EQUIPMENT: **FM-200® (UL/FM)**
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HYGOOD

FM-200® TOTAL FLOOD FIRE SUPPRESSION SYSTEMS

ENGINEERED SYSTEM DESIGN AND INSTALLATION MANUAL (UL/FM VERSION)

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About this Manual

This manual is a comprehensive guide that contains all the information necessary to design, install and maintain the FM-200® Engineered Extinguishing system. However the manual does not address information relating to fire detection.

Users of this manual are assumed to be competent fire engineers with a basic knowledge of such systems. The contents are arranged in a logical order describing the various procedures in turn, alternatively specific sections can be referred to as required. Users who are not familiar with the equipment should first read the complete manual.

Definitions

FM-200® FM-200® is a registered trade mark of the Du Pont.

System In this manual 'system' refers to the extinguishing equipment and does not include any detection system which may initiate an agent release.

Engineered Hydraulic flow program used to predict the two phase flow of FM-200® through a pipe network.

Contacts

Should any part of this manual not be understood, or there are any queries concerning a system, please contact:

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Introduction

FM-200® is a clean, safe fire fighting agent for use in total flooding automatic extinguishing systems. It is intended as a long term replacement for Halon 1301 and, whilst maintaining the excellent fire suppression properties of Halon, has none of the environmental problems. Storage and distribution requirements are similar to Halon and the majority of system components are identical. However, FM-200® is not a direct replacement for existing Halon 1301 installations due to the difference in agent quantity and discharge characteristics. The minimum FM-200® design concentration for Class A hazards is 6.4% for UL Listed systems or 7.17% for FM Approved systems, and for Class B hazard is at least 9.0%.

The US Environmental Protection Agency (EPA) accepts use in normally occupied areas where the concentration doesn't exceed 9%. The safe use criteria has further been confirmed by the Halon Alternative Group (HAG) report. Refer to NFPA 2001, 2008 edition "Clean Agent Fire Extinguishing Systems," Section 1-5 "Safety," for additional exposure requirements.

The systems described in this manual are 'engineered'. Engineered systems for example, may consist of several FM-200® containers, modularised or manifolded together and connected via a pipe network to a number of discharge nozzles.

Systems may be activated mechanically or electrically. Mechanical manual actuation is via a manual actuator attached to the container valve. Electrical actuation is via a removable side mounted solenoidor a top mounted electrical actuator. Actuation can occur automatically via a signal from a detection and alarm control panel.

Users of this manual should find that sufficient information is provided to plan, design, purchase components, install, operate and maintain the system. However, in the event that part of the document is not understood, or if there is any concern as to the suitability of the protection, do not hesitate to contact one of our specialist engineers for the matter to be quickly resolved.

Approvals and Standards

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

FM-200® Agent

Approvals include, but are not limited to:

- FM Approved
- Underwriters Laboratories Inc. (UL) Recognised Component
- NFPA 2001 Clean Agent Fire Extinguishing Systems (Listed Alternative)
- US EPA SNAP Rpt. (Unrestricted Listed Alternative)
- Australian Industrial Chemicals Notification (Approved)
- German Institute for Environmental Hygiene and Medicine (Approved)

Manufactured Systems

- Underwriters Laboratories Inc.
- Loss Prevention Certification Board
- Factory Mutual (FM)

FM-200® systems are manufactured in strict accordance with the internationally recognised Quality assurance Standard, BS EN IS0 9000 and approved to ISO 9001. FM-200® Extinguishing System units are to be designed, installed, inspected, maintained, tested and recharged by qualified, trained personnel in accordance with The Standard on Clean Agent Fire Extinguishing Systems, NFPA2001, 2008 edition and to be used in accordance with Environmental Protection Agency (EPA) Significant New Alternatives Program (SNAP). Where determined to be appropriate by the authority having jurisdiction, other applicable standards may additionally be utilised to specific system requirements for these purposes.

Health and Safety

A properly designed and installed extinguishing system should not present any significant health or safety problems, however, there are basic precautions to be taken to avoid accidents, and aspects of the system operation that should be understood. End-users often require reassurance regarding the safety of personnel, and this can only be given if a thorough understanding of the properties of the agent and its effects in different situations are known. Best practice should be observed.

FM-200® extinguishes primarily through heat absorption, and does not sufficiently deplete oxygen levels.

Therefore, exposure to FM-200® at the design concentration of 7.17%*, and up to 9.0%, is not hazardous to health. Exposure to higher concentrations is permissible for limited periods. Refer to NFPA 2001, 2008 edition Section 1-5 “Safety,” for exposure requirements. As with halons, the US EPA and the National Fire Protection Association (NFPA) recommend that unnecessary exposure to any agent be avoided and that personnel evacuate protected areas as quickly as possible to avoid the decomposition products of the fire.

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

The noise created by the FM-200® agent discharging can be 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 vaporising liquid discharged from an FM-200® nozzle has a chilling effect on objects and in extreme cases can cause frostbite to the skin. The liquid phase vaporises 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 due to the condensation of water vapour.

HMIS: 2-0-0/heptafloropropane/contents under pressure. 0-0-0/nitrogen expellant gas/very cold, contents under pressure.

Consult: DuPont de Nemours (Nederland) B.V., Baanhoekweg 22, NL-3313 LA Dordrecht, The Netherlands.

Emergency phone number: +44 (0)8456 006640.

WARNING

The discharge of clean agent systems to extinguish 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 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.

* UL Design Concentration - See Page 5

First Aid

Refer to the FM-200® Material Safety Data Sheet within Appendix C.

FM-200® Agent Characteristics

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

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

Typical areas that may be protected by an FM-200® system are detailed below; the list is by no means exhaustive:

Bank Vaults
Libraries
Rare Book Stores
Electronic Data Processing
Telephone Exchanges
Studios
Communication Centres
Transformer and Switchrooms
Control Rooms
Test Laboratories
Flammable Liquid Stores

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

- Less visual obscurity and minimal risk to personnel.
- Low toxicity.
- Most effective when used with automatic detection to introduce FM-200® with a 10 second discharge.
- The ability to prevent re-ignition providing concentration levels are maintained.

FM-200® is stored as a liquified compressed gas and is discharged into the protected area as a vapour. It is stored in approved DOT or TPED containers and is super-pressurised with dry nitrogen to 25 bar @ 21 °C (360 psi @ 70 °F).

WARNING

FM-200® shall not be used on fires involving the following materials unless they have been tested to the satisfaction of the authority having jurisdiction:

• Certain chemicals or mixtures of chemicals, such as cellulose nitrate and gunpowder, that are capable of rapid oxidation in the absence of air.

• Reactive metals such as lithium, sodium, potassium, magnesium, titanium, zirconium, uranium and plutonium.

• Metal hydrides.

• Chemicals capable of undergoing autothermal decomposition, such as certain organic peroxidase and hydrazine.

Agent Physical Properties

Table 1.

Agent Physical Properties	**HFC-227ea**
Chemical structure	CF_3CHFCF_3
Chemical name	Heptafluoropropane
Molecular weight	170
Boiling point	-16.40 °C (2.4°F)
Freezing point	-131 °C (-204 °F)
Critical temperature	101.7 °C (214 °F)
Critical pressure	2912 kPa (424 psi)
Critical volume	274 cc/mole (0.0280 ft^3/lbm.)
Critical density	621 kg/m^3 (35.77lbm./ft^3)
Saturated vapour density @20 °C (68 °F)	31.18 kg/m^3 (1.95 lb./ft^3)

(Reference: NFPA 2001, 2008 edition)

Table 2.

Agent Physical Properties	
Chemical structure	N2
Chemical name	Nitrogen
Molecular weight	28.0
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	3399 kPa (492.9 psi)

Table 3: Toxicology/Environmental

	FM-200®
Environmental	
Ozone Depletion (ODP)	0
Atmospheric Lifetime (yrs)	36.5
Toxicology	
Acute Exposure LC50	>80%
Cardiac Sensitization No Observed Adverse Effect Level (NOAEL)	9.0%
Lowest Observed Adverse Effect Level (LOAEL)	10.5%

(Reference: NFPA 2001, 2008 edition)

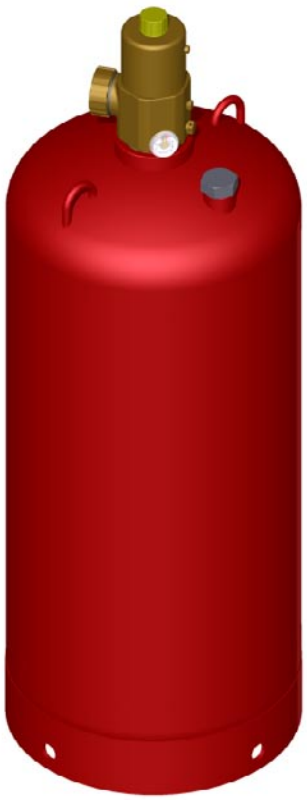
System Components

This section describes the individual components that comprise a complete system. Some items are optional depending on the application, and are indicated as such.

FM-200® Container

The container assembly consists of a container fitted with a valve and internal syphon tube, factory filled with FM-200®, and super-pressurised with dry nitrogen to 25 bar @ 21 °C (360 psi @ 70 °F). Containers sharing the same manifold shall be equal in size and fill density. Containers are finished in red and are available in various sizes. A nameplate is fixed to the container displaying the agent weight, tare weight, gross weight, fill density, charge date and fill location.

Figure 1 - FM-200® Container



Technical Information

The 4.5, 8, 16, 32, 52, 106, 147 and 180 litre containers are manufactured in accordance with DOT 4BW500 or 4BW450, the 343 litre container in accordance with DOT 4BW450 and the 40, 67.5 and 80 litre containers in accordance with DOT 3AA 580.

Material:	Carbon Steel
4BW500	
Hydraulic test pressure:	69.0 bar (1000 psi)
Working Pressure:	34.5 bar (500 psi)
4BW450	
Hydraulic test pressure:	62.1 bar (900 psi)
Working Pressure:	31.0 bar (450 psi)
3AA580	
Hydraulic test pressure:	70.0 bar (1015 psi)
Working Pressure:	40.0 bar (580 psi)
Paint Specification:	Red epoxy polyester or red polyester powder coated

The 8, 16, 32, 52, 106 and 147 litre containers are also available manufactured in accordance with EN 13322-1.

Material:	Carbon Steel
Hydraulic test pressure:	40.0 bar (580 psi)
Working Pressure:	34.5 bar (500 psi)
Paint Specification:	Red epoxy polyester or red polyester powder coated

Table 4: DOT Container details.

Part No. (Nominal Volume)	Minimum and Maximum Fills kg	(lbs)	Valve Size mm	(in)	Height from floor to outlet (nominal) mm	(in)	Diameter mm	(in)	Nominal Tare Weight kg	(lbs)
303.205.026 (4.5 litre)	2.3 to 4.5	(5 to 10)	25	(1″)	280	(11″)	178	(7″)	7.7	(17)
303.205.015 (8 litre)	4.0 to 8.0	(9 to 18)	25	(1″)	304	(12″)	254	(10″)	14.8	(32.6)
303.205.016 (16 litre)	8.0 to 16.0	(18 to 35)	25	(1″)	502	(19.8″)	254	(10″)	18.4	(40.6)
303.205.017 (32 litre)	16.0 to 32.0	(35 to 71)	25	(1″)	833	(32.8″)	254	(10″)	26.1	(57.5)
303.205.030 (40 litre) *	20.0 to 40.0	(44 to 88)	50	(2″)	1352	(53.2″)	227.2	(9″)	52.2	(115)
303.205.018 (52 litre)	26.0 to 52.0	(58 to 115)	50	(2″)	596	(23.5″)	406	(16″)	49.1	(108.3)
303.205.031 (67.5 litre) *	33.8 to 67.5	(75 to 149)	50	(2″)	1526	(60″)	265	(10.4″)	81.6	(180)
303.205.032 (80 litre) *	40.0 to 80.0	(88 to 176)	50	(2″)	1685	(66.3″)	276	(11″)	95.3	(210)
303.205.019 (106 litre)	53.0 to 106.0	(117 to 234)	50	(2″)	1021	(40.2″)	406	(16″)	71.8	(158.3)
303.205.020 (147 litre)	73.5 to 147.0	(162 to 324)	50	(2″)	1354	(53.3″)	406	(16″)	89.9	(198.2)
303.205.021 (180 litre)	90.0 to 180.0	(198 to 397)	50	(2″)	1634	(64.3″)	406	(16″)	105.8	(233.2)
303.205.022 (343 litre)	171.5 to 343	(378 to 756)	80	(3″)	1466	(57.7″)	610	(24″)	207	(456)

* For UL Listed Systems Only (Not FM Approved)

Table 5: TPED Container details.

Part No. (Nominal Volume)	Minimum and Maximum Fills kg	(lbs)	Valve Size mm	(in)	Height from floor to outlet (nominal) mm	(in)	Diameter mm	(in)	Nominal Tare Weight kg	(lbs)
303.205.045 (8 litre)	4.0 to 8.0	(9 to 18)	25	(1″)	304	(12″)	254	(10″)	17.4	(38.4)
303.205.046 (16 litre)	8.0 to 16.0	(18 to 35)	25	(1″)	502	(19.8″)	254	(10″)	23.4	(51.6)
303.205.047 (32 litre)	16.0 to 32.0	(35 to 71)	25	(1″)	833	(32.8″)	254	(10″)	27.5	(60.6)
303.205.048 (52 litre)	26.0 to 52.0	(58 to 115)	50	(2″)	596	(23.5″)	406	(16″)	68.7	(151.5)
303.205.049 (106 litre)	53.0 to 106.0	(117 to 234)	50	(2″)	1021	(40.2″)	406	(16″)	88.8	(195.8)
303.205.050 (147 litre)	73.5 to 147.0	(162 to 324)	50	(2″)	1354	(53.3″)	406	(16″)	108.8	(239.9)

Table 4a: DOT Container - valve equivalent lengths.

Part No. (Nominal Volume)	Equivalent Lengths (m)
303.205.026 (4.5 litre)	6.096
303.205.015 (8 litre)	6.096
303.205.016 (16 litre)	6.096
303.205.017 (32 litre)	6.096
303.205.030 (40 litre)	10.668
303.205.018 (52 litre)	10.668
303.205.031 (67.5 litre)	10.668
303.205.032 (80 litre)	10.668
303.205.019 (106 litre)	10.668
303.205.020 (147 litre)	10.668
303.205.021 (180 litre)	10.668
303.205.022 (343 litre)	25.91

Table 5a: TPED Container - valve equivalent lengths.

Part No. (Nominal Volume)	Equivalent Lengths (m)
303.205.045 (8 litre)	6.096
303.205.046 (16 litre)	6.096
303.205.047 (32 litre)	6.096
303.205.048 (52 litre)	10.668
303.205.049 (106 litre)	10.668
303.205.050 (147 litre)	10.668

Container Label

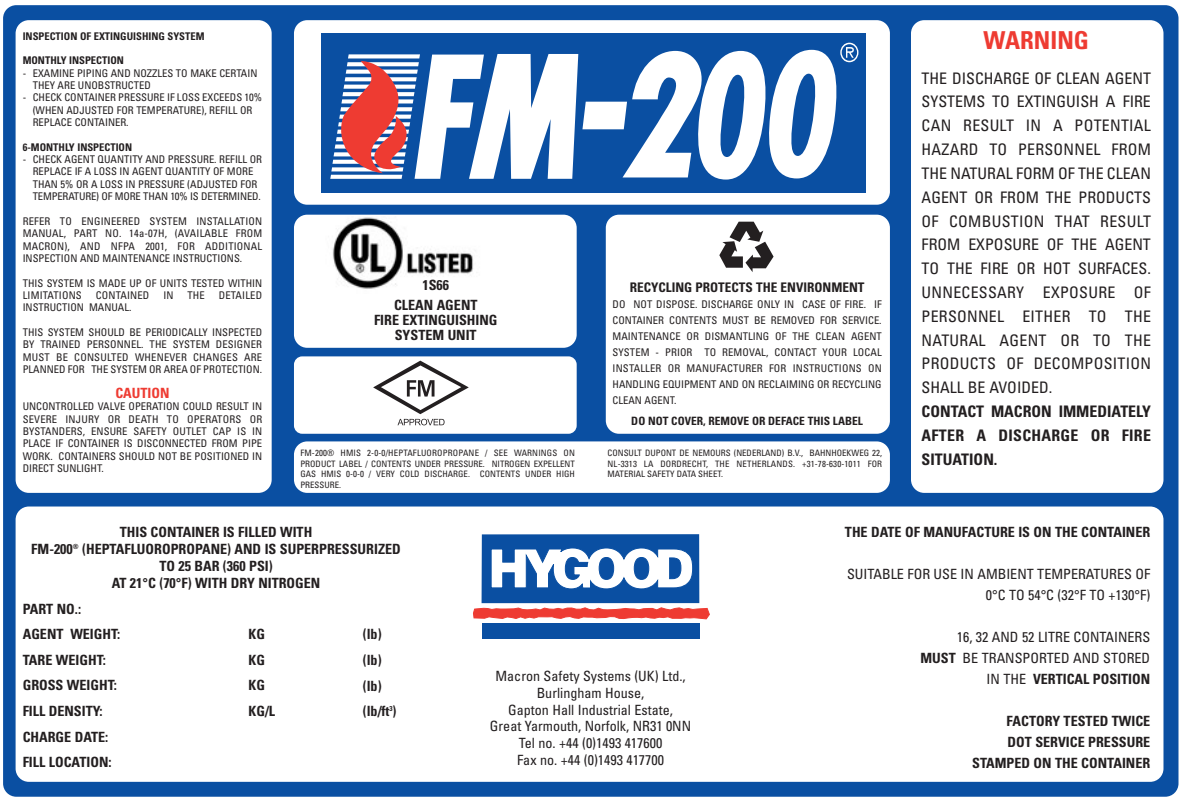
The container label details the weight of FM-200® contained, empty weight, fill density and charge date. Once the label is applied to the container surface, and to avoid possible tampering it can not be removed intact.

Technical Information

Material:	Aluminum
Adhesive:	Pre-applied 3M adhesive 9485
Certification:	UL Recognised
Overall Size:	241.3 mm x 165.1 mm (9.5″ x 6.5″) (Part No. 314.205.021) (Part No. 314.205.045)* 558 mm x 50.8 mm (22″ x 2″) (Part No. 314.205.022) (Part No. 314.205.046)*
Weight:	0.0416 kg (0.092 lbs) (Part No. 314.205.021) (Part No. 314.205.045)* 0.0300 kg (0.066 lbs) (Part No. 314.205.022) (Part No. 314.205.046)*

* For UL Listed Systems Only (Not FM Approved)

Figure 2 - Container Label (Part No. 314.205.021 Shown)



Valve Assembly

The container valve is the result of extensive research and development and incorporates many unique safety features. The valve assembly is factory-fitted to the container and is supplied pre-assembled with a low pressure switch (to be ordered seperately), pressure gauge and burst disc.

Figure 3 - Valve Assembly

25 mm (1") Valve Assembly
Part No. 302.209.001

50 mm (2") Valve Assembly
Part No. 302.209.002

80 mm (3") Valve Assembly
Part No. 302.205.002

Technical Information

25 mm (1") Valve

Body Material:	Brass CZ 121
Outlet Anti-Recoil Cap Material:	CZ122
Max. Working Pressure:	34 bar (493 psi)
Outlet:	25mm (1" BSPP)
Low Pressure Switch Port:	1/8" NPT
Gauge Port:	1/8" NPT
Pilot Pressure Port:	1/4" BSPP
Solenoid Adaptor Port:	1/8" NPT
Overall Size:	130mm (L) x 62mm (Dia) (5.12" (L) x 2.44" (Dia))
Weight:	2.96 kg (6.526 lbs)
Equivalent Length:	6.096 m (20 ft)

50 mm (2") Valve

Body Material:	Brass CZ 121
Outlet Anti-Recoil Cap Material:	CZ122
Max. Working Pressure:	34 bar (493 psi)
Outlet:	50mm (2"BSPP)
Low Pressure Switch Port:	1/8" NPT
Gauge Port:	1/8" NPT
Pilot Pressure Port:	1/4" BSPP
Solenoid Adaptor Port:	1/8" NPT
Overall Size:	173mm (L) x 100mm (Dia) (6.12" (L) x 3.94" (Dia))
Weight:	9.18 kg (20.238 lbs)
Equivalent Length:	10.668 m (35 ft)

80 mm (3")Valve

Material:	Brass UNS36000
Max. Working Pressure:	34 bar (493 psi)
Outlet:	80mm (3" Flared*)
Low Pressure Switch Port:	1/8" NPT
Gauge Port:	1/8" NPT
Pilot Pressure Port:	1/4" NPT
Solenoid Adaptor Port:	None
Overall Size:	241mm (L) x 129mm (Dia) (9.50" (L) x 5.06" (Dia))
Weight:	18.82 kg (41.491 lbs)
Equivalent Length:	25.91 m (85 ft)

*Outlet adaptors are available for 3" NPT, BSP and grooved.

Principle of Operation

The FM-200® valve is a high-flow-rate device specially designed for use in fire systems. Operation is by means of a pressure-differential piston. Container pressure is used within the valve to create a positive force on the piston, sealing the valve closed. Operation of the valve occurs when the upper chamber is vented faster than the 'make up device' in the shuttle can replace the pressure. Thereby allowing, the shuttle to be forced up, and free flow of FM-200® from the valve. Upper chamber pressure is released by the electrical, mechanical or pneumatic actuator.

The valve incorporates the following features:

- A pressure operated safety release device (burst disc).
- Main outlet, fitted with anti-recoil cap.
- A connection for a pneumatic, mechanical or electrical actuator, fitted with safety cap.
- A connection for an electrical solenoid.
- A connection for the pneumatic actuation port.

Burst Disc

A burst disc is factory fitted to every valve assembly. It is designed to rupture when the container becomes over pressurised when subjected to temperatures above the designed storage temperature of the container.

Figure 4 - Burst Disc

Burst Disc for 25 mm (1") Valve
Part No. 20915

Burst Disc for 50 mm (2") Valve
Part No. 20915

Burst Disc for 80 mm (3") Valve
Part No. 15330

Technical Information

25 mm (1") Valve & 50 mm (2") Valve

Body:	Brass CZ 121
Rating:	53.4 bar (774.5 psi) @ 50 °C (122 °F)
Thread:	M18 x 1.00
Hole Orientation:	90° to Body
Torque:	35 Nm (25.8 lbs.ft)
Overall Size :	20mm (L) x 18mm (Dia) (0.79" (L) x 0.71" (Dia))
Weight:	0.028 kg (0.062 lbs)

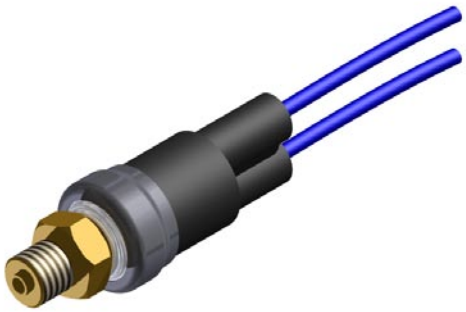
80 mm (3")Valve

Body:	Brass UNS-C36000
Rating:	52 bar (760 psi) @ 50 °C (122 °F)
Thread:	0.9375-16UN-3A
Hole Orientation:	90° to Body
Torque:	68 Nm (50 lbs.ft)
Overall Size :	33.3mm (L) x 18mm (Dia) (1.3125" (L) x 0.71" (Dia))
Weight:	0.088 kg (0.195 lbs)

Low Pressure Switch (Standard Open On Fall)

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

Figure 5 - Low Pressure Switch (Part No. 304.205.006)



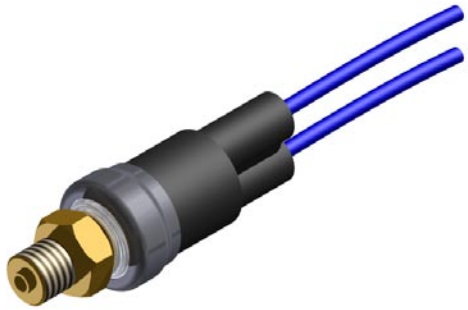
Technical Information

Body:	Hermetically sealed Stainless Steel
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)
Proof Pressure:	345 bar (5003 psi)
Electrical Housing:	Epoxy Sealed terminals
Connection:	Brass 1/8" NPT
Max. Current:	2.9 A
Voltage Range:	5-28 v dc
Electrical Connection:	0.9m (3ft) x 2 Core Cable
Certification:	UL Recognised
IP Rating:	IP65
Wire Leads:	1.82 m (6 ft)
Overall Size:	38mm (L) x 16mm (Dia) (1.50" (L) x 0.63" (Dia))
Weight:	0.087 kg (0.192 lbs)

Low Pressure Switch (Special Close On Fall)

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

Figure 6 - Low Pressure Switch (Part No. 305.209.005)



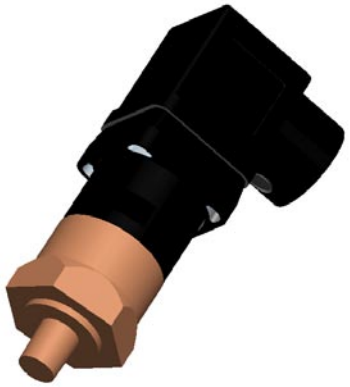
Technical Information

Body:	Hermetically sealed Stainless Steel
Switch Type:	Normally Closed at Atmospheric Pressure
Switch Point:	Close on Fall at 20 bar (290 psi) Open on Rise at 24.1 bar (350 psi)
Tolerance:	+/-0.7 bar (± 10 psi)
Proof Pressure:	345 bar (5003 psi)
Electrical Housing:	Epoxy Sealed terminals
Connection:	Brass 1/8" NPT
Max. Current:	2.9 A
Voltage Range:	5-28 v dc
Electrical Connection:	0.9m (3ft) x 2 Core Cable
Certification:	UL Recognised
IP Rating:	IP65
Wire Leads:	1.82 m (6 ft)
Overall Size:	38mm (L) x 16mm (Dia) (1.50" (L) x 0.63" (Dia))
Weight:	0.087 kg (0.192 lbs)

Low Pressure Switch (Alternate - Transfer On Fall - Option #1)

A low pressure warning switch is fitted to every container and must be ordered seperately. The device continuously monitors the container pressure and in the event of the pressure dropping below 20.3 bar (294 psi) the switch operates to enable the condition to be signalled to a control unit.
This low pressure switch is the primary supply, (option #1), of a dual source component used in order to maintain the supply chain and ensure that adequate stock levels are available to fully support customers and installers.

Figure 7 - Alternate Low Pressure Switch (Part No. 305.209.007) Option #1



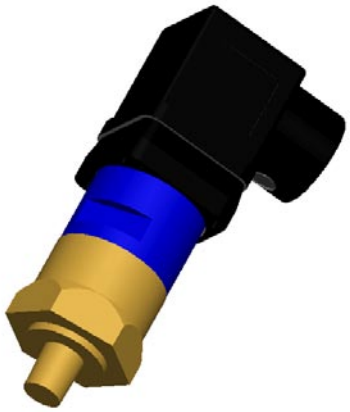
Technical Information

Body:	Zinc Plated Steel and Kapton
Switch Type:	Single Pole, Double Throw (SPDT)
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)
Proof Pressure:	206.8 bar (3000 psi)
Contact Reset Method:	Auto Resetting Contacts
Connection:	1/8" NPT Male
Electrical Rating:	5 A at 24 v dc (Resistive)
Electrical Connection:	DIN 43650A Connector with 1/2" NPT Female Conduit Connection
Certification:	UL Recognised
IP Rating:	IP65
Overall Size:	104mm (L) x 28mm (Dia) (4.10" (L) x 1.12" (Dia))
Weight:	0.16 kg (0.35 lbs)

Low Pressure Switch (Alternate - Transfer On Fall - Option #2)

A low pressure warning switch is fitted to every container and must be ordered seperately. The device continuously monitors the container pressure and in the event of the pressure dropping below 20 bar (290 psi) the switch operates to enable the condition to be signalled to a control unit.
This low pressure switch is the secondary supply, (option #2), of a dual source component used in order to maintain the supply chain and ensure that adequate stock levels are available to fully support customers and installers.

Figure 8 - Alternate Low Pressure Switch (Part No. 305.209.007) Option #2



Technical Information

Body:	Brass and Anodised Aluminium
Switch Type:	Single Pole, Double Throw (SPDT)
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)
Proof Pressure:	413.7 bar (6000 psi)
Contact Reset Method:	Auto Resetting Contacts
Connection:	1/8" NPT Male
Electrical Rating:	5 A at 24 v dc (Resistive)
Electrical Connection:	DIN 43650A Connector with 1/2" NPT Female Conduit Connection
Certification:	UL Recognised
IP Rating:	IP65
Overall Size:	104mm (L) x 32mm (Dia) (4.40" (L) x 1.25" (Dia))
Weight:	0.21 kg (0.46 lbs)

Fixing Brackets

The bracket assembly consists of one back channel and a nut and bolt with two bracket half straps. To securely hold the container in position during the system discharge, two bracket assemblies are required per container. The only exceptions are the 4.5 and 8 litre containers which only require one.

Each strap is notched for insertion into the back channel allowing the container to be properly aligned. The bracket assembly is designed to be mounted to a rigid vertical surface with the container assembly resting fully on the floor.

Figure 9 - Fixing Bracket (Strap Style)

Technical Information

Material: Mild Steel
Coating: Black Polyethylene powder-Plascoat LDPE
Mounting: Unistrut Channel
Weight: 0.34 kg (0.75 lbs) (Part No. 311.205.020)
0.30 kg (0.66 lbs) (Part No. 311.205.013)
0.46 kg (1.01 lbs) (Part No. 311.205.014)
0.28 kg (0.62 lbs) (Part No. 311.205.021)
0.30 kg (0.66 lbs) (Part No. 311.205.017)
0.34 kg (0.75 lbs) (Part No. 311.205.018)
0.71 kg (1.56 lbs) (Part No. 311.205.019)

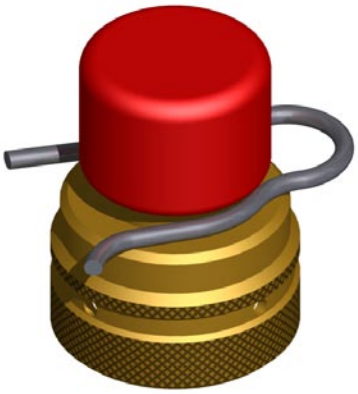
Part Number	Container Size	Length of Back Channel mm (in)
311.205.020	4.5 litre 178 mm dia. (7″)	400 (15.75″)
311.205.013	8, 16, 32 litre 254 mm dia. (10″)	500 (19.69″)
311.205.014	52, 106, 147, 180 litre 406 mm dia. (16″)	600 (23.6″)
311.205.021*	40 litre (Seamless) 227 mm dia. (9″)	400 (15.75″)
311.205.017*	67.5 litre (Seamless) 265 mm dia. (10.4″)	400 (15.75″)
311.205.018*	80 litre (Seamless) 276 mm dia. (11″)	400 (15.75″)
311.205.019	343 litre 610 mm dia. (24″)	693 (27.3″)

* For UL Listed Systems Only (Not FM Approved)

Manual Actuator

The manual actuator is used to mechanically operate the system at the container position and is fitted to the top of the valve assembly or removable electrical actuator. Inadvertent operation is prevented by a safety clip which has to be removed before activation.

Figure 10 - Manual Actuator (Part No. 304.209.002)



Technical Information

Body:	Brass CZ 121
Knob:	PVC (Colour: Red)
Safety Pin:	Stainless Steel 303
Piston Rod:	Brass CZ 121
Min. Actuation Force:	25.5 N (5.73 lbf)
Overall Size:	52mm (L) x 41.5mm (Dia) (2.05" (L) x 1.63" (Dia))
Weight:	0.265 kg (0.584 lbs)

Pneumatic Actuator

The pneumatic actuator is used to pneumatically operate the system at the container position and is fitted to the top of the valve assembly or removable electrical actuator. Pressure from a 'master' container is used to actuate the valve, via small bore piping or a flexible hose.

Figure 11 - Pneumatic Actuator (Part No. 304.209.004)

Technical Information

Body:	Brass CZ121
Actuation Pin:	Stainless Steel
Piston Rod:	Brass CZ 121
Pipe connection:	1/4" NPT Female
Min. Actuation Pressure:	4 bar (58 psi)
Max. Working Pressure:	56 bar (812 psi)
Overall Size:	48mm (L) x 41.5mm (Dia) (1.89" (L) x 1.63" (Dia))
Weight:	0.228 kg (0.503 lbs)

Removable Electrical Actuator (Suppression Diode)

The removable electrical actuator locates to the top of the container valve. 24 v dc is required for solenoid operation. Provision is made for the connection of a manual actuator to the top of the actuator assembly. The suppression diode electrical actuator must be wired up correctly with the positive supply from the control panel connected to terminal 1, and the negative supply connected to terminal 2.The removable electrical actuator has a life span of 10 years from manufacture, which is indicated on the label.

Figure 12 - Electrical Actuator - Suppression Diode (Part No. 304.205.010)

Technical Information

Body:	Mild Steel & Dull Nickel
Swivel nut:	Brass CZ121
Actuation Pin:	Stainless Steel
Actuation Type:	Latching
Reset Requirement:	Manually via Reset Tool supplied
Connection:	1" BSPP Brass
Nominal Voltage:	24 v dc
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")
Electrical connection:	3-pin plug connector
Back EMF Protection:	Suppression Diode
Certification:	UL Recognised
Overall Size:	104mm (L) x 44mm (Dia) (4.09" (L) x 1.73" (Dia))
Weight:	0.95 kg (2.09 lbs)

Removable Electrical Actuator (Bridge Rectifier)

The removable electrical actuator locates to the top of the container valve. 24 v dc is required for solenoid operation. Provision is made for the connection of a manual actuator to the top of the actuator assembly. Due to the design of the bridge rectifier it will operate regardless of how it is wired up; the positive supply from control panel can be connected to either terminal 1 or 2 with the reverse for the negative supply. The removable electrical actuator has a life span of 10 years from manufacture, which is indicated on the label.

Figure 13 - Electrical Actuator - Bridge Rectifier (Part No. 304.209.001)

Technical Information

Body:	Mild Steel & Dull Nickel
Swivel nut:	Brass CZ121
Actuation Pin:	Stainless Steel
Actuation Type:	Latching
Reset Requirement:	Manually via Reset Tool supplied
Connection:	1" BSPP Brass
Nominal Voltage:	24 v dc
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")
Electrical connection:	3-pin plug connector
Back EMF Protection:	Bridge Rectifier
Certification:	UL Recognised
Overall Size:	104mm (L) x 44mm (Dia) (4.09" (L) x 1.73" (Dia))
Weight:	0.95 kg (2.09 lbs)

25 mm (1") and 50 mm (2") Flexible Discharge Hose

FM-200® container installations may be connected to the system by means of a flexible discharge hose. This enables containers to be disconnected for maintenance or recharge without dismantling other container mountings, manifold connections and pipework, etc. The flexible discharge hose is provided with a swivel fitting at the inlet.

Figure 14 - Flexible Discharge Hose

25 mm (1") Hose	Part No. 306.207.002
50 mm (2") Hose	Part No. 306.207.003

Technical Information

25 mm (1") Hose

Hose Construction:	Twin steel wire braided oil resistant seamless synthetic rubber core to DIN EN 853 1SN
Connection:	Zinc Passivated Mild Steel 25 mm (1" NPT) Straight Fixed Male 25 mm (1" BSPP) 90° Female Swivel Union
Max. Bend Angle:	15° @ 0 °C (32 °F)
Max. Working Pressure:	88 bar (1276 psi)
Overall Size:	405mm (L) x 92mm (W) (15.95" (L) x 3.62" (W))
Weight:	1.25 kg (2.76 lbs)
Equivalent Length:	3.14 m (10.3 ft)

50 mm (2") Hose

Hose Construction:	Twin steel wire braided oil resistant seamless synthetic rubber core to DIN EN 853 2SN
Connection:	Zinc Passivated Mild Steel 50 mm (2" NPT) Straight Fixed Male 50 mm (2" BSPP) 90° Female Swivel Union
Max. Bend Angle:	15° @ 0 °C (32 °F)
Max. Working Pressure:	80 bar (1160 psi)
Overall Size:	520mm (L) x 125mm (W) (20.47" (L) x 4.92" (W))
Weight:	3.90 kg (8.60 lbs)
Equivalent Length:	5.36 m (17.6 ft)

80 mm (3″) Discharge Hose/Check Valve Assembly

The discharge hose/check valve assembly combines the elbow, hose, check valve, and swivel coupling for connection to the valve discharge outlet and the discharge manifold. The check valve provides the facility for a 40 mm (1½″) height adjustment.

Figure 15 - 80 mm (3") Discharge Hose / Check Valve Assembly (Part No. 306.205.006)

Technical Information

Hose:	Double braid stainless steel
Elbow:	Stainless steel UNS 30400
Valve Swivel Nut:	Stainless steel UNS 30400
Check Valve Swivel Nut:	Cadmium plated mild steel
Check Valve Body:	Cadmium plated mild steel
Check Valve Seal and Seat:	Brass UNS 36000
Spring:	Stainless steel 2.84 kg (6.27 lbs)
Max. Working Pressure:	35 bar (507.5 psi)
Overall Size (Minus Check Valve):	619mm (L) x 254mm (W) (24.37″ (L) x 10.00″ (W))
Weight:	20.50 kg (45.20 lbs)
Equivalent Length:	15.85 m (52 ft)

80 mm (3″) Discharge Hose

The discharge hose is used with the 3″ 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 16 - 80 mm (3") Discharge Hose (Part No. 306.205.005)

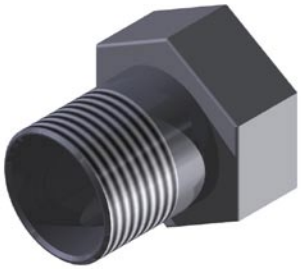
Technical Information

Hose Construction:	Double braid stainless steel
Max. Working Pressure:	35 bar (507.5 psi)
Min. Bend Radius:	460mm (18″)
Overall Size:	406mm (L) x 76mm (Dia) (15.98″ (L) x 2.99″ (Dia))
Weight:	3.00 kg (6.61 lbs)
Equivalent Length:	1.55 m (5.1 ft)

80 mm (3") Valve Single Tank Adaptors

When a single 343 litre container is being used without a manifold, three swivel adaptors are available for connection to the discharge outlet, either NPT, BSP or grooved.

Figure 17 - 80mm (3") Valve Single Tank Adaptor



3" Flared to 3" BSPT	Part No. 309.002.013
3" Flared to 3" NPT	Part No. 309.002.014
3" Flared to 3" Grooved	Part No. 309.002.015

Technical Information

Body:	Cadmium plated mild steel

3" Flared to 3" BSPT

Overall Size:	115mm (L) x 102mm (W) (4.51" (L) x 4.00" (W))
Weight:	2.84 kg (6.27 lbs)
Equivalent Length:	0.55m (1.8 ft)

3" Flared to 3" NPT

Overall Size:	115mm (L) x 102mm (W) (4.51" (L) x 4.00" (W))
Weight:	2.84 kg (6.27 lbs)
Equivalent Length:	0.55m (1.8 ft)

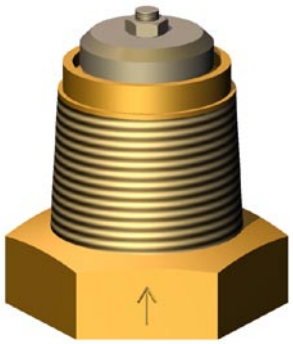
3" Flared to 3" Grooved

Overall Size:	72mm (L) x 102mm (W) (2.82" (L) x 4.00" (W))
Weight:	1.95 kg (4.30 lbs)
Equivalent Length:	0.55m (1.8 ft)

Manifold Check Valve

Manifold check valves are of mushroom pattern type and lift into the manifold as discharge occurs. The function of the check valve is to prevent loss of extinguishing agent during discharge from an outlet, should a container have been removed. All check valves are ordered seperately to the manifold assembly.

Figure 18 - Manifold Check Valve



25 mm (1") Check Valve Assembly
Part No. 302.209.004

50 mm (2") Check Valve Assembly
Part No. 302.209.005

Technical Information

Body:	Brass CZ122
Stem:	Stainless Steel
Spring:	Stainless Steel
Bottom Plate:	Brass CZ122
Top Plate:	Stainless Steel
Seal Material:	Nitrile

25 mm (1") Check Valve

Inlet Connection Thread:	25 mm (1" NPT) Female
Outlet Connection Thread:	40 mm (1½" NPT) Male
Overall Size:	54mm (L) x 52.4mm (W) (2.13" (L) x 2.06" (W))
Weight:	0.63 kg (1.39 lbs)
Equivalent Length:	0.40m (1.3 ft)

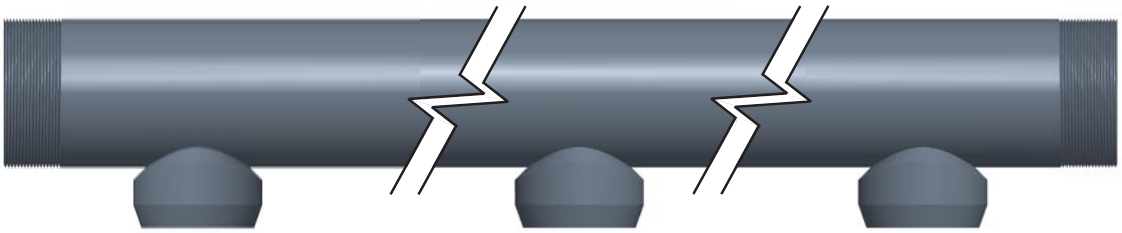
50 mm (2") Check Valve

Inlet Connection Thread:	50 mm (2" NPT) Female
Outlet Connection Thread:	65 mm (2½" NPT) Male
Overall Size:	73mm (L) x 83mm (W) (2.87" (L) x 3.25" (W))
Weight:	1.60 kg (3.53 lbs)
Equivalent Length:	6.66m (21.8 ft)

Manifold

Manifolds are fabricated sections of steel pipework. They enable multiple containers to be connected to a common pipe network. They may also be used in systems where main / reserve containers arrangements are required.

Figure 19 - Typical Manifold Assembly



Technical Information

Material: ASTM A106 Gr B / BS 3601 Schedule 80
Inlet: NPT socket
Outlet: BSP Taper / NPT Taper / 6" Flange
Test Press. 90 bar (1305 psi)
Finish: Primed, Ready to paint on site.

Note: Assemblies do not include check valves and end caps.
For 343 litre manifolds the check valves are part of the hose.

Table 6: Manifolds

Part No.	No. of Inlets	Manifold Pipe Size	Inlet to End Cap Distance mm	Inlet to Inlet Distance mm	Inlet to End Connection Distance mm	Container Size	Overall Length mm	End Thread Connection
307.209.022	2	65mm (2.5")	150 (6")	350 (14")	150 (6")	4.5 L to 32 L	650 (25.6")	BSPT
307.209.023	3	65mm (2.5")	150 (6")	350 (14")	150 (6")	4.5 L to 32 L	1000 (39.4")	BSPT
307.209.024	4	65mm (2.5")	150 (6")	350 (14")	150 (6")	4.5 L to 32 L	1350 (53.1")	BSPT
307.209.001	2	65mm (2.5")	150 (6")	350 (14")	150 (6")	4.5 L to 32 L	650 (25.6")	NPT
307.209.002	3	65mm (2.5")	150 (6")	350 (14")	150 (6")	4.5 L to 32 L	1000 (39.4")	NPT
307.209.003	4	65mm (2.5")	150 (6")	350 (14")	150 (6")	4.5 L to 32 L	1350 (53.1")	NPT
307.209.025	2	80mm (3")	150 (6")	508 (20")	150 (6")	52 L to 180 L	808 (31.8")	BSPT
307.209.026	3	80mm (3")	150 (6")	508 (20")	150 (6")	52 L to 180 L	1316 (51.8")	BSPT
307.209.027	4	80mm (3")	150 (6")	508 (20")	150 (6")	52 L to 180 L	1824 (71.8")	BSPT
307.209.028	5	80mm (3")	150 (6")	508 (20")	150 (6")	52 L to 180 L	2332 (91.8")	BSPT
307.209.029	6	80mm (3")	150 (6")	508 (20")	150 (6")	52 L to 180 L	2840 (111.8")	BSPT
307.209.004	2	80mm (3")	150 (6")	508 (20")	150 (6")	52 L to 180 L	808 (31.8")	NPT
307.209.005	3	80mm (3")	150 (6")	508 (20")	150 (6")	52 L to 180 L	1316 (51.8")	NPT
307.209.006	4	80mm (3")	150 (6")	508 (20")	150 (6")	52 L to 180 L	1824 (71.8")	NPT
307.209.007	5	80mm (3")	150 (6")	508 (20")	150 (6")	52 L to 180 L	2332 (91.8")	NPT
307.209.008	6	80mm (3")	150 (6")	508 (20")	150 (6")	52 L to 180 L	2840 (111.8")	NPT

Table 6: Manifolds (Continued)

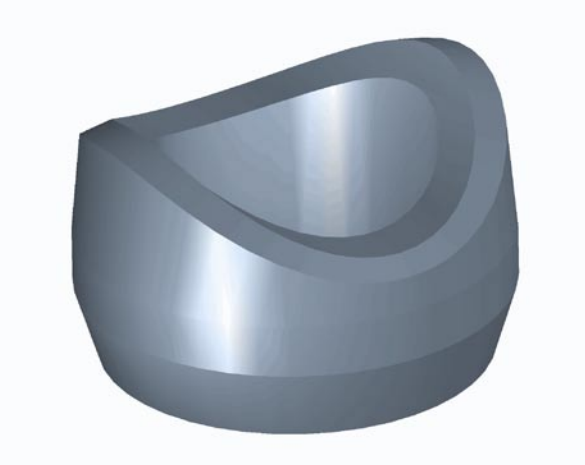
Part No.	No. of Inlets	Manifold Pipe Size	Inlet to End Cap Distance mm	Inlet to Inlet Distance mm	Inlet to End Connection Distance mm	Container Size	Overall Length mm	End Thread Connection
307.209.030	2	100mm (4″)	150 (6″)	508 (20″)	150 (6″)	52 L to 180 L	808 (31.8″)	BSPT
307.209.031	3	100mm (4″)	150 (6″)	508 (20″)	150 (6″)	52 L to 180 L	1316 (51.8″)	BSPT
307.209.032	4	100mm (4″)	150 (6″)	508 (20″)	150 (6″)	52 L to 180 L	1824 (71.8″)	BSPT
307.209.033	5	100mm (4″)	150 (6″)	508 (20″)	150 (6″)	52 L to 180 L	2332 (91.8″)	BSPT
307.209.034	6	100mm (4″)	150 (6″)	508 (20″)	150 (6″)	52 L to 180 L	2840 (111.8″)	BSPT
307.209.009	2	100mm (4″)	150 (6″)	508 (20″)	150 (6″)	52 L to 180 L	808 (31.8″)	NPT
307.209.010	3	100mm (4″)	150 (6″)	508 (20″)	150 (6″)	52 L to 180 L	1316 (51.8″)	NPT
307.209.011	4	100mm (4″)	150 (6″)	508 (20″)	150 (6″)	52 L to 180 L	1824 (71.8″)	NPT
307.209.012	5	100mm (4″)	150 (6″)	508 (20″)	150 (6″)	52 L to 180 L	2332 (91.8″)	NPT
307.209.013	6	100mm (4″)	150 (6″)	508 (20″)	150 (6″)	52 L to 180 L	2840 (111.8″)	NPT
307.209.014	3	150mm (6″)	150 (6″)	508 (20″)	200 (8″)	52 L to 180 L	1416 (55.7″)	Flange
307.209.015	4	150mm (6″)	150 (6″)	508 (20″)	200 (8″)	52 L to 180 L	1924 (75.7″)	Flange
307.209.016	5	150mm (6″)	150 (6″)	508 (20″)	200 (8″)	52 L to 180 L	2432 (95.7″)	Flange
307.209.017	6	150mm (6″)	150 (6″)	508 (20″)	200 (8″)	52 L to 180 L	2940 (115.7″)	Flange
307.209.018	7	150mm (6″)	150 (6″)	508 (20″)	200 (8″)	52 L to 180 L	3448 (135.7″)	Flange
307.209.019	8	150mm (6″)	150 (6″)	508 (20″)	200 (8″)	52 L to 180 L	3956 (155.7″)	Flange
307.209.020	9	150mm (6″)	150 (6″)	508 (20″)	200 (8″)	52 L to 180 L	4464 (175.7″)	Flange
307.209.021	10	150mm (6″)	150 (6″)	508 (20″)	200 (8″)	52 L to 180 L	4972 (195.7″)	Flange
307.209.038	2	100mm (4″)	150 (6″)	711 (28″)	150 (6″)	343 L	1011 (40″)	BSPT
307.209.039	3	100mm (4″)	150 (6″)	711 (28″)	150 (6″)	343 L	1722 (68″)	BSPT
307.209.040	4	100mm (4″)	150 (6″)	711 (28″)	150 (6″)	343 L	2433 (96″)	BSPT
307.209.035	2	100mm (4″)	150 (6″)	711 (28″)	150 (6″)	343 L	1011 (40″)	NPT
307.209.036	3	100mm (4″)	150 (6″)	711 (28″)	150 (6″)	343 L	1722 (68″)	NPT
307.209.037	4	100mm (4″)	150 (6″)	711 (28″)	150 (6″)	343 L	2433 (96″)	NPT
307.209.041	2	150mm (6″)	150 (6″)	711 (28″)	200 (8″)	343 L	1111 (43.7″)	Flange
307.209.042	3	150mm (6″)	150 (6″)	711 (28″)	200 (8″)	343 L	1822 (71.7″)	Flange
307.209.043	4	150mm (6″)	150 (6″)	711 (28″)	200 (8″)	343 L	2533 (99.7″)	Flange
307.209.044	5	150mm (6″)	150 (6″)	711 (28″)	200 (8″)	343 L	3244 (127.7″)	Flange
307.209.045	6	150mm (6″)	150 (6″)	711 (28″)	200 (8″)	343 L	3955 (155.7″)	Flange
307.209.046	7	150mm (6″)	150 (6″)	711 (28″)	200 (8″)	343 L	4666 (183.7″)	Flange
307.209.047	8	150mm (6″)	150 (6″)	711 (28″)	200 (8″)	343 L	5377 (211.7″)	Flange
307.209.048	9	150mm (6″)	150 (6″)	711 (28″)	200 (8″)	343 L	6088 (239.7″)	Flange
307.209.049	10	150mm (6″)	150 (6″)	711 (28″)	200 (8″)	343 L	6799 (267.7″)	Flange

Note: For ease of assembly flanged manifolds are available for 150 mm diameter.
150mm flanged manifolds with either 3 or 4 ports are supplied as a one piece assembly. Whilst manifolds with 5 to 10 ports are made up from smaller sections due to the size and weight as listed below:
5 port manifold - 3 port end and 2 port mid section
6 port manifold - 3 port end and 3 port mid section
7 port manifold - 3 port end and 2 port mid section
8 port manifold - 4 port end and 3 port mid section
9 port manifold - 3 port end and two 3 port mid sections
10 port manifold - 4 port end and two 3 port mid sections
All 150mm flanged manifolds include an end cap.

Manifold Inlets (Sockets)

Manifold inlets are available for the construction of system manifolds.

Figure 20 - Threaded Inlet for Manifolds.



Technical Information

Material: Carbon Steel to ASTM A105 / ASTM A350 LF2
Dimensions: ANSI B16.11 / BS3799
Pressure Rating: 3000lb

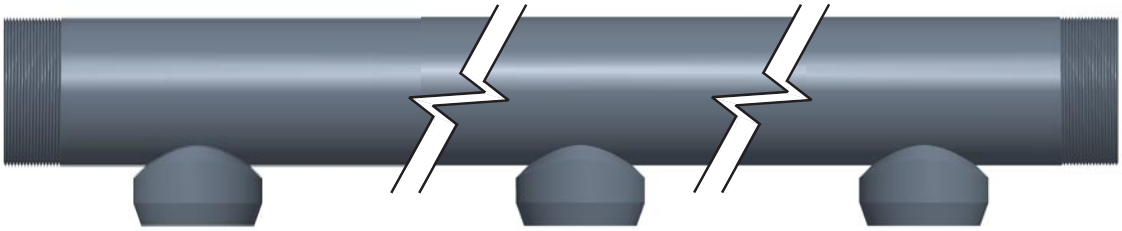
Table 7: Manifold Inlets

Part No.	Manifold Pipe Size	Container Size	Overall Diameter mm	Thread Connection	Overall Height mm	Weight kg
17036	65mm (2½")	4.5 L to 32 L	75 dia. (2.95")	1½ in. NPT	44 (1.73")	0.71 (1.57 lbs)
17037	80mm (3")	52 L to 180 L	100 dia. (3.94")	2½ in. NPT	63 (2.48")	1.20 (2.65 lbs)
17038	100mm (4")	52 L to 180 L	100 dia. (3.94")	2½ in. NPT	63 (2.48")	1.52 (3.35 lbs)
17467	150mm (6")	52 L to 180 L	100 dia. (3.94")	2½ in. NPT	63 (2.48")	1.54 (3.40 lbs)
15332	100mm (4")	343 L	122 dia. (4.80")	3 in. NPT	70 (2.76")	2.05 (4.52 lbs)
15333	150mm (6")	343 L	122 dia. (4.80")	3 in. NPT	63 (2.48")	1.53 (3.37 lbs)

Construction of Manifolds

For customers wishing to manufacture their own manifolds they must be constructed as detailed below, and use the manifold inlets specified on Page 24, (Figure 20 and Table 7).

Figure 21 - Manifold construction



- PIPING MUST BE SCHEDULE 80
- TEST PRESSURE - 90 BAR (1300 psi)
- ALL DIMENSIONS MUST BE WITHIN± 1/8″
- AFTER WELDING, MAKE CERTAIN ALL INLET HOLES IN THE PIPE ARE CLEAN OF ANY WELD SPATTER AND OPEN COMPLETELY

Table 8: Manifolds

No. of Inlets	End Connection	Overall Length mm	Inlet to End Cap Distance mm	Inlet to Inlet Distance mm	Container Size	Socket Part No.
2	2½ in. BSPT / 2½ in. NPT	650 (25.6″)	150 (6″)	350 (14″)	4.5 L to 32 L	17036
3	2½ in. BSPT / 2½ in. NPT	1000 (39.4″)	150 (6″)	350 (14″)	4.5 L to 32 L	17036
4	2½ in. BSPT / 2½ in. NPT	1350 (53.1″)	150 (6″)	350 (14″)	4.5 L to 32 L	17036
2	3 in. BSPT / 3 in. NPT	808 (31.8″)	150 (6″)	508 (20″)	52 L to 180 L	17037
3	3 in. BSPT / 3 in. NPT	1316 (51.8″)	150 (6″)	508 (20″)	52 L to 180 L	17037
4	3 in. BSPT / 3 in. NPT	1824 (71.8″)	150 (6″)	508 (20″)	52 L to 180 L	17037
5	3 in. BSPT / 3 in. NPT	2332 (91.8″)	150 (6″)	508 (20″)	52 L to 180 L	17037
6	3 in. BSPT / 3 in. NPT	2840 (111.8″)	150 (6″)	508 (20″)	52 L to 180 L	17037
2	4 in. BSPT / 4 in. NPT	808 (31.8″)	150 (6″)	508 (20″)	52 L to 180 L	17038
3	4 in. BSPT / 4 in. NPT	1316 (51.8″)	150 (6″)	508 (20″)	52 L to 180 L	17038
4	4 in. BSPT / 4 in. NPT	1824 (71.8″)	150 (6″)	508 (20″)	52 L to 180 L	17038
5	4 in. BSPT / 4 in. NPT	2332 (91.8″)	150 (6″)	508 (20″)	52 L to 180 L	17038
6	4 in. BSPT / 4 in. NPT	2840 (111.8″)	150 (6″)	508 (20″)	52 L to 180 L	17038
3	6 in. Flange	1366 (53.8″)	150 (6″)	508 (20″)	52 L to 180 L	17467
4	6 in. Flange	1874 (73.8″)	150 (6″)	508 (20″)	52 L to 180 L	17467
5	6 in. Flange	2382 (93.8″)	150 (6″)	508 (20″)	52 L to 180 L	17467
6	6 in. Flange	2890 (113.8″)	150 (6″)	508 (20″)	52 L to 180 L	17467
7	6 in. Flange	3398 (133.8″)	150 (6″)	508 (20″)	52 L to 180 L	17467
8	6 in. Flange	3906 (153.8″)	150 (6″)	508 (20″)	52 L to 180 L	17467
9	6 in. Flange	4414 (173.8″)	150 (6″)	508 (20″)	52 L to 180 L	17467
10	6 in. Flange	4922 (193.8″)	150 (6″)	508 (20″)	52 L to 180 L	17467

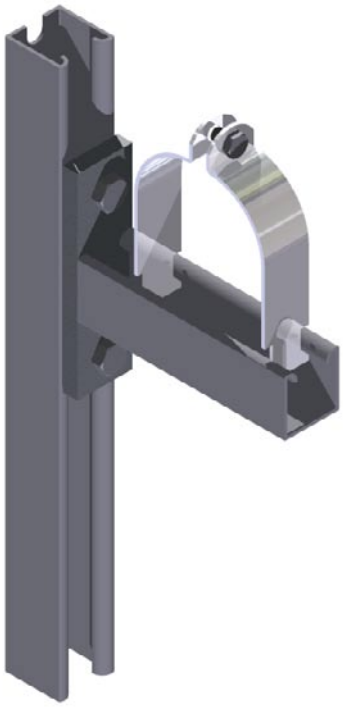
Table 8: Manifolds (Continued)

No. of Inlets	End Connection	Overall Length mm	Inlet to End Cap Distance mm	Inlet to Inlet Distance mm	Container Size	Socket Part No.
2	4 in. BSPT / 4 in. NPT	1011 (40″)	150 (6″)	711 (28″)	343 L	15332
3	4 in. BSPT / 4 in. NPT	1722 (68″)	150 (6″)	711 (28″)	343 L	15332
4	4 in. BSPT / 4 in. NPT	2433 (96″)	150 (6″)	711 (28″)	343 L	15332
2	6 in. Flange	1061 (42″)	150 (6″)	711 (28″)	343 L	15333
3	6 in. Flange	1772 (70″)	150 (6″)	711 (28″)	343 L	15333
4	6 in. Flange	2483 (98″)	150 (6″)	711 (28″)	343 L	15333
5	6 in. Flange	3192 (126″)	150 (6″)	711 (28″)	343 L	15333
6	6 in. Flange	3905 (154″)	150 (6″)	711 (28″)	343 L	15333
7	6 in. Flange	4616 (182″)	150 (6″)	711 (28″)	343 L	15333
8	6 in. Flange	5327 (210″)	150 (6″)	711 (28″)	343 L	15333
9	6 in. Flange	6038 (238″)	150 (6″)	711 (28″)	343 L	15333
10	6 in. Flange	6749 (266″)	150 (6″)	711 (28″)	343 L	15333

Manifold Bracket Assembly

A manifold bracket assembly consists of two lengths of unistrut, mounted vertically on a wall or bulk head to enable height adjustment of the manifold assembly. Cantilever brackets are fastened to the unistrut and each are held in position using a uninut long spring, washer and hex head screw. Manifold brackets slot into the cantilever and are clamped using a hex head screw and plain nut. Each manifold bracket assembly is supplied in pairs.

Figure 22 - Manifold Bracket



Technical Information

65 mm (2.5") Manifold Bracket	(Part No. 311.205.015)
Unistrut Channel Length:	400 mm (15.75")
Cantilever Arm Length:	150 mm (5.91")
80 mm (3") Manifold Bracket	(Part No. 311.205.010)
Unistrut Channel Length:	500 mm (16.69")
Cantilever Arm Length:	300 mm (11.81")
100 mm (4") Manifold Bracket	(Part No. 311.205.011)
Unistrut Channel Length:	500 mm (16.69")
Cantilever Arm Length:	300 mm (11.81")
150 mm (6") Manifold Bracket	(Part No. 311.205.012)
Unistrut Channel Length:	500 mm (16.69")
Cantilever Arm Length:	300 mm (11.81")

Flexible Pilot Hose

The flexible pilot hose is used to connect pressure activated devices to the system, e.g. the pilot cylinder to the slave container to the pressure switch.

Figure 23 - Flexible hose (Part No. 306.205.003)

Technical Information

Outer sheath:	Stainless Steel Braided
Inner sheath:	PTFE to BS 4976
Max. Working Pressure:	190 bar (2755 psi)
Max. Bend Radius:	60 mm (2.4")@ 0 °C (32 °F)
Connections:	Zinc Passivated Mild Steel 2 off 1/4" BSP Female Swivel
Overall Size:	710mm (L) x 7mm (Dia) (27.95" (L) x 0.28" (Dia))
Weight:	0.15 kg (0.33 lbs)

Male Adaptors

This adaptor (309.013.005) connects the pilot hose to the 25 mm (1") and 50 mm (2") container valve assembly. The male adapter (309.013.006) connects to the 80 mm (3") container valve assembly and also to the pressure switch.

Figure 24 - Male Adaptor

Technical Information

Material:	Steel 230 M07 Pb
Connection:	1/4"BSPP x 1/4" BSPT (Part No. 309.013.005) 1/4" BSPP x 1/4" NPT (Part No. 309.013.006)
Max. Working Pressure:	350 bar (5076 psi)
Overall Size:	34mm (L) x 19mm (W) (1.35" (L) x 0.75" (W))
Weight:	0.034 kg (0.08 lbs)

Male Pilot Hose Connector

The male pilot hose connector is used to connect two pilot hoses together for systems where a second container of a different size is used to protect a different enclosure. For example: a large container is protecting a room and a separate smaller container protects the subfloor, and both containers are to actuate simultaneously, and a hose longer than Part No. 306.205.003 is required.

Figure 25 - Male Pilot Hose Connector (Part No. 309.013.007)

Technical Information

Material:	Steel 230 M07 Pb
Connection:	1/4" BSPP x 1/4" BSPP
Max. Working Pressure:	350 bar (5076 psi)
Overall Size:	30mm (L) x 19mm (W) (1.18" (L) x 0.75" (W))
Weight:	0.034 kg (0.08 lbs)

Street Elbow

This elbow can be used to connect a pilot hose to an 80 mm (3″) valve. The street elbow's 1/4″ NPT male thread screws into the valve body actuation port. The 1/4″ NPT thread of the male adaptor (Part No. 309.013.006) screws into the street elbow. The flexible pilot hose (Part No. 306.205.003) would then screw onto the male adaptor.

Figure 26 - Street Elbow (Part No. 309.013.008)

Technical Information

Material:	Brass
Connection:	1/4″ NPT x 1/4″ NPT
Overall Size:	28mm (L) x 18mm (W) (1.10″ (L) x 0.71″ (W))
Weight:	0.042 kg (0.09 lbs)

Male Tee

This is used primarily in manifold systems for connecting pilot lines from one slave container to the next.

Figure 27 - Male Tee (Part No. 309.013.021)

Technical Information

Material:	Brass
Connection:	1/4″ BSPP x 1/4″ BSPP x 1/4″ NPT
Max. Working Pressure:	450 bar (6527 psi)
Overall Size:	42mm (L) x 29mm (W) (1.65″ (L) x 1.14″ (W))
Weight:	0.075 kg (0.17 lbs)

Male Elbow

This elbow can be used on the last slave container when the pressure switch connection is taken from the manifold or piping networks.

Figure 28 - Male Elbow (Part No. 309.013.009)

Technical Information

Material:	Brass
Connection:	1/4" BSPP x 1/4" NPT
Max. Working Pressure:	450 bar (6527 psi)
Overall Size:	28mm (L) x 25mm (W) (1.10" (L) x 1.00 (W))
Weight:	0.050 kg (0.11 lbs)

Pressure Switch

The pressure switch is activated by pressure from the agent during discharge and can be used to signal to a control panel that the system has actually discharged. The pressure switch latches on operation and has a reset button. The pressure switch is supplied with a 1/4" BSPP x 1/4" NPT male adaptor (Part No. 309.013.006).

Figure 29 - Pressure Switch (Part No. 304.205.007)

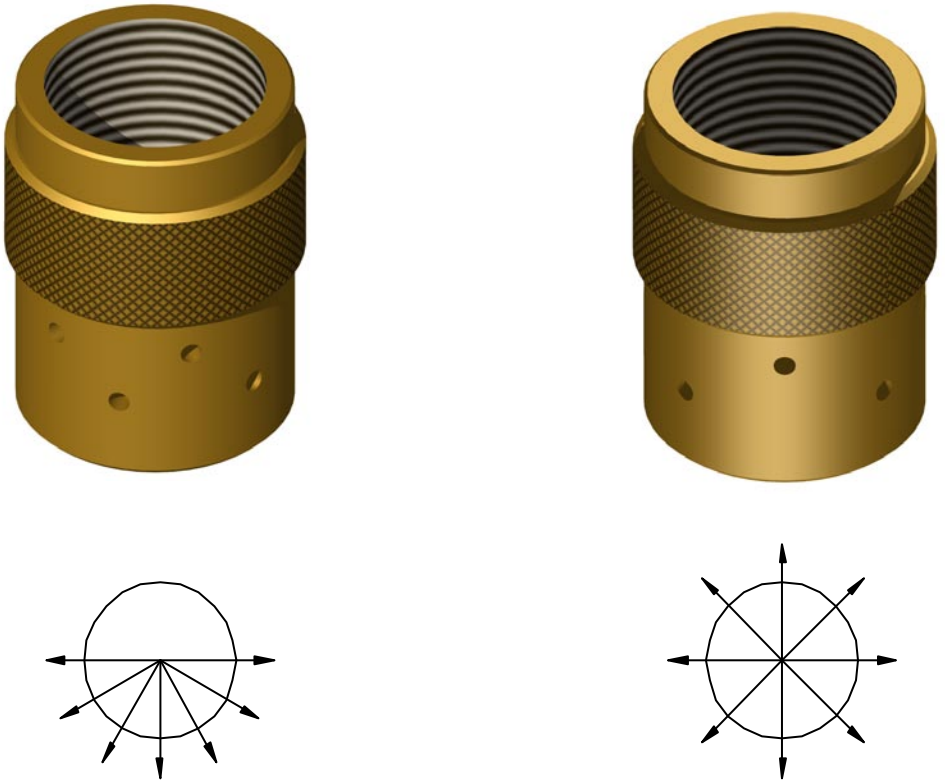
Technical Information

Housing:	Die-cast Aluminium
Pressure Connection:	Nickel Plated Brass
Switch Point:	4 bar Rising (58 psi)
Tolerance:	± 0.34 bar (± 5 psi)
IP Rating:	IP65
Connection:	1/4" NPT Female
Conduit Thread:	1/2" NPT Female
Max. Working Pressure:	103.4 bar (1500 psi)
DC Switch Rating:	1A 24v dc
Installation Environment:	non-corrosive / indoor
Overall Size:	165mm (L) x 101mm (W) (6.50" (L) x 3.98 (W))
Weight:	1.22 kg (2.69 lbs)

Discharge Nozzle

FM-200® is distributed 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 or eight ports to allow for 180° or 360° horizontal discharge patterns. Ports are drilled in 0.1 mm (0.004 in) increments to the specified system design. Nozzles are supplied as standard in Brass as BSPP or NPT with Stainless Steel as an option.

Figure 30 - 7 & 8 Port Nozzle Brass Configuration



Technical Information

Material:	Brass / Stainless Steel
Thread Type:	BSPP / NPT
Drill Incrementation:	0.1 mm
Nozzle Type:	8 Port 360° / 7 Port 180°
Max. Distance from Ceiling:	300mm
Max. Agent per Nozzle:	100 kg (220 lbs)
Orientation:	Pendant / Upright

Table 9: Discharge Nozzles

Part Number	Nozzle Size	Nozzle Type	Nozzle Material	Thread Type
310.205.201	10 mm (3/8″)	7 Port 180°	Brass	BSPP
310.205.202	10 mm (3/8″)	8 Port 360°	Brass	BSPP
310.205.203	15 mm (1/2″)	7 Port 180°	Brass	BSPP
310.205.204	15 mm (1/2″)	8 Port 360°	Brass	BSPP
310.205.205	20 mm (3/4″)	7 Port 180°	Brass	BSPP
310.205.206	20 mm (3/4″)	8 Port 360°	Brass	BSPP
310.205.207	25 mm (1″)	7 Port 180°	Brass	BSPP
310.205.208	25 mm (1″)	8 Port 360°	Brass	BSPP
310.205.209	32 mm (1¼″)	7 Port 180°	Brass	BSPP
310.205.210	32 mm (1¼″)	8 Port 360°	Brass	BSPP
310.205.211	40 mm (1½″)	7 Port 180°	Brass	BSPP
310.205.212	40 mm (1½″)	8 Port 360°	Brass	BSPP
310.205.213	50 mm (2″)	7 Port 180°	Brass	BSPP
310.205.214	50 mm (2″)	8 Port 360°	Brass	BSPP
310.205.215	10 mm (3/8″)	7 Port 180°	Brass	NPT
310.205.216	10 mm (3/8″)	8 Port 360°	Brass	NPT
310.205.217	15 mm (1/2″)	7 Port 180°	Brass	NPT
310.205.218	15 mm (1/2″)	8 Port 360°	Brass	NPT
310.205.219	20 mm (3/4″)	7 Port 180°	Brass	NPT
310.205.220	20 mm (3/4″)	8 Port 360°	Brass	NPT
310.205.221	25 mm (1″)	7 Port 180°	Brass	NPT
310.205.222	25 mm (1″)	8 Port 360°	Brass	NPT
310.205.223	32 mm (1¼″)	7 Port 180°	Brass	NPT
310.205.224	32 mm (1¼″)	8 Port 360°	Brass	NPT
310.205.225	40 mm (1½″)	7 Port 180°	Brass	NPT
310.205.226	40 mm (1½″)	8 Port 360°	Brass	NPT
310.205.227	50 mm (2″)	7 Port 180°	Brass	NPT
310.205.228	50 mm (2″)	8 Port 360°	Brass	NPT

Part Number	Nozzle Size	Nozzle Type	Nozzle Material	Thread Type
310.205.301	10 mm (3/8″)	7 Port 180°	Stainless	BSPP
310.205.302	10 mm (3/8″)	8 Port 360°	Stainless	BSPP
310.205.303	15 mm (1/2″)	7 Port 180°	Stainless	BSPP
310.205.304	15 mm (1/2″)	8 Port 360°	Stainless	BSPP
310.205.305	20 mm (3/4″)	7 Port 180°	Stainless	BSPP
310.205.306	20 mm (3/4″)	8 Port 360°	Stainless	BSPP
310.205.307	25 mm (1″)	7 Port 180°	Stainless	BSPP
310.205.308	25 mm (1″)	8 Port 360°	Stainless	BSPP
310.205.309	32 mm (1¼″)	7 Port 180°	Stainless	BSPP
310.205.310	32 mm (1¼″)	8 Port 360°	Stainless	BSPP
310.205.311	40 mm (1½″)	7 Port 180°	Stainless	BSPP
310.205.312	40 mm (1½″)	8 Port 360°	Stainless	BSPP
310.205.313	50 mm (2″)	7 Port 180°	Stainless	BSPP
310.205.314	50 mm (2″)	8 Port 360°	Stainless	BSPP
310.205.315	10 mm (3/8″)	7 Port 180°	Stainless	NPT
310.205.316	10 mm (3/8″)	8 Port 360°	Stainless	NPT
310.205.317	15 mm (1/2″)	7 Port 180°	Stainless	NPT
310.205.318	15 mm (1/2″)	8 Port 360°	Stainless	NPT
310.205.319	20 mm (3/4″)	7 Port 180°	Stainless	NPT
310.205.320	20 mm (3/4″)	8 Port 360°	Stainless	NPT
310.205.321	25 mm (1″)	7 Port 180°	Stainless	NPT
310.205.322	25 mm (1″)	8 Port 360°	Stainless	NPT
310.205.323	32 mm (1¼″)	7 Port 180°	Stainless	NPT
310.205.324	32 mm (1¼″)	8 Port 360°	Stainless	NPT
310.205.325	40 mm (1½″)	7 Port 180°	Stainless	NPT
310.205.326	40 mm (1½″)	8 Port 360°	Stainless	NPT
310.205.327	50 mm (2″)	7 Port 180°	Stainless	NPT
310.205.328	50 mm (2″)	8 Port 360°	Stainless	NPT

Nozzle Weights

Nozzle Size	Brass	Stainless Steel
10 mm (3/8″)	0.10 kg (0.22 lbs)	0.09 kg (0.20 lbs)
15 mm (1/2″)	0.15 kg (0.33 lbs)	0.14 kg (0.31 lbs)
20 mm (3/4″)	0.21kg (0.46 lbs)	0.20 kg (0.44 lbs)
25 mm (1″)	0.27 kg (0.60 lbs)	0.25 kg (0.55 lbs)
32 mm (1¼″)	0.41 kg (0.90 lbs)	0.38 kg (0.84 lbs)
40 mm (1½″)	0.46 kg (1.01 lbs)	0.43 kg (0.95 lbs)
50 mm (2″)	0.83kg (1.83 lbs)	0.78 kg (1.72 lbs)

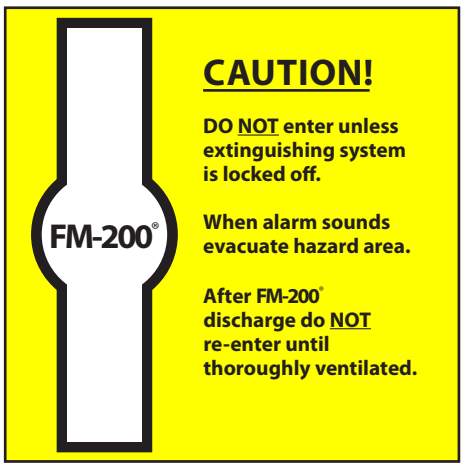
Nozzle Overall Sizes

Nozzle Size	Length	Diameter
10 mm (3/8″)	33.5 mm (1.32″)	25 mm (0.98″)
15 mm (1/2″)	41 mm (1.61″)	29 mm (1.14″)
20 mm (3/4″)	47 mm (1.85″)	34.5 mm (1.36″)
25 mm (1″)	52 mm (2.05″)	41.3 mm (1.63″)
32 mm (1¼″)	62 mm (2.44″)	50 mm (1.97″)
40 mm (1½″)	68 mm (2.68″)	60 mm (2.36″)
50 mm (2″)	89 mm (3.50″)	76 mm (2.99″)

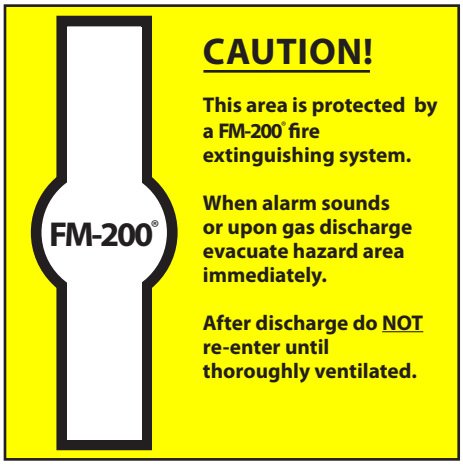
Door Notice

A door notice is required at each entrance to the risk to advise personnel that they are entering a protected area.

Figure 31 - Door Notice (Part No. 314.205.001)



For areas protected by concentrations greater than NOAEL (unoccupied spaces only).



For areas protected by concentrations less than NOAEL (Part No. 314.205.002).

Technical Information

Material	2 mm (0.08") Craylon
Finish	Gloss, scratch resistant
Overall Size:	210mm (L) x 210mm (W) (8.27" (L) x 8.27" (W))
Weight:	0.025 kg (0.055 lbs)

Manual Release Notice

A notice should be located at each manual release position.

Figure 32 - Manual Release Sign (Part No. 314.205.003)

Technical Information

Material	2 mm (0.08 in) Craylon
Finish	Gloss, scratch resistant
Overall Size:	212mm (L) x 75mm (W) (8.35" (L) x 2.95" (W))
Weight:	0.011 kg (0.024 lbs)

Liquid Level Measuring Device

The measuring device is used to measure the level of liquid FM-200® in 106, 147, 180, and 343 litre containers. The weight of the FM-200® in the container is determined by converting the level measurement into a weight measurement using the weight conversion tables in appendix D of this manual. The operating temperature range for the liquid level measuring device is 0 to 54 °C (32 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″) above the anticipated liquid level) and slowly lowering the tape until a magnetic interlock with the float is felt. The tape will then remain in the up position, allowing a reading at the top of the housing. This measurement is accomplished without removing the tank from the fire suppression system.

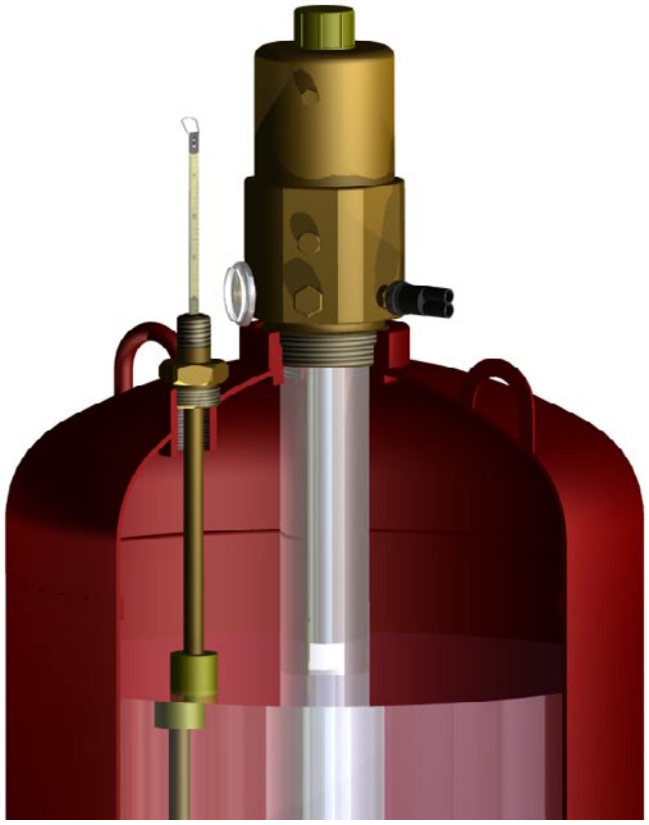
The device must be installed in an empty container assembly before filling, the liquid level measuring device must be ordered as a separate line item.

106 litre	Part No. 300.015.127
147, 180, 343 litre	Part No. 300.015.128

Technical Information

Mounting Thread:	1.3125-12UN-2A
Stem Material:	Brass
Mounting Material:	Brass
Float Material:	ECCO
Model:	Diptape Indicator
Approximate Length:	814 mm (32″) (Part No. 300.015.127) 1093 mm (43″) (Part No. 300.015.128)
Weight:	1.13 kg (2.49 lbs) (Part No. 300.015.127) 1.52 kg (3.36 lbs) (Part No. 300.015.128)

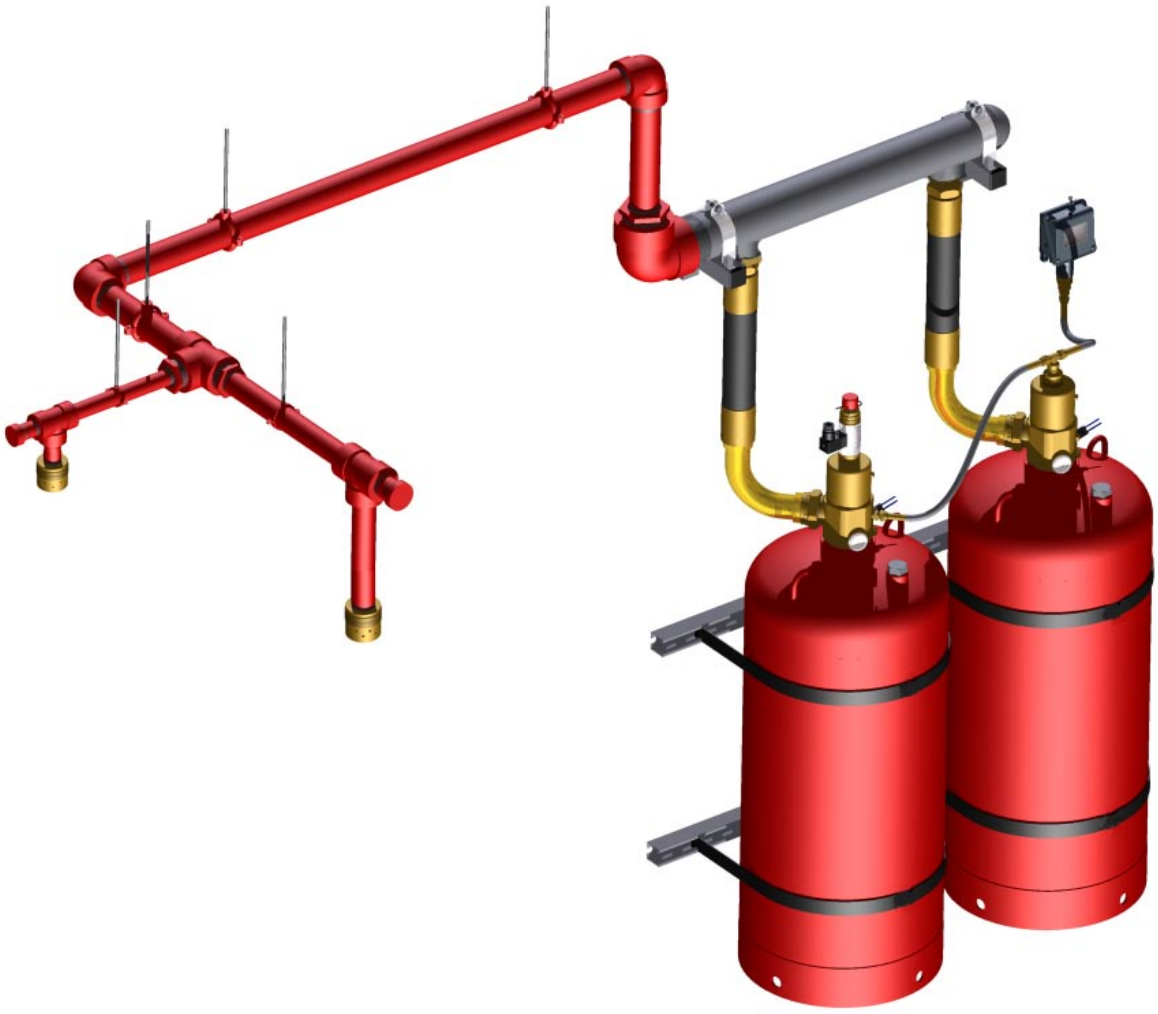
Figure 33 - Liquid Level Measuring Device



Typical Manifold System

Figure 34 indicates a typical two container system complete with electrical actuation, manual actuator, pressure switch, 2 x low pressure switch, flexible connections, distribution pipework and nozzles.

Figure 34 - Typical Manifold System



System Design

There are two main elements of system design. The first is the risk assessment; determining the type of protection required, considerations such as ventilation, openings and restrictions; equipment location. etc. The second is calculating the quantity of FM-200® required, including floor and/or ceiling voids, positioning of nozzles, electrical requirements, etc.

All systems are designed in accordance with NFPA 2001.

Hazard Analysis

The first, and one of the most important, exercises in planning an FM-200® extinguishing system is the hazard survey. The information derived from the survey should include risk assessment, environmental conditions, personnel considerations, system operation both in normal conditions and after a discharge, access and construction limitations, dimensions, volumes, and any special requirements.

FM-200® systems are suitable for use in normal commercial and industrial environments. The minimum design concentration for Class A & C fires is 7.17%* but differs for Class B fires. To determine other recommended design concentrations for Class B flammable liquids, refer to the methodology within NFPA 2001, 2008 edition. All design concentration calculations are based on extinguishing concentrations plus 20% safety factor for Class A & C and 30% safety factor for Class B.

All agent quantities are calculated at minimum design temperature to determine agent quantity. Maximum achieved concentration should be calculated at the maximum anticipated enclosure temperature, and compared to NOAEL / LOAEL values , see table 3.

The FM-200® cupburner value** is 6.7% for commercial grade Heptane.
Nozzle distribution test concentration = 6.9%

Calculations to determine minimum design concentration:

Cupburner or fire test concentration x nozzle efficiency factor x safety factor.

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

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

For Class A (Determined by fire test) -
5.8% x 1.03 x 1.2 = 7.17%
For UL 5.2% x 1.03 x 1.2 = 6.4%

For Class B (Commercial grade Heptane)-
6.7% x 1.3 = 8.7%

For Class B (Other class B fuels)-
cupburner x 1.03 x 1.3 = design concentration, but not less than 9.0%

For Class C -
Use at least design concentration for Class A surfaces fires (7.17%)*

For systems with only manual actuation -
cupburner x 1.03 x 1.3 = design concentration but not less than 9.0%

Rugged environments, and those requiring intrinsically safe or flameproof equipment, require special consideration and should be discussed fully with the technical support centre before finalising a system design. FM-200® is suitable for use with the following materials:

Class A	Fires involving solid materials usually of an organic nature, in which combustion normally takes place with the formation of glowing embers.
Class B	Fires involving flammable liquids or liquefiable solids and flammable gases.
Class C	Fires involving energized electrical equipment where the electrical nonconductivity of the extinguishing media is of importance

* UL Design Concentration - See Page 5
** Cupburner and Cupburner value as defined in NFPA 2001 Annex B

Note. Certain materials in this group may require increased concentrations to achieve satisfactory extinguishment. Consult the technical support centre for details of specific risk.

Caution. FM-200® is not effective on the following: -

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

Hazard Structure

The protected enclosure shall be bounded by rigid elements of building construction. The ceiling should be not less than 0.3 m (1. ft) above the hazard.

During agent discharge, the hazard enclosure will experience a pressure change. Consideration should be given to mitigating these pressure changes.

Hazard Volume

In total flooding applications the risk area must comprise an enclosed space with no significant openings so that the design concentration can be achieved and maintained. Generally, the calculation is based on an empty area; the subsequent furniture and fittings having little effect on the actual concentration. Similarly, large equipment cabinets and control panels should not be considered in the calculation as it is assumed that the internal area is required to be filled with agent.

Each enclosed space is considered as a risk area and requires at least one nozzle. A floor void, ceiling void, cable duct, etc., is treated as a separate adjacent area and requires simultaneous discharge to occur.

Ceiling obstructions such as beams that are less than 300 mm (12″) below the slab need not be considered. Obstructions greater than 300 mm (12″) can affect the distribution of agent and may require additional nozzles. Consult the technical support centre if in doubt.

To determine the volume refer to the site drawings, ensuring that the scale is accurate and that heights are denoted, or make a sketch of the area adding dimensions and any relevant details. Calculate the volume of each area.

Ventilation

If the hazard enclosure has no means of adequate venting after discharge, consideration should be given to installing a normally closed means of ventilation with extraction arrangements which will discharge directly to atmosphere.

Air conditioning and/or forced ventilation can affect the system performance and the quantity of agent required.

(i) Self-contained air conditioning unit

A self-contained unit conditions the air within the enclosure and does not rely on a fresh air supply, or draw air from other parts of the building.

If the hazard has a self-contained unit and it is located within the area without an outside air supply, no additional agent is required. It is not necessary to shut down the unit prior to a discharge as the mixing effect is beneficial.

(ii) Central air conditioning unit

A central air conditioning unit relies on air from outside and is often linked by ducts to other parts of the building, therefore, prior to a discharge, the unit should be shut down and/or dampers operated to close the ducts. Sufficient time must be allowed for the plant to stop, or dampers to close, before discharge occurs.

Dampers should be installed in both supply and return air ducts, as close as possible to the area. The duct volume between the hazard and the damper must be added to the overall volume.

Hazard Temperature

Determine as accurately as possible the anticipated minimum and maximum temperatures likely to be experienced within the protected area. Minimum agent quantity requirements are based on minimum hazard. At maximum temperature, hazard concentration must not exceed the NOAEL/LOAEL values for normally occupied spaces, reference NFPA 2001, Section 1.5 “Safety.”

Hazard Fuels

All fuels in the hazard must be identified and the corresponding agent concentration requirements assessed. The design concentration (percent by volume) required for the hazard will be the highest concentration required by any one of the fuels present in the hazard.

Personnel Safety

Natural Agent: To avoid possible injury, avoid any exposure to FM-200® in volume concentrations greater than 9% unless using self contained breathing apparatus. Limit exposure times as in NFPA 2001, Section 1.5 “Safety.”

Symptoms of overexposure to concentrations greater than 10.5% may include dizziness, impaired coordination, reduced mental acuity, cardiac effects or unconsciousness. In the event of overexposure, remove to fresh air immediately and summon medical assistance.

Frostbite: Direct skin contact with FM-200® in the immediate area of discharge may cause frostbite.

Agent Quantities

Normally the agent quantity is the weight required to produce the desired concentration at the lowest temperature within the hazard enclosure.

Agent Storage

FM-200® is stored as a liquified compressed gas in appropriate containers to meet DOT4BW450, DOT4BW500 and EN 13322-1 requirements. Nitrogen in the container maintains a superpressurisation of 25 bar at 21 °C (360 psi at 70 °F). The chosen location should provide protection from severe weather, mechanical, chemical, or other types of damage.

Once assembled, filled and pressurised the FM-200® extinguishing system should not be exposed to temperatures other than the storage / operating temperature range of 0 to 54 °C. (32 °F to 130 °F). This also includes while being in storage or transported.

Hydraulic calculations assume an agent temperature of 21 °C (70 °F). When the storage temperature varies by 5.5 °C (10 °F) , there is a risk that the system will not supply the designed quantity of extinguishing agent.

Manifolds

It may be necessary to manifold agent containers to provide the required amount of agent for a hazard, or to make available the proper increments of agent weight for the protection of multiple hazards.

Whenever containers are manifolded, the following rules must be observed.

1. All containers connected to the same manifold or pipe must be the same size and filled with the same agent weight, pressure and fill density.

2. Agent containers must be located in a single row and spaced according to section.

3. A connected reserve may be employed in some circumstances providing a secondary supply of agent.

4. Flexible discharge hoses and check valves must be used at each inlet.

Agent Distribution

Distribution piping will be installed only with approved piping as indicated in Section 5.

Pipe size reductions may be made by using reducing tees or reducing bushings or reducing couplings.

Agent Flow Characteristics

Nitrogen Superpressurisation

Nitrogen is added to the FM-200® containers. This addition of nitrogen, known as superpressurisation, will cause a portion of the nitrogen to mix with the FM-200®, the remaining portion of the nitrogen will remain in the vapour space above the liquid providing the increased propulsion necessary to discharge the FM-200® from the container.

Flow in Pipe

In a properly designed distribution piping network the flow of FM-200® will consist of a two phase mixture of liquid and vapour. The properties of this mixture will vary with its composition; therefore, when the mixture contacts the pipeline walls, the friction decreases the density of the mixture resulting in a non-linear pressure drop and an increase in flow velocity.

Another consequence of two-phase flow is the potential for separation of liquid and vapour. In a properly designed pipe network, the velocity of the mixture will be high enough to maintain highly turbulent flow. However, if the pipeline diameter is too large for the design flow rate, the two phases may separate, leading to alternate discharges of liquid and vapour (slugging) or layering of the two phases. Therefore, the pipeline must be properly sized to keep the FM-200® flow turbulent enough to prevent phase separation.

Initial Vapour Discharge

At the instant the discharge valve is opened, rapid expansion of the agent will cool the piping network.

Trailing Vapour Pressure

Discharge time is defined as the average liquid discharge time through all nozzles in the system. After the liquid portion of the discharge has been completed, there will be a short transition period followed by the delivery of the remaining FM-200® nitrogen mixture as a vapour. This is due to flashing of the trailing edge of the fluid as it moves from the tank to the nozzles. In some systems the transition period is relatively long; this can lead to confusion as to when the discharge is complete, possibly resulting in an inaccurate measurement of the discharge time.

Nozzle Selection and Location

The number of nozzles required is based on the hazard size and configuration and the coverage provided by the nozzle. Nozzles are available in 7-port or 8-port versions to provide 180 or 360 degree discharge patterns respectively. When considering the optimum nozzle location, the following factors should be taken into account.

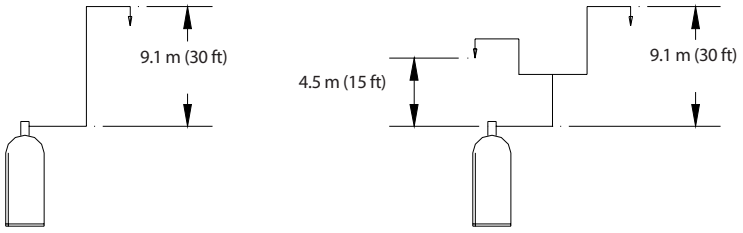
- Nozzle location is affected by the shape of the hazard area.
- The maximum discharge radius is 8.7 m (28.6 ft) for a 360° nozzle and 10.05 m (33 ft) for a 180° nozzle.
- The maximum coverage area for either nozzle is 95.3 m² (1026 ft²).
- Nozzle orifices must not be placed where they may discharge into nearby objects.
- Nozzles must be installed a maximum of 300 mm (12″) below the ceiling.
- 4.87 m (16 ft) maximum protection height for 360° and 180° nozzle.
- 180 degree nozzles must be mounted adjacent to a wall and must be located to cover the entire area.
- 300 mm (12″) minimum void height (i.e. Sub-floors and false ceilings).
- Maximum distance 180 degree nozzles should be placed from a wall 300 mm (12″), the minimum 50 mm (2″). Measured from centre of the nozzle to the wall.
- Nozzles located both above and below the container outlet, Maximum distance between them 9.1 m (30 ft).
- Nozzles located either above or below the container outlet, maximum distance between them 9.1 m (30 ft).

Maximum Limits (Elevation) in Pipe Work.

Examples:

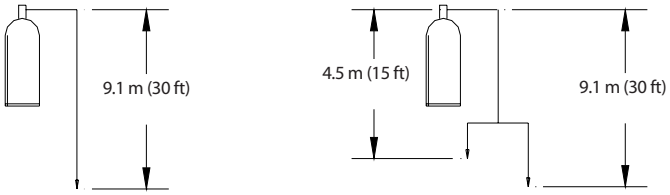
If nozzles are only located above the container outlet, then the maximum elevation difference between the container outlet and the furthest horizontal pipe run or discharge nozzle (whichever is furthest) shall not exceed 9.1 m (30 ft). See Figure 35.

Figure 35 - Nozzles Located Above the Container Outlet



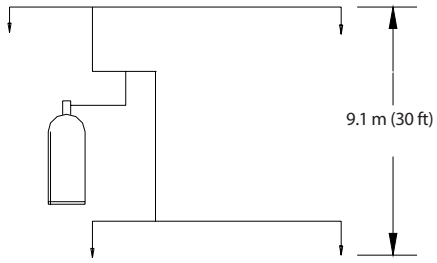
If nozzles are only located below the container outlet, then the maximum elevation difference between the container outlet and the furthest horizontal pipe run or discharge nozzle (whichever is furthest) shall not exceed 9.1 m (30 ft). See Figure 36.

Figure 36 - Nozzles Located Below the Container Outlet



If nozzles are located both above and below the container outlet, then the maximum distance between the furthest horizontal pipe runs, or discharge nozzles (whichever is further) shall not exceed 9.1 m (30 ft). See Figure 37.

Figure 37 - Nozzles Located Above and Below the Container Outlet

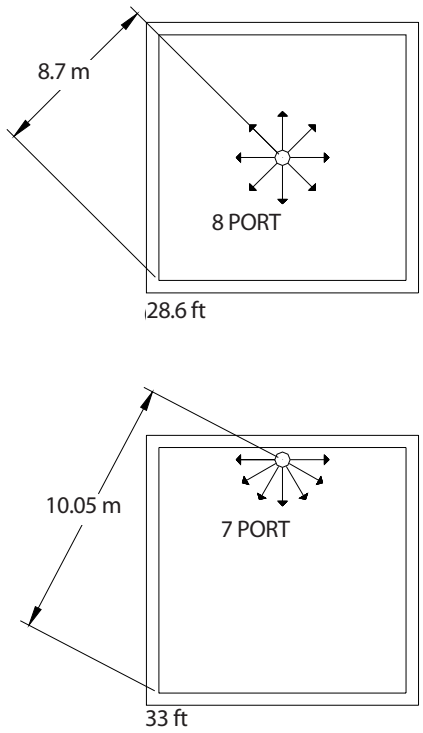


Note: If a system design violates these limits, contact the technical support centre to determine what action has to be taken.

Nozzle Discharge Radius

The maximum discharge radius is 8.7 m (28.6ft) for a 360° nozzle and 10.05 m (33ft) for a 180° nozzle.

Figure 38 - Nozzle Discharge Radius



Example: Nozzle Selection

Switch Room:	120.7 m^3 (4262.6 ft^3)	1 x 7 port nozzle
Computer Room:	543.3 m^3 (19237.1 ft^3)	4 x 8 port nozzles
Floor Void:	63.36 m^3 (2275.4 ft^3)	2 x 8 port nozzles

Nozzle placement and piping arrangements for the example are shown in Figure 45.

System Design Procedure

The following procedure must be followed when designing FM-200® systems.

- Determine hazard material and required design concentration.
- Identify individual enclosure volumes and deduct any impermeable volumes where appropriate.
- Determine hazard altitude and correction factor.
- Calculate quantity of FM-200® per enclosure, at minimum design temperature.
- Determine container size and fill density.
- Select nozzle type and location.
- Design pipe network.
- Calculate quantity of FM-200® per nozzle.
- Check percentage agent split at tee's.
- Identify all pipe lengths, rises, falls and nozzle reference numbers.

Note: The side tee splits shall be between 10-30%, bull tee splits will be between 30-70%. All Tee outlets must be in the same horizontal plane.

See examples figures 39 to 44.

Example: Tee Split Designs

Figure 39 - Side Tee Split limits.

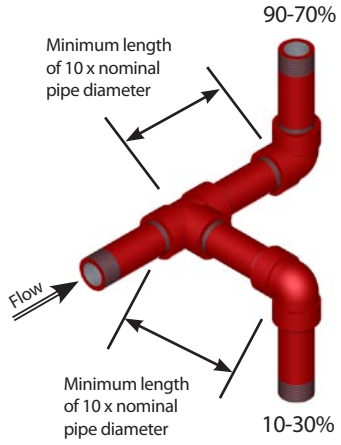


Figure 40 - Bull Tee Split limits.

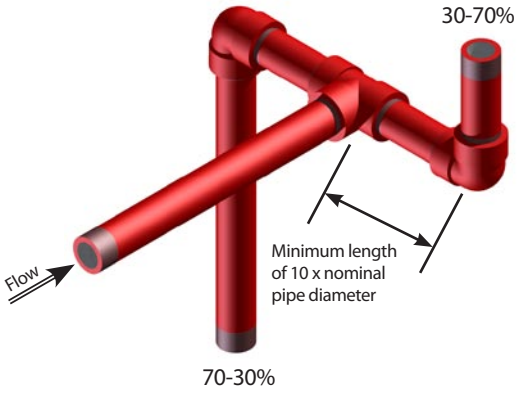


Figure 41 - Side tee orientation "correct"

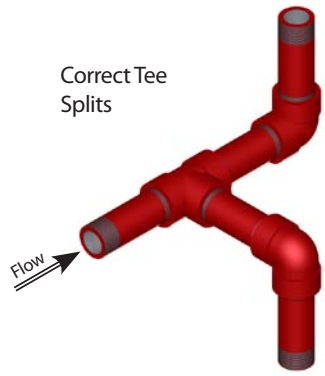
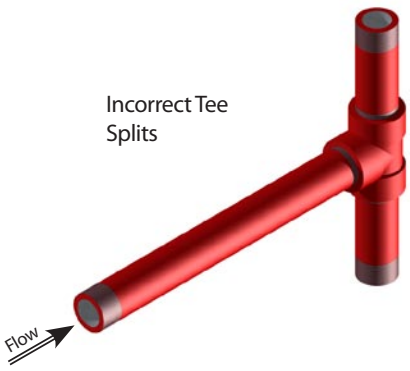


Figure 42 - Side tee orientation "incorrect"

Figure 43 - Bull tee orientation "correct"

Figure 44 - Bull tee orientation "incorrect"



NOTE: Incorrect orientation of side and bull tee could result in separation of the FM-200® from the Nitrogen (due to FM-200® greater density). The design would also be outside the parameters permitted by the calculation software. See figures 42 and 44.

Design Example - Calculations

Minimum Agent Quantity is based on the hazard volume at the minimum anticipated temperature and concentration required. To determine the minimum agent quantity the following equation is used:

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

W = Weight of agent required (kg)

V = Hazard volume (m^3)

S = Specific Vapour Volume (m^3/kg)

S = 0.1269 + 0.0005131t

t = Design Temperature in Hazard Area (°C)

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

Example:

Calculation for two rooms and floor void with the following dimensions:

Switch Room: 7.0 x 6.9 x 2.5 = 120.8 m^3

Computer Room: 16.0 x 12.0 x 2.8 = 537.6 m^3

Floor Void: 16.0 x 12.0 x 0.34 = 65.3 m^3

t = 21 °C for calculation example

Switch Room: (7.20% required design concentration example only)

$$W = \frac{120.8}{0.1376751} \times \frac{7.2}{(100-7.2)} = 68.1 \text{ kg}$$

Computer Room: (7.2% required design concentration example only)

$$W = \frac{537.6}{0.1376751} \times \frac{7.2}{(100-7.2)} = 303.0 \text{ kg}$$

Floor Void: (7.2% required design concentration example only)

$$W = \frac{65.3}{0.1376751} \times \frac{7.2}{(100-7.2)} = 36.8 \text{ kg}$$

When the minimum quantity of FM-200® has been calculated the weight is compared to the available agent container size. The container size must be equal to or greater then the weight of agent (see Table 4).

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;

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

Switch Room: 120.8/723.7 = 16.7% of agent

Computer Room: 537.6/723.7 = 74.3% of agent

Floor Void: 65.3/723.7 = 9.0% of agent

It is determined from the above that both the Switch Room and the Computer Room can be fed by one manifolded system using 3 x 180 litre containers, each filled with 124 kg of agent. The Floor Void would use 1 x 52 litre container filled with 37 kg as it requires less than 10% of the total agent and therefore equates as follows. (Separate tank is required for floor voids. If protected with nozzle from computer room system, the piping would be outside the tee split limits.)

Switch Room: 120.8/658.4 = 18.3% of agent

Computer Room: 537.6/658.4 = 81.7% of agent

Floor Void: 65.3/65.3 = 100% of agent

Actual agent to Switch Room :

0.183 x 3 x 124 = 68.1 kg

Agent to Computer Room :

3 x 124 - 68.1 = 303.9 kg

The minimum enclosure concentrations can be calculated based on the actual container fill (21 °C minimum design temperature).

Switch Room: $C = \frac{100 \times 68.1 \times 0.1376751}{(68.1 \times 0.1376751) + 120.8} = 7.20\%$

Computer Room: $C = \frac{100 \times 303.9 \times 0.1376751}{(303.9 \times 0.1376751) + 537.6} = 7.22\%$

Floor Void: $C = \frac{100 \times 36.8 \times 0.1376751}{(36.8 \times 0.1376751) + 65.3} = 7.20\%$

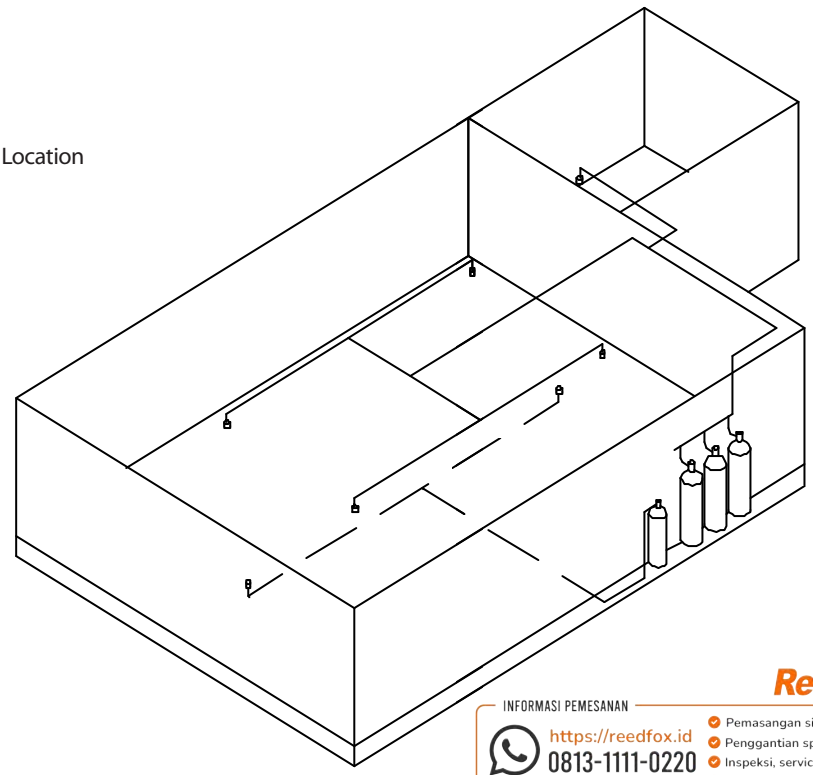
After determining the minimum weight and concentration, the maximum concentration can be determined by recalculating the equation based on the maximum temperature anticipated in each enclosure 27 °C maximum design temperature. This calculation is required to determine if the maximum concentration is below the NOAEL limit for normally occupied areas.

Switch Room: $C = \frac{100 \times 68.1 \times 0.1407537}{(68.1 \times 0.1407537) + 120.8} = 7.35\%$

Computer Room: $C = \frac{100 \times 303.9 \times 0.1407537}{(303.9 \times 0.1407537) + 537.6} = 7.37\%$

Floor Void: $C = \frac{100 \times 36.8 \times 0.1407537}{(36.8 \times 0.1407537) + 65.3} = 7.35\%$

Figure 45 - Example Nozzle Location



Piping Practices

Due to the two phase flow of FM-200®, certain piping practices must be adhered to. Mainly that the flow split must be on the horizontal plane. There are two types of tee used in FM-200® systems, a through /side tee and a bull tee. Both have limitations on the minimum and maximum allowable flow splits which are detailed on page 43.

It should also be noted that system designers shall allow a minimum of 10 times the nominal pipe diameter around tee splits before any change of direction.

System designers should aim to design as far as possible balanced pipe networks, use minimum lengths of pipe, use minimum numbers of elbows, maximize pipe volume before the 1st tee and incorporate similar pipe run lengths to nozzles.

Introduction

In determining the quantity of FM-200® required for a particular application, it is important to assess the hazard area correctly. The following information will need to be determined as discussed in Section 3.

1. Hazard Volume.
2. Minimum Room Temperature.
3. Hazard Type.
4. Height above sea-level.

The Hazard volume can be determined by calculating the room volume and deducting any impermeable volumes that may be contained within the area. The anticipated temperature of the Hazard area will normally be advised by the client. The agent concentration is dependant upon the type of hazard being protected and hazard altitude. The quantity of FM-200® can be calculated by using the flooding factors (Table 10. metric / 11. imperial) or by using the formula (FM-200® Equation Calculations) and then multiplying by the altitude correction factor (Table 12).

Example:

Hazard Volume: 280 m³
Room Temperature: 20 °C
Agent Concentration: 7.17%*
Flooding Factor: 0.5625

Quantity of FM-200® required: 0.5625 x 280 =175.5 kg

Note: Specific Vapour Volume data shown in Tables 10 and 11 are experimentally derived values and the specific vapour volume equation (S) has a correlation coefficient of 0.99. However the equation can be used to give a close approximation of required agent quantities.

Table 10: FM-200® Weight Calculations Metric

Temp	Specific Vapor Volume	Weight Requirements of Hazard Volume, W/V (kg/m³) Design Concentration (% per volume)										
		6.4	7	7.17	8	9	10	11	12	13	14	15
t (°C)[c]	s (m³/kg)[d]											
-10	0.1215	0.5615	0.6196	0.6357	0.7158	0.8142	0.9147	1.0174	1.1225	1.2301	1.3401	1.4527
-5	0.1241	0.5499	0.6064	0.6223	0.7005	0.7987	0.8951	0.9957	1.0985	1.2038	1.3114	1.4216
0	0.1268	0.5388	0.5936	0.6091	0.6858	0.78	0.8763	0.9748	1.0755	1.1785	1.2839	1.3918
5	0.1294	0.5281	0.5816	0.5968	0.6719	0.7642	0.8586	0.955	1.0537	1.1546	1.2579	1.3636
10	0.132	0.5179	0.57	0.5851	0.6585	0.749	0.8414	0.936	1.0327	1.1316	1.2328	1.2264
15	0.1347	0.5080	0.5589	0.5734	0.6457	0.7344	0.8251	0.9178	1.0126	1.1096	1.2089	1.3105
20	0.1373	0.4985	0.5483	0.5625	0.6335	0.7205	0.8094	0.9004	0.9934	1.0886	1.1859	1.2856
25	0.1399	0.4894	0.5382	0.5520	0.6217	0.7071	0.7944	0.8837	0.975	1.0684	1.164	1.2618
30	0.1425	0.4805	0.5284	0.5420	0.6104	0.6943	0.78	0.8676	0.9573	1.049	1.1428	1.2388
35	0.145	0.4720	0.519	0.5326	0.5996	0.6819	0.7661	0.8522	0.9402	1.0303	1.1224	1.2168
40	0.1476	0.4638	0.5099	0.5232	0.5891	0.6701	0.7528	0.8374	0.9230	1.0124	1.1029	1.1956
45	0.1502	0.4559	0.5012	0.5142	0.579	0.6586	0.7399	0.823	0.0908	0.995	1.084	1.1751
50	0.157	0.4482	0.4929	0.4919	0.5694	0.6476	0.7276	0.8093	0.8929	0.9784	1.066	1.1555
55	0.1553	0.4408	0.4847	0.4973	0.56	0.6369	0.7156	0.796	0.8782	0.9623	1.0484	1.1365

* UL Design Concentration - See Page 5

Table 11: FM-200® Weight Calculations Imperial

Temp	Specific Vapor Volume	Weight Requirements of Hazard Volume, W/V (lb/ft³) Design Concentration (% per volume)										
		6.4	7	7.17	8	9	10	11	12	13	14	15
t (°F)[c]	s (ft³/lb)[d]											
10	1.9264	0.0354	0.0391	0.0401	0.0451	0.0513	0.057	0.0642	0.0708	0.0776	0.0845	0.0916
20	1.9736	0.0346	0.0381	0.0391	0.0441	0.0501	0.0563	0.0626	0.0691	0.0757	0.0825	0.0894
30	2.0210	0.0338	0.0372	0.0382	0.0430	0.0489	0.0550	0.0612	0.0675	0.0739	0.0805	0.0873
40	2.0678	0.0330	0.0364	0.0373	0.0421	0.0478	0.0537	0.0598	0.0659	0.0723	0.0787	0.0853
50	2.1146	0.0323	0.0356	0.0365	0.0411	0.0468	0.0525	0.0584	0.0645	0.0707	0.0770	0.0835
60	2.1612	0.0316	0.0348	0.0357	0.0402	0.0458	0.0514	0.0572	0.0631	0.0691	0.0753	0.0817
70	2.2075	0.0310	0.0341	0.0349	0.0394	0.0448	0.0503	0.056	0.0618	0.0677	0.0737	0.0799
80	2.2538	0.0303	0.0334	0.0342	0.0386	0.0439	0.0493	0.0548	0.0605	0.0663	0.0722	0.0783
90	2.2994	0.0297	0.0327	0.0335	0.0378	0.0430	0.0483	0.0538	0.0593	0.0650	0.0708	0.0767
100	2.3452	0.0292	0.0321	0.0329	0.0371	0.0422	0.0474	0.0527	0.0581	0.0637	0.0694	0.0752
110	2.3912	0.0286	0.0315	0.0323	0.0364	0.0414	0.0465	0.0517	0.0570	0.0625	0.0681	0.0738
120	2.4366	0.0281	0.0309	0.0316	0.0357	0.0406	0.0456	0.0507	0.0560	0.0613	0.0668	0.0724
130	2.4820	0.0275	0.0303	0.0311	0.0350	0.0398	0.0448	0.0498	0.0549	0.0602	0.0656	0.0711
140	2.572	0.0270	0.0298	0.0306	0.0344	0.0391	0.0440	0.0489	0.0540	0.0591	0.0644	0.0698

Table 12: Altitude Correction Factor

Altitude above sea-level		Correction Factor
ft	(km)	
-3000	(-0.92)	1.11
-2000	(-0.61)	1.07
-1000	(-0.30)	1.04
0	(0.00)	1.00
1000	(0.30)	0.96
2000	(0.61)	0.93
3000	(0.91)	0.89
4000	(1.22)	0.86
5000	(1.52)	0.82
6000	(1.83)	0.78
7000	(2.13)	0.75
8000	(2.45)	0.72
9000	(2.74)	0.69
10000	(3.05)	0.66

(BS5306-5.1 / NPFA2001 Table 3-6)

At elevations above sea-level, FM-200® has a greater specific volume because of the reduced atmospheric pressure. A system designed for sea-level conditions will therefore develop an actual higher concentration at levels above sea-level and an actual lower concentration at levels below sea-level. The adjusted agent quantity is calculated by multiplying W (from the equation on the left) by the altitude correction factor. The design quantity of the clean agent shall be adjusted to compensate for ambient pressure that vary more than 11 percent (equivalent to approximately 915 m (3000 ft) of elevation change) from standard sea level pressure 760 mm Hg at 0 °C (29.92 in Hg at 70 °F).

FM-200® Equation Calculations

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

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

W = Weight of agent required kg (lbs)

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

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

where S = 0.1269 + 0.0005131 t (°C)

or (S= 1.885 + 0.0046 t °F)

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

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

Engineered Systems

Engineered systems are based on a Hydraulic Flow Program developed by Hughes Associates Inc. The program predicts the two phase flow of FM-200® and nitrogen through a pipe network. Information detailing the enclosure is entered and the program calculates the required pipe sizes, nozzle drill sizes, average nozzle pressures and discharge time. For further information on the Flow Program, refer to the Hughes Flow Program User's Manual.

As system design calculations are critical to the success of the extinguishing system, only trained personnel are permitted to perform system calculations. If in the future, other companies wish to use the program, representatives will be required to attend a formal training session. All system calculations are conducted 'in house' or by authorised suppliers.

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

Program Parameters

When designing pipe network systems, the following design parameters should be considered to avoid system reject when running the calculation.

- 4.87 bar (70.6 psi) minimum nozzle pressure.
- 80% maximum agent in pipe.
- Between 6 - 10 seconds discharge time.
- 10 - 30 % side tee split.
- 30 -70 % bull tee split.
- 0.5 kg/l (31.2 lbs/ft^3) - 1.0 kg/l (62.4 lbs/ft^3) fill density.
- Max. liquid arrival time imbalance of 1.0 seconds.
- Maximum liquid run out time of 2.0 seconds.
- Maximum nozzle height is 4.87 m (16.0 ft)
- Minimum of 10% agent in pipe before first tee.
- Maximum of 20 nozzles per system.
- Maximum of 10 enclosures per system.
- The ratio between the nozzle area and the pipe cross sectional area immediately preceding the nozzle is limited to a minimum of 0.20 (20%) and a maximum of 0.80 (80%).

(For extended discharge consult the technical support centre)

Table 13 : Max. & Min. Flow Rates

Pipe Size mm (in)	Minimum flow rate kg/s (lb/s)	Maximum flow rate kg/s (lb/s)
10 (3/8)	0.272 (0.60)	0.907 (2.00)
15(½)	0.454 (1.00)	1.361 (3.00)
20 (¾)	0.907 (2.00)	2.495 (5.50)
25 (1)	1.588 (3.50)	3.855 (8.50)
32 (1¼)	2.722 (6.00)	5.67 (12.50)
40 (1½)	4.082 (9.00)	9.072 (20.00)
50 (2)	6.35 (14.00)	13.61 (30.00)
65 (2½)	9.072 (20.00)	24.95 (55.00)
80 (3)	13.61 (30.00)	44.92 (99.00)
100 (4)	24.95 (55.00)	56.7 (125.00)
125 (5)	40.82 (90.00)	90.72 (200.00)
150 (6)	54.43 (120.00)	136.1 (300.00)

Note: This information is for Schedule 40 pipe, and serves as an estimate only.

Pipe and nozzle sizes need to be confirmed by the computer programme.

Table 14 : Equivalent Length for Pipe Fittings

Diameter		90° Elbow		45° Elbow		Thru Tee		Side Tee		Union	
m	(in)	m	(ft)	m	(ft)	m	(ft)	m	(ft)	m	(ft)
10	(3/8)	0.4	(1.2)	0.18	(0.5)	0.24	(0.7)	0.82	(2.5)	0.09	(0.3)
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	(1¼)	1.13	(3.4)	0.52	(1.6)	0.7	(2.1)	2.29	(7.0)	0.24	(0.7)
40	(1½)	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	(2½)	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	(30.5)	1.07	(3.3)

Equivalent length table for pipe fittings.
Figures based upon schedule 40 ASTM A 106 - 77 pipe
(nominal pipe size given in table).

Table 15 : Equivalent Length for other system components

Hardware Set	Size		Equivalent length	
Valve	25 mm	(1 ″)	6.096 m	(20 ft)
	50 mm	(2 ″)	10.668 m	(35 ft)
	80 mm	(3 ″)	25.91 m	(85.0 ft)
Flex Hose	25 mm	(1 ″)	3.14 m	(10.3 ft)
	50 mm	(2 ″)	5.36 m	(17.6 ft)
	80 mm	(3 ″)	1.55 m	(5.1 ft)
Flex Hose and Check Valve Combination	25 mm	(1 ″)	3.54 m	(11.6 ft)
	50 mm	(2 ″)	12.02 m	(39.4 ft)
	80 mm	(3 ″)	15.85 m	(52 ft)
Valve Outlet Adaptor	25 mm	(1 ″)	0.18 m	(0.6 ft)
	50 mm	(2 ″)	0.37 m	(1.2 ft)
	80 mm Flared to NPT		0.55 m	(1.8 ft)
	80 mm Flared to Grooved		0.55 m	(1.8 ft)
	80 mm Flared to BSP		0.55 m	(1.8 ft)

Figures based upon schedule 40 ASTM A 106- 77 pipe
(nominal pipe size given in table).

General Information

All installation shall be carried out by an approved contractor with the correct equipment and previous experience of gaseous extinguishing systems. The supplier can provide this service or provide a list of their factory trained installation contractors. Installation instructions are described under the following main headings, and in the order of installation.

- Container Installation
- Piping and Nozzles
- Actuation Controls
- Ancillary Equipment
- Completion Procedures

Specific installation drawings must be prepared for the hazard area in accordance with system design as calculated by the FM-200® Hydraulic Flow Program. These drawings should be followed closely in order to ensure the system meets its design criteria. The pipe network is sized in order to obtain correct discharge time, nozzle pressures, agent quantity and various other design considerations. If for any reason, the pipe network requires modifications the system must be recalculated before proceeding with installation. Installation drawings contain the following information;

- Enclosure Volumes.
- Agent Quantities.
- Scaled Pipe Network Plan.
- Pipe Network Isometric.
- Pipe Diameters, Pipe Length Drops & Rises.
- Nozzle Data.
- Container Data.
- Solenoid Actuator Technical Data.
- Low Pressure Switch Wiring Chart
- Fittings Data.

Installation drawings shall be submitted for approval to the appropriate authority prior to system installation.

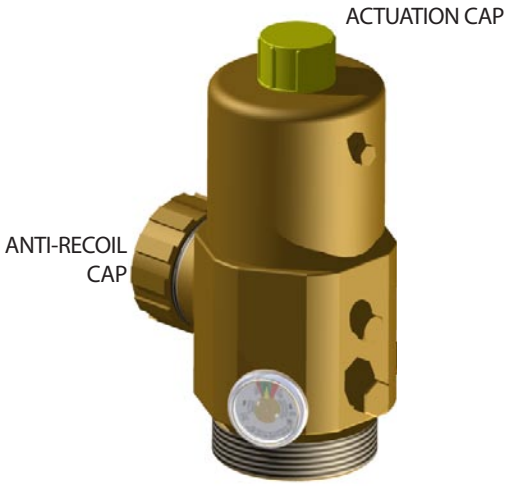
On receipt, unpack the supplied items and ensure that the components comply with the packing list and installation drawings.

The container weight is checked at the factory prior to dispatch, and recorded on the label attached to the container. If there is any doubt regarding the weight, or leakage is suspected, the container should be weighed to confirm there is no weight loss.To check agent weight in 106, 147, 180 and 343 litre containers with an installed liquid level measuring device, see Maintenance Section of this manual. Determine the container storage temperature and refer to the Temperature Correction Chart to check the pressure within the container (see Appendix A).

Container Installation

The container location is identified on the system drawings and should be protected from extremes of temperature, and be accessible for service and maintenance. The containers must be firmly secured to a wall or bulkhead, in a vertical orientation only.

Figure 46 - Outlet Anti-Recoil and Actuation Caps



Anti-recoil Caps

25 mm (1″)	1″ BSP	Brass	Part No. 12687
50 mm (2″)	2″ BSP	Brass	Part No. 14004
80 mm (3″)	3″ Flared	Brass	Part No. 15148

Actuation Cap

25 mm (1″)	Plastic	Part No. 12569

Single Container Installation

1. Fix the back channels of the mounting brackets to the wall at the appropriate heights (see table 16), using suitable anchor type bolts (not supplied).
2. Position the container against the back channel with the valve outlet pointing left.
3. Insert the container straps at top and bottom and secure with the bolts provided (see Figure 48).
4. Remove the anti-recoil cap from the valve outlet adaptor (see Figure 46).
5. For 8 - 180 litre containers (25 mm (1″) and 50 mm (2″) valves): With the anti-recoil cap removed from the valve outlet adaptor, install a union coupling.

   For 343 litre container (80 mm (3″) valve): Install single container adaptor onto the discharge outlet. Either a grooved pipe, NPT, or BSPT threaded adaptor may be used. See Figure 47.

Caution. Do not over tighten the container connection. Excessive tightening may cause the valve outlet thread to be damaged and adversely affect the system operation.

6. Install the initial pipe run and then disconnect the container and refit the anti-recoil cap to the valve outlet.
7. Re-connect the pipe to the container after the pipework system is complete and the discharge nozzles have been installed.

Note: For 343 litre container (80 mm (3″) valve): Connect elbow and discharge hose or pipe directly to the adaptor. A union is not required as the adaptor has swivel couplings to allow for pipe removal during recharging or maintenance.

Figure 47 - Discharge Outlet Connections.

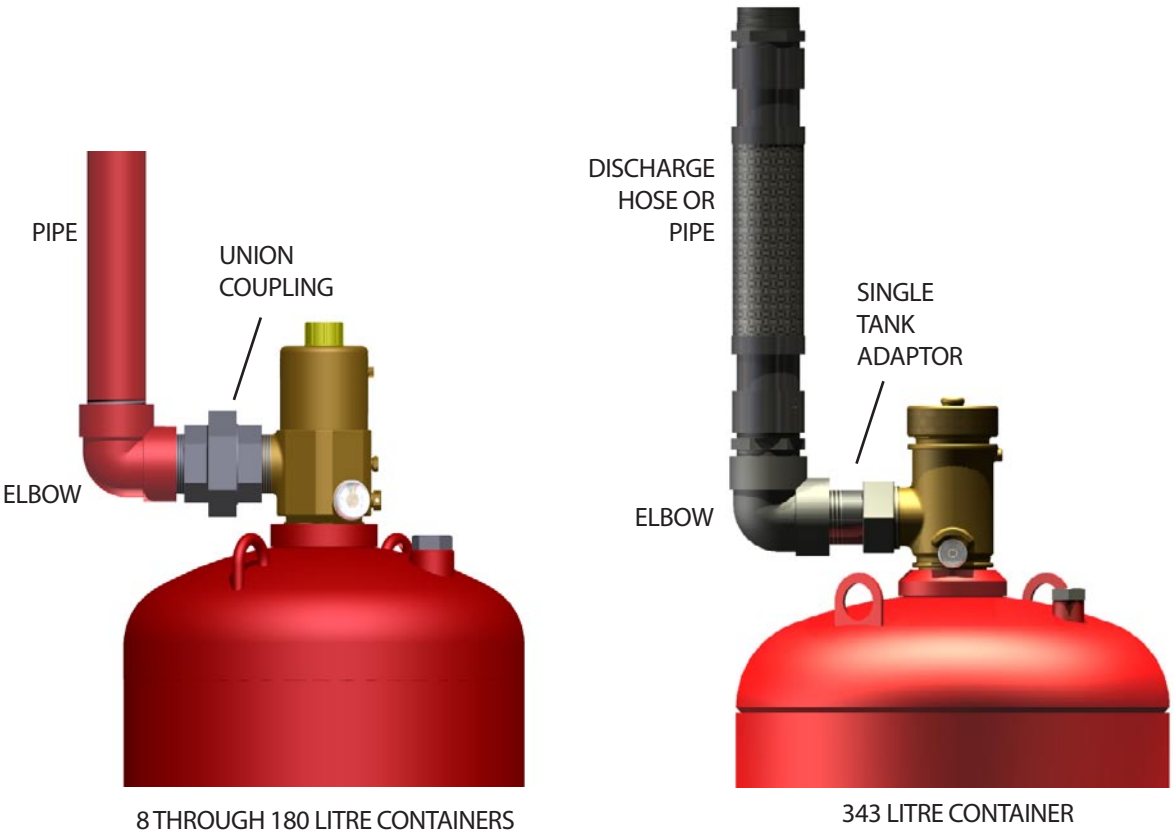
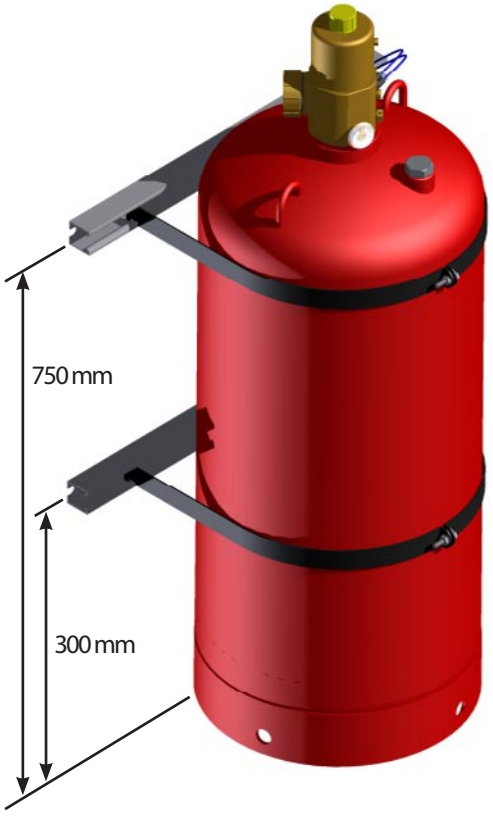


Table 16: Bracket Fixing Heights

Container Size	No. of Unistrut Channels	Height From Floor to Bracket mm	(in)
4.5 litre: 2.3 to 4.5 kg (5 to 10 lbs.)	1	130	(5″)
8 litre: 4.0 to 8.0 kg (9 to 18 lbs.)	1	130	(5″)
16 litre: 8.0 to 16.0 kg (18 to 35 lbs.)	2	60, 330	(2.5″, 13″)
32 litre: 16.0 to 32.0 kg (35 to 71 lbs.)	2	160, 595	(6.25″, 23.5″)
40 litre*: 20.0 to 40.0 kg (44 to 88 lbs.)	2	300, 1000	(11.75″, 39.25″)
52 litre: 26.0 to 52.0 kg (57 to 115 lbs.)	2	110, 343	(4.25″, 13.5″)
67.5 litre*: 33.8 to 67.5 kg (75 to 149 lbs.)	2	300, 1100	(11.75″, 43.25″)
80 litre*: 40.0 to 80.0 kg (88 to 176 lbs.)	2	300, 1200	(11.75″, 47.25″)
106 litre: 53.0 to 106.0 kg (117 to 234 lbs.)	2	300, 750	(11.75″, 29.5″)
147 litre: 73.5 to 147.0 kg (162 to 324 lbs.)	2	300, 1000	(11.75″, 39.25″)
180 litre: 90.0 to 180.0 kg (198 to 397 lbs.)	2	300, 1200	(11.75″, 47.25″)
343 litre: 171.5 to 343 kg (378 to 756 lbs.)	2	300, 1100	(11.75″, 43.25″)

* For UL Listed Systems Only (Not FM Approved)

Figure 48 - Container Strap Location (106L Example)



Multiple Container Installation

Containers are manifolded together for three main reasons;

- To reduce the amount of piping required by connection to one feeder pipe.
- For systems that require main and reserve.
- Combining the correct containers to obtain the required quantity of agent within a specific hazard area.

A typical 80 mm (3″), three port manifold assembly consists of the manifold, three check valves and an end cap. Each check valve is screwed to manifold (25 mm (1″) and 50 mm (2″) valves only).

1 Fix the back channels of the mounting brackets to the wall at the appropriate heights (see table 16), using suitable anchor type bolts (not supplied).

2 Position the containers against the back channels with the valve outlets pointing left at the required spacing for the manifold ports (see Figure 19, and Table 6).

3 Insert the container straps at top and bottom and secure with the bolts provided (see Figure 48).

Manifold Bracket Installation

1. Fix the two back vertical channels to the wall at the appropriate height using suitable anchor type bolts (see table 17).

Back channels are used to ensure that the appropriate height adjustment is available when connecting the discharge hose from the valve outlet to the manifold check valve (see figure 50).

2. Locate and secure the cantilever brackets to each channel using M10 x 40 mm Hex Head screw and uninut long spring 10 mm.
3. Locate manifold brackets in cantilever channel and unirax end caps.
4. For 25 mm (1″) and 50 mm (2″)Valves: Remove anti-recoil cap and attach discharge hose between valve and manifold. Adjust cantilever height as required and secure in position.
5. For safety remove discharge hose and replace safety caps, while pipework is installed.
6. For 80mm (3″) valve: To install hose/check valve assembly between the valve discharge outlet and the pipe manifold, complete the following steps.

(see Figure 49).

Caution. (80 mm Valve Only). Make certain the swivel nut covers the paint on the check valve threads or malfunction of the hose/check valve combination may result. Do not overtighten, as the nut will bend the hose, resulting in flow restriction.

a. Install the check valve into the manifold inlet.

b. Align the valve outlet with the inlet of the discharge hose. Install the swivel nut on the discharge valve. Wrench tighten.

c. Thread the hose swivel nut onto the check valve until the swivel nut covers the paint on the check valve threads. Secure the nut with the locking set screw (provided) to prevent the nut from loosening with vibration.

Figure 49 - 80mm (3") Hose/Check Valve Installation

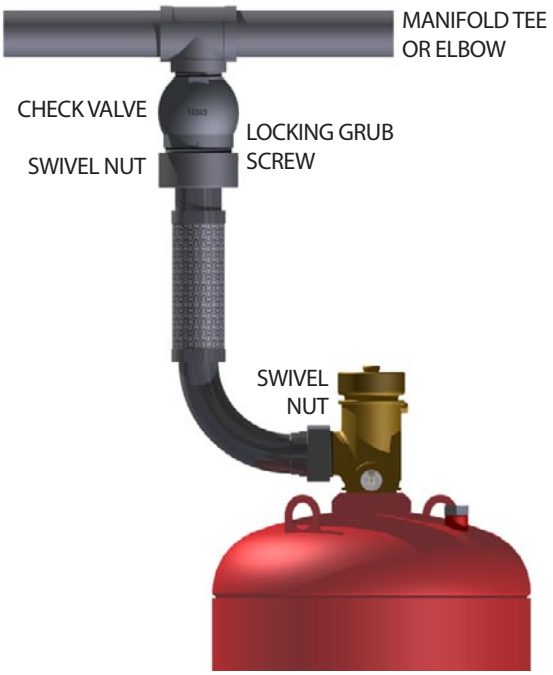
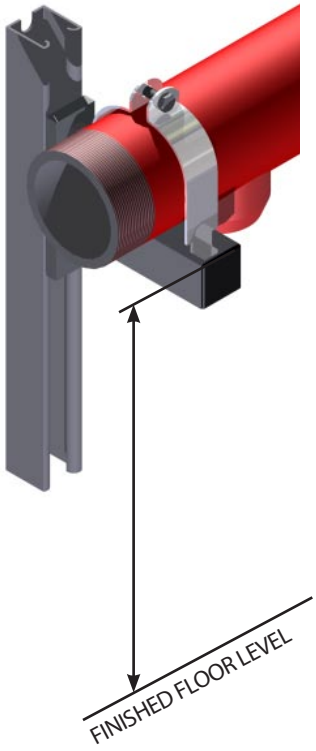


Table 17: Manifold Bracket Fixing Heights

Container Size (L)	Valve Size mm (in)	Manifold Size mm (in)	Nominal Height from Floor to top of cantilever mm (in)
4.5 2.3 to 4.5 kg (5 to 10 lb)	25 (1″)	65 (2.5″)	727 (28.6″)
8 4.0 to 8.0 kg (9 to 18 lb)	25 (1″)	65 (2.5″)	750 (29.5″)
16 8.0 to 16.0 kg (18 to 35 lb)	25 (1″)	65 (2.5″)	949 (37.4″)
32 16.0 to 32.0 kg (35 to 71 lb)	25 (1″)	65 (2.5″)	1289 (50.75″)
40* 20.0 to 40.0 kg (44 to 88 lb)	50 (2″)	80 (3″)	1932 (76.1″)
52 26.0 to 52.0 kg (57 to 115 lb)	50 (2″)	80 (3″)	1133 (44.6″)
67.5* 33.8 to 67.5 kg (75 to 149 lb)	50 (2″)	80 (3″)	2106 (82.9″)
67.5* 33.8 to 67.5 kg (75 to 149 lb)	50 (2″)	100 (4″)	2106 (82.9″)
80* 40.0 to 80.0 kg (88 to 176 lb)	50 (2″)	80 (3″)	2265 (89.2″)
80* 40.0 to 80.0 kg (88 to 176 lb)	50 (2″)	100 (4″)	2 2 6 5 (89.2″)
106 53.0 to 106.0 kg (117 to 234 lb)	50 (2″)	80 (3″)	1601 (63.0″)
106 53.0 to 106.0 kg (117 to 234 lb)	50 (2″)	100 (4″)	1061 (63″)
147 73.5 to 147.0 kg (162 to 324 lb)	50 (2″)	80 (3″)	1931 (76″)
147 73.5 to 147.0 kg (162 to 324 lb)	50 (2″)	100 (4″)	1931 (76″)
147 73.5 to 147.0 kg (162 to 324 lb)	50 (2″)	150 (6″)	1931 (67″)
180 90.0 to 180.0 kg (198 to 397 lb)	50 (2″)	100 (4″)	2210 (87″)
180 90.0 to 180.0 kg (198 to 397 lb)	50 (2″)	150 (6″)	2210 (87″)
343 171.5 to 343.0 kg (378 to 756 lb)	80 (3″)	100 (4″) 150 (6″) NPT	2274 (89.5″)

* For UL Listed Systems Only (Not FM Approved)

Figure 50 - Manifold Assembly



Pipe Installation

In general, the installation should commence at the union elbow / manifold assembly and progress along to the discharge nozzles. Install the Pipework to the installation drawings provided, ensuring that the following is adhered to:

- The piping material must conform to the requirements of NFPA 2001 4.2
- The pipe must be reamed, blown clear and swabbed with an appropriate solvent to remove mill varnish and cutting oil before assembly as required by NFPA 2001 4.2.
- PTFE (Teflon) tape is the only acceptable pipe sealant and must be applied to the male threads.

Table 19: UK Fittings

Fitting Description	Pipe Size
Screwed, complying with BS1256,BS1740 or Class 150 of ANSI B16.3; or	up to & including 20 mm
Forged Steel, Screwed complying with grade WPA or WPB of BS3799; or	
Forged Steel, Socket Weld, complying with grade WPA or WPB of BS3799; or	
Forged Steel, Butt Weld, complying with grade WPA or WPB of BS1640: Part 3 or Class 300 of ANSI B16.9;	
Screwed, complying with BS1740 or Class 150 of ANSI B16.3; or	above 20 mm up to & including 80 mm
Forged Steel, Screwed complying with grade WPA or WPB of BS3799; or	
Forged Steel, Socket Weld, complying with grade WPA or WPB of BS3799; or	
Forged Steel, Butt Weld, complying with grade WPA or WPB of BS1640: Part 3 or Class 300 of ANSI B16.9;	
Screwed, complying with BS1740; or	above 80 mm
Forged Steel, Screwed complying with grade WPA or WPB of BS3799; or	
Forged Steel, Socket Weld, complying with grade WPA or WPB of BS3799; or	
Forged Steel, Butt Weld, complying with grade WPA or WPB of BS1640: Part 3;	

(Note: Only use Fittings from table 20 that comply with US requirements specified in table 21. Do not use 90° sharp elbows/ tees for system installation)

Table 18: UK Steel Pipework Requirements

Nominal Pipe Size	Publication	Type of Pipe[1)]	Grade of Steel	Minimum Wall Thickness[2)]
Up to and including 50 mm	BS1387 (BS EN 10255)	BW	-	Heavy
	BS 3601 (BS EN 10216-1)	S	430	Schedule 40 (Schedule 80 for screwed joints)
	BS 3602-1 (BS EN 10216-1)	HFS or CFS	360 or 430	
	ASTM A106-77	HF or CD	A or B	
Over 50 mm up to and including 100 mm	BS3601 (BS EN 10216-1)	S	430	
	BS 3602-1 (BS EN 10216-1)	HFS or CFS	360 or 430	
	ASTM A106-77	HF 0R CD	A or B	
Above 100 mm	BS3601 (BS EN 10216-1)	S	430	Schedule 80
	BS 3602-1 (BS EN 10216-1)	HFS or CFS	360 or 430	Schedule 40 (Schedule 80 for screwed joints)
	ASTM A1 06-77	HF or CD	A or B	

1) Abbreviations:
BW - butt welded / CD - cold drawn / HFS - hot finished seamless / CFS - cold finished seamless / S - seamless

2) Where schedule numbers are given, these determine the minimum wall thickness in accordance with BS1600. Where the specified pipe is not obtainable in these dimensions, the next larger thickness should be used.

Table 20: US Steel Pipe Requirements

Pipe Reference	Connection	Pipe Type	Nominal Pipe Size
ASTM A -106 seamless Grade C	Threaded	Schedule 40	3/8″ - 69″ NPS
ASTM A -106/A-53 seamless Grade B	Threaded	Schedule 40	3/8″ - 6″ NPS
ASTM A -106/A-53 seamless Grade A	Threaded	Schedule 40	3/8″ - 6″ NPS
ASTM A -53 ERW Grade B	Threaded	Schedule 40	3/8″ - 6″ NPS
ASTM A -53 ERW Grade A	Threaded	Schedule 40	3/8″ - 6″ NPS
ASTM A -53 Furnace Weld Class F	Threaded	Schedule 40	3/8″ - 6″ NPS
ASTM A -106 seamless Grade C	Welded	Schedule 40	3/8″ - 6″ NPS
ASTM A -106/A-53 seamless Grade B	Welded	Schedule 40	3/8″ - 6″ NPS
ASTM A -106/A-53 seamless Grade A	Welded	Schedule 40	3/8″ - 6″ NPS
ASTM A -53 ERW Grade B	Welded	Schedule 40	3/8″ - 6″ NPS
ASTM A -53 ERW Grade A	Welded	Schedule 40	3/8″ - 6″ NPS
ASTM A -53 Furnace Weld Class F	Welded	Schedule 40	3/8″ - 6″ NPS

Table 21: US Fittings

Fitting Description	Pipe Size
Class 300 Malleable or Ductile Iron	Up to or < 3″ NPS
1000 -lb Rated Ductile Iron or Forged Steel Class 300 Flanged Joints	> 3″ NPS All

Note: Cautionary information indicating the calculation method has been investigated for specific types of fittings, type of pipe and pipe inside diameter. Also that when the specified limitations are not maintained there is the risk that the system will not supply the required quantity of extinguishing agent. The Flow Program contains pipe and fittings options together with Equivalent Length information for UK / US pipe and fittings.

Pipe Hangers

Pipe hangers must be spaced according to the size of pipe (see table 22).

- Hangers must be placed within 300 mm (12″) of the discharge nozzle (see Figure 51).
- Hangers must be placed between elbows that are more than 600 mm (24″) apart (see Figure 52).
- Hangers must be fixed to a structure capable of supporting the Pipework.

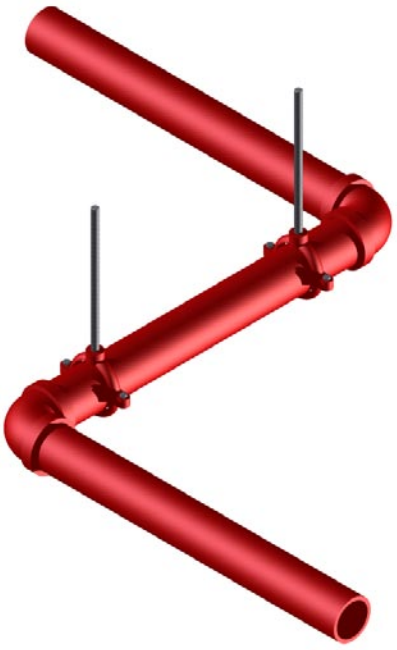
Table 22: Hanger Spacing

Pipe Size mm	Maximum Spacing m
10 (3/8″)	1. (3 ft)
15 (1/2″)	1.5 (5 ft)
20 (3/4″)	1.8 (6 ft)
25 (1″)	2.1 (7 ft)
32 (1¼″)	2.4 (8 ft)
40 (1½″)	2.7 (9 ft)
50 (2″)	3.4 (11 ft)
65 (2½″)	3.5 (11.5 ft)
80 (3″)	3.7 (12 ft)
100 (4″)	4.3 (14 ft)
150 (6″)	5.2 (17 ft)

(Reference: BS IS0 14520-1:2000)

Figure 51 - Nozzle Fixing

Figure 52 - Elbow Support



Earthing and Electrical Clearance

Systems within electrical substations or switchrooms shall be efficiently earthed to prevent the metalwork becoming electrically charged. Adequate earthing of systems will minimize the risk of electrostatic discharge. Where exposed electrical conductors are present and, where practicable, clearances no smaller than those given in table 24 shall be provided, between the electrical conductors and all parts of the system that may be approached during maintenance.

Table 23: Safety Clearances.

Max. Rated Voltage (kV)	Min. Section Clearance (m)	Min. Ground Clearance (m)
15	2.59 (8.5 ft)	-
33	2.74 (9 ft)	-
44	2.89 (9.5 ft)	-
66	3.05 (10 ft)	-
88	3.20 (10.5 ft)	2.44 (8 ft)
110	3.35 (11 ft)	2.44 (8 ft)
132	3.50 (11.5 ft)	2.44 (8 ft)
165	3.81 (12.5 ft)	2.44 (8 ft)
220	4.27 (14.0 ft)	2.44 (8 ft)
275	4.57 (15 ft)	2.44 (8 ft)

Minimum clearance from any point on or about the permanent equipment where a person may be required to stand (measure from position of the feet). Section clearance - to the nearest unscreened live conductor in air. Ground clearance - to the nearest part not at earth potential of an insulator supporting a live conductor. Reference NFPA 2001, section 1.5.2

Nozzles

All nozzles require the installation of a dirt trap comprising 1 side tee, 2 nipples, and 1 pipe cap. Fit the nozzle to the nipple on the dirt trap and check the nozzle orifice to ensure proper orientation. Dirt trap lengths should be no more than 10 times nominal pipe diameter.

A false ceiling comprising loose tiles must have the tiles retained within a 2 m (6.5 ft) radius of the nozzle, to prevent movement during system discharge. Nozzles should be installed a maximum of 300 mm (12″) below the ceiling.

Figure 53 - Dirt Trap

Actuation Installation

The method of actuation depends on the system configuration and any specific contract requirements and can be broken down as follows:

- Single Container Actuation
- Multiple Container Actuation

Single Container Actuation

Removable Electrical Actuator

The removable electrical actuator is fitted to the top of the valve assembly as follows:

- Check the actuator mechanism to ensure that it is in the non-fired position by fully screwing in the reset tool, i.e. pin retracted (see Figure 54).
- Remove the actuator cap from the top of the valve assembly (see Figure 46).
- Carefully screw the actuator to the valve assembly (see Figure 55).

Note: The actuator must be hand tight only.

If no other actuators are to be installed ensure that the protective cap on the actuator is retained in position.

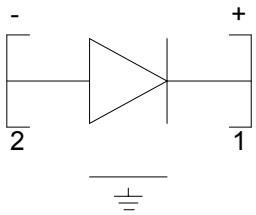
Figure 54 - Actuator Non-Fire Position

Figure 55 - Electrical Actuator Location

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 56 when all other installations have been completed.

Figure 56 - Electrical Actuator Wiring Diagram - Suppression Diode



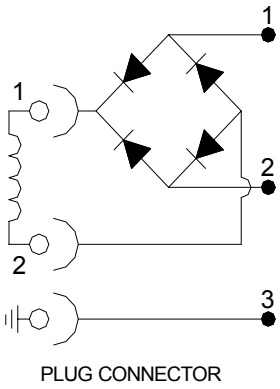
This Electrical Actuator is fitted with a suppression diode in parallel to the coil as indicated. Connect +ve from control panel to terminal 1 and -ve from control panel to terminal 2, on plug connector. End of line monitoring device (if required) to be fitted on site.

Before this system is put into operation, the removable solenoid can be checked by firing the system. To do this, REMOVE THE ELECTRICAL ACTUATOR from the valve. With power to the actuator, the pin should be firmly in the down position. Ensure that the electrical actuator is reset prior to fitting on to the conatainer valve. FAILURE TO RESET THE ACTUATOR WILL RESULT IN THE POTENTIALLY HAZARDOUS DISCHARGE OF THE CONTAINER.

Electrical Actuator - Bridge Rectifier

The electrical signal from the detection and/or control equipment is connected in accordance with the wiring diagram detailed in Figure 57 when all other installations have been completed.

Figure 57 - Electrical Actuator Wiring Diagram - Bridge Rectifier



This Electrical Actuator is fitted with a bridge rectifier as indicated. Connect +ve from control panel to either terminal 1 or 2 with the reverse for the -ve supply from control panel, on plug connector. End of line monitoring device (if required) to be fitted on site.

Before this system is put into operation, the removable solenoid can be checked by firing the system. To do this, REMOVE THE ELECTRICAL ACTUATOR from the valve. With power to the actuator, the pin should be firmly in the down position. Ensure that the electrical actuator is reset prior to fitting on to the conatainer valve. FAILURE TO RESET THE ACTUATOR WILL RESULT IN THE POTENTIALLY HAZARDOUS DISCHARGE OF THE CONTAINER.

Manual Actuator

The manual actuator can be fitted to the top of the electrical actuator or directly onto the valve, after first removing the protective cap.

Caution. Before attaching the manual actuator to the electrical actuator or valve, ensure that the firing pin is retracted and the safety pin is in place (see Figure 58).

Note. The actuator must be hand-tight only.

Figure 58 - Manual Actuator Non-Fire Position

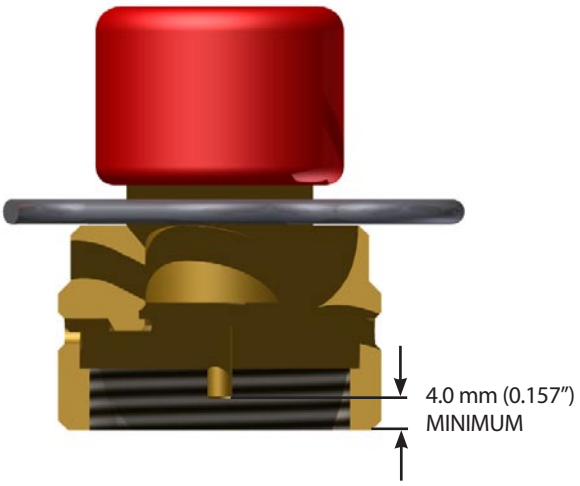


Figure 59 - Manual Actuator Location

Multiple Container Actuation

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

Pneumatic Actuator

Check that the actuating plungers are in the raised position (see Figure 60). Remove the actuation cap from the top of the valve assembly (see Figure 46) and carefully screw the pneumatic actuator to the valve on each slave container.

Note. The actuator must be hand-tight only.

Figure 60 - Pneumatic Actuator Non-Fire Position

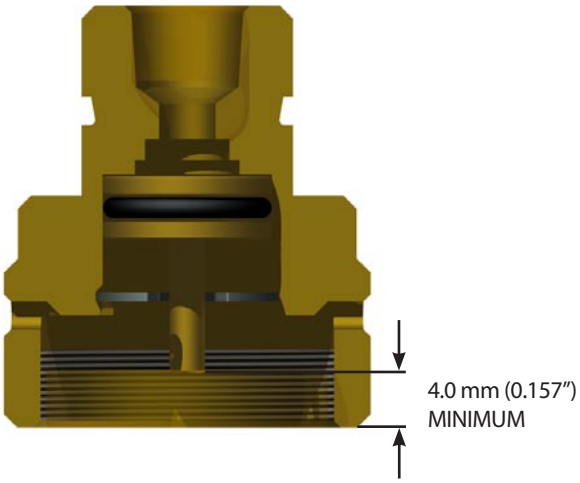


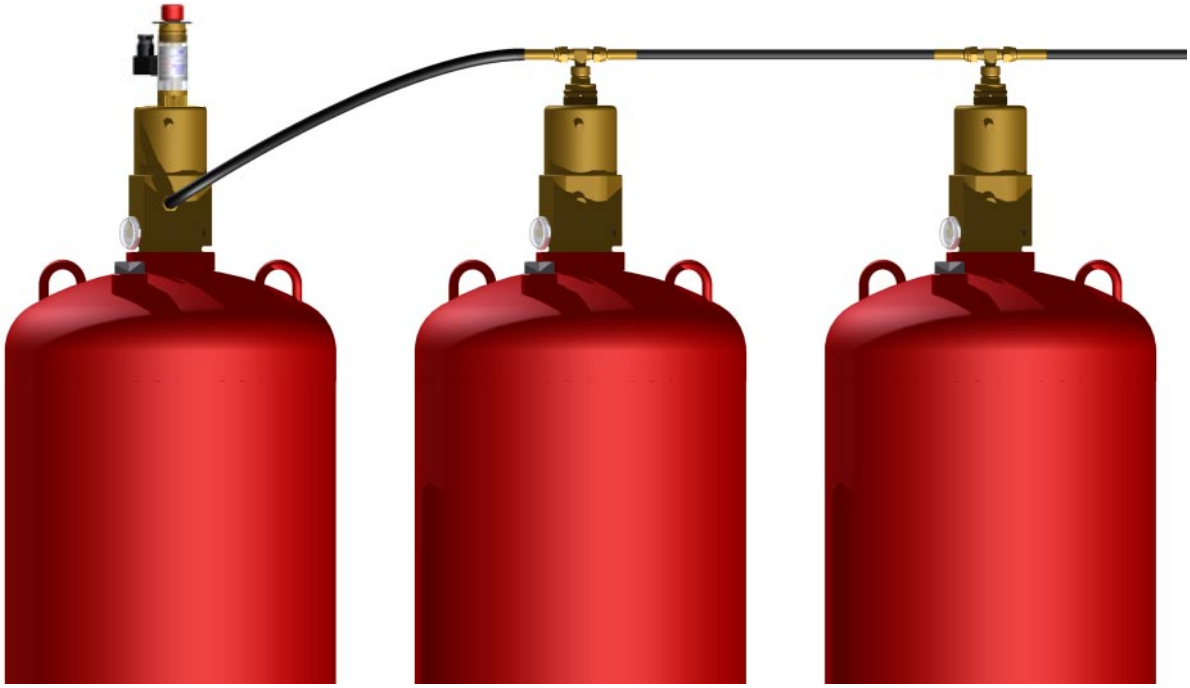
Figure 61 - Pneumatic Actuator Location

Slave Actuation Pilot Line

For slave containers the pneumatic connection is made using flexible pilot hoses. To fit the pilot hoses, remove the 1/4″ pilot pressure port plug from the master container valve assembly and install the 1/4″ male adaptor (Part No. 309.013.005) for the 25 mm (1″) and 50 mm (2″)valves, and a 1/4″ NPT street elbow and male adaptor for the 80 mm (3″) valve.

Install the pilot line tee, Part No. 309.013.003 on to all pneumatic actuators (wrench tight). Connect one end of the pilot hose Part No. 306.205.003 to the adaptor on the master container and one end to the pilot line tee on the pneumatic actuator. Connect a pilot hose between pilot line tees on all pneumatic actuators (see Figure 62).
The maximum number of slave actuated containers is 9 (10 containers system in total). After every 10 containers another master container must be created, using either an electrical actuator or pneumatically by removing the 1/4″ pilot pressure port plug on the tenth container, installing the 1/4″ male adaptor (Part No. 309.013.005) and another pilot hose (Part No. 306.205.003) and tee (Part No. 309.013.003) into the pneumatic actuation line. All the electrical actuators must operate simultaneously to ensure the correct discharge time.

Figure 62 - Multiple Container Actuation



Ancillary Equipment

Discharge Pressure Switch

Single Container Systems

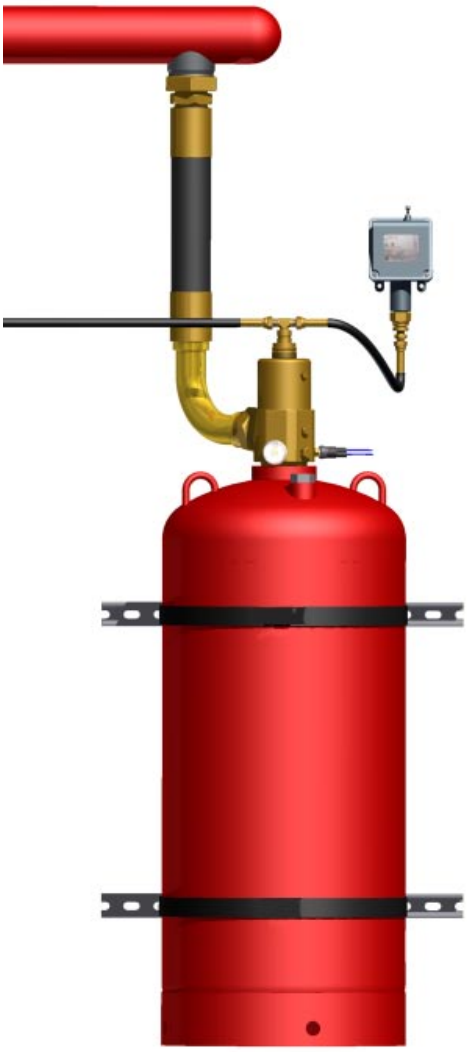
On single container installations the pressure switch should be located close to the valve assembly and connected with a pilot hose from the pressure port outlet on the valve to the connector on the pressure switch (see Figure 63).

Figure 63 - Discharge Pressure Switch Installation (Single Container System)

Multiple Container Systems

On multi-container installations the pressure switch should be located close to the last slave container and connected by pilot hose to the tee connector on the pneumatic actuator (see Figure 64).

Figure 64 - Discharge Pressure Switch Installation (Multiple Container System)



Discharge Pressure Switch (Continued)

To wire the discharge pressure switch to the control panel, unscrew and remove the switch cover plate. Connect to the appropriate terminals on the microswitch or if supplied with wires, to the coloured wires which are labelled as follows:-

Common (C) (violet)

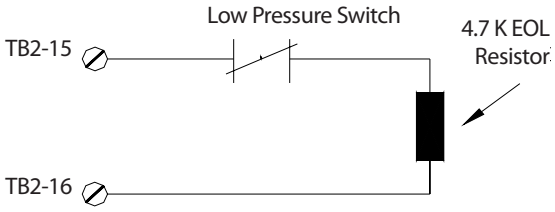
Normally Open (NO) (blue)

Normally Closed (NC) (black)

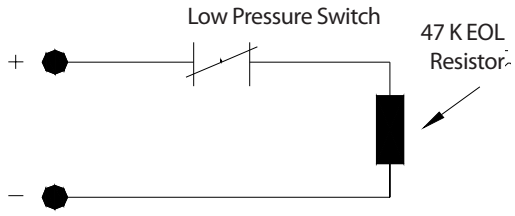
Low Pressure Switch

All container valves are 'Factory fitted' with low pressure warning switches. Voltage input can be applied to either terminal.

Figure 65 - Low Pressure Switch to Control Panel diagram.



Connections to Pyrochem PCR-100
NOTE: Program output circuit 4 as a supervisory input circuit. See Pyrochem PCR-100 manual for programming details.



Connections to Pyrochem FMM-101 or FMM-1 Module

NOTE: Program the addressable module as supervisory. See Pyrochem PCR-400 manual for programming details.

NOTE: When the device (i.e. pressure switch) is connected to a standard supervisory input circuit, there will be no distinction between a wiring fault and device actuation . This device is to only be utilised when accepted by the authority having jurisdiction.

Accessories

Door Notices

Warning notices are required at all exits and entrances to protected area, ideally mounted on the door. Plates may be drilled and screw fixed or attached using suitable adhesive.

Manual Release Notices

Manual release notices are required at all manual actuators, remote manual actuators and call points. Plates may be drilled and screw fixed or attached using suitable adhesive.

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 delay between hand-over and the risk area being available for protection, then the system must be left in a 'safe' condition to avoid accidental discharge. The system must only be made operative once the area for protection has been completed and is operational.

Pre-checks and Visual Inspections

General

When the installation is complete, and before making the final connections, the following checks should be made:

Mechanical Checks

Inspect protected area closely for conformance to original risk specifications and for enclosable 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 have been properly constructed and that voids in floors and above suspended ceilings have been sealed.
- All back channels should be secured firmly to the wall or bulk head.
- Containers should be securely held within brackets.
- Piping should be securely fixed within hangers.
- All pipe connections must be tight.
- Nozzles to be the proper type, correctly placed, and properly orientated.
- Check model and weight markings on container nameplates to verify that correct containers and charges have been installed as required.
- Verify that all warning and instruction plates are mounted where required.

Electrical Checks

The electrical systems may include interfaces with many other systems for alarm, indication, actuation, shutdown, etc. For complex electrical systems the scope and operating requirements will be described in other documents. Electrical checks are given below for a basic system using electrical actuation of the container valve;

- Remove top mounted electrical actuator or side mounted solenoid (which is connected via the solenoid adaptor) from valve. Check that solenoid is activated when system is triggered. If the solenoid adaptor is not present, remove electrical connections from side mounted solenoid and check wiring voltage is correct for actuation when system is triggered.

During detection system actuation verify the following functions operate;

- All apertures in hazard enclosure are closed by dampers or other suitable methods.
- Electrical equipment in the protected area is tripped and isolated.

Pneumatic Checks

The slave actuators on manifolded systems are fired by agent discharge. Pneumatic checks are detailed below;

- Remove all pneumatic actuators from container valves.
- Disconnect pilot hose from the master container valve adaptor (see Figure 62).
- Provide 4 bar (58 psi) pressure to the master container valve pilot hose.
- Verify all pneumatic actuator pistons are in the fired position.
- Check for leaks. There must be less than 10% loss in pressure within 1 minute).
- Provide 34 bar (493 psi) pressure to the master container valve pilot hose.
- Verify all pneumatic actuator pistons are in the fired position.
- Check for leaks. There must be less than 10% loss in pressure within 1 minute).

Before replacing the pneumatic actuators, ensure that all pistons are fully reset (see Figure 60). After reinstalling the pneumatic actuators, reconnect the pilot hose to the master container valve adaptor (see Figure 62).

Final Connections

Discharge Piping

The final connection of the discharge piping occurs at the container valve assembly. For single container systems, the valve anti-recoil cap can be removed and the discharge pipe connected to the container outlet. For multi-container systems, the valve anti-recoil caps can be removed and all discharge hoses fitted.

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 particularly important.

1. A container should be refilled or replaced when it shows a loss in agent quantity of more than 5% or a loss in pressure (adjusted for temperature) of more than 10%. (Operating pressure of unit at 25 bar at 21 °C, 360 psi at 70 °F). Refer to Appendix A for pressures at other container temperatures.
2. Check container weight information label against system requirement. If there is any doubt or if there has been a loss of weight, then the container must be weighed.
3. Make sure the system is armed and the actuating systems are operational.

Ensure 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/or insurance authorities as to the suitability, acceptability and availability of the system for the hazard area.

Introduction

The hazard integrity is the ability to retain the discharged FM-200®. For a total flooding extinguishing system to be effective, the design concentration must be achieved and then 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 FM-200® discharge. In order to determine with any degree of confidence that the hazard area will hold the gas for the required time period, where necessary an Enclosure Integrity Test in accordance with NFPA 2001 appendix C or the authority having jurisdiction must be conducted.

Principle

The test is conducted with a device known as a door fan, which has been used in the energy conservation field for over 25 years. It has three basic components as follows:

- 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 pinpoint where leaks exist. A cool chemical smoke or other air current indicator is used to detect 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 the discharging FM-200®. 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 (depressurisation), and then blowing air into the enclosure (pressurisation), is then averaged.

Below Ceiling Leakage Area (BCLA)

Experience has shown that leakage above a suspended ceiling has a negligible effect on the FM-200® concentration. Like water leaking from the holes in the bottom of a swimming pool, FM-200® tends to escape from leaks in the lower part of the enclosure due to the weight of the mixture above it. The rate at which FM-200® is lost is therefore 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 the next step is to calculate the retention time of the enclosure. The formula is derived from a standard engineering/fluid dynamics principle. The result of the calculation is the number of minutes it takes for the FM-200®/air interface to reach the minimum protected height required, normally about 75% of the enclosure area.

Slab to Slab Walls

The only major limitation is that it 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 should only be necessary to conduct one integrity test, therefore it is essential to ensure that the enclosure is ready, and that the relevant people have been informed. Having established that any outstanding works are completed prior to the test date, advise all interested parties in writing, if necessary outlining the testing method and principles involved.

Integrity Test Procedure

Evaluation. The enclosure and immediate surrounding area is initially examined visually to assess the readiness for testing, the existence of any attached spaces that could affect the results, and that there is an adequate relief area and return air path. The volume of the enclosure is confirmed and the highest equipment measured to ascertain the required level for retention time.

Preparation. All doors outside the area that are required to be open for the test are wedged open with suitable notices posted to advise personnel. Where voids are protected by FM-200®, tiles are removed to ensure a uniform air flow.

The enclosure is put in the state it would be in prior to a discharge, e.g. ventilation system shut down, dampers closed, etc.

Note. Equipment within the enclosure that does not affect the integrity may be left running even if it will be shut down in the event of a discharge, preventing unnecessary disruption and inconvenience.

Ventilation. Air conditioning and/or forced ventilation can affect the system performance and the quantity of agent required.

(i) Self-contained air conditioning unit

A self-contained unit conditions the air within the enclosure and does not rely on a fresh air supply, or draw air from other parts of the building. If the hazard has a self-contained unit and it is located within the area without an outside air supply, no additional agent is required. It is not necessary to shut down the unit prior to a discharge as the mixing effect is beneficial. However if the air-conditioning unit is left running, a depleting concentration rather than a descending FM-200®/air interface will be formed. The concentration will be depleted due to leakage. Therefore overgassing the enclosure may help to obtain the required ten minute retention time at minimum concentration.

(ii) Central air conditioning unit

A central air conditioning unit relies on air from outside and is often linked by ducts to other parts of the building, therefore, prior to a discharge, the unit should be shut down and/or dampers operated to close the ducts. Sufficient time must be allowed for the plant to stop, or dampers to close, before discharge occurs.

Dampers should be installed in both supply and return air ducts, as close as possible to the area. The duct volume between the hazard and the damper must be added to the overall volume.

Door Fan Installation. A door fan unit is installed in the designated test door in accordance with the manufacturer's instructions.

The gauges are zeroed by taking them to full scale deflection and holding for approximately ten seconds, after which the gauges are gently tapped and zeroed.

Enclosure Evaluation

Static Pressure Measurements. With the door fan equipment fully installed and set up, but with all openings closed, a measurement of any pressure difference between the enclosure and the relief area is made. If the measurement is unduly high its causes are ascertained and if possible permanently reduced or eliminated.

Total Enclosure Leakage Method. Using an adequate range on one fan, or a number of fans, a pressure difference of between column pressure and column pressure plus 30% is created. The pressure difference, and the air flow required to generate this, is then recorded. This is carried out for both pressurisation and depressurisation modes. The total equivalent leakage area and the predicted retention time is calculated.

Suspended Ceiling Leakage Neutralisation Method. This procedure is used to improve the accuracy of the predicted retention time where a reasonable air-tight ceiling exists, whether or not the ceiling is protected with FM-200®.

Note. Leak paths through the ceiling may be temporarily sealed.

The volumes above and below the false ceiling are depressurised to the same extent but using separate fans. This is confirmed by using cool chemical smoke to check that no air is flowing through the false ceiling.

Readings of the pressure difference between the enclosure, relief area, and the air flow through the fan(s) used to depressurise the room and false ceiling are made, and then the procedure is repeated in the pressurisation mode. The below ceiling leakage area is then calculated and used in conjunction with the ELA to predict a revised retention time.

Calculation

A portable computer is used to collate the data and calculate the values. The associated printer provides a detailed hard copy of the data on site.

Figure 66 - Typical Printout

RETROTEC DISCHARGE SIMULATION VER. HA5.1
RETENTION TIME PREDICTION MODEL

Location:	Hygood. Test Enclosure
Room Name:	Test House
Testing Company:	HYGOOD LIMITED
Technician:	C Uzzell
Date:	12.12.96

Whole Room Test.
All Outputs are in METRIC Units.

Gas Being Modelled:	FM200
Lbs/Kgs of Agent in Cylinder(s):	17.00
Net Room Volume (m^3):	30.00
Room Height (m):	3.20
Minimum Protected Height (m).	2.90
Minimum Retention Time (min):	10.00
Initial Gas Concentration (%):	7.22
Static Pressure @ Discharge:	0.00

Equivalent Leakage Area (ELA m^2):	0.0050
Hole in Ceiling (m^2):	0.0025
Hole in Floor (BCLA m^2):	0.0025

This Room PASSES the Test as the Predicted Retention Time is 10.1 minutes for the agent/air interface to drop below the minimum protected height.

Witnessed By:

X _____

Software Conforms to 1992 NFPA 12A/2001 TCD Room Integrity Procedure.

Maximum Allowable ELA (m^2):	0.005
Interface Height @ 10 minutes:	2.903

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Leakage Location

If the enclosure fails the test, or if the client requests, an inspection of the enclosure with the door fan running can be made. This makes it possible to locate the source of any leakage by using cool chemical smoke. This procedure also tests the efficiency of any dampers, etc.

FAN TEST READINGS & DATA

Location:	Hygood. Test Enclosure
Room Name:	Test House

Temperature IN: 20 Temperature OUT: 20
Static Pressure@FanTest: 0

Operator and Gauges Location	DEPRESSURE OUT	PRESSURE OUT
Room Pressure Gauge Reading	14.0	14.0
Corrected Room Delta P (pa)	-14.0	14.0
Blower Range Config Used	0.1	0.1
Flow Pressure Gauge Reading	45.0	45.0
Corrected Flow Pressure	31.0	45.0
Calculated Air Flow (1s)	13.4	16.2
Temp. Corrected Flow	13.4	16.2
Leakage Area (m^2)	0.0046	0.0055
Average Leakage Area (m^2)	0.0050	

R M =	1.639	P C =	13.7
A T=	0.003	A L L -	0.002
C 3 =	3.019	C 4=	0.000
G D =	7.260	K 1-	1.8850
A R =	9.374	T=	605.679
P A =	13.7	F A =	0.500
C F =	1.000	K 2=	0.0046
E L =	0.000	TD =	20.000

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General Comments

Personnel required to work in the protected area should be conversant with the detection and extinguishing equipment installed, and trained in fire procedures. All life-saving equipment must be properly maintained.

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 to that area. This part of the document provides information relevant to ALL the standard operational systems to cover the eventuality of changes to, or expansion of the original design.

System Detection and Actuation

General

Each system is designed to suit the hazard area, whether the area is normally manned or unmanned, and whether the detection/actuation devices are to be manual or automatic. The permutation of systems is large but from an operational point of view, the systems are best grouped as:-

- Manual.
- Fully Automatic.
- Automatic with Manual Intervention.

Manual System

Manual systems depend on human detection of a fire in the hazard area and prompt action to actuate the manual actuator for the FM-200® system to discharge and flood the protected area and extinguish the fire.

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

Fully Automatic System

Where a sensitive fire detection system is included for the automatic release of extinguishing agent, the system shall only be capable of automatic release once two or more sensors detect the fire.

The number of detectors and their spacing is designed to ensure a satisfactory response time. To ensure personnel may safely evacuate the risk area an adjustable time delay should be fitted such that sufficient time may elapse prior to system discharge. Ideally, the delay period shall not exceed 30 seconds (BS5306-5).

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

The design of a system for automatic detection, signal distribution, alarms, etc. is not always of our supply. Therefore, details appertaining to fire detection and alarm operation and maintenance are not included in this document.

UL Listed Detection & Control Equipment

Detectors shall be UL Listed for the intended application. Control Panels shall be UL Listed for releasing device service and compatible with detection and FM-200® Engineered Total Flooding Fire Extinguishing System.

Fully Automatic System with Manual Inter-vention

Manual intervention of an automatic system may be included for the following condition;

- **Where personnel are required to work within the protected area.**

  In protected areas where personnel are present and the concentration is greater than NOAEL, it is recommended that the automatic feature of the system is isolated during occupation. This may be achieved either by an electrically contacted lock assembly or by a clearly marked key switch at a suitable location outside the risk area.

Conditions During a Fire

The user's fire and safety instructions to personnel should include advice on the conditions prevailing during the discharge of an FM-200® system. This advice is intended to prepare the personnel for the situations likely to arise and therefore minimise the risks of panic. Three major conditions prevail during FM-200® discharge of which personnel should be made aware:

FM-200® Concentration

FM-200® total flooding systems greater than 9% design concentration should only be used with manual actuation in normally occupied areas. A normally occupied area is defined as an area intended for occupancy.

Any area protected by FM-200® should be evacuated prior to start of system discharge. Where egress of normally occupied areas cannot be accomplished within one minute, FM-200® total flooding systems shall be designed not to exceed 9.0% concentration.

Refer to NFPA 2001, Paragraph 1.5.1.2.1 for additional information.

FM-200® Decomposition

FM-200® decomposes when exposed to temperatures exceeding 482 °C (900 °F); such as flames, hot metal surfaces, etc. The rate of this decomposition is dependent upon the size of the area where extreme temperatures are found, and also upon the length of FM-200® exposure time.

To reduce decomposition, FM-200® systems are designed to discharge and extinguish the fire quickly. The maximum duration of discharge for these systems at 21 °C (70 °F) is 10 seconds, so the minimum amount of decomposition occurs. Hydrogen Fluoride is the most toxic decomposition product. This material generates a sharp acrid odour, which is easily detected and acts as a warning and a good safeguard to personnel.

FM-200® Discharge Conditions

FM-200® has low boiling point, consequently the discharge is very cold at the point where it leaves the nozzle. Care should be taken to avoid working within 1 metre (3.28 ft) of FM-200® discharge nozzles.

The velocity of discharge of FM-200® from a discharge nozzle is very high, care should be taken to insure that objects which may become dangerous projectiles are secured or removed from the hazard area.

Actions Following a Fire

General

These notes are only applicable to the hazard area(s) protected by a FM-200® fire extinguishing system. Where such a system may form part of, or combine with other forms of fire protection systems then composite instructions for all systems are necessary to ensure the safety of personnel and property following a fire. Assistance is available to help a client prepare composite instructions. If the organisation has appointed, or nominated, a responsible person to act as a 'Fire Officer'. Actions following a fire should be co-ordinated and/or directed by the Fire Officer.

Actions Immediately Following a Fire

These actions should, at a minimum, include the following:

- Advise the emergency services, Fire, Accident, Police if appropriate.
- Organize a 'roll-call' of employees and any visitors.
- Prevent unauthorised personnel from entering the hazard area.
- In the case of deep seated fires, the hazard space should be kept tightly closed for at least 60 minutes after discharge of the FM-200® extinguishing agent.

  It is essential that the fire be completely extinguished before ventilating the space. Before permitting any one to enter the space, ventilate thoroughly or ensure self-contained breathing equipment is used.
- Do not enter the hazard area in which fire has been extinguished with an open flame or lighted cigarette as the possible presence of flammable vapours may cause re-ignition or explosion.

Should it be necessary to enter a space containing FM-200® or decomposition products the following precautions should be taken;

- Use a fresh air mask or self contained breathing equipment.
- Do Not use a filter mask or canister type mask.
- Do Not enter space unless you are under observation from outside the space, or tethered by a lifeline.
- Ensure that all pressurised equipment is isolated or safe from release.

Introduction

This section provides user inspection and maintenance guidance for FM-200® Engineered Systems. A log book will be provided to record all inspections, maintenance, measurements and actions taken. The continued capability for effective performance of an FM-200® Total Flooding Fire Suppression System depends on fully adequate maintenance procedures, with periodic testing. Reference NFPA 2001 section 7-1 to 7-6 and ISO 14520-1.

User's Programme of Inspection

The installer should provide the user with an inspection programme for the system and components. The programme shall include instructions on the action to be taken in respect of faults. The user's inspection programme is intended to detect faults at an early stage to allow rectification before the system may have to operate.

A suitable programme is as follows:-

Weekly Check of Hazard Area

Inspect the hazard area against the original layout to ensure that there have been no changes that might affect the proper performance of the fire protection system. Changes might include:

- Contents of area.
- Use of area.
- Air Handling equipment in area.
- Openings in area.
- Floor/ceiling voids.
- Partitioning.

Weekly Check of Containers

Check storage container pressure gauges and ambient temperature, compare these pressures to the Temperature Correction Chart to determine temperature corrected pressure. If the container corrected pressure shows a loss of more than 10%, the containers should be removed for weighing. All measurements and actions shall be recorded in the log book.

Weekly Check of System Components

Make a visual inspection of the system components, distribution piping and nozzles. Check the immediate vicinity of all equipment to ensure that no accidental damage or tampering has occurred.

Weekly General Check

Inspect the hazard area, access routes, container storage area, floor voids and areas above suspended ceilings to ensure housekeeping is good and that no refuse has accumulated. Ensure that access to the system container assemblies and local remote controls is unobstructed.

Monthly Check of Notices

Inspect system and protected spaces to ensure that warning signs, safety precautions and operating instructions are posted and clearly visible.

Monthly Personnel Training Check

Check that all personnel who may have to operate the equipment or system are properly trained and are authorized to do so, and in particular that new employees have been instructed in its use.

Contract Service and Maintenance

Systems shall be thoroughly inspected and tested for proper operation by qualified contract personnel in accordance with the requirements of NFPA as well as any other standard accepted to the authority having jurisdiction. Before any checks are carried out, ensure the extinguishing system is isolated electrically and mechanically and remove all electrical and pneumatic actuators. No maintenance work should be carried out without obtaining approval from the Fire Officer and advising any personnel within the hazard area. The following Programme should be carried out in addition to the User's Programme of Inspection. The user shall be provided with a signed and dated report of the inspection advising any rectification carried out or needed.

3 Monthly Actuator Check .

Test and service all actuating mechanisms.

3 Monthly Electrical Systems Check

Test and service all electrical detection and alarm systems as recommended in NFPA as well as any other standard accepted to the authority having jurisdiction.

6 Monthly Container Check

Externally inspect containers for signs of damage or unauthorised modifications. Check container labels are securely fixed and legible. Check container brackets and fittings.

6 Monthly Contents Check

Examine the container pressure gauge reading and refer to the temperature correction chart. If the container pressure corrected to temperature is below 10% of the stated pressure it must be replaced or recharged.

Verification of the content of FM200® in the containers may be achieved through either liquid level detection or container weighing. If containers show a extinguishant loss of more than 5% or a pressure loss (adjusted for temperature) of more than 10%, the container should be refilled or replaced.

Container Weighing

Where a Client does not wish to use an approved distributors maintenance contract or the specialised liquid level detection equipment, then containers must be weighed to establish the FM200® content. The weighing procedure is as follows:

- Remove all manual controls, pressure actuators and pressure actuation pipe or tubing and flexible electrical connectors.
- Disconnect and remove discharge piping / discharge hoses from container valves.
- Fit anti-recoil caps onto container valves.
- Remove containers from bracketing and weigh containers. Any container showing more than the maximum allowable weight loss must be recharged by a qualified recharge agent.
- Record weight of container on record tag.
- Replace containers in bracketing and remove anti-recoil caps.
- Reconnect discharge piping / discharge hoses and all control heads, pressure actuators, pressure actuation pipe or tubing and flexible electric connectors.

Using the Liquid Level Measuring Device

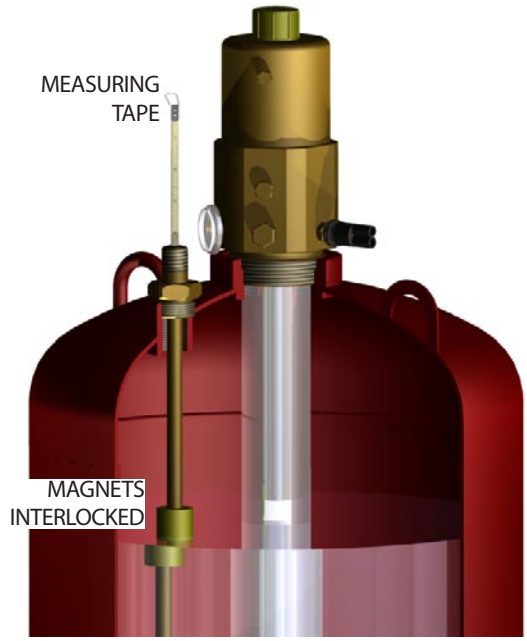
The liquid level measuring device is used to determine the liquid FM-200® level in 106, 147, 180 and 343 litre container assemblies. During a maintenance examination, the measuring device will enable a service representative to convert a linear measurement to agent weight in order to determine if the tank has any weight loss. This measurement is accomplished without removing the FM-200® tank from the fire suppression system.

Operation

To measure the liquid FM-200® level:

1. Remove the protective cap from the measuring device housing.
2. Lift the measuring tape to the end (or approximately 75 mm (3″) above the expected level). Slowly lower the tape until a magnetic interlock is felt (see Figure 67).

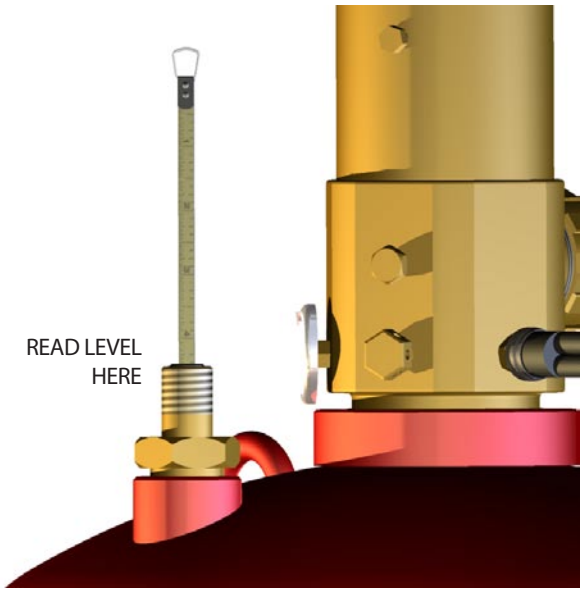
Figure 67 - Liquid Level Measuring Device



3. Read the measurement on the tape directly at the top of the plastic sleeve in the measuring device housing (see Figure 68). 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 68 - Reading Liquid Level



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.
5. Using the Weight Conversion Table located in Appendix D, determine the FM-200® weight of charge as follows:

a. Find the liquid level reading along the left hand vertical line of the table.

b. From that point, follow the horizontal line to the point where it intersects with the temperature column (using the FM-200® tank temperature noted in Step 3).

c. Read the weight of FM-200® at the level / temperature column intersection.

6. Compare the weight from the table to the weight of charge stamped on the container nameplate. If the measurement shows a net weight loss of more than 5%, the tank must be weighed to verify the liquid level measurement. If the weight loss still exceeds 5% of the weight of charge, the container requires recharging.

Example: Using the Container Weight Conversion Table

A semi-annual weight check is being performed on a 180 litre FM-200® tank filled with 137 kg (301 lbs.) of FM- 200®. The temperature of the container is 16 °C (60 °F). The liquid level measuring device reading is 36.2 cm. (14¼ in.)

Find the 36.2 cm (14¼ in.) line on the left side of the 180 litre container table and read horizontally across the table to the 16 °C (60 °F)column. Then, by reading the weight of FM-200® at the level/temperature column intersection, it is determined that the weight of FM-200® is 136 kg. (299.2 lbs.)

To determine if this is within the 5% weight loss tolerance, multiply the weight of charge (taken from the container nameplate) by 0.95 to determine the minimum weight of FM-200® required in this container:

137 kg x 0.95 = 130 kg (301 lb. x 0.95 = 286 lb.)

Because the measured weight of FM-200®, 136 kg, (299.2 lb.) is more than the minimum required FM-200® weight of 130 kg (286 lb.), the weight of FM-200® is within the 5% weight loss tolerance.

If the measured weight had been less than the 5% weight loss tolerance, the container should be weighted to verify the liquid level measurement. If the weight loss still exceeds 5% of the weight of charge, the container must be recharged.

6 Monthly Control Valve & Actuator Check

Check all manual and pneumatic actuators for free movement of the piston. Replace whole unit where appropriate. Check all control valves for correct manual function and automatic valves additionally, for correct automatic function.

6 Monthly Pipe Network Check

Externally check pipework to determine its conditions. Replace or pressure test and repair as necessary Pipework showing corrosion or mechanical damage.

6 Monthly Nozzle Check

Inspect nozzles for dust and debris, clean out where necessary.

6 Monthly Enclosure Check

Carry out a full visual check of the enclosure for integrity and confirm the dimensions and the configuration of the hazard are as the original drawings or previous visit. If drawings are not available and this is the first visit then dimensions should be taken and passed to the engineering department together with the quantity of agent to enable a calculation to be carried out to ensure the correct quantity of gas has been used.

12 Monthly Hose Check

All system hoses should be examined for damage. If visual examination shows any deficiency, the hose shall be replaced.

12 Monthly Integrity Test

Integrity test the enclosure to determine if the leakage area has changed sufficiently from that measured during installation.

Electrical Actuator Ten Year Lifespan

The removable electrical actuator has a life span of 10 years from manufacture, which is indicated on the label, and so should be replaced before this date is reached.

Personnel Training

All persons who may be expected to inspect, test, maintain or operate the fire extinguishing system shall be kept adequately trained in the functions they are expected to perform.Personnel working in an enclosure protected by a gaseous extinguishant shall receive training in the operation, use of the system and safety issues.

Mechanical Servicing Procedure

a. Remove valve actuator(s) from the container valve(s).

b. For master/slave system complete the following steps to check the slave actuation system:-

1. Disconnect pneumatic valve actuators from the slave container valves.

2. Disconnect the pilot loop from the master container valve and install the appropriate plug.

3. Introduce 4 bar (58 psi) pressure into the pilot actuation line to the pneumatic actuators.

4. Check that the pistons in the pneumatic valve actuators have fully operated.

5. Check for leaks. There must be less than 10% loss in pressure within 1 minute).

6. Vent pressure in the pilot actuation line and re-set all of the actuators.

7. Introduce 34 bar (493 psi) pressure into the pilot actuation line to the pneumatic actuators.

8. Check that the pistons in the pneumatic valve actuators have fully operated.

9. Check for leaks. There must be less than 10% loss in pressure within 1 minute).

10. Vent pressure in the pilot actuation line and re-set all of the actuators.

c. To check the electrical actuation system (for single container systems only electrical actuators are fitted):

i) Remove electrical actuators from valve assembles.

ii) Activate the detection system in accordance with procedures provided with the system. When this test is performed, the release circuit of the detection system must operate the electric actuators causing the plungers to be firmly extended.

iii) Examine the auxiliary electrical device/alarm, door closers etc., have all operated correctly.

iv) Ensure actuator is reset before refitting, using the reset tool provided.

d. For master/slave system, remove the appropriate port plug and reconnect the pilot actuation line to the slave port on the back of the master valve.

e. Reset pressure switches after the test has been completed.

(1) An approved distributor is carrying out the maintenance on the detection system.

(2) If the servicing of the detection system is being carried out at the same time as the mechanical service by another nominated body.

Specialised Maintenance Duties

Container Hydrostatic Pressure Testing

In countries where NFPA 2001 applies the following criteria are used for hydrostatic pressure testing :

Containers only need hydrostatic pressure testing after discharge. Systems under local jurisdiction may have other rules of hydrostatic pressure testing, please follow these rules.

Finally

Carry out a final visual inspection of the system and the protected area to ensure that all equipment has been reinstalled and reconnected properly. Ensure that any associated control/indication panel is displaying normal operation. Complete the site log book, recording work carried out and parts used. Inform the responsible person that the work is complete and that the system is back on-line.

Refurbishment of container valves can only be carried out by the Original Equipment Manufacturer (O.E.M). This section is for information only

Recharging (O.E.M Only)

This section describes the procedures to enable the refilling of a container that has been discharged and will require recharging. This covers 25 mm (1″), 50 mm (2″) and 80 mm (3″) container valve assemblies.

Valve Refurbishment (O.E.M Only)

On receiving a container that requires to be recharged the following operations are carried out. See figure 69 or 70 for component description. Ensure all parts are cleaned fully before any part is replaced.

1. Check that the container is empty.
2. Remove valve, syphon tube grub screw and syphon tube from container. Siphon tube for 343 litre container stays in the container collar, (This operation only needs to be undertaken if the burst disc needs replacing).
3. Unscrew top cap by removing locking grub screw located behind safety cap chain fixing screw. Once that has been taken off the schrader should also be removed. (80 mm (3″) valve does not use a grub screw, external type valve cap).

   All O-ring seals must be lubricated using PTFE silicone grease.
4. O-ring seal for the top cap has to be removed :

   25 mm (1″) valve O-ring (Part No.12869)

   50 mm (2″) valve O-ring (Part No.17035)

   80 mm (3″) valve O-ring (Part No.570295)
5. Remove shuttle from valve body and dispose.
6. Locate replacement suttle assembly :

   25 mm (1″) valve shuttle (Part No. 16855).

   50 mm (2″) valve shuttle(Part No.19490).

   80 mm (3″) valve shuttle (Part No. 570373)
7. Apply PTFE silicone grease to new top cap O-ring.
8. Replace shuttle into valve, spray a small quantity of PTFE silicone grease into the bore of the valve body.
9. Replace O-ring seal for the top cap with new :

   25 mm (1″) valve O-ring (Part No.12869)

   50 mm (2″) valve O-ring (Part No.17035)

   80 mm (3″) valve O-ring (Part No.570295)
10. Screw new schrader into top cap using schrader tool set to 0.275 Nm, (0.25 to 0.3 Nm tolerance). Replace top cap to valve and lock into place with grub screw. (80 mm (3″) valve does not use grub screw).
11. If valve has been removed from neck ring, replace neck seal : (This is to pre-dome burst disc if required)

    25 mm (1″) valve Neck O-ring (Part No. 12853)

    50 mm (2″) valve Neck O-ring (Part No. 12855)

    80 mm (3″) valve- Neck O-ring (Part No.570294)
12. The outlet adapter may require to be replaced, if this is so the outlet will need to be removed and threads cleaned. Apply Loctite 648 to the thread of the new outlet adapter and screw fully home. Re-fit anti-recoil cap.

    In the event that the pressure gauge or pressure switch needs to be replaced:
13. Remove to reveal grub screw. Check the grub screw setting, this should be initially tighten fully and then loosen by 1/2 a turn.
14. Apply PTFE tape to replacement components and refit.
15. Remove 53.4 bar (775 psi) burst disc assy if damaged from burst disc port and replace with a new assy.

    25 mm (1″) and 50 mm (2″) valve:
    M18 assembly, torque to 20 Nm, (Part No. 20915)

    80 mm (3″) valve:
    torque to 20.3 Nm, (Part No. 15330)
16. Valve assembly is now ready to be leak tested. See testing section.

Figure 69 - 50 mm (2") Valve exploded view.

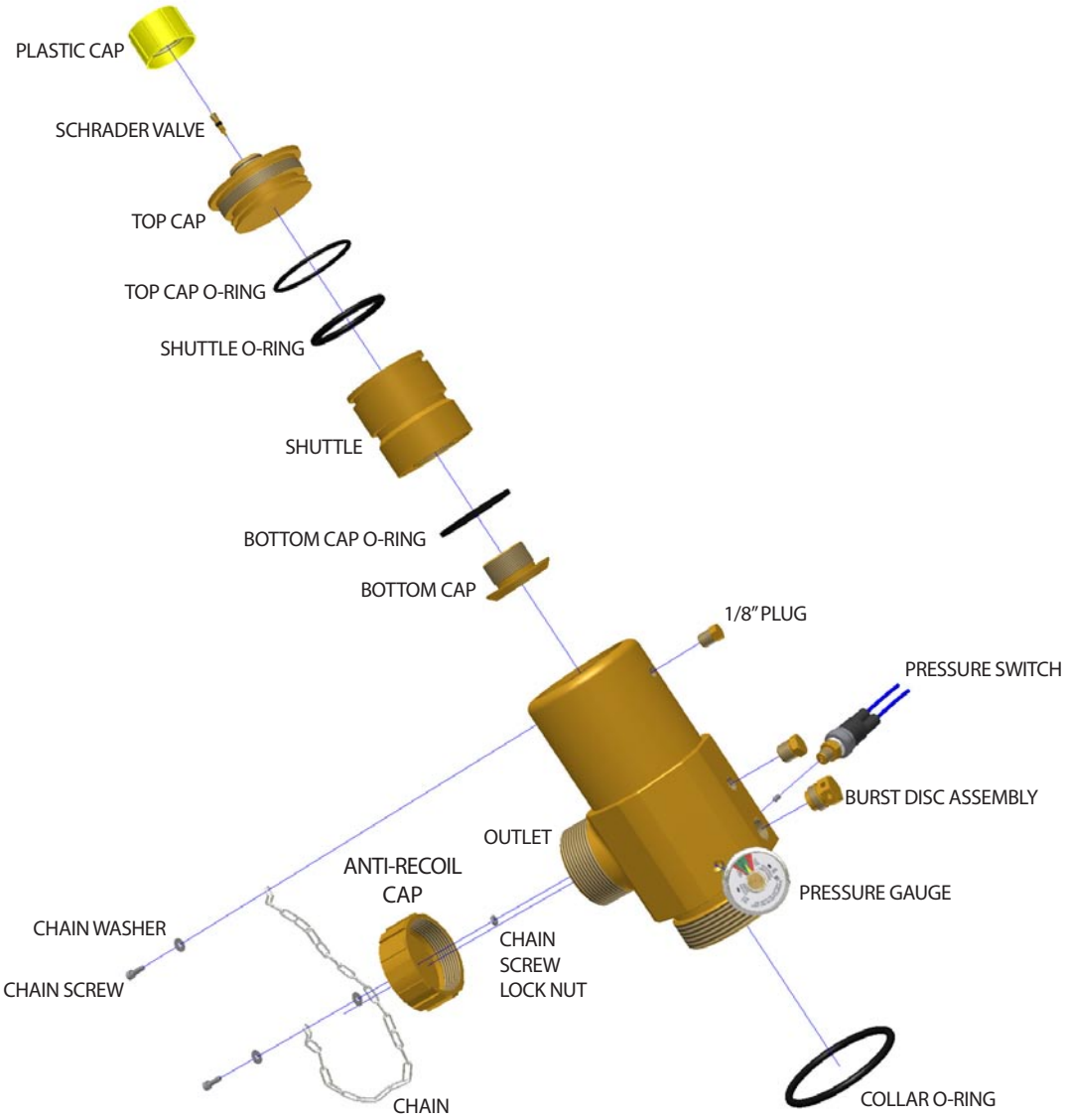
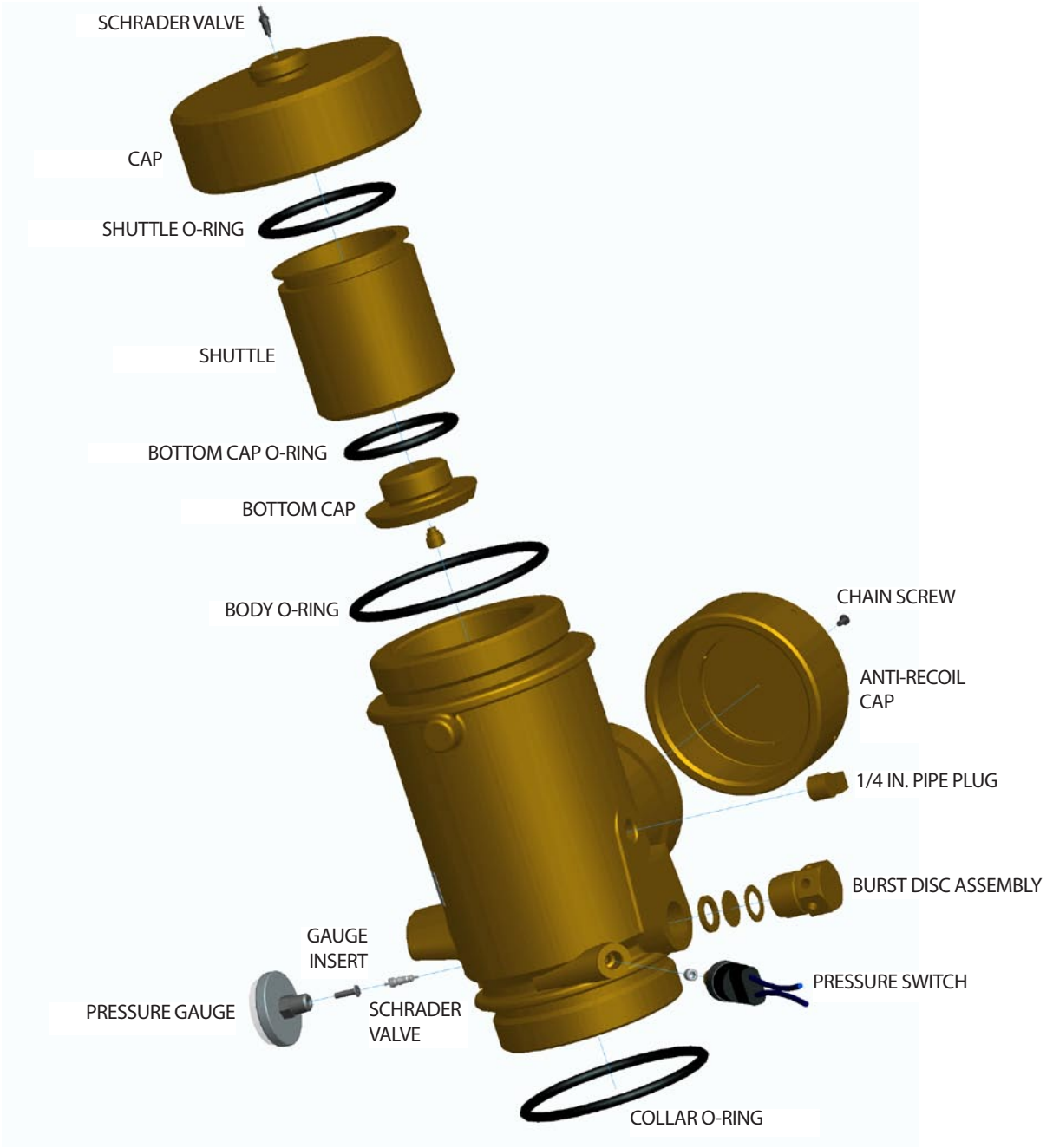


Figure 70 - 3"Valve exploded view.

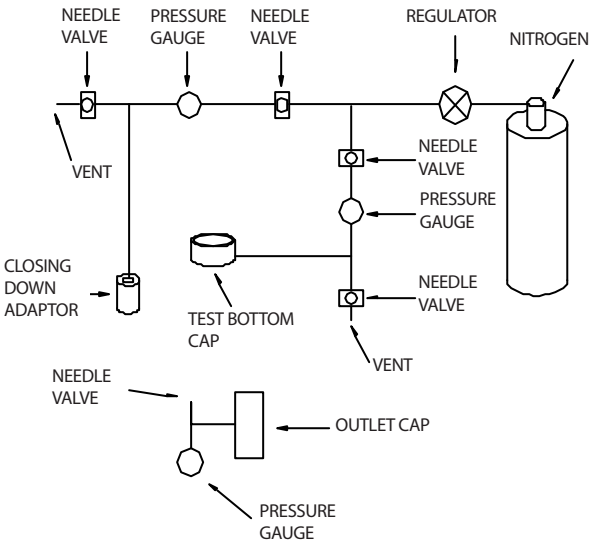


Testing (O.E.M Only)

On completion of a valve refurb the valve assy is subjected to two tests - Valve Assy Pre-dome and Leak Test. (Test required if burst disc was replaced)

The tests are conducted on a Nitrogen rig using a outlet filling adapter cap, test bottom cap and closing down adaptor. (See figure 71)

Figure 71 - Nitrogen Test Station Component Layout



1. The valve assy is assembled to the nitrogen rig bottom cap using PTFE/silicon greased O-ring on the valve neck thread. The outlet adapter cap is also fitted, ensuring that the vent tap is closed.

2. The nitrogen regulator is opened to 40 bar (580 psi) and the pressure to the valve is slowly increased to this pressure, this is to pre-dome the burst disc. This pressure is held for 1 minute ensuring that there is no drop in pressure indicated by nitrogen rig gauge.

3. A Water /soap solution is poured into the top cap schrader and leak detection spray is applied to all ports on the valve to check for leakage. If no leaks are present the pressure to the valve must be reduced to 25 bar (362.5 psi) and the closing down adapter fitted. To close the valve shuttle down, 40 bar (580 psi) is applied through the closing down adapter.

4. Once again check for leaks.

5. Slowly release the gas from the test rig, vent from closing down adapter and ensure that the outlet cap adapter tap is opened before attempting to remove the adapter.

If a leak is identified it should be rectified, if the leak persists the valve assembly should be rejected.

Replacing Valve Assembly to container

1. Take container and clean neck thread using a power drill and the appropriate attachment. Use care when cleaning neck threads as the O-ring seal could be damaged.

2. Remove debris from inside the container as well as from the neck thread, this should be done using the workshop vacuum cleaner and airline.

3. PTFE grease must be applied to the clean container neck thread.

4. Take the appropriate syphon tube for the correct container and valve assy, making sure that the syphon tube and grub screw hole has been properly de-burred.

5. The syphon must be cleaned either by hand with paper towels or in the workshop washer.

6. Ensure the siphon tube O-ring is in place. Fit the syphon tube into the valve assy, ensuring that the grub screw hole's line up (does not apply to 80 mm (3″) valve - tube remains in container).

7. Remove excess loctite adhesive and screw in grub screw.

8. Fit valve and syphon tube assembly to container, insuring that the neck O-ring is in place.

   25 mm (1″) valve - Neck O-ring (Part No. 12853)

   50 mm (2″) valve - Neck O-ring (Part No. 12855)

   80 mm (3″) valve- Neck O-ring (Part No.570294)

9. Secure the container in to the pneumatic belt vice and tighten the valve using the spanner, until the valve bottoms onto the top of the neck ring.

Field Installing Liquid Level Measuring Device

Caution. Container must be completely empty before removing the liquid level device or the port plug. Severe injury or damage could accur if container contains pressure.

If desired, and the container is equipped with a port for liquid level measuring device, it must be installed before filling the container.

To install the liquid liquid level measuring device, remove the plug the plug in the liquid level port on the container.

Make certain the O-ring on the device, the thread on the device and the container port, are clean. Apply a small amount of PTFE silicone grease to the O-ring and the thread on the device.

Install the device into the port and tighten to a metal to metal contact.

Filling

Filling can only be undertaken by trained and authorised UL and FM fill stations.

1. With the Container ready for filling a check is made to the filling instruction sheet and the container fill weight, time, date and fill details record.

2. The container is placed on a scales and the appropriate filling adapter attached to the container valve discharge port.

3. Attach the fill hose / vent line from the filling rig outlet to filling adapter.

4. Reset the scale to zero to compensate for weight of container and fill hose.

5. Switch on the pump marked 'Liquid' on filling cabinet and fill container to required weight, refer to fill tolerances table 24. (less approximately 0.7 kg (1.5 lbs) which is present in pipework and will be forced through during pressurisation). When the fill is reached switch off pump.

6. Remove container from scales, zero scales and weigh to verify fill is within tolerance, adjust if required.

7. Attach low pressure switch wires to test box and regulate nitrogen pressure to 13.8 bar (200 psi) on fill rig and switch on supply.

8. Slowly increase the nitrogen pressure on the approved pressure regulator to the stated pressure on the filling instruction sheet, making the relevant allowances in pressure to compensate for the current room temperature (see the temperature correction chart Table 25). Read off the calibrated external fill pressure gauge to determine when the intended charging pressure has been reached. (Check that the container pressure gauge reads within ± 1 bar (± 14.5 psi) of the fill gauge, replace container gauge if outside this tolerance).

Caution. When superpressurising, a pressure regulator must be used when the pressure source is a tank of high pressure gas.

Ensure that the test box registers a change in state (normally open to normally closed or normally closed to normally open) at approximately 24 bar rising (350 psi).

9. Agitate the container to accelerate nitrogen absorption into the agent and top up the pressure accordingly. Switch off nitrogen supply once absorption has stopped.

10. Attach the closing down adaptor to the container valve top cap and connect the nitrogen closing down line. Regulate the nitrogen pressure to 40 bar (580 psi) with the fill rig.

11. Open the closing down valve for 1 second only to force the valve shuttle down. The container valve can be heard to close. Turn off the nitrogen supply and vent the closing down line with the needle valve.

12. Vent the fill hose to atmosphere. If the pressure drops to zero as shown on fill rig gauge marked outlet within 10 seconds, the valve has closed. (Top up if necessary)

13. Remove the closing down line adapter.

14. If valve does not close after 5 applications, the cylinder must be de-pressurised. Ensure vent valve is closed when not required to prevent contamination on fill line.

15. Test all ports with leak detection spray, and Schrader with water/soap solution.

If a leaks is observed, minor leaks may be cured by tightening the offending components.

16. Remove fill hose and filling adapter, leak test the outlet and attach anti-recoil cap. Note : When leak testing outlet with spray, do not look directly into port, examine quickly from an angle.)

17. Reset scales and note down gross weight.

18. Make certain all safety caps are in place, schrader protection cap Part No. 12569.

19. Attach label to container stating the following information. Job number, Customer, Project, Container size, Fill weight, Gross weight, Date filled, Type of agent.

20. Place container in bonded area for leak monitoring for at least 24 hours prior to dispatch.

21. After 24 hours a Leak Test on the container is conducted - see section on Container / valve assy leakage test.

22. Insert fill information on to container label.

4.5 to 16 litre Container:	Label part No. 314.205.021
	Label part No. 314.205.045*
32 to 343 litre Container:	Label part No. 314.205.022
	Label part No. 314.205.046*

23. Adhere label to container 50 mm (2″) below the container top fixing bracket height.

Table 24 :Fill Tolerance Table.

Container Size	Fill Tolerance	Tolerance
4.5 litre	+0.04, -0 kg (+0.09, -0 lb)	+0.75, -0 bar (+11, -0 psi)
8 litre	+0.04, -0 kg (+0.09, -0 lb)	+0.75, -0 bar (+11, -0 psi)
16 litre	+0.08, -0 kg (+0.18, -0 lb)	+0.75, -0 bar (+11, -0 psi)
32 litre	+0.16, -0 kg (+0.35, -0 lb)	+0.75, -0 bar (+11, -0 psi)
40 litre*	+0.16, -0 kg (+0.35, -0 lb)	+0.75, -0 bar (+11, -0 psi)
52 litre	+0.26, -0 kg (+0.57, -0 lb)	+0.75, -0 bar (+11, -0 psi)
67.5 litre*	+0.26, -0 kg (+0.57, -0 lb)	+0.75, -0 bar (+11, -0 psi)
80 litre*	+0.50, -0 kg (+1.10, -0 lb)	+0.75, -0 bar (+11, -0 psi)
106 litre	+0.50, -0 kg (+1.10, -0 lb)	+0.75, -0 bar (+11, -0 psi)
147 litre	+0.75, -0 kg (+1.65, -0 lb)	+0.75, -0 bar (+11, -0 psi)
180 litre	+1.00, -0 kg (+2.21, -0 lb)	+0.75, -0 bar (+11, -0 psi)
343 litre	+1.50, -0 kg (+3.31, -0 lb)	+0.75, -0 bar (+11, -0 psi)

* For UL Listed Systems Only (Not FM Approved)

Table 25: Temperature Correction Chart.

Temperature		Developed Pressure		Temperature		Developed Pressure		Temperature		Developed Pressure	
°C	(°F)	Bar	(psi)	°C	(°F)	Bar	(psi)	°C	(°F)	Bar	(psi)
0.0	(32)	20.2	(292.8)	18.3	(65)	24.6	(356.7)	36.7	(98)	29.0	(420.6)
0.6	(33	20.3	(294.8)	18.9	(66)	24.7	(358.7)	37.2	(99)	29.1	(422.6)
1.1	(34)	20.5	(296.7)	19.4	(67)	24.9	(360.6)	37.8	(100)	29.3	(424.5)
1.7	(35)	20.6	(298.6)	20.0	(68)	25.0	(362.5)	38.3	(101)	29.4	(426.4)
2.2	(36)	20.7	(300.6)	20.6	(69)	25.1	(364.5)	38.9	(102)	29.5	(428.4)
2.8	(37)	20.9	(302.5)	21.1	(70)	25.3	(366.4)	39.4	(103)	29.7	(430.3)
3.3	(38)	21.0	(304.5)	21.7	(71)	25.4	(368.4)	40.0	(104)	29.8	(432.2)
3.9	(39)	21.1	(306.4)	22.2	(72)	25.5	(370.3)	40.6	(105)	29.9	(434.2)
4.4	(40)	21.3	(308.3)	22.8	(73)	25.7	(372.2)	41.1	(106)	30.1	(436.1)
5.0	(41)	21.4	(310.3)	23.3	(74)	25.8	(374.2)	41.7	(107)	30.2	(438.1)
5.6	(42)	21.5	(312.2)	23.9	(75)	25.9	(376.1)	42.2	(108)	30.3	(440.0)
6.1	(43)	21.7	(314.1)	24.4	(76)	26.1	(378.0)	42.8	(109)	30.5	(441.9)
6.7	(44)	21.8	(316.1)	25.0	(77)	26.2	(380.0)	43.3	(110)	30.6	(443.9)
7.2	(45)	21.9	(318.0)	25.6	(78)	26.3	(381.9)	43.9	(111)	30.7	(445.8)
7.8	(46)	22.1	(319.9)	26.1	(79)	26.5	(383.8)	44.4	(112)	30.9	(447.7)
8.3	(47)	22.2	(321.9)	26.7	(80)	26.6	(385.8)	45.0	(113)	31.0	(449.7)
8.9	(48)	22.3	(323.8)	27.2	(81)	26.7	(387.7)	45.6	(114)	31.1	(451.6)
9.4	(49)	22.5	(325.8)	27.8	(82)	26.9	(389.6)	46.1	(115)	31.3	(453.5)
10.0	(50)	22.6	(327.7)	28.3	(83)	27.0	(391.6)	46.7	(116)	31.4	(455.5)
10.6	(51)	22.7	(329.6)	28.9	(84)	27.1	(393.5)	47.2	(117)	31.5	(457.4)
11.1	(52)	22.9	(331.6)	29.4	(85)	27.3	(395.5)	47.8	(118)	31.7	(459.4)
11.7	(53)	23.0	(333.5)	30.0	(86)	27.4	(397.4)	48.3	(119)	31.8	(461.3)
12.2	(54)	23.1	(335.4)	30.6	(87)	27.5	(399.3)	48.9	(120)	31.9	(463.2)
12.8	(55)	23.3	(337.4)	31.1	(88)	27.7	(401.3)	49.4	(121)	32.1	(465.2)
13.3	(56)	23.4	(339.3)	31.7	(89)	27.8	(403.2)	50.0	(122)	32.2	(467.1)
13.9	(57)	23.5	(341.2)	32.2	(90)	27.9	(405.1)	50.6	(123)	32.3	(469.0)
14.4	(58)	23.7	(343.2)	32.8	(91)	28.1	(407.1)	51.1	(124)	32.5	(471.0)
15.0	(59)	23.8	(345.1)	33.3	(92)	28.2	(409.0)	51.7	(125)	32.6	(472.9)
15.6	(60)	23.9	(347.1)	33.9	(93)	28.3	(410.9)	52.2	(126)	32.7	(474.8)
16.1	(61)	24.1	(349.0)	34.4	(94)	28.5	(412.9)	52.8	(127)	32.9	(476.8)
16.7	(62)	24.2	(350.9)	35.0	(95)	28.6	(414.8)	53.3	(128)	33.0	(478.7)
17.2	(63)	24.3	(352.9)	35.6	(96)	28.7	(416.8)	53.9	(129)	33.1	(480.7)
17.8	(64)	24.5	(354.8)	36.1	(97)	28.9	(418.7)	54.4	(130)	33.3	(482.6)

Note: Filling can only be carried out by UL approved fill stations using containers assembled and tested by the O.E.M.

Container / Valve Assy leakage Test

A leakage test is required for all filled FM-200® valves and container assemblies after being left to stand in a bonded area for at least 24 hours. Two test options are available. The test equipment used for both test options is a leak detector and calibration gas.

Halotek Leak Detector Test

1. After 24 hours standing, the valve pressure gauge should be checked for pressure loss (refer to temperature correction chart to adjust for temperature change). The container and valve assembly should then be checked for leakage using the Halotek leak detector unit.

2. Testing should take place in an area free of FM-200® contamination.

3. Take the Halotek unit & calibration gas and within the FM-200® free environment, calibrate the unit.

4. Adjust the Halotek leak detector to gain a steady audible pulse, in free air, of about 2 to 4 pulses per second.

5. Conduct a stability check by leaving the Halotek unit for approximately 3 minutes in a clean air environment. If the pulse rate is observed to stay within the range of 2 to 4 pulses per second, proceed to the repeatability check.

If the stability check is inconclusive, repeat stability check in an alternative clean environment. If stability problems persist, contact R&D department for instruction.

6. The leak standard of 0.13 oz/year should be conditioned to a temperature of 20 °C +/-5 °C (68 °F ± 9 °F) for at least 24 hours.

7. Conduct a calibration repeatability test.

8. Remove the cap from the leak standard, screw the calibration nozzle into the outlet of the bottle and open the hand valve fully.

9. Place the Halotek probe into the calibration nozzle. Within 5 seconds the pulse rate should start to increase and be a continuous tone within 15 seconds.

10. Remove the probe from the nozzle and position the Halotek unit away from the gas source. The pulse rate should revert back to the original rate of 2 to 4 pulses per second within 15 seconds.

11. Repeat test a further two times. If repeatability test indicates that the unit is functioning within the set parameters, proceed to the container leak test.

However, if the repeatability check is inconclusive, repeat check in an alternative clean environment. If repeatability problems persist, contact R&D department for instruction. Close the hand valve of the leak standard after use.

Helium Sniffer Test (Alternative Test)

Details of the procedure and equipment required are available from the Original Equipment Manufacturer (O.E.M) on request.

Container Leak Test

Carefully probe the container/valve assembly at all probes and openings. Ensure that the probe is not brought into direct contact with any objects as this can lead to spurious results and ensure that the dwell time of the probe is sufficiently long (more than 5 seconds) to ensure any leak is detected. Any significant and repeatable increase of the audible pulse rate should be taken as an indication of a leak and the container and valve assembly should be rejected.

Once the leakage source has been rectified, the container and valve assembly should be subjected to a further leak test using the Halotek unit.

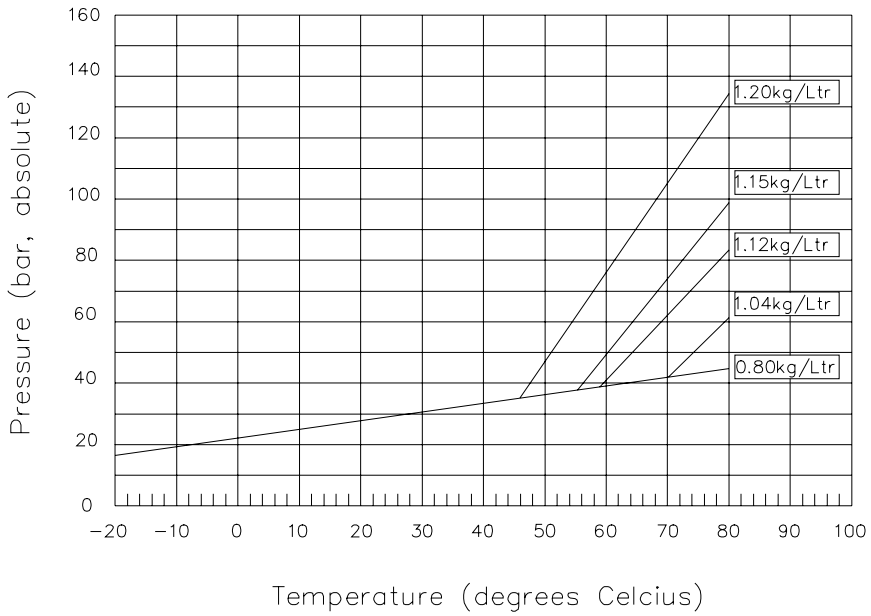
Warranty

Following the commissioning of the system, all equipment will be covered by the company's twelve month parts warranty (excluding parts accidentally or maliciously damaged by others). For further information, refer to the company's 'Terms and conditions' document.

Disclaimers and Limitations

Whilst every care has been taken in the publication of this user's guide to describe our products accurately, it is not considered binding. The right is reserved to make any alterations without notice. All issues are uncontrolled copies.

FM-200® PRESSURISED TO 24.8 BAR (360 psig)
WITH NITROGEN AT 21˚C



FM-200®
Calculation Program

Computer printout

Example Calculation

Consolidated Report

10 pages

TFS & BP FM-200 FLOW CALCULATION TEPG3.03b
UL: EX4678/EX6077
Project: Example Calculation
File Name: example for UL Design Manual-updated.FLC

Consolidated Report

Customer Information

Company Name:	TFS&BP
Address:	Hewett Road Great Yarmouth Norfolk, N231 ONN
Phone:	44(0) 1493 417 600
Contact:	Tim Broughton
Title:	Engineering Manager

Project Data

Project Name:	Example Calculation
Designer:	Tim Broughton
Number:	001
Account:	001
Location:	Example
Description:	Computer Suite

Calculation Date/Time: Sunday, June 29, 2008, 12:24:17 PM

tyco Fire Suppression & Building Products

Consolidated Report
Enclosure Information

Elevation:	0 m (relative to sea level)
Atmospheric Correction Factor:	1

Enclosure Number:	1
Name:	Switch Room
Enclosure Temperature...	
Minimum:	20.0 C
Maximum:	20.0 C
Maximum Concentration:	6.429 %
Design Concentration...	
Adjusted:	6.428 %
Minimum:	6.400 %
Minimum Agent Required:	60.4 kg
Width:	6.98 m
Length:	6.92 m
Height:	2.50 m
Volume:	120.75 cubic m
Non-permeable:	0.00 cubic m
Total Volume:	120.75 cubic m
Adjusted Agent Required:	60.6 kg
Number of Nozzles:	1

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tyco / Fire Suppression & Building Products

Consolidated Report
Enclosure Information

Elevation:	0 m (relative to sea level)
Atmospheric Correction Factor:	1
Enclosure Number:	2
Name:	Computer Room
Enclosure Temperature...	
Minimum:	20.0 C
Maximum:	20.0 C
Maximum Concentration:	6.422 %
Design Concentration...	
Adjusted:	6.422 %
Minimum:	6.400 %
Minimum Agent Required:	271.4 kg
Width:	12.00 m
Length:	16.00 m
Height:	2.83 m
Volume:	543.36 cubic m
Non-permeable:	0.00 cubic m
Total Volume:	543.36 cubic m
Adjusted Agent Required:	272.4 kg
Number of Nozzles:	4

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Consolidated Report
Agent Information

Agent: FM-200 / Propellant N2
(FM-200 is a Trademark of DuPont.)

Adjusted Agent Required:	333.0 kg
Container Name:	180L DOT Container Assy
Container Part Number:	304.205.021
Number of Main Containers:	3
Number of Reserve Containers:	0
Manifold:	3 Port 80mm End Manifold Assy (BSP) - 52-180L
Pipe Take Off Direction:	Horizontal
Agent Per Container:	111.0 kg
Fill Density:	0.617 kg / l
Container Empty Weight:	105.8 kg
Weight, All Containers + Agent:	650.4 kg
Floor Area Per Container:	0.13 square m
Floor Loading Per Container:	1681 kg /square m

Pipe Network

Part 1 - Pipe

			Pipe			
Description	Start	End	Type	Diameter	Length	Elevation
Main Cyl. X 3	0	1		50 mm	1.63 m	1.63 m
Manifold X 3	1	2	US40B TS	50 mm	0.74 m	0.62 m
Manifold X 1	2	3	UK80B WS	80 mm	1.17 m	0.00 m
Pipe	3	4	UK80G TS	80 mm	0.45 m	0.45 m
Pipe	4	5	UK80G TS	80 mm	0.45 m	0.00 m
Pipe	5	6	UK80G TS	80 mm	2.25 m	0.00 m
Pipe	6	7	UK80G TS	80 mm	3.75 m	0.00 m

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tyco Fire Suppression & Building Products

Consolidated Report

Part 1 - Pipe

			Pipe			
Description	Start	End	Type	Diameter	Length	Elevation
Pipe	7	8	UK80G TS	80 mm	8.00 m	0.00 m
Pipe	8	9	UK80G TS	65 mm	3.00 m	0.00 m
Pipe	9	10	UK80G TS	40 mm	4.00 m	0.00 m
Pipe/E2-N1	10	11	UK80G TS	40 mm	0.10 m	-0.10 m
Pipe	9	12	UK80G TS	40 mm	4.00 m	0.00 m
Pipe/E2-N2	12	13	UK80G TS	40 mm	0.10 m	-0.10 m
Pipe	8	14	UK80G TS	50 mm	3.00 m	0.00 m
Pipe	14	15	UK80G TS	40 mm	4.00 m	0.00 m
Pipe/E2-N3	15	16	UK80G TS	40 mm	0.10 m	-0.10 m
Pipe	14	17	UK80G TS	40 mm	4.00 m	0.00 m
Pipe/E2-N4	17	18	UK80G TS	40 mm	0.10 m	-0.10 m
Pipe	6	19	UK80G TS	40 mm	0.42 m	0.00 m
Pipe	19	20	UK80G TS	40 mm	6.30 m	0.00 m
Pipe/E1-N1	20	21	UK80G TS	40 mm	0.10 m	-0.10 m

Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
0	1	0	0	0	0	0		0.00 m	10.67 m
1	2	0	0	0	0	0	50mmDH&CV	0.00 m	12.74 m
2	3	0	0	2	1	0		0.00 m	6.28 m
3	4	1	0	0	0	0		0.00 m	2.96 m
4	5	1	0	0	0	0		0.00 m	2.96 m
5	6	1	0	0	0	0		0.00 m	4.75 m

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Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
6	7	0	0	1	0	0		0.00 m	5.30 m
7	8	1	0	0	0	0		0.00 m	10.52 m
8	9	0	0	0	1	0		0.00 m	7.07 m
9	10	0	0	0	1	0		0.00 m	6.64 m
10	11	1	0	0	0	0		0.00 m	1.40 m
9	12	0	0	0	1	0		0.00 m	6.64 m
12	13	1	0	0	0	0		0.00 m	1.40 m
8	14	0	0	0	1	0		0.00 m	6.40 m
14	15	0	0	0	1	0		0.00 m	6.64 m
15	16	1	0	0	0	0		0.00 m	1.40 m
14	17	0	0	0	1	0		0.00 m	6.64 m
17	18	1	0	0	0	0		0.00 m	1.40 m
6	19	0	0	0	1	0		0.00 m	3.08 m
19	20	1	0	0	0	0		0.00 m	7.62 m
20	21	1	0	0	0	0		0.00 m	1.40 m

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
0	1	111.0 kg				
1	2	111.0 kg				
2	3	333.0 kg				
3	4	333.0 kg				
4	5	333.0 kg				
5	6	333.0 kg				
6	7	272.4 kg				
7	8	272.4 kg				
8	9	136.4 kg				
9	10	68.2 kg				
10	11	68.2 kg	E2-N1	40 mm	360-BR (BSP)	760.27 square mm
9	12	68.2 kg				
12	13	68.2 kg	E2-N2	40 mm	360-BR (BSP)	760.27 square mm
8	14	136.0 kg				
14	15	68.0 kg				

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Consolidated Report

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
15	16	68.0 kg	E2-N3	40 mm	360-BR (BSP)	860.11 square mm
14	17	68.0 kg				
17	18	68.0 kg	E2-N4	40 mm	360-BR (BSP)	860.11 square mm
6	19	60.6 kg				
19	20	60.6 kg				
20	21	60.6 kg	E1-N1	40 mm	180-BR (BSP)	765.51 square mm

Parts Information

Total Agent Required: 333.0 kg
Container Name: 180L DOT Container Assy (Part: 304.205.021)
Number Of Containers: 3
Manifold: 3 Port 80mm End Manifold Assy (BSP) - 52-180L (Part: 307.209.026)

Nozzle	Type	Diameter	Nozzle Area	Part Number
E1-N1	180-BR (BSP)	40 mm	765.51 square mm	310.205.211
E2-N1	360-BR (BSP)	40 mm	760.27 square mm	310.205.212
E2-N2	360-BR (BSP)	40 mm	760.27 square mm	310.205.212
E2-N3	360-BR (BSP)	40 mm	860.11 square mm	310.205.212
E2-N4	360-BR (BSP)	40 mm	860.11 square mm	310.205.212

Nozzle	Drill Diameter	Drill Size
E1-N1	11.8000 mm	11.8 mm
E2-N1	11.0000 mm	11 mm
E2-N2	11.0000 mm	11 mm
E2-N3	11.7000 mm	11.7 mm
E2-N4	11.7000 mm	11.7 mm

Pipe:	Type	Diameter	Length

tyco / Fire Suppression & Building Products

Consolidated Report

Pipe:	Type	Diameter	Length
	UK80BWS	80 mm	1.17 m
	UK80GTS	40 mm	23.22 m
	UK80GTS	50 mm	3.00 m
	UK80GTS	65 mm	3.00 m
	UK80GTS	80 mm	14.90 m

'Other' Items:
3 - 50 mm Check&Flex (Part: 306207002/302209004)

List of 90 degree elbows:
6 - 40 mm
4 - 80 mm

List of Tees:
1 - 50 mm
1 - 65 mm
2 - 80 mm

System Acceptance

System Discharge Time: 8.4 seconds
Percent Agent In Pipe: 53.9%
Percent Agent Before First Tee: 14.3%

Enclosure Number: 1
Enclosure Name: Switch Room

Minimum Design Concentration: 6.400%
Adjusted Design Concentration: 6.428%
Predicted Concentration: 6.479%
Maximum Expected Agent Concentration: 6.479% (At 20.0 C)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E1-N1	60.4 kg	60.6 kg	61.1 kg	8.538 bar

Enclosure Number: 2
Enclosure Name: Computer Room

Minimum Design Concentration: 6.400%
Adjusted Design Concentration: 6.422%

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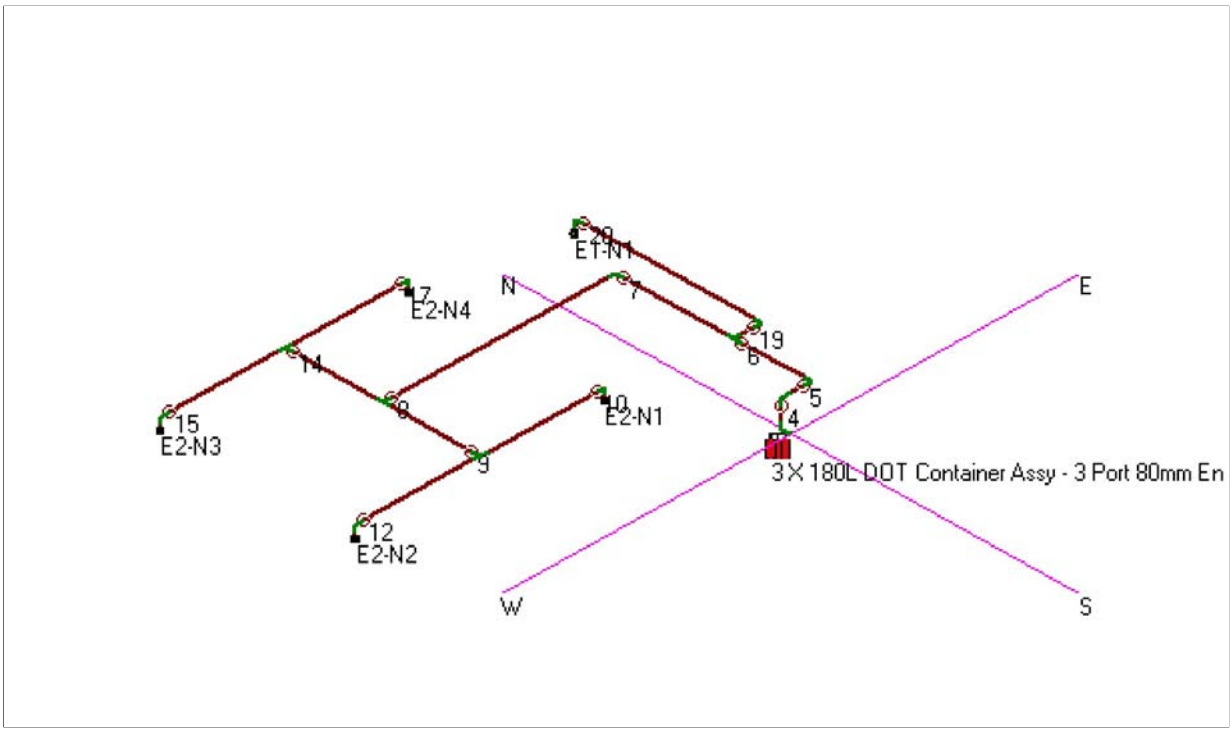
Consolidated Report

Predicted Concentration: 6.411%

Maximum Expected Agent Concentration: 6.411% (At 20.0 C)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E2-N1	67.9 kg	68.2 kg	68.5 kg	6.887 bar
E2-N2	67.9 kg	68.2 kg	68.5 kg	6.887 bar
E2-N3	67.8 kg	68.0 kg	67.5 kg	6.069 bar
E2-N4	67.8 kg	68.0 kg	67.5 kg	6.069 bar

Standard Isometric View



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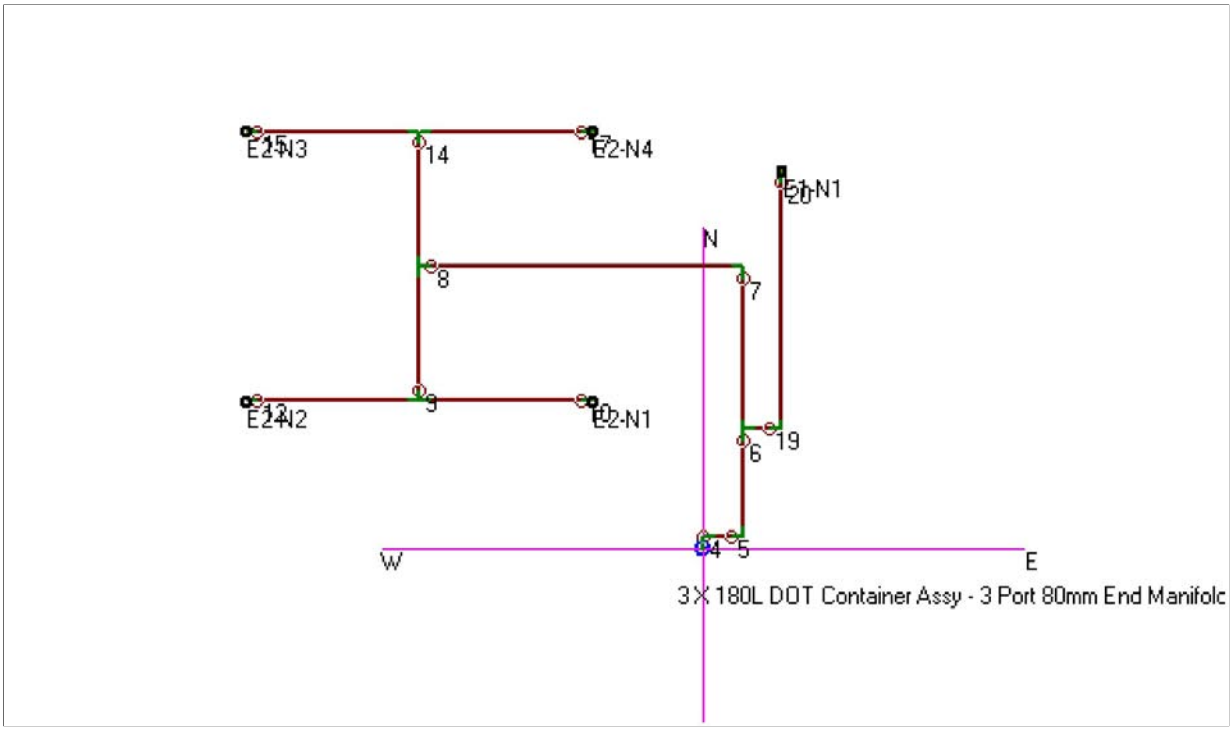
tyco / Fire Suppression & Building Products

Consolidated Report

Standard Plan View



Standard Elevation View

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FM-200® Material Safety Data Sheet

(MSDS)

SAFETY DATA SHEET according to Regulation (EC) No. 1907/2006

FM-200®

Version 2.0
Revision Date 25.01.2008 Ref. 130000036866

This SDS adheres to the standards and regulatory requirements of Great Britain and may not meet the regulatory requirements in other countries.

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

Product information

Product name	:	FM-200®
Synonyms	:	HFC-227
Use of the Substance/Preparation	:	Fire extinguishing agent
Company	:	Du Pont de Nemours (Nederland) B.V. Baanhoekweg 22 NL-3313 LA Dordrecht The Netherlands
Telephone	:	+31-78-630.1011
Emergency telephone	:	+44-(0)8456-006.640
E-mail address	:	sds-support@che.dupont.com

2. HAZARDS IDENTIFICATION

Rapid evaporation of the liquid may cause frostbite.
Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Name	CAS-No.	EC-No.	Classification	Concentration [%]
1,1,1,2,3,3,3-Heptafluoropropane	431-89-0	207-079-2		>= 99

4. FIRST AID MEASURES

General advice	:	If unconscious, place in recovery position and seek medical advice. Never give anything by mouth to an unconscious person. If breathing is irregular or stopped, administer artificial respiration. If symptoms persist, call a physician.
Inhalation	:	Move to fresh air. Keep patient warm and at rest. Artificial respiration and/or oxygen may be necessary.
Skin contact	:	Wash off with warm water. Take off all contaminated clothing immediately.
Eye contact	:	Rinse thoroughly with plenty of water, also under the eyelids. Consult a physician.

Notes to physician

Treatment	:	Do not give adrenaline or similar drugs.

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5. FIRE-FIGHTING MEASURES

Specific hazards during fire fighting	:	pressure build-up
Special protective equipment for fire-fighters	:	In the event of fire, wear self-contained breathing apparatus.
Further information	:	Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. Cool containers / tanks with water spray.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions	:	Evacuate personnel to safe areas. Ventilate the area. Refer to protective measures listed in sections 7 and 8.
Environmental precautions	:	Should not be released into the environment.
Methods for cleaning up	:	Evaporates.

7. HANDLING AND STORAGE

Handling

Advice on safe handling	:	Provide sufficient air exchange and/or exhaust in work rooms. For personal protection see section 8.
Advice on protection against fire and explosion	:	No special protective measures against fire required.

Storage

Requirements for storage areas and containers	:	Keep container tightly closed in a dry and well-ventilated place. Store in original container.
Advice on common storage	:	No materials to be especially mentioned.
German storage class	:	2A : Compressed, liquefied or pressurised gas

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering measures

Ensure adequate ventilation, especially in confined areas.

Personal protective equipment

Respiratory protection	:	For rescue and maintenance work in storage tanks use self-contained breathing apparatus. Vapours are heavier than air and can cause suffocation by reducing oxygen available for breathing.

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Hand protection	:	Heat insulating gloves
Eye protection	:	Safety glasses
Hygiene measures	:	Handle in accordance with good industrial hygiene and safety practice.

9. PHYSICAL AND CHEMICAL PROPERTIES

Form	:	Liquefied gas,
Colour	:	colourless,
Odour	:	slight, ether-like,
pH	:	neutral
Melting point/range	:	-133 - -131 °C
Boiling point/boiling range	:	-17 - -15 °C at 1 013 hPa
Flash point	:	does not flash
Explosive properties	:	Not explosive
Vapour pressure	:	4 468 hPa at 25 °C
Vapour pressure	:	4 000 hPa at 20 °C
Density	:	1,4 - 1,5 g/cm3 at 25 °C, (as liquid)
Density	:	0,0076 g/cm3 at 0 °C (1 013 hPa)
Density	:	0,0070 g/cm3 at 25 °C (1 013 hPa)
Relative vapour density	:	5,87

10. STABILITY AND REACTIVITY

Conditions to avoid	:	The product is not flammable in air under ambient conditions of temperature and pressure. When pressurised with air or oxygen the mixture may become flammable. Certain mixtures of HCFCs or HFCs with chlorine may become flammable or reactive under certain conditions.
Materials to avoid	:	Alkali metals, Alkaline earth metals, Powdered metals, Powdered metal salts
Hazardous decomposition products	:	Hydrogen halides, Carbon dioxide (CO2), Carbon monoxide, Fluorocarbons, Carbonyl halides

11. TOXICOLOGICAL INFORMATION

Acute inhalation toxicity

3/5

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• 1,1,1,2,3,3,3-Heptafluoropropane	:	LC50/ 4 h/ rat : 5 485 mg/l
Carcinogenicity assessment	:	Did not show carcinogenic effects in animal experiments.
Toxicity to reproduction assessment	:	Did not show mutagenic or teratogenic effects in animal experiments.
Human experience	:	Excessive exposures may affect human health, as follows: Inhalation Severe shortness of breath, narcosis, Irregular cardiac activity
Further information	:	Rapid evaporation of the liquid may cause frostbite.

12. ECOLOGICAL INFORMATION

Ozone depletion potential	:	0
Global warming potential (GWP)	:	3 500

13. DISPOSAL CONSIDERATIONS

Product	:	Can be used after re-conditioning.
Contaminated packaging	:	Empty pressure vessels should be returned to the supplier.

14. TRANSPORT INFORMATION

ADR

Class:	2
Classification Code:	2A
HI No::	20
UN-Number:	3296
Labelling No.:	2.2
Proper shipping name:	Heptafluoropropane

IATA_C

Class:	2.2
UN-Number:	3296
Labelling No.:	2.2
Proper shipping name:	Heptafluoropropane

IMDG

Class:	2.2
UN-Number:	3296
Labelling No.:	2.2
Proper shipping name:	Heptafluoropropane

SAFETY DATA SHEET according to Regulation (EC) No. 1907/2006

FM-200®

Version 2.0
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15. REGULATORY INFORMATION

Labelling according to EC Directives

Special labelling of certain preparations : Contains fluorinated greenhouse gas covered by the Kyoto Protocol.

The product does not need to be labelled in accordance with EC directives or respective national laws.

16. OTHER INFORMATION

Further information

Before use read DuPont's safety information., For further information contact the local DuPont office or DuPont's nominated distributors., ® DuPont's registered trademark

Significant change from previous version is denoted with a double bar.

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The above information relates only to the specific material(s) designated herein and may not be valid for such material(s) used in combination with any other materials or in any process or if the material is altered or processed, unless specified in the text.

Print Date: 2008 - 6 - 20

FM-200® Liquid Level Indicator Charts

(13 PAGES)

APPENDIX D - FM-200® LIQUID LEVEL INDICATOR CHARTS

106L Tank

LLI Inches	"Temperature, Degrees F" 32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
7.5										
7.75	110.9	110.4	109.8							
8	113.2	112.8	112.2	110.9	109.7					
8.25	115.6	115.1	114.5	113.2	112.0	111.2	110.4			
8.5	118.0	117.5	116.8	115.5	114.2	113.4	112.5	111.7	110.8	
8.75	120.4	119.8	119.1	117.8	116.5	115.6	114.7	113.8	112.9	
9	122.8	122.2	121.4	120.1	118.7	117.8	116.9	115.9	114.9	112.0
9.25	125.1	124.5	123.7	122.4	121.0	120.0	119.0	118.0	116.9	114.0
9.5	127.5	126.9	126.1	124.6	123.2	122.2	121.2	120.1	119.0	116.0
9.75	129.9	129.2	128.4	126.9	125.5	124.4	123.4	122.2	121.0	118.0
10	132.3	131.6	130.7	129.2	127.7	126.6	125.5	124.3	123.0	120.0
10.25	134.7	133.9	133.0	131.5	130.0	128.9	127.7	126.4	125.1	122.0
10.5	137.1	136.3	135.3	133.8	132.3	131.1	129.9	128.5	127.1	124.0
10.75	139.4	138.6	137.6	136.1	134.5	133.3	132.0	130.6	129.1	126.0
11	141.8	141.0	140.0	138.4	136.8	135.5	134.2	132.7	131.2	128.0
11.25	144.2	143.3	142.3	140.6	139.0	137.7	136.4	134.8	133.2	130.0
11.5	146.6	145.7	144.6	142.9	141.3	139.9	138.5	136.9	135.3	132.0
11.75	149.0	148.1	146.9	145.2	143.5	142.1	140.7	139.0	137.3	134.1
12	151.4	150.4	149.2	147.5	145.8	144.3	142.9	141.1	139.3	136.1
12.25	153.7	152.8	151.5	149.8	148.0	146.5	145.0	143.2	141.4	138.1
12.5	156.1	155.1	153.8	152.1	150.3	148.7	147.2	145.3	143.4	140.1
12.75	158.5	157.5	156.2	154.4	152.6	151.0	149.4	147.4	145.4	142.1
13	160.9	159.8	158.5	156.6	154.8	153.2	151.5	149.5	147.5	144.1
13.25	163.3	162.2	160.8	158.9	157.1	155.4	153.7	151.6	149.5	146.1
13.5	165.7	164.5	163.1	161.2	159.3	157.6	155.9	153.7	151.5	148.1
13.75	168.0	166.9	165.4	163.5	161.6	159.8	158.0	155.8	153.6	150.1
14	170.4	169.2	167.7	165.8	163.8	162.0	160.2	157.9	155.6	152.1
14.25	172.8	171.6	170.1	168.1	166.1	164.2	162.4	160.0	157.6	154.1
14.5	175.2	173.9	172.4	170.4	168.3	166.4	164.5	162.1	159.7	156.1
14.75	177.6	176.3	174.7	172.6	170.6	168.6	166.7	164.2	161.7	158.1
15	179.9	178.6	177.0	174.9	172.9	170.9	168.9	166.3	163.7	160.1
15.25	182.2	180.9	179.2	177.2	175.1	173.1	171.0	168.4	165.8	162.1
15.5	184.6	183.2	181.5	179.4	177.4	175.3	173.2	170.5	167.8	164.2
15.75	186.9	185.5	183.7	181.6	179.6	177.5	175.4	172.6	169.8	166.2
16	189.3	187.8	185.9	183.8	181.8	179.6	177.5	174.7	171.9	168.2
16.25	191.6	190.1	188.2	186.1	184.0	181.8	179.7	176.8	173.9	170.2
16.5	194.0	192.4	190.4	188.3	186.2	184.0	181.8	178.9	175.9	172.2
16.75	196.3	194.7	192.6	190.5	188.4	186.2	184.0	181.0	178.0	174.2
17	198.6	197.0	194.8	192.7	190.6	188.3	186.1	183.0	180.0	176.2
17.25	201.0	199.2	197.1	194.9	192.8	190.5	188.3	185.1	182.0	178.2
17.5	203.3	201.5	199.3	197.1	195.0	192.7	190.4	187.2	184.0	180.2
17.75	205.7	203.8	201.5	199.3	197.2	194.9	192.6	189.3	186.0	182.3
18	208.0	206.1	203.8	201.6	199.4	197.0	194.7	191.4	188.1	184.3
18.25	210.4	208.4	206.0	203.8	201.6	199.2	196.8	193.5	190.1	186.3
18.5	212.7	210.7	208.2	206.0	203.8	201.4	199.0	195.5	192.1	188.4
18.75	215.0	213.0	210.5	208.2	206.0	203.6	201.1	197.6	194.1	190.4
19	217.4	215.3	212.7	210.4	208.2	205.7	203.3	199.7	196.1	192.4
19.25	219.7	217.6	214.9	212.6	210.4	207.9	205.4	201.8	198.1	194.4
19.5	222.1	219.9	217.2	214.9	212.6	210.1	207.6	203.9	200.2	196.5
19.75	224.4	222.2	219.4	217.1	214.8	212.2	209.7	206.0	202.2	198.5
20	226.8	224.5	221.6	219.3	217.0	214.4	211.9	208.0	204.2	200.5
20.25	229.1	226.8	223.8	221.5	219.2	216.6	214.0	210.1	206.2	202.6
20.5	231.4	229.1	226.1	223.7	221.4	218.8	216.2	212.2	208.2	204.6
20.75	233.8	231.3	228.3	225.9	223.6	220.9	218.3	214.3	210.2	206.6
21	236.1	233.6	230.5	228.1	225.8	223.1	220.5	216.4	212.3	208.6
21.25	238.5	235.9	232.8	230.4	228.0	225.3	222.6	218.4	214.3	210.7
21.5	240.8	238.2	235.0	232.6	230.2	227.5	224.8	220.5	216.3	212.7
21.75			237.2	234.8	232.4	229.6	226.9	222.6	218.3	214.7
22			239.5	237.0	234.6	231.8	229.1	224.7	220.3	216.7
22.25					236.8	234.0	231.2	226.8	222.3	218.8
22.5					239.0	236.2	233.4	228.9	224.4	220.8
22.75							235.5	230.9	226.4	222.8
23							237.7	233.0	228.4	224.9
23.25							239.8	235.1	230.4	226.9
23.5							242.0	237.2	232.4	228.9
23.75									234.4	230.9
24									236.5	233.0
24.25									235.0	
24.5									237.0	

147L Tank LLI Inches	"Temperature, Degrees F" 32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
10										
10.25	154.2	153.8	153.3							
10.5	156.7	156.3	155.8	154.4	153.0					
10.75	159.2	158.7	158.2	156.7	155.3	154.2	153.0			
11	161.7	161.2	160.6	159.1	157.6	156.4	155.2	153.2	151.2	
11.25	164.2	163.7	163.0	161.5	159.9	158.7	157.4	155.4	153.4	
11.5	166.7	166.1	165.4	163.8	162.3	161.0	159.7	157.6	155.5	
11.75	169.2	168.6	167.8	166.2	164.6	163.2	161.9	159.7	157.6	
12	171.7	171.1	170.2	168.6	166.9	165.5	164.1	161.9	159.8	153.3
12.25	174.2	173.5	172.7	170.9	169.2	167.7	166.3	164.1	161.9	155.4
12.5	176.7	176.0	175.1	173.3	171.6	170.0	168.5	166.2	164.0	157.6
12.75	179.2	178.5	177.5	175.7	173.9	172.3	170.7	168.4	166.2	159.7
13	181.7	180.9	179.9	178.1	176.2	174.5	172.9	170.6	168.3	161.9
13.25	184.2	183.4	182.3	180.4	178.5	176.8	175.1	172.7	170.4	164.0
13.5	186.7	185.8	184.7	182.8	180.9	179.1	177.3	174.9	172.5	166.2
13.75	189.2	188.3	187.2	185.2	183.2	181.3	179.5	177.1	174.7	168.3
14	191.7	190.8	189.6	187.5	185.5	183.6	181.7	179.2	176.8	170.5
14.25	194.2	193.2	192.0	189.9	187.8	185.9	183.9	181.4	178.9	172.6
14.5	196.7	195.7	194.4	192.3	190.2	188.1	186.1	183.6	181.1	174.8
14.75	199.2	198.2	196.8	194.7	192.5	190.4	188.3	185.8	183.2	176.9
15	201.7	200.6	199.2	197.0	194.8	192.7	190.5	187.9	185.3	179.0
15.25	204.3	203.1	201.7	199.4	197.1	194.9	192.7	190.1	187.5	181.2
15.5	206.8	205.6	204.1	201.8	199.5	197.2	194.9	192.3	189.6	183.3
15.75	209.3	208.0	206.5	204.1	201.8	199.4	197.1	194.4	191.7	185.5
16	211.8	210.5	208.9	206.5	204.1	201.7	199.3	196.6	193.9	187.6
16.25	214.3	213.0	211.3	208.9	206.4	204.0	201.5	198.8	196.0	189.8
16.5	216.8	215.4	213.7	211.3	208.8	206.2	203.7	200.9	198.1	191.9
16.75	219.3	217.9	216.2	213.6	211.1	208.5	205.9	203.1	200.3	194.1
17	221.8	220.4	218.6	216.0	213.4	210.8	208.1	205.3	202.4	196.2
17.25	224.3	222.8	221.0	218.4	215.7	213.0	210.3	207.4	204.5	198.4
17.5	226.8	225.3	223.4	220.7	218.1	215.3	212.5	209.6	206.7	200.5
17.75	229.3	227.7	225.8	223.1	220.4	217.6	214.7	211.8	208.8	202.6
18	231.8	230.2	228.2	225.5	222.7	219.8	216.9	213.9	210.9	204.8
18.25	234.3	232.7	230.7	227.8	225.0	222.1	219.1	216.1	213.0	206.9
18.5	236.8	235.1	233.1	230.2	227.4	224.4	221.3	218.3	215.2	209.1
18.75	239.3	237.6	235.5	232.6	229.7	226.6	223.6	220.4	217.3	211.2
19	241.8	240.1	237.9	235.0	232.0	228.9	225.8	222.6	219.4	213.4
19.25	244.3	242.5	240.3	237.3	234.3	231.1	228.0	224.8	221.6	215.5
19.5	246.6	244.9	242.7	239.7	236.7	233.4	230.2	226.9	223.7	217.7
19.75	249.0	247.3	245.1	242.0	239.0	235.7	232.4	229.1	225.8	219.8
20	251.4	249.6	247.3	244.3	241.3	237.9	234.6	231.3	228.0	221.9
20.25	253.7	251.9	249.6	246.6	243.6	240.2	236.8	233.4	230.1	224.1
20.5	256.1	254.2	251.8	248.8	245.8	242.4	239.0	235.6	232.2	226.2
20.75	258.5	256.5	254.1	251.1	248.0	244.6	241.2	237.8	234.4	228.4
21	260.8	258.8	256.3	253.3	250.2	246.8	243.4	239.9	236.5	230.5
21.25	263.2	261.2	258.6	255.5	252.4	249.0	245.5	242.1	238.6	232.7
21.5	265.6	263.5	260.8	257.7	254.6	251.1	247.6	244.2	240.8	234.8
21.75	267.9	265.8	263.1	260.0	256.8	253.3	249.8	246.3	242.9	237.0
22	270.3	268.1	265.3	262.2	259.0	255.5	251.9	248.4	245.0	239.1
22.25	272.7	270.4	267.6	264.4	261.2	257.6	254.0	250.5	247.0	241.3
22.5	275.0	272.7	269.8	266.6	263.4	259.8	256.1	252.6	249.1	243.4
22.75	277.4	275.0	272.1	268.9	265.6	261.9	258.2	254.7	251.1	245.5
23	279.8	277.4	274.3	271.1	267.8	264.1	260.4	256.7	253.1	247.6
23.25	282.1	279.7	276.6	273.3	270.0	266.3	262.5	258.8	255.2	249.6
23.5	284.5	282.0	278.8	275.5	272.2	268.4	264.6	260.9	257.2	251.7
23.75	286.9	284.3	281.1	277.8	274.4	270.6	266.7	263.0	259.2	253.7
24	289.2	286.6	283.3	280.0	276.6	272.7	268.8	265.1	261.3	255.8
24.25	291.6	288.9	285.6	282.2	278.8	274.9	270.9	267.1	263.3	257.9
24.5	294.0	291.2	287.8	284.4	281.0	277.0	273.1	269.2	265.4	259.9
24.75	296.3	293.6	290.1	286.7	283.2	279.2	275.2	271.3	267.4	262.0
25	298.7	295.9	292.3	288.9	285.4	281.4	277.3	273.4	269.4	264.1
25.25	301.1	298.2	294.6	291.1	287.6	283.5	279.4	275.4	271.5	266.1
25.5	303.4	300.5	296.8	293.3	289.8	285.7	281.5	277.5	273.5	268.2
25.75	305.8	302.8	299.1	295.5	292.0	287.8	283.7	279.6	275.5	270.3
26	308.2	305.1	301.3	297.8	294.2	290.0	285.8	281.7	277.6	272.3
26.25	310.5	307.4	303.6	300.0	296.4	292.2	287.9	283.7	279.6	274.4
26.5	312.9	309.8	305.8	302.2	298.6	294.3	290.0	285.8	281.6	276.4
26.75	315.3	312.1	308.1	304.4	300.8	296.5	292.1	287.9	283.7	278.5
27	317.6	314.4	310.3	306.7	303.0	298.6	294.2	290.0	285.7	280.6
27.25	320.0	316.7	312.6	308.9	305.2	300.8	296.4	292.1	287.8	282.6
27.5	322.4	319.0	314.8	311.1	307.4	302.9	298.5	294.1	289.8	284.7
27.75	324.7	321.3	317.1	313.3	309.6	305.1	300.6	296.2	291.8	286.8

APPENDIX D - FM-200® LIQUID LEVEL INDICATOR CHARTS

147L Tank (Continued)

LLI	"Temperature, Degrees F"									
Inches	32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
28	327.1	323.6	319.3	315.6	311.8	307.3	302.7	298.3	293.9	288.8
28.25	329.4	326.0	321.6	317.8	314.0	309.4	304.8	300.4	295.9	290.9
28.5			323.8	320.0	316.2	311.6	307.0	302.4	297.9	293.0
28.75			326.1	322.2	318.4	313.7	309.1	304.5	300.0	295.0
29			328.3	324.5	320.6	315.9	311.2	306.6	302.0	297.1
29.25			330.6	326.7	322.8	318.1	313.3	308.7	304.1	299.2
29.5					325.0	320.2	315.4	310.8	306.1	301.2
29.75					327.2	322.4	317.5	312.8	308.1	303.3
30					329.4	324.5	319.7	314.9	310.2	305.3
30.25					331.6	326.7	321.8	317.0	312.2	307.4
30.5							323.9	319.1	314.2	309.5
30.75							326.0	321.1	316.3	311.5
31							328.1	323.2	318.3	313.6
31.25							330.3	325.3	320.4	315.7
31.5									322.4	317.7
31.75									324.4	319.8
32									326.5	321.9
32.25										323.9
32.5										326.0

180L Tank

LLI	"Temperature, Degrees F"									
Inches	32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
2.5	189.9	188.9	187.5							
2.75	192.4	191.3	190.0	188.7	187.4					
3	195.0	193.8	192.4	191.1	189.7	189.2	188.7			
3.25	197.5	196.3	194.9	193.5	192.1	191.5	190.9			
3.5	200.0	198.8	197.3	195.9	194.5	193.8	193.1	189.5	185.9	
3.75	202.5	201.3	199.7	198.3	196.8	196.1	195.4	191.7	188.0	
4	205.0	203.8	202.2	200.7	199.2	198.4	197.6	193.9	190.2	
4.25	207.5	206.2	204.6	203.1	201.6	200.7	199.8	196.1	192.4	
4.5	210.1	208.7	207.0	205.5	203.9	203.0	202.1	198.3	194.5	
4.75	212.6	211.2	209.5	207.9	206.3	205.3	204.3	200.5	196.7	190.4
5	215.1	213.7	211.9	210.3	208.7	207.6	206.5	202.7	198.8	192.5
5.25	217.6	216.2	214.4	212.7	211.0	209.9	208.8	204.9	201.0	194.7
5.5	220.1	218.7	216.8	215.1	213.4	212.2	211.0	207.1	203.2	196.8
5.75	222.7	221.1	219.2	217.5	215.8	214.5	213.2	209.3	205.3	198.9
6	225.2	223.6	221.7	219.9	218.1	216.8	215.5	211.5	207.5	201.0
6.25	227.7	226.1	224.1	222.3	220.5	219.1	217.7	213.7	209.6	203.1
6.5	230.2	228.6	226.6	224.7	222.9	221.4	219.9	215.9	211.8	205.2
6.75	232.7	231.1	229.0	227.1	225.2	223.7	222.2	218.1	214.0	207.3
7	235.2	233.6	231.4	229.5	227.6	226.0	224.4	220.3	216.1	209.5
7.25	237.8	236.0	233.9	231.9	230.0	228.3	226.6	222.5	218.3	211.6
7.5	240.3	238.5	236.3	234.3	232.3	230.6	228.9	224.7	220.4	213.7
7.75	242.8	241.0	238.8	236.7	234.7	232.9	231.1	226.9	222.6	215.8
8	245.3	243.5	241.2	239.1	237.1	235.2	233.4	229.1	224.8	217.9
8.25	247.8	246.0	243.6	241.5	239.4	237.5	235.6	231.3	226.9	220.0
8.5	250.3	248.4	246.1	243.9	241.8	239.8	237.8	233.5	229.1	222.2
8.75	252.9	250.9	248.5	246.3	244.2	242.1	240.1	235.7	231.3	224.3
9	255.4	253.4	251.0	248.8	246.5	244.4	242.3	237.8	233.4	226.4
9.25	257.9	255.9	253.4	251.2	248.9	246.7	244.5	240.0	235.6	228.5
9.5	260.4	258.4	255.8	253.6	251.3	249.0	246.8	242.2	237.7	230.6
9.75	262.9	260.9	258.3	256.0	253.7	251.3	249.0	244.4	239.9	232.7
10	265.5	263.3	260.7	258.4	256.0	253.6	251.2	246.6	242.1	234.8
10.25	268.0	265.8	263.1	260.8	258.4	255.9	253.5	248.8	244.2	237.0
10.5	270.5	268.3	265.6	263.2	260.8	258.2	255.7	251.0	246.4	239.1
10.75	273.0	270.8	268.0	265.6	263.1	260.5	257.9	253.2	248.5	241.2
11	275.5	273.3	270.5	268.0	265.5	262.8	260.2	255.4	250.7	243.3
11.25	278.0	275.8	272.9	270.4	267.9	265.1	262.4	257.6	252.9	245.4
11.5	280.6	278.2	275.3	272.8	270.2	267.4	264.6	259.8	255.0	247.5
11.75	283.1	280.7	277.8	275.2	272.6	269.7	266.9	262.0	257.2	249.6
12	285.6	283.2	280.2	277.6	275.0	272.0	269.1	264.2	259.3	251.8
12.25	288.1	285.7	282.7	280.0	277.3	274.3	271.3	266.4	261.5	253.9
12.5	290.6	288.2	285.1	282.4	279.7	276.6	273.6	268.6	263.7	256.0
12.75	293.1	290.7	287.5	284.8	282.1	278.9	275.8	270.8	265.8	258.1
13	295.7	293.1	290.0	287.2	284.4	281.2	278.0	273.0	268.0	260.2
13.25	298.2	295.6	292.4	289.6	286.8	283.5	280.3	275.2	270.1	262.3
13.5	300.7	298.1	294.9	292.0	289.2	285.8	282.5	277.4	272.3	264.5
13.75	303.1	300.5	297.3	294.4	291.5	288.1	284.7	279.6	274.5	266.6
14	305.4	302.9	299.7	296.8	293.9	290.4	287.0	281.8	276.6	268.7

180L Tank (Continued)

LLI	"Temperature, Degrees F"									
Inches	32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
14.25	307.7	305.2	302.1	299.2	296.3	292.7	289.2	284.0	278.8	270.8
14.5	310.1	307.6	304.4	301.5	298.6	295.0	291.4	286.2	280.9	272.9
14.75	312.4	309.9	306.7	303.9	301.0	297.3	293.7	288.4	283.1	275.0
15	314.8	312.2	309.0	306.1	303.2	299.5	295.9	290.6	285.3	277.1
15.25	317.1	314.5	311.3	308.3	305.4	301.7	298.1	292.8	287.4	279.3
15.5	319.4	316.8	313.6	310.6	307.5	304.0	300.4	295.0	289.6	281.4
15.75	321.8	319.2	315.9	312.8	309.7	306.1	302.5	297.1	291.8	283.5
16	324.1	321.5	318.2	315.0	311.9	308.2	304.6	299.2	293.9	285.6
16.25	326.4	323.8	320.5	317.3	314.1	310.4	306.7	301.4	296.1	287.7
16.5	328.8	326.1	322.8	319.5	316.2	312.5	308.8	303.5	298.2	289.8
16.75	331.1	328.4	325.1	321.8	318.4	314.6	310.8	305.6	300.4	291.9
17	333.5	330.8	327.4	324.0	320.6	316.8	312.9	307.7	302.5	294.1
17.25	335.8	333.1	329.7	326.2	322.8	318.9	315.0	309.7	304.5	296.2
17.5	338.1	335.4	332.0	328.5	325.0	321.0	317.1	311.8	306.5	298.3
17.75	340.5	337.7	334.3	330.7	327.1	323.1	319.2	313.8	308.5	300.4
18	342.8	340.1	336.6	333.0	329.3	325.3	321.3	315.9	310.5	302.5
18.25	345.2	342.4	338.9	335.2	331.5	327.4	323.3	317.9	312.6	304.5
18.5	347.5	344.7	341.2	337.4	333.7	329.5	325.4	320.0	314.6	306.5
18.75	349.8	347.0	343.5	339.7	335.8	331.7	327.5	322.1	316.6	308.6
19	352.2	349.3	345.8	341.9	338.0	333.8	329.6	324.1	318.6	310.6
19.25	354.5	351.7	348.1	344.2	340.2	335.9	331.7	326.2	320.6	312.6
19.5	356.8	354.0	350.4	346.4	342.4	338.1	333.8	328.2	322.7	314.7
19.75	359.2	356.3	352.7	348.6	344.6	340.2	335.8	330.3	324.7	316.7
20	361.5	358.6	355.0	350.9	346.7	342.3	337.9	332.3	326.7	318.8
20.25	363.9	360.9	357.3	353.1	348.9	344.5	340.0	334.4	328.7	320.8
20.5	366.2	363.3	359.6	355.3	351.1	346.6	342.1	336.4	330.7	322.8
20.75	368.5	365.6	361.9	357.6	353.3	348.7	344.2	338.5	332.8	324.9
21	370.9	367.9	364.2	359.8	355.4	350.8	346.3	340.5	334.8	326.9
21.25	373.2	370.2	366.5	362.1	357.6	353.0	348.3	342.6	336.8	328.9
21.5	375.6	372.6	368.8	364.3	359.8	355.1	350.4	344.6	338.8	331.0
21.75	377.9	374.9	371.1	366.5	362.0	357.2	352.5	346.7	340.9	333.0
22	380.2	377.2	373.4	368.8	364.2	359.4	354.6	348.7	342.9	335.0
22.25	382.6	379.5	375.7	371.0	366.3	361.5	356.7	350.8	344.9	337.1
22.5	384.9	381.8	378.0	373.3	368.5	363.6	358.8	352.8	346.9	339.1
22.75	387.2	384.2	380.3	375.5	370.7	365.8	360.8	354.9	348.9	341.1
23	389.6	386.5	382.6	377.7	372.9	367.9	362.9	356.9	351.0	343.2
23.25	391.9	388.8	384.9	380.0	375.0	370.0	365.0	359.0	353.0	345.2
23.5	394.3	391.1	387.2	382.2	377.2	372.2	367.1	361.0	355.0	347.3
23.75	396.6	393.4	389.5	384.4	379.4	374.3	369.2	363.1	357.0	349.3
24	398.9	395.8	391.8	386.7	381.6	376.4	371.3	365.1	359.0	351.3
24.25	401.3	398.1	394.1	388.9	383.8	378.5	373.3	367.2	361.1	353.4
24.5	403.6	400.4	396.4	391.2	385.9	380.7	375.4	369.3	363.1	355.4
24.75	406.0	402.7	398.7	393.4	388.1	382.8	377.5	371.3	365.1	357.4
25	408.3	405.1	401.0	395.6	390.3	384.9	379.6	373.4	367.1	359.5
25.25			403.3	397.9	392.5	387.1	381.7	375.4	369.1	361.5
25.5			405.6	400.1	394.6	389.2	383.8	377.5	371.2	363.5
25.75			407.9	402.4	396.8	391.3	385.8	379.5	373.2	365.6
26					399.0	393.5	387.9	381.6	375.2	367.6
26.25					401.2	395.6	390.0	383.6	377.2	369.6
26.5					403.4	397.7	392.1	385.7	379.3	371.7
26.75					405.5	399.8	394.2	387.7	381.3	373.7
27					407.7	402.0	396.3	389.8	383.3	375.8
27.25							398.3	391.8	385.3	377.8
27.5							400.4	393.9	387.3	379.8
27.75							402.5	395.9	389.4	381.9
28							404.6	398.0	391.4	383.9
28.25							406.7	400.0	393.4	385.9
28.5							408.8	402.1	395.4	388.0
28.75									397.4	390.0
29									399.5	392.0
29.25									401.5	394.1
29.5										396.1
29.75										398.1
30										400.2
30.25										402.2

APPENDIX D - FM-200® LIQUID LEVEL INDICATOR CHARTS

343L Tank

LLI	"Temperature, Degrees F"									
Inches	32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
7.75	356.4	354.7	352.4	350.2	347.9					
8	362.1	360.2	357.8	355.5	353.1					
8.25	367.7	365.7	363.3	360.8	358.3					
8.5	373.4	371.3	368.7	366.1	363.5					
8.75	379.0	376.8	374.1	371.4	368.6	361.4	354.1	346.8	339.5	332.2
9	384.6	382.4	379.5	376.7	373.8	366.5	359.2	351.8	344.5	337.2
9.25	390.3	387.9	384.9	382.0	379.0	371.6	364.2	356.8	349.5	342.1
9.5	395.9	393.4	390.4	387.3	384.2	376.7	369.3	361.9	354.4	347.0
9.75	401.6	399.0	395.8	392.6	389.4	381.9	374.4	366.9	359.4	351.9
10	407.2	404.5	401.2	397.9	394.5	387.0	379.4	371.9	364.3	356.8
10.25	412.8	410.1	406.6	403.2	399.7	392.1	384.5	376.9	369.3	361.7
10.5	418.5	415.6	412.0	408.5	404.9	397.2	389.6	381.9	374.3	366.6
10.75	424.1	421.1	417.4	413.8	410.1	402.3	394.6	386.9	379.2	371.5
11	429.7	426.7	422.9	419.0	415.2	407.5	399.7	392.0	384.2	376.4
11.25	435.4	432.2	428.3	424.3	420.4	412.6	404.8	397.0	389.2	381.4
11.5	441.0	437.8	433.7	429.6	425.6	417.7	409.9	402.0	394.1	386.3
11.75	446.7	443.3	439.1	434.9	430.8	422.8	414.9	407.0	399.1	391.2
12	452.3	448.9	444.5	440.2	435.9	428.0	420.0	412.0	404.1	396.1
12.25	457.9	454.4	450.0	445.5	441.1	433.1	425.1	417.0	409.0	401.0
12.5	463.6	459.9	455.4	450.8	446.3	438.2	430.1	422.1	414.0	405.9
12.75	469.2	465.5	460.8	456.1	451.5	443.3	435.2	427.1	419.0	410.8
13	474.9	471.0	466.2	461.4	456.6	448.5	440.3	432.1	423.9	415.7
13.25	480.5	476.6	471.6	466.7	461.8	453.6	445.3	437.1	428.9	420.7
13.5	486.1	482.1	477.1	472.0	467.0	458.7	450.4	442.1	433.8	425.6
13.75	491.8	487.6	482.5	477.3	472.2	463.8	455.5	447.1	438.8	430.5
14	497.4	493.2	487.9	482.6	477.3	468.9	460.6	452.2	443.8	435.4
14.25	503.0	498.7	493.3	487.9	482.5	474.1	465.6	457.2	448.7	440.3
14.5	508.7	504.3	498.7	493.2	487.7	479.2	470.7	462.2	453.7	445.2
14.75	514.3	509.8	504.2	498.5	492.9	484.3	475.8	467.2	458.7	450.1
15	520.0	515.3	509.6	503.8	498.0	489.4	480.8	472.2	463.6	455.0
15.25	525.6	520.9	515.0	509.1	503.2	494.6	485.9	477.2	468.6	459.9
15.5	531.2	526.4	520.4	514.4	508.4	499.7	491.0	482.3	473.6	464.9
15.75	536.9	532.0	525.8	519.7	513.6	504.8	496.0	487.3	478.5	469.8
16	542.5	537.5	531.2	525.0	518.7	509.9	501.1	492.3	483.5	474.7
16.25	548.2	543.0	536.7	530.3	523.9	515.0	506.2	497.3	488.5	479.6
16.5	553.8	548.6	542.1	535.6	529.1	520.2	511.3	502.3	493.4	484.5
16.75	559.4	554.1	547.5	540.9	534.3	525.3	516.3	507.4	498.4	489.4
17	565.1	559.7	552.9	546.2	539.4	530.4	521.4	512.4	503.3	494.3
17.25	570.6	565.1	558.3	551.4	544.6	535.5	526.5	517.4	508.3	499.2
17.5	576.0	570.5	563.6	556.7	549.8	540.7	531.5	522.4	513.3	504.1
17.75	581.4	575.8	568.9	561.9	555.0	545.8	536.6	527.4	518.2	509.1
18	586.8	581.2	574.2	567.1	560.1	550.9	541.7	532.4	523.2	514.0
18.25	592.2	586.5	579.5	572.4	565.3	556.0	546.7	537.5	528.2	518.9
18.5	597.6	591.9	584.7	577.6	570.4	561.1	551.8	542.4	533.1	523.8
18.75	603.0	597.2	590.0	582.7	575.5	566.1	556.8	547.4	538.1	528.7
19	608.4	602.5	595.2	587.8	580.5	571.1	561.8	552.4	543.0	533.6
19.25	613.8	607.8	600.4	593.0	585.5	576.1	566.7	557.3	547.9	538.5
19.5	619.2	613.2	605.6	598.1	590.6	581.2	571.7	562.3	552.9	543.4
19.75	624.6	618.5	610.9	603.3	595.6	586.2	576.7	567.3	557.8	548.4
20	630.0	623.8	616.1	608.4	600.7	591.2	581.7	572.2	562.7	553.3
20.25	635.4	629.1	621.3	613.5	605.7	596.2	586.7	577.2	567.7	558.2
20.5	640.8	634.5	626.6	618.7	610.8	601.2	591.7	582.2	572.6	563.1
20.75	646.2	639.8	631.8	623.8	615.8	606.2	596.7	587.1	577.6	568.0
21	651.6	645.1	637.0	628.9	620.8	611.1	601.4	591.7	582.0	572.2
21.25	657.0	650.4	642.3	634.1	625.9	616.0	606.1	596.3	586.4	576.5
21.5	662.4	655.8	647.5	639.2	630.9	620.9	610.9	600.8	590.8	580.7
21.75	667.8	661.1	652.7	644.3	636.0	625.8	615.6	605.4	595.2	585.0
22	673.2	666.4	658.0	649.5	641.0	630.7	620.3	609.9	599.6	589.2
22.25	678.6	671.7	663.2	654.6	646.1	635.5	625.0	614.5	604.0	593.5
22.5	684.0	677.1	668.4	659.8	651.1	640.4	629.7	619.1	608.4	597.7
22.75	689.4	682.4	673.6	664.9	656.1	645.3	634.5	623.6	612.8	602.0
23	694.8	687.7	678.9	670.0	661.2	650.2	639.2	628.2	617.2	606.2
23.25	700.2	693.0	684.1	675.2	666.2	655.1	643.9	632.8	621.6	610.5
23.5	705.6	698.4	689.3	680.3	671.3	660.0	648.6	637.3	626.0	614.7
23.75	711.0	703.7	694.6	685.4	676.3	664.8	653.4	641.9	630.4	618.9
24	716.4	709.0	699.8	690.6	681.4	669.7	658.1	646.5	634.8	623.2
24.25	721.8	714.3	705.0	695.7	686.4	674.6	662.8	651.0	639.2	627.4
24.5	727.2	719.7	710.3	700.9	691.4	679.5	667.5	655.6	643.6	631.7
24.75	732.6	725.0	715.5	706.0	696.5	684.4	672.3	660.1	648.0	635.9
25	738.0	730.3	720.7	711.1	701.5	689.3	677.0	664.7	652.4	640.2
25.25	743.4	735.6	726.0	716.3	706.6	694.1	681.7	669.3	656.8	644.4
25.5	748.8	741.0	731.2	721.4	711.6	699.0	686.4	673.8	661.3	648.7

343L Tank (Continued)

LLI	"Temperature, Degrees F"									
Inches	32	40	50	60	70	80	90	100	110	120
	"Weight of FM-200, pounds"									
25.75	754.2	746.3	736.4	726.5	716.7	703.9	691.2	678.4	665.7	652.9
26	759.6	751.6	741.6	731.7	721.7	708.8	695.9	683.0	670.1	657.2
26.25	765.0	756.9	746.9	736.8	726.7	713.7	700.6	687.5	674.5	661.4
26.5	770.4	762.3	752.1	741.9	731.8	718.6	705.3	692.1	678.9	665.6
26.75	775.8	767.6	757.3	747.1	736.8	723.4	710.1	696.7	683.3	669.9
27	781.2	772.9	762.6	752.2	741.9	728.3	714.8	701.2	687.7	674.1
27.25	786.6	778.2	767.8	757.4	746.9	733.2	719.5	705.8	692.1	678.4
27.5					752.0	738.1	724.2	710.4	696.5	682.6
27.75					757.0	743.0	728.9	714.9	700.9	686.9
28					762.0	747.9	733.7	719.5	705.3	691.1
28.25					767.1	752.7	738.4	724.0	709.7	695.4
28.5					772.1	757.6	743.1	728.6	714.1	699.6
28.75					777.2	762.5	747.8	733.2	718.5	703.8
29					782.2	767.4	752.6	737.7	722.9	708.1
29.25					787.3	772.3	757.3	742.3	727.3	712.3
29.5					792.3	777.2	762.0	746.9	731.7	716.6
29.75					797.3	782.0	766.7	751.4	736.1	720.8
30					802.4	786.9	771.5	756.0	740.5	725.1
30.25					807.4	791.8	776.2	760.6	744.9	729.3
30.5					812.5	796.7	780.9	765.1	749.3	733.6
30.75					817.5	801.6	785.6	769.7	753.8	737.8
31					822.6	806.5	790.4	774.3	758.2	742.1
31.25										746.3
31.5										750.5
31.75										754.8
32										759.0

106L Tank

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
19.5											
20	50.8	50.6	50.3								
20.5	51.6	51.4	51.1	50.6	50.1						
21	52.5	52.2	52.0	51.5	50.9	50.6	50.3				
21.5	53.3	53.1	52.8	52.3	51.7	51.4	51.0	50.7	50.3		
22	54.2	53.9	53.6	53.1	52.6	52.2	51.8	51.4	51.0	50.3	50.8
22.5	55.1	54.8	54.5	53.9	53.4	53.0	52.6	52.2	51.8	51.0	51.5
23	55.9	55.6	55.3	54.7	54.2	53.8	53.4	53.0	52.5	51.8	52.2
23.5	56.8	56.4	56.1	55.5	55.0	54.5	54.2	53.7	53.2	52.5	52.9
24	57.6	57.3	56.9	56.4	55.8	55.3	54.9	54.5	54.0	53.2	53.7
24.5	58.5	58.1	57.8	57.2	56.6	56.1	55.7	55.2	54.7	53.9	54.4
25	59.3	59.0	58.6	58.0	57.4	56.9	56.5	56.0	55.5	54.6	55.1
25.5	60.2	59.8	59.4	58.8	58.2	57.7	57.3	56.8	56.2	55.4	55.8
26	61.0	60.6	60.3	59.6	59.0	58.5	58.1	57.5	56.9	56.1	56.5
26.5	61.9	61.5	61.1	60.5	59.8	59.3	58.8	58.3	57.7	56.8	57.2
27	62.7	62.3	61.9	61.3	60.6	60.1	59.6	59.0	58.4	57.5	57.9
27.5	63.6	63.2	62.7	62.1	61.5	60.9	60.4	59.8	59.1	58.3	58.6
28	64.4	64.0	63.6	62.9	62.3	61.7	61.2	60.6	59.9	59.0	59.3
28.5	65.3	64.8	64.4	63.7	63.1	62.5	62.0	61.3	60.6	59.7	60.0
29	66.1	65.7	65.2	64.6	63.9	63.3	62.7	62.1	61.4	60.4	60.7
29.5	67.0	66.5	66.1	65.4	64.7	64.1	63.5	62.9	62.1	61.2	61.4
30	67.8	67.4	66.9	66.2	65.5	64.9	64.3	63.6	62.8	61.9	62.1
30.5	68.7	68.2	67.7	67.0	66.3	65.7	65.1	64.4	63.6	62.6	62.8
31	69.5	69.0	68.5	67.8	67.1	66.5	65.9	65.1	64.3	63.3	63.5
31.5	70.4	69.9	69.4	68.6	67.9	67.3	66.6	65.9	65.1	64.1	64.2
32	71.2	70.7	70.2	69.5	68.7	68.1	67.4	66.7	65.8	64.8	65.0
32.5	72.1	71.6	71.0	70.3	69.5	68.9	68.2	67.4	66.5	65.5	65.7
33	73.0	72.4	71.9	71.1	70.4	69.7	69.0	68.2	67.3	66.2	66.4
33.5	73.8	73.2	72.7	71.9	71.2	70.5	69.8	68.9	68.0	67.0	67.1
34	74.7	74.1	73.5	72.7	72.0	71.3	70.5	69.7	68.7	67.7	67.8
34.5	75.5	74.9	74.3	73.6	72.8	72.0	71.3	70.5	69.5	68.4	68.5
35	76.4	75.8	75.2	74.4	73.6	72.8	72.1	71.2	70.2	69.1	69.2
35.5	77.2	76.6	76.0	75.2	74.4	73.6	72.9	72.0	71.0	69.8	69.9
36	78.1	77.4	76.8	76.0	75.2	74.4	73.7	72.8	71.7	70.6	70.6
36.5	78.9	78.3	77.6	76.8	76.0	75.2	74.5	73.5	72.4	71.3	71.3
37	79.8	79.1	78.5	77.6	76.8	76.0	75.2	74.3	73.2	72.0	72.0
37.5	80.6	80.0	79.3	78.5	77.6	76.8	76.0	75.0	73.9	72.7	72.7
38	81.5	80.8	80.1	79.3	78.4	77.6	76.8	75.8	74.7	73.5	73.4
38.5	82.3	81.6	80.9	80.1	79.2	78.4	77.6	76.6	75.4	74.2	74.1
39	83.1	82.4	81.7	80.9	80.1	79.2	78.4	77.3	76.1	74.9	74.8
39.5	84.0	83.2	82.5	81.7	80.8	80.0	79.1	78.1	76.9	75.6	75.5

106L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
40	84.8	84.1	83.3	82.5	81.6	80.8	79.9	78.8	77.6	76.4	76.3
40.5	85.6	84.9	84.1	83.3	82.4	81.6	80.7	79.6	78.4	77.1	77.0
41	86.5	85.7	84.9	84.1	83.2	82.3	81.5	80.4	79.1	77.8	77.7
41.5	87.3	86.5	85.7	84.9	84.0	83.1	82.2	81.1	79.8	78.5	78.4
42	88.1	87.3	86.5	85.6	84.8	83.9	83.0	81.9	80.6	79.3	79.1
42.5	89.0	88.1	87.3	86.4	85.6	84.7	83.8	82.6	81.3	80.0	79.9
43	89.8	89.0	88.1	87.2	86.4	85.5	84.5	83.4	82.0	80.7	80.6
43.5	90.6	89.8	88.9	88.0	87.1	86.2	85.3	84.1	82.8	81.4	81.3
44	91.5	90.6	89.7	88.8	87.9	87.0	86.1	84.9	83.5	82.1	82.0
44.5	92.3	91.4	90.5	89.6	88.7	87.8	86.9	85.6	84.2	82.9	82.8
45	93.2	92.2	91.3	90.4	89.5	88.6	87.6	86.4	85.0	83.6	83.5
45.5	94.0	93.0	92.1	91.2	90.3	89.4	88.4	87.2	85.7	84.3	84.2
46	94.8	93.9	92.9	92.0	91.1	90.1	89.2	87.9	86.4	85.0	84.9
46.5	95.7	94.7	93.7	92.8	91.9	90.9	89.9	88.7	87.1	85.7	85.7
47	96.5	95.5	94.5	93.6	92.7	91.7	90.7	89.4	87.9	86.5	86.4
47.5	97.3	96.3	95.3	94.4	93.4	92.5	91.5	90.2	88.6	87.2	87.1
48	98.2	97.1	96.1	95.1	94.2	93.3	92.3	90.9	89.3	87.9	87.9
48.5	99.0	97.9	96.9	95.9	95.0	94.0	93.0	91.7	90.1	88.6	88.6
49	99.8	98.8	97.7	96.7	95.8	94.8	93.8	92.4	90.8	89.4	89.3
49.5	100.7	99.6	98.5	97.5	96.6	95.6	94.6	93.2	91.5	90.1	90.0
50	101.5	100.4	99.3	98.3	97.4	96.4	95.3	93.9	92.3	90.8	90.8
50.5	102.4	101.2	100.1	99.1	98.2	97.1	96.1	94.7	93.0	91.5	91.5
51	103.2	102.0	100.8	99.9	99.0	97.9	96.9	95.5	93.7	92.2	92.2
51.5	104.0	102.8	101.6	100.7	99.7	98.7	97.7	96.2	94.5	93.0	93.0
52	104.9	103.7	102.4	101.5	100.5	99.5	98.4	97.0	95.2	93.7	93.7
52.5	105.7	104.5	103.2	102.3	101.3	100.3	99.2	97.7	95.9	94.4	94.4
53	106.5	105.3	104.0	103.1	102.1	101.0	100.0	98.5	96.6	95.1	95.1
53.5	107.4	106.1	104.8	103.9	102.9	101.8	100.7	99.2	97.4	95.8	95.9
54	108.2	106.9	105.6	104.7	103.7	102.6	101.5	100.0	98.1	96.6	96.6
54.5	109.0	107.7	106.4	105.4	104.5	103.4	102.3	100.7	98.8	97.3	97.3
55	109.9	108.5	107.2	106.2	105.2	104.2	103.1	101.5	99.6	98.0	98.1
55.5	110.7	109.4	108.0	107.0	106.0	104.9	103.8	102.2	100.3	98.7	98.8
56	111.5	110.2	108.8	107.8	106.8	105.7	104.6	103.0	101.0	99.5	99.5
56.5						106.5	105.4	103.8	101.8	100.2	100.2
57						107.3	106.1	104.5	102.5	100.9	101.0
57.5							106.9	105.3	103.2	101.6	101.7
58								106.0	104.0	102.3	102.4
58.5								106.8	104.7	103.1	103.1
59									105.4	103.8	103.9
59.5									106.2	104.5	104.6
60									106.9	105.2	105.3
60.5										106.0	106.1
61										106.7	106.8
61.5										107.4	
62											
62.5											
63											

147L Tank

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
26											
26.5	70.8	70.6	70.4	69.8							
27	71.7	71.5	71.3	70.7	70.1	69.6					
27.5	72.6	72.4	72.1	71.5	70.9	70.5	70.0				
28	73.5	73.3	73.0	72.4	71.8	71.3	70.8	70.1			
28.5	74.4	74.1	73.9	73.2	72.6	72.1	71.6	70.9	69.9		
29	75.3	75.0	74.7	74.1	73.5	72.9	72.4	71.6	70.7		
29.5	76.2	75.9	75.6	74.9	74.3	73.7	73.2	72.4	71.5	69.8	
30	77.1	76.8	76.5	75.8	75.1	74.6	74.0	73.2	72.2	70.6	
30.5	78.0	77.7	77.3	76.6	76.0	75.4	74.8	74.0	73.0	71.4	
31	78.9	78.6	78.2	77.5	76.8	76.2	75.6	74.8	73.8	72.1	70.0
31.5	79.8	79.4	79.1	78.4	77.6	77.0	76.4	75.6	74.6	72.9	70.8
32	80.7	80.3	79.9	79.2	78.5	77.8	77.2	76.3	75.3	73.7	71.6
32.5	81.6	81.2	80.8	80.1	79.3	78.6	78.0	77.1	76.1	74.4	72.4
33	82.5	82.1	81.7	80.9	80.2	79.5	78.8	77.9	76.9	75.2	73.1
33.5	83.4	83.0	82.5	81.8	81.0	80.3	79.6	78.7	77.6	76.0	73.9
34	84.3	83.8	83.4	82.6	81.8	81.1	80.4	79.5	78.4	76.7	74.7
34.5	85.2	84.7	84.3	83.5	82.7	81.9	81.2	80.3	79.2	77.5	75.5
35	86.1	85.6	85.1	84.3	83.5	82.7	82.0	81.0	80.0	78.3	76.2

147L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
35.5	87.0	86.5	86.0	85.2	84.3	83.6	82.8	81.8	80.7	79.0	77.0
36	87.9	87.4	86.9	86.0	85.2	84.4	83.6	82.6	81.5	79.8	77.8
36.5	88.8	88.3	87.7	86.9	86.0	85.2	84.4	83.4	82.3	80.6	78.6
37	89.7	89.1	88.6	87.7	86.9	86.0	85.2	84.2	83.0	81.3	79.3
37.5	90.6	90.0	89.5	88.6	87.7	86.8	86.0	85.0	83.8	82.1	80.1
38	91.5	90.9	90.3	89.4	88.5	87.6	86.8	85.7	84.6	82.9	80.9
38.5	92.4	91.8	91.2	90.3	89.4	88.5	87.6	86.5	85.3	83.6	81.7
39	93.3	92.7	92.1	91.1	90.2	89.3	88.4	87.3	86.1	84.4	82.4
39.5	94.2	93.6	92.9	92.0	91.0	90.1	89.2	88.1	86.9	85.2	83.2
40	95.1	94.4	93.8	92.8	91.9	90.9	90.0	88.9	87.7	85.9	84.0
40.5	96.0	95.3	94.7	93.7	92.7	91.7	90.8	89.7	88.4	86.7	84.8
41	96.9	96.2	95.5	94.5	93.5	92.6	91.6	90.4	89.2	87.5	85.5
41.5	97.8	97.1	96.4	95.4	94.4	93.4	92.4	91.2	90.0	88.2	86.3
42	98.7	98.0	97.3	96.3	95.2	94.2	93.2	92.0	90.7	89.0	87.1
42.5	99.6	98.9	98.1	97.1	96.1	95.0	94.0	92.8	91.5	89.8	87.9
43	100.4	99.7	99.0	98.0	96.9	95.8	94.8	93.6	92.3	90.5	88.6
43.5	101.3	100.6	99.9	98.8	97.7	96.6	95.6	94.4	93.1	91.3	89.4
44	102.2	101.5	100.8	99.7	98.6	97.5	96.4	95.1	93.8	92.1	90.2
44.5	103.1	102.4	101.6	100.5	99.4	98.3	97.2	95.9	94.6	92.8	91.0
45	104.0	103.3	102.5	101.4	100.2	99.1	98.0	96.7	95.4	93.6	91.7
45.5	104.9	104.1	103.4	102.2	101.1	99.9	98.8	97.5	96.1	94.4	92.5
46	105.8	105.0	104.2	103.1	101.9	100.7	99.5	98.3	96.9	95.1	93.3
46.5	106.7	105.9	105.1	103.9	102.8	101.6	100.3	99.0	97.7	95.9	94.1
47	107.6	106.8	106.0	104.8	103.6	102.4	101.1	99.8	98.4	96.7	94.8
47.5	108.5	107.7	106.8	105.6	104.4	103.2	101.9	100.6	99.2	97.4	95.6
48	109.4	108.6	107.7	106.5	105.3	104.0	102.7	101.4	100.0	98.2	96.4
48.5	110.3	109.4	108.6	107.3	106.1	104.8	103.5	102.2	100.8	99.0	97.2
49	111.2	110.3	109.4	108.2	106.9	105.6	104.3	103.0	101.5	99.7	97.9
49.5	112.1	111.2	110.3	109.0	107.8	106.5	105.1	103.7	102.3	100.5	98.7
50	112.9	112.0	111.1	109.9	108.6	107.3	105.9	104.5	103.1	101.3	99.5
50.5	113.7	112.8	111.9	110.7	109.4	108.1	106.7	105.3	103.8	102.0	100.3
51	114.6	113.7	112.8	111.5	110.3	108.9	107.5	106.1	104.6	102.8	101.0
51.5	115.4	114.5	113.6	112.3	111.1	109.7	108.3	106.9	105.4	103.6	101.8
52	116.3	115.3	114.4	113.1	111.9	110.5	109.1	107.7	106.2	104.3	102.6
52.5	117.1	116.1	115.2	113.9	112.7	111.3	109.9	108.4	106.9	105.1	103.3
53	118.0	117.0	116.0	114.7	113.5	112.1	110.7	109.2	107.7	105.9	104.1
53.5	118.8	117.8	116.8	115.5	114.3	112.9	111.5	110.0	108.5	106.6	104.9
54	119.7	118.6	117.6	116.3	115.1	113.7	112.3	110.8	109.2	107.4	105.7
54.5	120.5	119.5	118.4	117.1	115.8	114.4	113.0	111.5	110.0	108.2	106.5
55	121.4	120.3	119.2	117.9	116.6	115.2	113.8	112.3	110.8	108.9	107.3
55.5	122.2	121.1	120.0	118.7	117.4	116.0	114.5	113.1	111.5	109.7	108.1
56	123.1	121.9	120.8	119.5	118.2	116.8	115.3	113.8	112.3	110.4	108.9
56.5	123.9	122.8	121.6	120.3	119.0	117.6	116.1	114.6	113.0	111.2	109.6
57	124.7	123.6	122.4	121.1	119.8	118.3	116.8	115.3	113.7	111.9	110.4
57.5	125.6	124.4	123.2	121.9	120.6	119.1	117.6	116.1	114.5	112.7	111.1
58	126.4	125.2	124.0	122.7	121.4	119.9	118.4	116.8	115.2	113.4	111.9
58.5	127.3	126.1	124.8	123.5	122.1	120.7	119.1	117.6	115.9	114.1	112.6
59	128.1	126.9	125.6	124.3	122.9	121.4	119.9	118.3	116.7	114.9	113.4
59.5	129.0	127.7	126.4	125.1	123.7	122.2	120.7	119.1	117.4	115.6	114.2
60	129.8	128.5	127.2	125.9	124.5	123.0	121.4	119.8	118.1	116.3	114.9
60.5	130.7	129.4	128.0	126.7	125.3	123.8	122.2	120.6	118.9	117.1	115.7
61	131.5	130.2	128.8	127.5	126.1	124.5	122.9	121.3	119.6	117.8	116.4
61.5	132.4	131.0	129.7	128.3	126.9	125.3	123.7	122.1	120.3	118.5	117.2
62	133.2	131.8	130.5	129.1	127.7	126.1	124.5	122.8	121.1	119.3	117.9
62.5	134.1	132.7	131.3	129.9	128.5	126.9	125.2	123.6	121.8	120.0	118.7
63	134.9	133.5	132.1	130.7	129.2	127.7	126.0	124.3	122.6	120.7	119.4
63.5	135.7	134.3	132.9	131.5	130.0	128.4	126.8	125.1	123.3	121.5	120.2
64	136.6	135.1	133.7	132.2	130.8	129.2	127.5	125.8	124.0	122.2	120.9
64.5	137.4	136.0	134.5	133.0	131.6	130.0	128.3	126.6	124.8	122.9	121.7
65	138.3	136.8	135.3	133.8	132.4	130.8	129.1	127.3	125.5	123.7	122.4
65.5	139.1	137.6	136.1	134.6	133.2	131.5	129.8	128.1	126.2	124.4	123.2
66	140.0	138.4	136.9	135.4	134.0	132.3	130.6	128.8	127.0	125.1	123.9
66.5	140.8	139.3	137.7	136.2	134.8	133.1	131.4	129.6	127.7	125.9	124.7
67	141.7	140.1	138.5	137.0	135.6	133.9	132.1	130.3	128.4	126.6	125.4
67.5	142.5	140.9	139.3	137.8	136.3	134.6	132.9	131.1	129.2	127.3	126.2
68	143.4	141.7	140.1	138.6	137.1	135.4	133.6	131.8	129.9	128.1	126.9
68.5	144.2	142.6	140.9	139.4	137.9	136.2	134.4	132.6	130.6	128.8	127.7
69	145.1	143.4	141.7	140.2	138.7	137.0	135.2	133.3	131.4	129.5	128.4
69.5	145.9	144.2	142.5	141.0	139.5	137.7	135.9	134.1	132.1	130.3	129.2
70	146.8	145.0	143.3	141.8	140.3	138.5	136.7	134.8	132.8	131.0	129.9
70.5	147.6	145.9	144.1	142.6	141.1	139.3	137.5	135.6	133.6	131.7	130.7
71	148.4	146.7	144.9	143.4	141.9	140.1	138.2	136.3	134.3	132.5	131.4

APPENDIX D - FM-200® LIQUID LEVEL INDICATOR CHARTS

147L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
71.5	149.3	147.5	145.8	144.2	142.6	140.9	139.0	137.1	135.1	133.2	132.2
72	150.1	148.3	146.6	145.0	143.4	141.6	139.8	137.8	135.8	133.9	132.9
72.5	151.0	149.2	147.4	145.8	144.2	142.4	140.5	138.6	136.5	134.7	133.7
73	151.8	150.0	148.2	146.6	145.0	143.2	141.3	139.3	137.3	135.4	134.4
73.5	152.7	150.8	149.0	147.4	145.8	144.0	142.0	140.1	138.0	136.1	135.2
74	153.5	151.6	149.8	148.2	146.6	144.7	142.8	140.8	138.7	136.9	135.9
74.5	154.4	152.5	150.6	149.0	147.4	145.5	143.6	141.6	139.5	137.6	136.7
75						146.3	144.3	142.3	140.2	138.3	137.4
75.5						147.1	145.1	143.1	140.9	139.1	138.2
76						147.8	145.9	143.8	141.7	139.8	138.9
76.5							146.6	144.6	142.4	140.5	139.7
77							147.4	145.3	143.1	141.3	140.4
77.5								146.1	143.9	142.0	141.2
78								146.8	144.6	142.7	141.9
78.5								147.6	145.3	143.5	142.7
79									146.1	144.2	143.5
79.5									146.8	144.9	144.2
80									147.6	145.7	145.0
80.5										146.4	145.7
81										147.1	146.5
81.5										147.8	147.2
82											
82.5											
83											
83.5											

180L Tank

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
6											
6.5	86.5										
7	87.4	86.9	86.3								
7.5	88.3	87.8	87.2	86.6							
8	89.2	88.6	88.0	87.5	86.9	86.6	86.4				
8.5	90.1	89.5	88.9	88.4	87.8	87.5	87.2	86.2			
9	91.0	90.4	89.8	89.2	88.6	88.3	88.0	87.0			
9.5	91.9	91.3	90.7	90.1	89.5	89.1	88.8	87.8			
10	92.9	92.2	91.5	90.9	90.3	90.0	89.6	88.6	86.9		
10.5	93.8	93.1	92.4	91.8	91.2	90.8	90.4	89.4	87.7		
11	94.7	94.0	93.3	92.7	92.0	91.6	91.3	90.2	88.5	86.5	
11.5	95.6	94.9	94.2	93.5	92.9	92.5	92.1	90.9	89.2	87.3	
12	96.5	95.7	95.0	94.4	93.7	93.3	92.9	91.7	90.0	88.1	
12.5	97.4	96.6	95.9	95.3	94.6	94.1	93.7	92.5	90.8	88.8	86.8
13	98.3	97.5	96.8	96.1	95.5	94.9	94.5	93.3	91.6	89.6	87.5
13.5	99.2	98.4	97.7	97.0	96.3	95.8	95.3	94.1	92.4	90.4	88.2
14	100.1	99.3	98.5	97.8	97.2	96.6	96.1	94.9	93.1	91.1	89.0
14.5	101.0	100.2	99.4	98.7	98.0	97.4	96.9	95.7	93.9	91.9	89.7
15	101.9	101.1	100.3	99.6	98.9	98.3	97.7	96.5	94.7	92.7	90.5
15.5	102.8	102.0	101.2	100.4	99.7	99.1	98.5	97.3	95.5	93.4	91.2
16	103.7	102.9	102.0	101.3	100.6	99.9	99.4	98.1	96.3	94.2	91.9
16.5	104.6	103.7	102.9	102.2	101.4	100.8	100.2	98.9	97.0	95.0	92.7
17	105.5	104.6	103.8	103.0	102.3	101.6	101.0	99.7	97.8	95.7	93.4
17.5	106.4	105.5	104.7	103.9	103.1	102.4	101.8	100.5	98.6	96.5	94.2
18	107.3	106.4	105.5	104.7	104.0	103.3	102.6	101.3	99.4	97.3	94.9
18.5	108.2	107.3	106.4	105.6	104.8	104.1	103.4	102.1	100.2	98.0	95.6
19	109.1	108.2	107.3	106.5	105.7	104.9	104.2	102.8	100.9	98.8	96.4
19.5	110.0	109.1	108.2	107.3	106.5	105.8	105.0	103.6	101.7	99.6	97.1
20	110.9	110.0	109.0	108.2	107.4	106.6	105.8	104.4	102.5	100.4	97.8
20.5	111.8	110.8	109.9	109.1	108.2	107.4	106.6	105.2	103.3	101.1	98.6
21	112.7	111.7	110.8	109.9	109.1	108.3	107.5	106.0	104.1	101.9	99.3
21.5	113.6	112.6	111.6	110.8	109.9	109.1	108.3	106.8	104.9	102.7	100.1
22	114.5	113.5	112.5	111.6	110.8	109.9	109.1	107.6	105.6	103.4	100.8
22.5	115.4	114.4	113.4	112.5	111.6	110.7	109.9	108.4	106.4	104.2	101.5
23	116.3	115.3	114.3	113.4	112.5	111.6	110.7	109.2	107.2	105.0	102.3
23.5	117.2	116.2	115.1	114.2	113.3	112.4	111.5	110.0	108.0	105.7	103.0
24	118.1	117.1	116.0	115.1	114.2	113.2	112.3	110.8	108.8	106.5	103.8
24.5	119.0	117.9	116.9	116.0	115.0	114.1	113.1	111.6	109.5	107.3	104.5
25	119.9	118.8	117.8	116.8	115.9	114.9	113.9	112.4	110.3	108.0	105.2
25.5	120.8	119.7	118.6	117.7	116.7	115.7	114.7	113.2	111.1	108.8	106.0
26	121.7	120.6	119.5	118.5	117.6	116.6	115.6	114.0	111.9	109.6	106.7

180L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
26.5	122.6	121.5	120.4	119.4	118.4	117.4	116.4	114.7	112.7	110.3	107.4
27	123.5	122.4	121.3	120.3	119.3	118.2	117.2	115.5	113.4	111.1	108.2
27.5	124.4	123.3	122.1	121.1	120.1	119.1	118.0	116.3	114.2	111.9	108.9
28	125.3	124.2	123.0	122.0	121.0	119.9	118.8	117.1	115.0	112.6	109.7
28.5	126.2	125.0	123.9	122.8	121.8	120.7	119.6	117.9	115.8	113.4	110.4
29	127.1	125.9	124.8	123.7	122.7	121.6	120.4	118.7	116.6	114.2	111.1
29.5	128.0	126.8	125.6	124.6	123.5	122.4	121.2	119.5	117.3	114.9	111.9
30	128.9	127.7	126.5	125.4	124.4	123.2	122.0	120.3	118.1	115.7	112.6
30.5	129.8	128.6	127.4	126.3	125.2	124.0	122.8	121.1	118.9	116.5	113.4
31	130.7	129.5	128.3	127.2	126.1	124.9	123.7	121.9	119.7	117.2	114.1
31.5	131.6	130.4	129.1	128.0	126.9	125.7	124.5	122.7	120.5	118.0	114.8
32	132.5	131.3	130.0	128.9	127.8	126.5	125.3	123.5	121.2	118.8	115.6
32.5	133.4	132.2	130.9	129.7	128.6	127.4	126.1	124.3	122.0	119.5	116.3
33	134.3	133.0	131.7	130.6	129.5	128.2	126.9	125.1	122.8	120.3	117.0
33.5	135.2	133.9	132.6	131.5	130.3	129.0	127.7	125.9	123.6	121.1	117.8
34	136.1	134.8	133.5	132.3	131.2	129.9	128.5	126.6	124.4	121.8	118.5
34.5	137.0	135.7	134.4	133.2	132.0	130.7	129.3	127.4	125.1	122.6	119.3
35	137.9	136.5	135.2	134.1	132.9	131.5	130.1	128.2	125.9	123.4	120.0
35.5	138.7	137.4	136.1	134.9	133.7	132.4	130.9	129.0	126.7	124.1	120.7
36	139.5	138.3	137.0	135.8	134.6	133.2	131.8	129.8	127.5	124.9	121.5
36.5	140.4	139.1	137.8	136.6	135.4	134.0	132.6	130.6	128.3	125.7	122.2
37	141.2	139.9	138.6	137.4	136.3	134.9	133.4	131.4	129.0	126.5	123.0
37.5	142.0	140.7	139.4	138.3	137.1	135.7	134.2	132.2	129.8	127.2	123.7
38	142.9	141.6	140.3	139.1	137.9	136.5	135.0	133.0	130.6	128.0	124.4
38.5	143.7	142.4	141.1	139.9	138.7	137.3	135.8	133.8	131.4	128.8	125.2
39	144.5	143.2	141.9	140.7	139.5	138.0	136.6	134.6	132.2	129.5	125.9
39.5	145.4	144.1	142.7	141.5	140.2	138.8	137.4	135.4	132.9	130.3	126.6
40	146.2	144.9	143.6	142.3	141.0	139.6	138.1	136.1	133.7	131.1	127.4
40.5	147.1	145.7	144.4	143.1	141.8	140.4	138.9	136.9	134.5	131.8	128.1
41	147.9	146.5	145.2	143.9	142.6	141.1	139.6	137.6	135.2	132.6	128.9
41.5	148.7	147.4	146.0	144.7	143.4	141.9	140.4	138.4	136.0	133.4	129.7
42	149.6	148.2	146.8	145.5	144.2	142.7	141.1	139.1	136.8	134.1	130.5
42.5	150.4	149.0	147.7	146.3	144.9	143.4	141.9	139.9	137.6	134.9	131.3
43	151.2	149.9	148.5	147.1	145.7	144.2	142.6	140.6	138.3	135.6	132.1
43.5	152.1	150.7	149.3	147.9	146.5	145.0	143.4	141.4	139.0	136.4	132.9
44	152.9	151.5	150.1	148.7	147.3	145.7	144.1	142.1	139.8	137.1	133.6
44.5	153.7	152.3	151.0	149.5	148.1	146.5	144.9	142.9	140.5	137.9	134.3
45	154.6	153.2	151.8	150.3	148.9	147.3	145.6	143.6	141.2	138.6	135.1
45.5	155.4	154.0	152.6	151.1	149.6	148.0	146.4	144.3	141.9	139.3	135.8
46	156.2	154.8	153.4	151.9	150.4	148.8	147.1	145.1	142.7	140.0	136.5
46.5	157.1	155.7	154.2	152.7	151.2	149.6	147.9	145.8	143.4	140.8	137.3
47	157.9	156.5	155.1	153.5	152.0	150.3	148.6	146.5	144.1	141.5	138.0
47.5	158.8	157.3	155.9	154.3	152.8	151.1	149.4	147.3	144.8	142.2	138.7
48	159.6	158.2	156.7	155.1	153.6	151.9	150.1	148.0	145.6	142.9	139.5
48.5	160.4	159.0	157.5	155.9	154.3	152.6	150.9	148.8	146.3	143.7	140.2
49	161.3	159.8	158.4	156.7	155.1	153.4	151.7	149.5	147.0	144.4	140.9
49.5	162.1	160.6	159.2	157.5	155.9	154.2	152.4	150.2	147.8	145.1	141.7
50	162.9	161.5	160.0	158.3	156.7	154.9	153.2	151.0	148.5	145.8	142.4
50.5	163.8	162.3	160.8	159.1	157.5	155.7	153.9	151.7	149.2	146.6	143.1
51	164.6	163.1	161.6	159.9	158.2	156.5	154.7	152.5	149.9	147.3	143.9
51.5	165.4	164.0	162.5	160.8	159.0	157.2	155.4	153.2	150.7	148.0	144.6
52	166.3	164.8	163.3	161.6	159.8	158.0	156.2	153.9	151.4	148.7	145.3
52.5	167.1	165.6	164.1	162.4	160.6	158.8	156.9	154.7	152.1	149.5	146.1
53	168.0	166.4	164.9	163.2	161.4	159.5	157.7	155.4	152.8	150.2	146.8
53.5	168.8	167.3	165.8	164.0	162.2	160.3	158.4	156.1	153.6	150.9	147.5
54	169.6	168.1	166.6	164.8	162.9	161.1	159.2	156.9	154.3	151.6	148.3
54.5	170.5	168.9	167.4	165.6	163.7	161.8	159.9	157.6	155.0	152.4	149.0
55	171.3	169.8	168.2	166.4	164.5	162.6	160.7	158.4	155.8	153.1	149.7
55.5	172.1	170.6	169.0	167.2	165.3	163.4	161.4	159.1	156.5	153.8	150.5
56	173.0	171.4	169.9	168.0	166.1	164.1	162.2	159.8	157.2	154.5	151.2
56.5	173.8	172.2	170.7	168.8	166.9	164.9	162.9	160.6	157.9	155.3	151.9
57	174.6	173.1	171.5	169.6	167.6	165.7	163.7	161.3	158.7	156.0	152.7
57.5	175.5	173.9	172.3	170.4	168.4	166.4	164.4	162.1	159.4	156.7	153.4
58	176.3	174.7	173.2	171.2	169.2	167.2	165.2	162.8	160.1	157.4	154.1
58.5	177.1	175.6	174.0	172.0	170.0	168.0	165.9	163.5	160.9	158.2	154.9
59	178.0	176.4	174.8	172.8	170.8	168.7	166.7	164.3	161.6	158.9	155.6
59.5	178.8	177.2	175.6	173.6	171.6	169.5	167.4	165.0	162.3	159.6	156.4
60	179.7	178.1	176.4	174.4	172.3	170.3	168.2	165.8	163.0	160.3	157.1
60.5	180.5	178.9	177.3	175.2	173.1	171.0	168.9	166.5	163.8	161.1	157.8
61	181.3	179.7	178.1	176.0	173.9	171.8	169.7	167.2	164.5	161.8	158.6
61.5	182.2	180.5	178.9	176.8	174.7	172.6	170.4	168.0	165.2	162.5	159.3
62	183.0	181.4	179.7	177.6	175.5	173.3	171.2	168.7	165.9	163.2	160.0

APPENDIX D - FM-200® LIQUID LEVEL INDICATOR CHARTS

180L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
62.5	183.8	182.2	180.6	178.4	176.3	174.1	171.9	169.4	166.7	164.0	160.8
63	184.7	183.0	181.4	179.2	177.0	174.9	172.7	170.2	167.4	164.7	161.5
63.5	185.5	183.9	182.2	180.0	177.8	175.6	173.4	170.9	168.1	165.4	162.2
64	186.3	184.7	183.0	180.8	178.6	176.4	174.2	171.7	168.9	166.1	163.0
64.5	187.2	185.5	183.8	181.6	179.4	177.2	174.9	172.4	169.6	166.9	163.7
65	188.0	186.3	184.7	182.4	180.2	177.9	175.7	173.1	170.3	167.6	164.4
65.5	188.9	187.2	185.5	183.2	181.0	178.7	176.5	173.9	171.0	168.3	165.2
66	189.7	188.0	186.3	184.0	181.7	179.5	177.2	174.6	171.8	169.0	165.9
66.5	190.5	188.8	187.1	184.8	182.5	180.2	178.0	175.4	172.5	169.8	166.6
67						181.0	178.7	176.1	173.2	170.5	167.4
67.5						181.8	179.5	176.8	173.9	171.2	168.1
68						182.5	180.2	177.6	174.7	171.9	168.8
68.5							181.0	178.3	175.4	172.7	169.6
69							181.7	179.0	176.1	173.4	170.3
69.5							182.5	179.8	176.9	174.1	171.0
70								180.5	177.6	174.8	171.8
70.5								181.3	178.3	175.6	172.5
71								182.0	179.0	176.3	173.2
71.5								182.7	179.8	177.0	174.0
72									180.5	177.7	174.7
72.5									181.2	178.5	175.4
73									182.0	179.2	176.2
73.5									182.7	179.9	176.9
74										180.6	177.6
74.5										181.4	178.4
75										182.1	179.1
75.5										182.8	179.8
76											180.6
76.5											181.3
77											182.0
77.5											182.8
78											
78.5											
79											
79.5											

343L Tank

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
15											
15.5											
16											
16.5											
17											
17.5											
18											
18.5											
19											
19.5											
20											
20.5	165.2	164.2	163.3	162.3							
21	167.2	166.2	165.2	164.2	163.2						
21.5	169.3	168.2	167.1	166.1	165.0	162.5					
22	171.3	170.2	169.1	168.0	166.9	164.3					
22.5	173.3	172.2	171.0	169.9	168.7	166.2	163.2				
23	175.3	174.1	173.0	171.8	170.6	168.0	165.0	162.0			
23.5	177.3	176.1	174.9	173.7	172.5	169.9	166.8	163.8			
24	179.3	178.1	176.8	175.6	174.3	171.7	168.7	165.6	162.6		163.6
24.5	181.4	180.1	178.8	177.5	176.2	173.5	170.5	167.4	164.4		165.3
25	183.4	182.1	180.7	179.4	178.1	175.4	172.3	169.3	166.2	163.1	167.1
25.5	185.4	184.0	182.7	181.3	179.9	177.2	174.1	171.1	168.0	164.9	168.8
26	187.4	186.0	184.6	183.2	181.8	179.1	176.0	172.9	169.8	166.7	170.6
26.5	189.4	188.0	186.5	185.1	183.6	180.9	177.8	174.7	171.6	168.4	172.3
27	191.5	190.0	188.5	187.0	185.5	182.7	179.6	176.5	173.3	170.2	174.1
27.5	193.5	192.0	190.4	188.9	187.4	184.6	181.4	178.3	175.1	172.0	175.8
28	195.5	193.9	192.4	190.8	189.2	186.4	183.3	180.1	176.9	173.8	177.6
28.5	197.5	195.9	194.3	192.7	191.1	188.3	185.1	181.9	178.7	175.5	179.3
29	199.5	197.9	196.2	194.6	193.0	190.1	186.9	183.7	180.5	177.3	181.1
29.5	201.6	199.9	198.2	196.5	194.8	191.9	188.7	185.5	182.3	179.1	182.9
30	203.6	201.9	200.1	198.4	196.7	193.8	190.5	187.3	184.1	180.8	184.6

343L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
30.5	205.6	203.8	202.1	200.3	198.5	195.6	192.4	189.1	185.9	182.6	186.4
31	207.6	205.8	204.0	202.2	200.4	197.5	194.2	190.9	187.6	184.4	188.1
31.5	209.6	207.8	206.0	204.1	202.3	199.3	196.0	192.7	189.4	186.1	189.9
32	211.7	209.8	207.9	206.0	204.1	201.1	197.8	194.5	191.2	187.9	191.6
32.5	213.7	211.8	209.8	207.9	206.0	203.0	199.7	196.3	193.0	189.7	193.4
33	215.7	213.7	211.8	209.8	207.9	204.8	201.5	198.1	194.8	191.5	195.1
33.5	217.7	215.7	213.7	211.7	209.7	206.7	203.3	199.9	196.6	193.2	196.9
34	219.7	217.7	215.7	213.6	211.6	208.5	205.1	201.7	198.4	195.0	198.6
34.5	221.8	219.7	217.6	215.5	213.4	210.3	206.9	203.6	200.2	196.8	200.4
35	223.8	221.7	219.5	217.4	215.3	212.2	208.8	205.4	201.9	198.5	202.1
35.5	225.8	223.6	221.5	219.3	217.2	214.0	210.6	207.2	203.7	200.3	203.9
36	227.8	225.6	223.4	221.2	219.0	215.9	212.4	209.0	205.5	202.1	205.6
36.5	229.8	227.6	225.4	223.1	220.9	217.7	214.2	210.8	207.3	203.8	207.4
37	231.8	229.6	227.3	225.0	222.8	219.5	216.1	212.6	209.1	205.6	209.1
37.5	233.9	231.6	229.2	226.9	224.6	221.4	217.9	214.4	210.9	207.4	210.9
38	235.9	233.5	231.2	228.8	226.5	223.2	219.7	216.2	212.7	209.2	212.6
38.5	237.9	235.5	233.1	230.7	228.3	225.1	221.5	218.0	214.5	210.9	214.4
39	239.9	237.5	235.1	232.6	230.2	226.9	223.3	219.8	216.2	212.7	216.2
39.5	241.9	239.5	237.0	234.5	232.1	228.7	225.2	221.6	218.0	214.5	217.9
40	244.0	241.5	238.9	236.4	233.9	230.6	227.0	223.4	219.8	216.2	219.7
40.5	246.0	243.4	240.9	238.3	235.8	232.4	228.8	225.2	221.6	218.0	221.4
41	248.0	245.4	242.8	240.2	237.7	234.3	230.6	227.0	223.4	219.8	223.2
41.5	250.0	247.4	244.8	242.1	239.5	236.1	232.5	228.8	225.2	221.5	224.9
42	252.0	249.4	246.7	244.0	241.4	237.9	234.3	230.6	227.0	223.3	226.7
42.5	254.1	251.4	248.7	245.9	243.2	239.8	236.1	232.4	228.8	225.1	228.4
43	256.1	253.3	250.6	247.8	245.1	241.6	237.9	234.2	230.5	226.9	230.2
43.5	258.1	255.3	252.5	249.7	247.0	243.5	239.8	236.0	232.3	228.6	231.9
44	260.0	257.2	254.4	251.6	248.8	245.3	241.6	237.9	234.1	230.4	233.7
44.5	262.0	259.1	256.3	253.5	250.7	247.1	243.4	239.7	235.9	232.2	235.4
45	263.9	261.1	258.2	255.4	252.5	249.0	245.2	241.5	237.7	233.9	237.2
45.5	265.8	263.0	260.1	257.3	254.4	250.8	247.0	243.3	239.5	235.7	238.9
46	267.8	264.9	262.0	259.1	256.3	252.7	248.9	245.1	241.3	237.5	240.7
46.5	269.7	266.8	263.9	261.0	258.1	254.5	250.7	246.9	243.1	239.2	242.5
47	271.6	268.7	265.8	262.9	259.9	256.3	252.5	248.7	244.8	241.0	244.2
47.5	273.6	270.6	267.7	264.7	261.7	258.1	254.3	250.4	246.6	242.8	246.0
48	275.5	272.5	269.5	266.5	263.6	259.9	256.1	252.2	248.4	244.5	247.7
48.5	277.4	274.4	271.4	268.4	265.4	261.7	257.9	254.0	250.2	246.3	249.5
49	279.4	276.3	273.3	270.2	267.2	263.5	259.6	255.8	251.9	248.1	251.2
49.5	281.3	278.2	275.1	272.1	269.0	265.3	261.4	257.6	253.7	249.8	253.0
50	283.2	280.1	277.0	273.9	270.8	267.1	263.2	259.3	255.5	251.6	254.7
50.5	285.2	282.0	278.9	275.7	272.6	268.9	265.0	261.1	257.2	253.4	256.5
51	287.1	283.9	280.8	277.6	274.4	270.7	266.8	262.9	259.0	255.1	258.1
51.5	289.0	285.8	282.6	279.4	276.2	272.5	268.6	264.7	260.8	256.9	259.6
52	291.0	287.7	284.5	281.3	278.0	274.3	270.4	266.5	262.6	258.6	261.1
52.5	292.9	289.6	286.4	283.1	279.8	276.1	272.2	268.2	264.3	260.4	262.6
53	294.8	291.5	288.2	285.0	281.7	277.9	273.9	270.0	266.0	262.1	264.1
53.5	296.8	293.4	290.1	286.8	283.5	279.6	275.6	271.6	267.6	263.6	265.7
54	298.7	295.3	292.0	288.6	285.3	281.4	277.3	273.3	269.2	265.2	267.2
54.5	300.6	297.2	293.9	290.5	287.1	283.1	279.0	274.9	270.8	266.7	268.7
55	302.6	299.1	295.7	292.3	288.9	284.9	280.8	276.6	272.4	268.3	270.2
55.5	304.5	301.0	297.6	294.2	290.7	286.7	282.5	278.3	274.1	269.9	271.7
56	306.4	302.9	299.5	296.0	292.5	288.4	284.2	279.9	275.7	271.4	273.2
56.5	308.4	304.8	301.3	297.8	294.3	290.2	285.9	281.6	277.3	273.0	274.7
57	310.3	306.8	303.2	299.7	296.1	292.0	287.6	283.2	278.9	274.5	276.2
57.5	312.2	308.7	305.1	301.5	297.9	293.7	289.3	284.9	280.5	276.1	277.7
58	314.2	310.6	307.0	303.4	299.8	295.5	291.0	286.6	282.1	277.7	279.2
58.5	316.1	312.5	308.8	305.2	301.6	297.3	292.7	288.2	283.7	279.2	280.7
59	318.0	314.4	310.7	307.0	303.4	299.0	294.5	289.9	285.3	280.8	282.2
59.5	320.0	316.3	312.6	308.9	305.2	300.8	296.2	291.6	286.9	282.3	283.8
60	321.9	318.2	314.4	310.7	307.0	302.5	297.9	293.2	288.6	283.9	285.3
60.5	323.8	320.1	316.3	312.6	308.8	304.3	299.6	294.9	290.2	285.5	286.8
61	325.8	322.0	318.2	314.4	310.6	306.1	301.3	296.5	291.8	287.0	288.3
61.5	327.7	323.9	320.1	316.2	312.4	307.8	303.0	298.2	293.4	288.6	289.8
62	329.6	325.8	321.9	318.1	314.2	309.6	304.7	299.9	295.0	290.1	291.3
62.5	331.6	327.7	323.8	319.9	316.0	311.4	306.4	301.5	296.6	291.7	292.8
63	333.5	329.6	325.7	321.8	317.9	313.1	308.2	303.2	298.2	293.3	294.3
63.5	335.4	331.5	327.5	323.6	319.7	314.9	309.9	304.9	299.8	294.8	295.8
64	337.4	333.4	329.4	325.4	321.5	316.7	311.6	306.5	301.4	296.4	297.3
64.5	339.3	335.3	331.3	327.3	323.3	318.4	313.3	308.2	303.1	297.9	298.8
65	341.2	337.2	333.2	329.1	325.1	320.2	315.0	309.8	304.7	299.5	300.4
65.5	343.1	339.1	335.0	331.0	326.9	321.9	316.7	311.5	306.3	301.1	301.9
66	345.1	341.0	336.9	332.8	328.7	323.7	318.4	313.2	307.9	302.6	303.4

343L Tank (Continued)

LLI	"Temperature, Degrees C"										
cm	0	5	10	15	20	25	30	35	40	45	50
	"Weight of FM-200, kilograms"										
66.5	347.0	342.9	338.8	334.6	330.5	325.5	320.1	314.8	309.5	304.2	304.9
67	348.9	344.8	340.6	336.5	332.3	327.2	321.9	316.5	311.1	305.7	306.4
67.5	350.9	346.7	342.5	338.3	334.1	329.0	323.6	318.1	312.7	307.3	307.9
68	352.8	348.6	344.4	340.2	336.0	330.8	325.3	319.8	314.3	308.9	309.4
68.5	354.7	350.5	346.3	342.0	337.8	332.5	327.0	321.5	315.9	310.4	310.9
69	356.7	352.4	348.1	343.9	339.6	334.3	328.7	323.1	317.6	312.0	312.4
69.5	358.6	354.3	350.0	345.7	341.4	336.1	330.4	324.8	319.2	313.5	313.9
70	360.5	356.2	351.9	347.5	343.2	337.8	332.1	326.5	320.8	315.1	315.4
70.5						339.6	333.8	328.1	322.4	316.7	317.0
71						341.3	335.6	329.8	324.0	318.2	318.5
71.5						343.1	337.3	331.4	325.6	319.8	320.0
72						344.9	339.0	333.1	327.2	321.3	321.5
72.5							340.7	334.8	328.8	322.9	323.0
73							342.4	336.4	330.4	324.5	324.5
73.5							344.1	338.1	332.0	326.0	326.0
74								339.7	333.7	327.6	327.5
74.5								341.4	335.3	329.1	329.0
75								343.1	336.9	330.7	330.5
75.5								344.7	338.5	332.3	332.0
76									340.1	333.8	333.6
76.5									341.7	335.4	335.1
77									343.3	336.9	336.6
77.5									344.9	338.5	338.1
78										340.1	339.6
78.5										341.6	341.1
79										343.2	342.6
79.5										344.7	344.1
80											
80.5											
81											
81.5											

Dual Supply System Components

Primary and Secondary supply components are used in order to maintain the supply chain and ensure that adequate stock levels are available to fully support customers and installers.
The customer may receive items of either primary or secondary supply, there is no difference between each supply, except for the source.

Table 26: Primary and Secondary Supply System Components

System Component	Primary Supply Part No.	Secondary Supply Part No.	Manual Page Reference
25mm (1") Valve Assembly	302.209.001	302.207.001	Page 12
50mm (2") Valve Assembly	302.209.002	302.207.002	Page 12
Manual Actuator	304.209.002	304.207.002	Page 17
Pneumatic Actuator	304.209.004	304.207.004	Page 17
25mm (1") Manifold Check Valve Assembly	302.209.004	302.207.004	Page 21
50mm (2") Manifold Check Valve Assembly	302.209.005	302.207.005	Page 21