.5	911.8	904.3
77	1013.2	1005.0	996.7	988.3	980.1	971.7	963.4	955.0	947.3	939.6	931.8	924.1	916.4	908.7
77.5	1018.5	1010.1	1001.7	993.4	985.0	976.6	968.2	959.8	951.9	944.2	936.5	928.7	921.0	913.3
78	1023.6	1015.0	1006.6	998.2	989.8	981.4	973.1	964.7	956.7	949.0	941.1	933.4	925.7	917.9
78.5	1028.6	1020.0	1011.7	1003.3	994.7	986.3	977.9	969.5	961.6	953.7	945.9	938.0	930.3	922.4
79	1033.7	1025.1	1016.7	1008.1	999.7	991.1	982.8	974.2	966.2	958.3	950.6	942.6	934.7	927.0

106 L container (280 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
15.5	50.3	49.7	49.0	48.4	47.8	47.1	46.5	45.8	45.2	44.5	43.8	43.1	42.5	41.8
16	51.3	50.6	50.0	49.4	48.7	48.1	47.4	46.8	46.1	45.5	44.8	44.1	43.4	42.7
16.5	52.2	51.6	51.0	50.3	49.7	49.1	48.4	47.8	47.1	46.4	45.7	45.1	44.4	43.7
17	53.2	52.6	51.9	51.3	50.7	50.0	49.4	48.8	48.1	47.4	46.7	46.0	45.3	44.6
17.5	54.2	53.5	52.9	52.3	51.6	51.0	50.4	49.7	49.0	48.4	47.7	47.0	46.3	45.6
18	55.1	54.5	53.8	53.2	52.6	52.0	51.3	50.7	50.0	49.3	48.6	47.9	47.2	46.5
18.5	56.1	55.4	54.8	54.2	53.6	52.9	52.3	51.7	51.0	50.3	49.6	48.9	48.2	47.5
19	57.0	56.4	55.8	55.1	54.5	53.9	53.3	52.7	52.0	51.2	50.5	49.8	49.1	48.4
19.5	58.0	57.3	56.7	56.1	55.5	54.9	54.3	53.6	52.9	52.2	51.5	50.8	50.1	49.3
20	58.9	58.3	57.7	57.1	56.5	55.8	55.2	54.6	53.9	53.2	52.5	51.7	51.0	50.3
20.5	59.9	59.3	58.6	58.0	57.4	56.8	56.2	55.6	54.9	54.1	53.4	52.7	52.0	51.2
21	60.8	60.2	59.6	59.0	58.4	57.8	57.2	56.6	55.8	55.1	54.4	53.6	52.9	52.2
21.5	61.8	61.2	60.6	60.0	59.4	58.7	58.1	57.5	56.8	56.1	55.3	54.6	53.8	53.1
22	62.7	62.1	61.5	60.9	60.3	59.7	59.1	58.5	57.8	57.0	56.3	55.5	54.8	54.1
22.5	63.7	63.1	62.5	61.9	61.3	60.7	60.1	59.5	58.8	58.0	57.3	56.5	55.7	55.0
23	64.6	64.0	63.4	62.9	62.3	61.7	61.1	60.5	59.7	59.0	58.2	57.5	56.7	55.9
23.5	65.6	65.0	64.4	63.8	63.2	62.6	62.0	61.4	60.7	59.9	59.2	58.4	57.6	56.9
24	66.6	66.0	65.4	64.8	64.2	63.6	63.0	62.4	61.7	60.9	60.1	59.4	58.6	57.8
24.5	67.5	66.9	66.3	65.7	65.2	64.6	64.0	63.4	62.7	61.9	61.1	60.3	59.5	58.8
25	68.5	67.9	67.3	66.7	66.1	65.5	64.9	64.4	63.6	62.8	62.1	61.3	60.5	59.7
25.5	69.4	68.8	68.3	67.7	67.1	66.5	65.9	65.3	64.6	63.8	63.0	62.2	61.4	60.6
26	70.4	69.8	69.2	68.6	68.1	67.5	66.9	66.3	65.6	64.8	64.0	63.2	62.4	61.6
26.5	71.3	70.8	70.2	69.6	69.0	68.4	67.9	67.3	66.5	65.7	64.9	64.1	63.3	62.5
27	72.3	71.7	71.1	70.6	70.0	69.4	68.8	68.3	67.5	66.7	65.9	65.1	64.3	63.5
27.5	73.2	72.7	72.1	71.5	71.0	70.4	69.8	69.2	68.5	67.7	66.9	66.0	65.2	64.4
28	74.2	73.6	73.1	72.5	71.9	71.3	70.8	70.2	69.5	68.6	67.8	67.0	66.2	65.4
28.5	75.1	74.6	74.0	73.4	72.9	72.3	71.8	71.2	70.4	69.6	68.8	68.0	67.1	66.3
29	76.1	75.5	75.0	74.4	73.9	73.3	72.7	72.2	71.4	70.6	69.7	68.9	68.1	67.2
29.5	77.1	76.5	75.9	75.4	74.8	74.3	73.7	73.1	72.4	71.5	70.7	69.9	69.0	68.2
30	78.0	77.5	76.9	76.3	75.8	75.2	74.7	74.1	73.3	72.5	71.7	70.8	70.0	69.1
30.5	79.0	78.4	77.9	77.3	76.8	76.2	75.6	75.1	74.3	73.5	72.6	71.8	70.9	70.1
31	79.9	79.4	78.8	78.3	77.7	77.2	76.6	76.1	75.3	74.4	73.6	72.7	71.9	71.0
31.5	80.9	80.3	79.8	79.2	78.7	78.1	77.6	77.0	76.3	75.4	74.5	73.7	72.8	72.0
32	81.8	81.3	80.7	80.2	79.7	79.1	78.6	78.0	77.2	76.4	75.5	74.6	73.8	72.9
32.5	82.8	82.2	81.7	81.2	80.6	80.1	79.5	79.0	78.2	77.3	76.5	75.6	74.7	73.8
33	83.7	83.2	82.7	82.1	81.6	81.0	80.5	80.0	79.2	78.3	77.4	76.5	75.7	74.8
33.5	84.7	84.2	83.6	83.1	82.6	82.0	81.5	80.9	80.1	79.3	78.4	77.5	76.6	75.7
34	85.6	85.1	84.6	84.0	83.5	83.0	82.5	81.9	81.1	80.2	79.3	78.4	77.6	76.7
34.5	86.6	86.1	85.5	85.0	84.5	84.0	83.4	82.9	82.1	81.2	80.3	79.4	78.5	77.6
35	87.5	87.0	86.5	86.0	85.4	84.9	84.4	83.9	83.1	82.2	81.3	80.4	79.5	78.6
35.5	88.5	88.0	87.5	86.9	86.4	85.9	85.4	84.9	84.0	83.1	82.2	81.3	80.4	79.5
36	89.5	88.9	88.4	87.9	87.4	86.9	86.3	85.8	85.0	84.1	83.2	82.3	81.3	80.4
36.5	90.4	89.9	89.4	88.9	88.3	87.8	87.3	86.8	86.0	85.1	84.1	83.2	82.3	81.4
37	91.4	90.9	90.3	89.8	89.3	88.8	88.3	87.8	86.9	86.0	85.1	84.2	83.2	82.3
37.5	92.3	91.8	91.3	90.8	90.3	89.8	89.3	88.8	87.9	87.0	86.1	85.1	84.2	83.3
38	93.3	92.8	92.3	91.8	91.2	90.7	90.2	89.7	88.9	87.9	87.0	86.1	85.1	84.2
38.5	94.2	93.7	93.2	92.7	92.2	91.7	91.2	90.7	89.9	88.9	88.0	87.0	86.1	85.2
39	95.2	94.7	94.2	93.7	93.2	92.7	92.2	91.7	90.8	89.9	88.9	88.0	87.0	86.1
39.5	96.1	95.6	95.1	94.6	94.1	93.6	93.2	92.7	91.8	90.8	89.9	88.9	88.0	87.0
40	97.1	96.6	96.1	95.6	95.1	94.6	94.1	93.6	92.8	91.8	90.9	89.9	88.9	88.0
40.5	98.0	97.6	97.1	96.6	96.1	95.6	95.1	94.6	93.7	92.8	91.8	90.9	89.9	88.9
41	99.0	98.5	98.0	97.5	97.0	96.6	96.1	95.6	94.7	93.7	92.8	91.8	90.8	89.9
41.5	100.0	99.5	99.0	98.5	98.0	97.5	97.0	96.6	95.7	94.7	93.7	92.8	91.8	90.8
42	100.9	100.4	99.9	99.5	99.0	98.5	98.0	97.5	96.7	95.7	94.7	93.7	92.7	91.7
42.5	101.9	101.4	100.9	100.4	99.9	99.5	99.0	98.5	97.6	96.6	95.7	94.7	93.7	92.7
43	102.8	102.3	101.9	101.4	100.9	100.4	100.0	99.5	98.6	97.6	96.6	95.6	94.6	93.6
43.5	103.8	103.3	102.8	102.3	101.9	101.4	100.9	100.5	99.6	98.6	97.6	96.6	95.6	94.6
44	104.7	104.3	103.8	103.3	102.8	102.4	101.9	101.4	100.5	99.5	98.5	97.5	96.5	95.5
44.5	105.7	105.2	104.7	104.3	103.8	103.3	102.9	102.4	101.5	100.5	99.5	98.5	97.5	96.5
45	106.6	106.2	105.7	105.2	104.8	104.3	103.8	103.4	102.5	101.5	100.5	99.4	98.4	97.4
45.5	107.6	107.1	106.7	106.2	105.7	105.3	104.8	104.4	103.5	102.4	101.4	100.4	99.4	98.3
46	108.5	108.1	107.6	107.2	106.7	106.2	105.8	105.3	104.4	103.4	102.4	101.3	100.3	99.3
46.5	109.5	109.0	108.6	108.1	107.7	107.2	106.8	106.3	105.4	104.4	103.3	102.3	101.3	100.2
47	110.4	110.0	109.5	109.1	108.6	108.2	107.7	107.3	106.4	105.3	104.3	103.3	102.2	101.2

106 L container (280 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
47.5	111.4	111.0	110.5	110.1	109.6	109.2	108.7	108.3	107.3	106.3	105.3	104.2	103.2	102.1
48	112.4	111.9	111.5	111.0	110.6	110.1	109.7	109.2	108.3	107.3	106.2	105.2	104.1	103.1
48.5	113.3	112.9	112.4	112.0	111.5	111.1	110.7	110.2	109.3	108.2	107.2	106.1	105.1	104.0
49	114.3	113.8	113.4	112.9	112.5	112.1	111.6	111.2	110.3	109.2	108.1	107.1	106.0	104.9
49.5	115.2	114.8	114.3	113.9	113.5	113.0	112.6	112.2	111.2	110.2	109.1	108.0	107.0	105.9
50	116.2	115.7	115.3	114.9	114.4	114.0	113.6	113.1	112.2	111.1	110.1	109.0	107.9	106.8
50.5	117.1	116.7	116.3	115.8	115.4	115.0	114.5	114.1	113.2	112.1	111.0	109.9	108.8	107.8
51	118.1	117.7	117.2	116.8	116.4	115.9	115.5	115.1	114.1	113.1	112.0	110.9	109.8	108.7
51.5	119.0	118.6	118.2	117.8	117.3	116.9	116.5	116.1	115.1	114.0	112.9	111.8	110.7	109.7
52	120.0	119.6	119.1	118.7	118.3	117.9	117.5	117.0	116.1	115.0	113.9	112.8	111.7	110.6
52.5	120.9	120.5	120.1	119.7	119.3	118.9	118.4	118.0	117.1	116.0	114.9	113.7	112.6	111.5
53	121.9	121.5	121.1	120.7	120.2	119.8	119.4	119.0	118.0	116.9	115.8	114.7	113.6	112.5
53.5	122.9	122.4	122.0	121.6	121.2	120.8	120.4	120.0	119.0	117.9	116.8	115.7	114.5	113.4
54	123.8	123.4	123.0	122.6	122.2	121.8	121.4	120.9	120.0	118.9	117.7	116.6	115.5	114.4
54.5	124.8	124.4	123.9	123.5	123.1	122.7	122.3	121.9	120.9	119.8	118.7	117.6	116.4	115.3
55	125.7	125.3	124.9	124.5	124.1	123.7	123.3	122.9	121.9	120.8	119.7	118.5	117.4	116.3
55.5	126.7	126.3	125.9	125.5	125.1	124.7	124.3	123.9	122.9	121.8	120.6	119.5	118.3	117.2
56	127.6	127.2	126.8	126.4	126.0	125.6	125.2	124.8	123.9	122.7	121.6	120.4	119.3	118.1
56.5	128.6	128.2	127.8	127.4	127.0	126.6	126.2	125.8	124.8	123.7	122.5	121.4	120.2	119.1
57	129.5	129.1	128.8	128.4	128.0	127.6	127.2	126.8	125.8	124.7	123.5	122.3	121.2	120.0
57.5	130.5	130.1	129.7	129.3	128.9	128.5	128.2	127.8	126.8	125.6	124.5	123.3	122.1	121.0
58	131.4	131.1	130.7	130.3	129.9	129.5	129.1	128.7	127.8	126.6	125.4	124.2	123.1	121.9
58.5	132.4	132.0	131.6	131.2	130.9	130.5	130.1	129.7	128.7	127.5	126.4	125.2	124.0	122.8
59	133.3	133.0	132.6	132.2	131.8	131.5	131.1	130.7	129.7	128.5	127.3	126.2	125.0	123.8
59.5	134.3	133.9	133.6	133.2	132.8	132.4	132.1	131.7	130.7	129.5	128.3	127.1	125.9	124.7
60	135.3	134.9	134.5	134.1	133.8	133.4	133.0	132.7	131.6	130.4	129.3	128.1	126.9	125.7
60.5	136.2	135.8	135.5	135.1	134.7	134.4	134.0	133.6	132.6	131.4	130.2	129.0	127.8	126.6
61	137.2	136.8	136.4	136.1	135.7	135.3	135.0	134.6	133.6	132.4	131.2	130.0	128.8	127.6
61.5	138.1	137.8	137.4	137.0	136.7	136.3	135.9	135.6	134.6	133.3	132.1	130.9	129.7	128.5
62	139.1	138.7	138.4	138.0	137.6	137.3	136.9	136.6	135.5	134.3	133.1	131.9	130.7	129.4
62.5	140.0	139.7	139.3	139.0	138.6	138.2	137.9	137.5	136.5	135.3	134.1	132.8	131.6	130.4
63	141.0	140.6	140.3	139.9	139.6	139.2	138.9	138.5	137.5	136.2	135.0	133.8	132.6	131.3
63.5	141.9	141.6	141.2	140.9	140.5	140.2	139.8	139.5	138.4	137.2	136.0	134.7	133.5	132.3
64	142.9	142.5	142.2	141.8	141.5	141.1	140.8	140.5	139.4	138.2	136.9	135.7	134.5	133.2
64.5	143.8	143.5	143.2	142.8	142.5	142.1	141.8	141.4	140.4	139.1	137.9	136.6	135.4	134.2
65	144.8	144.5	144.1	143.8	143.4	143.1	142.7	142.4	141.4	140.1	138.9	137.6	136.3	135.1
65.5	145.8	145.4	145.1	144.7	144.4	144.1	143.7	143.4	142.3	141.1	139.8	138.6	137.3	136.0
66	146.7	146.4	146.0	145.7	145.4	145.0	144.7	144.4	143.3	142.0	140.8	139.5	138.2	137.0

147 L container (390 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
17.5	66.0	65.3	64.6	63.9	63.2	62.5	61.74	61.0	60.6	60.3	59.9	59.6	59.2	58.9
18	67.1	66.4	65.6	64.9	64.2	63.4	62.72	62.0	61.6	61.2	60.9	60.5	60.2	59.8
18.5	68.1	67.4	66.6	65.9	65.2	64.4	63.69	63.0	62.5	62.2	61.8	61.4	61.1	60.7
19	69.2	68.4	67.7	66.9	66.2	65.4	64.67	63.9	63.5	63.1	62.7	62.4	62.0	61.6
19.5	70.2	69.5	68.7	67.9	67.2	66.4	65.65	64.9	64.4	64.1	63.7	63.3	62.9	62.6
20	71.3	70.5	69.7	68.9	68.2	67.4	66.63	65.9	65.4	65.0	64.6	64.2	63.9	63.5
20.5	72.3	71.5	70.7	70.0	69.2	68.4	67.60	66.8	66.3	66.0	65.6	65.2	64.8	64.4
21	73.3	72.6	71.8	71.0	70.2	69.4	68.58	67.8	67.3	66.9	66.5	66.1	65.7	65.3
21.5	74.4	73.6	72.8	72.0	71.2	70.4	69.56	68.8	68.3	67.9	67.5	67.1	66.7	66.2
22	75.4	74.6	73.8	73.0	72.2	71.4	70.54	69.7	69.2	68.8	68.4	68.0	67.6	67.2
22.5	76.5	75.7	74.8	74.0	73.2	72.3	71.51	70.7	70.2	69.8	69.3	68.9	68.5	68.1
23	77.5	76.7	75.8	75.0	74.2	73.3	72.49	71.7	71.1	70.7	70.3	69.9	69.4	69.0
23.5	78.6	77.7	76.9	76.0	75.2	74.3	73.47	72.6	72.1	71.7	71.2	70.8	70.4	69.9
24	79.6	78.8	77.9	77.0	76.2	75.3	74.44	73.6	73.0	72.6	72.2	71.7	71.3	70.9
24.5	80.7	79.8	78.9	78.0	77.2	76.3	75.42	74.5	74.0	73.6	73.1	72.7	72.2	71.8
25	81.7	80.8	79.9	79.1	78.2	77.3	76.40	75.5	75.0	74.5	74.1	73.6	73.2	72.7
25.5	82.8	81.9	81.0	80.1	79.2	78.3	77.38	76.5	75.9	75.5	75.0	74.5	74.1	73.6
26	83.8	82.9	82.0	81.1	80.2	79.3	78.35	77.4	76.9	76.4	75.9	75.5	75.0	74.5
26.5	84.8	83.9	83.0	82.1	81.2	80.2	79.33	78.4	77.8	77.4	76.9	76.4	75.9	75.5
27	85.9	85.0	84.0	83.1	82.2	81.2	80.31	79.4	78.8	78.3	77.8	77.3	76.9	76.4
27.5	86.9	86.0	85.0	84.1	83.2	82.2	81.29	80.3	79.8	79.3	78.8	78.3	77.8	77.3
28	88.0	87.0	86.1	85.1	84.2	83.2	82.26	81.3	80.7	80.2	79.7	79.2	78.7	78.2
28.5	89.0	88.1	87.1	86.1	85.2	84.2	83.24	82.3	81.7	81.2	80.7	80.2	79.7	79.1
29	90.1	89.1	88.1	87.1	86.2	85.2	84.22	83.2	82.6	82.1	81.6	81.1	80.6	80.1
29.5	91.1	90.1	89.1	88.2	87.2	86.2	85.20	84.2	83.6	83.1	82.5	82.0	81.5	81.0
30	92.2	91.2	90.2	89.2	88.2	87.2	86.17	85.2	84.5	84.0	83.5	83.0	82.4	81.9
30.5	93.2	92.2	91.2	90.2	89.2	88.2	87.15	86.1	85.5	85.0	84.4	83.9	83.4	82.8
31	94.2	93.2	92.2	91.2	90.2	89.1	88.13	87.1	86.5	85.9	85.4	84.8	84.3	83.8
31.5	95.3	94.3	93.2	92.2	91.2	90.1	89.11	88.1	87.4	86.9	86.3	85.8	85.2	84.7
32	96.3	95.3	94.2	93.2	92.2	91.1	90.08	89.0	88.4	87.8	87.3	86.7	86.2	85.6
32.5	97.4	96.3	95.3	94.2	93.2	92.1	91.06	90.0	89.3	88.8	88.2	87.6	87.1	86.5
33	98.4	97.4	96.3	95.2	94.2	93.1	92.04	91.0	90.3	89.7	89.2	88.6	88.0	87.4
33.5	99.5	98.4	97.3	96.2	95.2	94.1	93.01	91.9	91.3	90.7	90.1	89.5	88.9	88.4
34	100.5	99.4	98.3	97.3	96.2	95.1	93.99	92.9	92.2	91.6	91.0	90.5	89.9	89.3
34.5	101.6	100.5	99.4	98.3	97.2	96.1	94.97	93.9	93.2	92.6	92.0	91.4	90.8	90.2
35	102.6	101.5	100.4	99.3	98.2	97.1	95.95	94.8	94.1	93.5	92.9	92.3	91.7	91.1
35.5	103.6	102.5	101.4	100.3	99.2	98.0	96.92	95.8	95.1	94.5	93.9	93.3	92.7	92.0
36	104.7	103.6	102.4	101.3	100.2	99.0	97.90	96.8	96.0	95.4	94.8	94.2	93.6	93.0
36.5	105.7	104.6	103.4	102.3	101.2	100.0	98.88	97.7	97.0	96.4	95.8	95.1	94.5	93.9
37	106.8	105.6	104.5	103.3	102.2	101.0	99.86	98.7	98.0	97.3	96.7	96.1	95.4	94.8
37.5	107.8	106.7	105.5	104.3	103.2	102.0	100.83	99.7	98.9	98.3	97.6	97.0	96.4	95.7
38	108.9	107.7	106.5	105.3	104.2	103.0	101.81	100.6	99.9	99.2	98.6	97.9	97.3	96.7
38.5	109.9	108.7	107.5	106.3	105.2	104.0	102.79	101.6	100.8	100.2	99.5	98.9	98.2	97.6
39	111.0	109.8	108.6	107.4	106.2	105.0	103.77	102.6	101.8	101.1	100.5	99.8	99.2	98.5
39.5	112.0	110.8	109.6	108.4	107.2	106.0	104.74	103.5	102.7	102.1	101.4	100.7	100.1	99.4
40	113.0	111.8	110.6	109.4	108.2	106.9	105.72	104.5	103.7	103.0	102.4	101.7	101.0	100.3
40.5	114.1	112.9	111.6	110.4	109.2	107.9	106.70	105.5	104.7	104.0	103.3	102.6	101.9	101.3
41	115.1	113.9	112.6	111.4	110.2	108.9	107.67	106.4	105.6	104.9	104.2	103.6	102.9	102.2
41.5	116.2	114.9	113.7	112.4	111.2	109.9	108.65	107.4	106.6	105.9	105.2	104.5	103.8	103.1
42	117.2	116.0	114.7	113.4	112.2	110.9	109.63	108.4	107.5	106.8	106.1	105.4	104.7	104.0
42.5	118.3	117.0	115.7	114.4	113.2	111.9	110.61	109.3	108.5	107.8	107.1	106.4	105.7	104.9
43	119.3	118.0	116.7	115.4	114.2	112.9	111.58	110.3	109.5	108.7	108.0	107.3	106.6	105.9
43.5	120.4	119.1	117.8	116.5	115.2	113.9	112.56	111.3	110.4	109.7	109.0	108.2	107.5	106.8
44	121.4	120.1	118.8	117.5	116.2	114.9	113.54	112.2	111.4	110.6	109.9	109.2	108.4	107.7
44.5	122.4	121.1	119.8	118.5	117.2	115.8	114.52	113.2	112.3	111.6	110.9	110.1	109.4	108.6
45	123.5	122.2	120.8	119.5	118.2	116.8	115.49	114.2	113.3	112.5	111.8	111.0	110.3	109.6
45.5	124.5	123.2	121.8	120.5	119.2	117.8	116.47	115.1	114.2	113.5	112.7	112.0	111.2	110.5
46	125.6	124.2	122.9	121.5	120.2	118.8	117.45	116.1	115.2	114.4	113.7	112.9	112.2	111.4
46.5	126.6	125.3	123.9	122.5	121.2	119.8	118.43	117.1	116.2	115.4	114.6	113.9	113.1	112.3
47	127.7	126.3	124.9	123.5	122.2	120.8	119.40	118.0	117.1	116.3	115.6	114.8	114.0	113.2
47.5	128.7	127.3	125.9	124.5	123.2	121.8	120.38	119.0	118.1	117.3	116.5	115.7	114.9	114.2
48	129.8	128.4	127.0	125.6	124.2	122.8	121.36	120.0	119.0	118.2	117.5	116.7	115.9	115.1
48.5	130.8	129.4	128.0	126.6	125.2	123.7	122.33	120.9	120.0	119.2	118.4	117.6	116.8	116.0
49	131.8	130.4	129.0	127.6	126.2	124.7	123.31	121.9	120.9	120.1	119.3	118.5	117.7	116.9

147 L container (390 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
49.5	132.9	131.5	130.0	128.6	127.2	125.7	124.29	122.9	121.9	121.1	120.3	119.5	118.7	117.8
50	133.9	132.5	131.0	129.6	128.2	126.7	125.27	123.8	122.9	122.0	121.2	120.4	119.6	118.8
50.5	135.0	133.5	132.1	130.6	129.2	127.7	126.24	124.8	123.8	123.0	122.2	121.3	120.5	119.7
51	136.0	134.6	133.1	131.6	130.2	128.7	127.22	125.8	124.8	123.9	123.1	122.3	121.4	120.6
51.5	137.1	135.6	134.1	132.6	131.2	129.7	128.20	126.7	125.7	124.9	124.1	123.2	122.4	121.5
52	138.1	136.6	135.1	133.6	132.2	130.7	129.18	127.7	126.7	125.8	125.0	124.2	123.3	122.5
52.5	139.2	137.7	136.2	134.7	133.2	131.7	130.15	128.7	127.7	126.8	125.9	125.1	124.2	123.4
53	140.2	138.7	137.2	135.7	134.2	132.6	131.13	129.6	128.6	127.8	126.9	126.0	125.2	124.3
53.5	141.2	139.7	138.2	136.7	135.2	133.6	132.11	130.6	129.6	128.7	127.8	127.0	126.1	125.2
54	142.3	140.8	139.2	137.7	136.2	134.6	133.09	131.6	130.5	129.7	128.8	127.9	127.0	126.1
54.5	143.3	141.8	140.2	138.7	137.2	135.6	134.06	132.5	131.5	130.6	129.7	128.8	127.9	127.1
55	144.4	142.8	141.3	139.7	138.2	136.6	135.04	133.5	132.4	131.6	130.7	129.8	128.9	128.0
55.5	145.4	143.9	142.3	140.7	139.2	137.6	136.02	134.5	133.4	132.5	131.6	130.7	129.8	128.9
56	146.5	144.9	143.3	141.7	140.2	138.6	137.00	135.4	134.4	133.5	132.5	131.6	130.7	129.8
56.5	147.5	145.9	144.3	142.7	141.2	139.6	137.97	136.4	135.3	134.4	133.5	132.6	131.7	130.7
57	148.6	147.0	145.4	143.8	142.2	140.6	138.95	137.4	136.3	135.4	134.4	133.5	132.6	131.7
57.5	149.6	148.0	146.4	144.8	143.2	141.5	139.93	138.3	137.2	136.3	135.4	134.4	133.5	132.6
58	150.6	149.0	147.4	145.8	144.2	142.5	140.90	139.3	138.2	137.3	136.3	135.4	134.5	133.5
58.5	151.7	150.1	148.4	146.8	145.2	143.5	141.88	140.3	139.2	138.2	137.3	136.3	135.4	134.4
59	152.7	151.1	149.4	147.8	146.2	144.5	142.86	141.2	140.1	139.2	138.2	137.3	136.3	135.4
59.5	153.8	152.1	150.5	148.8	147.2	145.5	143.84	142.2	141.1	140.1	139.2	138.2	137.2	136.3
60	154.8	153.2	151.5	149.8	148.2	146.5	144.81	143.2	142.0	141.1	140.1	139.1	138.2	137.2
60.5	155.9	154.2	152.5	150.8	149.2	147.5	145.79	144.1	143.0	142.0	141.0	140.1	139.1	138.1
61	156.9	155.2	153.5	151.8	150.2	148.5	146.77	145.1	143.9	143.0	142.0	141.0	140.0	139.0
61.5	158.0	156.3	154.6	152.9	151.2	149.5	147.75	146.0	144.9	143.9	142.9	141.9	141.0	140.0
62	159.0	157.3	155.6	153.9	152.2	150.4	148.72	147.0	145.9	144.9	143.9	142.9	141.9	140.9
62.5	160.0	158.3	156.6	154.9	153.2	151.4	149.70	148.0	146.8	145.8	144.8	143.8	142.8	141.8
63	161.1	159.4	157.6	155.9	154.2	152.4	150.68	148.9	147.8	146.8	145.8	144.7	143.7	142.7
63.5	162.1	160.4	158.6	156.9	155.2	153.4	151.66	149.9	148.7	147.7	146.7	145.7	144.7	143.7
64	163.2	161.4	159.7	157.9	156.2	154.4	152.63	150.9	149.7	148.7	147.6	146.6	145.6	144.6
64.5	164.2	162.5	160.7	158.9	157.2	155.4	153.61	151.8	150.6	149.6	148.6	147.6	146.5	145.5
65	165.3	163.5	161.7	159.9	158.2	156.4	154.59	152.8	151.6	150.6	149.5	148.5	147.5	146.4
65.5	166.3	164.5	162.7	160.9	159.2	157.4	155.56	153.8	152.6	151.5	150.5	149.4	148.4	147.3
66	167.4	165.6	163.8	162.0	160.2	158.3	156.54	154.7	153.5	152.5	151.4	150.4	149.3	148.3
66.5	168.4	166.6	164.8	163.0	161.2	159.3	157.52	155.7	154.5	153.4	152.4	151.3	150.2	149.2
67	169.4	167.6	165.8	164.0	162.2	160.3	158.50	156.7	155.4	154.4	153.3	152.2	151.2	150.1
67.5	170.5	168.7	166.8	165.0	163.2	161.3	159.47	157.6	156.4	155.3	154.2	153.2	152.1	151.0
68	171.5	169.7	167.8	166.0	164.2	162.3	160.45	158.6	157.4	156.3	155.2	154.1	153.0	151.9
68.5	172.6	170.7	168.9	167.0	165.2	163.3	161.43	159.6	158.3	157.2	156.1	155.0	154.0	152.9
69	173.6	171.8	169.9	168.0	166.2	164.3	162.41	160.5	159.3	158.2	157.1	156.0	154.9	153.8
69.5	174.7	172.8	170.9	169.0	167.2	165.3	163.38	161.5	160.2	159.1	158.0	156.9	155.8	154.7
70	175.7	173.8	171.9	170.0	168.2	166.3	164.36	162.5	161.2	160.1	159.0	157.8	156.7	155.6
70.5	176.8	174.9	173.0	171.0	169.1	167.2	165.34	163.4	162.1	161.0	159.9	158.8	157.7	156.6
71	177.8	175.9	174.0	172.1	170.1	168.2	166.32	164.4	163.1	162.0	160.9	159.7	158.6	157.5
71.5	178.8	176.9	175.0	173.1	171.1	169.2	167.29	165.4	164.1	162.9	161.8	160.7	159.5	158.4
72	179.9	178.0	176.0	174.1	172.1	170.2	168.27	166.3	165.0	163.9	162.7	161.6	160.5	159.3
72.5	180.9	179.0	177.0	175.1	173.1	171.2	169.25	167.3	166.0	164.8	163.7	162.5	161.4	160.2
73	182.0	180.0	178.1	176.1	174.1	172.2	170.23	168.3	166.9	165.8	164.6	163.5	162.3	161.2
73.5	183.0	181.1	179.1	177.1	175.1	173.2	171.20	169.2	167.9	166.7	165.6	164.4	163.2	162.1
74	184.1	182.1	180.1	178.1	176.1	174.2	172.18	170.2	168.8	167.7	166.5	165.3	164.2	163.0
74.5	185.1	183.1	181.1	179.1	177.1	175.2	173.16	171.2	169.8	168.6	167.5	166.3	165.1	163.9
75	186.2	184.2	182.2	180.1	178.1	176.1	174.13	172.1	170.8	169.6	168.4	167.2	166.0	164.8
75.5	187.2	185.2	183.2	181.2	179.1	177.1	175.11	173.1	171.7	170.5	169.3	168.1	167.0	165.8
76	188.2	186.2	184.2	182.2	180.1	178.1	176.09	174.1	172.7	171.5	170.3	169.1	167.9	166.7
76.5	189.3	187.3	185.2	183.2	181.1	179.1	177.07	175.0	173.6	172.4	171.2	170.0	168.8	167.6
77	190.3	188.3	186.2	184.2	182.1	180.1	178.04	176.0	174.6	173.4	172.2	171.0	169.7	168.5
77.5	191.4	189.3	187.3	185.2	183.1	181.1	179.02	177.0	175.6	174.3	173.1	171.9	170.7	169.5
78	192.4	190.4	188.3	186.2	184.1	182.1	180.00	177.9	176.5	175.3	174.1	172.8	171.6	170.4
78.5	193.5	191.4	189.3	187.2	185.1	183.1	180.98	178.9	177.5	176.2	175.0	173.8	172.5	171.3
79	194.5	192.4	190.3	188.2	186.1	184.1	181.95	179.9	178.4	177.2	175.9	174.7	173.5	172.2
79.5	195.6	193.5	191.4	189.2	187.1	185.0	182.93	180.8	179.4	178.1	176.9	175.6	174.4	173.1

147 L container (390 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
80	196.6	194.5	192.4	190.3	188.1	186.0	183.91	181.8	180.3	179.1	177.8	176.6	175.3	174.1
80.5	197.7	195.5	193.4	191.3	189.1	187.0	184.89	182.8	181.3	180.0	178.8	177.5	176.2	175.0
81	198.7	196.6	194.4	192.3	190.1	188.0	185.86	183.7	182.3	181.0	179.7	178.4	177.2	175.9
81.5	199.7	197.6	195.4	193.3	191.1	189.0	186.84	184.7	183.2	181.9	180.7	179.4	178.1	176.8
82	200.8	198.6	196.5	194.3	192.1	190.0	187.82	185.7	184.2	182.9	181.6	180.3	179.0	177.7
82.5	201.8	199.7	197.5	195.3	193.1	191.0	188.79	186.6	185.1	183.8	182.6	181.3	180.0	178.7
83	202.9	200.7	198.5	196.3	194.1	192.0	189.77	187.6	186.1	184.8	183.5	182.2	180.9	179.6
83.5	203.9	201.7	199.5	197.3	195.1	193.0	190.75	188.6	187.1	185.7	184.4	183.1	181.8	180.5
84	205.0	202.8	200.6	198.3	196.1	193.9	191.73	189.5	188.0	186.7	185.4	184.1	182.7	181.4
84.5	206.0	203.8	201.6	199.4	197.1	194.9	192.70	190.5	189.0	187.6	186.3	185.0	183.7	182.4
85	207.1	204.8	202.6	200.4	198.1	195.9	193.68	191.5	189.9	188.6	187.3	185.9	184.6	183.3
85.5	208.1	205.9	203.6	201.4	199.1	196.9	194.66	192.4	190.9	189.5	188.2	186.9	185.5	184.2
86	209.1	206.9	204.6	202.4	200.1	197.9	195.64	193.4	191.8	190.5	189.2	187.8	186.5	185.1

180 L container (450 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
25.5	81.1	80.4	79.7	79.0	78.3	77.6	76.9	76.2	75.4	74.6	73.8	73.0	72.2	71.4
26	82.2	81.4	80.7	80.0	79.3	78.6	77.9	77.2	76.4	75.6	74.8	74.0	73.2	72.4
26.5	83.2	82.5	81.8	81.1	80.4	79.7	78.9	78.2	77.4	76.6	75.8	75.0	74.1	73.3
27	84.3	83.5	82.8	82.1	81.4	80.7	80.0	79.2	78.4	77.6	76.8	75.9	75.1	74.3
27.5	85.3	84.6	83.9	83.1	82.4	81.7	81.0	80.2	79.4	78.6	77.8	76.9	76.1	75.2
28	86.4	85.6	84.9	84.2	83.4	82.7	82.0	81.3	80.4	79.6	78.7	77.9	77.0	76.2
28.5	87.4	86.7	86.0	85.2	84.5	83.7	83.0	82.3	81.4	80.6	79.7	78.9	78.0	77.2
29	88.5	87.7	87.0	86.3	85.5	84.8	84.0	83.3	82.4	81.6	80.7	79.8	79.0	78.1
29.5	89.5	88.8	88.0	87.3	86.5	85.8	85.0	84.3	83.4	82.6	81.7	80.8	79.9	79.1
30	90.6	89.8	89.1	88.3	87.6	86.8	86.0	85.3	84.4	83.5	82.7	81.8	80.9	80.0
30.5	91.6	90.9	90.1	89.4	88.6	87.8	87.1	86.3	85.4	84.5	83.7	82.8	81.9	81.0
31	92.7	91.9	91.2	90.4	89.6	88.8	88.1	87.3	86.4	85.5	84.6	83.7	82.8	81.9
31.5	93.8	93.0	92.2	91.4	90.6	89.9	89.1	88.3	87.4	86.5	85.6	84.7	83.8	82.9
32	94.8	94.0	93.2	92.5	91.7	90.9	90.1	89.3	88.4	87.5	86.6	85.7	84.8	83.9
32.5	95.9	95.1	94.3	93.5	92.7	91.9	91.1	90.3	89.4	88.5	87.6	86.7	85.7	84.8
33	96.9	96.1	95.3	94.5	93.7	92.9	92.1	91.3	90.4	89.5	88.6	87.6	86.7	85.8
33.5	98.0	97.2	96.4	95.6	94.8	93.9	93.1	92.3	91.4	90.5	89.6	88.6	87.7	86.7
34	99.0	98.2	97.4	96.6	95.8	95.0	94.2	93.3	92.4	91.5	90.5	89.6	88.6	87.7
34.5	100.1	99.3	98.5	97.6	96.8	96.0	95.2	94.4	93.4	92.5	91.5	90.6	89.6	88.6
35	101.1	100.3	99.5	98.7	97.8	97.0	96.2	95.4	94.4	93.5	92.5	91.5	90.6	89.6
35.5	102.2	101.4	100.5	99.7	98.9	98.0	97.2	96.4	95.4	94.5	93.5	92.5	91.5	90.6
36	103.2	102.4	101.6	100.7	99.9	99.1	98.2	97.4	96.4	95.4	94.5	93.5	92.5	91.5
36.5	104.3	103.5	102.6	101.8	100.9	100.1	99.2	98.4	97.4	96.4	95.4	94.5	93.5	92.5
37	105.4	104.5	103.7	102.8	102.0	101.1	100.2	99.4	98.4	97.4	96.4	95.4	94.4	93.4
37.5	106.4	105.6	104.7	103.8	103.0	102.1	101.3	100.4	99.4	98.4	97.4	96.4	95.4	94.4
38	107.5	106.6	105.7	104.9	104.0	103.1	102.3	101.4	100.4	99.4	98.4	97.4	96.4	95.3
38.5	108.5	107.6	106.8	105.9	105.0	104.2	103.3	102.4	101.4	100.4	99.4	98.4	97.3	96.3
39	109.6	108.7	107.8	106.9	106.1	105.2	104.3	103.4	102.4	101.4	100.4	99.3	98.3	97.3
39.5	110.6	109.7	108.9	108.0	107.1	106.2	105.3	104.4	103.4	102.4	101.3	100.3	99.3	98.2
40	111.7	110.8	109.9	109.0	108.1	107.2	106.3	105.4	104.4	103.4	102.3	101.3	100.2	99.2
40.5	112.7	111.8	110.9	110.0	109.1	108.2	107.3	106.4	105.4	104.4	103.3	102.3	101.2	100.1
41	113.8	112.9	112.0	111.1	110.2	109.3	108.4	107.5	106.4	105.4	104.3	103.2	102.2	101.1
41.5	114.9	113.9	113.0	112.1	111.2	110.3	109.4	108.5	107.4	106.3	105.3	104.2	103.1	102.1
42	115.9	115.0	114.1	113.2	112.2	111.3	110.4	109.5	108.4	107.3	106.3	105.2	104.1	103.0
42.5	117.0	116.0	115.1	114.2	113.3	112.3	111.4	110.5	109.4	108.3	107.2	106.2	105.1	104.0
43	118.0	117.1	116.2	115.2	114.3	113.4	112.4	111.5	110.4	109.3	108.2	107.1	106.0	104.9
43.5	119.1	118.1	117.2	116.3	115.3	114.4	113.4	112.5	111.4	110.3	109.2	108.1	107.0	105.9
44	120.1	119.2	118.2	117.3	116.3	115.4	114.5	113.5	112.4	111.3	110.2	109.1	108.0	106.8
44.5	121.2	120.2	119.3	118.3	117.4	116.4	115.5	114.5	113.4	112.3	111.2	110.0	108.9	107.8
45	122.2	121.3	120.3	119.4	118.4	117.4	116.5	115.5	114.4	113.3	112.2	111.0	109.9	108.8
45.5	123.3	122.3	121.4	120.4	119.4	118.5	117.5	116.5	115.4	114.3	113.1	112.0	110.9	109.7
46	124.3	123.4	122.4	121.4	120.5	119.5	118.5	117.5	116.4	115.3	114.1	113.0	111.8	110.7
46.5	125.4	124.4	123.4	122.5	121.5	120.5	119.5	118.5	117.4	116.3	115.1	113.9	112.8	111.6
47	126.5	125.5	124.5	123.5	122.5	121.5	120.5	119.6	118.4	117.3	116.1	114.9	113.8	112.6
47.5	127.5	126.5	125.5	124.5	123.5	122.5	121.6	120.6	119.4	118.2	117.1	115.9	114.7	113.5
48	128.6	127.6	126.6	125.6	124.6	123.6	122.6	121.6	120.4	119.2	118.1	116.9	115.7	114.5
48.5	129.6	128.6	127.6	126.6	125.6	124.6	123.6	122.6	121.4	120.2	119.0	117.8	116.7	115.5
49	130.7	129.7	128.7	127.6	126.6	125.6	124.6	123.6	122.4	121.2	120.0	118.8	117.6	116.4
49.5	131.7	130.7	129.7	128.7	127.7	126.6	125.6	124.6	123.4	122.2	121.0	119.8	118.6	117.4
50	132.8	131.8	130.7	129.7	128.7	127.7	126.6	125.6	124.4	123.2	122.0	120.8	119.5	118.3
50.5	133.8	132.8	131.8	130.7	129.7	128.7	127.6	126.6	125.4	124.2	123.0	121.7	120.5	119.3
51	134.9	133.9	132.8	131.8	130.7	129.7	128.7	127.6	126.4	125.2	124.0	122.7	121.5	120.2
51.5	135.9	134.9	133.9	132.8	131.8	130.7	129.7	128.6	127.4	126.2	124.9	123.7	122.4	121.2
52	137.0	135.9	134.9	133.8	132.8	131.7	130.7	129.6	128.4	127.2	125.9	124.7	123.4	122.2
52.5	138.1	137.0	135.9	134.9	133.8	132.8	131.7	130.6	129.4	128.2	126.9	125.6	124.4	123.1
53	139.1	138.0	137.0	135.9	134.8	133.8	132.7	131.6	130.4	129.2	127.9	126.6	125.3	124.1
53.5	140.2	139.1	138.0	137.0	135.9	134.8	133.7	132.7	131.4	130.1	128.9	127.6	126.3	125.0
54	141.2	140.1	139.1	138.0	136.9	135.8	134.7	133.7	132.4	131.1	129.9	128.6	127.3	126.0
54.5	142.3	141.2	140.1	139.0	137.9	136.8	135.8	134.7	133.4	132.1	130.8	129.5	128.2	127.0
55	143.3	142.2	141.1	140.1	139.0	137.9	136.8	135.7	134.4	133.1	131.8	130.5	129.2	127.9
55.5	144.4	143.3	142.2	141.1	140.0	138.9	137.8	136.7	135.4	134.1	132.8	131.5	130.2	128.9
56	145.4	144.3	143.2	142.1	141.0	139.9	138.8	137.7	136.4	135.1	133.8	132.5	131.1	129.8
56.5	146.5	145.4	144.3	143.2	142.0	140.9	139.8	138.7	137.4	136.1	134.8	133.4	132.1	130.8
57	147.5	146.4	145.3	144.2	143.1	142.0	140.8	139.7	138.4	137.1	135.8	134.4	133.1	131.7

180 L container (450 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
57.5	148.6	147.5	146.4	145.2	144.1	143.0	141.8	140.7	139.4	138.1	136.7	135.4	134.0	132.7
58	149.7	148.5	147.4	146.3	145.1	144.0	142.9	141.7	140.4	139.1	137.7	136.4	135.0	133.7
58.5	150.7	149.6	148.4	147.3	146.2	145.0	143.9	142.7	141.4	140.1	138.7	137.3	136.0	134.6
59	151.8	150.6	149.5	148.3	147.2	146.0	144.9	143.7	142.4	141.0	139.7	138.3	136.9	135.6
59.5	152.8	151.7	150.5	149.4	148.2	147.1	145.9	144.7	143.4	142.0	140.7	139.3	137.9	136.5
60	153.9	152.7	151.6	150.4	149.2	148.1	146.9	145.8	144.4	143.0	141.6	140.3	138.9	137.5
60.5	154.9	153.8	152.6	151.4	150.3	149.1	147.9	146.8	145.4	144.0	142.6	141.2	139.8	138.4
61	156.0	154.8	153.6	152.5	151.3	150.1	148.9	147.8	146.4	145.0	143.6	142.2	140.8	139.4
61.5	157.0	155.9	154.7	153.5	152.3	151.1	150.0	148.8	147.4	146.0	144.6	143.2	141.8	140.4
62	158.1	156.9	155.7	154.5	153.4	152.2	151.0	149.8	148.4	147.0	145.6	144.2	142.7	141.3
62.5	159.2	158.0	156.8	155.6	154.4	153.2	152.0	150.8	149.4	148.0	146.6	145.1	143.7	142.3
63	160.2	159.0	157.8	156.6	155.4	154.2	153.0	151.8	150.4	149.0	147.5	146.1	144.7	143.2
63.5	161.3	160.1	158.9	157.6	156.4	155.2	154.0	152.8	151.4	150.0	148.5	147.1	145.6	144.2
64	162.3	161.1	159.9	158.7	157.5	156.2	155.0	153.8	152.4	151.0	149.5	148.1	146.6	145.1
64.5	163.4	162.2	160.9	159.7	158.5	157.3	156.0	154.8	153.4	152.0	150.5	149.0	147.6	146.1
65	164.4	163.2	162.0	160.8	159.5	158.3	157.1	155.8	154.4	152.9	151.5	150.0	148.5	147.1
65.5	165.5	164.2	163.0	161.8	160.5	159.3	158.1	156.8	155.4	153.9	152.5	151.0	149.5	148.0
66	166.5	165.3	164.1	162.8	161.6	160.3	159.1	157.9	156.4	154.9	153.4	152.0	150.5	149.0
66.5	167.6	166.3	165.1	163.9	162.6	161.4	160.1	158.9	157.4	155.9	154.4	152.9	151.4	149.9
67	168.6	167.4	166.1	164.9	163.6	162.4	161.1	159.9	158.4	156.9	155.4	153.9	152.4	150.9
67.5	169.7	168.4	167.2	165.9	164.7	163.4	162.1	160.9	159.4	157.9	156.4	154.9	153.4	151.9
68	170.8	169.5	168.2	167.0	165.7	164.4	163.2	161.9	160.4	158.9	157.4	155.9	154.3	152.8
68.5	171.8	170.5	169.3	168.0	166.7	165.4	164.2	162.9	161.4	159.9	158.4	156.8	155.3	153.8
69	172.9	171.6	170.3	169.0	167.7	166.5	165.2	163.9	162.4	160.9	159.3	157.8	156.3	154.7
69.5	173.9	172.6	171.3	170.1	168.8	167.5	166.2	164.9	163.4	161.9	160.3	158.8	157.2	155.7
70	175.0	173.7	172.4	171.1	169.8	168.5	167.2	165.9	164.4	162.9	161.3	159.8	158.2	156.6
70.5	176.0	174.7	173.4	172.1	170.8	169.5	168.2	166.9	165.4	163.9	162.3	160.7	159.2	157.6
71	177.1	175.8	174.5	173.2	171.9	170.5	169.2	167.9	166.4	164.8	163.3	161.7	160.1	158.6
71.5	178.1	176.8	175.5	174.2	172.9	171.6	170.3	168.9	167.4	165.8	164.3	162.7	161.1	159.5
72	179.2	177.9	176.6	175.2	173.9	172.6	171.3	169.9	168.4	166.8	165.2	163.6	162.1	160.5
72.5	180.2	178.9	177.6	176.3	174.9	173.6	172.3	171.0	169.4	167.8	166.2	164.6	163.0	161.4
73	181.3	180.0	178.6	177.3	176.0	174.6	173.3	172.0	170.4	168.8	167.2	165.6	164.0	162.4
73.5	182.4	181.0	179.7	178.3	177.0	175.7	174.3	173.0	171.4	169.8	168.2	166.6	165.0	163.3
74	183.4	182.1	180.7	179.4	178.0	176.7	175.3	174.0	172.4	170.8	169.2	167.5	165.9	164.3
74.5	184.5	183.1	181.8	180.4	179.1	177.7	176.3	175.0	173.4	171.8	170.2	168.5	166.9	165.3
75	185.5	184.2	182.8	181.4	180.1	178.7	177.4	176.0	174.4	172.8	171.1	169.5	167.9	166.2
75.5	186.6	185.2	183.8	182.5	181.1	179.7	178.4	177.0	175.4	173.8	172.1	170.5	168.8	167.2
76	187.6	186.3	184.9	183.5	182.1	180.8	179.4	178.0	176.4	174.8	173.1	171.4	169.8	168.1
76.5	188.7	187.3	185.9	184.5	183.2	181.8	180.4	179.0	177.4	175.7	174.1	172.4	170.8	169.1
77	189.7	188.4	187.0	185.6	184.2	182.8	181.4	180.0	178.4	176.7	175.1	173.4	171.7	170.0
77.5	190.8	189.4	188.0	186.6	185.2	183.8	182.4	181.0	179.4	177.7	176.1	174.4	172.7	171.0
78	191.9	190.4	189.1	187.7	186.2	184.8	183.4	182.0	180.4	178.7	177.0	175.3	173.7	172.0
78.5	192.9	191.5	190.1	188.7	187.3	185.9	184.5	183.0	181.4	179.7	178.0	176.3	174.6	172.9
79	194.0	192.5	191.1	189.7	188.3	186.9	185.5	184.1	182.4	180.7	179.0	177.3	175.6	173.9
79.5	195.0	193.6	192.2	190.8	189.3	187.9	186.5	185.1	183.4	181.7	180.0	178.3	176.5	174.8
80	196.1	194.6	193.2	191.8	190.4	188.9	187.5	186.1	184.4	182.7	181.0	179.2	177.5	175.8
80.5	197.1	195.7	194.3	192.8	191.4	190.0	188.5	187.1	185.4	183.7	182.0	180.2	178.5	176.8
81	198.2	196.7	195.3	193.9	192.4	191.0	189.5	188.1	186.4	184.7	182.9	181.2	179.4	177.7
81.5	199.2	197.8	196.3	194.9	193.4	192.0	190.5	189.1	187.4	185.7	183.9	182.2	180.4	178.7
82	200.3	198.8	197.4	195.9	194.5	193.0	191.6	190.1	188.4	186.7	184.9	183.1	181.4	179.6
82.5	201.3	199.9	198.4	197.0	195.5	194.0	192.6	191.1	189.4	187.6	185.9	184.1	182.3	180.6
83	202.4	200.9	199.5	198.0	196.5	195.1	193.6	192.1	190.4	188.6	186.9	185.1	183.3	181.5
83.5	203.5	202.0	200.5	199.0	197.6	196.1	194.6	193.1	191.4	189.6	187.9	186.1	184.3	182.5
84	204.5	203.0	201.5	200.1	198.6	197.1	195.6	194.1	192.4	190.6	188.8	187.0	185.2	183.5
84.5	205.6	204.1	202.6	201.1	199.6	198.1	196.6	195.1	193.4	191.6	189.8	188.0	186.2	184.4
85	206.6	205.1	203.6	202.1	200.6	199.1	197.6	196.2	194.4	192.6	190.8	189.0	187.2	185.4
85.5	207.7	206.2	204.7	203.2	201.7	200.2	198.7	197.2	195.4	193.6	191.8	190.0	188.1	186.3
86	208.7	207.2	205.7	204.2	202.7	201.2	199.7	198.2	196.4	194.6	192.8	190.9	189.1	187.3
86.5	209.8	208.3	206.8	205.2	203.7	202.2	200.7	199.2	197.4	195.6	193.7	191.9	190.1	188.2
87	210.8	209.3	207.8	206.3	204.8	203.2	201.7	200.2	198.4	196.6	194.7	192.9	191.0	189.2

180 L container (450 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
87.5	211.9	210.4	208.8	207.3	205.8	204.2	202.7	201.2	199.4	197.6	195.7	193.9	192.0	190.2
88	212.9	211.4	209.9	208.3	206.8	205.3	203.7	202.2	200.4	198.5	196.7	194.8	193.0	191.1
88.5	214.0	212.5	210.9	209.4	207.8	206.3	204.8	203.2	201.4	199.5	197.7	195.8	193.9	192.1
89	215.1	213.5	212.0	210.4	208.9	207.3	205.8	204.2	202.4	200.5	198.7	196.8	194.9	193.0
89.5	216.1	214.6	213.0	211.5	209.9	208.3	206.8	205.2	203.4	201.5	199.6	197.8	195.9	194.0
90	217.2	215.6	214.0	212.5	210.9	209.4	207.8	206.2	204.4	202.5	200.6	198.7	196.8	194.9
90.5	218.2	216.7	215.1	213.5	211.9	210.4	208.8	207.2	205.4	203.5	201.6	199.7	197.8	195.9
91	219.3	217.7	216.1	214.6	213.0	211.4	209.8	208.2	206.4	204.5	202.6	200.7	198.8	196.9
91.5	220.3	218.7	217.2	215.6	214.0	212.4	210.8	209.3	207.4	205.5	203.6	201.7	199.7	197.8
92	221.4	219.8	218.2	216.6	215.0	213.4	211.9	210.3	208.4	206.5	204.6	202.6	200.7	198.8
92.5	222.4	220.8	219.3	217.7	216.1	214.5	212.9	211.3	209.4	207.5	205.5	203.6	201.7	199.7
93	223.5	221.9	220.3	218.7	217.1	215.5	213.9	212.3	210.4	208.5	206.5	204.6	202.6	200.7
93.5	224.5	222.9	221.3	219.7	218.1	216.5	214.9	213.3	211.4	209.5	207.5	205.6	203.6	201.7
94	225.6	224.0	222.4	220.8	219.1	217.5	215.9	214.3	212.4	210.4	208.5	206.5	204.6	202.6
94.5	226.7	225.0	223.4	221.8	220.2	218.5	216.9	215.3	213.4	211.4	209.5	207.5	205.5	203.6
95	227.7	226.1	224.5	222.8	221.2	219.6	217.9	216.3	214.4	212.4	210.5	208.5	206.5	204.5
95.5	228.8	227.1	225.5	223.9	222.2	220.6	219.0	217.3	215.4	213.4	211.4	209.5	207.5	205.5
96	229.8	228.2	226.5	224.9	223.3	221.6	220.0	218.3	216.4	214.4	212.4	210.4	208.4	206.4
96.5	230.9	229.2	227.6	225.9	224.3	222.6	221.0	219.3	217.4	215.4	213.4	211.4	209.4	207.4
97	231.9	230.3	228.6	227.0	225.3	223.7	222.0	220.3	218.4	216.4	214.4	212.4	210.4	208.4
97.5	233.0	231.3	229.7	228.0	226.3	224.7	223.0	221.3	219.4	217.4	215.4	213.4	211.3	209.3
98	234.0	232.4	230.7	229.0	227.4	225.7	224.0	222.4	220.4	218.4	216.4	214.3	212.3	210.3
98.5	235.1	233.4	231.7	230.1	228.4	226.7	225.0	223.4	221.4	219.4	217.3	215.3	213.3	211.2
99	236.2	234.5	232.8	231.1	229.4	227.7	226.1	224.4	222.4	220.4	218.3	216.3	214.2	212.2
99.5	237.2	235.5	233.8	232.1	230.5	228.8	227.1	225.4	223.4	221.4	219.3	217.2	215.2	213.1
100	238.3	236.6	234.9	233.2	231.5	229.8	228.1	226.4	224.4	222.3	220.3	218.2	216.2	214.1
100.5	239.3	237.6	235.9	234.2	232.5	230.8	229.1	227.4	225.4	223.3	221.3	219.2	217.1	215.1
101	240.4	238.7	237.0	235.2	233.5	231.8	230.1	228.4	226.4	224.3	222.3	220.2	218.1	216.0
101.5	241.4	239.7	238.0	236.3	234.6	232.8	231.1	229.4	227.4	225.3	223.2	221.1	219.1	217.0
102	242.5	240.8	239.0	237.3	235.6	233.9	232.1	230.4	228.4	226.3	224.2	222.1	220.0	217.9
102.5	243.5	241.8	240.1	238.4	236.6	234.9	233.2	231.4	229.4	227.3	225.2	223.1	221.0	218.9
103	244.6	242.9	241.1	239.4	237.6	235.9	234.2	232.4	230.4	228.3	226.2	224.1	222.0	219.8
103.5	245.6	243.9	242.2	240.4	238.7	236.9	235.2	233.4	231.4	229.3	227.2	225.0	222.9	220.8
104	246.7	245.0	243.2	241.5	239.7	238.0	236.2	234.5	232.4	230.3	228.2	226.0	223.9	221.8
104.5	247.8	246.0	244.2	242.5	240.7	239.0	237.2	235.5	233.4	231.3	229.1	227.0	224.9	222.7
105	248.8	247.0	245.3	243.5	241.8	240.0	238.2	236.5	234.4	232.3	230.1	228.0	225.8	223.7
105.5	249.9	248.1	246.3	244.6	242.8	241.0	239.2	237.5	235.4	233.2	231.1	228.9	226.8	224.6
106	250.9	249.1	247.4	245.6	243.8	242.0	240.3	238.5	236.4	234.2	232.1	229.9	227.8	225.6
106.5	252.0	250.2	248.4	246.6	244.8	243.1	241.3	239.5	237.4	235.2	233.1	230.9	228.7	226.6
107	253.0	251.2	249.5	247.7	245.9	244.1	242.3	240.5	238.4	236.2	234.1	231.9	229.7	227.5

343 L container (850 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C)

	Temperature °C (°F)													
LLI	-15	-10	-5	0	5	10	15	20	25	30	35	40	45	50
cm	(5)	(14)	(23)	(32)	(41)	(50)	(59)	(68)	(77)	(86)	(95)	(104)	(113)	(122)
13	164.8	163.5	162.1	160.7	159.3	157.9	156.6	155.2	153.9	152.7	151.4	150.2	148.9	147.7
13.5	167.1	165.7	164.3	162.9	161.5	160.2	158.8	157.4	156.1	154.8	153.5	152.3	151.0	149.8
14	169.4	168.0	166.6	165.2	163.8	162.4	160.9	159.5	158.2	156.9	155.7	154.4	153.1	151.8
14.5	171.7	170.3	168.9	167.4	166.0	164.6	163.1	161.7	160.4	159.1	157.8	156.5	155.2	153.9
15	174.1	172.6	171.1	169.7	168.2	166.8	165.3	163.9	162.5	161.2	159.9	158.6	157.3	156.0
15.5	176.4	174.9	173.4	171.9	170.5	169.0	167.5	166.0	164.7	163.4	162.0	160.7	159.4	158.0
16	178.7	177.2	175.7	174.2	172.7	171.2	169.7	168.2	166.8	165.5	164.1	162.8	161.4	160.1
16.5	181.0	179.5	177.9	176.4	174.9	173.4	171.9	170.4	169.0	167.6	166.3	164.9	163.5	162.2
17	183.3	181.7	180.2	178.7	177.1	175.6	174.1	172.6	171.1	169.8	168.4	167.0	165.6	164.2
17.5	185.6	184.0	182.5	180.9	179.4	177.8	176.3	174.7	173.3	171.9	170.5	169.1	167.7	166.3
18	187.9	186.3	184.7	183.2	181.6	180.0	178.5	176.9	175.5	174.0	172.6	171.2	169.8	168.4
18.5	190.2	188.6	187.0	185.4	183.8	182.2	180.7	179.1	177.6	176.2	174.7	173.3	171.9	170.4
19	192.5	190.9	189.3	187.7	186.1	184.5	182.9	181.2	179.8	178.3	176.8	175.4	173.9	172.5
19.5	194.8	193.2	191.5	189.9	188.3	186.7	185.0	183.4	181.9	180.4	179.0	177.5	176.0	174.6
20	197.1	195.4	193.8	192.1	190.5	188.9	187.2	185.6	184.1	182.6	181.1	179.6	178.1	176.6
20.5	199.4	197.7	196.1	194.4	192.7	191.1	189.4	187.8	186.2	184.7	183.2	181.7	180.2	178.7
21	201.7	200.0	198.3	196.6	195.0	193.3	191.6	189.9	188.4	186.9	185.3	183.8	182.3	180.7
21.5	204.0	202.3	200.6	198.9	197.2	195.5	193.8	192.1	190.5	189.0	187.4	185.9	184.4	182.8
22	206.3	204.6	202.9	201.1	199.4	197.7	196.0	194.3	192.7	191.1	189.6	188.0	186.4	184.9
22.5	208.6	206.9	205.1	203.4	201.6	199.9	198.2	196.4	194.8	193.3	191.7	190.1	188.5	186.9
23	210.9	209.1	207.4	205.6	203.9	202.1	200.4	198.6	197.0	195.4	193.8	192.2	190.6	189.0
23.5	213.2	211.4	209.6	207.9	206.1	204.3	202.6	200.8	199.1	197.5	195.9	194.3	192.7	191.1
24	215.5	213.7	211.9	210.1	208.3	206.5	204.8	203.0	201.3	199.7	198.0	196.4	194.8	193.1
24.5	217.8	216.0	214.2	212.4	210.6	208.7	206.9	205.1	203.5	201.8	200.2	198.5	196.9	195.2
25	220.1	218.3	216.4	214.6	212.8	211.0	209.1	207.3	205.6	203.9	202.3	200.6	198.9	197.3
25.5	222.4	220.6	218.7	216.9	215.0	213.2	211.3	209.5	207.8	206.1	204.4	202.7	201.0	199.3
26	224.7	222.8	221.0	219.1	217.2	215.4	213.5	211.6	209.9	208.2	206.5	204.8	203.1	201.4
26.5	227.0	225.1	223.2	221.4	219.5	217.6	215.7	213.8	212.1	210.3	208.6	206.9	205.2	203.5
27	229.3	227.4	225.5	223.6	221.7	219.8	217.9	216.0	214.2	212.5	210.7	209.0	207.3	205.5
27.5	231.6	229.7	227.8	225.8	223.9	222.0	220.1	218.2	216.4	214.6	212.9	211.1	209.4	207.6
28	233.9	232.0	230.0	228.1	226.1	224.2	222.3	220.3	218.5	216.8	215.0	213.2	211.4	209.7
28.5	236.2	234.3	232.3	230.3	228.4	226.4	224.5	222.5	220.7	218.9	217.1	215.3	213.5	211.7
29	238.5	236.5	234.6	232.6	230.6	228.6	226.7	224.7	222.8	221.0	219.2	217.4	215.6	213.8
29.5	240.8	238.8	236.8	234.8	232.8	230.8	228.8	226.9	225.0	223.2	221.3	219.5	217.7	215.9
30	243.1	241.1	239.1	237.1	235.1	233.0	231.0	229.0	227.1	225.3	223.5	221.6	219.8	217.9
30.5	245.4	243.4	241.4	239.3	237.3	235.3	233.2	231.2	229.3	227.4	225.6	223.7	221.9	220.0
31	247.7	245.7	243.6	241.6	239.5	237.5	235.4	233.4	231.4	229.6	227.7	225.8	223.9	222.1
31.5	250.0	248.0	245.9	243.8	241.7	239.7	237.6	235.5	233.6	231.7	229.8	227.9	226.0	224.1
32	252.3	250.2	248.2	246.1	244.0	241.9	239.8	237.7	235.8	233.8	231.9	230.0	228.1	226.2
32.5	254.6	252.5	250.4	248.3	246.2	244.1	242.0	239.9	237.9	236.0	234.1	232.1	230.2	228.3
33	256.9	254.8	252.7	250.6	248.4	246.3	244.2	242.1	240.1	238.1	236.2	234.2	232.3	230.3
33.5	259.2	257.1	254.9	252.8	250.7	248.5	246.4	244.2	242.2	240.3	238.3	236.3	234.4	232.4
34	261.5	259.4	257.2	255.0	252.9	250.7	248.6	246.4	244.4	242.4	240.4	238.4	236.4	234.5
34.5	263.8	261.7	259.5	257.3	255.1	252.9	250.8	248.6	246.5	244.5	242.5	240.5	238.5	236.5
35	266.1	263.9	261.7	259.5	257.3	255.1	252.9	250.7	248.7	246.7	244.6	242.6	240.6	238.6
35.5	268.5	266.2	264.0	261.8	259.6	257.3	255.1	252.9	250.8	248.8	246.8	244.7	242.7	240.7
36	270.8	268.5	266.3	264.0	261.8	259.6	257.3	255.1	253.0	250.9	248.9	246.8	244.8	242.7
36.5	273.1	270.8	268.5	266.3	264.0	261.8	259.5	257.3	255.1	253.1	251.0	248.9	246.9	244.8
37	275.4	273.1	270.8	268.5	266.2	264.0	261.7	259.4	257.3	255.2	253.1	251.0	248.9	246.9
37.5	277.7	275.4	273.1	270.8	268.5	266.2	263.9	261.6	259.4	257.3	255.2	253.1	251.0	248.9
38	280.0	277.7	275.3	273.0	270.7	268.4	266.1	263.8	261.6	259.5	257.4	255.2	253.1	251.0
38.5	282.3	279.9	277.6	275.3	272.9	270.6	268.3	265.9	263.8	261.6	259.5	257.3	255.2	253.1
39	284.6	282.2	279.9	277.5	275.2	272.8	270.5	268.1	265.9	263.8	261.6	259.4	257.3	255.1
39.5	286.9	284.5	282.1	279.8	277.4	275.0	272.7	270.3	268.1	265.9	263.7	261.5	259.4	257.2
40	289.2	286.8	284.4	282.0	279.6	277.2	274.8	272.5	270.2	268.0	265.8	263.6	261.4	259.3
40.5	291.5	289.1	286.7	284.3	281.8	279.4	277.0	274.6	272.4	270.2	267.9	265.7	263.5	261.3
41	293.8	291.4	288.9	286.5	284.1	281.6	279.2	276.8	274.5	272.3	270.1	267.8	265.6	263.4
41.5	296.1	293.6	291.2	288.7	286.3	283.9	281.4	279.0	276.7	274.4	272.2	269.9	267.7	265.5
42	298.4	295.9	293.5	291.0	288.5	286.1	283.6	281.1	278.8	276.6	274.3	272.0	269.8	267.5
42.5	300.7	298.2	295.7	293.2	290.8	288.3	285.8	283.3	281.0	278.7	276.4	274.1	271.9	269.6
43	303.0	300.5	298.0	295.5	293.0	290.5	288.0	285.5	283.1	280.8	278.5	276.2	273.9	271.6
43.5	305.3	302.8	300.2	297.7	295.2	292.7	290.2	287.7	285.3	283.0	280.7	278.3	276.0	273.7
44	307.6	305.1	302.5	300.0	297.4	294.9	292.4	289.8	287.4	285.1	282.8	280.4	278.1	275.8
44.5	309.9	307.3	304.8	302.2	299.7	297.1	294.6	292.0	289.6	287.3	284.9	282.5	280.2	277.8

343 L container (850 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI cm	-15 (5)	-10 (14)	-5 (23)	0 (32)	5 (41)	10 (50)	15 (59)	20 (68)	25 (77)	30 (86)	35 (95)	40 (104)	45 (113)	50 (122)
45	312.2	309.6	307.0	304.5	301.9	299.3	296.7	294.2	291.8	289.4	287.0	284.6	282.3	279.9
45.5	314.5	311.9	309.3	306.7	304.1	301.5	298.9	296.3	293.9	291.5	289.1	286.7	284.4	282.0
46	316.8	314.2	311.6	309.0	306.3	303.7	301.1	298.5	296.1	293.7	291.3	288.8	286.4	284.0
46.5	319.1	316.5	313.8	311.2	308.6	305.9	303.3	300.7	298.2	295.8	293.4	290.9	288.5	286.1
47	321.4	318.8	316.1	313.5	310.8	308.2	305.5	302.9	300.4	297.9	295.5	293.1	290.6	288.2
47.5	323.7	321.0	318.4	315.7	313.0	310.4	307.7	305.0	302.5	300.1	297.6	295.2	292.7	290.2
48	326.0	323.3	320.6	317.9	315.3	312.6	309.9	307.2	304.7	302.2	299.7	297.3	294.8	292.3
48.5	328.3	325.6	322.9	320.2	317.5	314.8	312.1	309.4	306.8	304.3	301.8	299.4	296.9	294.4
49	330.6	327.9	325.2	322.4	319.7	317.0	314.3	311.5	309.0	306.5	304.0	301.5	298.9	296.4
49.5	332.9	330.2	327.4	324.7	321.9	319.2	316.5	313.7	311.1	308.6	306.1	303.6	301.0	298.5
50	335.2	332.5	329.7	326.9	324.2	321.4	318.7	315.9	313.3	310.8	308.2	305.7	303.1	300.6
50.5	337.5	334.7	332.0	329.2	326.4	323.6	320.8	318.1	315.4	312.9	310.3	307.8	305.2	302.6
51	339.8	337.0	334.2	331.4	328.6	325.8	323.0	320.2	317.6	315.0	312.4	309.9	307.3	304.7
51.5	342.1	339.3	336.5	333.7	330.8	328.0	325.2	322.4	319.8	317.2	314.6	312.0	309.4	306.8
52	344.4	341.6	338.8	335.9	333.1	330.2	327.4	324.6	321.9	319.3	316.7	314.1	311.4	308.8
52.5	346.7	343.9	341.0	338.2	335.3	332.4	329.6	326.7	324.1	321.4	318.8	316.2	313.5	310.9
53	349.0	346.2	343.3	340.4	337.5	334.7	331.8	328.9	326.2	323.6	320.9	318.3	315.6	313.0
53.5	351.3	348.4	345.6	342.7	339.8	336.9	334.0	331.1	328.4	325.7	323.0	320.4	317.7	315.0
54	353.6	350.7	347.8	344.9	342.0	339.1	336.2	333.3	330.5	327.8	325.2	322.5	319.8	317.1
54.5	355.9	353.0	350.1	347.2	344.2	341.3	338.4	335.4	332.7	330.0	327.3	324.6	321.9	319.2
55	358.2	355.3	352.3	349.4	346.4	343.5	340.6	337.6	334.8	332.1	329.4	326.7	323.9	321.2
55.5	360.5	357.6	354.6	351.6	348.7	345.7	342.7	339.8	337.0	334.2	331.5	328.8	326.0	323.3
56	362.8	359.9	356.9	353.9	350.9	347.9	344.9	341.9	339.1	336.4	333.6	330.9	328.1	325.4
56.5	365.2	362.1	359.1	356.1	353.1	350.1	347.1	344.1	341.3	338.5	335.7	333.0	330.2	327.4
57	367.5	364.4	361.4	358.4	355.4	352.3	349.3	346.3	343.4	340.7	337.9	335.1	332.3	329.5
57.5	369.8	366.7	363.7	360.6	357.6	354.5	351.5	348.5	345.6	342.8	340.0	337.2	334.4	331.6
58	372.1	369.0	365.9	362.9	359.8	356.7	353.7	350.6	347.8	344.9	342.1	339.3	336.4	333.6
58.5	374.4	371.3	368.2	365.1	362.0	359.0	355.9	352.8	349.9	347.1	344.2	341.4	338.5	335.7
59	376.7	373.6	370.5	367.4	364.3	361.2	358.1	355.0	352.1	349.2	346.3	343.5	340.6	337.8
59.5	379.0	375.9	372.7	369.6	366.5	363.4	360.3	357.1	354.2	351.3	348.5	345.6	342.7	339.8
60	381.3	378.1	375.0	371.9	368.7	365.6	362.5	359.3	356.4	353.5	350.6	347.7	344.8	341.9
60.5	383.6	380.4	377.3	374.1	370.9	367.8	364.6	361.5	358.5	355.6	352.7	349.8	346.9	344.0
61	385.9	382.7	379.5	376.4	373.2	370.0	366.8	363.7	360.7	357.7	354.8	351.9	348.9	346.0
61.5	388.2	385.0	381.8	378.6	375.4	372.2	369.0	365.8	362.8	359.9	356.9	354.0	351.0	348.1
62	390.5	387.3	384.1	380.8	377.6	374.4	371.2	368.0	365.0	362.0	359.0	356.1	353.1	350.2
62.5	392.8	389.6	386.3	383.1	379.9	376.6	373.4	370.2	367.1	364.2	361.2	358.2	355.2	352.2
63	395.1	391.8	388.6	385.3	382.1	378.8	375.6	372.3	369.3	366.3	363.3	360.3	357.3	354.3
63.5	397.4	394.1	390.9	387.6	384.3	381.0	377.8	374.5	371.4	368.4	365.4	362.4	359.4	356.4
64	399.7	396.4	393.1	389.8	386.5	383.3	380.0	376.7	373.6	370.6	367.5	364.5	361.4	358.4
64.5	402.0	398.7	395.4	392.1	388.8	385.5	382.2	378.9	375.8	372.7	369.6	366.6	363.5	360.5
65	404.3	401.0	397.6	394.3	391.0	387.7	384.4	381.0	377.9	374.8	371.8	368.7	365.6	362.5
65.5	406.6	403.3	399.9	396.6	393.2	389.9	386.5	383.2	380.1	377.0	373.9	370.8	367.7	364.6
66	408.9	405.5	402.2	398.8	395.4	392.1	388.7	385.4	382.2	379.1	376.0	372.9	369.8	366.7
66.5	411.2	407.8	404.4	401.1	397.7	394.3	390.9	387.5	384.4	381.2	378.1	375.0	371.9	368.7
67	413.5	410.1	406.7	403.3	399.9	396.5	393.1	389.7	386.5	383.4	380.2	377.1	373.9	370.8
67.5	415.8	412.4	409.0	405.6	402.1	398.7	395.3	391.9	388.7	385.5	382.4	379.2	376.0	372.9
68	418.1	414.7	411.2	407.8	404.4	400.9	397.5	394.1	390.8	387.7	384.5	381.3	378.1	374.9
68.5	420.4	417.0	413.5	410.1	406.6	403.1	399.7	396.2	393.0	389.8	386.6	383.4	380.2	377.0
69	422.7	419.2	415.8	412.3	408.8	405.3	401.9	398.4	395.1	391.9	388.7	385.5	382.3	379.1
69.5	425.0	421.5	418.0	414.5	411.0	407.6	404.1	400.6	397.3	394.1	390.8	387.6	384.4	381.1
70	427.3	423.8	420.3	416.8	413.3	409.8	406.3	402.7	399.4	396.2	392.9	389.7	386.4	383.2
70.5	429.6	426.1	422.6	419.0	415.5	412.0	408.5	404.9	401.6	398.3	395.1	391.8	388.5	385.3
71	431.9	428.4	424.8	421.3	417.7	414.2	410.6	407.1	403.7	400.5	397.2	393.9	390.6	387.3
71.5	434.2	430.7	427.1	423.5	420.0	416.4	412.8	409.3	405.9	402.6	399.3	396.0	392.7	389.4
72	436.5	432.9	429.4	425.8	422.2	418.6	415.0	411.4	408.1	404.7	401.4	398.1	394.8	391.5
72.5	438.8	435.2	431.6	428.0	424.4	420.8	417.2	413.6	410.2	406.9	403.5	400.2	396.9	393.5
73	441.1	437.5	433.9	430.3	426.6	423.0	419.4	415.8	412.4	409.0	405.7	402.3	398.9	395.6
73.5	443.4	439.8	436.2	432.5	428.9	425.2	421.6	417.9	414.5	411.2	407.8	404.4	401.0	397.7
74	445.7	442.1	438.4	434.8	431.1	427.4	423.8	420.1	416.7	413.3	409.9	406.5	403.1	399.7
74.5	448.0	444.4	440.7	437.0	433.3	429.6	426.0	422.3	418.8	415.4	412.0	408.6	405.2	401.8

343 L container (850 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI cm and temperature °C) (Continued)

	Temperature °C (°F)													
LLI cm	-15 (5)	-10 (14)	-5 (23)	0 (32)	5 (41)	10 (50)	15 (59)	20 (68)	25 (77)	30 (86)	35 (95)	40 (104)	45 (113)	50 (122)
75	450.3	446.6	442.9	439.3	435.5	431.9	428.2	424.5	421.0	417.6	414.1	410.7	407.3	403.9
75.5	452.6	448.9	445.2	441.5	437.8	434.1	430.4	426.6	423.1	419.7	416.3	412.8	409.4	405.9
76	454.9	451.2	447.5	443.8	440.0	436.3	432.5	428.8	425.3	421.8	418.4	414.9	411.4	408.0
76.5	457.2	453.5	449.7	446.0	442.2	438.5	434.7	431.0	427.4	424.0	420.5	417.0	413.5	410.1
77	459.5	455.8	452.0	448.2	444.5	440.7	436.9	433.1	429.6	426.1	422.6	419.1	415.6	412.1
77.5	461.9	458.1	454.3	450.5	446.7	442.9	439.1	435.3	431.7	428.2	424.7	421.2	417.7	414.2
78	464.2	460.3	456.5	452.7	448.9	445.1	441.3	437.5	433.9	430.4	426.8	423.3	419.8	416.3
78.5	466.5	462.6	458.8	455.0	451.1	447.3	443.5	439.7	436.1	432.5	429.0	425.4	421.9	418.3
79	468.8	464.9	461.1	457.2	453.4	449.5	445.7	441.8	438.2	434.6	431.1	427.5	423.9	420.4

106 L container (280 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI in. and temperature °F)

	Temperature °F (°C)													
LLI	0	10	20	30	40	50	60	70	80	90	100	110	120	130
in.	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.6)	(43.3)	(48.9)	(54.4)
6	50.2	49.5	48.8	48.0	47.3	46.6	45.9	45.2	44.5	43.7	43.0	42.2	41.5	40.7
6.25	51.4	50.7	50.0	49.3	48.5	47.9	47.1	46.4	45.7	44.9	44.2	43.4	42.6	41.9
6.5	52.6	51.9	51.2	50.5	49.8	49.1	48.4	47.7	46.9	46.1	45.4	44.6	43.9	43.1
6.75	53.8	53.1	52.4	51.7	51.0	50.3	49.6	48.9	48.1	47.4	46.6	45.8	45.0	44.3
7	55.0	54.3	53.6	52.9	52.3	51.5	50.8	50.1	49.4	48.6	47.8	47.0	46.3	45.5
7.25	56.2	55.6	54.8	54.2	53.5	52.8	52.1	51.4	50.6	49.8	49.0	48.2	47.4	46.7
7.5	57.5	56.7	56.1	55.4	54.7	54.0	53.3	52.6	51.8	51.0	50.3	49.4	48.7	47.9
7.75	58.7	58.0	57.3	56.6	55.9	55.2	54.5	53.8	53.1	52.3	51.4	50.7	49.9	49.0
8	59.9	59.2	58.5	57.8	57.2	56.5	55.8	55.1	54.3	53.5	52.7	51.8	51.0	50.3
8.25	61.1	60.4	59.7	59.1	58.4	57.7	57.0	56.3	55.5	54.7	53.9	53.1	52.3	51.4
8.5	62.3	61.6	61.0	60.3	59.6	58.9	58.2	57.6	56.7	55.9	55.1	54.3	53.4	52.6
8.75	63.5	62.8	62.1	61.5	60.8	60.1	59.5	58.8	58.0	57.2	56.3	55.5	54.7	53.8
9	64.7	64.0	63.4	62.7	62.1	61.4	60.7	60.1	59.2	58.4	57.5	56.7	55.8	55.0
9.25	65.9	65.3	64.6	64.0	63.3	62.6	62.0	61.3	60.5	59.6	58.7	57.9	57.0	56.2
9.5	67.1	66.5	65.8	65.2	64.5	63.9	63.2	62.6	61.7	60.8	60.0	59.1	58.2	57.4
9.75	68.4	67.7	67.0	66.4	65.7	65.1	64.4	63.8	62.9	62.1	61.2	60.3	59.4	58.6
10	69.5	68.9	68.3	67.6	67.0	66.3	65.7	65.0	64.1	63.3	62.4	61.5	60.6	59.7
10.25	70.8	70.1	69.5	68.8	68.2	67.5	66.9	66.3	65.4	64.5	63.6	62.7	61.8	61.0
10.5	72.0	71.4	70.7	70.0	69.4	68.8	68.1	67.5	66.6	65.7	64.8	63.9	63.1	62.1
10.75	73.2	72.5	71.9	71.3	70.6	70.0	69.4	68.7	67.8	67.0	66.0	65.1	64.2	63.3
11	74.4	73.8	73.1	72.5	71.9	71.2	70.6	70.0	69.1	68.2	67.3	66.3	65.4	64.5
11.25	75.6	75.0	74.3	73.7	73.1	72.5	71.9	71.2	70.3	69.4	68.4	67.5	66.6	65.7
11.5	76.8	76.2	75.6	74.9	74.3	73.7	73.1	72.4	71.5	70.6	69.7	68.8	67.8	66.9
11.75	78.0	77.4	76.8	76.2	75.6	74.9	74.3	73.7	72.8	71.8	70.9	69.9	69.0	68.1
12	79.2	78.6	78.0	77.4	76.8	76.2	75.5	74.9	74.0	73.0	72.1	71.2	70.2	69.3
12.25	80.4	79.8	79.2	78.6	78.0	77.4	76.8	76.2	75.2	74.3	73.3	72.3	71.4	70.5
12.5	81.6	81.1	80.4	79.8	79.2	78.6	78.0	77.4	76.4	75.5	74.5	73.6	72.6	71.7
12.75	82.9	82.2	81.6	81.1	80.5	79.8	79.2	78.7	77.7	76.7	75.8	74.8	73.8	72.8
13	84.1	83.5	82.9	82.3	81.7	81.1	80.5	79.9	78.9	77.9	77.0	76.0	75.0	74.0
13.25	85.3	84.7	84.1	83.5	82.9	82.3	81.7	81.1	80.2	79.2	78.2	77.2	76.2	75.3
13.5	86.5	85.9	85.3	84.7	84.1	83.6	83.0	82.4	81.4	80.4	79.4	78.4	77.4	76.4
13.75	87.7	87.1	86.5	86.0	85.4	84.8	84.2	83.6	82.6	81.6	80.6	79.6	78.6	77.6
14	88.9	88.3	87.7	87.2	86.6	86.0	85.4	84.9	83.8	82.8	81.8	80.8	79.8	78.8
14.25	90.1	89.5	89.0	88.4	87.8	87.2	86.7	86.1	85.1	84.1	83.1	82.0	81.0	80.0
14.5	91.3	90.8	90.2	89.6	89.0	88.5	87.9	87.3	86.3	85.3	84.3	83.2	82.2	81.2
14.75	92.5	92.0	91.4	90.9	90.3	89.7	89.1	88.6	87.5	86.5	85.5	84.5	83.4	82.4
15	93.8	93.2	92.6	92.1	91.5	90.9	90.4	89.8	88.8	87.7	86.7	85.6	84.6	83.6
15.25	94.9	94.4	93.8	93.3	92.7	92.2	91.6	91.0	90.0	89.0	87.9	86.9	85.8	84.7
15.5	96.2	95.6	95.1	94.5	93.9	93.4	92.9	92.3	91.2	90.2	89.1	88.0	87.0	86.0
15.75	97.4	96.8	96.3	95.7	95.2	94.6	94.1	93.5	92.4	91.4	90.3	89.3	88.2	87.1
16	98.6	98.0	97.5	96.9	96.4	95.8	95.3	94.8	93.7	92.6	91.5	90.5	89.4	88.3
16.25	99.8	99.2	98.7	98.2	97.6	97.1	96.6	96.0	94.9	93.8	92.8	91.7	90.6	89.5
16.5	101.0	100.5	99.9	99.4	98.8	98.3	97.8	97.3	96.2	95.1	94.0	92.9	91.8	90.7
16.75	102.2	101.7	101.2	100.6	100.1	99.6	99.0	98.5	97.4	96.3	95.2	94.1	93.0	91.9
17	103.4	102.9	102.4	101.8	101.3	100.8	100.2	99.7	98.6	97.5	96.4	95.3	94.2	93.1
17.25	104.6	104.1	103.6	103.1	102.6	102.0	101.5	101.0	99.8	98.7	97.6	96.5	95.4	94.3
17.5	105.8	105.3	104.8	104.3	103.8	103.2	102.7	102.2	101.1	100.0	98.8	97.7	96.6	95.5
17.75	107.0	106.6	106.0	105.5	105.0	104.5	104.0	103.5	102.3	101.2	100.1	98.9	97.8	96.7
18	108.3	107.7	107.2	106.7	106.2	105.7	105.2	104.7	103.6	102.4	101.3	100.1	99.0	97.8
18.25	109.5	109.0	108.5	108.0	107.5	107.0	106.4	105.9	104.8	103.6	102.5	101.3	100.2	99.0
18.5	110.7	110.2	109.7	109.2	108.7	108.2	107.7	107.2	106.0	104.9	103.7	102.6	101.4	100.2
18.75	111.9	111.4	110.9	110.4	109.9	109.4	108.9	108.4	107.2	106.1	104.9	103.7	102.6	101.4
19	113.1	112.6	112.1	111.6	111.1	110.6	110.1	109.6	108.5	107.3	106.1	105.0	103.8	102.6
19.25	114.3	113.8	113.4	112.9	112.4	111.9	111.4	110.9	109.7	108.5	107.3	106.1	105.0	103.8
19.5	115.5	115.0	114.5	114.1	113.6	113.1	112.6	112.1	111.0	109.7	108.5	107.4	106.2	105.0
19.75	116.7	116.3	115.8	115.3	114.8	114.3	113.9	113.4	112.2	111.0	109.8	108.6	107.4	106.2
20	117.9	117.5	117.0	116.5	116.0	115.6	115.1	114.6	113.4	112.2	111.0	109.8	108.6	107.4
20.25	119.2	118.7	118.2	117.8	117.3	116.8	116.3	115.8	114.6	113.4	112.2	111.0	109.8	108.5
20.5	120.3	119.9	119.4	118.9	118.5	118.0	117.6	117.1	115.8	114.6	113.4	112.2	111.0	109.8
20.75	121.6	121.1	120.7	120.2	119.7	119.3	118.8	118.3	117.1	115.8	114.6	113.4	112.2	111.0
21	122.8	122.3	121.9	121.4	120.9	120.5	120.0	119.6	118.3	117.1	115.8	114.6	113.4	112.1
21.25	124.0	123.5	123.1	122.6	122.2	121.7	121.2	120.8	119.6	118.3	117.1	115.8	114.6	113.3
21.5	125.2	124.7	124.3	123.8	123.4	122.9	122.5	122.1	120.8	119.5	118.3	117.0	115.8	114.5
21.75	126.4	126.0	125.5	125.1	124.6	124.2	123.7	123.3	122.0	120.7	119.5	118.2	117.0	115.7

106 L container (280 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI in. and temperature °F) (Continued)

	Temperature °F (°C)													
LLI in.	0 (-17.8)	10 (-12.2)	20 (-6.7)	30 (-1.1)	40 (4.4)	50 (10)	60 (15.6)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.6)	110 (43.3)	120 (48.9)	130 (54.4)
22	127.6	127.2	126.7	126.3	125.8	125.4	125.0	124.5	123.2	122.0	120.7	119.4	118.2	116.9
22.25	128.8	128.4	128.0	127.5	127.1	126.6	126.2	125.8	124.5	123.2	121.9	120.7	119.3	118.1
22.5	130.0	129.6	129.2	128.7	128.3	127.9	127.4	127.0	125.7	124.4	123.2	121.8	120.6	119.3
22.75	131.2	130.8	130.4	130.0	129.5	129.1	128.7	128.2	127.0	125.6	124.3	123.1	121.7	120.5
23	132.5	132.0	131.6	131.2	130.8	130.3	129.9	129.5	128.2	126.9	125.6	124.2	123.0	121.7
23.25	133.7	133.2	132.8	132.4	132.0	131.5	131.1	130.7	129.4	128.1	126.8	125.5	124.2	122.8
23.5	134.9	134.4	134.0	133.6	133.2	132.8	132.4	132.0	130.6	129.3	128.0	126.7	125.4	124.0
23.75	136.1	135.7	135.3	134.9	134.4	134.0	133.6	133.2	131.9	130.5	129.2	127.9	126.6	125.2
24	137.3	136.9	136.5	136.1	135.7	135.3	134.9	134.4	133.1	131.8	130.4	129.1	127.7	126.4
24.25	138.5	138.1	137.7	137.3	136.9	136.5	136.1	135.7	134.4	133.0	131.6	130.3	129.0	127.6
24.5	139.7	139.3	138.9	138.5	138.1	137.7	137.3	136.9	135.6	134.2	132.9	131.5	130.1	128.8
24.75	140.9	140.5	140.1	139.8	139.3	138.9	138.6	138.2	136.8	135.4	134.1	132.7	131.4	130.0
25	142.1	141.8	141.3	141.0	140.6	140.2	139.8	139.4	138.0	136.7	135.3	133.9	132.5	131.2
25.25	143.3	143.0	142.6	142.2	141.8	141.4	141.0	140.7	139.3	137.9	136.5	135.1	133.7	132.4
25.5	144.6	144.2	143.8	143.4	143.0	142.7	142.2	141.9	140.5	139.1	137.7	136.4	134.9	133.5
25.75	145.7	145.4	145.0	144.6	144.2	143.9	143.5	143.1	141.7	140.3	138.9	137.5	136.1	134.8
26	147.0	146.6	146.2	145.8	145.5	145.1	144.7	144.4	143.0	141.6	140.2	138.8	137.4	135.9

147 L container (390 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI in. and temperature °F)

	Temperature °F (°C)													
LLI	0	10	20	30	40	50	60	70	80	90	100	110	120	130
in.	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.6)	(43.3)	(48.9)	(54.4)
7	67.0	66.2	65.4	64.6	63.8	63.0	62.2	61.4	61.0	60.6	60.2	59.9	59.5	59.1
7.25	68.4	67.5	66.7	65.9	65.1	64.3	63.5	62.6	62.2	61.8	61.4	61.1	60.6	60.2
7.5	69.7	68.9	68.0	67.2	66.4	65.5	64.7	63.9	63.5	63.1	62.6	62.2	61.8	61.4
7.75	71.0	70.2	69.3	68.5	67.6	66.8	65.9	65.1	64.6	64.2	63.8	63.4	63.0	62.6
8	72.3	71.5	70.6	69.8	68.9	68.0	67.2	66.3	65.9	65.5	65.0	64.6	64.1	63.7
8.25	73.7	72.8	71.9	71.0	70.2	69.3	68.4	67.5	67.1	66.6	66.2	65.8	65.3	64.9
8.5	75.0	74.1	73.3	72.3	71.4	70.5	69.6	68.8	68.3	67.9	67.4	67.0	66.5	66.0
8.75	76.4	75.4	74.5	73.6	72.7	71.8	70.9	70.0	69.5	69.0	68.6	68.1	67.7	67.2
9	77.7	76.7	75.8	74.9	74.0	73.1	72.1	71.2	70.7	70.3	69.8	69.3	68.9	68.4
9.25	79.0	78.1	77.2	76.2	75.3	74.3	73.3	72.4	71.9	71.4	71.0	70.5	70.0	69.5
9.5	80.4	79.4	78.4	77.5	76.5	75.6	74.6	73.7	73.2	72.7	72.2	71.7	71.2	70.7
9.75	81.7	80.7	79.7	78.8	77.8	76.8	75.8	74.8	74.3	73.8	73.3	72.8	72.3	71.9
10	83.1	82.1	81.1	80.1	79.1	78.1	77.1	76.1	75.6	75.1	74.6	74.0	73.5	73.0
10.25	84.4	83.4	82.4	81.3	80.3	79.3	78.3	77.3	76.8	76.3	75.8	75.3	74.7	74.2
10.5	85.7	84.7	83.6	82.6	81.6	80.6	79.6	78.5	78.0	77.5	76.9	76.4	75.9	75.3
10.75	87.0	86.0	85.0	83.9	82.9	81.8	80.8	79.7	79.2	78.7	78.2	77.6	77.1	76.5
11	88.4	87.3	86.3	85.2	84.1	83.1	82.1	81.0	80.4	79.9	79.3	78.8	78.2	77.7
11.25	89.7	88.6	87.6	86.5	85.4	84.4	83.3	82.2	81.6	81.1	80.5	80.0	79.4	78.8
11.5	91.0	89.9	88.9	87.8	86.7	85.6	84.5	83.4	82.9	82.3	81.7	81.1	80.6	80.0
11.75	92.4	91.3	90.2	89.1	88.0	86.9	85.8	84.6	84.1	83.5	82.9	82.3	81.7	81.1
12	93.7	92.6	91.5	90.4	89.2	88.1	87.0	85.9	85.3	84.7	84.1	83.5	82.9	82.3
12.25	95.0	93.9	92.8	91.6	90.5	89.4	88.2	87.1	86.5	85.9	85.3	84.7	84.1	83.5
12.5	96.4	95.3	94.1	92.9	91.8	90.6	89.5	88.3	87.7	87.1	86.5	85.9	85.3	84.6
12.75	97.7	96.6	95.4	94.2	93.0	91.9	90.7	89.5	89.0	88.3	87.7	87.0	86.5	85.8
13	99.1	97.9	96.7	95.5	94.3	93.1	91.9	90.8	90.1	89.5	88.9	88.2	87.6	87.0
13.25	100.4	99.2	98.0	96.8	95.6	94.4	93.2	92.0	91.4	90.7	90.1	89.4	88.8	88.1
13.5	101.7	100.5	99.3	98.1	96.9	95.7	94.4	93.2	92.6	91.9	91.3	90.6	89.9	89.3
13.75	103.1	101.8	100.6	99.4	98.2	96.9	95.7	94.4	93.8	93.1	92.4	91.8	91.1	90.4
14	104.4	103.1	101.9	100.7	99.4	98.2	96.9	95.7	95.0	94.3	93.7	93.0	92.3	91.6
14.25	105.7	104.5	103.2	101.9	100.7	99.4	98.2	96.9	96.2	95.5	94.8	94.2	93.5	92.8
14.5	107.0	105.8	104.5	103.2	102.0	100.7	99.4	98.1	97.4	96.7	96.0	95.3	94.6	93.9
14.75	108.4	107.1	105.8	104.5	103.2	101.9	100.7	99.3	98.7	97.9	97.2	96.5	95.8	95.1
15	109.7	108.4	107.1	105.8	104.5	103.2	101.9	100.6	99.8	99.2	98.4	97.7	97.0	96.3
15.25	111.0	109.7	108.4	107.1	105.8	104.4	103.1	101.8	101.1	100.3	99.6	98.9	98.2	97.4
15.5	112.4	111.0	109.7	108.4	107.0	105.7	104.4	103.0	102.3	101.6	100.8	100.1	99.3	98.6
15.75	113.7	112.4	111.0	109.7	108.3	107.0	105.6	104.2	103.5	102.7	102.0	101.2	100.5	99.7
16	115.1	113.7	112.3	111.0	109.6	108.2	106.8	105.5	104.7	104.0	103.2	102.4	101.7	100.9
16.25	116.4	115.0	113.6	112.2	110.9	109.5	108.1	106.7	105.9	105.1	104.4	103.6	102.8	102.1
16.5	117.8	116.3	114.9	113.5	112.1	110.7	109.3	107.9	107.1	106.4	105.6	104.8	104.0	103.2
16.75	119.1	117.7	116.2	114.8	113.4	112.0	110.5	109.1	108.4	107.5	106.8	106.0	105.2	104.4
17	120.4	119.0	117.5	116.1	114.7	113.2	111.8	110.4	109.5	108.8	108.0	107.2	106.4	105.6
17.25	121.7	120.3	118.8	117.4	115.9	114.5	113.0	111.6	110.8	110.0	109.1	108.4	107.5	106.7
17.5	123.1	121.6	120.2	118.7	117.2	115.8	114.3	112.8	112.0	111.2	110.4	109.5	108.7	107.9
17.75	124.4	122.9	121.4	120.0	118.5	117.0	115.5	114.0	113.2	112.4	111.5	110.7	109.9	109.0
18	125.7	124.2	122.7	121.2	119.8	118.3	116.8	115.3	114.4	113.6	112.7	111.9	111.0	110.2
18.25	127.1	125.6	124.1	122.5	121.0	119.5	118.0	116.5	115.6	114.8	113.9	113.1	112.2	111.4
18.5	128.4	126.9	125.4	123.8	122.3	120.7	119.3	117.7	116.8	116.0	115.1	114.3	113.4	112.5
18.75	129.7	128.2	126.6	125.1	123.6	122.0	120.5	118.9	118.1	117.2	116.3	115.4	114.6	113.7
19	131.1	129.5	128.0	126.4	124.8	123.3	121.7	120.2	119.3	118.4	117.5	116.6	115.8	114.9
19.25	132.4	130.8	129.3	127.7	126.1	124.5	123.0	121.4	120.5	119.6	118.7	117.8	116.9	116.0
19.5	133.8	132.2	130.5	129.0	127.4	125.8	124.2	122.6	121.7	120.8	119.9	119.0	118.1	117.2
19.75	135.1	133.5	131.9	130.3	128.6	127.1	125.4	123.8	122.9	122.0	121.1	120.2	119.3	118.3
20	136.4	134.8	133.2	131.5	129.9	128.3	126.7	125.1	124.1	123.2	122.3	121.3	120.4	119.5
20.25	137.8	136.1	134.5	132.8	131.2	129.5	127.9	126.3	125.3	124.4	123.5	122.5	121.6	120.7
20.5	139.1	137.4	135.8	134.1	132.5	130.8	129.1	127.5	126.6	125.6	124.6	123.7	122.8	121.8
20.75	140.4	138.8	137.1	135.4	133.7	132.0	130.4	128.7	127.8	126.8	125.9	124.9	124.0	123.0
21	141.8	140.1	138.4	136.7	135.0	133.3	131.6	130.0	129.0	128.0	127.1	126.1	125.1	124.2
21.25	143.1	141.4	139.7	138.0	136.3	134.6	132.9	131.2	130.2	129.2	128.2	127.3	126.3	125.3
21.5	144.4	142.7	141.0	139.3	137.5	135.8	134.1	132.4	131.4	130.4	129.5	128.5	127.5	126.5
21.75	145.7	144.0	142.3	140.6	138.8	137.1	135.4	133.6	132.6	131.6	130.6	129.6	128.6	127.6
22	147.1	145.3	143.6	141.8	140.1	138.3	136.6	134.9	133.8	132.8	131.8	130.8	129.8	128.8
22.25	148.4	146.6	144.9	143.1	141.3	139.6	137.8	136.1	135.0	134.0	133.0	132.0	131.0	130.0
22.5	149.8	148.0	146.2	144.4	142.6	140.8	139.1	137.3	136.3	135.2	134.2	133.2	132.1	131.1
22.75	151.1	149.3	147.5	145.7	143.9	142.1	140.3	138.5	137.5	136.4	135.4	134.4	133.3	132.3

147 L container (390 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI in. and temperature °F) (Continued)

	Temperature °F (°C)													
LLI	0	10	20	30	40	50	60	70	80	90	100	110	120	130
in.	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.6)	(43.3)	(48.9)	(54.4)
23	152.5	150.6	148.8	147.0	145.2	143.4	141.6	139.8	138.7	137.6	136.6	135.5	134.5	133.4
23.25	153.8	152.0	150.1	148.3	146.5	144.6	142.8	141.0	139.9	138.8	137.8	136.7	135.7	134.6
23.5	155.1	153.3	151.4	149.6	147.7	145.9	144.0	142.2	141.1	140.0	139.0	137.9	136.9	135.8
23.75	156.4	154.6	152.7	150.9	149.0	147.1	145.3	143.4	142.3	141.3	140.2	139.1	138.0	136.9
24	157.8	155.9	154.0	152.1	150.3	148.4	146.5	144.6	143.6	142.5	141.4	140.3	139.2	138.1
24.25	159.1	157.2	155.3	153.4	151.5	149.6	147.7	145.8	144.7	143.7	142.6	141.5	140.3	139.3
24.5	160.4	158.5	156.6	154.7	152.8	150.9	149.0	147.1	146.0	144.9	143.7	142.7	141.5	140.4
24.75	161.8	159.8	157.9	156.0	154.1	152.1	150.2	148.3	147.2	146.1	144.9	143.8	142.7	141.6
25	163.1	161.2	159.2	157.3	155.4	153.4	151.5	149.5	148.4	147.3	146.1	145.0	143.9	142.7
25.25	164.4	162.5	160.5	158.6	156.6	154.7	152.7	150.7	149.6	148.5	147.3	146.2	145.1	143.9
25.5	165.8	163.8	161.8	159.8	157.9	155.9	154.0	152.0	150.8	149.7	148.5	147.4	146.2	145.1
25.75	167.1	165.1	163.1	161.2	159.2	157.2	155.2	153.2	152.0	150.9	149.7	148.6	147.4	146.2
26	168.5	166.4	164.4	162.4	160.4	158.4	156.4	154.4	153.3	152.1	150.9	149.7	148.6	147.4
26.25	169.8	167.7	165.7	163.7	161.7	159.7	157.7	155.6	154.5	153.3	152.1	150.9	149.7	148.6
26.5	171.1	169.1	167.1	165.0	163.0	160.9	158.9	156.9	155.7	154.5	153.3	152.1	150.9	149.7
26.75	172.5	170.4	168.3	166.3	164.2	162.2	160.2	158.1	156.9	155.7	154.5	153.3	152.1	150.9
27	173.8	171.7	169.6	167.6	165.5	163.4	161.4	159.3	158.1	156.9	155.7	154.5	153.3	152.0
27.25	175.1	173.0	171.0	168.9	166.8	164.7	162.6	160.5	159.3	158.1	156.9	155.6	154.5	153.2
27.5	176.5	174.4	172.3	170.1	168.1	166.0	163.9	161.8	160.5	159.3	158.1	156.9	155.6	154.4
27.75	177.8	175.7	173.5	171.5	169.3	167.2	165.1	163.0	161.8	160.5	159.3	158.0	156.8	155.5
28	179.1	177.0	174.9	172.7	170.6	168.5	166.3	164.2	163.0	161.7	160.4	159.2	157.9	156.7
28.25	180.4	178.3	176.2	174.0	171.9	169.7	167.6	165.4	164.2	162.9	161.7	160.4	159.1	157.9
28.5	181.8	179.6	177.4	175.3	173.1	171.0	168.8	166.7	165.4	164.1	162.8	161.6	160.3	159.0
28.75	183.1	180.9	178.8	176.6	174.4	172.2	170.1	167.9	166.6	165.3	164.0	162.8	161.5	160.2
29	184.5	182.3	180.1	177.9	175.7	173.5	171.3	169.1	167.8	166.5	165.2	163.9	162.6	161.3
29.25	185.8	183.6	181.4	179.2	176.9	174.8	172.5	170.3	169.0	167.7	166.4	165.1	163.8	162.5
29.5	187.1	184.9	182.7	180.4	178.2	176.0	173.8	171.6	170.2	168.9	167.6	166.3	165.0	163.7
29.75	188.5	186.2	184.0	181.8	179.5	177.3	175.0	172.8	171.5	170.1	168.8	167.5	166.2	164.8
30	189.8	187.6	185.3	183.0	180.8	178.5	176.3	174.0	172.7	171.3	170.0	168.6	167.3	166.0
30.25	191.1	188.9	186.6	184.3	182.0	179.8	177.5	175.2	173.9	172.5	171.2	169.8	168.5	167.2
30.5	192.5	190.2	187.9	185.6	183.3	181.0	178.7	176.5	175.1	173.7	172.4	171.0	169.7	168.3
30.75	193.8	191.5	189.2	186.9	184.6	182.3	180.0	177.7	176.3	175.0	173.6	172.2	170.8	169.5
31	195.1	192.8	190.5	188.2	185.8	183.5	181.2	178.9	177.5	176.1	174.8	173.4	172.0	170.6
31.25	196.5	194.1	191.8	189.5	187.1	184.8	182.4	180.1	178.7	177.4	176.0	174.6	173.2	171.8
31.5	197.8	195.5	193.1	190.7	188.4	186.1	183.7	181.3	179.9	178.5	177.2	175.8	174.4	173.0
31.75	199.1	196.8	194.4	192.1	189.7	187.3	184.9	182.6	181.2	179.8	178.4	176.9	175.5	174.1
32	200.5	198.1	195.7	193.3	191.0	188.6	186.2	183.8	182.4	180.9	179.5	178.1	176.7	175.3
32.25	201.8	199.4	197.0	194.6	192.2	189.8	187.4	185.0	183.6	182.2	180.7	179.3	177.9	176.5
32.5	203.1	200.7	198.3	195.9	193.5	191.1	188.7	186.2	184.8	183.3	181.9	180.5	179.0	177.6
32.75	204.5	202.0	199.6	197.2	194.8	192.3	189.9	187.5	186.0	184.6	183.1	181.7	180.2	178.8
33	205.8	203.3	200.9	198.5	196.0	193.6	191.1	188.7	187.2	185.8	184.3	182.8	181.4	179.9
33.25	207.2	204.7	202.2	199.8	197.3	194.8	192.4	189.9	188.4	187.0	185.5	184.0	182.6	181.1
33.5	208.5	206.0	203.5	201.0	198.6	196.1	193.6	191.1	189.7	188.2	186.7	185.2	183.8	182.3
33.75	209.8	207.3	204.8	202.4	199.9	197.4	194.9	192.4	190.9	189.4	187.9	186.4	184.9	183.4
34	211.2	208.7	206.1	203.6	201.1	198.6	196.1	193.6	192.1	190.6	189.1	187.6	186.1	184.6

180 L container (450 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI in. and temperature °F)

	Temperature °F (°C)													
LLI	0	10	20	30	40	50	60	70	80	90	100	110	120	130
in.	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.6)	(43.3)	(48.9)	(54.4)
10	81.3	80.5	79.7	79.0	78.2	77.4	76.6	75.8	75.0	74.1	73.2	72.3	71.4	70.5
10.25	82.6	81.8	81.1	80.3	79.5	78.7	77.9	77.1	76.3	75.3	74.4	73.5	72.6	71.7
10.5	84.0	83.2	82.4	81.6	80.8	80.0	79.2	78.4	77.5	76.6	75.7	74.8	73.8	72.9
10.75	85.3	84.5	83.7	82.9	82.1	81.3	80.5	79.7	78.7	77.8	76.9	76.0	75.1	74.1
11	86.6	85.8	85.1	84.2	83.4	82.6	81.8	81.0	80.0	79.1	78.2	77.2	76.3	75.3
11.25	88.0	87.2	86.4	85.5	84.7	83.9	83.1	82.2	81.3	80.3	79.4	78.4	77.5	76.5
11.5	89.4	88.5	87.7	86.9	86.0	85.2	84.4	83.5	82.6	81.6	80.7	79.7	78.7	77.7
11.75	90.7	89.9	89.0	88.2	87.3	86.5	85.6	84.8	83.8	82.9	81.9	80.9	79.9	78.9
12	92.0	91.2	90.3	89.5	88.6	87.8	86.9	86.1	85.1	84.1	83.1	82.1	81.1	80.2
12.25	93.4	92.5	91.7	90.8	89.9	89.1	88.2	87.4	86.4	85.4	84.4	83.4	82.4	81.4
12.5	94.7	93.8	93.0	92.1	91.3	90.4	89.5	88.6	87.6	86.6	85.6	84.6	83.6	82.6
12.75	96.1	95.2	94.3	93.4	92.5	91.7	90.8	89.9	88.9	87.9	86.9	85.8	84.8	83.8
13	97.4	96.5	95.6	94.8	93.8	93.0	92.1	91.2	90.2	89.1	88.1	87.0	86.0	85.0
13.25	98.7	97.8	97.0	96.1	95.2	94.3	93.4	92.5	91.4	90.4	89.3	88.3	87.2	86.2
13.5	100.1	99.2	98.3	97.4	96.5	95.6	94.7	93.8	92.7	91.6	90.6	89.5	88.5	87.4
13.75	101.4	100.5	99.6	98.7	97.8	96.8	95.9	95.0	93.9	92.9	91.8	90.8	89.7	88.6
14	102.8	101.9	100.9	100.0	99.1	98.2	97.3	96.3	95.2	94.1	93.1	92.0	90.9	89.8
14.25	104.1	103.2	102.2	101.3	100.4	99.5	98.5	97.6	96.5	95.4	94.3	93.2	92.1	91.0
14.5	105.5	104.5	103.6	102.6	101.7	100.7	99.8	98.9	97.8	96.7	95.5	94.4	93.4	92.2
14.75	106.8	105.9	104.9	104.0	103.0	102.1	101.1	100.2	99.0	97.9	96.8	95.7	94.5	93.4
15	108.2	107.2	106.2	105.3	104.3	103.3	102.4	101.4	100.3	99.2	98.0	96.9	95.8	94.6
15.25	109.5	108.5	107.5	106.6	105.6	104.6	103.6	102.7	101.6	100.4	99.3	98.1	97.0	95.8
15.5	110.9	109.9	108.9	107.9	106.9	106.0	105.0	104.0	102.8	101.7	100.5	99.3	98.2	97.1
15.75	112.2	111.2	110.2	109.2	108.2	107.2	106.2	105.2	104.1	102.9	101.7	100.6	99.4	98.2
16	113.5	112.5	111.5	110.5	109.5	108.5	107.5	106.6	105.4	104.2	103.0	101.8	100.7	99.5
16.25	114.9	113.9	112.9	111.9	110.9	109.8	108.8	107.8	106.6	105.4	104.2	103.1	101.9	100.7
16.5	116.2	115.2	114.2	113.2	112.1	111.1	110.1	109.1	107.9	106.7	105.5	104.3	103.1	101.9
16.75	117.6	116.5	115.5	114.5	113.4	112.4	111.4	110.4	109.1	108.0	106.7	105.5	104.3	103.1
17	118.9	117.9	116.8	115.8	114.8	113.7	112.7	111.6	110.4	109.2	108.0	106.7	105.5	104.3
17.25	120.2	119.2	118.2	117.1	116.1	115.0	114.0	112.9	111.7	110.5	109.2	108.0	106.7	105.5
17.5	121.6	120.6	119.5	118.4	117.4	116.3	115.3	114.2	112.9	111.7	110.5	109.2	108.0	106.7
17.75	123.0	121.9	120.8	119.8	118.7	117.6	116.5	115.5	114.2	112.9	111.7	110.5	109.2	107.9
18	124.3	123.2	122.2	121.1	120.0	118.9	117.8	116.8	115.5	114.2	112.9	111.7	110.4	109.1
18.25	125.6	124.6	123.5	122.4	121.3	120.2	119.1	118.0	116.8	115.5	114.2	112.9	111.6	110.3
18.5	127.0	125.9	124.8	123.7	122.6	121.5	120.4	119.3	118.0	116.7	115.4	114.1	112.8	111.5
18.75	128.3	127.2	126.1	125.0	123.9	122.8	121.7	120.6	119.3	118.0	116.7	115.4	114.0	112.7
19	129.7	128.6	127.5	126.3	125.2	124.1	123.0	121.9	120.6	119.2	117.9	116.6	115.3	113.9
19.25	131.0	129.9	128.8	127.6	126.5	125.4	124.3	123.2	121.8	120.5	119.2	117.8	116.5	115.2
19.5	132.4	131.2	130.1	129.0	127.8	126.7	125.6	124.4	123.1	121.7	120.4	119.1	117.7	116.3
19.75	133.7	132.5	131.4	130.3	129.1	128.0	126.8	125.7	124.3	123.0	121.7	120.3	118.9	117.6
20	135.0	133.9	132.7	131.6	130.5	129.3	128.1	127.0	125.6	124.2	122.9	121.5	120.2	118.8
20.25	136.4	135.2	134.1	132.9	131.7	130.6	129.4	128.3	126.9	125.5	124.1	122.7	121.3	120.0
20.5	137.8	136.6	135.4	134.2	133.0	131.9	130.7	129.5	128.1	126.7	125.4	124.0	122.6	121.2
20.75	139.1	137.9	136.7	135.5	134.4	133.2	132.0	130.8	129.4	128.0	126.6	125.2	123.8	122.4
21	140.4	139.3	138.0	136.9	135.7	134.5	133.3	132.1	130.7	129.3	127.9	126.4	125.0	123.6
21.25	141.8	140.6	139.4	138.2	137.0	135.8	134.6	133.4	132.0	130.5	129.1	127.6	126.2	124.8
21.5	143.1	141.9	140.7	139.5	138.3	137.1	135.9	134.6	133.2	131.8	130.3	128.9	127.5	126.0
21.75	144.5	143.2	142.0	140.8	139.6	138.3	137.2	135.9	134.5	133.0	131.6	130.1	128.7	127.2
22	145.8	144.6	143.3	142.1	140.9	139.7	138.4	137.2	135.8	134.3	132.8	131.4	129.9	128.4
22.25	147.1	145.9	144.7	143.4	142.2	141.0	139.7	138.5	137.0	135.5	134.0	132.6	131.1	129.6
22.5	148.5	147.2	146.0	144.7	143.5	142.2	141.0	139.8	138.3	136.8	135.3	133.8	132.3	130.9
22.75	149.8	148.6	147.3	146.1	144.8	143.6	142.3	141.0	139.5	138.0	136.5	135.0	133.5	132.0
23	151.2	149.9	148.6	147.4	146.1	144.8	143.6	142.3	140.8	139.3	137.8	136.3	134.8	133.3
23.25	152.5	151.2	150.0	148.7	147.4	146.1	144.9	143.6	142.1	140.6	139.0	137.5	136.0	134.4
23.5	153.9	152.6	151.3	150.0	148.7	147.5	146.1	144.9	143.3	141.8	140.3	138.8	137.2	135.7
23.75	155.2	153.9	152.6	151.3	150.1	148.7	147.5	146.1	144.6	143.1	141.5	140.0	138.4	136.9
24	156.6	155.3	154.0	152.6	151.4	150.1	148.7	147.4	145.9	144.3	142.7	141.2	139.6	138.1
24.25	157.9	156.6	155.3	154.0	152.6	151.3	150.0	148.7	147.1	145.6	144.0	142.4	140.8	139.3
24.5	159.3	157.9	156.6	155.3	154.0	152.6	151.3	150.0	148.4	146.8	145.2	143.7	142.1	140.5
24.75	160.6	159.3	157.9	156.6	155.3	154.0	152.6	151.3	149.7	148.1	146.5	144.9	143.3	141.7
25	161.9	160.6	159.3	157.9	156.6	155.2	153.9	152.5	151.0	149.3	147.7	146.1	144.5	142.9
25.25	163.3	161.9	160.6	159.2	157.9	156.5	155.2	153.8	152.2	150.6	149.0	147.3	145.7	144.1
25.5	164.6	163.3	161.9	160.5	159.2	157.8	156.4	155.1	153.5	151.8	150.2	148.6	147.0	145.3
25.75	166.0	164.6	163.3	161.8	160.5	159.1	157.8	156.4	154.7	153.1	151.5	149.8	148.2	146.5

180 L container (450 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI in. and temperature °F) (Continued)

	Temperature °F (°C)													
LLI	0	10	20	30	40	50	60	70	80	90	100	110	120	130
in.	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.6)	(43.3)	(48.9)	(54.4)
26	167.3	165.9	164.6	163.2	161.8	160.4	159.0	157.7	156.0	154.4	152.7	151.0	149.4	147.7
26.25	168.6	167.3	165.9	164.5	163.1	161.7	160.3	158.9	157.3	155.6	154.0	152.3	150.6	149.0
26.5	170.0	168.6	167.2	165.8	164.4	163.0	161.6	160.2	158.5	156.9	155.2	153.5	151.8	150.1
26.75	171.4	169.9	168.5	167.1	165.7	164.3	162.9	161.5	159.8	158.1	156.4	154.7	153.0	151.4
27	172.7	171.3	169.9	168.4	167.0	165.6	164.2	162.8	161.1	159.3	157.7	155.9	154.3	152.5
27.25	174.0	172.6	171.2	169.7	168.3	166.9	165.5	164.1	162.3	160.6	158.9	157.2	155.5	153.8
27.5	175.4	174.0	172.5	171.1	169.6	168.2	166.7	165.3	163.6	161.9	160.2	158.4	156.7	155.0
27.75	176.7	175.3	173.8	172.4	171.0	169.5	168.1	166.6	164.9	163.1	161.4	159.7	157.9	156.2
28	178.1	176.6	175.2	173.7	172.2	170.8	169.3	167.9	166.2	164.4	162.6	160.9	159.1	157.4
28.25	179.4	177.9	176.5	175.0	173.5	172.1	170.6	169.1	167.4	165.7	163.9	162.1	160.3	158.6
28.5	180.8	179.3	177.8	176.3	174.9	173.4	171.9	170.4	168.6	166.9	165.1	163.3	161.6	159.8
28.75	182.1	180.6	179.1	177.6	176.2	174.7	173.2	171.7	169.9	168.1	166.4	164.6	162.8	161.0
29	183.4	181.9	180.4	179.0	177.5	176.0	174.5	173.0	171.2	169.4	167.6	165.8	164.0	162.2
29.25	184.8	183.3	181.8	180.3	178.8	177.3	175.8	174.3	172.5	170.6	168.8	167.1	165.2	163.4
29.5	186.2	184.6	183.1	181.6	180.1	178.6	177.1	175.5	173.7	171.9	170.1	168.3	166.5	164.6
29.75	187.5	186.0	184.4	182.9	181.4	179.9	178.4	176.8	175.0	173.2	171.3	169.5	167.7	165.8
30	188.8	187.3	185.7	184.3	182.7	181.2	179.6	178.1	176.3	174.4	172.6	170.7	168.9	167.1
30.25	190.1	188.6	187.1	185.6	184.0	182.5	180.9	179.4	177.5	175.7	173.8	172.0	170.1	168.2
30.5	191.5	190.0	188.4	186.9	185.3	183.8	182.2	180.7	178.8	176.9	175.0	173.2	171.3	169.5
30.75	192.9	191.3	189.7	188.2	186.6	185.1	183.5	181.9	180.1	178.2	176.3	174.4	172.5	170.6
31	194.2	192.6	191.1	189.5	187.9	186.3	184.8	183.2	181.3	179.4	177.5	175.6	173.8	171.9
31.25	195.5	194.0	192.4	190.8	189.2	187.7	186.1	184.5	182.6	180.7	178.8	176.9	175.0	173.1
31.5	196.9	195.3	193.7	192.1	190.6	189.0	187.4	185.8	183.8	181.9	180.0	178.1	176.2	174.3
31.75	198.2	196.6	195.0	193.5	191.8	190.2	188.7	187.1	185.1	183.2	181.3	179.4	177.4	175.5
32	199.6	198.0	196.4	194.8	193.1	191.6	189.9	188.3	186.4	184.4	182.5	180.6	178.6	176.7
32.25	200.9	199.3	197.7	196.1	194.5	192.8	191.2	189.6	187.7	185.7	183.8	181.8	179.9	177.9
32.5	202.3	200.6	199.0	197.4	195.8	194.1	192.5	190.9	188.9	187.0	185.0	183.0	181.1	179.1
32.75	203.6	202.0	200.4	198.7	197.1	195.5	193.8	192.1	190.2	188.2	186.2	184.3	182.3	180.3
33	204.9	203.3	201.7	200.0	198.4	196.7	195.1	193.5	191.5	189.5	187.5	185.5	183.5	181.5
33.25	206.3	204.7	203.0	201.4	199.7	198.0	196.4	194.7	192.7	190.7	188.7	186.7	184.8	182.8
33.5	207.7	206.0	204.3	202.7	201.0	199.3	197.7	196.0	194.0	192.0	190.0	188.0	185.9	183.9
33.75	209.0	207.3	205.7	204.0	202.3	200.6	198.9	197.3	195.3	193.2	191.2	189.2	187.2	185.2
34	210.3	208.7	207.0	205.3	203.6	201.9	200.2	198.5	196.5	194.5	192.5	190.4	188.4	186.3
34.25	211.7	210.0	208.3	206.6	204.9	203.2	201.5	199.9	197.8	195.7	193.7	191.6	189.6	187.6
34.5	213.0	211.3	209.6	207.9	206.2	204.5	202.8	201.1	199.0	197.0	195.0	192.9	190.8	188.8
34.75	214.4	212.6	210.9	209.2	207.5	205.8	204.1	202.4	200.3	198.3	196.2	194.1	192.1	190.0
35	215.7	214.0	212.3	210.6	208.8	207.1	205.4	203.7	201.6	199.5	197.4	195.4	193.3	191.2
35.25	217.0	215.3	213.6	211.9	210.2	208.4	206.7	204.9	202.8	200.8	198.7	196.6	194.5	192.4
35.5	218.4	216.6	214.9	213.2	211.4	209.7	208.0	206.2	204.1	202.0	199.9	197.8	195.7	193.6
35.75	219.7	218.0	216.2	214.5	212.7	211.0	209.2	207.5	205.4	203.3	201.2	199.0	196.9	194.8
36	221.1	219.3	217.6	215.8	214.1	212.3	210.6	208.8	206.7	204.5	202.4	200.3	198.1	196.0
36.25	222.4	220.7	218.9	217.1	215.4	213.6	211.8	210.1	207.9	205.8	203.6	201.5	199.4	197.2
36.5	223.8	222.0	220.2	218.5	216.7	214.9	213.1	211.3	209.2	207.0	204.9	202.7	200.6	198.4
36.75	225.1	223.4	221.5	219.8	218.0	216.2	214.4	212.6	210.5	208.3	206.1	203.9	201.8	199.6
37	226.5	224.7	222.9	221.1	219.3	217.5	215.7	213.9	211.7	209.6	207.4	205.2	203.0	200.9
37.25	227.8	226.0	224.2	222.4	220.6	218.8	217.0	215.2	213.0	210.8	208.6	206.4	204.2	202.0
37.5	229.2	227.3	225.5	223.7	221.9	220.1	218.3	216.5	214.2	212.1	209.8	207.7	205.4	203.3
37.75	230.5	228.7	226.8	225.0	223.2	221.4	219.5	217.7	215.5	213.3	211.1	208.9	206.7	204.4
38	231.8	230.0	228.2	226.3	224.5	222.7	220.9	219.0	216.8	214.6	212.3	210.1	207.9	205.7
38.25	233.2	231.3	229.5	227.7	225.8	224.0	222.1	220.3	218.0	215.8	213.6	211.3	209.1	206.9
38.5	234.5	232.7	230.8	229.0	227.1	225.3	223.4	221.6	219.3	217.0	214.8	212.6	210.3	208.1
38.75	235.9	234.0	232.2	230.3	228.4	226.6	224.7	222.9	220.6	218.3	216.0	213.8	211.6	209.3
39	237.2	235.4	233.5	231.6	229.7	227.8	226.0	224.1	221.9	219.6	217.3	215.1	212.8	210.5
39.25	238.5	236.7	234.8	232.9	231.1	229.2	227.3	225.4	223.1	220.8	218.5	216.3	214.0	211.7
39.5	239.9	238.0	236.1	234.2	232.3	230.5	228.6	226.7	224.4	222.1	219.8	217.5	215.2	212.9
39.75	241.3	239.4	237.5	235.6	233.6	231.7	229.8	227.9	225.7	223.4	221.0	218.7	216.4	214.1
40	242.6	240.7	238.8	236.9	235.0	233.1	231.2	229.2	226.9	224.6	222.3	220.0	217.6	215.3
40.25	243.9	242.0	240.1	238.2	236.3	234.3	232.4	230.5	228.2	225.8	223.5	221.2	218.9	216.5
40.5	245.3	243.4	241.5	239.5	237.6	235.6	233.7	231.8	229.4	227.1	224.8	222.4	220.1	217.7
40.75	246.6	244.7	242.8	240.8	238.9	237.0	235.0	233.1	230.7	228.3	226.0	223.6	221.3	219.0

180 L container (450 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI in. and temperature °F) (Continued)

	Temperature °F (°C)													
LLI in.	0 (-17.8)	10 (-12.2)	20 (-6.7)	30 (-1.1)	40 (4.4)	50 (10)	60 (15.6)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.6)	110 (43.3)	120 (48.9)	130 (54.4)
41	248.0	246.0	244.1	242.1	240.2	238.2	236.3	234.3	232.0	229.6	227.3	224.9	222.5	220.1
41.25	249.3	247.3	245.4	243.4	241.5	239.5	237.6	235.6	233.2	230.9	228.5	226.1	223.7	221.4
41.5	250.7	248.7	246.7	244.8	242.8	240.8	238.9	236.9	234.5	232.1	229.7	227.3	224.9	222.5
41.75	252.0	250.0	248.1	246.1	244.1	242.1	240.1	238.2	235.8	233.4	231.0	228.6	226.2	223.8
42	253.3	251.4	249.4	247.4	245.4	243.4	241.5	239.5	237.1	234.6	232.2	229.8	227.4	225.0

343 L container (850 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI in. and temperature °F)

	Temperature °F (°C)													
LLI	0	10	20	30	40	50	60	70	80	90	100	110	120	130
in.	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.6)	(43.3)	(48.9)	(54.4)
5	164.2	162.7	161.2	159.7	158.1	156.6	155.1	153.6	152.2	150.8	149.5	148.1	146.7	145.4
5.25	167.2	165.6	164.1	162.5	161.0	159.4	157.9	156.4	154.9	153.5	152.1	150.8	149.4	148.0
5.5	170.1	168.5	167.0	165.4	163.8	162.3	160.7	159.1	157.7	156.3	154.8	153.4	152.0	150.5
5.75	173.0	171.5	169.8	168.2	166.7	165.0	163.4	161.8	160.4	158.9	157.5	156.1	154.6	153.2
6	176.0	174.4	172.7	171.1	169.5	167.8	166.2	164.6	163.1	161.7	160.2	158.7	157.3	155.8
6.25	178.9	177.3	175.6	174.0	172.3	170.6	169.0	167.3	165.8	164.3	162.8	161.4	159.9	158.4
6.5	181.8	180.2	178.5	176.8	175.1	173.5	171.8	170.1	168.6	167.1	165.6	164.0	162.5	161.0
6.75	184.8	183.1	181.4	179.7	177.9	176.3	174.5	172.9	171.3	169.8	168.2	166.7	165.1	163.6
7	187.7	186.0	184.3	182.5	180.8	179.1	177.4	175.6	174.0	172.5	170.9	169.3	167.7	166.2
7.25	190.6	188.9	187.2	185.4	183.6	181.9	180.1	178.4	176.8	175.2	173.6	172.0	170.4	168.8
7.5	193.6	191.8	190.0	188.2	186.5	184.7	182.9	181.1	179.5	177.9	176.3	174.6	173.0	171.4
7.75	196.5	194.7	192.9	191.1	189.3	187.5	185.7	183.8	182.2	180.6	178.9	177.3	175.6	174.0
8	199.5	197.6	195.8	194.0	192.1	190.3	188.5	186.6	184.9	183.3	181.6	179.9	178.3	176.6
8.25	202.4	200.5	198.7	196.8	195.0	193.1	191.2	189.4	187.7	186.0	184.3	182.6	180.9	179.2
8.5	205.3	203.4	201.6	199.7	197.8	195.9	194.0	192.1	190.4	188.7	187.0	185.3	183.5	181.8
8.75	208.3	206.4	204.4	202.5	200.6	198.7	196.8	194.9	193.1	191.4	189.7	187.9	186.2	184.4
9	211.2	209.3	207.3	205.4	203.4	201.5	199.6	197.6	195.9	194.1	192.3	190.6	188.8	187.0
9.25	214.1	212.2	210.2	208.2	206.3	204.3	202.4	200.4	198.6	196.8	195.0	193.2	191.4	189.6
9.5	217.1	215.1	213.1	211.1	209.1	207.1	205.1	203.1	201.3	199.5	197.7	195.9	194.1	192.2
9.75	220.0	218.0	216.0	214.0	212.0	209.9	207.9	205.9	204.0	202.2	200.4	198.5	196.7	194.8
10	223.0	220.9	218.9	216.8	214.8	212.7	210.7	208.7	206.8	204.9	203.0	201.2	199.3	197.5
10.25	225.9	223.9	221.8	219.7	217.6	215.6	213.5	211.4	209.5	207.6	205.7	203.8	201.9	200.0
10.5	228.8	226.8	224.6	222.5	220.4	218.4	216.2	214.1	212.2	210.3	208.4	206.5	204.6	202.7
10.75	231.8	229.7	227.5	225.4	223.3	221.1	219.0	216.9	215.0	213.0	211.1	209.1	207.2	205.3
11	234.7	232.6	230.4	228.3	226.1	223.9	221.8	219.6	217.7	215.7	213.7	211.8	209.8	207.8
11.25	237.6	235.5	233.3	231.1	228.9	226.8	224.6	222.4	220.4	218.4	216.4	214.4	212.5	210.5
11.5	240.6	238.4	236.2	234.0	231.8	229.6	227.3	225.2	223.1	221.1	219.1	217.1	215.1	213.1
11.75	243.5	241.3	239.0	236.8	234.6	232.4	230.2	227.9	225.8	223.8	221.8	219.7	217.7	215.7
12	246.5	244.2	242.0	239.7	237.4	235.2	232.9	230.7	228.6	226.5	224.5	222.4	220.3	218.3
12.25	249.4	247.1	244.9	242.5	240.3	238.0	235.7	233.4	231.3	229.2	227.2	225.0	222.9	220.9
12.5	252.3	250.0	247.7	245.4	243.1	240.8	238.5	236.1	234.1	231.9	229.8	227.7	225.6	223.5
12.75	255.3	252.9	250.6	248.3	245.9	243.6	241.3	238.9	236.8	234.6	232.5	230.3	228.2	226.1
13	258.2	255.9	253.5	251.1	248.8	246.4	244.0	241.7	239.5	237.3	235.2	233.0	230.8	228.7
13.25	261.1	258.8	256.4	254.0	251.6	249.2	246.8	244.4	242.2	240.0	237.9	235.6	233.5	231.3
13.5	264.1	261.7	259.3	256.8	254.4	252.0	249.6	247.2	244.9	242.8	240.5	238.3	236.1	233.9
13.75	267.0	264.6	262.1	259.7	257.2	254.8	252.4	249.9	247.7	245.4	243.2	241.0	238.7	236.5
14	270.0	267.5	265.0	262.5	260.1	257.6	255.2	252.7	250.4	248.2	245.9	243.6	241.4	239.1
14.25	272.9	270.4	267.9	265.4	262.9	260.4	257.9	255.4	253.2	250.8	248.6	246.3	244.0	241.7
14.5	275.8	273.3	270.8	268.3	265.8	263.2	260.7	258.2	255.9	253.6	251.2	248.9	246.6	244.3
14.75	278.8	276.2	273.7	271.1	268.6	266.0	263.5	261.0	258.6	256.3	253.9	251.6	249.3	246.9
15	281.7	279.1	276.6	274.0	271.4	268.8	266.3	263.7	261.3	259.0	256.6	254.2	251.9	249.5
15.25	284.6	282.0	279.5	276.8	274.2	271.7	269.0	266.4	264.0	261.7	259.3	256.9	254.5	252.1
15.5	287.6	285.0	282.3	279.7	277.1	274.5	271.8	269.2	266.8	264.4	262.0	259.5	257.1	254.7
15.75	290.5	287.9	285.2	282.5	279.9	277.2	274.6	271.9	269.5	267.1	264.6	262.2	259.8	257.3
16	293.5	290.8	288.1	285.4	282.7	280.1	277.4	274.7	272.3	269.8	267.3	264.9	262.4	259.9
16.25	296.4	293.7	291.0	288.3	285.6	282.9	280.1	277.5	275.0	272.5	270.0	267.5	265.0	262.5
16.5	299.3	296.6	293.9	291.1	288.4	285.7	283.0	280.2	277.7	275.2	272.7	270.2	267.7	265.1
16.75	302.3	299.5	296.7	294.0	291.3	288.5	285.7	283.0	280.4	277.9	275.3	272.8	270.3	267.8
17	305.2	302.4	299.6	296.8	294.1	291.3	288.5	285.7	283.1	280.6	278.0	275.5	272.9	270.3
17.25	308.1	305.3	302.5	299.7	296.9	294.1	291.3	288.4	285.9	283.3	280.7	278.1	275.5	272.9
17.5	311.1	308.3	305.4	302.6	299.7	296.9	294.1	291.2	288.6	286.0	283.4	280.8	278.1	275.6
17.75	314.0	311.2	308.3	305.5	302.6	299.7	296.8	294.0	291.3	288.7	286.1	283.4	280.8	278.1
18	317.0	314.1	311.2	308.3	305.4	302.5	299.6	296.7	294.1	291.4	288.8	286.1	283.4	280.8
18.25	319.9	317.0	314.1	311.2	308.2	305.3	302.4	299.5	296.8	294.1	291.4	288.7	286.0	283.4
18.5	322.8	319.9	316.9	314.0	311.1	308.1	305.2	302.2	299.5	296.8	294.1	291.4	288.7	285.9
18.75	325.8	322.8	319.8	316.9	313.9	310.9	307.9	305.0	302.2	299.5	296.8	294.0	291.3	288.6
19	328.7	325.7	322.7	319.7	316.7	313.7	310.7	307.7	305.0	302.2	299.5	296.7	293.9	291.2
19.25	331.7	328.6	325.6	322.6	319.6	316.5	313.5	310.5	307.7	304.9	302.1	299.3	296.6	293.8
19.5	334.6	331.5	328.5	325.5	322.4	319.3	316.3	313.3	310.4	307.6	304.8	302.0	299.2	296.4
19.75	337.5	334.4	331.4	328.3	325.2	322.1	319.1	316.0	313.2	310.3	307.5	304.6	301.8	299.0
20	340.5	337.3	334.3	331.2	328.0	325.0	321.8	318.7	315.9	313.0	310.2	307.3	304.5	301.6
20.25	343.4	340.3	337.2	334.0	330.9	327.8	324.6	321.5	318.6	315.8	312.8	309.9	307.1	304.2
20.5	346.3	343.2	340.0	336.9	333.7	330.5	327.4	324.2	321.3	318.4	315.5	312.6	309.7	306.8
20.75	349.3	346.1	342.9	339.7	336.5	333.4	330.2	327.0	324.1	321.1	318.2	315.3	312.3	309.4

343 L container (850 lb tank) – Weight (kg) of FK-5-1-12 agent (per LLI in. and temperature °F) (Continued)

	Temperature °F (°C)													
LLI in.	0 (-17.8)	10 (-12.2)	20 (-6.7)	30 (-1.1)	40 (4.4)	50 (10)	60 (15.6)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.6)	110 (43.3)	120 (48.9)	130 (54.4)
21	352.2	349.0	345.8	342.6	339.4	336.2	332.9	329.8	326.8	323.8	320.9	317.9	315.0	312.0
21.25	355.2	351.9	348.7	345.5	342.2	339.0	335.8	332.5	329.5	326.5	323.6	320.6	317.6	314.6
21.5	358.1	354.8	351.6	348.3	345.1	341.8	338.5	335.3	332.3	329.3	326.2	323.2	320.2	317.2
21.75	361.0	357.8	354.4	351.2	347.9	344.6	341.3	338.0	335.0	331.9	328.9	325.9	322.9	319.8
22	364.0	360.7	357.3	354.0	350.7	347.4	344.1	340.7	337.7	334.7	331.6	328.5	325.5	322.4
22.25	366.9	363.6	360.2	356.9	353.5	350.2	346.9	343.5	340.4	337.3	334.3	331.2	328.1	325.0
22.5	369.8	366.5	363.1	359.8	356.3	353.0	349.6	346.3	343.1	340.1	336.9	333.8	330.7	327.6
22.75	372.8	369.4	366.0	362.6	359.2	355.8	352.4	349.0	345.9	342.7	339.6	336.5	333.4	330.2
23	375.7	372.3	368.9	365.5	362.0	358.6	355.2	351.8	348.6	345.5	342.3	339.2	336.0	332.9
23.25	378.7	375.2	371.8	368.3	364.9	361.4	358.0	354.5	351.4	348.2	345.0	341.8	338.6	335.4
23.5	381.6	378.1	374.6	371.2	367.7	364.2	360.7	357.3	354.1	350.9	347.7	344.5	341.2	338.1
23.75	384.5	381.0	377.5	374.0	370.5	367.1	363.5	360.0	356.8	353.6	350.4	347.1	343.9	340.7
24	387.5	383.9	380.4	376.9	373.4	369.8	366.3	362.8	359.5	356.3	353.0	349.8	346.5	343.2
24.25	390.4	386.8	383.3	379.8	376.2	372.6	369.1	365.6	362.2	359.0	355.7	352.4	349.1	345.9
24.5	393.3	389.8	386.2	382.6	379.0	375.4	371.9	368.3	365.0	361.7	358.4	355.1	351.8	348.5
24.75	396.3	392.7	389.1	385.5	381.8	378.3	374.6	371.0	367.7	364.4	361.1	357.7	354.4	351.1
25	399.2	395.6	392.0	388.3	384.7	381.1	377.4	373.8	370.5	367.1	363.7	360.4	357.0	353.7
25.25	402.2	398.5	394.8	391.2	387.5	383.9	380.2	376.5	373.2	369.8	366.4	363.0	359.7	356.3
25.5	405.1	401.4	397.7	394.0	390.4	386.6	383.0	379.3	375.9	372.5	369.1	365.7	362.3	358.9
25.75	408.0	404.3	400.6	396.9	393.2	389.5	385.8	382.1	378.6	375.2	371.8	368.3	364.9	361.5
26	411.0	407.2	403.5	399.8	396.0	392.3	388.6	384.8	381.3	377.9	374.4	371.0	367.6	364.1
26.25	413.9	410.1	406.4	402.6	398.9	395.1	391.3	387.6	384.1	380.6	377.1	373.6	370.2	366.7
26.5	416.8	413.0	409.2	405.5	401.7	397.9	394.1	390.3	386.8	383.3	379.8	376.3	372.8	369.3
26.75	419.8	416.0	412.1	408.3	404.5	400.7	396.9	393.0	389.6	386.0	382.5	378.9	375.4	371.9
27	422.7	418.9	415.0	411.2	407.3	403.5	399.7	395.8	392.3	388.7	385.2	381.6	378.1	374.5
27.25	425.7	421.8	417.9	414.0	410.2	406.3	402.4	398.6	395.0	391.4	387.8	384.2	380.7	377.1
27.5	428.6	424.7	420.8	416.9	413.0	409.1	405.2	401.3	397.7	394.1	390.5	386.9	383.3	379.7
27.75	431.5	427.6	423.7	419.8	415.9	411.9	408.0	404.1	400.4	396.8	393.2	389.6	385.9	382.3
28	434.5	430.5	426.6	422.6	418.7	414.7	410.8	406.8	403.2	399.5	395.9	392.2	388.6	384.9
28.25	437.4	433.4	429.5	425.5	421.5	417.5	413.5	409.6	405.9	402.2	398.5	394.9	391.2	387.5
28.5	440.3	436.3	432.3	428.3	424.3	420.4	416.3	412.3	408.6	404.9	401.2	397.5	393.8	390.1
28.75	443.3	439.2	435.2	431.2	427.2	423.1	419.1	415.1	411.4	407.7	403.9	400.2	396.4	392.7
29	446.2	442.2	438.1	434.0	430.0	425.9	421.9	417.9	414.1	410.3	406.6	402.8	399.1	395.3
29.25	449.2	445.1	441.0	436.9	432.8	428.7	424.7	420.6	416.8	413.0	409.3	405.5	401.7	397.9
29.5	452.1	448.0	443.9	439.8	435.7	431.6	427.5	423.3	419.5	415.7	412.0	408.1	404.3	400.5
29.75	455.0	450.9	446.8	442.6	438.5	434.4	430.2	426.1	422.3	418.4	414.6	410.8	407.0	403.2
30	458.0	453.8	449.7	445.5	441.3	437.2	433.0	428.8	425.0	421.2	417.3	413.5	409.6	405.7
30.25	460.9	456.7	452.5	448.3	444.2	440.0	435.8	431.6	427.7	423.8	420.0	416.1	412.2	408.4
30.5	463.9	459.6	455.4	451.2	447.0	442.8	438.6	434.4	430.5	426.6	422.7	418.8	414.9	411.0
30.75	466.8	462.5	458.3	454.1	449.8	445.6	441.4	437.1	433.2	429.2	425.3	421.4	417.5	413.5

NOTES: