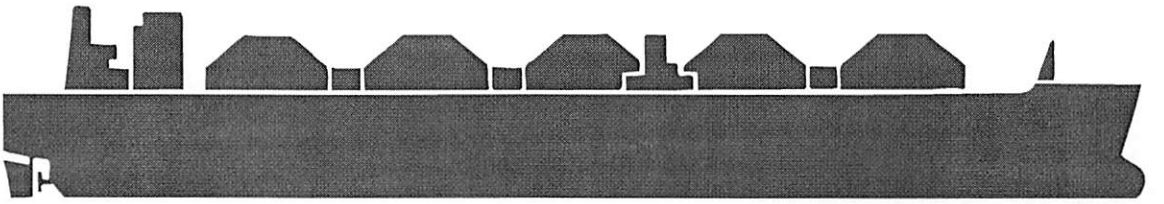
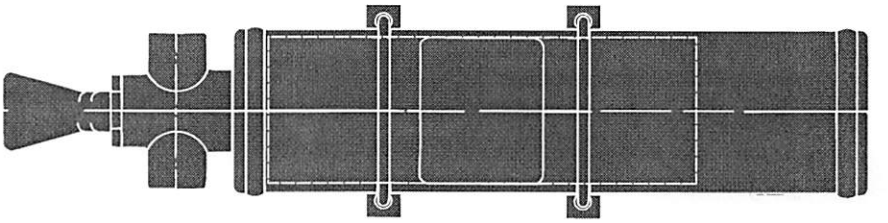
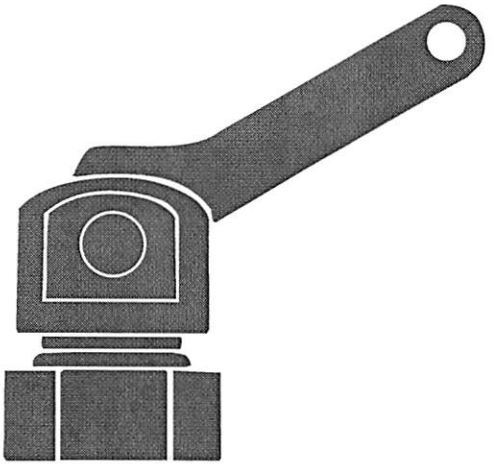
ANSUL

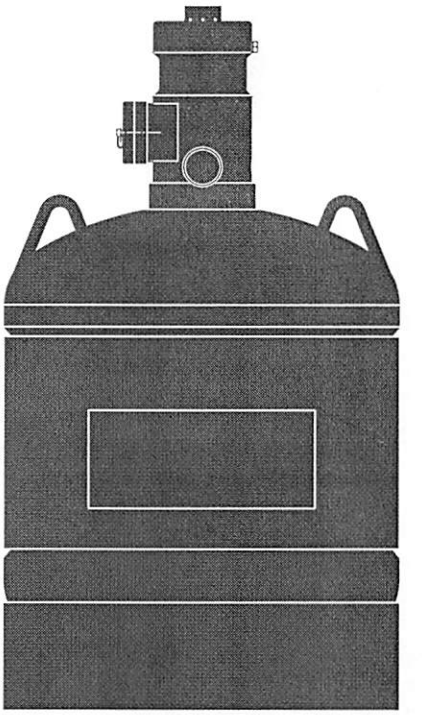
DESIGN
INSTALLATION
RECHARGE AND
MAINTENANCE
MANUAL

MARINE SAPPHIRE™ ENGINEERED CLEAN AGENT SYSTEMS









ANSUL
MARINE SAPPHIRE™ ENGINEERED
CLEAN AGENT SYSTEM
DESIGN, INSTALLATION, RECHARGE AND MAINTENANCE MANUAL
ANSUL PART NO. 433036

U.S. COAST GUARD APPROVAL 162.161/6/0
UNDERWRITERS LABORATORIES FILE NO. EX-4510

DECEMBER 1, 2004

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PARTS LIST FOR MARINE SAPPHIRE SYSTEMS

Cylinder Shipping Assemblies

UL Part No.	Description
570635	20 lb. Tank
570636	50 lb. Tank
570637	90 lb. Tank
570638	140 lb. Tank
570639	280 lb. Tank
570640	390 lb. Tank
570641	450 lb. Tank
570586	850 lb. Tank
433098	Nitrogen Pilot Cylinder with CV-98 Valve

Actuation Components

Part No.	Description
42484	Lever Release
423309	Lever Release
427207	Lever Release
42514	Connecting Link
41527	Type "A" Break Glass Pull Box
43827	Combination Latch/Break Glass Pull Box
45062	Latch Door Type Pull Box
42329	Type "B" Combination Latch/Break Glass Pull Box (Watertight)
41542	Mounting Legs for Pull Box
426312	Enclosed Double Cable Pull Box with Microswitch
45515	Corner Pulley – Watertight, Hazardous Location
423250	Corner Pulley – Aluminum
40696	Right and Left Hand Pulley Adaptor
42784	Dual/Triple Control Box – Short
43166	Dual/Triple Control Box – Long
42791	Remote Cable Pull Equalizer – Short
43168	Remote Cable Pull Equalizer – Long
42104	1/16 in. Pull Cable – 50 ft. (15.2 m)
42109	1/16 in. Pull Cable – 100 ft. (30.5 m)
42113	1/16 in. Pull Cable – 150 ft. (45.7 m)
45333	1/16 in. Cable Clamp
40060	Flared End Fitting
31809	16 in. Stainless Steel Hose
32335	20 in. Stainless Steel Hose
32336	24 in. Stainless Steel Hose
42175	1/4 in. Pressure Bleeder
28037	Line Vent
31810	Male Elbow
31811	Male Tee
418359	Flared Tee 1/8 x 1/4 x 1/4 in. (3.18 x 6.35 x 6.35 mm)
32338	Male Straight Adaptor
73236	Pilot Valve Actuation Adaptor
32334	Male Elbow (for pilot valve act. adaptor)
570342	Male Adaptor
570550	Pneumatic Actuator – Pilot Cylinder Valves
427082	Flexible Discharge Bend
428566	Stackable Actuator
570392	Cable/Pneumatic Actuator (Single Agent Tank)
42267	Quartzoid Bulb Actuator – 135 °F (57 °C)
42274	Quartzoid Bulb Actuator – 175 °F (79 °C)
42276	Quartzoid Bulb Actuator – 250 °F (121 °C)

Check Valves

Part No.	Description
25627	1/4 in. NPT Check Valve
40860	1/2 in . NPT Check Valve
40852	3/4 in. NPT Check Valve
41470	1 in. NPT Check Valve
41549	1 1/4 in. NPT Check Valve
41463	1 1/2 in. NPT Check Valve
40649	2 in. NPT Check Valve
40656	2 1/2 in. NPT Check Valve

Time Delays

Part No.	Description
417504	Variable Time Delay

Globe Valves and Controls (for Pull Cable or Manual Operation)

Part No.	Description
41451	1/2 in. Globe Valve
40276	1/2 in. Sector
40238	1/2 in. Lever, Normally Closed
40248	1/2 in. Lever, Normally Open
41102	3/4 in. Globe Valve
40279	3/4 in. Sector
40239	3/4 in. Lever, Normally Closed
40267	3/4 in. Lever, Normally Open

Selector Valves

Part No.	Description
427185	1 in. Selector Valve – Threaded

Stop/Isolation Valves

Part No.	Description
418596	3/4 in. Stop/Isolation Valve

Actuation Components for Selector Valves

Part No.	Description
427207	Lever Release
42484	Lever Release
428566	Pressure Operated Stackable Actuator

Remote Pressure Actuation Components

Part No.	Description
418731	Marine Actuation Station – 2 Step
67686	Marine Actuation Station – 1 Step
7012	LT-20-L Nitrogen Cartridge
52056	1/2 in. 14 NPT Pipe Plug

360° Discharge Nozzles

Part No.	Description
570602	1/2 in. NPT Nozzle
570603	3/4 in. NPT Nozzle
570604	1 in. NPT Nozzle
570605	1 1/4 in. NPT Nozzle
570606	1 1/2 in. NPT Nozzle
570607	2 in. NPT Nozzle

PARTS LIST FOR MARINE SAPPHIRE SYSTEMS (Continued)

Nameplates

Part No.	Description
41942	Nameplate – Main
41943	Nameplate – Reserve
570581	Warning Plate – Inside Room with Alarm
570580	Warning Plate – Outside Room without Alarm
552860	Operating Instructions – Pull Cable Actuation

Tank Bracketing Components

Part No.	Description
57700	Clamp for 20, 50, 90 lb. Tanks
57702	Clamp for 140, 280, 390, 450 lb. Tanks
433131	Clamp for 850 lb. Tank

Miscellaneous System Components

Part No.	Description
46250	Pressure Switch 2PST
42344	Pressure Switch 3PST
43241	Pressure Switch DPST-EXP-Proof
5156	Pressure Trip
423923	Pressure Test Assembly – CV-98 Valve
419700	Pressure Operated Siren
570539	1 in. Flexible Discharge Hose
570538	2 in. Flexible Discharge Hose
69990	3 in. Flexible Discharge Hose
69470	3 in. Flared Swivel Adaptor
570566	1 in. Manifold Check Valve
570568	2 in. Manifold Check Valve
69841	3 in. Discharge Hose/Check Valve Assembly
570277	Liquid Level Measuring Device – 280 lb. Tank
570278	Liquid Level Measuring Device – 390, 850 lb. Tanks
570589	Liquid Level Measuring Device – 450 lb. Tank
570585	Low Pressure Switch
42514	Connecting Link
418378	1/2 in. Manifold Relief Valve
40309	Vent Plug
427082	Flexible Discharge Bend
42430	Washer
426028	Bleed Down Device
42410	Plug for Actuation Port
79638	Pilot Cylinder Bracket Back Frame
73091	Pilot Cylinder Clamp
73252	Pilot Cylinder Bracket Bolt with Nut and Lockwasher

Recharge/Rebuild Components

Part No.	Description
570574	Spanner Wrench
570576	1 in. Recharge Adaptor
570592	2 in. Recharge Adaptor
69891	3 in. Recharge Adaptor
570559	1 in. Rebuild Kit
570584	2 in. Rebuild Kit
570373	3 in. Rebuild Kit

3M™ Novec™ 1230 Fire Protection Fluid

Novec 1230 fluid has been developed as a halon replacement alternative to HFCs, HCFCs, and PFCs in special hazard, high value applications. It has unique qualities that provide the right balance of fire extinguishing performance, end use safety, and environmental sustainability. Novec 1230 fluid is low in toxicity and environment impact. It is a liquid at room temperature, with a low vapor pressure, which allows for ease in handling, storage, and shipping.

Novec 1230 fluid is available in two sizes of containers:

Part No. 433290 – 1 Gallon (3.8 L) Jug Shipping Assembly

Part No. 570533 – 30 Gallon (113.6 L) Drum Shipping Assembly

Part No. 570534 – 220 Gallon (832.8 L) Tote Shipping Assembly

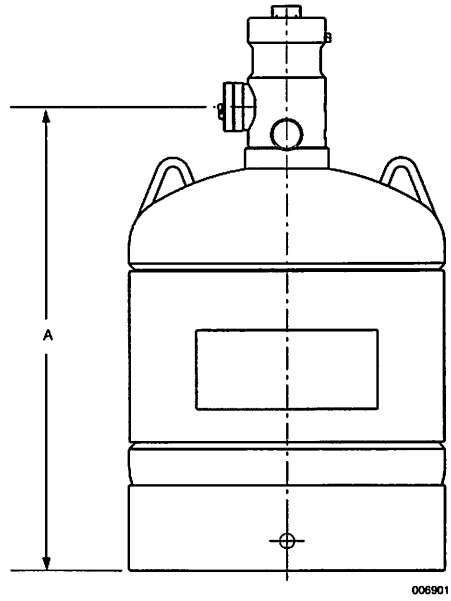
AGENT TANK SHIPPING ASSEMBLY

The agent tank assemblies are manufactured in accordance with DOT 4BW450 and consist of a tank fitted with a valve and internal siphon tube. Eight partial filled tank sizes are available. A nameplate is adhered to the tank displaying the agent weight and gross weight. Tanks are superpressurized with dry nitrogen to 360 psi (25 bar) at 70 °F (21 °C). All tanks are available in multiple fill increments.

Note: Quantity of agent will have to be specified on customer P.O. when ordering factory filled tank shipping assemblies.

Also, when low pressure switch and liquid level indicator installed options are required, they must be specified when ordering.

Component	Material	Approvals
Tank	Steel	DOT4BW450
Valve	Brass	



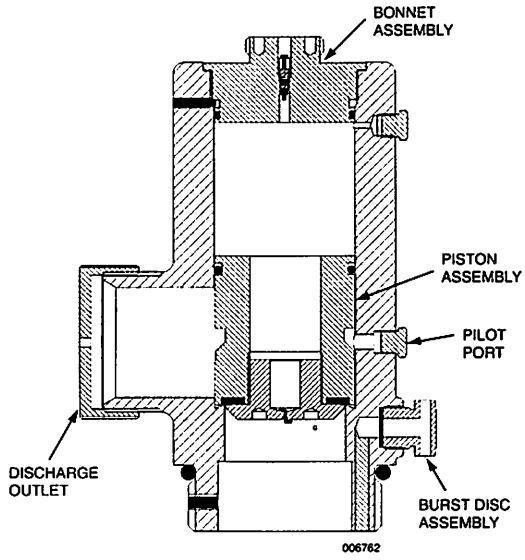
Shipping Assembly Part No.	Nominal Tank Size lbs.	(kg)	Agent Quantity lbs.	(kg)	Approximate Empty Weight lbs.	(kg)	Dimension "A" in.	(cm)	Diameter in.	(cm)	Valve Size
570635	20	(9.1)	10 to 21	(4.5 to 9.5)	33	(15)	12	(30.4)	10	(25.4)	1 in.
570633	50	(22.7)	20 to 46	(9.1 to 21)	41	(18.6)	19.8	(50.2)	10	(25.4)	1 in.
570634	90	(40.8)	37 to 88	(17 to 40)	57.5	(26)	32.8	(83.3)	10	(25.4)	1 in.
570638	140	(63.5)	58 to 138	(26 to 62.6)	108	(49)	23.5	(59.6)	16	(40.6)	2 in.
570639	280	(127)	116 to 280	(52.6 to 127)	158	(71.7)	40.2	(102)	16	(40.6)	2 in.
570640	390	(177)	161 to 388	(73 to 176)	198	(90)	53.3	(135)	16	(40.6)	2 in.
570641	450	(204)	194 to 459	(88 to 204)	233	(106)	64.3	(163)	16	(40.6)	2 in.
570586	850	(386)	375 to 851	(170 to 386)	456	(207)	57.7	(146.6)	24	(61)	3 in.

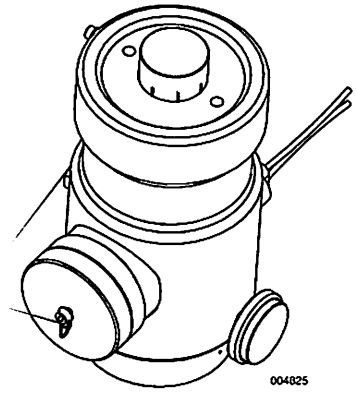
DISCHARGE VALVE ASSEMBLY

The replacement valve assembly is available for field replacement. The valve is fully assembled, with internal components, gauge, and burst disc assembly. The replacement valve is 100% leak tested before it leaves the factory.

Component	Material
Valve	Brass

Shipping Assembly Part No.	Description
570535	1 in. Valve Shipping Assembly
570536	2 in. Valve Shipping Assembly
570588	3 in. Valve Shipping Assembly





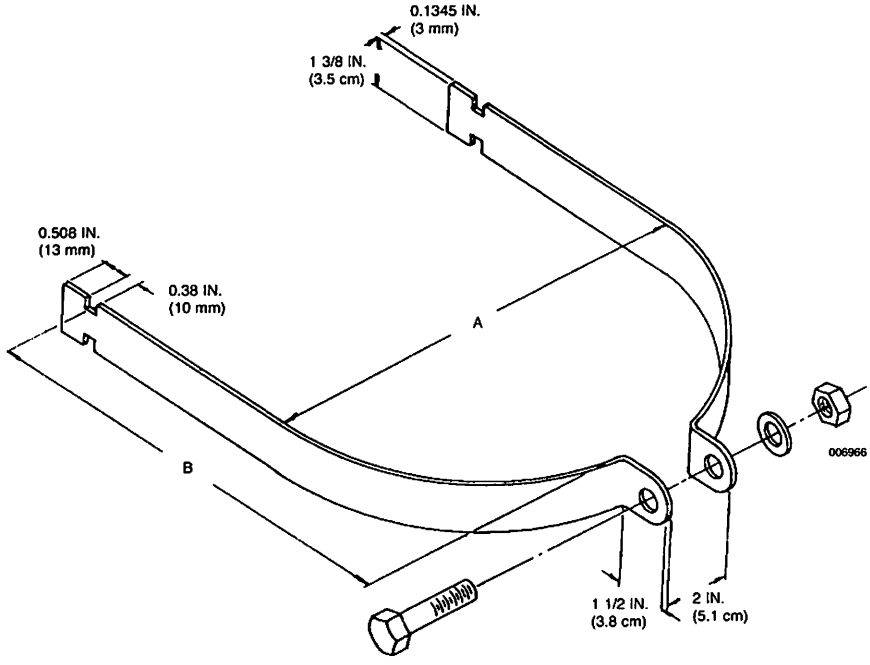
AGENT TANK BRACKETS

Each tank must be secured with two brackets. Each bracket assembly includes two bracket halves with fastening nut, bolt, and washer. Brackets are designed to be used in conjunction with continuous slot channel.

Bracket assemblies are manufactured from 304 stainless steel with S.S. nut, bolt, and washer.

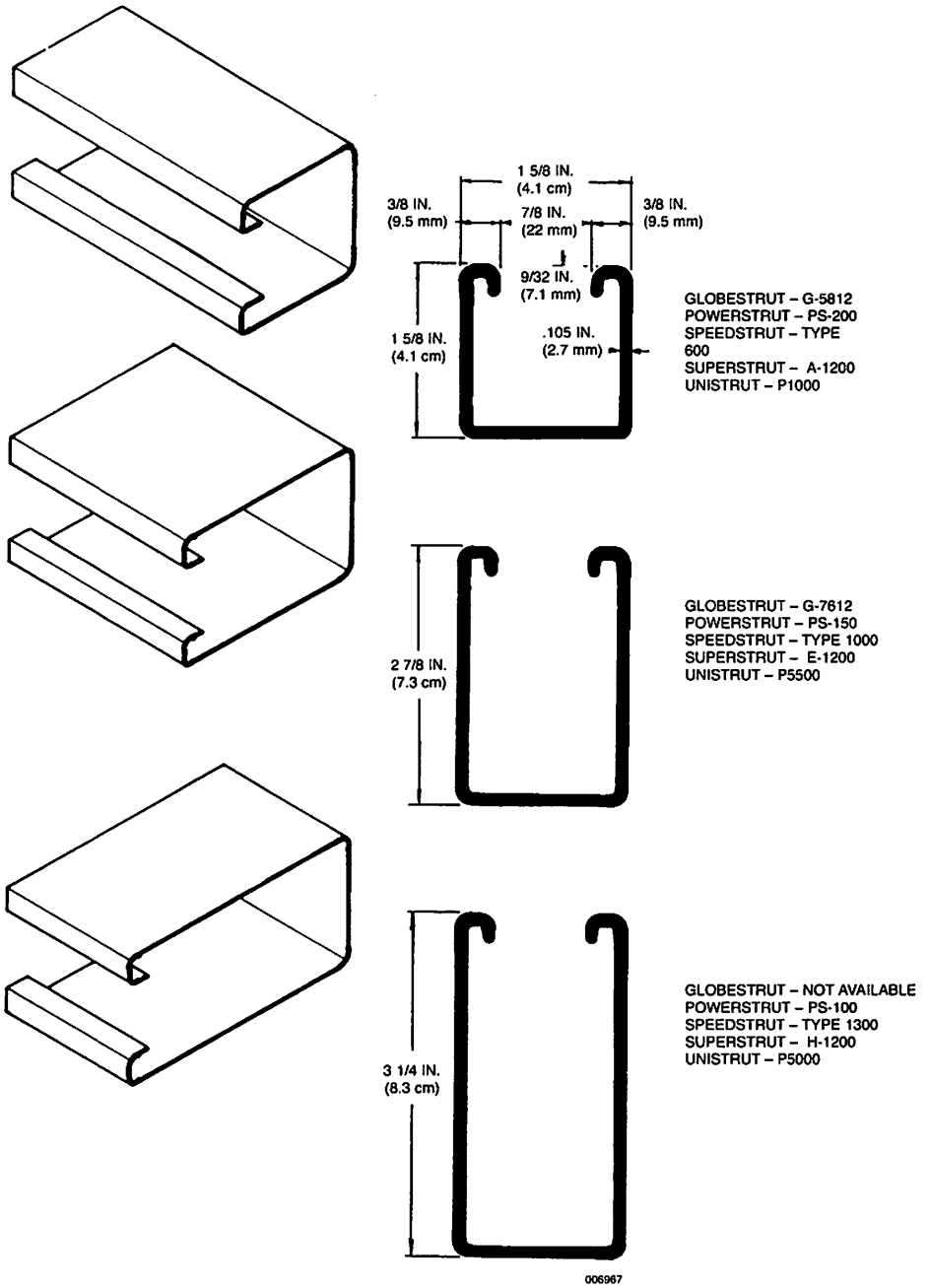
Nominal Tank Size (lbs.)	Bracket Part No.	Tank Diameter in.	(cm)	Bracket Dimension A and B in.	(cm)	Approximate Weight lb.	(kg)
20, 50, 90	57700	10	(25)	10.38	(26)	2	(.9)
140, 280, 390, 450	57702	16	(41)	16.12	(41)	3	(1.4)
850	433131	24	(61)	24.5	(62)	4	(1.8)

Back channel is not supplied with the bracket and must be ordered separately. Refer to Components Section, Page 1-5, for description of acceptable channel.



BRACKET CHANNEL

Bracket channel shall be of the modular type, formed from 12 gauge, .105 in. (2.7 mm) steel. The channel shall be painted, or otherwise protected from corrosion. Approved channel sizes and manufacturers are listed below. Channel is to be ordered direct from manufacturer or manufacturer's dealers.



FLEXIBLE DISCHARGE HOSE

The flexible discharge hose is used to connect the tank valve outlet to rigid distribution piping. On single tank systems, a check valve is not required. Three sizes of flexible discharge hoses are available: 1 in. (for 20, 50, and 90 lb. tank sizes), 2 in. (for 140, 280, 390, and 450 lb. tank sizes), and 3 in. (for 850 lb. tank sizes).

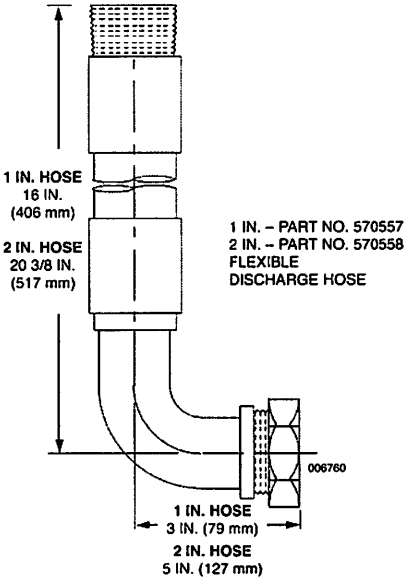
For 1 in. flexible hose, adaptor, Part No. 570557, is required to connect the valve outlet to rigid pipe.

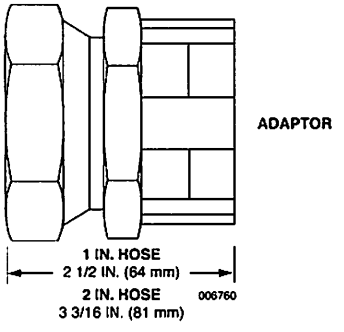
For 2 in. flexible hose, adaptor, Part No. 570558, is required to connect the valve outlet to rigid pipe.

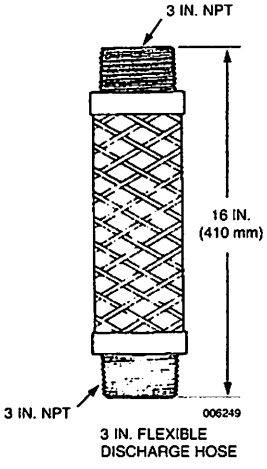
When using a 3 in. flexible discharge hose (without a manifold), three single tank swivel adaptors are available for connection from the valve outlet to the flexible discharge hose.

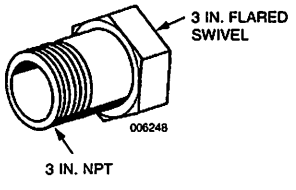
Component	Material
1, 2, 3 in. Flexible Discharge Hose	Stainless Steel Tubing with Stainless Steel Braid Cover

Shipping Assembly Part No.	Description
570539	1 in. Flexible Discharge Hose
570538	2 in. Flexible Discharge Hose
69990	3 in. Flexible Discharge Hose
570557	1 in. Single Tank Swivel Adaptor
570558	2 in. Single Tank Swivel Adaptor
69470	3 in. Flared to 3 in. NPT Single Tank Swivel Adaptor









MANIFOLD CHECK VALVES

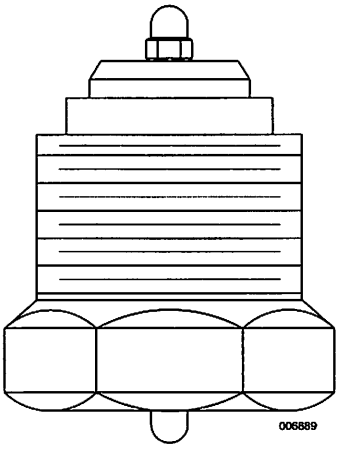
The manifold check valve is designed to prevent a loss of agent during a discharge in the event that a tank has been removed from the system. The check valve is a "mushroom" type, which lifts into the manifold as discharge occurs.

Two sizes of manifold check valves are available: 1 in. and 2 in.

Manifold are constructed of standard Schedule 40 pipe and 300 lb. fittings. The check valves assemble directly into the fittings.

Component	Thread Material	Type
Check Valve	Body: Brass Stem and Seal: Stainless Steel	1 in. NPT and 2 in. NPT

Shipping Assembly Part No.	Description
570566	1 in. Manifold Check Valve
570568	2 in. Manifold Check Valve

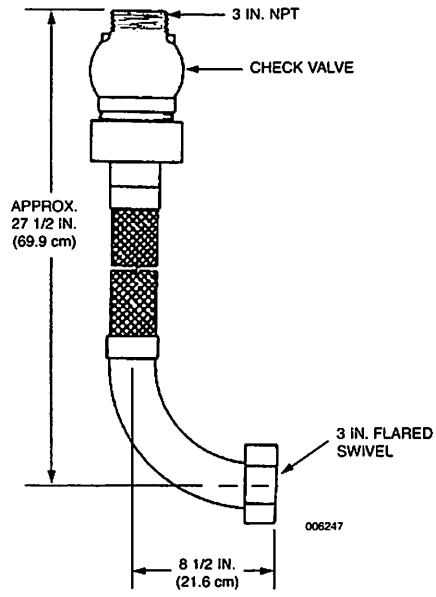


3 IN. DISCHARGE HOSE/CHECK VALVE ASSEMBLY

The 3 in. 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 a 1 1/2 in. (3.8 cm) height adjustment.

Component	Material
3 in. Discharge Hose/Check Valve	Hose: Double Braided Stainless Steel Elbow: Stainless Steel Valve Swivel Nut: Stainless Steel Check Valve Body: Cadmium Plated Mild Steel Check Valve Seal and Seat: Brass Spring: Stainless Steel

Shipping Assembly Part No.	Description
69841	3 in. Discharge Hose/ Check Valve Assembly



DISCHARGE NOZZLES

The discharge nozzles are available in a 360° pattern and are designed to uniformly distribute the Novec™ 1230 agent throughout the hazard area.

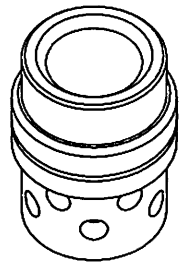
The 360° nozzle has sixteen ports. Six sizes of nozzles are available, 1/2 through 2 in.

The hydraulic flow program will determine the nozzle size and orifice size required.

Note: When ordering nozzles, orifice size must be specified when ordered.

Component	Material	Threads
1/2 in. Nozzle	Brass	1/2 in. NPT
3/4 in. Nozzle	Brass	3/4 in. NPT
1 in. Nozzle	Brass	1 in. NPT
1 1/4 in. Nozzle	Brass	1 1/4 in. NPT
1 1/2 in. Nozzle	Brass	1 1/2 in. NPT
2 in. Nozzle	Brass	2 in. NPT

Shipping Assembly Part No.	Description
570602	1/2 in. Nozzle – 360°
570603	3/4 in. Nozzle – 360°
570604	1 in. Nozzle – 360°
570605	1 1/4 in. Nozzle – 360°
570606	1 1/2 in. Nozzle – 360°
570607	2 in. Nozzle – 360°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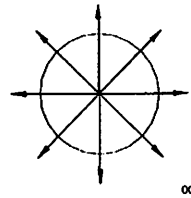
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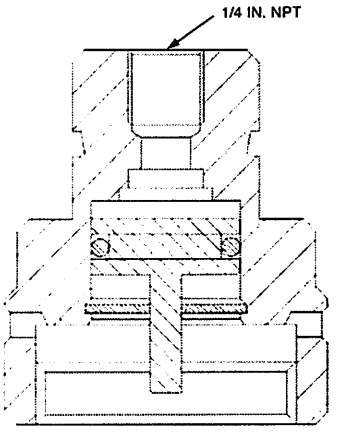
360° NOZZLE PATTERN

PNEUMATIC ACTUATOR

The pneumatic actuator is required to pneumatically actuate the agent tanks. The actuator operates from pressure received from the nitrogen pilot cylinders. When the pneumatic actuator is pressurized, the internal actuator piston pushes down on the valve stem, opening the tank valve, allowing the agent to discharge.

Component	Material
Pneumatic Actuator	Brass

Shipping Assembly Part No.	Description
570550	Pneumatic Actuator



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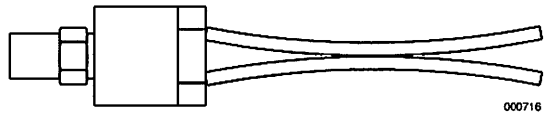
LOW PRESSURE SWITCH



The low pressure switch is used to indicate a pressure drop within the SAPPHIRE tank. The switch is factory mounted (must be specified when ordering tank) in the 1/8 in. switch port of the tank valve. The switch continuously monitors the tank pressure and in the event of the pressure dropping below 290 psi (20 bar), the switch operates, enabling the condition to be signaled at the control panel.

The low pressure switch is optional and must be ordered separately when ordering the SAPPHIRE tank.

Shipping Assembly Part No.	Description
570585	Low Pressure Switch

Component	Material	Switch Point/Type	Electrical Rating
Low Pressure Switch	Hermetically Sealed Stainless Steel Body	Opens on fall at 290 psi +/- 10 psi (20 bar +/- .7 bar)	Maximum Current: 2.9A
	6 ft. (1.8 m) Wire Leads	Closes on rise at 350 psi +/- 10 psi (24 bar +/- .7 bar)	Voltage Range: 5-28 VDC

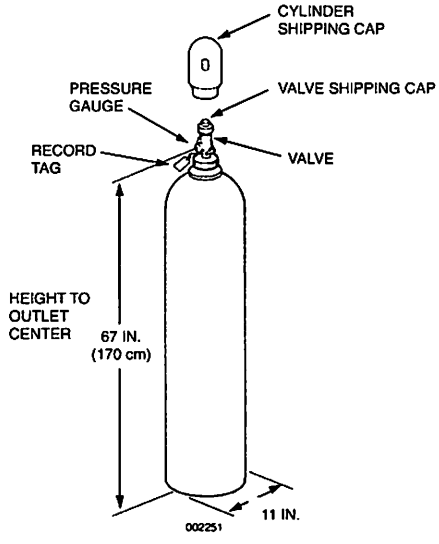
NITROGEN PILOT CYLINDER

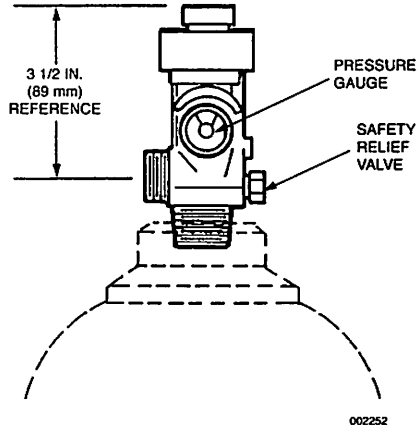
The Nitrogen Pilot Cylinder is factory filled with nitrogen. The quantity of pilot cylinders required is based on the number of agent tanks in the system.

The cylinders can be actuated pneumatically, manually, or by remote cable pull.

Component	Material
Cylinder	Steel
Valve	Brass
Safety Relief Valve	Brass
Shipping Cap	Steel

Shipping Assembly Part No.	Description
433098	Nitrogen Pilot Cylinder





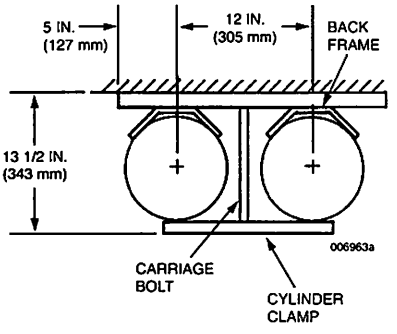
NITROGEN PILOT CYLINDER BRACKET

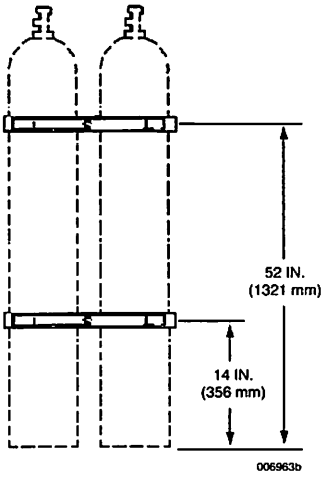
Material: Steel

Part No.	Description
79638	Back Frame – 2 required
73091	Cylinder Clamp – 2 required
73252	Carriage Bolt with Lockwasher and Nut – 2 required

Finish:

Back Frame – Red Polyester Powder Paint
Cylinder Clamp – Red Polyester Powder Paint
Carriage Bolt/Washer and Nut – Zinc Plated





PILOT VALVE LEVER RELEASE ACTUATOR

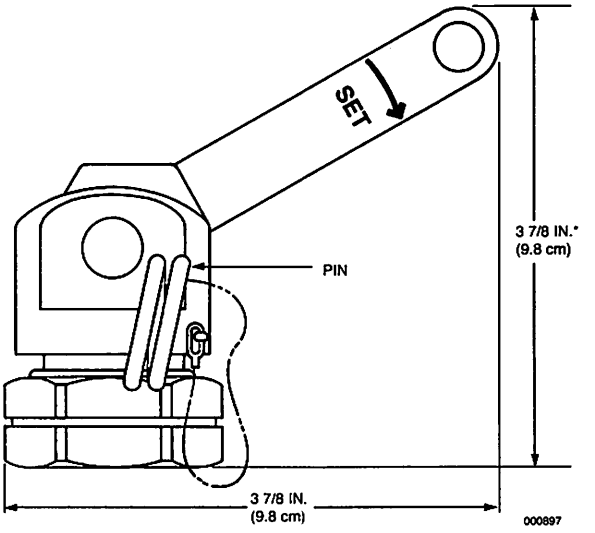
The manual lever release actuator provides a manual means of actuating pilot cylinder valves and selector valves. This can be accomplished by direct manual actuation of its pull lever or cable actuation when used in conjunction with a remote manual pull station. When used with a remote manual pull station, the pull station must contain the components necessary to meet the actuator lever traveling requirements of 7 in. (178 mm).

The actuator is shipped with ring pin and chain attached. If the ring pin is not required, it must be removed. Failure to remove the ring pin/chain assembly will prevent system actuation if a remote cable pull actuation system is employed and the ring pin is accidentally installed in the actuator.

Three actuators are available. Each is designed for a specific component.

Component	Material
All Manual Cable-pull Actuators	Brass with Stainless Steel Pin

Shipping Assembly Part No.	Description
423309	Lever Release (1 1/8-18 mounting thread) – Mounts directly to a CV-98 pilot cylinder valve.
427207	Lever Release (1 1/8-18 mounting thread) – Mounts directly to the 1 in. selector valves. Mounts directly to pressure operated stackable actuator for 1 in. selector valves. Actuator has the handle painted red.

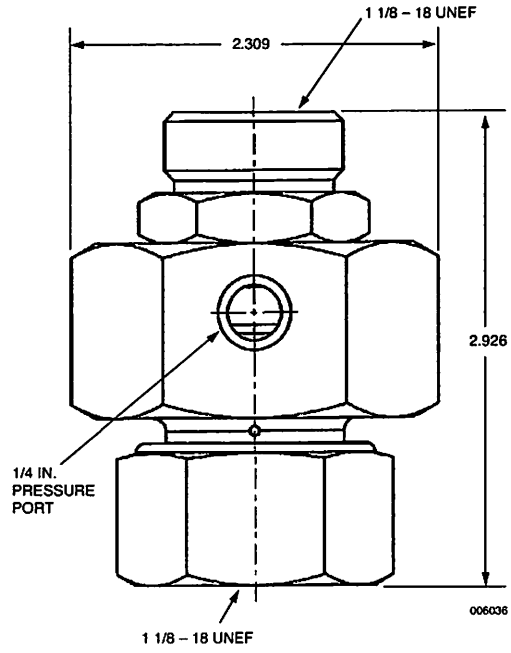


DEPTH: 3 7/8 IN. (7.6 cm)

*Add 1 9/16 in. (3.9 cm) to height when lever is in the straight up position.

PRESSURE OPERATED STACKABLE ACTUATOR

The pressure operated stackable actuator, Part No. 428566, is necessary when pneumatic actuation is required on a pilot cylinder valve or a selector valve if included in actuation piping. This actuator is installed on top of the valve and a 1/4 in. pressure line must be attached to the 1/4 in. pressure port on the side of the actuator. The pressure operated stackable actuator is spring loaded and does not have to be reset after use. The actuator is constructed of brass.

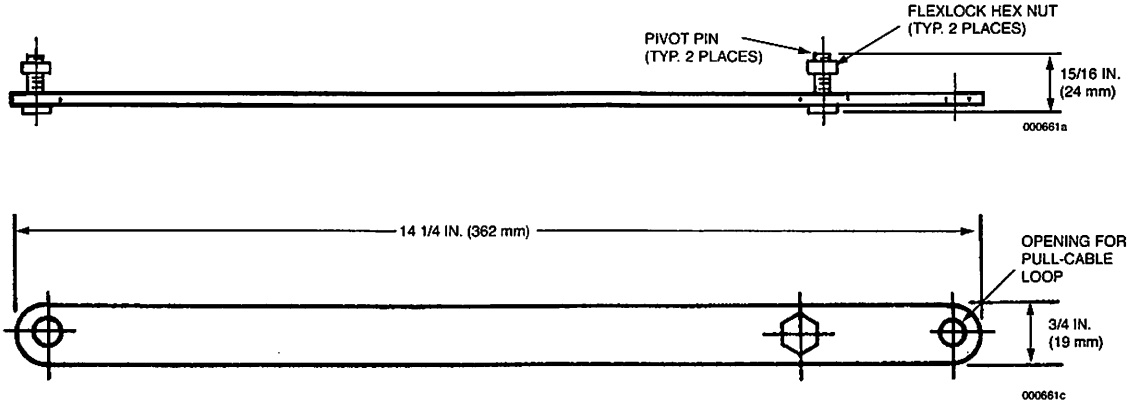


CONNECTING LINK

The connecting link is used to connect the lever releases located on two (2) CV-98 valve pilot cylinders. An opening in the end of the connecting link allows connection of the wire rope for pull-cable actuated systems.

Component	Material
Connecting Link	Steel (Painted Red)

Shipping Assembly Part No.	Description
42514	Connecting Link for CV-98 Lever Release Actuator



MANUAL PULL BOX

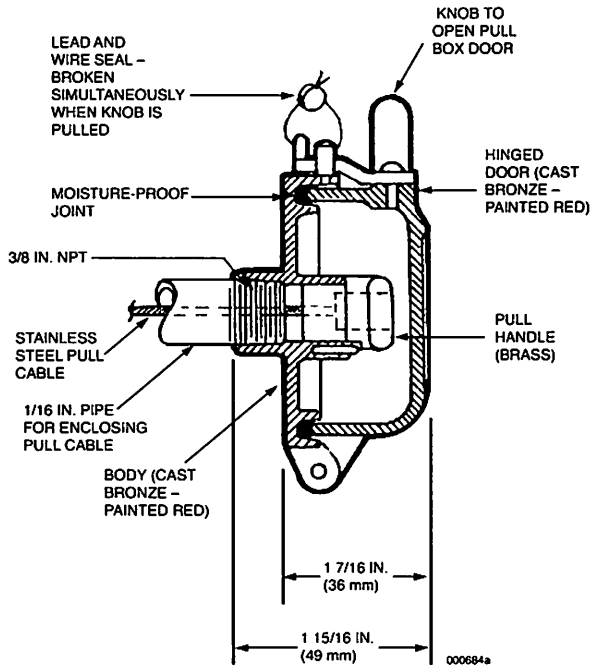
The pull box on a SAPPHIRE system is used to provide mechanical release of the system from a manually operated remote station. Two types of pull boxes are available. The latched door type has a solid cast brass door which must be opened to reach the pull handle. The second type has a break glass window and a spring mounted handle which rotates forward for use when the glass is broken. A 3/8 in. female NPT opening is provided at the back of each enclosure for connection of the cable housing. Both types are painted red.

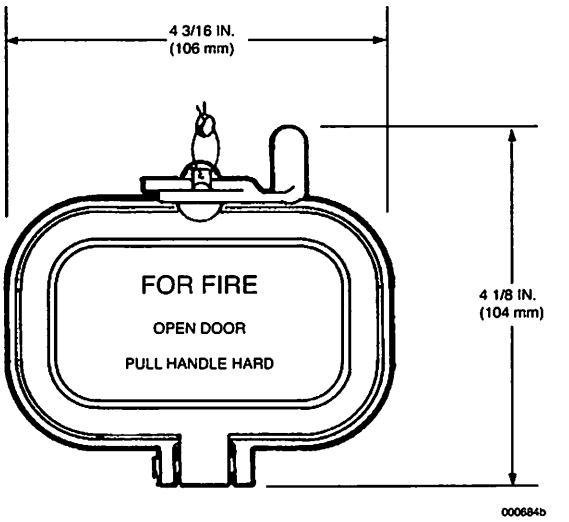
A pulley elbow may be attached directly to the back of the pull box, if necessary, to provide immediate changes in pull cable direction. With this option, the pull box can be extended an additional 3 1/2 in. (89 mm) from the mounting surface by using support legs attached to the back of the pull box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

Component	Material
Latch door pull box	Brass (painted red)
Break glass window pull box	Brass (painted red)
Support legs	Brass (painted red)

Shipping Assembly Part No.	Description
45062	Latch Door Type Pull Box
41527	Break-Glass Window Pull Box
41542	Support Legs

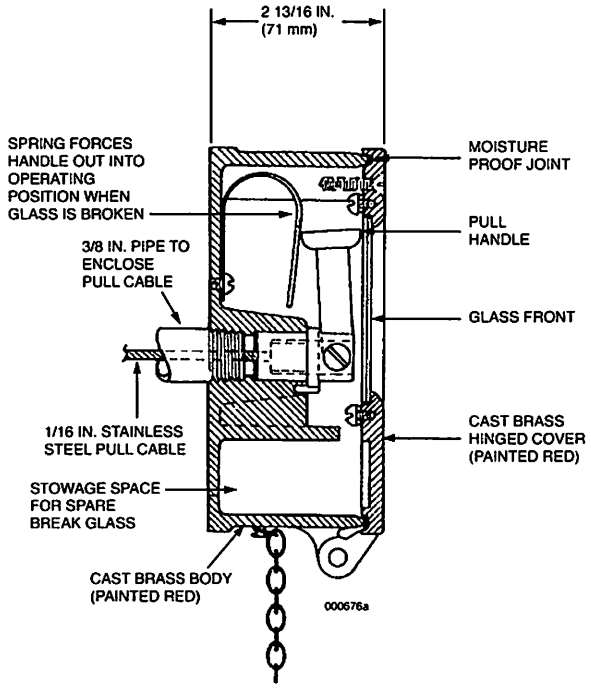
Manual Pull Box Latched Door Type – Part No. 45062

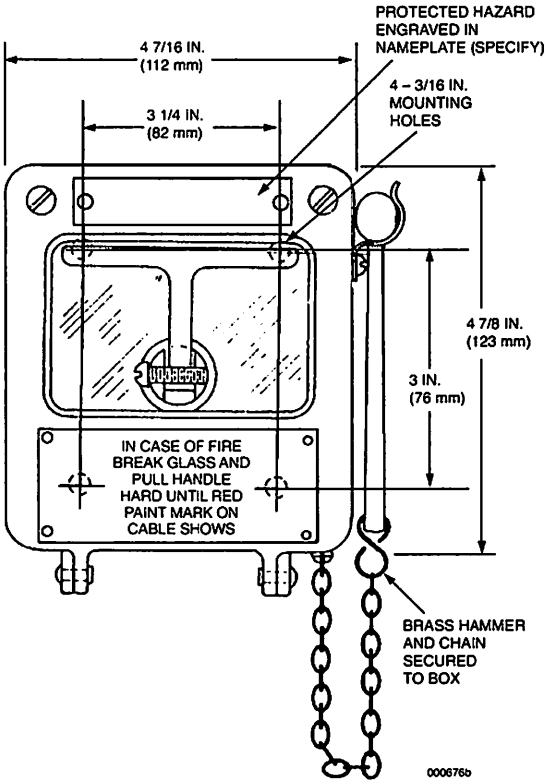




MANUAL PULL BOX (Continued)

Manual Pull Box Break Glass Type "A" – Part No. 41527



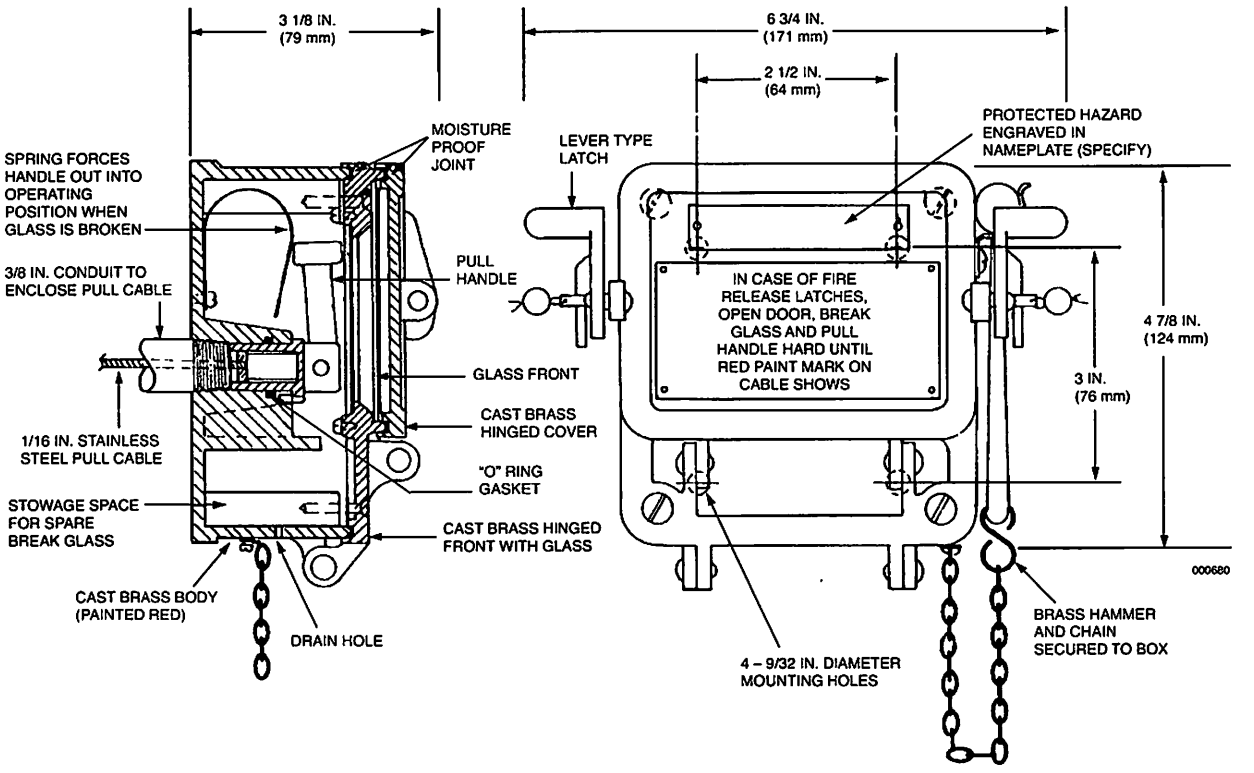


COMBINATION LATCH AND BREAK GLASS PULL BOX

The pull box on a SAPPHIRE system provides mechanical release of the system or directional valve from a manually operated remote station. To operate, release both latches and open the door. Break the glass with the hammer attached to side of box. When the glass is broken, a spring rotates the handle forward for a straight pull.

Component	Material
Latch door pull box	Brass (painted red)
Watertight latch-type pull box	Brass (painted red)

Shipping Assembly Part No.	Description
43827	Latch Type Pull Box
42329	Type "B" Latch Type Pull Box (watertight)

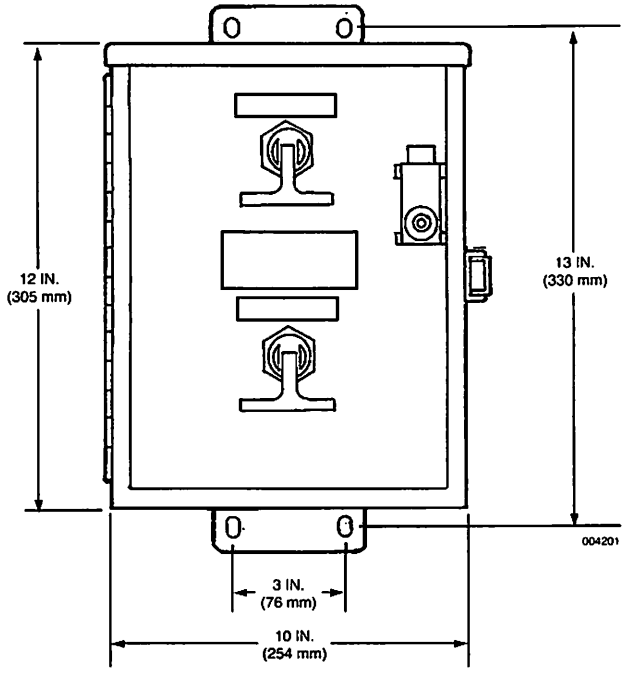


ENCLOSED DOUBLE CABLE PULL BOX WITH MICROSWITCH

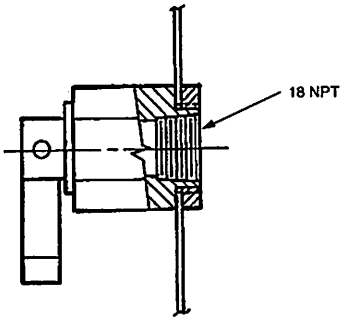
The double pull box on a SAPPHIRE system provides mechanical release of the pilot cylinders and the stop valve from a manually operated remote station. To reach the pull handles, release the cover latch and open the door. When the door opens, the microswitch activates the system alarm and system indicators or devices. Pull the CYLINDER RELEASE handle to open the pilot cylinders. Pull the VALVE RELEASE handle to open the selector valve to the protected space.

Component	Material
Double Pull Box	Steel
Cable Pull	Brass
Enclosed Assembly	

Shipping Assembly Part No.	Description
426312	Enclosed Double Cable Pull Box with Microswitch



INSIDE VIEW SHOWING CABLE PULLS AND MICROSWITCH
6 IN. (152 mm) DEEP



SIDE VIEW OF CABLE PULL

CABLE WITH SWAGED END FITTING

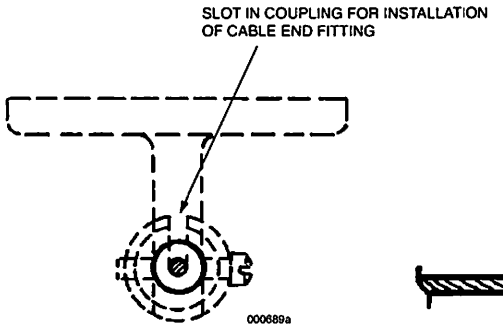
The 1/16 in. diameter cable is used to attach remote manual pull boxes to cylinder valves, pull equalizers and control boxes. The cable is constructed of stranded, stainless steel wire. The cable is available in lengths of 50, 100, and 150 ft. (15.2, 30.5, and 45.7 m). The cable assemblies include a brass swaged end fitting for attaching to the remote pull box.

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

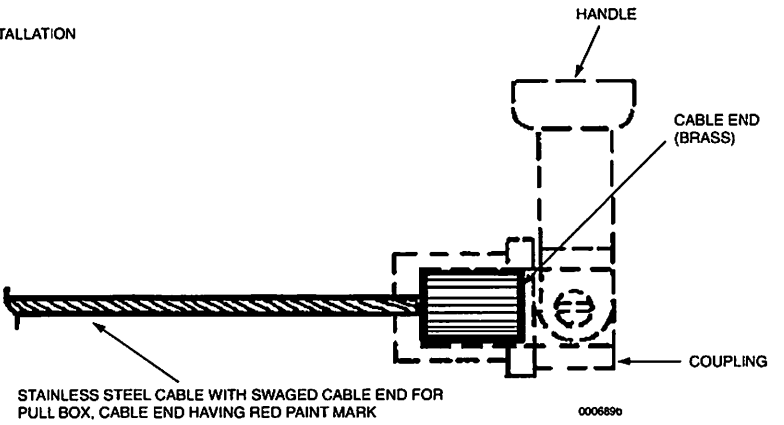
The Flared End Fitting provides a smooth transition on the end of a pipe run for the pull cable. When the wire rope exits the pipe to connect to lever actuators on pilot cylinders, selector valves, or globe valves the fitting prevents chaffing of the wire rope due to sharp edges on the end of the pipe. Use the flared end fitting on pipe ends any time the wire rope extends beyond the piping.

Component	Material
Cable	Stainless Steel
Swaged Fitting	Brass
Cable Assembly	

Shipping Assembly Part No.	Description
42104	50 ft. (15.2 m) 1/16 in. (16 mm) Cable with Swaged End Fitting
42109	100 ft. (30.5 m) 1/16 in. (16 mm) Cable with Swaged End Fitting
42113	150 ft. (45.7 m) 1/16 in. (16 mm) Cable with Swaged End Fitting
45333	1/16 in. (16 mm) Cable Clamp
40060	Flared End Fitting



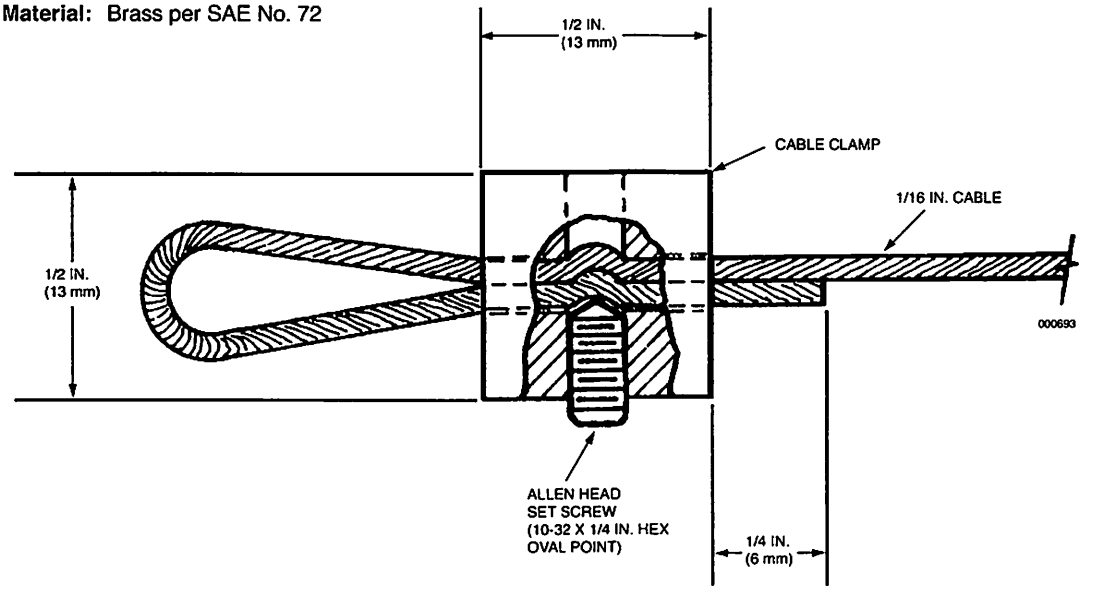
NOTE: The strength of the end fitting exceeds the breaking point of the cable.



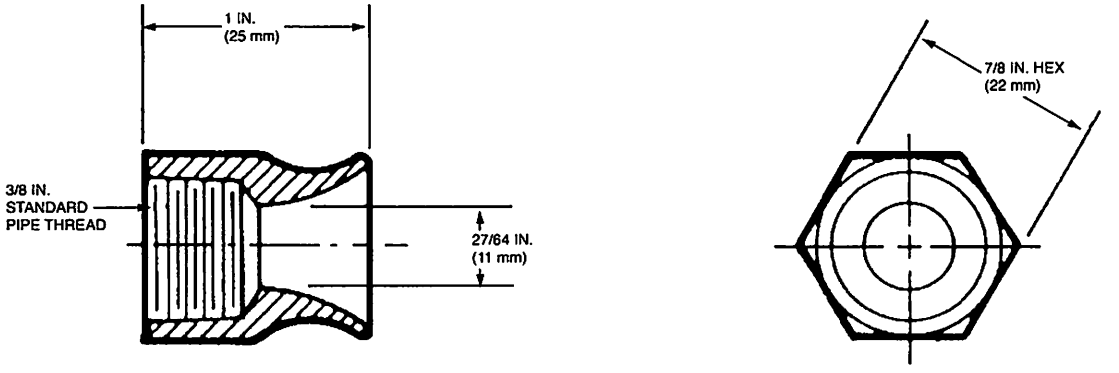
CABLE WITH SWAGED END FITTING (Continued)

CABLE CLAMP (PART NO. 45333)

Material: Brass per SAE No. 72



FLARED END FITTING (PART NO. 40060)



CORNER PULLEY

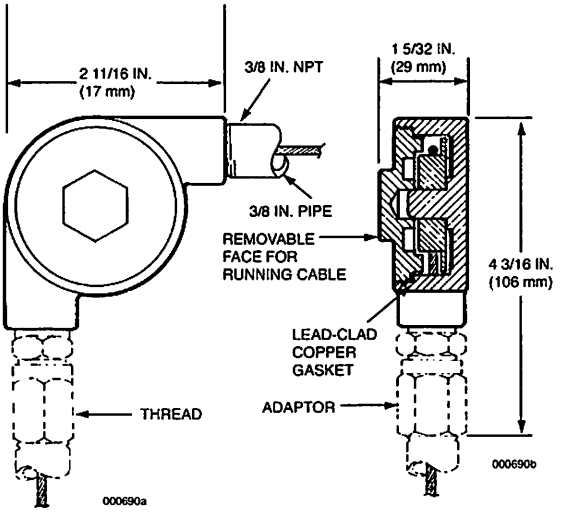
The corner pulley is required on a SAPPHIRE system whenever a mechanical release pull cable run involves a change in direction. Corner pulleys are installed as part of the cable housing (pipe) and provide 90° direction changes with minimal force loss and no induced kinking.

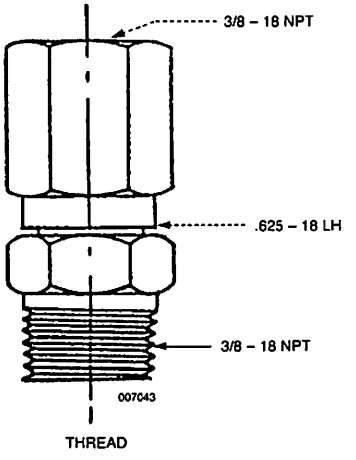
The corner pulley is made of forged brass and is threaded for 3/8 in. NPT pipe. The pulley is watertight and is designed for location inside or outside the protected space. Thread adaptors are available to simplify the installation.

Component	Material	Thread Size/Type
Corner Pulley – Brass	Brass	3/8 in. NPT
Thread Adaptor	Brass	–

Shipping Assembly Part No.	Description
45515	Brass Corner Pulley (brass wheel)
40696	Thread Adaptor – right/left hand

Forged Brass Watertight Corner Pulley, Sheave Type, Part No. 45515





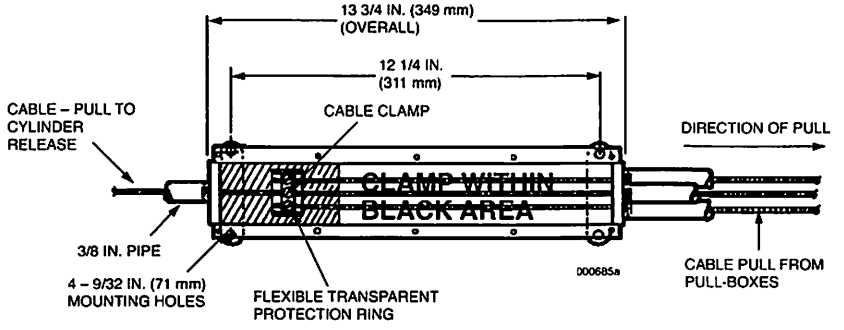
DUAL/TRIPLE CONTROL BOXES

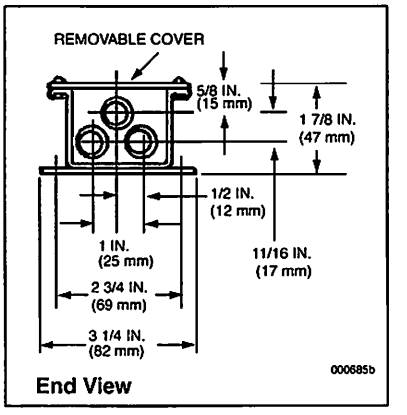
The dual/triple control boxes allow manual actuation of a cylinder valve from two or three remote pull stations. Two styles of control boxes are available. Part No. 42784 is 13 3/4 in. (349 mm) and Part No. 43166 is 20 3/4 in. (527 mm) long. Both styles can be used for cylinder valve actuation. Only the longest control box, Part No. 43166, can be used for valves utilizing sectors (globe valves). The inlet and outlet connections are threaded for 3/8 in. pipe.

Component	Material	Thread Size/Type
Control Box (short)	Steel	3/8 in. NPT Female
Control Box (long)	Steel	3/8 in. NPT Female

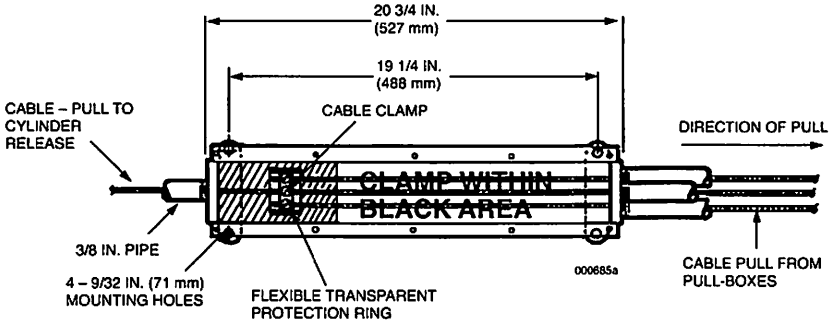
Shipping Assembly Part No.	Description
42784	Dual/Triple Control Box (short)
43166	Dual/Triple Control Box (long)

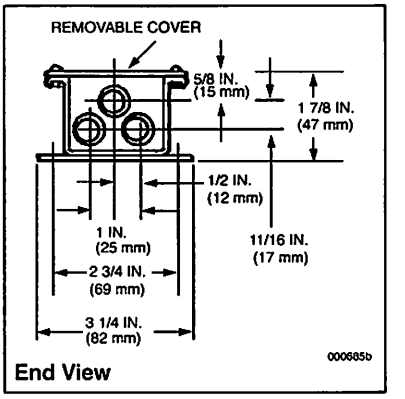
Short Control Box (Shown Without Cover), Part No. 42784





Long Control Box (Shown Without Cover), Part No. 43166





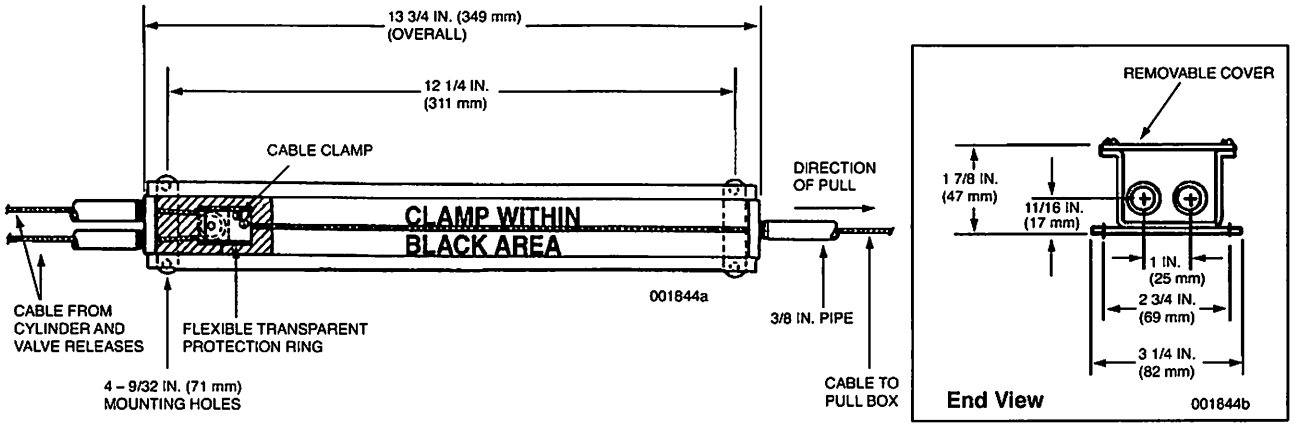
REMOTE CABLE PULL EQUALIZER

The remote cable pull equalizer is used in systems where manual actuation of the pilot cylinder valve and operation of a selector valve must be accomplished at the same time. The pull equalizer is mounted in the remote pull station cable line. By pulling the remote pull box, the cable attached to the pull equalizer will pull the internal cable clamp in the pull equalizer which in turn will pull the cables attached to the cylinder valve and selector valve, causing them to operate. Two styles of pull equalizers are available. Part No. 42791 is 13 3/4 in. (349 mm) long and Part No. 43168 is 20 3/4 in. (527 mm). Only the longest equalizer, Part No. 43168, can be used for valves utilizing sectors. The inlet and outlet connections are threaded for 3/8 in. pipe.

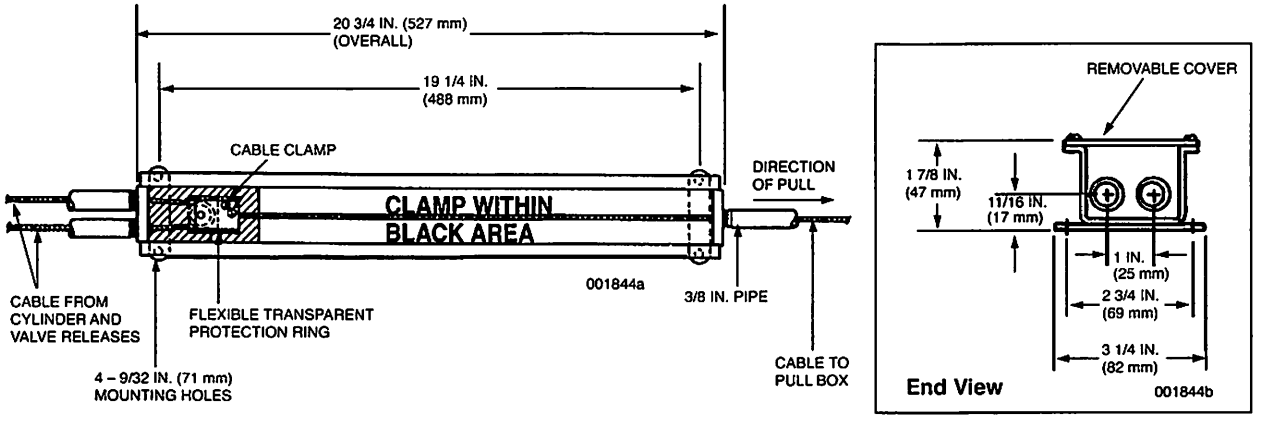
Component	Material	Thread Size/Type
Pull Equalizer (short)	Steel	3/8 in. NPT Female
Pull Equalizer (long)	Steel	3/8 in. NPT Female

Shipping Assembly Part No.	Description
42791	Remote Cable Pull Equalizer (short)
43168	Remote Cable Pull Equalizer (long)

Short Equalizer Box (Shown Without Cover), Part No. 42791



Long Equalizer Box (Shown Without Cover), Part No. 43168



MARINE ACTUATION STATION – TWO STEP – (S.O.L.A.S.)

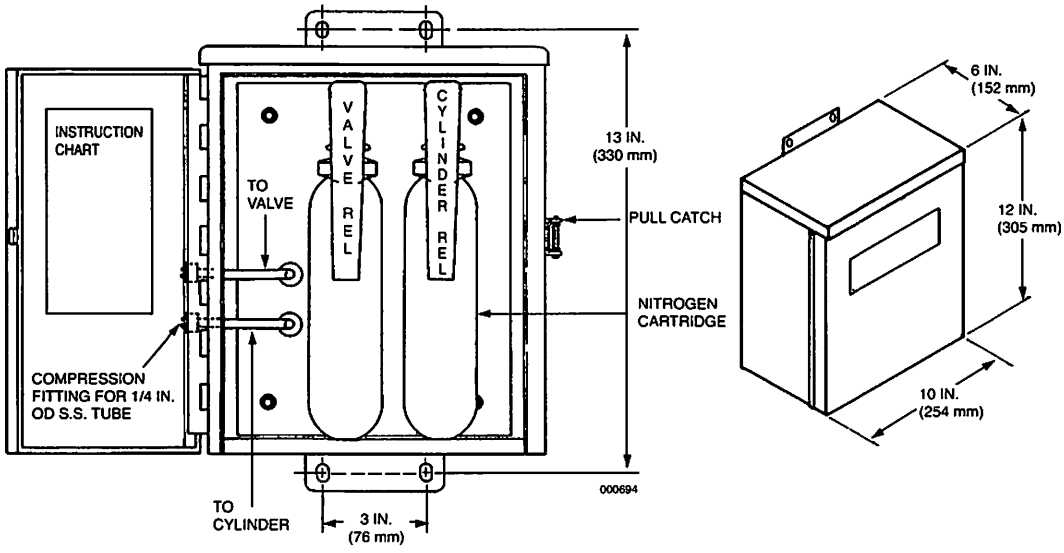
The marine actuation station is used to release the system pilot cylinders by means of compressed nitrogen gas. This is accomplished by pulling the operating handle marked CYLINDER RELEASE which punctures the nitrogen cartridge, allowing the gas to flow to a pilot port located on the pilot cylinders, and pulling the operating handle marked VALVE RELEASE which punctures the nitrogen cartridge, allowing the gas to flow to a pressure operated stop valve.

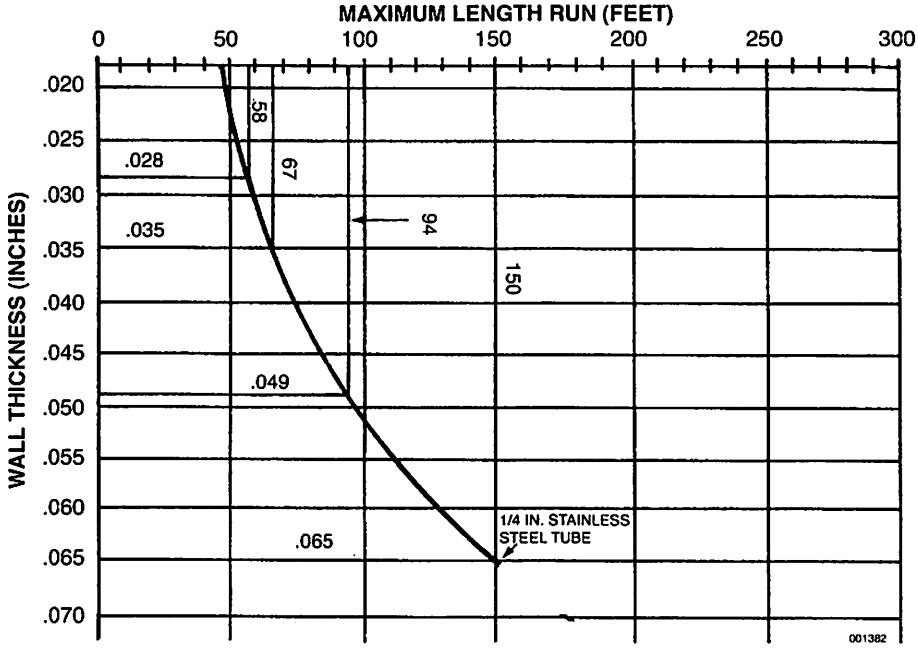
The marine actuation station comes equipped with 1/4 in. stainless steel compression fittings for attaching 1/4 in. O.D. stainless steel tubing. The enclosure is rainproof, constructed of 16 ga. galvanized steel and is equipped with a draw pull catch.

Actuation pressure is achieved by means of an LT-20-L Nitrogen cartridge, Part No. 7012.

Component	Material	Finish
Marine Actuation Station – Two Step	Steel	Red Epoxy Paint

Shipping Assembly Part No.	Description
418731	Marine Actuation Station – Two Step
7012	LT-20-L Nitrogen Cartridge





MAXIMUM LENGTH OF ACTUATION TUBING FROM REMOTE STATION TO CYLINDERS

NOTE: Actuation Line Vent, Part No. 28037, must be utilized in actuation line near system actuator.

MARINE ACTUATION STATION – ONE STEP

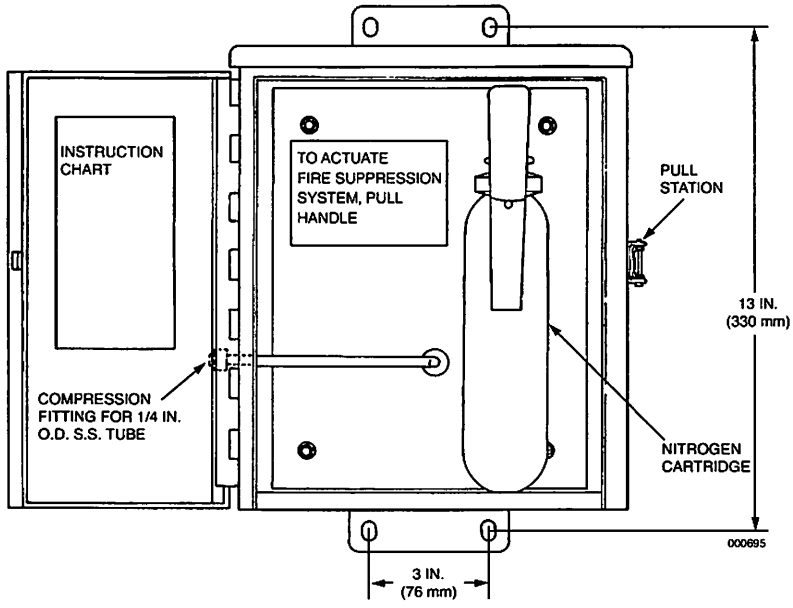
The marine actuation station is used to release the system pilot cylinders. Actuation is accomplished simply by pulling on the handle which allows pressurized nitrogen flow through 1/4 in. O.D. S.S. tube to a pressure actuator located on the carbon dioxide valve. The marine actuation station comes equipped with a 1/4 in. stainless steel compression fitting for attaching 1/4 in. O.D. stainless steel tube.

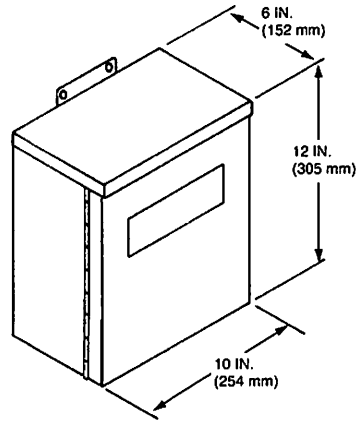
The enclosure is 16 ga. galvanized steel, rainproof, and equipped with a draw pull catch.

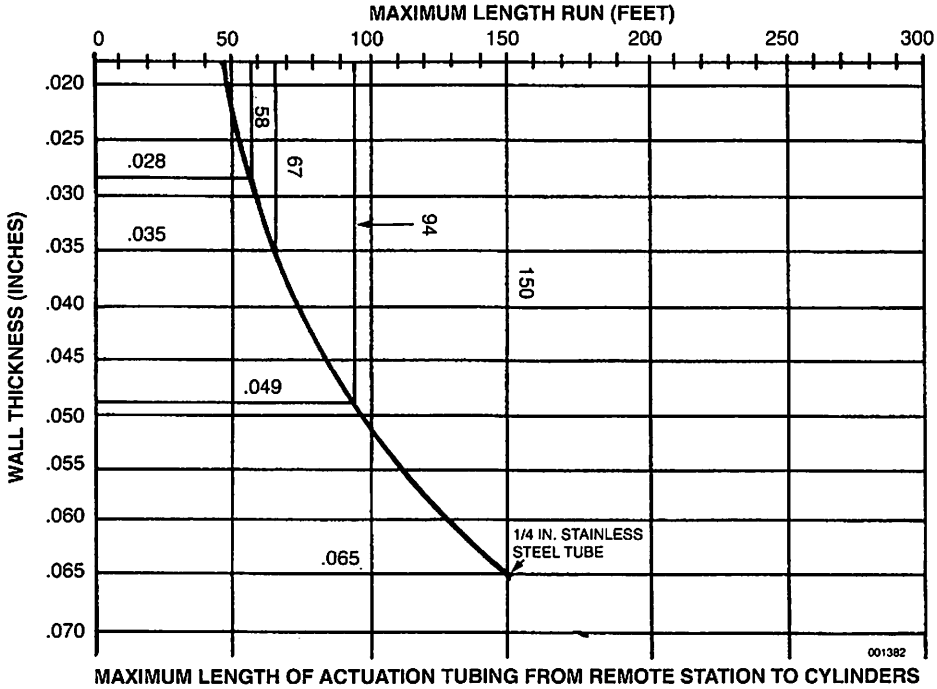
Actuation pressure is achieved by means of an LT-20-L nitrogen cartridge, Part No. 7012.

Component	Material	Finish
Marine Actuation Station – One Step	Steel	Red Epoxy Paint

Shipping Assembly Part No.	Description
67686	Marine Actuation Station – One Step
7012	LT-20-L Nitrogen Cartridge







MAXIMUM LENGTH OF ACTUATION TUBING FROM REMOTE STATION TO CYLINDERS

NOTE: Actuation Line Vent, Part No. 28037, must be utilized in actuation line near system actuator.

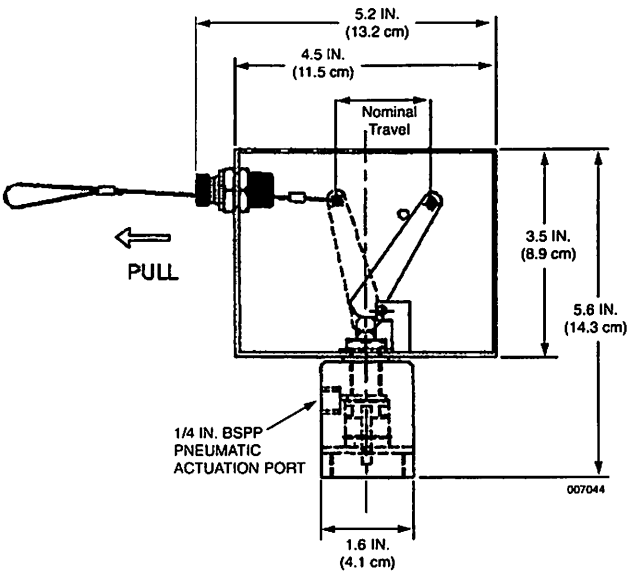
CABLE/PNEUMATIC ACTUATOR (SINGLE AGENT TANK)

The Cable/Pneumatic Actuator (Single Agent Tank), Part No. 570392, can be utilized to manually (cable pull) actuate a single FM-200 agent tank from a remote location.

Component	Material
Body	Brass CZ121
Actuator Pin	Stainless Steel
Cable Arm	Brass CZ121
Actuator Housing	Brass CZ121
Safety Pin	Stainless Steel
Pipe Connection	1/4 in. BSPP Female
Stroke	.31 in. – .33 in. (1.2 – 1.3 mm)
Arm Travel Distance:	1.6 in. (40 mm) Nominal Travel
Proof Pressure	4350 psi (300 bar)
Min. Actuation Pressure	30 psi (2 bar)

In order to adapt to NPT inlet threads, a male adaptor is available, Part No. 570342, to adapt from 1/4 in. BSPP to 1/4 in. NPT.

Component	Material
Male Adaptor 1/4 in. Male BSPP to 1/4 in. Male NPT	Brass

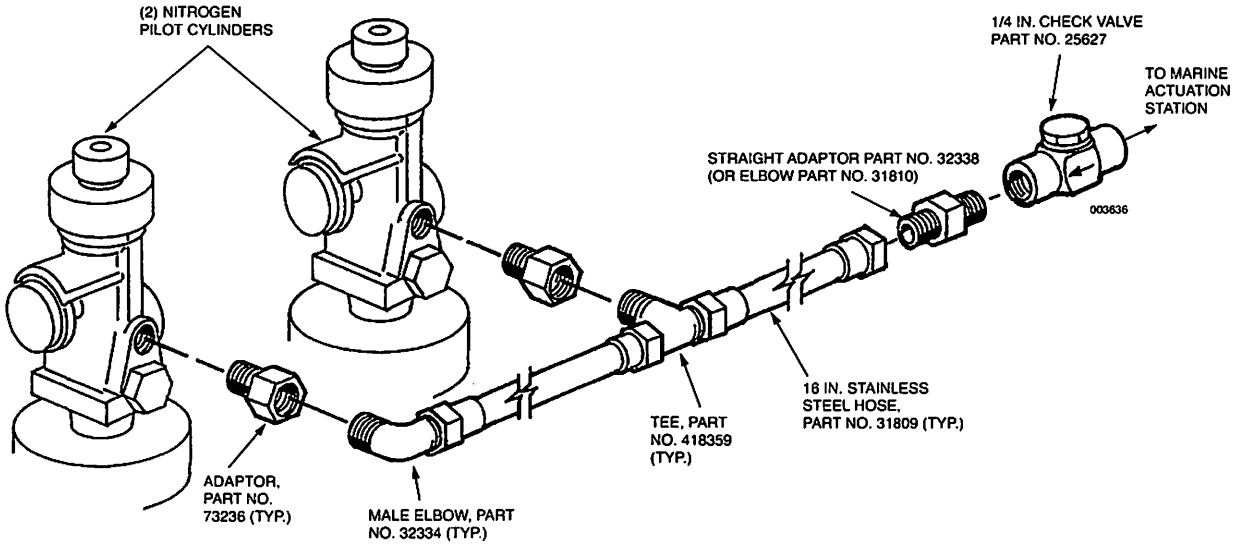


PILOT VALVE ACTUATION COMPONENTS – PNEUMATIC ACTUATION

The pilot valve actuation components are required to attach the 1/4 in. piping from the marine actuation station(s) to the pilot cylinders.

Component	Material
Pilot valve actuator adaptor	Brass
Male elbow	Brass
Flared tee	Brass
1/4 in. stainless steel hose	Stainless Steel
Straight adaptor	Brass
1/4 in. check valve	Brass

Shipping Assembly Part No.	Description
73236	Pilot Valve Actuator Adaptor
32334	Male Elbow
418359	Flared Tee
31809	16 in. Stainless Steel Hose
32338	Straight adaptor
25627	1/4 in. Check Valve
433098	Nitrogen Pilot Cylinder

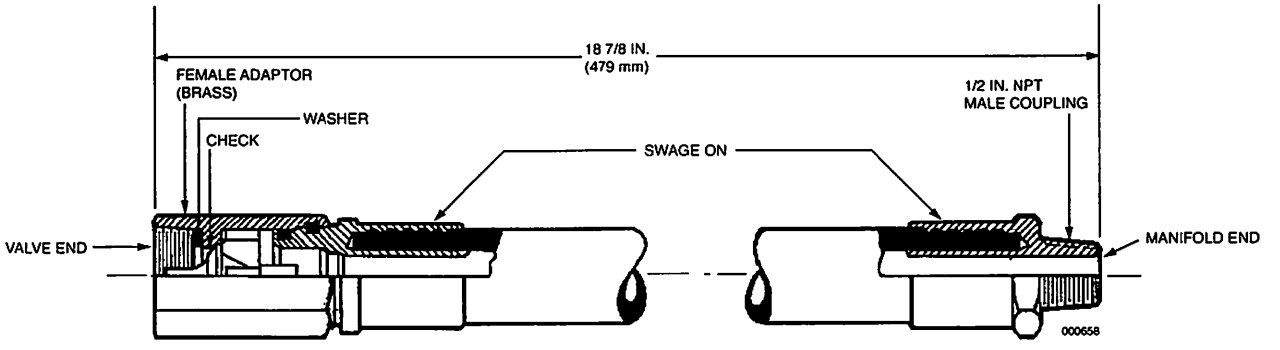


PILOT CYLINDER FLEXIBLE DISCHARGE BEND

The valve Flexible Discharge Bend (Part No. 427082) is a 5/8 in. (16 mm) I.D. extra-heavy flexible hose which connects the valve discharge outlet to the pilot cylinder manifold. The discharge bend has a special female thread for connecting to the valve outlet and a male 1/2 in. NPT thread for connecting to the fixed piping or manifold. The discharge bend will withstand a pressure of 9000 psi (620.5 bar). Its flexible connection allows for easy alignment. Each bend has a built-in check valve that prevents loss of agent should the system discharge while any cylinder is removed.

Component End	Material	Thread Size/Type Valve End	Manifold
5/8 in. Flexible Discharge Bend	SAE 100 R2 Hose Type AT	Special to mate with CV-98 Valve	1/2 in. NPT Male

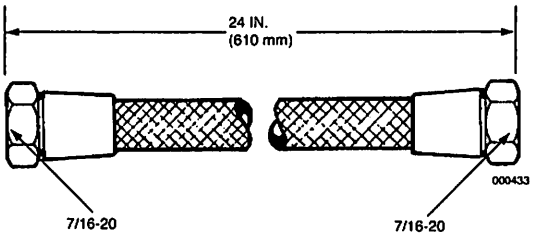
Shipping Assembly Part No.	Description
427082	Flexible Discharge Bend
42430	Washer



STAINLESS STEEL ACTUATION HOSE

The Stainless Steel Actuation Hose is used to connect the actuation line compression tees between each agent tank. The hose has the same thread, 7/16-20, as the compression tees. The actuation hose allows flexibility between the rigid actuation piping and the tank valve.

Component	Material	Thread Size/Type
Stainless Steel Hose	Stainless Steel	Female 7/16-20 (Both ends)



Shipping Assembly Part No.	Description
31809	16 in. (406 mm) Stainless Steel Hose
32335	20 in. (508 mm) Stainless Steel Hose
32336	24 in. (609 mm) Stainless Steel Hose

Additional actuation fittings are available:

Part No.	Description
31810	Male Elbow (7/16-20 x 1/4 in. NPT)
31811	Male Tee (7/16-20 x 7/16-20 x 1/4 in. NPT)
32338	Male Straight Connector (7/16-20 x 1/4 in. NPT)
418359	Flared Tee (7/16 – 20 x 7/16 – 20 x 1/8 in. NPT)
73236	Pilot Valve Actuation Adaptor
32334	Male Elbow (7/16 – 20 Flare x 1/8 in. NPT)
570342	Male Adaptor (1/4 in. male BSP x 1/4 in. male NPT)

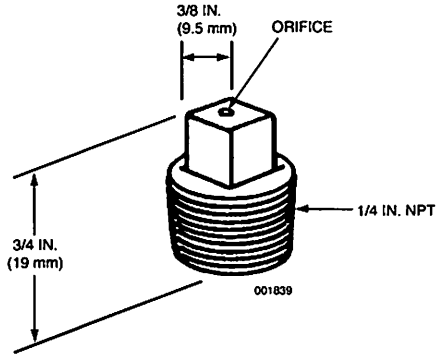
1/4 IN. PRESSURE BLEEDER PLUG AND 1/4 IN. VENT FITTING

The pressure bleeder plug and vent fitting can be used to relieve the pressure in closed actuation lines. The plug and vent relieves the pressure through a small orifice. This slow relief of pressure does not affect the function of the actuation line.

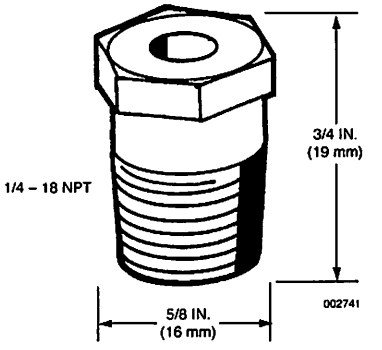
Component	Material	Thread Size/Type
Bleeder Plug	Brass	1/4 in. NPT Male
Vent Fitting	Brass	1/4 in. NPT Male

Shipping Assembly Part No.	Description
42175	Pressure Bleeder Plug
28037	Actuation Line Vent Fitting

1/4 in. Pressure Bleeder Plug



1/4 in. Vent Fitting



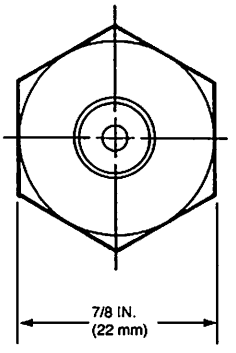
HEADER VENT PLUG

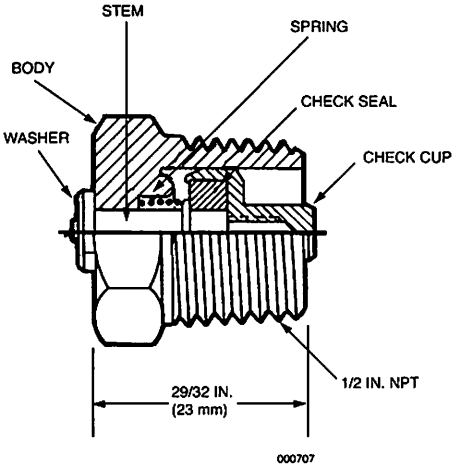
The header vent plug is used to release low pressure buildup that may occur in a closed system utilizing stop valves or check valves. The header vent plug should also be installed on the cylinder sides of the check valves on both main and reserve systems to relieve any pressure that may leak past the check valve and accidentally actuate the reserve system while the main system is discharging.

Closing pressure is 30 psi (2.1 bar).

Component	Material	Thread Size/Type
Vent Plug	Body: Brass	1/2 in. NPT Male
	Spring: Bronze	
	Seal: Neoprene	

Shipping Assembly Part No.	Description
40309	Header Vent Plug





1/2 IN. MANIFOLD PILOT RELIEF VALVE

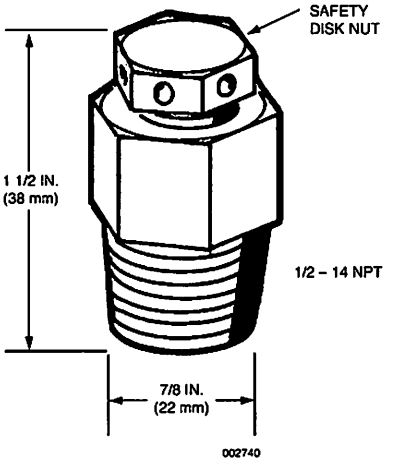
The manifold pilot relief valve will release pressure buildup in the manifold line. This slow release of pressure does not affect the function of the manifold line.

Burst Pressure: 2,900 – 3,360 psi (200 – 232 bar)

Component	Material
1/2 in. Manifold Relief Valve	Brass

Shipping Assembly Part No.	Description
418378	1/2 in. Pilot Manifold Relief Valve

1/2 In. Manifold Pilot Relief Valve



PRE-DISCHARGE TIME DELAY (PART NO. 417504)

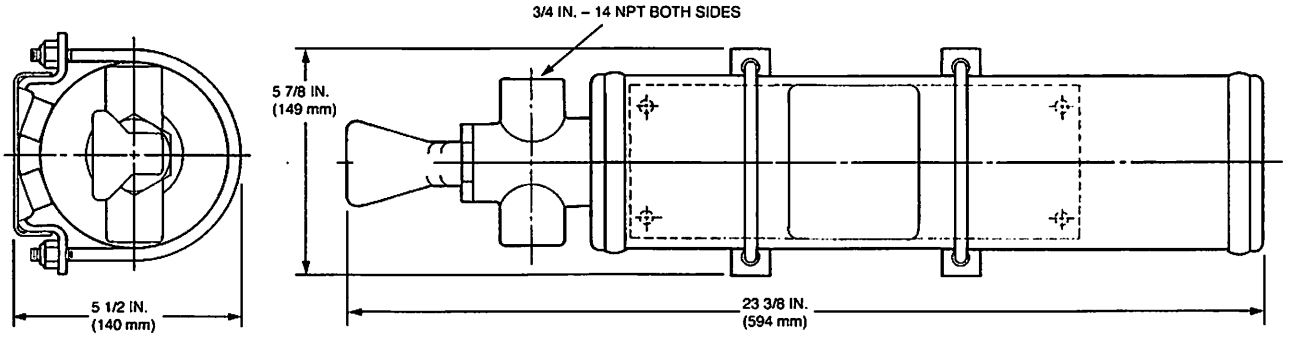
The system discharge must be delayed for a short time following actuation. This is usually in areas where it is necessary to evacuate personnel prior to discharge. A manual release is incorporated on the time delay valve to allow instant override of the time delay. The length of delay is factory set and is not adjustable.

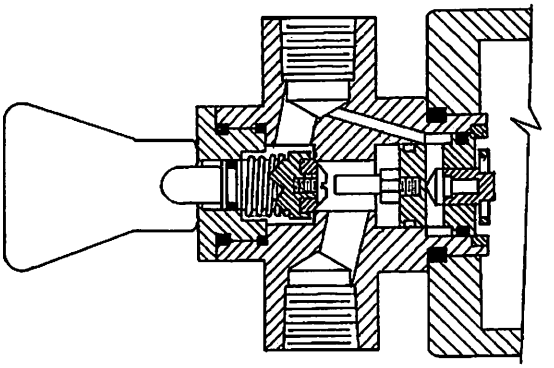
The time delay assembly uses nitrogen pressure to power the factory-set delay mechanism. Install the assembly in the discharge piping, either directly after the control (pilot) cylinder or further along the piping. The assembly is reversible to accommodate right and left hand configurations and will operate in any mounting orientation. After the discharge is complete, pressure in the assembly slowly returns to normal and closes the time delay valve.

Shipping Assembly Part No.	Description
426170	60 Second time delay
54169	30 Second time delay

Component	Material
Valve	Brass
Accumulator	Steel (Sch. 80 Pipe)

Time Delay Assembly





CROSS SECTION OF VALVE 004372

3/4 IN. PRESSURE ACTUATED STOP/ISOLATION VALVE (PART NO. 418596)

Material: Brass

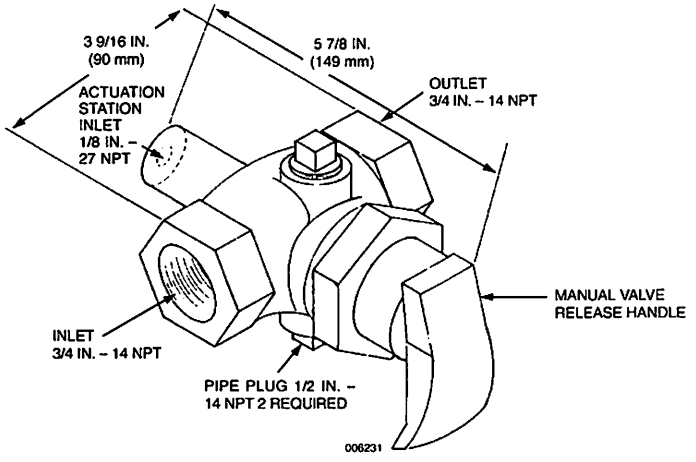
The 3/4 in. pressure actuated stop/isolation valve is used in conjunction with pilot actuation systems, and can be used to isolate pressure operated alarms and shut down devices.

There are three methods of opening the 3/4 in. pressure actuated valve:

1. By applying pressure into the 1/8 in. NPT port located in the rear of the valve.
2. By applying pressure at the outlet side of the valve.
3. By pulling on the manual release handle located on the front of the valve.

The 3/4 in. pressure actuated stop/isolation valve is designed to withstand a minimum burst pressure of 6000 psi (41370 kPa) and is tested to a working pressure, with carbon dioxide, of 900 psi (6206 kPa).

Two 1/2 in. – 14 pipe plugs (Part No. 52056) should be ordered to complete the assembly



CHECK VALVES – THREADED

Check valves are used in main/reserve systems. On main/reserve systems, the check valve prevents pressurization of the reserve system manifold by blocking the flow of SAPPHIRE System agent from the main system to the reserve system. The check valve allows gas flow from the reserve (if actuated) to pass through into the distribution piping. Only the cylinders needed for the particular hazard are activated.

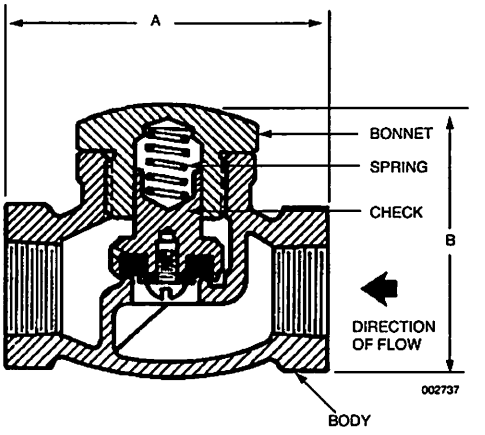
The threaded check valves are available in sizes from 1/4 in. through 2 1/2 in.

Check Valve – Threaded

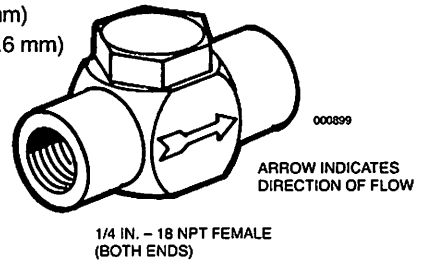
Valve Size	Dimension A in.	(mm)	Dimension B in.	(mm)	Weight	
1/2 in.	3	(76)	2 5/8	(66)	2 lb.	(0.9 kg)
3/4 in.	3 5/8	(92)	3 1/8	(79)	4 lb.	(1.8 kg)
1 in.	4 1/8	(104)	3 3/4	(95)	7 lb.	(3 kg)
1 1/4 in.	5	(127)	4 1/2	(114)	10 lb.	(8.7 kg)
1 1/2 in.	5 1/2	(139)	5 1/8	(130)	13 lb.	(5.9 kg)
2 in.	6 1/2	(165)	6 7/16	(164)	15 lb.	(6.8 kg)
2 1/2 in.	8	(203)	6 3/4	(171)	34 lb.	(15.4 kg)

Shipping Assembly Part No.	Description
25627	1/4 in. Check Valve (pkg. of 2)
40860	1/2 in. Check Valve
40852	3/4 in. Check Valve
41470	1 in. Check Valve
41549	1 1/4 in. Check Valve
41463	1 1/2 in. Check Valve
40649	2 in. Check Valve
40656	2 1/2 in. Check Valve

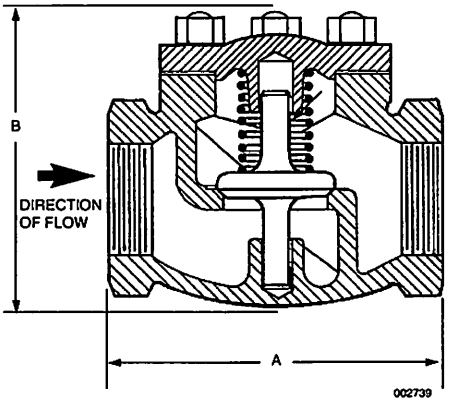
Component Type	Material	Thread Size/Type	Body
Check Valve	Brass	1/4 – 18 NPT Female	Threaded
Check Valve	Bronze	1/2-14 NPT Female	Threaded
Check Valve	Bronze	3/4-14 NPT Female	Threaded
Check Valve	Bronze	1 - 11 1/2 NPT Female	Threaded
Check Valve	Bronze	1 1/4 - 11 1/2 NPT Female	Threaded
Check Valve	Bronze	1 1/2 - 11 1/2 NPT Female	Threaded
Check Valve	Bronze	2 - 11 1/2 NPT Female	Threaded
Check Valve	Bronze	2 1/2 - 8 NPT Female	Threaded



1/4 in. Check Valve (Part No. 25627)
Length: 1 5/8 in. (41.3 mm)
Width: 3/4 in. (19 mm)
Height: 1 1/8 in. (28.6 mm)



2 1/2 in. Check Valve (Part No. 40656)

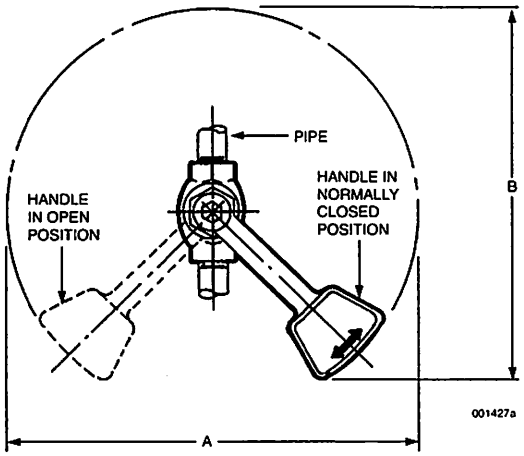


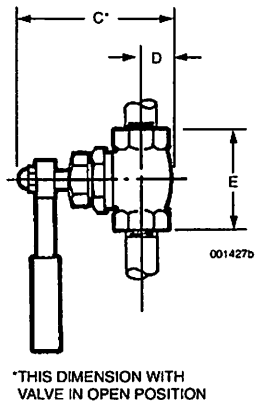
GLOBE VALVES AND CONTROLS

Globe valves are used to either manually control the flow of SAPPHIRE System agent into a hazard area or to manually control the flow into one of several hazards being protected by a common bank of SAPPHIRE System cylinders. These valves are operated manually, either by the use of a hand lever attached directly to the valve or by means of a remote manual pull box which will operate a sector attached to the valve. Globe valves can be used as a safety feature, keeping the flow of agent from entering a hazard area, either because of a false discharge or to allow the occupants enough time to exit the area prior to the valve being manually opened. The valves are available in 1/2 in. and 3/4 in. sizes. Each size can be used with a hand lever or a sector. **Globe valves are installed in pilot lines only.**

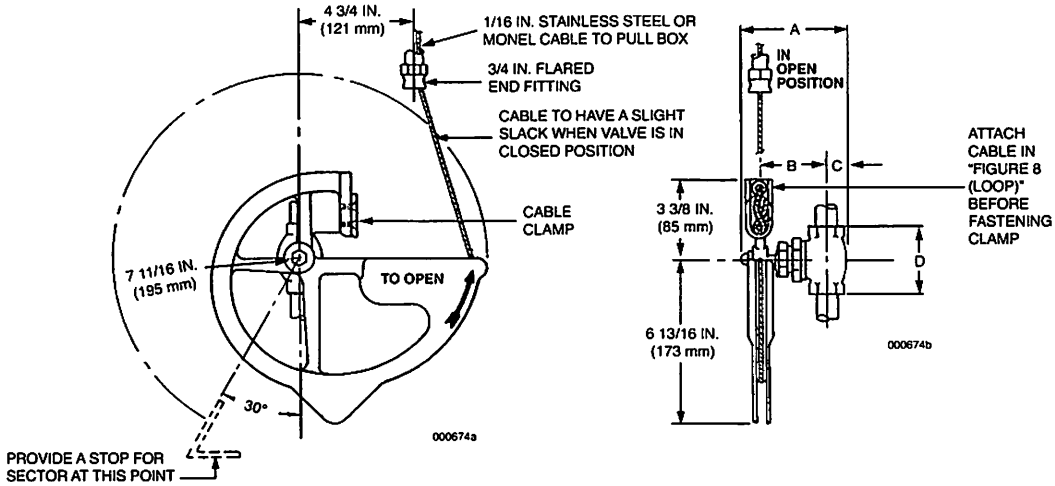
Component	Material	Thread Size/Type
Globe Valve	Forged Brass	1/2 in. NPT Female
Globe Valve	Forged Brass	3/4 in. NPT Female

Shipping Assembly Part No.	Description
41451	1/2 in. direction/stop valve (valve only)
41102	3/4 in. direction/stop valve (valve only)
40248	Handle – normally open (for use with 1/2 in. valve)
40267	Handle – normally open (for use with 3/4 in. valve)
40238	Handle – normally closed (for use with 1/2 in. valve)
40239	Handle – normally closed (for use with 3/4 in. valve)
40276	Sector (for use with 1/2 in. valve)
40279	Sector (for use with 3/4 in. valve)





	A		B		C		D		E	
Valve Size	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
1/2 in.	10	(254)	9 3/8	(238)	4 3/4	(121)	7/8	(22)	2 15/16	(74)
3/4 in.	14	(355)	12 3/4	(323)	5 5/8	(142)	1 1/8	(28)	3 5/8	(92)



	A		B		C		D	
Valve Size	in.	(mm)	in.	(mm)	in.	(mm)	in.	(mm)
1/2 in.	4 3/4	(121)	3	(76)	7/8	(22)	2 15/16	(74)
3/4 in.	5 5/8	(142)	3 5/8	(93)	1 1/8	(28)	3 5/8	(92)

SELECTOR VALVES

Selector valves are used in actuation piping.

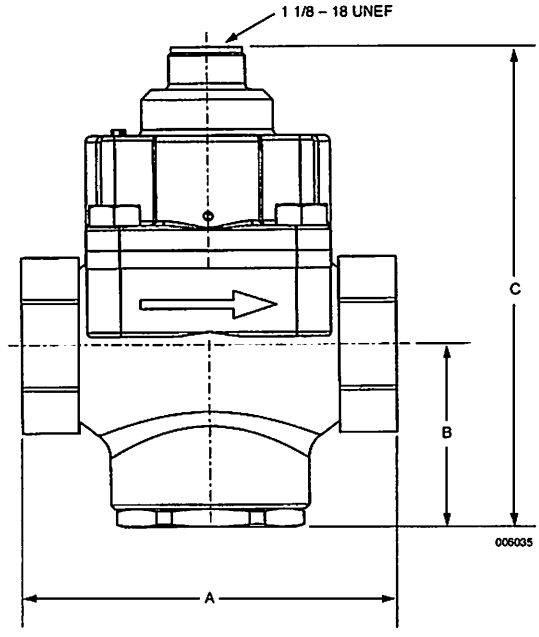
When pneumatic actuation is required for the 1 in. valve, a Stackable Actuator Assembly, Part No. 428566, must be ordered separately.

Selector valves can be manually operated by mounting a lever actuator either directly onto the valve or onto the top of the electric actuator. See Lever Release Actuator Component Sheet for correct actuator.

Component	Material	Thread Size/Type
1 in. Selector Valve (Used for 1/2 in., 3/4 in.) and 1 in. pipe sizes)	Bronze	1 in. NPT Female

Shipping Assembly Part No.	Description
427185	1 in. Selector Valve – threaded

Valve Size	Body	A in.	A (mm)	B in.	B (mm)	C in.	C (mm)
1 in.	Threaded – 1 in. NPT female	5 1/2	(140)	2 9/16	(67)	7	(178)

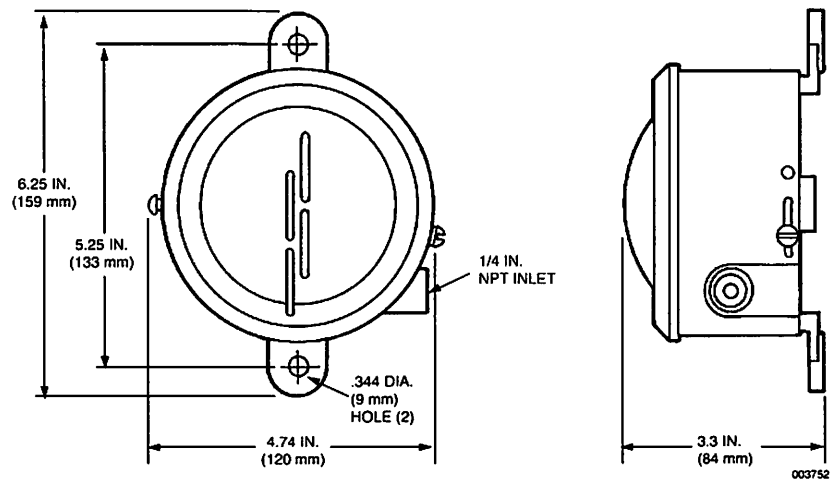


PRESSURE OPERATED SIREN

The pressure operated siren is used to warn personnel of a system discharge. The siren is operated with the nitrogen pressure from the pilot cylinder. The siren will operate at the start of the SAPPHIRE System discharge and will continue through most of the discharge time. The minimum decibel level at 10 ft. (3 m) is 90 dB with a flow rate of 100 cu. ft./minute (2.83 cu. m/minute). A pipe hanger or bracket must be installed within one foot of the siren.

Component	Material	Specifications
Siren	Body: Brass	Required Pipe: 1/4 in., Schedule 40
	Grill: Steel	Maximum Sirens: 4
	Screen: Stainless Steel	Maximum Pipe Length: 200 ft. (61 m) minus 1 ft. (0.3 m) for every elbow used
		Flow Rate: 100 cu. ft./min.
		Design of system must include agent used through siren if siren is not located in hazard area

Shipping Assembly Part No.	Description
419700	Pressure Operated Siren



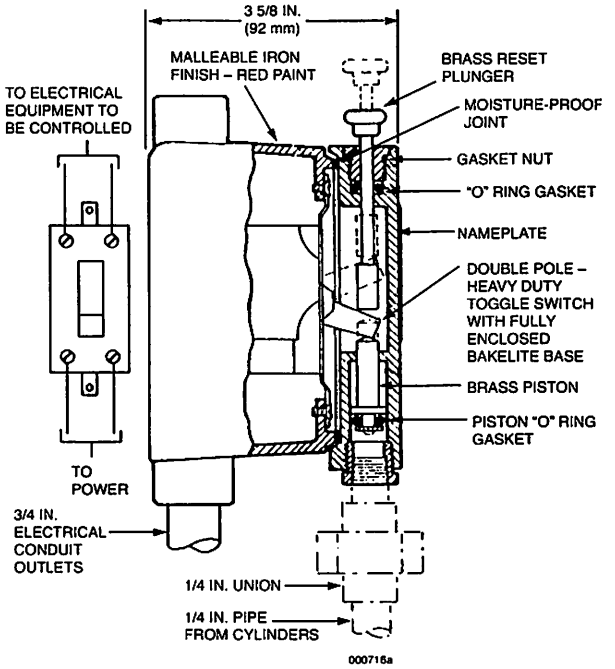
PRESSURE SWITCH – DPST

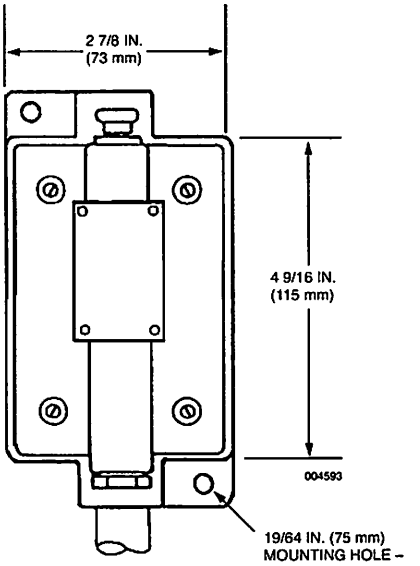
The pressure switch is operated by the nitrogen pressure when the system is actuated. The pressure switch can be used to open or close electrical circuits to either shut down equipment or ventilation systems and turn on lights or alarms. The double pole, single throw (DPST) pressure switch is constructed with a gasketed, water tight housing. The housing is constructed of malleable iron, painted red. A 1/4 in. NPT pressure inlet is used to connect the 1/4 in. pipe from the pilot system.

Minimum operating pressure is 50 psi (3.5 bar).

Component	Material	Thread Size/ Type	Electrical Rating
Pressure Switch VAC DPST	Switch: BAKELITE	Conduit Inlet: 3/4 in. NPT	2 HP – 240 VAC/480
		Female	2 HP – 250 VDC
	Housing: Malleable Iron	Pressure Inlet: 1/4 in. NPT Female	30A – 250V AC/DC
			5A – 480V AC/DC
	Piston: Brass		
	Cover: Brass		

Shipping Assembly Part No.	Description
46250	Pressure Switch – DPST





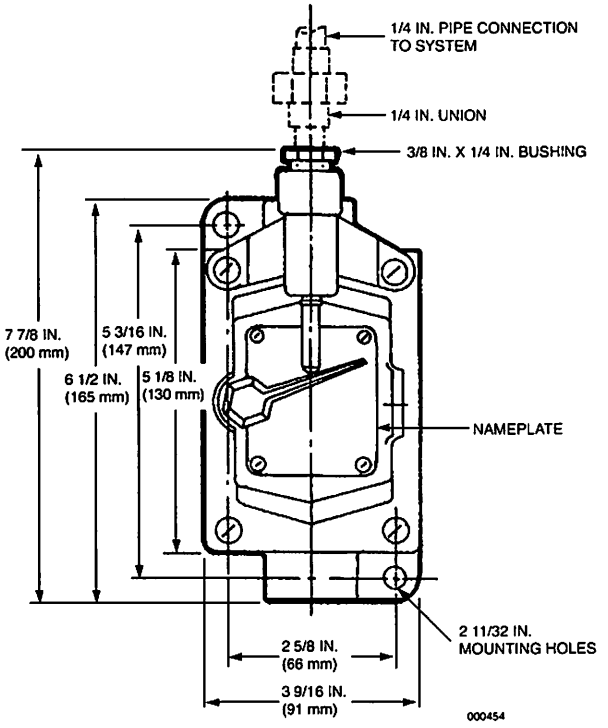
PRESSURE SWITCH DPDT – EXPLOSION-PROOF

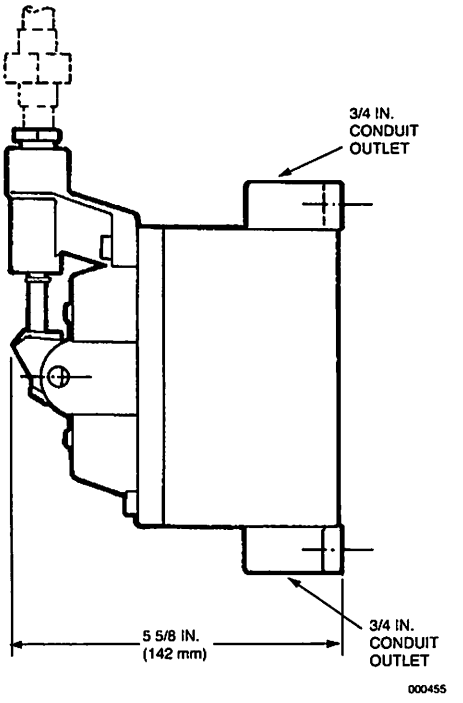
The pressure switch is operated by the nitrogen pressure when the system is actuated. The pressure switch can be used to open or close electrical circuits to either shut down equipment or ventilation systems and turn on lights or alarms. The double pole, double throw (DPDT) pressure switch is constructed with an explosion-proof housing suitable for hazardous environments. A 1/4 in. NPT pressure inlet is used to connect the 1/4 in. pipe from the pilot system.

Minimum operating pressure is 100 psi (6.9 bar).

Component	Material	Thread Size/Type	Electrical Rating
Pressure Switch DPDT	Housing: Malleable Iron	Conduit Inlet: 3/4 in. NPT Female Pressure Inlet: 1/4 in. NPT Female	10A - 125 VAC 5A - 250 VAC

Shipping Assembly Part No.	Description
43241	Pressure Switch – DPDT





NOTE: Suitable for hazardous locations, Class I, Division I, Groups C, D, and Class II, Division I, Groups E, F, G.

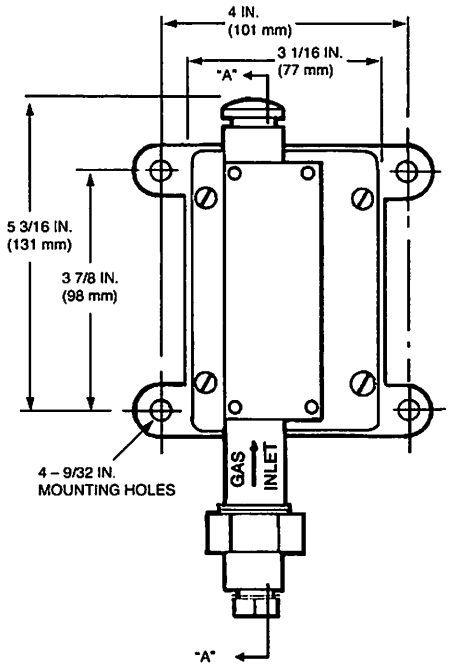
PRESSURE SWITCH – 3PST

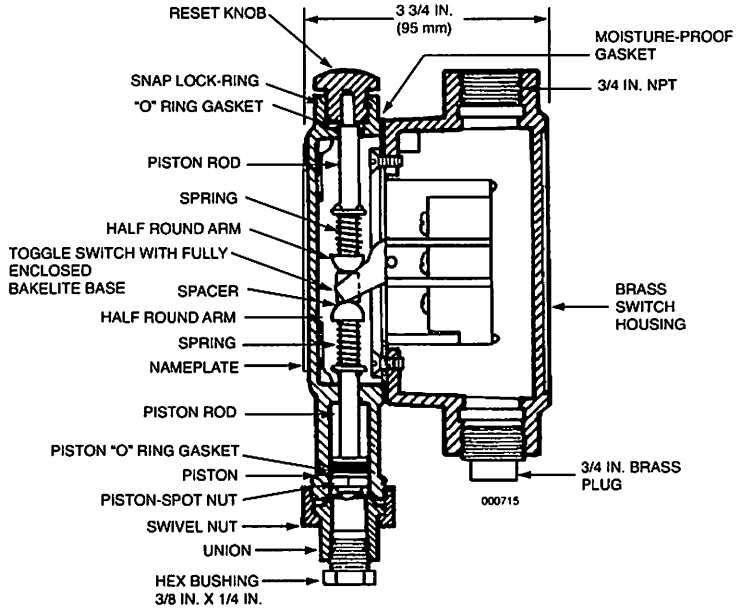
The pressure switch is operated by the nitrogen pressure when the system is actuated. The pressure switch can be used to open or close electrical circuits to either shut down equipment or ventilation systems and turn on lights or alarms. The three pole, single throw (3PST) pressure switch is constructed with a gasketed, water tight housing. The switch may be used for 3 phase wiring requirements. The housing is constructed of malleable iron, painted red. A 1/4 in. NPT pressure inlet is used to connect the 1/4 in. pipe from the pilot system.

Minimum operating pressure is 100 psi (6.9 bar).

Component	Material	Thread Size/Type	Electrical Rating
Pressure Switch 3PST	Switch: BAKELITE	Conduit Inlet: 3/4 in. NPT Female	30A - 240 VAC 20A - 600 VAC
	Housing: Malleable Iron	Pressure Inlet: 1/4 in. NPT Female	3 HP - 120 VAC 7.5 HP - 240 VAC 15 HP - 600 VAC
	Piston: Brass		3 PHASE AC

Shipping Assembly Part No.	Description
42344	Pressure Switch – 3PST





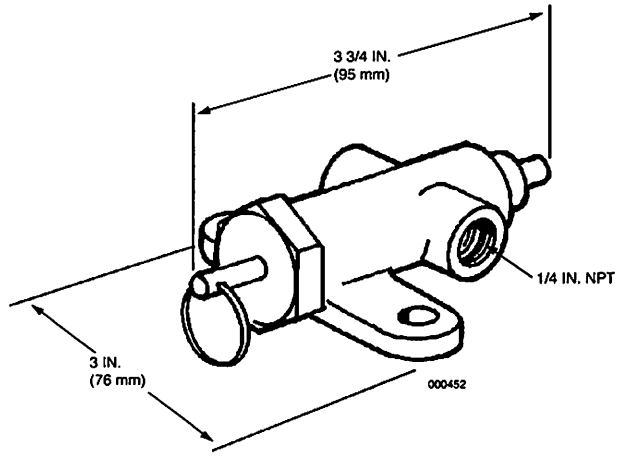
SECTION "A" – "A"

BAKELITE is a trademark of Union Carbide Corp.

PRESSURE TRIP

The pressure trip is connected to the pilot line of a SAPPHIRE system. By either pneumatic or manual actuation, the pressure trip can release spring or weight powered devices to close ventilation dampers, open fuel dump valves, close fire dampers or close fuel supply valves. The pressure trip is constructed of brass with two 1/4 in. NPT fittings for connection to discharge or actuation lines. The link on the pressure switch is released either pneumatically, by agent discharge pressure; or manually, by use of the pull ring. The link then releases the device which performs the auxiliary functions.

NOTE: Operating pressure must be a minimum of 75 psi (5.2 bar) with a maximum load of 70 lbs. (31.8 kg).

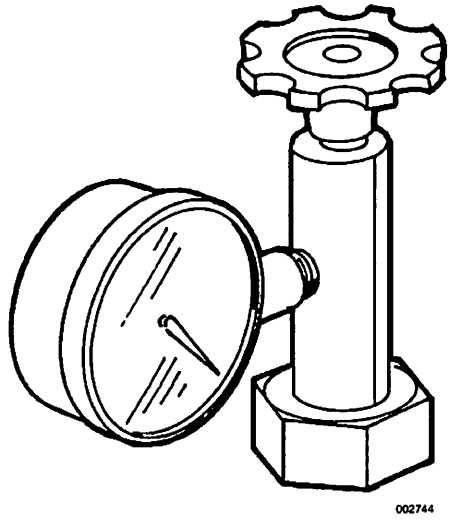


Component	Material	Thread Size/Type
Pressure Trip	Brass	1/4 in. NPT Female

Shipping Assembly Part No.	Description
5156	Pressure Trip

PRESSURE TEST ASSEMBLY

The Pressure Test Assembly, Part No. 423923, is required to properly perform the semi-annual pressure check on the pilot cylinders. The pressure test assembly consists of a calibrated gauge, adaptor, and handwheel. The assembly is attached to the fill port of the pilot cylinder valves. As the handwheel is turned in, the fill port is opened and the pressure is read on the gauge. After verifying the pressure in the cylinder, the handwheel is turned out, closing the fill port and venting the pressure. With the pressure vented, the assembly can be removed.



Component	Material
Handwheel	Cast Zinc Alloy
Body	Brass
Adaptor	Brass
Gauge	Stainless Steel Case Laminated Safety Glass Lens

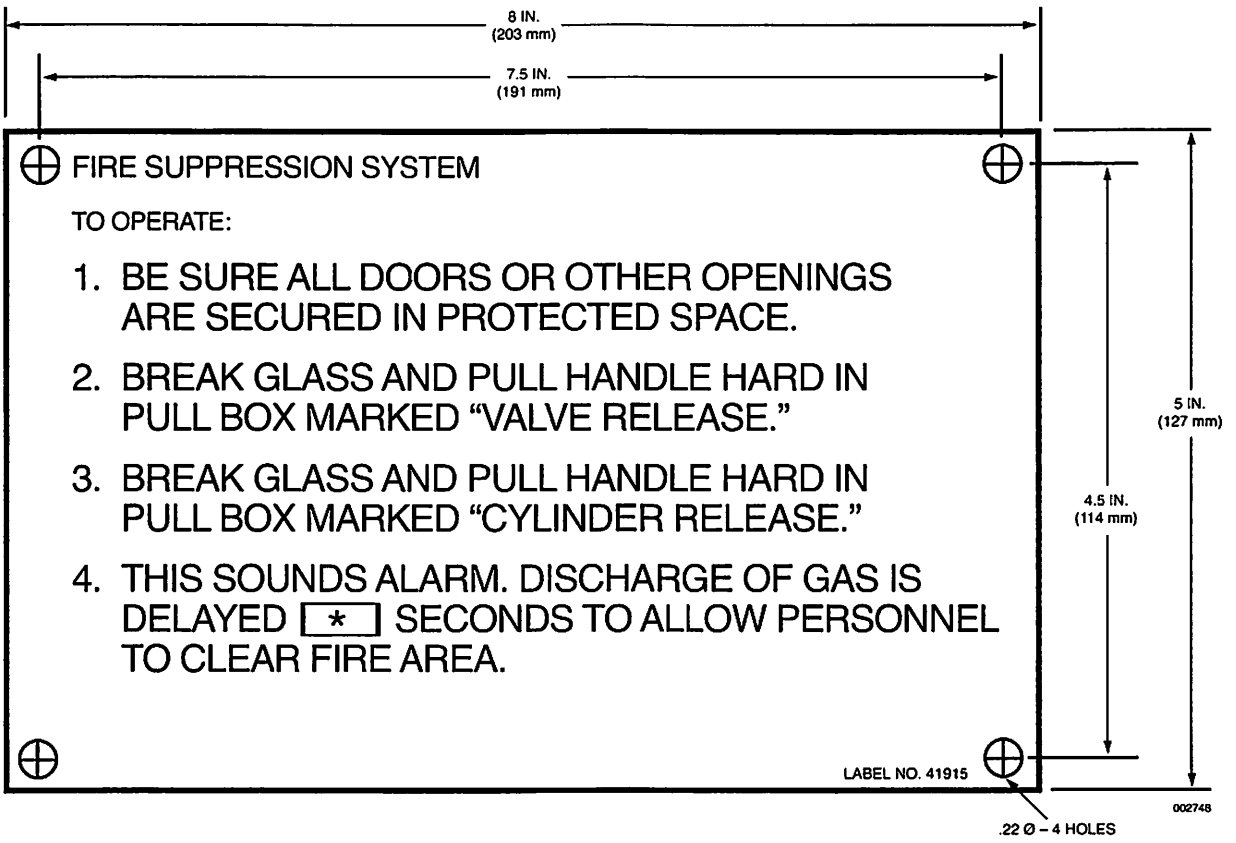
Shipping Assembly Part No.	Description
423923	Pressure Test Assembly

OPERATING INSTRUCTIONS PLATE – PULL CABLE ACTUATION

The operating instruction plate is available for mounting at the pull box location to instruct personnel on system actuation. The operating plate is furnished with four mounting holes for ease of installation. The plate is constructed of aluminum.

Component	Material	Mounting Hole Size
Operating Instructions Instructions – Pull Cable Actuation	Aluminum	1/4 in. (64 mm)

Shipping Assembly Part No.	Description
41915	Operating Instructions – Pull Cable Actuation



WARNING SIGNS

Two warning signs are available for warning personnel that the space is protected by a SAPPHIRE system and no one should enter after a discharge without being properly protected. Each sign is made of aluminum and contains four mounting holes for ease of installation.

Component	Material
Warning Sign	Aluminum

Shipping Assembly Part No.	Description
570580	Warning Sign
570581	Agent Discharge Warning Sign

006894

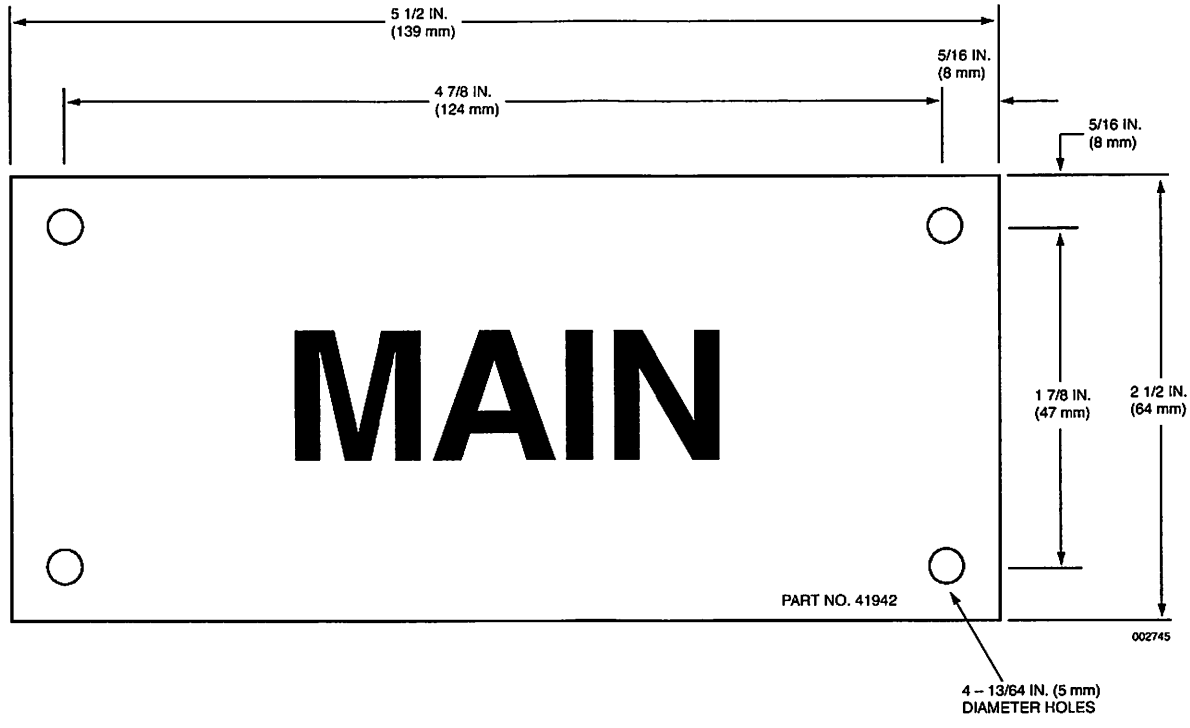
006895

NAMEPLATE – MAIN

The "MAIN" nameplate is available for labeling components and/or remote pull stations to distinguish them from reserve system components. The nameplate is furnished with four mounting holes for ease of installation.

Component	Material	Mounting Hole Size
Nameplate	Aluminum	13/64 in. (52 mm)

Shipping Assembly Part No.	Description
41942	Nameplate – MAIN

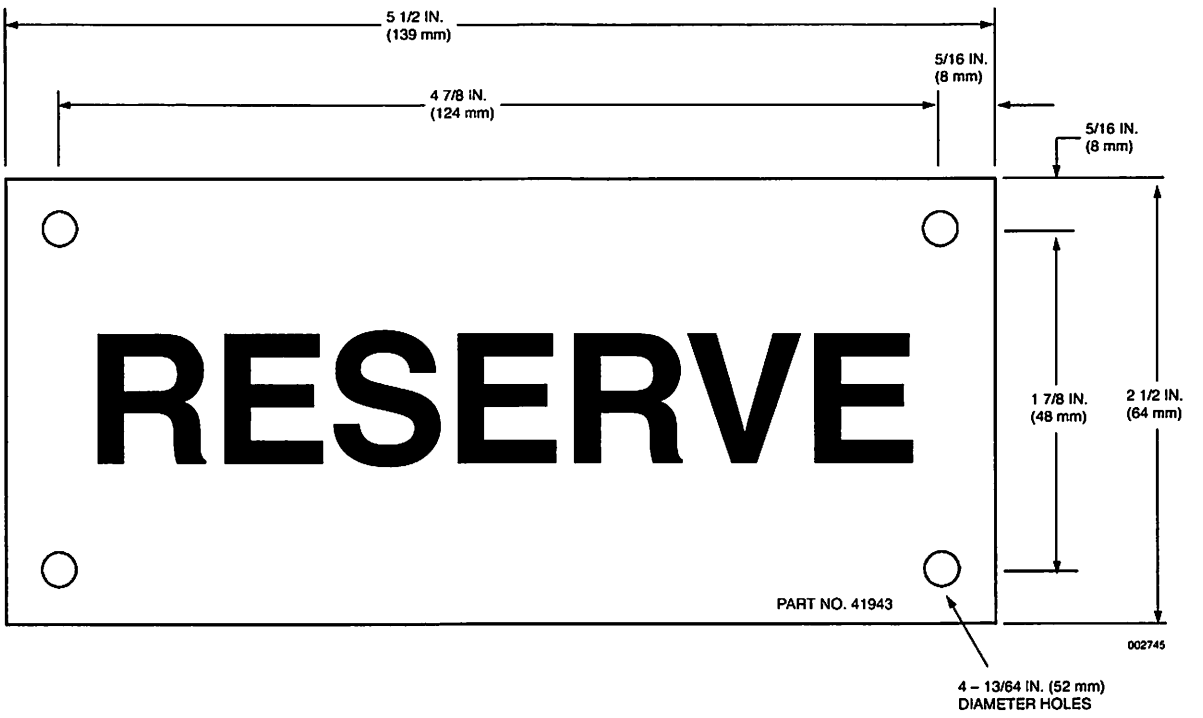


NAMEPLATE – RESERVE

The "RESERVE" nameplate is available for labeling components and/or remote pull stations to distinguish them from main system components. The nameplate is furnished with four mounting holes for ease of installation.

Component	Material	Mounting Hole Size
Nameplate	Aluminum	13/64 in. (52 mm)

Shipping Assembly Part No.	Description
41943	Nameplate – RESERVE



LIQUID LEVEL INDICATOR

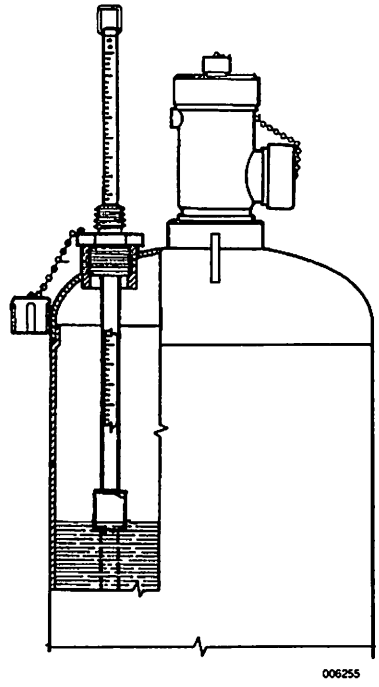
The liquid level indicator is used to measure the level of liquid Novec™ 1230 agent in the tanks. The amount (weight) of agent is determined by converting the level measurement into a weight measurement using the weight conversion tables located in this manual.

The liquid level is found by lifting the measuring tape from inside the tube to the end (or approximately 3 in. 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 indicator can be installed in empty tanks with the proper port or tanks can be ordered with the indicator already installed.

Component	Material
Liquid Level Indicator	Body: Brass Tape: Steel

Shipping Assembly Part No.	Description
570277	Liquid Level Indicator for 280 lb. Tank
570278	Liquid Level Indicator for 390 and 850 lb. Tanks
570589	Liquid Level Indicator for 450 lb. Tank



QUARTZOID BULB ACTUATOR

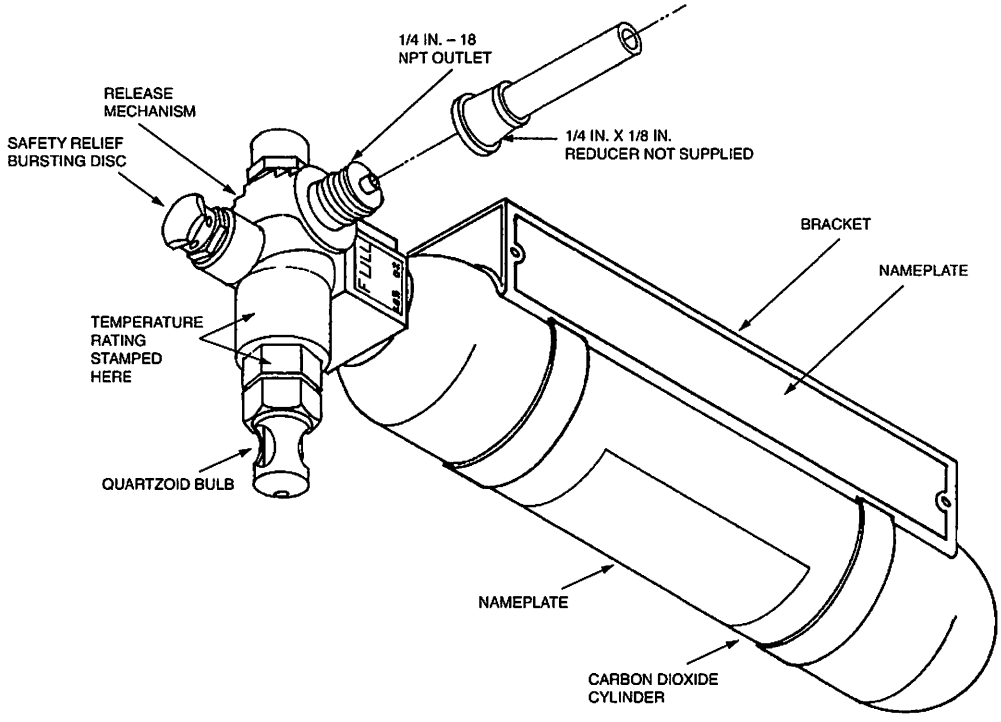
The Quartzoid Bulb Pressure Type Automatic Release (QBA-5) pneumatically actuates a single system tank by releasing carbon dioxide through a maximum of 100 ft. (30.5 m) of 1/8 inch pipe. The QBA-5 is available with temperature ratings of 135, 175, and 250 °F (57, 79, and 121 °C).

The 1/8 in. pneumatic piping is run to the 1/4 in. BSPP (reducer and adaptor required) inlet thread on the cable/pneumatic actuator, Part No. 570392.

Part No.	Temperature
42267	135 °F (57 °C)
42274	175 °F (79 °C)
42276	250 °F (121 °C)

Material: Spun Steel Cylinder with Brass Release Valve

Component Dimensions:
Length: 10 in. (25.4 cm)
Width: 2 7/8 in. (7.3 cm)
Height: 3 3/4 in. (9.5 cm)



RECHARGE COMPONENTS

Recharge and rebuild tools and kits are available for disassembling the valves after a discharge. O-ring kits are available to replace internal valve O-rings after a discharge.

Spanner Wrench – Part No. 570574

This tool is required to remove the valve bonnet assembly for access to the valve piston and O-ring replacement on 1 and 2 in. valves.

Recharge Adaptors

Top Adaptor Assembly for 1 and 2 in. Valves – Part No. 570579

Fill Adaptor Assembly for 1 in. Valve – Part No. 570576

Fill Adaptor Assembly for 2 in. Valve – Part No. 570592

Fill Adaptor Assembly for 3 in. Valve – Part No. 69891

Rebuild Kits

Rebuild Kit for 1 in. Valve – Part No. 570559 (contains bonnet O-ring, collar O-ring, siphon tube O-ring)

Rebuild Kit for 2 in. Valve – Part No. 570584 (contains bonnet O-ring, collar O-ring, siphon tube O-ring)

Rebuild Kit for 3 in. Valve – Part No. 570373 (contains top cap O-ring, complete piston assembly, collar O-ring)

3M™ NOVEC™ 1230 FIRE PROTECTION FLUID MATERIAL SAFETY DATA SHEET CONFORMS TO DIRECTIVE 2001/58/EC

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

1.1. Identification of the preparation

Product Name:	"3M™ Novec™ 1230 Fire Protection Fluid
Chemical Name:	1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone.
CAS No.:	756-13-8.
Chemical Formula:	$CF_3CF_2C(O)CF(CF_3)_2$.
EINECS Number:	Product complies with chemical notification requirements.
NOTE:	"3M" and "Novec" are Trademarks of the 3M Company.

1.2. Use of the preparation

The intended or recommended use of this preparation is as a FIRE EXTINGUISHING AGENT.

1.3. Company identification

Manufacturer/Supplier:	ANSUL INCORPORATED
Address:	One Stanton Street, Marinette, WI 54143-2542
Prepared by:	Safety and Health Department
Phone:	715-735-7411
Internet/Home Page:	http://www.ansul.com
Date of Issue:	May, 2004

1.4. Emergency telephone

CHEMTREC 800-424-9300 or 703-527-3887

2. COMPOSITION/INFORMATION ON INGREDIENTS

2.1.	Ingredient Name:	1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone.
	Chemical Formula:	$CF_3CF_2C(O)CF(CF_3)_2$.
	CAS No.:	756-13-8.
	EINECS Number:	Product complies with chemical notification requirements.
	Concentration, Wt %:	> 99.9 %.
	Hazard Identification:	See Heading 3.

2.2. (i) There are NO substances presenting a health or environmental hazard within the meaning of Directive 67/548/EEC, in concentrations equal to or greater than those laid down in the table set out in Article 3 (3) of Directive 1999/45/EC, nor with lower limits given in Annex I to Directive 67/548/EEC or in Annexes II, III or V to Directive 1999/45/EC.

(ii) There are NO substances for which there are Community workplace exposure limits, which are not already included in (i) above.

NOTE: Unless a component presents a severe hazard, it does not need to be considered in the MSDS if the concentration is less than 1%. [According to Directive 1999/45/EC.]

3. HAZARDS IDENTIFICATION

FOR HUMANS:
EU Classification: This product is not classified as dangerous according to Directive 1999/45/EC.

Limit Values for Exposure:
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone
TWA Limit: 150 ppm. Limit set by 3M Company.

Neither this preparation nor the substances contained in it have been listed as carcinogenic by National Toxicology Program, I.A.R.C., or OSHA.

AS PART OF GOOD INDUSTRIAL AND PERSONAL HYGIENE AND SAFETY PROCEDURE, avoid all unnecessary exposure to the chemical substance and ensure prompt removal from skin, eyes, and clothing. DO NOT eat, drink or smoke when using this product.

SIGNS AND SYMPTOMS:

Acute Exposure:	
Eye Contact:	Contact with the eyes during product use is not expected to result in significant irritation.
Skin Contact:	Contact with the skin during product use is not expected to result in significant irritation.
Inhalation:	Prolonged or repeated exposure, above recommended guidelines, may be absorbed following inhalation and cause target organ effects.
Ingestion:	No health effects are expected.
Chronic Overexposure:	Prolonged or repeated exposure, above recommended guidelines may cause liver effects. Signs or symptoms may include loss of appetite, weight loss, fatigue, weakness, abdominal tenderness, and jaundice.

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE: None known.

FOR ENVIRONMENT:
NO harm to the environment is expected from an accidental release of this preparation. See Heading 12 ECOLOGICAL INFORMATION.

4. FIRST AID MEASURES

Eye Contact:	Flush eyes with large amounts of water. If signs or symptoms persist, get medical attention.
Skin Contact:	Wash affected area with soap and water. If signs or symptoms persist, get medical attention.
Inhalation:	If signs or symptoms develop, remove person to fresh air. If signs or symptoms persist, get medical attention.
Ingestion:	Do not induce vomiting. Give victim two glasses of water. Never give anything by mouth to an unconscious person. If signs or symptoms develop, get medical attention.

5. FIRE-FIGHTING MEASURES

This preparation is a fire extinguishing agent.
There are NO extinguishing media which must not be used for safety reasons.
Fire fighters should wear full protective equipment (Bunker Gear) and a self-contained breathing apparatus (SCBA).
See Heading 10 STABILITY AND REACTIVITY for hazardous combustion and thermal decomposition information.

6. ACCIDENTAL RELEASE MEASURES

For personal protection: Prevent skin and eye contact, see Heading 8 EXPOSURE CONTROLS/PERSONAL PROTECTION.

Clean up: Ventilate the area with fresh air. Contain spill. Working from around the edges of the spill inward, cover with bentonite, vermiculite, or commercially available inorganic absorbent material. Mix in sufficient absorbent until it appears dry. Collect as much of the spilled material as possible. Clean up residue. Place in a metal container approved for transportation by appropriate authorities. Dispose of collected material as soon as possible. See Heading 13 DISPOSAL CONSIDERATIONS.

NO harm to the environment is expected from an accidental release of this preparation. See Heading 12 ECOLOGICAL INFORMATION.

In the event of a release of this material, the user should determine if the release qualifies as reportable according to local, state, and federal regulations.

7. HANDLING AND STORAGE

7.1. Handling

Avoid eye contact with vapors, mists, or spray. Avoid breathing of vapors, mists or spray.
Contents may be under pressure, open carefully.
See incompatibility information in Heading 10 STABILITY AND REACTIVITY.

7.2. Storage

Keep container in well-ventilated area.
See incompatibility information in Heading 10 STABILITY AND REACTIVITY.
Store in original container. Keep tightly closed until used.
There is minimal danger to the environment from a storage release. See Heading 12 ECOLOGICAL INFORMATION.

7.3. Specific use

The intended or recommended use of this preparation is as a FIRE EXTINGUISHING AGENT.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Exposure limit values

1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone
TWA Limit: 150 ppm. Limit set by 3M Company.

8.2. Exposure controls

Do not eat, drink or smoke when using this product.

8.2.1. Occupational exposure controls

8.2.1.1. Respiratory protection

Avoid breathing of vapors, mists or spray.
Under normal use conditions, airborne concentrations are not expected to be significant enough to require respiratory protection.
Select one of the following NIOSH approved respirators based on airborne concentration of contaminants and in accordance with OSHA regulations: Half facepiece or fullface air-purifying respirator with organic vapor cartridges.
Consult the current 3M Respiratory Selection Guide for additional information or call 1-800-243-4630 for 3M technical assistance.
If thermal decomposition occurs, wear supplied air respiratory protection.

8.2.1.2. Hand protection

Butyl Rubber gloves are recommended.
Select and use gloves and/or protective clothing to prevent skin contact based on the results of an exposure assessment. Consult with your glove and/or protective clothing manufacturer for selection of appropriate compatible materials.

8.2.1.3. Eye protection

Indirect Vented Goggles are recommended.

8.2.1.4. Skin protection

Select and use gloves and/or protective clothing to prevent skin contact based on the results of an exposure assessment. Consult with your glove and/or protective clothing manufacturer for selection of appropriate compatible materials.

8.2.2. Environmental exposure controls

There is minimal danger to the environment from a storage release. See Heading 12 ECOLOGICAL INFORMATION.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1. General information

Appearance:	Clear, colorless liquid.
Odor:	Low odor.

9.2. Important health, safety, and environmental information

pH:	Not applicable.
Boiling point/boiling range:	49.2 °C (120.6 °F).
Heat of vaporization @ boiling point:	88.0 kJ/kg (37.9 BTU/lb).
Freezing point:	–108 °C (–162.4 °F).
Flash point:	Not applicable.
Flammability (solid/gas):	Not applicable.
Explosive properties:	Not applicable.
Oxidizing properties:	Not an oxidizer.
Vapor Pressure:	244 mmHg, at 20 °C.
Relative Density (Water = 1):	1.6.
Solubility: — Water solubility:	<0.001 % by weight.
— Fat solubility:	Not determined.
Partition coefficient, n-octanol/water:	Not determined.
Viscosity:	0.6 centipoise, at 25 °C.
Vapor density (Air = 1):	11.6.
Evaporation rate (Butyl Acetate = 1):	> 1.

9.3. Other information

Auto-ignition temperature:	Not applicable.

10. STABILITY AND REACTIVITY

10.1. Conditions to avoid

Avoid direct sunlight and ultraviolet light.

There are NO other known conditions such as temperature, pressure, shock, etc., which may cause a dangerous reaction.

10.2. Materials to avoid

Strong bases, amines, or alcohols.

10.3. Hazardous decomposition products

Normally stable.

Hazardous polymerization will NOT occur.

Combustion or decomposition products include carbon monoxide, carbon dioxide, and hydrogen fluoride.

11. TOXICOLOGICAL INFORMATION

Product:

Toxicity Data:	Inhalation LC50 (rat)	>10 % v/v.
	NOAEL for cardiac sensitization	>10 % v/v.

12. ECOLOGICAL INFORMATION

12.1. Ecotoxicity
Not determined.

12.2. Mobility
Product is highly insoluble in water and volatile. Normal use would not typically result in releases to aquatic environments.

12.3. Persistence and degradability
Photolytic half-life is 3 to 5 days. The persistent photolytic degradation product is trifluoroacetic acid.

12.4. Bioaccumulative potential
Not determined.

12.5. Other adverse effects

Ozone depletion potential:	None.
Photochemical ozone creation potential:	None.
Global warming potential:	1.

13. DISPOSAL CONSIDERATIONS

Not regulated as a hazardous waste by the EPA under RCRA.
Reclaim if feasible.
Incinerate in an industrial or commercial facility in the presence of a combustible material. Combustion products will include HF. Facility must be capable of handling halogenated materials.
As a disposal alternative, dispose of waste product in a facility permitted to accept chemical waste.
Dispose of in compliance with national, regional, and local provisions that may be in force.
No harm to the environment is expected from this preparation. See Heading 12 ECOLOGICAL INFORMATION.

14. TRANSPORT INFORMATION

Hazard Class or Division:	Not hazardous.
Label:	No special label required.
Emergency response guide page number:	Not applicable.

For additional transport information, contact Ansul Incorporated.
No harm to the environment is expected from this preparation. See Heading 12 ECOLOGICAL INFORMATION.

15. REGULATORY INFORMATION

EU Classification: This product is not classified as dangerous according to Directive 1999/45/EC.

Exposure Limit Values:
1,1,1,2,2,4,5,5,5-Nonafluoro-4-(trifluoromethyl)-3-pentanone

TWA Limit:	150 ppm.	Limit set by 3M Company.

EINECS Status: The component of this product has been notified to ELINCS (European List of Notified or New Chemical Substances). Certain restrictions apply. Contact your distributor for additional information.
EPA TSCA Status: All components are included in TSCA inventories or are exempt from listing.
Canadian DSL (Domestic Substances List): All components are included in the DSL or are exempt from listing.
The product also complies with the chemical notification requirements for Korea (KECI), Australia (AICS), Japan (METI), and China (CICS).

Environmental restrictions:	None are known.
Restrictions on Marketing and Use:	None are known.

Refer to any other national measures that may be relevant.

16. OTHER INFORMATION

(HMIS) HAZARDOUS MATERIAL IDENTIFICATION SYSTEM RATINGS:

HEALTH:	0	4. Severe Hazard
FLAMMABILITY:	0	3. Serious Hazard
REACTIVITY:	1	2. Moderate Hazard
		1. Slight Hazard
		0. Minimal Hazard

PROTECTION:
See Section 8. EXPOSURE CONTROLS/PERSONAL PROTECTION.

(WHMIS) CANADIAN WORKPLACE HAZARDOUS MATERIAL IDENTIFICATION SYSTEM RATINGS:
This product is rated: **Not Hazardous.**

Format is from directive 2001/58/EC.
There is no data in EINECS http://exb.jrc.it/existing-chemicals/
Data used to compile the data sheet is from 3M Material Safety Data Sheet, Jan. 21, 2004 and other product literature.
The EU Classification is in accordance with Directive 1999/45/EC.

17. DISCLAIMER

THE ABOVE INFORMATION IS BELIEVED TO BE CORRECT, BUT DOES NOT PURPORT TO BE ALL INCLUSIVE AND SHALL BE USED ONLY AS A GUIDE. ANSUL SHALL NOT BE HELD LIABLE FOR ANY DAMAGE RESULTING FROM HANDLING OR FROM CONTACT WITH THE ABOVE PRODUCT.

3M™ NOVEC™ 1230 FIRE PROTECTION FLUID

General Information

3M™ Novec™ 1230 Fire Protection Fluid has been developed as an alternative to Halon 1301, production of which has ceased at the end of 1993, under the agreed adjustments made to the Montreal Protocol in Nov. 1992.

Novec 1230 contains no Bromine or Chlorine and has no ozone depleting potential.

Novec 1230 systems utilize one or more storage containers arranged to provide the protected area with a pre-determined quantity of agent.

Novec 1230 storage container are designed to hold Novec 1230 in liquid form. Nitrogen is used to super-pressurize the container to 360 psi (24.8 bar) at 70 °F (21 °C).

Handling and installation of Novec 1230 equipment should only be conducted by persons trained in dealing with this type of equipment.

Under normal conditions Novec 1230 is a colorless and low odor fluid with a density around 11 times greater than air. It has negligible vapor pressure and is super-pressurized with nitrogen to 360 psi (24.8 bar) when used in fire suppression applications.

It contains no particulates or oily residues and is produced under ISO 9001 guidelines to strict manufacturing specifications ensuring product purity.

Present understanding of Novec 1230 is that fire suppression is through heat absorption and chemical means.

Novec 1230 decomposes at temperatures in excess of 932 °F (500°C) and it is therefore important to avoid applications involving hazards where continuously hot surfaces are involved. Upon exposure to the flame, Novec 1230 will decompose to form halogen acids. Their presence will be readily detected by a sharp, pungent odor before maximum hazardous exposure levels are reached.

Storage and Handling Recommendations

The unique properties of Novec 1230 fluid necessitate the user to follow certain handling and storage guidelines. Failure to follow these recommendations may result in contamination of the agent and potential failure of the system in which it is used. Contact with water or solvents either polar or hydrocarbon could render Novec 1230 fluid ineffective. Novec 1230 fluid should not be mixed with other extinguishing agents (liquid, powder, or foam) without consulting Ansul to determine compatibility.

Novec 1230 fluid should be stored indoors, out of direct sunlight at temperatures below 104 °F (40 °C). If container must be stored outdoors, confirm that all openings are fully closed. Protect container from direct sunlight and precipitation to every extent possible, and fully dry the exterior of the container prior to opening.

Based on the results of accelerated aging studies, Novec 1230 fluid is expected to have a shelf life and perform as a clean agent for at least 30 years in a properly designed, maintained, and operating fire suppression system, provided the agent has been stored and handled in accordance with the information provided in this manual.

Novec 1230 fluid is a liquid at room temperature allowing it to be transferred using conventional pumping or gravity transfer through a closed system. Novec 1230 fluid has a viscosity similar to water. Consequently, it can be transferred using any pump that would be used to transport a low viscosity, nonflammable liquid. A gravity feed method may also be used to fill the system tanks, in lieu of pumping. If using a pump, it is recommended that an inline filter (equal to or less than 20 microns) be used when filling container.

Standards used by the fire protection industry typically specify that clean agents meet certain standards of quality. In order to maintain the low water content of the original Novec 1230 fluid, procedures must be used to prevent the entry of moist, ambient air into the storage containers. When transferring fluid, the receiving containers should be free of water and purged with dry nitrogen prior to filling with Novec 1230 fluid to remove moisture-laden air. The end of the fluid dispensing pipe must extend into the receiving container. The dispensing container should be fitted with a vent drier or nitrogen purge to prevent the influx of moist air as Novec 1230 fluid is withdrawn. Vent driers employing disposable or refillable desiccant cartridges are available from vendors such as W.A. Hammond Drierite Co. Ltd. Alternatively, a nitrogen purge can be set up by installing a "tee" onto the vent bung of the dispensing container and establishing flow of dry nitrogen at a volumetric flow rate that is in excess of the rate of withdrawal of Novec 1230 fluid from the container.

Good industrial hygiene practices should be followed when handling Novec 1230 fluid. Novec 1230 fluid must be used in a well-ventilated area. Provide local exhaust ventilation at transfer points. If adequate ventilation cannot be accomplished to maintain air concentrations below the recommended exposure guideline, use respiratory protection. The use of vented goggles for eye protection is required when handling Novec 1230 fluid. Always wear gloves when handling Novec 1230 fluid. Gloves made from butyl rubber are recommended. For more specific information regarding the use of Novec 1230 fluid, refer to the Material Safety Data Sheet.

Disposal Recommendations

Novec 1230 fluid may be disposed using an approved industrial or commercial incinerator. Since Novec 1230 fluid is nonflammable, it must be burned in the presence of a combustible material. Refer to the Material Safety Data Sheet, Section II, for additional details.

Health and Safety

A proper designed and installed suppression 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.

Reference should be made to NFPA 2001 for the toxic and asphyxiating hazards of clean agent replacement.

Novec 1230 agent has acceptable toxicity for use in occupied spaces when used as specified in the United States Environmental Protection Agency (EPA) proposed Significant New Alternative Policy (SNAP) program rules and NFPA 2001, "Clean Agent Fire Extinguishing Systems."

Novec 1230 fluid extinguishes fires via its cooling effect, not by displacement of oxygen as is the extinguishment mechanism of CO_2, thus providing the ability to utilize Novec 1230 fluid in occupied areas.

Therefore, exposure to Novec 1230 at the design concentration of up to 10.0% is not a hazard to health. Exposure to higher concentrations is permissible for limited periods. Refer to NFPA 2002 for exposure requirements. As with halons, the 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.

3M™ NOVEC™ 1230 FIRE PROTECTION FLUID (Continued)

Health and Safety (Continued)

Novec 1230 can decompose at high temperatures to form acids. If so, their presence is readily detected as a sharp, pungent odor long before hazardous maximum exposure levels are reached.

The noise created by the Novec 1230 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 general turbulence within the protected area to move paper and light objects.

Direct contact with the vaporizing liquid discharged from a Novec 1230 nozzle has a chilling effect on objects and in extreme cases can cause frostbite to the skin. The liquid phase vaporizes rapidly when mixed with air and therefore limits the risk to the immediate vicinity of the nozzle. Reduction in visibility will occur due to the condensation of water vapor.

⚠ CAUTION

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 result from exposure of the agent to the fire or hot surfaces. Unnecessary exposure of personnel either to the products of decomposition shall be avoided.

DESCRIPTION OF SAPPHIRE SYSTEMS

SAPPHIRE systems are designed to suppress fires in Class B (minimum Class B design concentration is 5.85%; contact Ansul for all Class B applications), and C hazards.

Novec 1230 suppress fires by a combination of physical and chemical means. It does not significantly deplete the oxygen content in the room.

A system comprises one or more containers connected to a system of piping and nozzles. Novec 1230 is liquid under pressure and is stored in steel containers, each of which is fitted with a valve specially designed to allow the contents of the container to discharge within 10 seconds. When the valve opens, Novec 1230 flows into the distribution piping to the discharge nozzles where it is rapidly dispersed as a vapor.

Discharged Novec 1230 gives the appearance of a fog which may reduce visibility. This normally clears rapidly and should not obstruct the ability of personnel to safely exit the protected area.

SAPPHIRE Engineered Fire Suppression Systems are particularly valuable in extinguishing fires in enclosures containing hazards or equipment where a clean, electrically non-conductive medium is essential or where the cleaning up of foam, water or dry chemical would be a problem.

APPROVALS

The SAPPHIRE Fire Suppression System has been tested and listed by Underwriters Laboratories, Inc. (EX-4510), USCG (162.161/6/0) and Underwriters Laboratories of Canada as an engineered system for Class B and C fire suppression, at temperatures between 0 °F to 130 °F (–18 °C to 55 °C).

TYPE OF SYSTEM

Total flooding is the approved type of system available. A total flooding system normally consists of a fixed supply of Novec 1230 agent connected to piping with nozzles to direct the agent into an enclosed hazard space. In a total flooding system, the enclosure around the hazard must be tight enough to hold the required percentage of Novec 1230 agent concentration for a period of time to extinguish the fire.

TYPES OF ACTUATION

There are two basic types of actuation for the SAPPHIRE systems: pneumatic and mechanical.

Mechanical

Mechanical actuation is accomplished by means of a local manual actuator mounted on top of the tank valve. The tank is actuated by removing the safety pin on the actuator and rotating the lever. The pin in the actuator opens the tank valve, allowing the tank to discharge the agent.

Pneumatic

Pneumatic actuation utilizes nitrogen gas pressure from a cartridge located in a Marine Actuation Station. The gas pressure forces the pneumatic actuator, located on the pilot tank valve, down, which in turn forces the cylinder valve open, releasing the nitrogen gas to pneumatically open the agent tank valves, allowing the agent to discharge into the hazard area.

SYSTEM LIMITATIONS

SAPPHIRE engineered systems are based on a Hydraulic Flow Program developed by Hughes Associates Inc. The program predicts the two-phase flow of Novec 1230 agent 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.

As system design calculations are critical to the success of the suppression system, only Ansul or Ansul trained personnel are authorized to perform system calculations.

NOTICE

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

SYSTEM LIMITATIONS (Continued)

Design/Flow Calculation Limitations

- System Operating Temperature: 0 °F to 130 °F (18 °C to 54 °C)
- Minimum Design Concentration: Class B, 5.85%
- Fill Density: Maximum 75 lbs/ft^3, Minimum 31.0 lbs/ft^3
- Discharge Time: Maximum 10 seconds, Minimum 6 seconds
- Maximum Arrival Imbalance: 1 second
- Maximum Runout Imbalance: 2 seconds
- Maximum Pipe Volume to Cylinder Liquid Volume: 80%
- Minimum Pipe Volume Ratio Before First Tee: 10%
- Nozzle Area Ratio:

Maximum All Size Nozzles	Minimum 1/2 in. Nozzle	All Other Sizes
80%	10%	20%

- Minimum Nozzle Pressure: 73 psi (5.0 bar)
- Flow Rate Limit:

Pipe Diameter	Minimum Flow Rate lb/s	(kg/s)	Maximum Flow Rate lb/s	(kg/s)
1/2 in.	1.0	(0.5)	3.0	(1.4)
3/4 in.	2.0	(0.9)	5.5	(2.5)
1 in.	3.5	(1.6)	8.5	(3.9)
1 1/4 in.	6.0	(2.7)	12.5	(5.7)
1 1/2 in.	9.0	(4.1)	20.0	(9.1)
2 in.	14.0	(6.4)	30.0	(13.6)
2 1/2 in.	20.0	(9.1)	55.0	(24.9)
3 in.	30.0	(13.6)	90.0	(40.8)
4 in.	55.0	(24.9)	125.0	(56.7)
5 in.	90.0	(40.8)	200.0	(90.7)
6 in.	120.0	(54.4)	300.0	(136.1)

- Maximum Allowed Split Through a Tee:

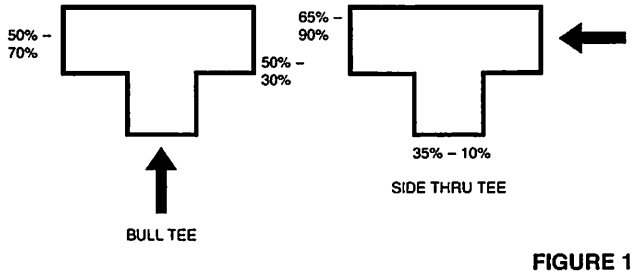


FIGURE 1
002201

- Maximum nozzle height above deck for a single row of nozzles is 14 ft. (4.3 m). For deck heights over 14 ft. (4.3 m), additional rows of nozzles may be added.
- Nozzles to be located a maximum of 12 in. (30.5 cm) down from the deck head, positioned vertically down.
- Maximum Linear Nozzle Coverage: 32 ft. x 32 ft. (9.8 m x 9.8 m)
- Minimum Bilge Height: 12 in. (30.5 cm)
- Piping/Tee Orientation:

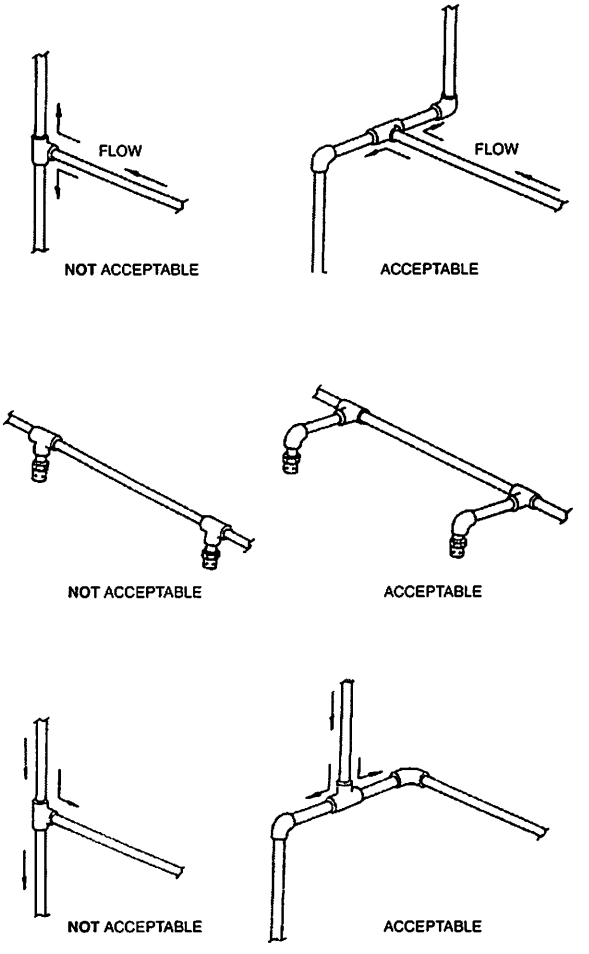


FIGURE 2
006903

- Critical Pipe Length Before a Tee Split: Minimum of 10 pipe diameters

SYSTEM LIMITATIONS (Continued)

Design/Flow Calculation Limitations (Continued)

- Maximum Elevation Difference in Pipe Runs:
  - Statement No. 1. If nozzles are only located **above** the tank outlet, then the maximum elevation difference between the tank outlet and the furthest horizontal pipe run or discharge nozzle (whichever is furthest) shall not exceed 30 ft. (9.1 m). See Figure 3.
  - Statement No. 2. If nozzles are only located **below** the tank outlet, then the maximum elevation difference between the tank outlet and the furthest horizontal pipe run or discharge nozzle (whichever is furthest) shall not exceed 30 ft. (9.1 m). See Figure 3.
  - Statement No. 3. If nozzles are located both **above and below** the tank outlet, then the maximum elevation difference between the furthest horizontal pipe runs or discharge nozzles (whichever is furthest) shall not exceed 30 ft. (9.1 m). See Figure 3.

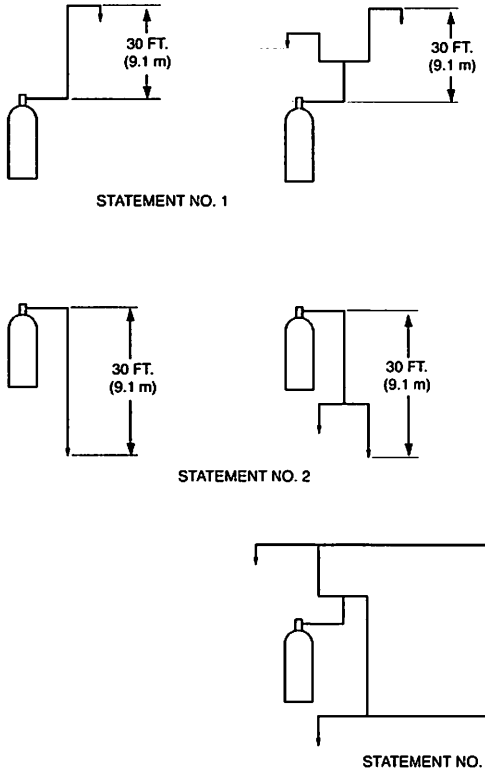


FIGURE 3
006050

Note: If the system design violates these limits, contact the Marine and Government Division of Tyco Safety Products to determine what action has to be taken.

- Manifolding: All tanks on the same manifold must be the same size and fill density.
- The calculation method has been designed for specific types of fittings, pipe, 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.
- Maximum design concentration for occupied spaces: 10%
- The SAPPHIRE Designer Program is designed for a +70 °F (+21 °C) tank operating/storage temperature. Therefore, the tank operating/storage temperature must be in the range of +60 °F to +80 °F (+15.5 °C to 26.7 °C) for a single system protecting two or more separate hazards. If the tank operating/storage temperature is outside this range, an insufficient or excessive quantity of agent may be discharged from one or more discharge nozzles. If tanks cannot be stored within this range, then each hazard must be protected with its own individual system.

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

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

INITIAL GENERAL INFORMATION

- Are Specifications available? If so, obtain a copy.
- Who is "Classing" the vessel? What is the Flag of Registry?
- Will the system need to be approved by any other marine regulatory authority?
- Will any special requirements apply to the system design or installation?

HAZARD INFORMATION

- Secure the vessel general arrangement drawings of the spaces to be protected.
- If the general arrangement drawings do not include the following information, then you must obtain it.
- Record all dimensions for the hazard enclosure such as length, width, overhead height, angles of corners if not 90 degrees, etc.
- Draw a sketch including plan and elevation views of the hazard area if drawings are not available.
- Indicate the quantity and locations of all exits from the hazard on the sketches.
- Record all dimensions for any structural objects such as main auxiliary engines, generator sets, permanent closed tanks, etc. which may allow a reduction of the hazard volume. **Note:** System design can be calculated based on either gross volume (no volume reductions for solid, fixed objects) or net volume (solid, fixed object volumes subtracted from gross volume). If using gross volume for system calculations, a door fan test **IS NOT** required. If using net volume for system calculations, a door fan test **IS** required.
- Identify the location of the tanks and, if on an existing vessel, supply a drawing on the proposed discharge piping layout.
- Identify anything unique about the hazard that would affect system design or installation.
- Identify the hazards normal, maximum, and minimum ambient temperatures.
- Will the hazard area be normally occupied?
- Identify any openings, or potential openings in the hazard enclosure that may cause loss of agent during or after discharge.

NOVEC 1230 SUPPLY REQUIREMENTS

- Will the cylinders be located in a dedicated space? If so, record dimensions of that space.
- Is the storage and operating temperature range within 0° to 130° F (–18° to 54° C)?
- Determine if the deck will support the cylinders and bracketing. Assume 275 lbs/ft^2 (1343 kg/m^2) for this requirement.
- Will the cylinder bracketing be secured to a bulkhead? If so, is the bulkhead strong enough to support it and the cylinders?
- Will Uprights be required for the bracketing?
- Will Manifold Supports be required to support the manifold?
- Will a reserve supply of agent be required? If so, will it need to be connected to the manifold?
- Will a discharge test be required?

ACTUATION AND ALARM REQUIREMENTS

- Will the system be actuated automatically as well as manually?

> **CAUTION**
> Automatic actuation can only be used on U.S. Flagged vessels and for only hazards of 6000 cu. ft. (170 cu. m.) or less with horizontal egress.

- What type of manual actuation (cable pull or pneumatic) is required?
- Will multiple areas or compartments be protected by a single system? If so, will the areas be protected separately or simultaneously?
- Identify the locations for all Manual Pull Stations.
- Should the Time Delay be set for 30 seconds or 60 seconds?
- What types of additional alarm devices are required: audible and/or visible?
- Where will the system actuation be annunciated?
- Does the hazard area require explosion-proof or weather-proof wiring and devices?
- What devices need to be shut down or started up? Identify the number of contacts required.

PIPING INFORMATION

- Determine the cylinder location.
- Identify preferred supply piping routes.
- Indicate any obstructions to the piping or wiring runs.
- If the system includes Selector Valves, indicate their location.

VENTILATION AND LEAKAGE CONCERNS

- Identify any unclosable openings regardless of their size.
- Advise the customer of the possible need to seal these openings to prevent agent loss.
- Advise the customer of the possible need to provide pressure venting during discharge.
- If necessary, determine the route venting will need to take to reach outside atmosphere.
- Will the venting route involve venting through other enclosures or ducts? If so, provide details about the rooms or duct routing information.
- If the venting will be through other enclosures, will they be protected also? If so, will they be protected separately or simultaneously?
- Will dampers be required for Inlet or Exhaust ducts? If so, how

will they be operated, electrically or pneumatically?

Small Systems (Under 6,000 cu. ft. (170 cu. m))

For paint lockers, emergency generator rooms, etc.

Shown in Figure 4-1 is a typical system layout for a hazard less than 6,000 cu. ft. (170 cu. m).

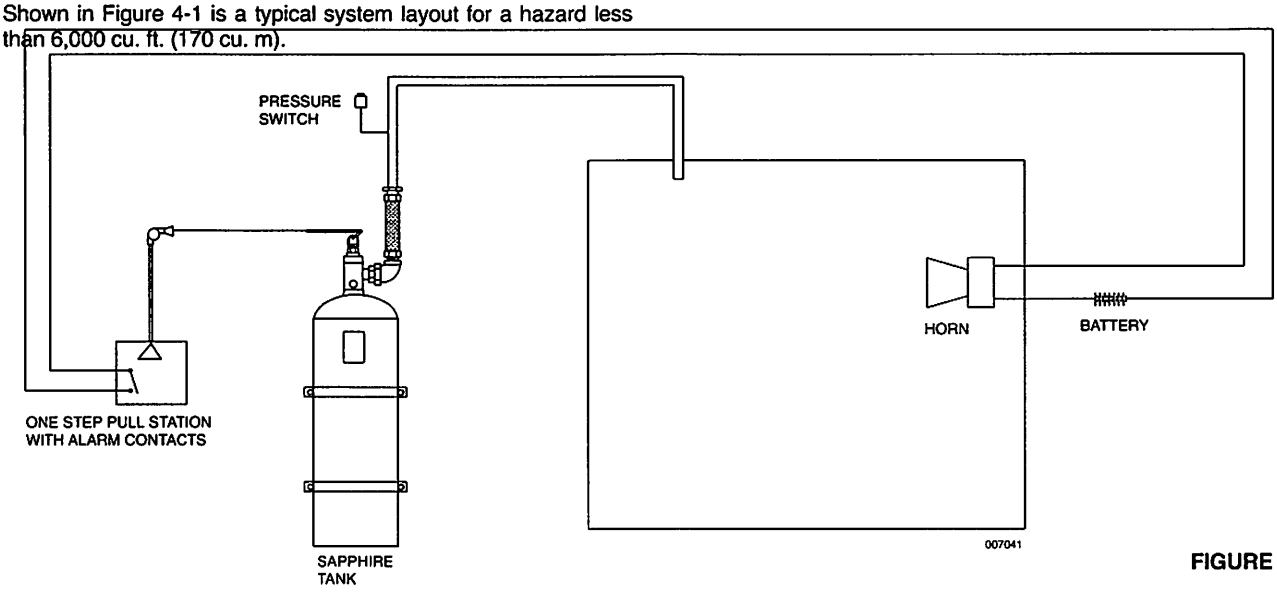


FIGURE 4-1

Small Systems (Under 6,000 cu. ft. (170 cu. m))

Shown in Figure 4-2 are the required guidelines for tank locations in hazards under 6,000 cu. ft. (170 cu. m) with different types of egress routes.

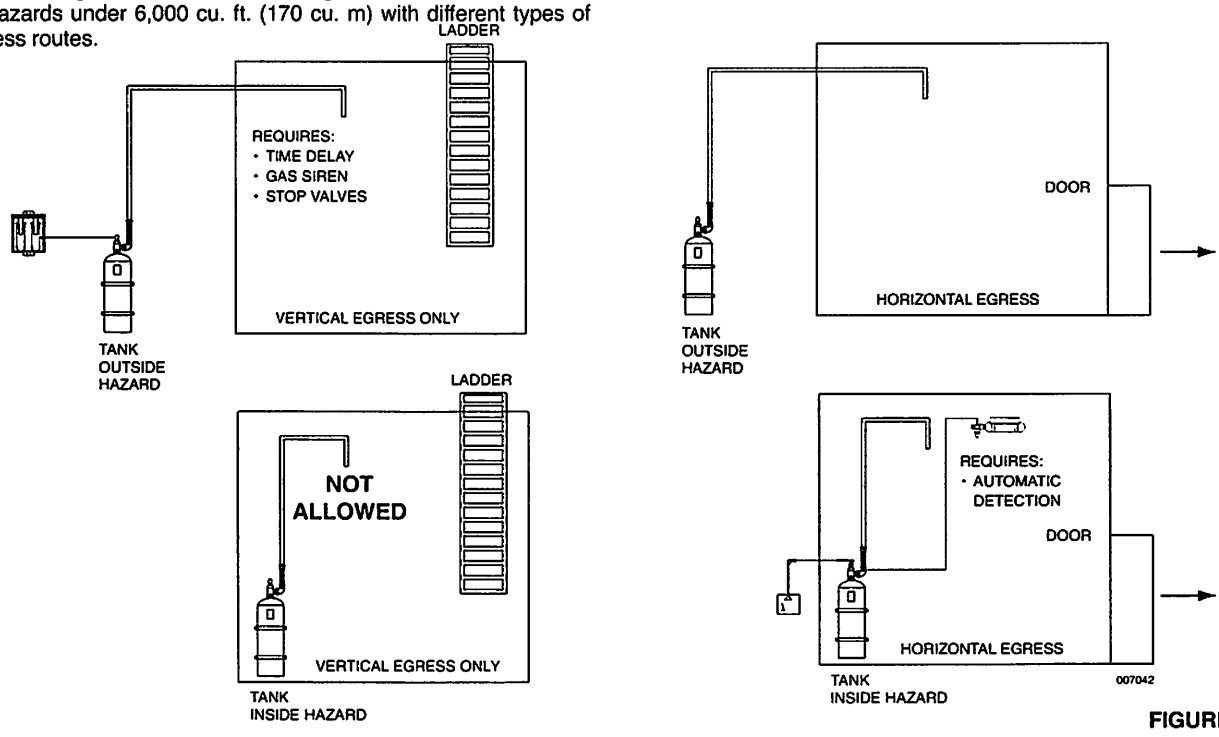


FIGURE 4-2

After completing the hazard analysis sub-section in Section IV Planning, proceed with the following elements to work up a complete design and bill of materials. An example is included with each step to help the reader to understand the procedure. The example uses a simple machinery space as shown below.

APPLICATION METHOD

Total flooding is the only approved application method for Ansul's SAPPHIRE systems under U.S. Coast Guard and SOLAS regulations. Novec 1230 agent is stored in a liquid form and will turn to a gas upon discharge; it does not create a liquid stream therefore local application of SAPPHIRE system is not possible because the flow of gas cannot be accurately predicted once it exits the nozzle.

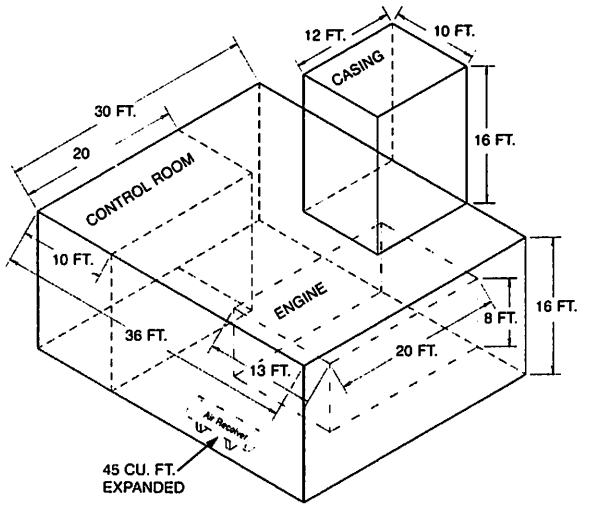


FIGURE 5-1
003785

Total Flooding

The following steps must be followed, in the order they are presented, to properly design a SAPPHIRE total flooding system. A simple design example will be used throughout the steps to help understand each step. Use the Design Calculations Worksheet in this section.

Note: System design can be calculated based on either gross volume (no volume reductions for solid, fixed objects) or net volume (solid, fixed object volumes subtracted from gross volume). This example represents a design calculation based on net volume.

STEP NO. 1 – Determine hazard gross volume(s)

The first step in the design of a SAPPHIRE system is to calculate the volume of each area to be protected. Multiply the length times the width to determine the area, and then multiply the area times the height to determine the gross volume for each hazard area. If any area is an odd shape the designer may need to divide it up into regular shapes that will allow volume calculations, and then total all of the volumes together to determine the actual volume of that area. If the irregular shape will affect distribution of agent it may be best to calculate sections of the hazard as separate areas and include nozzles for each of these areas.

If the protected volume is a machinery space the casing volume must be included in the volume for the quantity calculations.

If air receivers are located in the protected space, the expanded, non-compressed volume of air (in standard cubic feet) must be added to the volume of the enclosure.

If the overhead height exceeds the maximum allowable overhead height as defined in the General Information Section of this manual, multiple levels of nozzles must be designed into the system. In this case it is usually beneficial to treat each level as a separate protected area so that proper agent distribution is achieved.

Complete this step for each area protected by the system.

Example (English):

- Engine Room
  Large Area: 26 ft. (length) x 30 ft. (width) = 780 ft.^{2}
  780 ft.^{2} x 16 ft. (height) = 12,480 ft.^{3}
  12,480 ft.^{3} + 45 ft.^{3} (air receiver) = **12,525 ft.^{3}**
  Small Area: 10 ft. (length) x 10 ft. (width) = 100 ft.^{2}
  100 ft.^{2} x 16 ft. (height) = **1,600 ft.^{3}**
  Engine Room Total = 12,525 ft.^{3} + 1,600 ft.^{3} = 14,125 ft.^{3}
- Control Room
  10 ft. (length) x 20 ft. (width) x 16 ft. (height) = **3,200 ft.^{3}**
- Casing
  10 ft. x 12 ft. x 16 ft. = **1,920 ft.^{3}**

Example (Metric Conversion):

- Engine Room
  Large Area: 7.93 m (length) x 9.14 m (width) = 72.46 m^2
  72.46 m^2 x 4.88 m (height) = 353.40 m^3
  353.40 m^3 + 1.27 m^3 (air receiver) = **354.67 m^3**
  Small Area: 3.05 m (length) x 3.05 m (width) = 9.29 m^2
  9.29 m^2 x 4.88 m (height) = **45.31 m^3**
  Engine Room Total = 354.67 m^3 + 45.31 m^3 = **399.98 m^3**
- Control Room
  3.05 m (length) x 6.10 m (width) x 4.88 m (height) = **90.61 m^3**
- Casing
  3.05 m x 3.66 m x 4.88 m = **54.37 m^3**

STEP NO. 2 – Determine volume of solid, permanent structures or equipment

The volume of **solid** objects in each hazard area that are not removable can be deducted from the volume of the hazard.

This volume may include auxiliary machinery, boilers, condensers, evaporators, main engines, reduction gears, tanks, trunks, compartments that will always be closed, and any other large, permanently fixed objects that cannot be removed from the hazard enclosure.

Casings and air receivers must not be included as part of the volume reduction.

Calculate the volume of all such objects and add them together to determine the amount of space to be deducted from the volume.

Complete this step for each enclosure protected by the system.

Example (English):

- Engine Room
  Engine: 20 ft. x 13 ft. x 8 ft. = **2,080 ft.^{3}**

Example (Metric Conversion):

- Engine Room
  Engine: 6.10 m x 3.96 m x 2.44 m = **58.90 m^3**

APPLICATION METHOD (Continued)

STEP NO. 3 – Calculate Net Volume

Subtract the volume of solid, permanent objects (Step No. 2) from the hazard's volumes (Step No. 1). The resulting value is the Net Volume.

Volume – Solid Object Volume = Net Volume

Complete this step for each area protected by the system.

Example (English):

- Engine Room
  Large Area: 12,525 ft.^{3} – 2,080 ft.^{3} = **10,445 ft.^{3}**
  All other areas remain the same

Example (Metric Conversion):

- Engine Room
  Large Area: 354.67 m^3 – 58.90 m^3 = **295.77 m^3**
  All other areas remain the same

STEP NO. 4 – Determine minimum design concentration

Minimum Design Concentration is defined by NFPA 2001 as the Extinguishing Concentration for the specific Class B fuel plus a 30% safety factor. Extinguishing Concentration is the agent concentration required to extinguish a test fire.

The Minimum Design Concentration for various fuels can be determined from the following table:

SAPPHIRE Minimum Design Concentrations

Class B Fuels – (Heptane)* 5.85%

Minimum Class B design concentration is 5.85%

Class C Fuels 4.20%

* Contact the Marine and Government Department for Minimum Design Concentrations for fuels not listed above. The minimum design concentration for Class B is 5.85%.

Small amounts of Class A materials which are typically found in machinery spaces are acceptable in a marine hazard.

Design Concentrations are determined by NFPA 2001, 2004 edition, Paragraph 3-4.2 and UL-2127, first edition, Paragraph 59.2(b).

Calculations:

Cup burner or fire test concentration x safety factor

Safety Factor: Class B = 1.3

Example:

Diesel Fuel = **5.85% minimum design concentration.**

STEP NO. 5 – Determine minimum quantity of SAPPHIRE agent required

This step is used to determine the minimum amount of Novec 1230 agent required to protect each hazard area. The amount of agent calculated during this step is the minimum amount of agent that is required to protect the hazard area.

The amount of agent in the system must always be at least this much and may be exceeded. Failure to supply at least the amount of agent indicated in this step may prevent the system from suppressing a fire.

To determine the minimum quantity of Novec 1230 agent required, determine the lowest anticipated ambient temperature for the area being protected and determine the design concentration required for the material to be extinguished.

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

Using these two variables, the quantity of Novec 1230 agent can be calculated in either of two ways:

First: The formula in NFPA 2001 can be used.

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

W = Weight of clean agent [lb kg]

V = net volume of hazard, cu. ft.

S = specific Vapor Volume – 0.9856 + 0.002441t

t = Design temperature in the hazard area – (°F)

C = Required Novec 1230 Design Conc. (% by volume) at Design Temperature (t)

Note: This calculation includes an allowance for the normal leakage from a "tight" enclosure due to agent expansion.

The second option for calculating the required quantity of SAPPHIRE agent is to refer to the "Flooding Factor Chart" to determine the correct flooding factor to use. To do this, start by locating the Minimum Ambient Temperature in the left column, follow this line across until you reach the column for the Minimum Design Concentration needed for the design. The number listed where the temperature line and the concentration column meet is the Flooding Factor to be used.

Note: If the minimum temperature, the minimum design concentration, or both are not listed, interpolation will be required.

Next, to determine the quantity of Novec 1230 agent, multiply the net Hazard Volume by the Flooding Factor determined from the table.

Complete this step for each area protected by the system.

NOTICE

The actual design concentration of Novec 1230 agent cannot be less than the concentration selected in Step No. 4.

Example (English) (Class B):

Minimum Ambient Temperature = 40 °F.

Flooding Factor = 0.0574

- Engine Room
  Large Area: 10,445 ft.^{3} x 0.0574 = **599.54 lbs**
  Small Area: 1,600 ft.^{3} x 0.0574 = **91.84 lbs**
- Control Room
  3,200 ft.^{3} x 0.0574 = **183.68**
- Casing
  1,920 ft.^{3} x 0.0574 = **110.20**

APPLICATION METHOD (Continued)

Example (Metric Conversion):

Minimum Ambient Temperature = 5 °C.

Flooding Factor = 0.9168

- Engine Room
  Large Area: 295.77 m^3 x 0.9168 = **271.16 kg**
  Small Area: 45.31 m^3 x 0.9168 = **41.54 kg**
- Control Room
  90.61 m^3 x 0.9168 = **83.07 kg**
- Casing
  54.37 m^3 x 0.9168 = **49.84 kg**

STEP NO. 6 – Determine the total system Novec 1230 agent quantity required

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

Example (English):

599.54 + 91.84 + 183.68 + 110.20 = **985.26 lbs**

Example (Metric Conversion):

271.16 + 41.54 + 83.07 + 49.84 = **445.61 kg**

STEP NO. 7 – Determine number of SAPPHIRE cylinders required

To determine the estimated number of tanks required, divide the quantity of SAPPHIRE agent for the entire system by the actual tank capacity and then round up to the next whole number.

Note: The SAPPHIRE tank size listed on the Component Sheet is a nominal size. The quantity entered into the calculation should be the Minimum Fill Quantity in the tank. Refer to the table below for exact quantities.

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

Nominal Tank Size	Min.-Max. Fill Weight
20 lb.	10-21 lbs.
50 lb.	20-46 lbs.
90 lb.	37-88 lbs.
140 lb.	58-138 lbs.
280 lb.	116-280 lbs.
390 lb.	161-388 lbs.
450 lb.	194-450 lbs.
850 lb.	375-851 lbs.

Note: Actual tank(s) size(s) and fill weights may change based upon the SAPPHIRE Flow Calculation Software ANSL 3.60 program system calculations.

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

691.38 lbs. (Engine Room) + 183.68 (Control Room) + 110.20 (Casing Room) = 985.26 lbs. (Rounded up to 986 lbs.)

986/851 = 1.158 rounded up to 2 tanks required.

STEP NO. 8 – Determine the Design Concentration at the Maximum Ambient Temperature for Each Area

This step determines the Design Concentration of Novec 1230 agent in each protected area using the Reduced Volume and the supplied quantity of agent for the area at the "Maximum Ambient Temperature." It is necessary to assure that we do not over-concentrate the area due to the additional agent actually supplied to the area and the increased concentration of agent caused by increased temperature.

Example:

Maximum Ambient Temperature = 120 °F

The following calculation is used:

C = (100 WS) / (WS + V)

Where:

W = Weight of agent used – lbs

V = Volume of hazard – ft^3

S = Specific vapor volume – S = 0.9856 + 0.002441t

t = Maximum ambient temperature – °F

C = Design Novec 1230 concentration at max. ambient temperature(t)

Example:

- Engine Room
  C = (100 x 691.38 lb x 1.278) / ((691.38 x 1.278) + 12045 ft^3))
  (100 x 883.58.) / 883.58 + 12045)
  88358.58 / 12928.58
  C = 6.84%
- Control Room
  C = (100 x 183.68 lb x 1.278) / ((183.68 x 1.278) + 3200ft^3))
  23474.30 / 3434.74
  C = 6.84%
- Casing
  C = (100 x 110.20 lb x 1.278) / ((110.20 x 1.278) + 1920ft^3))
  14083.56 / 2060.835
  C = 6.84%

STEP NO. 9 – Verify the actual Novec 1230 agent concentration

This step is used to verify that the "worst case" design concentration will not exceed limits for fire suppression on the low end and life safety on the high end.

Complete this step for each area protected by the system.

Example:

6.84% is below 10.0%, therefore the system design is acceptable for **normally occupied space**

Where concentrations exceed 10.0% by volume, steps must be taken to eliminate expose to personnel. Time delays and two step manual actuation utilizing stop valves are stipulated under USCG and SOLAS regulations. These steps are mandatory were possible exposure would exceed 10.0%.

Where concentrations above 10.0% may exist, escape from space must be possible in 30 seconds or less.

APPLICATION METHOD (Continued)

STEP NO. 10 – Determine the Nozzle Quantity

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

To determine the quantity of nozzles required, divide the area length by 32 ft. and then round up to the next whole number. Then divide the area width by 32 ft. and round up to the next whole number. Then, multiply the two answers to determine the total nozzle quantity.

Complete this step for each area protected by the system.

360° NOZZLE REQUIREMENTS:

- Maximum coverage length per nozzle – 32 ft. (9.8 m)
- Maximum coverage width per nozzle – 32 ft. (9.8 m)
- Maximum radial distance per nozzle – 28.6 ft. (8.7 m)

The radial distance is defined as the distance from the nozzle to the farthest point of the area protected.

Note: The length and width coverage is for estimating only.

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

REQUIREMENTS COMMON TO ALL NOZZLES:

- Maximum nozzle height above floor level for a single row of nozzles is 14 ft. (4.3 m). For ceiling heights over 14 ft. (4.3 m), an additional row of nozzles is required.
- The nozzle(s) must be located in the hazard area to be protected. Separate enclosures or partial enclosures located within one common, protected hazard area may require additional nozzles within the enclosure to assure proper agent distribution within the entire common hazard area.
- If nozzle velocity is a concern, the designer may wish to add additional nozzles to lower the individual nozzle velocity to an acceptable limit.
- If the room is an odd shape, the designer may wish to increase the nozzle quantity to provide a more even distribution of agent.
- For multiple level hazards, the intermediate levels of nozzles must be positioned at the top of the designed height for each intermediate level. Nozzles mounted at the deck head must be within 12 in. (305 mm) of the deck head.

Example:

- Engine Room
  - 36 ft. Length ÷ 32 = 1.125 = 2 nozzles
  - 30 ft. Width ÷ 32 = 0.9375 = 1 nozzle
  - 2 nozzles x 1 nozzle = 2 nozzles required for engine room
- Control Room
  - 20 ft. Length ÷ 32 = .625 = 1 nozzle
  - 10 ft. Width ÷ 32 = .3125 = 1 nozzle
  - 1 nozzle x 1 nozzle = 1 nozzle required for control room
- Casing
  - 12 ft. Length ÷ 32 = .375 = 1 nozzle
  - 10 ft. Width ÷ 32 = .3125 = 1 nozzle
  - 1 nozzle x 1 nozzle = 1 nozzle required for casing

STEP NO. 11 – Determine the Nozzle Locations and Lay Out the Interconnecting Piping

Using a plan view drawing of the protected areas, locate each nozzle and the tanks. **Note:** Nozzles should be located at the top of the hazard area. (Nozzles can be aimed upward or downward.) Connect the nozzles with piping following the piping guidelines listed in the General Information Section and the Installation Section. After all of the nozzles are connected, lay out the piping to the tanks and lay out the manifold.

Step 12 – Complete an Isometric Sketch of the Piping Layout

Create an isometric sketch of the piping for use in inputting the information into the SAPPHIRE Designer program.

Piping Node Points

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

Segment 1 (Node 0 to 1) always represents the cylinder. This segment can never be changed. The pipe length is the siphon tube/valve length (which is also the elevation change for the vertical cylinder) and the total equivalent length is the measured equivalent length of the siphon tube/valve assembly. The designer program will number the rest of the pipe segments, as they are input.

Nozzles

Nozzles are indicated with the number of the enclosure and the number of the nozzle in that enclosure. (i.e., E1N1 – E1N2). The designer program assigns the nozzle indicators. Sequential placement is not required; however, it is recommended that the designer use some sort of numbering system to prevent confusion.

STEP NO. 13 – Perform Flow Calculations

With the information developed in Steps No. 11 and 12, run the computer program to determine the final pipe sizes and nozzle orifice sizes. The SAPPHIRE Designer Program is the only calculation method to be used with Ansul SAPPHIRE Engineered Systems.

DATE: _____

QUOTE/JOB NUMBER: _____

CUSTOMER: _____

SAPPHIRE™ SYSTEM DESIGN CALCULATION WORKSHEET

VOLUME CALCULATIONS:	AREA 1	AREA 2	AREA 3	AREA 4	AREA 5
Area Name:					
Length (ft):					
Width (ft):					
Height (ft):					
Area (sq ft):					
Volume (cu ft):					
Additional Volume (air receivers, etc.) (sq ft):					
Gross Volume (cu ft):					
Volume Reductions:					
Structural Reductions (cu ft):					
Net Volume: (Volume – Structural Reductions)					
ROOM MINIMUM AMBIENT TEMP.:					
DESIGN CONCENTRATION:					
FLOODING FACTOR: (From Table)					
INITIAL NOVEC 1230 QUANTITY CALC.:					
NOVEC 1230 Quantity (lbs): (Total Reduced Volume x Flooding Factor) or (Formula from Design Manual)					

ALTITUDE CORRECTION:	
Height Above or Below Sea Level:	
Factor: (From Design Manual Table)	
ACTUAL NOVEC 1230 QUANTITY (lbs): (Initial NOVEC 1230 Quantity x Altitude Correction Factor)	
TOTAL NOVEC 1230 QTY. (lbs): (Sum of all Actual NOVEC 1230 quantities)	
TOTAL NOVEC 1230 QTY. (lbs): (From Page 1)	

SAPPHIRE™ SYSTEM DESIGN CALCULATION WORKSHEET (Continued)

DATE: _____

QUOTE/JOB NUMBER: _____

CUSTOMER: _____

	AREA 1	AREA 2	AREA 3	AREA 4	AREA 5
Area Name:					
ACTUAL NOVEC 1230 AGENT PER AREA: [(Actual NOVEC 1230 Qty. ÷ Total NOVEC 1230 Qty.) x NOVEC 1230 Agent Supplied]					
ACTUAL NOVEC 1230 FLOODING FACTOR: [(Actual NOVEC 1230 Agent per Area ÷ Alt. Correction Factor) ÷ Total Reduced Volume]					

CONCENTRATION RANGE CHECK:
(Design Conc. Must be Between 4.2% – 10% For Occupied Spaces)

Room Max. Ambient Temp.:					
Design Concentration at Max. Temp.:					

(Locate Actual NOVEC 1230 Conc. at Max. Temp. on Table, or Use Calc. in Design Manual)
WARNING: CONCENTRATION EXCEEDS LIMITS – REVISE DESIGN

DISCHARGE TIME:

Normal Ambient Temperature:					
Design Concentration at Ambient Temp.:					

(Locate Actual NOVEC 1230 Conc. at Ambient Temp. on Table, or Use Calc. in Design Manual)

Nozzle Quantity: [Length ÷ 32 (Rounded to Next Highest Whole Number) x width ÷ 32 (Rounded to Next Highest Whole Number)]					
Estimated Nozzle Flow Rate (lbs/sec): [((Actual NOVEC 1230 Agent Per Area x .9) ÷ 90% Discharge Time (Min.)) ÷ Nozzle Quantity]					

Estimated Nozzle Pipe Size:

Pipe Size: (Refer to Pipe Sizing Chart)					

TOTAL FLOODING QUANTITY (English Units)

Temp. t (°F)[b]	Specific Vapor Volume s (ft³/lb)[c]	Weight Requirements of Hazard Volume, W/V (lb/ft³)[a] Design Concentration (% by volume)													
		4.2	4.5	5	5.5	5.85	6	6.5	7	7.5	8	8.5	9	9.5	10
–20	0.9368	0.0468	0.0503	0.0562	0.0621	0.0663	0.0681	0.0742	0.0803	0.0866	0.0928	0.0992	0.1056	0.1121	0.1186
–10	0.9612	0.0456	0.0490	0.0548	0.0606	0.0646	0.0664	0.0723	0.0783	0.0844	0.0905	0.0966	0.1029	0.1092	0.1156
0	0.9856	0.0445	0.0478	0.0534	0.0591	0.0630	0.0648	0.0705	0.0764	0.0823	0.0882	0.0943	0.1003	0.1065	0.1127
10	1.0100	0.0434	0.0467	0.0521	0.0576	0.0615	0.0632	0.0688	0.0745	0.0803	0.0861	0.0920	0.0979	0.1039	0.1100
20	1.0344	0.0424	0.0456	0.0509	0.0563	0.0601	0.0617	0.0672	0.0728	0.0784	0.0841	0.0898	0.0956	0.1015	0.1074
30	1.0588	0.0414	0.0445	0.0497	0.0550	0.0587	0.0603	0.0657	0.0711	0.0766	0.0821	0.0877	0.0934	0.0991	0.1049
40	1.0832	0.0405	0.0435	0.0486	0.0537	0.0574	0.0589	0.0642	0.0695	0.0749	0.0803	0.0858	0.0913	0.0969	0.1026
50	1.1077	0.0396	0.0425	0.0475	0.0525	0.0561	0.0576	0.0628	0.0680	0.0732	0.0785	0.0839	0.0893	0.0948	0.1003
60	1.1321	0.0387	0.0416	0.0465	0.0514	0.0549	0.0564	0.0614	0.0665	0.0716	0.0768	0.0821	0.0874	0.0927	0.0981
70	1.1565	0.0379	0.0407	0.0455	0.0503	0.0537	0.0552	0.0601	0.0651	0.0701	0.0752	0.0803	0.0855	0.0908	0.0961
80	1.1809	0.0371	0.0399	0.0446	0.0493	0.0526	0.0541	0.0589	0.0637	0.0687	0.0736	0.0787	0.0838	0.0889	0.0941
90	1.2053	0.0364	0.0391	0.0437	0.0483	0.0516	0.0530	0.0577	0.0624	0.0673	0.0721	0.0771	0.0821	0.0871	0.0922
100	1.2297	0.0357	0.0383	0.0428	0.0473	0.0505	0.0519	0.0565	0.0612	0.0659	0.0707	0.0755	0.0804	0.0854	0.0904
110	1.2541	0.0350	0.0376	0.0420	0.0464	0.0495	0.0509	0.0554	0.0600	0.0647	0.0693	0.0741	0.0789	0.0837	0.0886
120	1.2785	0.0343	0.0369	0.0412	0.0455	0.0486	0.0499	0.0544	0.0589	0.0634	0.0680	0.0727	0.0774	0.0821	0.0869
130	1.3029	0.0336	0.0362	0.0404	0.0447	0.0477	0.0490	0.0534	0.0578	0.0622	0.0667	0.0713	0.0759	0.0806	0.0853
140	1.3273	0.0330	0.0355	0.0397	0.0438	0.0468	0.0481	0.0524	0.0567	0.0611	0.0655	0.0700	0.0745	0.0791	0.0837
150	1.3518	0.0324	0.0349	0.0389	0.0431	0.0460	0.0472	0.0514	0.0557	0.0600	0.0643	0.0687	0.0732	0.0777	0.0822
160	1.3762	0.0319	0.0342	0.0382	0.0423	0.0452	0.0464	0.0505	0.0547	0.0589	0.0632	0.0675	0.0719	0.0763	0.0807
170	1.4006	0.0313	0.0336	0.0376	0.0416	0.0444	0.0456	0.0496	0.0537	0.0579	0.0621	0.0663	0.0706	0.0749	0.0793
180	1.4250	0.0308	0.0331	0.0369	0.0408	0.0436	0.0448	0.0488	0.0528	0.0569	0.0610	0.0652	0.0694	0.0737	0.0780
190	1.4494	0.0302	0.0325	0.0363	0.0402	0.0429	0.0440	0.0480	0.0519	0.0559	0.0600	0.0641	0.0682	0.0724	0.0767
200	1.4738	0.0297	0.0320	0.0357	0.0395	0.0422	0.0433	0.0472	0.0511	0.0550	0.0590	0.0630	0.0671	0.0712	0.0754
210	1.4982	0.0293	0.0315	0.0351	0.0388	0.0415	0.0426	0.0464	0.0502	0.0541	0.0580	0.0620	0.0660	0.0701	0.0742
220	1.5226	0.0288	0.0309	0.0346	0.0382	0.0408	0.0419	0.0457	0.0494	0.0533	0.0571	0.0610	0.0650	0.0689	0.0730

TOTAL FLOODING QUANTITY (SI UNITS)

Temp. t (°C)[b]	Specific Vapor Volume s	Weight Requirements of Hazard Volume, W/V (kg/m³)[a] Design Concentration (% by volume)[d]													
	(m³/kg)[c]	4.2	4.5	5	5.5	5.85	6	6.5	7	7.5	8	8.5	9	9.5	10
–20	0.0609	0.7197	0.7736	0.8640	0.9555	1.0200	1.0479	1.1413	1.2357	1.3311	1.4275	1.5250	1.6236	1.7233	1.8241
–17.7	0.0615	0.7123	0.7656	0.8552	0.9457	1.0096	1.0371	1.1296	1.2230	1.3174	1.4129	1.5094	1.6070	1.7056	1.8054
–15	0.0623	0.7039	0.7565	0.8450	0.9344	0.9976	1.0248	1.1161	1.2084	1.3018	1.3961	1.4915	1.5879	1.6853	1.7839
–10	0.0637	0.6887	0.7402	0.8268	0.9143	0.9761	1.0027	1.0921	1.1824	1.2737	1.3660	1.4593	1.5537	1.6490	1.7455
–5	0.0650	0.6742	0.7246	0.8094	0.8950	0.9555	0.9816	1.0690	1.1575	1.2469	1.3372	1.4285	1.5209	1.6143	1.7087
0	0.0664	0.6603	0.7096	0.7926	0.8765	0.9358	0.9613	1.0470	1.1336	1.2211	1.3096	1.3990	1.4895	1.5809	1.6734
5	0.0678	0.6469	0.6953	0.7766	0.8588	0.9168	0.9418	1.0258	1.1106	1.1964	1.2831	1.3707	1.4593	1.5489	1.6395
10	0.0691	0.6341	0.6815	0.7612	0.8417	0.8986	0.9232	1.0054	1.0886	1.1727	1.2576	1.3435	1.4304	1.5182	1.6070
15	0.0705	0.6217	0.6682	0.7464	0.8254	0.8812	0.9052	0.9859	1.0674	1.1498	1.2332	1.3174	1.4026	1.4887	1.5757
20	0.0719	0.6099	0.6555	0.7322	0.8096	0.8644	0.8879	0.9671	1.0471	1.1279	1.2096	1.2923	1.3758	1.4603	1.5457
21.1	0.0722	0.6073	0.6527	0.7291	0.8062	0.8607	0.8842	0.9630	1.0427	1.1232	1.2046	1.2869	1.3701	1.4542	1.5392
25	0.0733	0.5985	0.6432	0.7184	0.7945	0.8482	0.8713	0.9490	1.0275	1.1068	1.1870	1.2681	1.3500	1.4329	1.5167
30	0.0746	0.5875	0.6314	0.7052	0.7799	0.8326	0.8553	0.9315	1.0086	1.0865	1.1652	1.2448	1.3252	1.4066	1.4888
35	0.0760	0.5769	0.6200	0.6925	0.7658	0.8176	0.8399	0.9147	0.9904	1.0668	1.1442	1.2223	1.3013	1.3812	1.4620
40	0.0774	0.5666	0.6090	0.6802	0.7522	0.8031	0.8250	0.8985	0.9728	1.0479	1.1239	1.2006	1.2783	1.3567	1.4361
45	0.0787	0.5568	0.5984	0.6684	0.7391	0.7891	0.8106	0.8829	0.9559	1.0297	1.1043	1.1797	1.2560	1.3331	1.4111
50	0.0801	0.5472	0.5882	0.6570	0.7265	0.7756	0.7967	0.8677	0.9395	1.0121	1.0854	1.1595	1.2345	1.3103	1.3869
54.44	0.0813	0.5390	0.5794	0.6471	0.7156	0.7640	0.7848	0.8547	0.9254	0.9969	1.0691	1.1422	1.2160	1.2907	1.3661
55	0.0815	0.5380	0.5783	0.6459	0.7142	0.7625	0.7833	0.8531	0.9237	0.9950	1.0671	1.1400	1.2137	1.2882	1.3636
60	0.0829	0.5291	0.5687	0.6352	0.7024	0.7499	0.7704	0.8390	0.9084	0.9786	1.0495	1.1211	1.1936	1.2669	1.3410
65	0.0842	0.5205	0.5594	0.6249	0.6910	0.7377	0.7578	0.8253	0.8936	0.9626	1.0324	1.1029	1.1742	1.2463	1.3191
70	0.0856	0.5122	0.5505	0.6148	0.6799	0.7259	0.7457	0.8121	0.8793	0.9472	1.0158	1.0852	1.1554	1.2263	1.2980
75	0.0870	0.5041	0.5418	0.6052	0.6692	0.7144	0.7339	0.7993	0.8654	0.9323	0.9998	1.0681	1.1372	1.2070	1.2775
80	0.0883	0.4963	0.5334	0.5958	0.6588	0.7033	0.7225	0.7869	0.8520	0.9178	0.9843	1.0515	1.1195	1.1882	1.2577
85	0.0897	0.4887	0.5252	0.5866	0.6487	0.6926	0.7115	0.7749	0.8390	0.9038	0.9692	1.0355	1.1024	1.1701	1.2385
90	0.0911	0.4813	0.5173	0.5778	0.6390	0.6821	0.7008	0.7632	0.8263	0.8901	0.9547	1.0199	1.0858	1.1524	1.2198
95	0.0925	0.4742	0.5096	0.5692	0.6295	0.6720	0.6904	0.7519	0.8141	0.8769	0.9405	1.0047	1.0697	1.1353	1.2017
100	0.0938	0.4672	0.5022	0.5609	0.6203	0.6622	0.6803	0.7409	0.8022	0.8641	0.9267	0.9900	1.0540	1.1188	1.1842
105	0.0952	0.4605	0.4950	0.5528	0.6113	0.6527	0.6705	0.7302	0.7906	0.8517	0.9134	0.9758	1.0389	1.1026	1.1671
110	0.0966	0.4540	0.4879	0.5450	0.6027	0.6434	0.6609	0.7199	0.7794	0.8396	0.9004	0.9619	1.0241	1.0870	1.1505
115	0.0979	0.4476	0.4811	0.5374	0.5942	0.6344	0.6517	0.7098	0.7685	0.8278	0.8878	0.9485	1.0098	1.0718	1.1344
120	0.0993	0.4414	0.4744	0.5299	0.5860	0.6256	0.6427	0.7000	0.7579	0.8164	0.8756	0.9354	0.9958	1.0570	1.1188
125	0.1007	0.4354	0.4680	0.5227	0.5780	0.6171	0.6339	0.6904	0.7475	0.8053	0.8636	0.9226	0.9823	1.0426	1.1035
130	0.1021	0.4296	0.4617	0.5157	0.5703	0.6088	0.6254	0.6812	0.7375	0.7945	0.8520	0.9102	0.9691	1.0285	1.0887

INSTALLATION

All installations are to be performed in accordance with the parameters of this manual and all appropriate codes and standards from the local, state, and federal authority having jurisdiction.

Equipment should be per this manual. Other materials should be in accordance with industry standards and practices and acceptable to the authority having jurisdiction. Installation should be by personnel experienced in this type of work.

Before the SAPPHIRE system is installed, the qualified installer should develop installation drawings in order to locate the equipment, to determine an actuation and distribution piping routing. Installation drawings shall be submitted for approval to the appropriate authority having jurisdiction (AHJ, Flag State, Classification Society) prior to system installation.

For successful system performance, the SAPPHIRE system components and the hazard area must be within a temperature range of 0 °F to 130 °F (–18 °C to 54 °C).

Note: For hazards larger than 6000 cu. ft. (170 cu. m), the tanks should be located outside the protected space. For those few cases where the tanks need to be located inside the protected space, the following requirements must be met:

- Dual (looped) actuation lines for simultaneous actuation.
- Stainless steel welded piping rather than tubing for pneumatic actuation lines.
- Tank pressure must be monitored through a supervisory pressure switch (in addition to the usual pressure gauge and liquid level indicator).
- Concentration calculations must be based on maximum (gross) hazard volume, i.e. no deductions are to be taken for installed equipment.

MOUNTING COMPONENTS

Tank/Bracket Assembly

SAPPHIRE tanks may be located inside or outside the protected space, although it is preferable to locate them outside of the space. They must not be located where they will be exposed to a fire or explosion in the hazard. When they are installed within the space they protect, a remote manual pull station must be installed outside the hazard area to actuate the system.

The tanks should be installed so that they can be easily removed for recharging. Tanks must be installed indoors. Do not install the tanks where they are exposed to direct sun rays. See the following table for dimensions of bracket location.

⚠ CAUTION

Do not remove the outlet safety shipping cap until tank is securely mounted in the bracket. Failure to comply could result in personal injury, death, or property damage from violent tank movement or overexposure to high concentrations of Novec 1230 agent.

1. Mount the back channels (supplied by others) for the mounting brackets to a rigid, vertical surface at the appropriate height. See Table 1. Make certain to use suitable fastening hardware. **Note: If manifolding is being utilized, make certain tank brackets are spaced properly to accommodate the manifold inlet spacing.**
2. Position the tank(s) against the back channel, with the valve outlet pointing to the left.
3. Insert the tank straps into the top and bottom back channel and secure with the bolts provided. See Figure 1.
4. If a connected reserve system is required, mount the reserve tanks directly next to the main system tanks.

Tank Size	No. of Unistrut Channels	Height From Floor to Bracket in.	(mm)
10 to 21 lbs. (4.5 to 9.5 kg)	1	5.0	(130)
20 to 46 lbs. (9 to 21 kg)	2	2.5, 13.0	(60, 330)
37 to 88 lbs. (17 to 40 kg)	2	6.25, 23.5	(160, 595)
58 to 138 lbs. (26 to 63 kg)	2	4.25, 13.5	(110, 343)
116 to 280 lbs. (53 to 127 kg)	2	11.75, 29.5	(300, 750)
161 to 388 lbs. (73 to 176 kg)	2	11.75, 39.25	(300, 1000)
194 to 459 lbs. (88 to 204 kg)	2	11.75, 47.25	(300, 1200)
375 to 851 lbs. (170 to 386 kg)	2	11.75, 43.25	(300, 1100)

Table 1: Bracket Mounting Heights

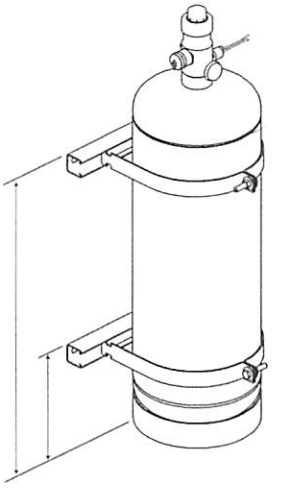


FIGURE 1
004833

INSTALLING DISTRIBUTION PIPING

General Piping Requirements (Including Manifolding)

- Use Schedule 40 black iron, galvanized, chrome-plated, or stainless steel pipe conforming to ASTM A53, or A106. All fittings must be a minimum Class 300, malleable or ductile iron.
- Pipe unions are acceptable.
- Reducing bushings only are allowed when reducing pipe size.
- Cast iron pipe and fittings are **not** acceptable.
- PTFE (Teflon) tape is the only acceptable pipe sealant and must be applied to male threads only.

NOTICE

Do not allow tape to overlap the pipe opening, as this could cause possible blockage of the agent. **Thread sealant or compound must not be used.**

- Before assembling the pipe and fittings, make certain all ends are carefully reamed and blown clear of chips and scale. The inside of pipe and fittings must be free of oil and dirt.
- All pipe lengths are measured center to center of fittings.
- Hangers must be placed within 12 in. (30.5 cm) of the discharge nozzle.
- Hangers must be UL listed or FM approved and mounted to a structure capable of supporting the weight of the pipe and agent.
- All dead end pipe lines to be provided with a capped nipple, 2 in. long. See Figure 2.
- Vertical drops on the end of line are acceptable.

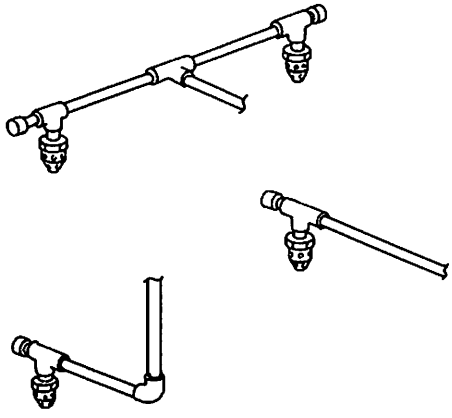


FIGURE 2
001876

Piping and Nozzle Installation

1. With the tank properly secured in the bracket, remove the discharge outlet safety shipping cap.
2. If utilizing a discharge hose, connect the hose directly to the valve outlet. If rigid piping directly to the valve, first attach the appropriate union adaptor to the valve outlet.
3. Continue piping the remainder of distribution piping, following the piping sketch completed in System Design Section.
4. Verify that the nozzle locations are correct and rigidly mount the nozzles and connect to the distribution piping. Make certain not to exceed the piping limitations as stated in "Design/Flow Calculation Limitations" in Section III.

INSTALLING ACTUATION PIPING

General Actuation Piping Requirements

1. Use only 1/4 in. Schedule 40 black iron, hot-dipped galvanized, chrome-plated, or stainless steel pipe/braided hose and fittings conforming to ASTM A120, A53, or A106.
2. Before assembling the pipe and fittings, make certain all ends are carefully reamed and blown clear of chips and scale. Inside of pipe and fittings must be free of oil and dirt.
3. The piping and fitting connections must be sealed with pipe tape. When applying pipe tape, start at the second male thread and wrap the tape (two turns maximum clockwise around the thread), away from the pipe opening.

NOTICE

Do not allow tape to overlap the pipe opening, as this could cause possible blockage of the gas pressure. **Thread sealant or compound must not be used.**

4. Cast iron pipe and fittings are not acceptable.
5. Actuation piping must be rigidly supported by UL listed hangers.
6. Refer to "Actuation Requirements – Option 1 and Option 2" in Design Section for detailed piping limitations.

INSTALLING ACTUATION PIPING (Continued)

Actuation Piping Installation

Install actuation gas line by completing the following:

⚠ CAUTION

Piston in each valve actuator must be in the "UP" position before installing on valve. If piston is not in the "UP" position, tank may actuate, causing personal injury or property damage.

1. Make certain the piston in each pneumatic actuator is in the "UP" position. See Figure 3.

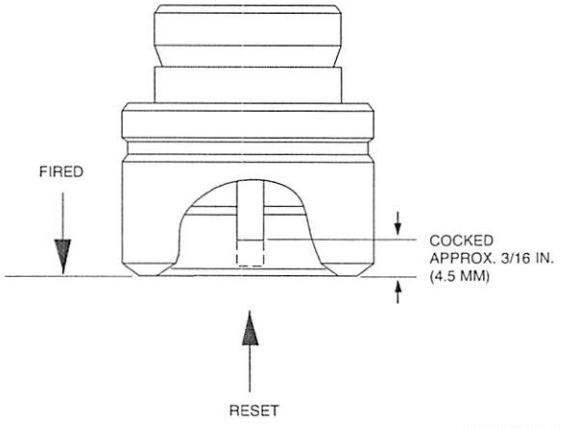


FIGURE 3
006775

2. Remove actuation port protector cap from the valve assembly and install the pneumatic actuator; hand tighten. See Figure 4.

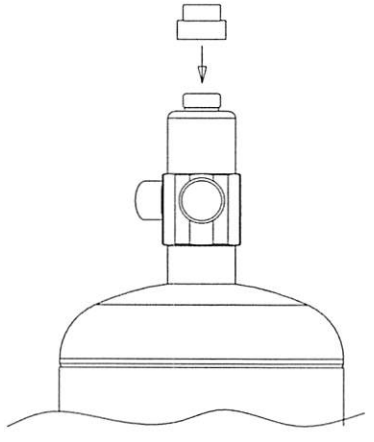


FIGURE 4
006776

ACTUATION OF SAPPHIRE SYSTEMS UTILIZING NITROGEN PILOT CYLINDERS

Marine SAPPHIRE Systems which are installed for the protection of engine rooms, pump rooms, or other larger spaces (greater than 6,000 cu. ft. (170 m^3)) are normally actuated by high pressure, nitrogen pilot cylinders. For single or two tank SAPPHIRE systems, one nitrogen pilot cylinder is employed. Two nitrogen pilot cylinders will be used for systems using three or more SAPPHIRE tanks.

Marine systems normally require two separate and distinct actions to release the suppression systems. The first action will release the pilot cylinder(s) to operate the sirens, shutdowns, and initiate the time delay. The second action will cause the stop valve on the pilot line to open, thus allowing the nitrogen pilot pressure to pneumatically actuate the SAPPHIRE storage tanks at the end of the time delay period.

Upon actuation, nitrogen gas is utilized to operate pressure-operated sirens located within the protected space, pneumatic switches for ventilation and machinery shut down, and a time delay to allow personnel to evacuate the protected space. After a pre-determined delay period, nitrogen is allowed to flow through the time delay valve and actuate the SAPPHIRE tanks by applying pressure to the pneumatic actuators located on the SAPPHIRE storage tank valves.

A normally closed stop valve is located in the actuation line between the nitrogen pilot cylinders and the SAPPHIRE tanks to provide protection against accidental discharge of agent due to overpressurization of the pilot cylinder manifold or accidental release of the nitrogen cylinders. A pressure relief vent and a header safety will be located in the pilot cylinder manifold.

Two methods of remotely actuating SAPPHIRE systems include:

1. Pull cable actuation (Figures 5 and 6)
2. Pneumatic actuation (Figure 7 and 8)

Both methods require two separate and distinct actions to actuate the SAPPHIRE system.

Pull Cable Actuation

Pull cable actuation utilizes 1/16 in. cable run in 3/8 in. pipe to operate a normally closed stop valve and the control valves on the nitrogen pilot cylinders. Corner pulleys are provided for each change in direction in the cable run. Two break glass pull boxes are provided for each actuation station location, one operating the stop valve and one operating the pilot cylinder valves. When more than one actuation station is required, dual/triple control boxes shall be used to splice the cable.

Actuation can also be initiated at the pilot cylinder location by manually opening the stop valve and operating the lever releases located on the pilot cylinder valves.

Pneumatic Actuation

There are two pneumatic cartridges: The first step operates the pilot cylinder(s). The second step operates the stop valve. After the time delay, actuation pressure from the pilot cylinders will be applied to the SAPPHIRE storage tank valves.

Direct Manual Actuation

Actuation can also be initiated at the pilot cylinder location by manually opening the stop valve and operating the lever releases located on the pilot cylinder valves.

Nitrogen Pilot Cylinders

Each nitrogen pilot cylinder contains 2175 psi (150 bar) of nitrogen pressure at 70 °F (21 °C). The cylinder complies with the requirements of the U.S. Department of Transportation.

PULL CABLE ACTUATION

Item	Part No.	Description
1	433098	Nitrogen pilot cylinder
2	427082	Pilot cylinder flexible discharge bend
3	423309	Pilot valve lever release actuator
4	42514	Connecting link
5	As required	1/16 in. pull cable
6	45333	Cable clamp
7	40060	Flared end fitting
8	418378	Manifold relief valve
9	40309	Vent plug
10	40276	Sector
11	41451	1/2 in. globe valve
12	426170/54169	Time delay

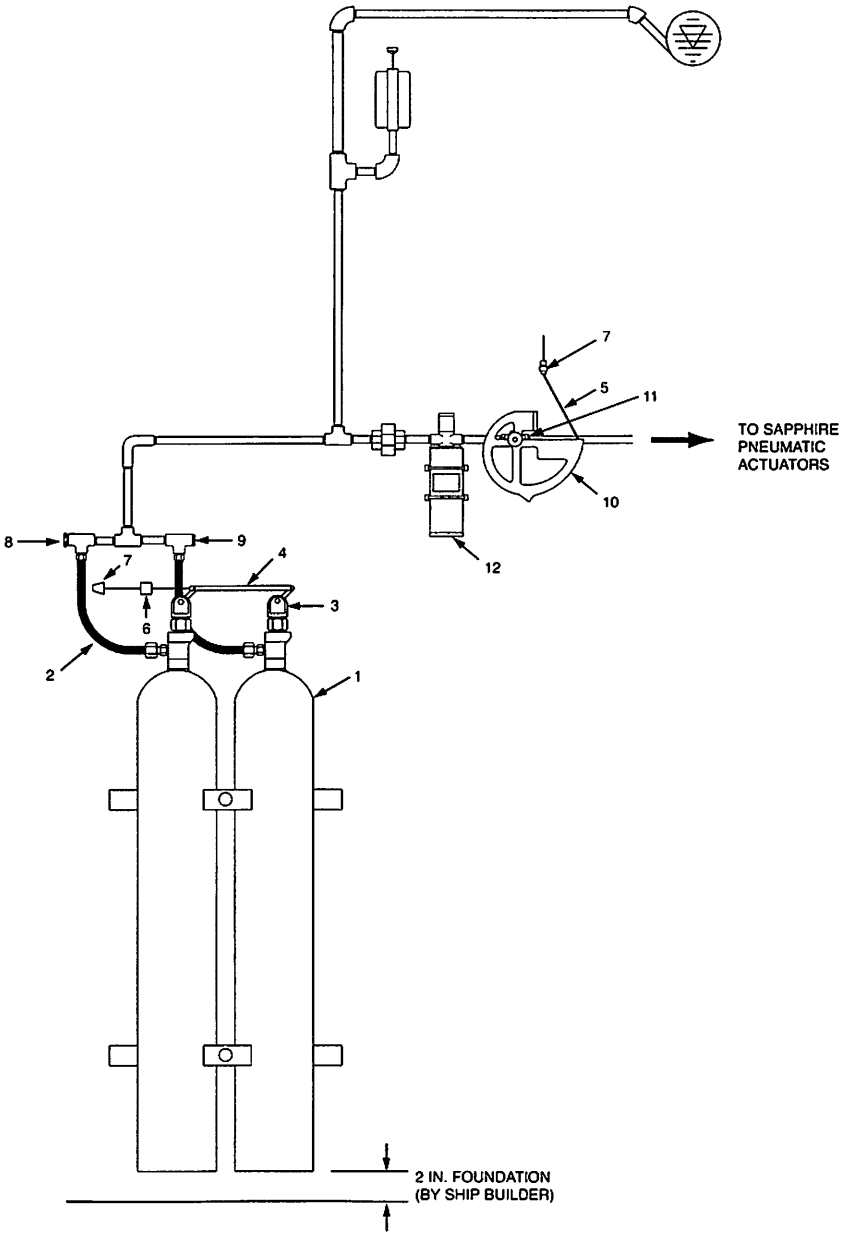


FIGURE 5
006986

SAPPHIRE FIRE SUPPRESSION SYSTEM WITH NITROGEN PILOT CYLINDERS AND PULL CABLE ACTUATION

Item	Description
1	Nitrogen pilot cylinder
2	Pilot cylinder flexible discharge bend
3	Pilot valve lever release actuator
4	Connecting link
5	1/16 in. pull cable
6	Cable clamp
7	Flared end fitting
8	Manifold relief valve
9	Vent plug
10	Sector
11	1/2 in. globe valve
12	Time delay
13	Pressure switch
14	Corner pulley
15	Siren
16	Warning plate
17	Manual pull station/valve release
18	Instruction chart
19	SAPPHIRE tank
20	Tank bracket
21	Actuation hose
22	Male branch tee
23	Male straight adaptor
24	Manifold weld inlet
25	Discharge hose
26	Discharge nozzle
27	Manual pull station-cylinder release

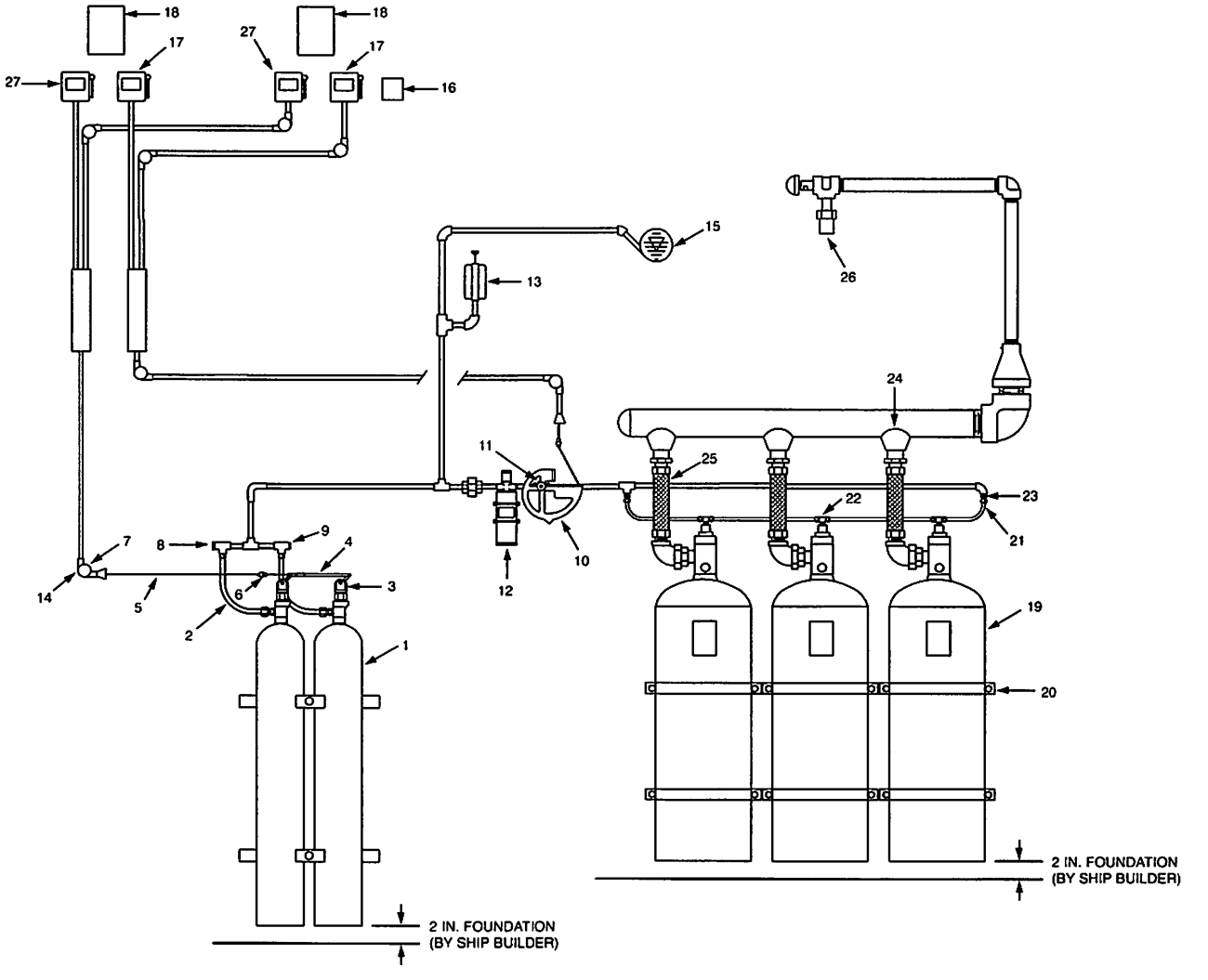


FIGURE 6
006987

REMOTE PRESSURE OPERATED ACTUATION

Item	Part No.	Description
1	433098	Nitrogen pilot cylinder
2	427082	Pilot cylinder flexible discharge bend
3	423309	Pilot valve lever release actuator
4	42514	Connecting link
5	32338	Male straight adaptor
6	32335	20 in. stainless steel hose
7	418378	Manifold relief valve
8	40309	Vent plug
9	28037	Actuation line vent fitting
10	418596	Stop/isolation valve
11	426170/54169	Time delay
12	25627	1/4 in. check valve
13	418731	Marine actuation station – two step
14	7012	LT-20-L nitrogen cartridge

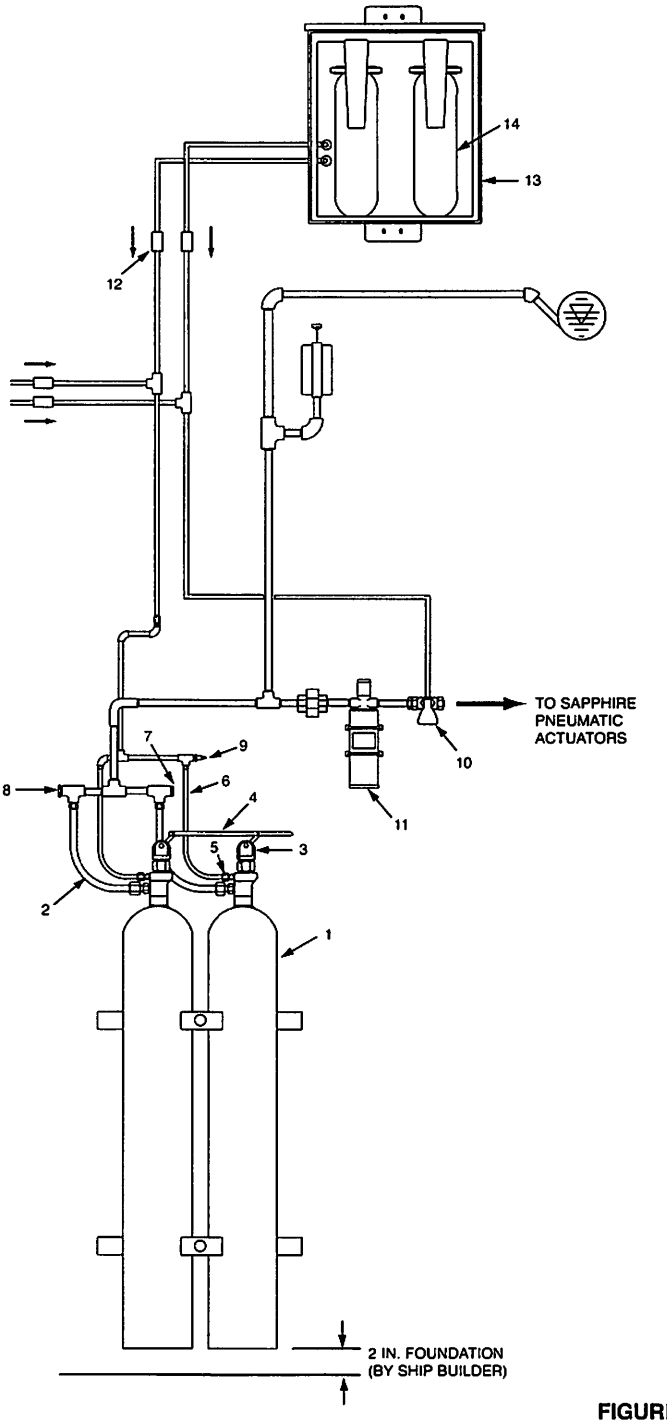


FIGURE 7
006988

SAPPHIRE FIRE SUPPRESSION SYSTEM WITH NITROGEN PILOT CYLINDERS AND REMOTE PRESSURE OPERATED ACTUATION

Item	Description	Item	Description
1	Nitrogen pilot cylinder	13	Marine actuation station – two step
2	Pilot cylinder flexible discharge bend	14	LT-20-L nitrogen cartridge
3	Pilot valve lever release actuator	15	Siren
4	Connecting link	16	Pressure switch
5	Male straight adaptor	17	SAPPHIRE tank
6	20 in. stainless steel hose	18	Tank bracket
7	Manifold relief valve	19	Actuation hose
8	Vent plug	20	Male branch tee
9	Actuation line vent fitting	21	Male straight adaptor
10	Stop/isolation valve	22	Manifold weld inlet
11	Time delay	23	Discharge hose
12	1/4 in. check valve	24	Discharge nozzle

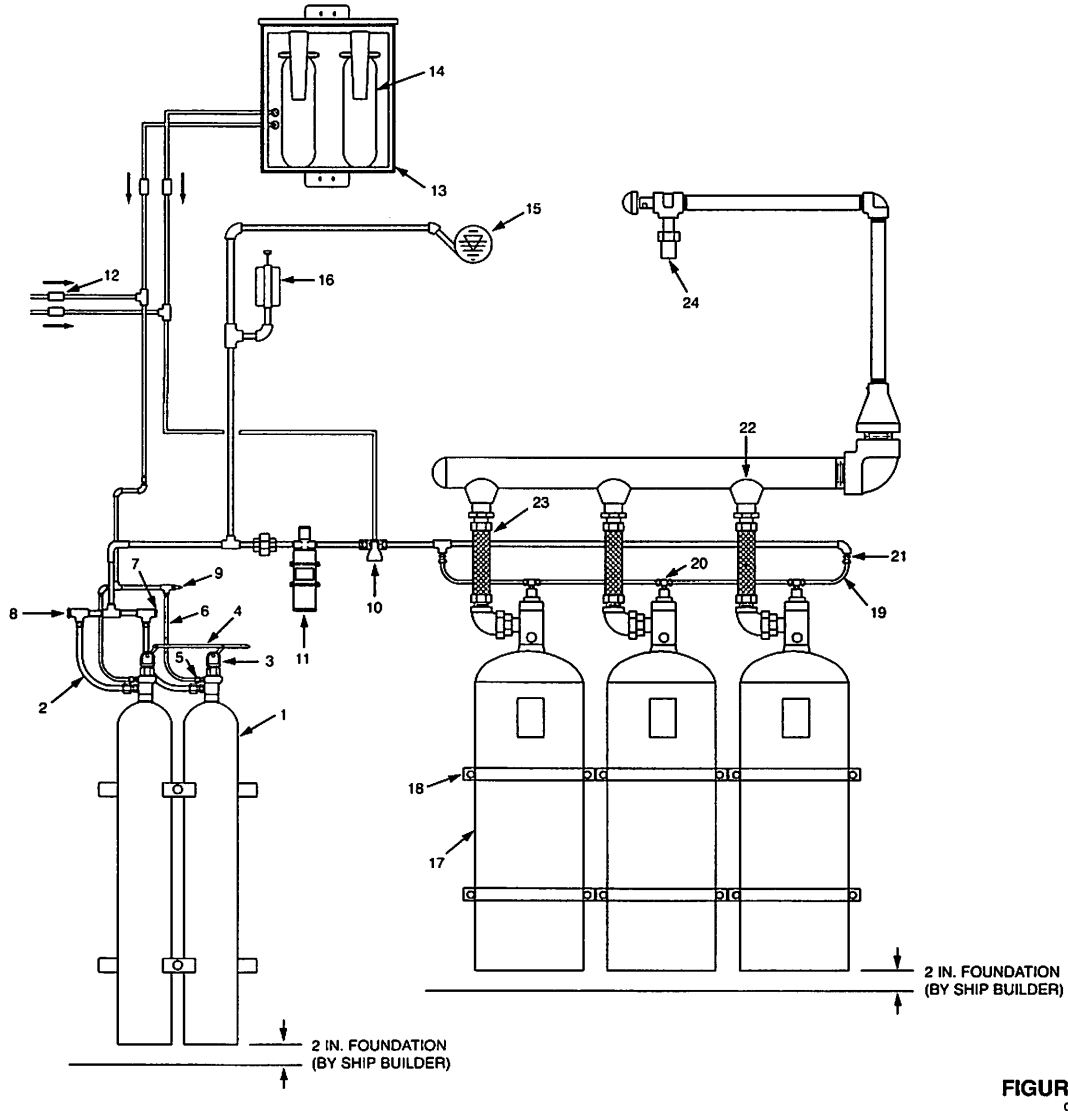


FIGURE 8
006969

LOW PRESSURE SWITCH

Some tank valves are ordered "Factory fitted" with low pressure warning switches. Voltage input can be applied to either terminal.

When the device is connected to a standard supervisory input circuit, there will be no distinction between a wiring fault and device actuation. This device is only to be utilized when accepted by the authority having jurisdiction.

Note: In the normal position, the switch contacts are closed. This will indicate a tank pressure above 300 psi (20.7 bar). If the switch contacts are open, the switch may have been subjected to low temperatures during shipping or storage. To close the switch contacts, the tank must be warmed to a temperature above 70 °F (21 °C). This will allow the tank pressure to close the switch contacts.

ACCESSORIES

Door Signs

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

Manual Release Signs

Manual release signs are required at all manual actuators, remote manual actuators and call points. Plates may be drilled and screw mounted 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 handover may occur before the area is ready for use. In the event of delay between handover and the hazard area being available for protection, 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.

- Hazard areas should be thoroughly checked to ensure that enclosures have been properly constructed and that openings have been sealed.
- All manifolds should be secured firmly to the wall or bulk head.
- Tanks should be securely held within brackets.
- Piping should be securely mounted within brackets.
- All pipe connections must be tight.
- Nozzles are to be the proper type, correctly placed, and properly orientated.
- Check model and weight markings on tank nameplates to verify that correct tanks and charges have been installed as required.
- Verify that all warning and instruction signs are mounted where required.

FINAL CONNECTIONS

Discharge Piping

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

HANDOVER 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 360 psi (25 bar) at 70 °F (21 °C)). Refer to Appendix for pressures at other container temperatures.
2. Check tank weight information label against system requirement. If there is any doubt or if there has been a loss of pressure, the tank 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 handover 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.

NOTES:

DISTRIBUTION PIPING PRESSURE TESTING

After completion of all distribution piping installation, pressure testing (using a gas) must be completed to test the piping network for tightness. The test pressure is to be 540 psi (37 bar) and held for two minutes. The pressure drop is not to be more than 150 psi (10 bar) per minute.

TESTING CABLE PULL STATION

To test a remote cable pull station to pilot cylinder lever release(s), complete the following steps:

CAUTION

Make certain lever actuator(s) are removed from pilot cylinder valves prior to testing pull station. Failure to do so will cause cylinder discharge.

1. Remove lever actuator(s) from cylinder valve.

NOTICE

After removing actuator(s) from cylinder valve, securely support actuator(s) in order for it to operate when pull station is pulled.

2. Pull remote cable pull station. Lever actuator should move to the tripped position.

   If lever actuator does not trip, remove each pulley elbow cover to make certain wire rope is resting on the pulley sheave. If this does not correct the problem, there is too much slack in the cable and it must be retightened.

3. If retightening or realignment was necessary, retry pull station.
4. When pull station operates properly, reset lever actuator.

CAUTION

Make certain lever actuator is in the "SET" position before reinstalling on cylinder valve. Failure to do so will cause actuation when reinstalling.

5. Reinstall lever actuator on cylinder valve. Wrench tighten.

TESTING SELECTOR VALVE

When utilizing selector valves in the distribution piping network, make certain all selector valve actuators are in the "SET" position.

TESTING TIME DELAY

To determine if the time delay is functioning properly, test per the following steps:

CAUTION

Disconnect all system cylinders from actuation and distribution piping before running time delay test. Failure to disconnect system cylinders could cause cylinder actuation during time delay test.

NOTICE

The nitrogen test cylinder should be a minimum of 250 cu. ft. for the delay plus an additional 100 cu. ft./min. for each siren in the system.

CAUTION

Notify proper personnel that alarms will sound and which devices will start-up and/or shut-down.

1. Disconnect all pneumatic actuators from all SAPPHIRE tanks and plug all actuation lines.
2. Disconnect all non-test pilot cylinders from the pilot cylinder manifold.
3. Install the nitrogen test cylinder in the end pilot cylinder position and plug all open actuation hoses.
4. Install a pressure gauge between the test cylinder and the time delay device. The gauge should be calibrated with a capability of at least 3000 psi (20.69 bar) with increments of 50 psi (3.45 bar).
5. Disconnect the piping from the outlet of the time delay and install another pressure gauge, similar to the type specified in Step 1. See Figure 1.

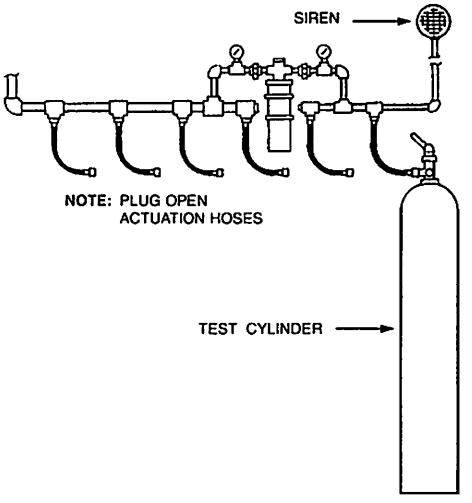


FIGURE 1
000927

NOTICE

The timing cycle should begin when agent is introduced into the time delay device inlet and should end when the pressure gauge in the outlet of the time delay reads 50 psi (3.45 bar).

6. Open the test cylinder to allow flow into the inlet of the time delay and simultaneously begin timing.
7. Observe the inlet pressure gauge approximately 2-3 seconds after opening the test cylinder and record the pressure reading.
8. Observe the pressure gauge on the outlet of the time delay. When the gauge reads 50 psi (3.45 bar), stop timing. Record the time delay period measured.

TESTING FOR COMMISSIONING

Testing shall be done according to the requirements of the appropriate marine authority.

Actuation Test

NOTICE
Inspect system before testing.

1. Check pilot cylinder pressure. Recharge if pressure loss exceeds 5 percent of charge.
2. Actuation test. Remove all cylinders from the system excluding those pilot cylinders required for the hazard being tested.

   NOTICE
   Do not remove discharge hoses from the manifold.

   Actuation tests are normally performed by actuating the furthest remote actuation station from the pilot cylinder in order to ensure the integrity of the pilot tubing and the quantity of pressure in the line. This will normally require two or more personnel due to the distance involved.
3. When the system is actuated, the following items should be verified:
   a. Immediately upon actuation of the pilot cylinders, the audible alarms located in the protected space should sound.
   b. Pressure operated switches (if provided) shall activate.
   c. The time delay immediately downstream from the pilot cylinders shall operate after the designed delay (30 or 60 seconds).
   d. Depending upon the system design; after time delay period, the time delay valve will open allowing gas from the pilot cylinders to:
      – Flow through the manifold and out the open stop/ directional valve.
      – Supply pressure to each pneumatic actuator(s). The pin in each actuator will be pushed to the "down" position.
   e. Time delay should reset itself once the pressure is bled from the manifold.
4. After the system test, reset pneumatic actuators, pressure switches, and pull station. Globe valves should be reset to the closed position. If pneumatic actuation is used, remaining pressure should be bled from the actuation lines, and the LT-20-L nitrogen cartridges should be replaced after ensuring that the puncture pins in the actuator assemblies are in the full upright and set position.
5. Recharge nitrogen pilot cylinders according to manufacturer's instructions and procedures, and replace according to installation instructions.

INSPECTION

Inspection is a "quick check" that a system is operable. It is intended to give reasonable assurance that the system is fully charged and will operate. This is done by seeing that the system has not been tampered with and there is no obvious physical damage, or condition, to prevent operation. The value of an inspection lies in the frequency, and thoroughness, with which it is conducted. Systems should be inspected at regular monthly intervals, or at more frequent intervals when circumstances require.

The following visual checks should be performed during a SAPPHIRE system inspection:

- Visually inspect the hazard area to verify that it has not changed. Look for different fuels, new equipment, blocked open doors or dampers.
- Check detectors to make certain they are in place, not damaged or coated with dirt, grease, paint, or any contaminating substance.
- Check all manual pull stations to assure they have not been tampered with and are not blocked from use.
- Check all alarm devices for damage, dirt, corrosion, etc.
- Check that the piping is secure and nozzles are in place. Make certain the nozzles are not covered with dirt, grease, or paint and that there is nothing structural blocking the discharge.
- Visually inspect all components for signs of damage, such as disconnected or loose parts, corrosion, twisted or dented components, etc.
- Check each SAPPHIRE tank gauge to determine that tank pressure is in the operable range.
- Visually verify that the control panel and/or releasing device is functioning properly.
- Perform any other checks that may be required by the authority having jurisdiction.
- Record that the system has been inspected and inform the proper personnel.

NOTES:

ANNUAL MAINTENANCE EXAMINATION

General

Systems shall be maintained at regular intervals, not more than one year apart, or when specifically indicated by an inspection. (Exception: Cylinder pressure must be checked every six months per NFPA 2001.) Maintenance is a "thorough check" of the system. It is intended to give maximum assurance that a system will operate effectively and safely. It includes a thorough examination and any necessary repair, recharge, or replacement. It will reveal if there is a need for hydrostatic testing of the cylinder. The procedures listed in this section are the minimum that is necessary to maintain a system. If circumstances warrant them, a more thorough procedure should be followed to assure system performance. Refer to Section VII, Testing and Placing in Service, Actuation Test, to test potential problems encountered during the maintenance exam. Make certain that all people affected by the maintenance are informed before you start. This may include all personnel who may be affected by equipment shutdown or start up.

NOTICE

If the system includes a Marine Actuation Station, before proceeding with annual maintenance examination, remove nitrogen cartridge(s). Install safety shipping cap on cartridge.

1. Survey the hazard to make certain it has not changed from what the system was designed to protect. While surveying the hazard, look for different fuels, loss of hazard integrity, new hazards, etc.
2. Check all nozzles to make certain they are in place, that the orifice plates are in place and with the proper orifice. Check the condition of the nozzle for corrosion or damage and make certain it is not obstructed internally or externally.
3. Check the condition of the piping to make certain that it is properly secured in the hangers and that all fittings are connected tightly.
4. Check all warning nameplates throughout the area. Make certain they are in place, mounted securely, readable, and are not damaged.
5. Check all cylinder bracketing. Make certain all cylinders are secured in the brackets. Check for corrosion, damage, or missing components.
6. Check the condition of all cylinders. Look for signs of damage or corrosion, and check the cylinder's last hydrotest date. (NFPA 2001 states "Cylinders continuously in service without discharging shall be given a complete external visual inspection every five years or more frequently if required. The visual inspection shall be in accordance with Compressed Gas Association Pamphlet C-6, Section 3, except that the cylinders need not be emptied or stamped while under pressure.")

   Using the Pressure Test Gauge Assembly, Part No. 423923, check each pilot cylinder to determine if pressure is within the acceptable range.

   To use the pressure test gauge assembly, first make certain cylinder is properly bracketed. Before attaching assembly, make certain stem is completely backed out by turning hand wheel counterclockwise until it stops. Attach the assembly to the fill inlet port of the pilot cylinder valve. Wrench tighten. To read the cylinder pressure, turn handwheel completely clockwise until it stops, then back it off 1/4 turn. This will open the fill port. After pressure has been read, close fill port by turning handwheel completely counterclockwise. Slowly loosen the adaptor nut to remove the pressure test gauge assembly from the fill port. While removing this, you may hear a small hiss of pressure remaining in the assembly. This is normal and will not last long. You will also notice the gauge pressure will drop to zero.

   Record the cylinder pressure for reference on the next pressure test.

   Visually note the location of the indicator needle on the cylinder valve to determine if it is in close proximity to the actual reading of the test gauge.
7. Check condition of all discharge hoses. Look for signs of structural problems like abrasions or weather checking. Make certain all hoses are connected properly. All hoses must be tested every 5 years. Refer to NFPA 2001 for detailed testing requirements.
8. Check condition of all actuators by completing the following:

   CAUTION

   To avoid accidental discharge of the system, remove actuators from pilot cylinders and agent tanks before performing any check or testing procedures.

   a. Remove all actuators from the pilot cylinders and agent tanks and leave them off until the final step in the Maintenance Section.

   b. For manual actuators, check the condition of each actuator to make certain they operate freely. When finished, reset them and seal with inspection seals as required. Do not install on valves.

   c. For pneumatic actuators, check to make certain they operate freely. Make certain they are reset after checking. Do not install on valves.
9. Check all pressure switches for signs of damage or corrosion. Make certain piping to switch is properly attached.
10. Check all pull stations. Make certain they are in place, that they are not blocked or damaged. Operate each pull station to make certain that they operate the appropriate pilot cylinder or selector valve. **Note:** Pull cable should not exceed 14 in. (356 mm) of travel to actuate the system. Reset each pull station and seal with visual inspection seal.
11. Inspect each alarm device. Check the alarms condition and verify that it operates properly.
12. Test the time delay following the instructions in Section VII, Page 7-1.

ANNUAL MAINTENANCE EXAMINATION (Continued)

General (Continued)

13. For systems with pneumatic actuation using a nitrogen cartridge(s) complete the following:
    a. Remove nitrogen cartridge.
    b. Test actuator for operation and ease of movement.
    c. Weigh the nitrogen cartridge (use weigh scale, Part No. 3923). If weight is 1/2 oz. (14.2 g) less than weight stamped on cartridge, replace with a fully charged cartridge. Cartridges that weigh more than 1/8 oz. (3.6 g) over stamped weight should also be replaced.
    d. Make sure all pins are in the up (stand by) position.
    e. Replace cartridge(s).
    f. Replace visual inspection seal.

AGENT TANKS

Tank Weighing

Tanks must be weighed or measured utilizing the liquid level to establish the Novec 1230 agent 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 tank valves.
- Install Safety Outlet Caps onto tank valves.
- Remove tanks from bracketing and weigh tanks. Any tank showing more than the maximum allowable weight loss must be recharged by a qualified recharge agent.
- Record weight of tank on record tag.
- Replace tanks in bracketing and remove Safety Outlet 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 level in 280, 390, 450, and 850 lb. storage tank 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 SAPPHIRE tank from the fire suppression system.

Operation

To measure the liquid level:

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

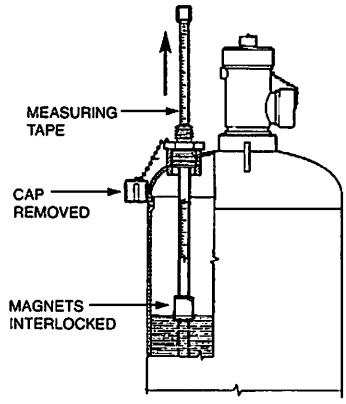


FIGURE 1
006255

3. Read the measurement on the tape directly at the top of the plastic sleeve in the measuring device housing (see Figure 2). Record this measurement and note the temperature of the tank module.

> **NOTICE**
> The tank module temperature can be determined by measuring the ambient temperature at the tank location. The tank must be stored at this temperature for at least 24 hours to obtain an accurate liquid level reading.

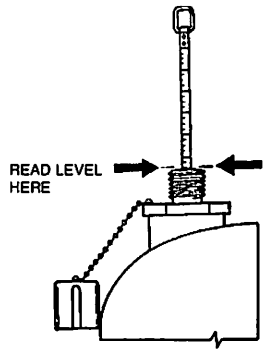


FIGURE 2
006263

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.

AGENT TANKS (Continued

Operation (Continued)

5. Using the Weight Conversion Table located in this section, determine the Novec 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 SAPPHIRE tank temperature noted in Step 3).
   c. Read the weight of agent at the level/temperature column intersection.
6. Compare the weight from the table to the weight of charge stamped on the tank nameplate. If the measurement shows a net weight loss of more than 5%, the tank must be weighted to verify the liquid level measurement. If the weight loss still exceeds 5% of the weight of charge, the tank requires recharging.

Example – Using the Tank Weight Conversion Table

A semi-annual weight check is being performed on a 280 lb. tank filled with 142 lbs. (64 kg) of agent. The temperature of the tank is 60 °F (16 °C). The liquid level measuring device reading is 9.5 in. (24 cm).

Find the 9.5 in. (24 cm) line on the left side of the 280 lb. tank table and read horizontally across the table to the 60 °F (16 °C) column. Then, by reading the weight of agent at the level/temperature column intersection, it is determined that the weight of agent is 139.3 lbs. (63.2 kg).

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

142 lb. x 0.95 = 134.9 lb. (61 kg x 0.95 = 58 kg)

Because the measured weight of agent, 139.3 lb. (63.2 kg), is more than the minimum required weight of 134.9 lb. (61 kg), the weight of agent is within the 5% weight loss tolerance.

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

As a final Maintenance step, record that the maintenance has been performed, as required, to the appropriate marine authority. Notify all personnel that the maintenance has been completed and the system is back to normal.

280 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level Inches	0 (-17.8)	10 (-12.2)	20 (-6.7)	30 (-1.1)	40 (4.4)	50 (10)	60 (15.6)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.8)	110 (43.3)	120 (48.9)	130 (54.4)
6	110.7	109.1	107.5	105.9	104.3	102.8	101.2	99.6	98.0	96.3	94.7	93.0	91.4	89.8
6.25	113.3	111.8	110.2	108.6	107.0	105.5	103.9	102.3	100.7	99.0	97.4	95.7	94.0	92.4
6.5	116.0	114.4	112.9	111.3	109.8	108.2	106.6	105.1	103.4	101.7	100.0	98.4	96.7	95.0
6.75	118.7	117.1	115.6	114.0	112.5	110.9	109.4	107.8	106.1	104.4	102.7	101.0	99.3	97.6
7	121.3	119.8	118.2	116.7	115.2	113.6	112.1	110.5	108.8	107.1	105.4	103.7	102.0	100.3
7.25	124.0	122.5	120.9	119.4	117.9	116.3	114.8	113.3	111.5	109.8	108.1	106.3	104.6	102.9
7.5	126.7	125.1	123.6	122.1	120.6	119.0	117.5	116.0	114.2	112.5	110.8	109.0	107.3	105.5
7.75	129.3	127.8	126.3	124.8	123.3	121.8	120.2	118.7	117.0	115.2	113.4	111.7	109.9	108.1
8	132.0	130.5	129.0	127.5	126.0	124.5	123.0	121.5	119.7	117.9	116.1	114.3	112.5	110.8
8.25	134.7	133.2	131.7	130.2	128.7	127.2	125.7	124.2	122.4	120.6	118.8	117.0	115.2	113.4
8.5	137.3	135.8	134.4	132.9	131.4	129.9	128.4	126.9	125.1	123.3	121.5	119.6	117.8	116.0
8.75	140.0	138.5	137.0	135.6	134.1	132.6	131.1	129.7	127.8	126.0	124.1	122.3	120.5	118.6
9	142.7	141.2	139.7	138.3	136.8	135.3	133.9	132.4	130.5	128.7	126.8	125.0	123.1	121.2
9.25	145.3	143.9	142.4	141.0	139.5	138.0	136.6	135.1	133.3	131.4	129.5	127.6	125.7	123.9
9.5	148.0	146.6	145.1	143.7	142.2	140.8	139.3	137.9	136.0	134.1	132.2	130.3	128.4	126.5
9.75	150.7	149.2	147.8	146.4	144.9	143.5	142.0	140.6	138.7	136.8	134.9	132.9	131.0	129.1
10	153.3	151.9	150.5	149.0	147.6	146.2	144.8	143.3	141.4	139.5	137.5	135.6	133.7	131.7
10.25	156.0	154.6	153.2	151.7	150.3	148.9	147.5	146.1	144.1	142.2	140.2	138.3	136.3	134.4
10.5	158.7	157.3	155.8	154.4	153.0	151.6	150.2	148.8	146.8	144.9	142.9	140.9	139.0	137.0
10.75	161.3	159.9	158.5	157.1	155.7	154.3	152.9	151.5	149.5	147.6	145.6	143.6	141.6	139.6
11	164.0	162.6	161.2	159.8	158.4	157.0	155.7	154.3	152.3	150.3	148.3	146.2	144.2	142.2
11.25	166.7	165.3	163.9	162.5	161.1	159.8	158.4	157.0	155.0	153.0	150.9	148.9	146.9	144.9
11.5	169.3	168.0	166.6	165.2	163.8	162.5	161.1	159.7	157.7	155.6	153.6	151.6	149.5	147.5
11.75	172.0	170.6	169.3	167.9	166.6	165.2	163.8	162.5	160.4	158.3	156.3	154.2	152.2	150.1
12	174.7	173.3	172.0	170.6	169.3	167.9	166.5	165.2	163.1	161.0	159.0	156.9	154.8	152.7
12.25	177.3	176.0	174.6	173.3	172.0	170.6	169.3	167.9	165.8	163.7	161.6	159.5	157.5	155.4
12.5	180.0	178.7	177.3	176.0	174.7	173.3	172.0	170.7	168.5	166.4	164.3	162.2	160.1	158.0
12.75	182.7	181.3	180.0	178.7	177.4	176.0	174.7	173.4	171.3	169.1	167.0	164.9	162.7	160.6
13	185.3	184.0	182.7	181.4	180.1	178.8	177.4	176.1	174.0	171.8	169.7	167.5	165.4	163.2
13.25	188.0	186.7	185.4	184.1	182.8	181.5	180.2	178.9	176.7	174.5	172.4	170.2	168.0	165.9
13.5	190.7	189.4	188.1	186.8	185.5	184.2	182.9	181.6	179.4	177.2	175.0	172.9	170.7	168.5
13.75	193.3	192.1	190.8	189.5	188.2	186.9	185.6	184.3	182.1	179.9	177.7	175.5	173.3	171.1
14	196.0	194.7	193.4	192.2	190.9	189.6	188.3	187.1	184.8	182.6	180.4	178.2	176.0	173.7

280 POUND NOVEC TANK AGENT QUANTITY TABLES (Continued)

Liquid	Temperature Degrees F (Degrees C)													
Level Inches	0 (-17.8)	10 (-12.2)	20 (-6.7)	30 (-1.1)	40 (4.4)	50 (10)	60 (15.6)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.8)	110 (43.3)	120 (48.9)	130 (54.4)
14.25	198.7	197.4	196.1	194.9	193.6	192.3	191.1	189.8	187.6	185.3	183.1	180.8	178.6	176.4
14.5	201.3	200.1	198.8	197.6	196.3	195.0	193.8	192.5	190.3	188.0	185.8	183.5	181.2	179.0
14.75	204.0	202.8	201.5	200.3	199.0	197.8	196.5	195.3	193.0	190.7	188.4	186.2	183.9	181.6
15	206.7	205.4	204.2	203.0	201.7	200.5	199.2	198.0	195.7	193.4	191.1	188.8	186.5	184.2
15.25	209.3	208.1	206.9	205.6	204.4	203.2	202.0	200.7	198.4	196.1	193.8	191.5	189.2	186.8
15.5	212.0	210.8	209.6	208.3	207.1	205.9	204.7	203.5	201.1	198.8	196.5	194.1	191.8	189.5
15.75	214.7	213.5	212.3	211.0	209.8	208.6	207.4	206.2	203.8	201.5	199.1	196.8	194.4	192.1
16	217.3	216.1	214.9	213.7	212.5	211.3	210.1	208.9	206.6	204.2	201.8	199.5	197.1	194.7
16.25	220.0	218.8	217.6	216.4	215.2	214.0	212.9	211.7	209.3	206.9	204.5	202.1	199.7	197.3
16.5	222.7	221.5	220.3	219.1	217.9	216.8	215.6	214.4	212.0	209.6	207.2	204.8	202.4	200.0
16.75	225.3	224.2	223.0	221.8	220.6	219.5	218.3	217.1	214.7	212.3	209.9	207.4	205.0	202.6
17	228.0	226.8	225.7	224.5	223.4	222.2	221.0	219.9	217.4	215.0	212.5	210.1	207.7	205.2
17.25	230.7	229.5	228.4	227.2	226.1	224.9	223.7	222.6	220.1	217.7	215.2	212.8	210.3	207.8
17.5	233.3	232.2	231.1	229.9	228.8	227.6	226.5	225.3	222.9	220.4	217.9	215.4	212.9	210.5
17.75	236.0	234.9	233.7	232.6	231.5	230.3	229.2	228.1	225.6	223.1	220.6	218.1	215.6	213.1
18	238.7	237.5	236.4	235.3	234.2	233.0	231.9	230.8	228.3	225.8	223.3	220.7	218.2	215.7
18.25	241.3	240.2	239.1	238.0	236.9	235.8	234.6	233.5	231.0	228.5	225.9	223.4	220.9	218.3
18.5	244.0	242.9	241.8	240.7	239.6	238.5	237.4	236.3	233.7	231.2	228.6	226.1	223.5	221.0
18.75	246.7	245.6	244.5	243.4	242.3	241.2	240.1	239.0	236.4	233.9	231.3	228.7	226.2	223.6
19	249.3	248.3	247.2	246.1	245.0	243.9	242.8	241.7	239.1	236.6	234.0	231.4	228.8	226.2
19.25	252.0	250.9	249.9	248.8	247.7	246.6	245.5	244.5	241.9	239.3	236.6	234.0	231.4	228.8
19.5	254.7	253.6	252.5	251.5	250.4	249.3	248.3	247.2	244.6	241.9	239.3	236.7	234.1	231.5
19.75	257.3	256.3	255.2	254.2	253.1	252.0	251.0	249.9	247.3	244.6	242.0	239.4	236.7	234.1
20	260.0	259.0	257.9	256.9	255.8	254.8	253.7	252.7	250.0	247.3	244.7	242.0	239.4	236.7
20.25	262.7	261.6	260.6	259.6	258.5	257.5	256.4	255.4	252.7	250.0	247.4	244.7	242.0	239.3
20.5	265.3	264.3	263.3	262.2	261.2	260.2	259.2	258.1	255.4	252.7	250.0	247.3	244.6	242.0
20.75	268.0	267.0	266.0	264.9	263.9	262.9	261.9	260.9	258.1	255.4	252.7	250.0	247.3	244.6
21	270.7	269.7	268.7	267.6	266.6	265.6	264.6	263.6	260.9	258.1	255.4	252.7	249.9	247.2
21.25	273.3	272.3	271.3	270.3	269.3	268.3	267.3	266.3	263.6	260.8	258.1	255.3	252.6	249.8
21.5	276.0	275.0	274.0	273.0	272.0	271.0	270.1	269.1	266.3	263.5	260.8	258.0	255.2	252.4
21.75	278.7	277.7	276.7	275.7	274.7	273.8	272.8	271.8	269.0	266.2	263.4	260.6	257.9	255.1
22	281.3	280.4	279.4	278.4	277.4	276.5	275.5	274.5	271.7	268.9	266.1	263.3	260.5	257.7
22.25	284.0	283.0	282.1	281.1	280.2	279.2	278.2	277.3	274.4	271.6	268.8	266.0	263.1	260.3

280 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level Inches	0 (-17.8)	10 (-12.2)	20 (-6.7)	30 (-1.1)	40 (4.4)	50 (10)	60 (15.6)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.8)	110 (43.3)	120 (48.9)	130 (54.4)
22.5	286.7	285.7	284.8	283.8	282.9	281.9	280.9	280.0	277.2	274.3	271.5	268.6	265.8	262.9
22.75	289.3	288.4	287.5	286.5	285.6	284.6	283.7	282.7	279.9	277.0	274.1	271.3	268.4	265.6
23	292.0	291.1	290.1	289.2	288.3	287.3	286.4	285.5	282.6	279.7	276.8	273.9	271.1	268.2
23.25	294.7	293.7	292.8	291.9	291.0	290.0	289.1	288.2	285.3	282.4	279.5	276.6	273.7	270.8
23.5	297.3	296.4	295.5	294.6	293.7	292.8	291.8	290.9	288.0	285.1	282.2	279.3	276.4	273.4
23.75	300.0	299.1	298.2	297.3	296.4	295.5	294.6	293.7	290.7	287.8	284.9	281.9	279.0	276.1
24	302.7	301.8	300.9	300.0	299.1	298.2	297.3	296.4	293.4	290.5	287.5	284.6	281.6	278.7
24.25	305.3	304.5	303.6	302.7	301.8	300.9	300.0	299.1	296.2	293.2	290.2	287.2	284.3	281.3
24.5	308.0	307.1	306.3	305.4	304.5	303.6	302.7	301.9	298.9	295.9	292.9	289.9	286.9	283.9
24.75	310.7	309.8	308.9	308.1	307.2	306.3	305.5	304.6	301.6	298.6	295.6	292.6	289.6	286.6
25	313.3	312.5	311.6	310.8	309.9	309.0	308.2	307.3	304.3	301.3	298.3	295.2	292.2	289.2
25.25	316.0	315.2	314.3	313.5	312.6	311.8	310.9	310.1	307.0	304.0	300.9	297.9	294.8	291.8
25.5	318.7	317.8	317.0	316.2	315.3	314.5	313.6	312.8	309.7	306.7	303.6	300.6	297.5	294.4
25.75	321.3	320.5	319.7	318.8	318.0	317.2	316.4	315.5	312.4	309.4	306.3	303.2	300.1	297.1
26	324.0	323.2	322.4	321.5	320.7	319.9	319.1	318.3	315.2	312.1	309.0	305.9	302.8	299.7

390 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level Inches	0 (-17.8)	10 (-12.2)	20 (-6.7)	30 (-1.1)	40 (4.4)	50 (10)	60 (15.6)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.8)	110 (43.3)	120 (48.9)	130 (54.4)
7	147.8	146.0	144.2	142.5	140.7	138.9	137.1	135.4	134.5	133.7	132.8	132.0	131.1	130.3
7.25	150.7	148.9	147.1	145.3	143.5	141.7	139.9	138.1	137.2	136.3	135.4	134.6	133.7	132.8
7.5	153.6	151.8	150.0	148.1	146.3	144.4	142.6	140.8	139.9	139.0	138.1	137.2	136.3	135.4
7.75	156.6	154.7	152.8	151.0	149.1	147.2	145.3	143.5	142.5	141.6	140.7	139.8	138.9	137.9
8	159.5	157.6	155.7	153.8	151.9	150.0	148.1	146.2	145.2	144.3	143.3	142.4	141.4	140.5
8.25	162.5	160.5	158.6	156.6	154.7	152.7	150.8	148.9	147.9	146.9	146.0	145.0	144.0	143.1
8.5	165.4	163.4	161.5	159.5	157.5	155.5	153.5	151.6	150.6	149.6	148.6	147.6	146.6	145.6
8.75	168.4	166.3	164.3	162.3	160.3	158.3	156.3	154.3	153.2	152.2	151.2	150.2	149.2	148.2
9	171.3	169.2	167.2	165.2	163.1	161.1	159.0	157.0	155.9	154.9	153.9	152.8	151.8	150.8
9.25	174.2	172.2	170.1	168.0	165.9	163.8	161.7	159.7	158.6	157.5	156.5	155.4	154.4	153.3
9.5	177.2	175.1	172.9	170.8	168.7	166.6	164.5	162.4	161.3	160.2	159.1	158.0	157.0	155.9
9.75	180.1	178.0	175.8	173.7	171.5	169.4	167.2	165.0	163.9	162.8	161.7	160.6	159.5	158.4
10	183.1	180.9	178.7	176.5	174.3	172.1	169.9	167.7	166.6	165.5	164.4	163.2	162.1	161.0
10.25	186.0	183.8	181.6	179.3	177.1	174.9	172.7	170.4	169.3	168.2	167.0	165.9	164.7	163.6
10.5	189.0	186.7	184.4	182.2	179.9	177.7	175.4	173.1	172.0	170.8	169.6	168.5	167.3	166.1
10.75	191.9	189.6	187.3	185.0	182.7	180.4	178.1	175.8	174.6	173.5	172.3	171.1	169.9	168.7
11	194.8	192.5	190.2	187.9	185.5	183.2	180.9	178.5	177.3	176.1	174.9	173.7	172.5	171.2
11.25	197.8	195.4	193.1	190.7	188.3	186.0	183.6	181.2	180.0	178.8	177.5	176.3	175.0	173.8
11.5	200.7	198.3	195.9	193.5	191.1	188.7	186.3	183.9	182.7	181.4	180.2	178.9	177.6	176.4
11.75	203.7	201.2	198.8	196.4	193.9	191.5	189.1	186.6	185.4	184.1	182.8	181.5	180.2	178.9
12	206.6	204.1	201.7	199.2	196.7	194.3	191.8	189.3	188.0	186.7	185.4	184.1	182.8	181.5
12.25	209.5	207.0	204.5	202.0	199.5	197.0	194.5	192.0	190.7	189.4	188.0	186.7	185.4	184.1
12.5	212.5	210.0	207.4	204.9	202.3	199.8	197.3	194.7	193.4	192.0	190.7	189.3	188.0	186.6
12.75	215.4	212.9	210.3	207.7	205.1	202.6	200.0	197.4	196.1	194.7	193.3	191.9	190.6	189.2
13	218.4	215.8	213.2	210.6	207.9	205.3	202.7	200.1	198.7	197.3	195.9	194.5	193.1	191.7
13.25	221.3	218.7	216.0	213.4	210.7	208.1	205.5	202.8	201.4	200.0	198.6	197.1	195.7	194.3
13.5	224.3	221.6	218.9	216.2	213.6	210.9	208.2	205.5	204.1	202.6	201.2	199.7	198.3	196.9
13.75	227.2	224.5	221.8	219.1	216.4	213.6	210.9	208.2	206.8	205.3	203.8	202.4	200.9	199.4
14	230.1	227.4	224.6	221.9	219.2	216.4	213.7	210.9	209.4	207.9	206.5	205.0	203.5	202.0
14.25	233.1	230.3	227.5	224.7	222.0	219.2	216.4	213.6	212.1	210.6	209.1	207.6	206.1	204.5
14.5	236.0	233.2	230.4	227.6	224.8	221.9	219.1	216.3	214.8	213.2	211.7	210.2	208.6	207.1
14.75	239.0	236.1	233.3	230.4	227.6	224.7	221.9	219.0	217.5	215.9	214.3	212.8	211.2	209.7
15	241.9	239.0	236.1	233.3	230.4	227.5	224.6	221.7	220.1	218.6	217.0	215.4	213.8	212.2

390 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level Inches	0 (-17.8)	10 (-12.2)	20 (-6.7)	30 (-1.1)	40 (4.4)	50 (10)	60 (15.6)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.8)	110 (43.3)	120 (48.9)	130 (54.4)
15.25	244.8	241.9	239.0	236.1	233.2	230.2	227.3	224.4	222.8	221.2	219.6	218.0	216.4	214.8
15.5	247.8	244.8	241.9	238.9	236.0	233.0	230.1	227.1	225.5	223.9	222.2	220.6	219.0	217.4
15.75	250.7	247.7	244.8	241.8	238.8	235.8	232.8	229.8	228.2	226.5	224.9	223.2	221.6	219.9
16	253.7	250.7	247.6	244.6	241.6	238.6	235.5	232.5	230.8	229.2	227.5	225.8	224.2	222.5
16.25	256.6	253.6	250.5	247.4	244.4	241.3	238.3	235.2	233.5	231.8	230.1	228.4	226.7	225.0
16.5	259.6	256.5	253.4	250.3	247.2	244.1	241.0	237.9	236.2	234.5	232.8	231.0	229.3	227.6
16.75	262.5	259.4	256.2	253.1	250.0	246.9	243.7	240.6	238.9	237.1	235.4	233.6	231.9	230.2
17	265.4	262.3	259.1	256.0	252.8	249.6	246.5	243.3	241.5	239.8	238.0	236.3	234.5	232.7
17.25	268.4	265.2	262.0	258.8	255.6	252.4	249.2	246.0	244.2	242.4	240.6	238.9	237.1	235.3
17.5	271.3	268.1	264.9	261.6	258.4	255.2	251.9	248.7	246.9	245.1	243.3	241.5	239.7	237.9
17.75	274.3	271.0	267.7	264.5	261.2	257.9	254.7	251.4	249.6	247.7	245.9	244.1	242.2	240.4
18	277.2	273.9	270.6	267.3	264.0	260.7	257.4	254.1	252.2	250.4	248.5	246.7	244.8	243.0
18.25	280.2	276.8	273.5	270.1	266.8	263.5	260.1	256.8	254.9	253.0	251.2	249.3	247.4	245.5
18.5	283.1	279.7	276.4	273.0	269.6	266.2	262.9	259.5	257.6	255.7	253.8	251.9	250.0	248.1
18.75	286.0	282.6	279.2	275.8	272.4	269.0	265.6	262.2	260.3	258.3	256.4	254.5	252.6	250.7
19	289.0	285.5	282.1	278.7	275.2	271.8	268.3	264.9	262.9	261.0	259.1	257.1	255.2	253.2
19.25	291.9	288.4	285.0	281.5	278.0	274.5	271.1	267.6	265.6	263.6	261.7	259.7	257.7	255.8
19.5	294.9	291.4	287.8	284.3	280.8	277.3	273.8	270.3	268.3	266.3	264.3	262.3	260.3	258.3
19.75	297.8	294.3	290.7	287.2	283.6	280.1	276.5	273.0	271.0	269.0	266.9	264.9	262.9	260.9
20	300.7	297.2	293.6	290.0	286.4	282.8	279.3	275.7	273.6	271.6	269.6	267.5	265.5	263.5
20.25	303.7	300.1	296.5	292.8	289.2	285.6	282.0	278.4	276.3	274.3	272.2	270.1	268.1	266.0
20.5	306.6	303.0	299.3	295.7	292.0	288.4	284.7	281.1	279.0	276.9	274.8	272.8	270.7	268.6
20.75	309.6	305.9	302.2	298.5	294.8	291.1	287.5	283.8	281.7	279.6	277.5	275.4	273.3	271.2
21	312.5	308.8	305.1	301.4	297.6	293.9	290.2	286.5	284.3	282.2	280.1	278.0	275.8	273.7
21.25	315.5	311.7	307.9	304.2	300.4	296.7	292.9	289.2	287.0	284.9	282.7	280.6	278.4	276.3
21.5	318.4	314.6	310.8	307.0	303.2	299.4	295.7	291.9	289.7	287.5	285.4	283.2	281.0	278.8
21.75	321.3	317.5	313.7	309.9	306.0	302.2	298.4	294.6	292.4	290.2	288.0	285.8	283.6	281.4
22	324.3	320.4	316.6	312.7	308.8	305.0	301.1	297.3	295.0	292.8	290.6	288.4	286.2	284.0
22.25	327.2	323.3	319.4	315.5	311.6	307.8	303.9	300.0	297.7	295.5	293.2	291.0	288.8	286.5
22.5	330.2	326.2	322.3	318.4	314.4	310.5	306.6	302.7	300.4	298.1	295.9	293.6	291.3	289.1
22.75	333.1	329.1	325.2	321.2	317.3	313.3	309.3	305.4	303.1	300.8	298.5	296.2	293.9	291.6
23	336.1	332.1	328.1	324.1	320.1	316.1	312.1	308.1	305.7	303.4	301.1	298.8	296.5	294.2
23.25	339.0	335.0	330.9	326.9	322.9	318.8	314.8	310.8	308.4	306.1	303.8	301.4	299.1	296.8

390 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level	0	10	20	30	40	50	60	70	80	90	100	110	120	130
Inches	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.8)	(43.3)	(48.9)	(54.4)
23.5	341.9	337.9	333.8	329.7	325.7	321.6	317.5	313.5	311.1	308.7	306.4	304.0	301.7	299.3
23.75	344.9	340.8	336.7	332.6	328.5	324.4	320.3	316.2	313.8	311.4	309.0	306.6	304.3	301.9
24	347.8	343.7	339.5	335.4	331.3	327.1	323.0	318.8	316.5	314.1	311.7	309.3	306.9	304.5
24.25	350.8	346.6	342.4	338.2	334.1	329.9	325.7	321.5	319.1	316.7	314.3	311.9	309.4	307.0
24.5	353.7	349.5	345.3	341.1	336.9	332.7	328.5	324.2	321.8	319.4	316.9	314.5	312.0	309.6
24.75	356.6	352.4	348.2	343.9	339.7	335.4	331.2	326.9	324.5	322.0	319.5	317.1	314.6	312.1
25	359.6	355.3	351.0	346.8	342.5	338.2	333.9	329.6	327.2	324.7	322.2	319.7	317.2	314.7
25.25	362.5	358.2	353.9	349.6	345.3	341.0	336.7	332.3	329.8	327.3	324.8	322.3	319.8	317.3
25.5	365.5	361.1	356.8	352.4	348.1	343.7	339.4	335.0	332.5	330.0	327.4	324.9	322.4	319.8
25.75	368.4	364.0	359.6	355.3	350.9	346.5	342.1	337.7	335.2	332.6	330.1	327.5	324.9	322.4
26	371.4	366.9	362.5	358.1	353.7	349.3	344.9	340.4	337.9	335.3	332.7	330.1	327.5	325.0
26.25	374.3	369.8	365.4	360.9	356.5	352.0	347.6	343.1	340.5	337.9	335.3	332.7	330.1	327.5
26.5	377.2	372.8	368.3	363.8	359.3	354.8	350.3	345.8	343.2	340.6	338.0	335.3	332.7	330.1
26.75	380.2	375.7	371.1	366.6	362.1	357.6	353.1	348.5	345.9	343.2	340.6	337.9	335.3	332.6
27	383.1	378.6	374.0	369.5	364.9	360.3	355.8	351.2	348.6	345.9	343.2	340.5	337.9	335.2
27.25	386.1	381.5	376.9	372.3	367.7	363.1	358.5	353.9	351.2	348.5	345.8	343.1	340.5	337.8
27.5	389.0	384.4	379.8	375.1	370.5	365.9	361.3	356.6	353.9	351.2	348.5	345.8	343.0	340.3
27.75	391.9	387.3	382.6	378.0	373.3	368.6	364.0	359.3	356.6	353.8	351.1	348.4	345.6	342.9
28	394.9	390.2	385.5	380.8	376.1	371.4	366.7	362.0	359.3	356.5	353.7	351.0	348.2	345.4
28.25	397.8	393.1	388.4	383.6	378.9	374.2	369.4	364.7	361.9	359.1	356.4	353.6	350.8	348.0
28.5	400.8	396.0	391.2	386.5	381.7	376.9	372.2	367.4	364.6	361.8	359.0	356.2	353.4	350.6
28.75	403.7	398.9	394.1	389.3	384.5	379.7	374.9	370.1	367.3	364.5	361.6	358.8	356.0	353.1
29	406.7	401.8	397.0	392.2	387.3	382.5	377.6	372.8	370.0	367.1	364.3	361.4	358.5	355.7
29.25	409.6	404.7	399.9	395.0	390.1	385.3	380.4	375.5	372.6	369.8	366.9	364.0	361.1	358.3
29.5	412.5	407.6	402.7	397.8	392.9	388.0	383.1	378.2	375.3	372.4	369.5	366.6	363.7	360.8
29.75	415.5	410.5	405.6	400.7	395.7	390.8	385.8	380.9	378.0	375.1	372.1	369.2	366.3	363.4
30	418.4	413.5	408.5	403.5	398.5	393.6	388.6	383.6	380.7	377.7	374.8	371.8	368.9	365.9
30.25	421.4	416.4	411.4	406.3	401.3	396.3	391.3	386.3	383.3	380.4	377.4	374.4	371.5	368.5
30.5	424.3	419.3	414.2	409.2	404.1	399.1	394.0	389.0	386.0	383.0	380.0	377.0	374.1	371.1
30.75	427.3	422.2	417.1	412.0	406.9	401.9	396.8	391.7	388.7	385.7	382.7	379.6	376.6	373.6
31	430.2	425.1	420.0	414.9	409.7	404.6	399.5	394.4	391.4	388.3	385.3	382.3	379.2	376.2
31.25	433.1	428.0	422.8	417.7	412.5	407.4	402.2	397.1	394.0	391.0	387.9	384.9	381.8	378.7
31.5	436.1	430.9	425.7	420.5	415.3	410.2	405.0	399.8	396.7	393.6	390.6	387.5	384.4	381.3

390 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level	0	10	20	30	40	50	60	70	80	90	100	110	120	130
Inches	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.8)	(43.3)	(48.9)	(54.4)
31.75	439.0	433.8	428.6	423.4	418.1	412.9	407.7	402.5	399.4	396.3	393.2	390.1	387.0	383.9
32	442.0	436.7	431.5	426.2	421.0	415.7	410.4	405.2	402.1	398.9	395.8	392.7	389.6	386.4
32.25	444.9	439.6	434.3	429.0	423.8	418.5	413.2	407.9	404.7	401.6	398.4	395.3	392.1	389.0
32.5	447.8	442.5	437.2	431.9	426.6	421.2	415.9	410.6	407.4	404.2	401.1	397.9	394.7	391.6
32.75	450.8	445.4	440.1	434.7	429.4	424.0	418.6	413.3	410.1	406.9	403.7	400.5	397.3	394.1
33	453.7	448.3	442.9	437.6	432.2	426.8	421.4	416.0	412.8	409.6	406.3	403.1	399.9	396.7
33.25	456.7	451.2	445.8	440.4	435.0	429.5	424.1	418.7	415.4	412.2	409.0	405.7	402.5	399.2
33.5	459.6	454.2	448.7	443.2	437.8	432.3	426.8	421.4	418.1	414.9	411.6	408.3	405.1	401.8
33.75	462.6	457.1	451.6	446.1	440.6	435.1	429.6	424.1	420.8	417.5	414.2	410.9	407.7	404.4
34	465.5	460.0	454.4	448.9	443.4	437.8	432.3	426.8	423.5	420.2	416.9	413.5	410.2	406.9

450 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level	0	10	20	30	40	50	60	70	80	90	100	110	120	130
Inches	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.8)	(43.3)	(48.9)	(54.4)
10	179.2	177.5	175.8	174.1	172.4	170.6	168.9	167.2	165.3	163.3	161.3	159.4	157.4	155.4
10.25	182.1	180.4	178.7	177.0	175.2	173.5	171.8	170.0	168.1	166.1	164.1	162.1	160.1	158.1
10.5	185.1	183.4	181.6	179.9	178.1	176.4	174.6	172.9	170.8	168.8	166.8	164.8	162.8	160.7
10.75	188.1	186.3	184.5	182.8	181.0	179.2	177.5	175.7	173.6	171.6	169.5	167.5	165.5	163.4
11	191.0	189.2	187.5	185.7	183.9	182.1	180.3	178.5	176.4	174.4	172.3	170.2	168.1	166.1
11.25	194.0	192.2	190.4	188.6	186.8	184.9	183.1	181.3	179.2	177.1	175.0	172.9	170.8	168.7
11.5	197.0	195.1	193.3	191.5	189.6	187.8	186.0	184.1	182.0	179.9	177.8	175.6	173.5	171.4
11.75	199.9	198.1	196.2	194.4	192.5	190.7	188.8	187.0	184.8	182.7	180.5	178.4	176.2	174.0
12	202.9	201.0	199.1	197.3	195.4	193.5	191.6	189.8	187.6	185.4	183.2	181.1	178.9	176.7
12.25	205.9	204.0	202.1	200.2	198.3	196.4	194.5	192.6	190.4	188.2	186.0	183.8	181.6	179.4
12.5	208.8	206.9	205.0	203.1	201.2	199.2	197.3	195.4	193.2	190.9	188.7	186.5	184.3	182.0
12.75	211.8	209.8	207.9	206.0	204.0	202.1	200.2	198.2	196.0	193.7	191.5	189.2	186.9	184.7
13	214.7	212.8	210.8	208.9	206.9	205.0	203.0	201.0	198.8	196.5	194.2	191.9	189.6	187.4
13.25	217.7	215.7	213.8	211.8	209.8	207.8	205.8	203.9	201.6	199.2	196.9	194.6	192.3	190.0
13.5	220.7	218.7	216.7	214.7	212.7	210.7	208.7	206.7	204.3	202.0	199.7	197.3	195.0	192.7
13.75	223.6	221.6	219.6	217.6	215.6	213.5	211.5	209.5	207.1	204.8	202.4	200.1	197.7	195.3
14	226.6	224.6	222.5	220.5	218.4	216.4	214.4	212.3	209.9	207.5	205.2	202.8	200.4	198.0
14.25	229.6	227.5	225.4	223.4	221.3	219.3	217.2	215.1	212.7	210.3	207.9	205.5	203.1	200.7
14.5	232.5	230.4	228.4	226.3	224.2	222.1	220.0	218.0	215.5	213.1	210.6	208.2	205.8	203.3
14.75	235.5	233.4	231.3	229.2	227.1	225.0	222.9	220.8	218.3	215.8	213.4	210.9	208.4	206.0
15	238.5	236.3	234.2	232.1	230.0	227.8	225.7	223.6	221.1	218.6	216.1	213.6	211.1	208.6
15.25	241.4	239.3	237.1	235.0	232.8	230.7	228.5	226.4	223.9	221.4	218.9	216.3	213.8	211.3
15.5	244.4	242.2	240.1	237.9	235.7	233.6	231.4	229.2	226.7	224.1	221.6	219.0	216.5	214.0
15.75	247.3	245.2	243.0	240.8	238.6	236.4	234.2	232.0	229.5	226.9	224.3	221.8	219.2	216.6
16	250.3	248.1	245.9	243.7	241.5	239.3	237.1	234.9	232.3	229.7	227.1	224.5	221.9	219.3
16.25	253.3	251.0	248.8	246.6	244.4	242.1	239.9	237.7	235.1	232.4	229.8	227.2	224.6	221.9
16.5	256.2	254.0	251.7	249.5	247.2	245.0	242.7	240.5	237.8	235.2	232.5	229.9	227.2	224.6
16.75	259.2	256.9	254.7	252.4	250.1	247.9	245.6	243.3	240.6	238.0	235.3	232.6	229.9	227.3
17	262.2	259.9	257.6	255.3	253.0	250.7	248.4	246.1	243.4	240.7	238.0	235.3	232.6	229.9
17.25	265.1	262.8	260.5	258.2	255.9	253.6	251.3	248.9	246.2	243.5	240.8	238.0	235.3	232.6
17.5	268.1	265.8	263.4	261.1	258.8	256.4	254.1	251.8	249.0	246.3	243.5	240.7	238.0	235.2
17.75	271.1	268.7	266.4	264.0	261.6	259.3	256.9	254.6	251.8	249.0	246.2	243.5	240.7	237.9
18	274.0	271.6	269.3	266.9	264.5	262.1	259.8	257.4	254.6	251.8	249.0	246.2	243.4	240.6

450 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level	0	10	20	30	40	50	60	70	80	90	100	110	120	130
Inches	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.8)	(43.3)	(48.9)	(54.4)
18.25	277.0	274.6	272.2	269.8	267.4	265.0	262.6	260.2	257.4	254.6	251.7	248.9	246.1	243.2
18.5	279.9	277.5	275.1	272.7	270.3	267.9	265.5	263.0	260.2	257.3	254.5	251.6	248.7	245.9
18.75	282.9	280.5	278.0	275.6	273.2	270.7	268.3	265.9	263.0	260.1	257.2	254.3	251.4	248.5
19	285.9	283.4	281.0	278.5	276.0	273.6	271.1	268.7	265.8	262.8	259.9	257.0	254.1	251.2
19.25	288.8	286.4	283.9	281.4	278.9	276.4	274.0	271.5	268.6	265.6	262.7	259.7	256.8	253.9
19.5	291.8	289.3	286.8	284.3	281.8	279.3	276.8	274.3	271.3	268.4	265.4	262.5	259.5	256.5
19.75	294.8	292.2	289.7	287.2	284.7	282.2	279.6	277.1	274.1	271.1	268.2	265.2	262.2	259.2
20	297.7	295.2	292.6	290.1	287.6	285.0	282.5	279.9	276.9	273.9	270.9	267.9	264.9	261.8
20.25	300.7	298.1	295.6	293.0	290.4	287.9	285.3	282.8	279.7	276.7	273.6	270.6	267.5	264.5
20.5	303.7	301.1	298.5	295.9	293.3	290.7	288.2	285.6	282.5	279.4	276.4	273.3	270.2	267.2
20.75	306.6	304.0	301.4	298.8	296.2	293.6	291.0	288.4	285.3	282.2	279.1	276.0	272.9	269.8
21	309.6	307.0	304.3	301.7	299.1	296.5	293.8	291.2	288.1	285.0	281.9	278.7	275.6	272.5
21.25	312.6	309.9	307.3	304.6	302.0	299.3	296.7	294.0	290.9	287.7	284.6	281.4	278.3	275.1
21.5	315.5	312.8	310.2	307.5	304.8	302.2	299.5	296.8	293.7	290.5	287.3	284.2	281.0	277.8
21.75	318.5	315.8	313.1	310.4	307.7	305.0	302.4	299.7	296.5	293.3	290.1	286.9	283.7	280.5
22	321.4	318.7	316.0	313.3	310.6	307.9	305.2	302.5	299.3	296.0	292.8	289.6	286.4	283.1
22.25	324.4	321.7	318.9	316.2	313.5	310.8	308.0	305.3	302.0	298.8	295.5	292.3	289.0	285.8
22.5	327.4	324.6	321.9	319.1	316.4	313.6	310.9	308.1	304.8	301.6	298.3	295.0	291.7	288.5
22.75	330.3	327.6	324.8	322.0	319.2	316.5	313.7	310.9	307.6	304.3	301.0	297.7	294.4	291.1
23	333.3	330.5	327.7	324.9	322.1	319.3	316.5	313.8	310.4	307.1	303.8	300.4	297.1	293.8
23.25	336.3	333.4	330.6	327.8	325.0	322.2	319.4	316.6	313.2	309.9	306.5	303.1	299.8	296.4
23.5	339.2	336.4	333.6	330.7	327.9	325.1	322.2	319.4	316.0	312.6	309.2	305.9	302.5	299.1
23.75	342.2	339.3	336.5	333.6	330.8	327.9	325.1	322.2	318.8	315.4	312.0	308.6	305.2	301.8
24	345.2	342.3	339.4	336.5	333.7	330.8	327.9	325.0	321.6	318.2	314.7	311.3	307.8	304.4
24.25	348.1	345.2	342.3	339.4	336.5	333.6	330.7	327.8	324.4	320.9	317.5	314.0	310.5	307.1
24.5	351.1	348.2	345.2	342.3	339.4	336.5	333.6	330.7	327.2	323.7	320.2	316.7	313.2	309.7
24.75	354.0	351.1	348.2	345.2	342.3	339.4	336.4	333.5	330.0	326.5	322.9	319.4	315.9	312.4
25	357.0	354.0	351.1	348.1	345.2	342.2	339.3	336.3	332.8	329.2	325.7	322.1	318.6	315.1
25.25	360.0	357.0	354.0	351.0	348.1	345.1	342.1	339.1	335.5	332.0	328.4	324.8	321.3	317.7
25.5	362.9	359.9	356.9	353.9	350.9	347.9	344.9	341.9	338.3	334.7	331.2	327.6	324.0	320.4
25.75	365.9	362.9	359.9	356.8	353.8	350.8	347.8	344.8	341.1	337.5	333.9	330.3	326.7	323.0
26	368.9	365.8	362.8	359.7	356.7	353.7	350.6	347.6	343.9	340.3	336.6	333.0	329.3	325.7
26.25	371.8	368.8	365.7	362.6	359.6	356.5	353.4	350.4	346.7	343.0	339.4	335.7	332.0	328.4

450 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level	0	10	20	30	40	50	60	70	80	90	100	110	120	130
Inches	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.8)	(43.3)	(48.9)	(54.4)
26.5	374.8	371.7	368.6	365.5	362.5	359.4	356.3	353.2	349.5	345.8	342.1	338.4	334.7	331.0
26.75	377.8	374.6	371.5	368.4	365.3	362.2	359.1	356.0	352.3	348.6	344.8	341.1	337.4	333.7
27	380.7	377.6	374.5	371.3	368.2	365.1	362.0	358.8	355.1	351.3	347.6	343.8	340.1	336.3
27.25	383.7	380.5	377.4	374.2	371.1	367.9	364.8	361.7	357.9	354.1	350.3	346.6	342.8	339.0
27.5	386.6	383.5	380.3	377.1	374.0	370.8	367.6	364.5	360.7	356.9	353.1	349.3	345.5	341.7
27.75	389.6	386.4	383.2	380.0	376.9	373.7	370.5	367.3	363.5	359.6	355.8	352.0	348.1	344.3
28	392.6	389.4	386.2	382.9	379.7	376.5	373.3	370.1	366.3	362.4	358.5	354.7	350.8	347.0
28.25	395.5	392.3	389.1	385.8	382.6	379.4	376.2	372.9	369.0	365.2	361.3	357.4	353.5	349.6
28.5	398.5	395.2	392.0	388.7	385.5	382.2	379.0	375.7	371.8	367.9	364.0	360.1	356.2	352.3
28.75	401.5	398.2	394.9	391.6	388.4	385.1	381.8	378.6	374.6	370.7	366.8	362.8	358.9	355.0
29	404.4	401.1	397.8	394.6	391.3	388.0	384.7	381.4	377.4	373.5	369.5	365.5	361.6	357.6
29.25	407.4	404.1	400.8	397.5	394.1	390.8	387.5	384.2	380.2	376.2	372.2	368.3	364.3	360.3
29.5	410.4	407.0	403.7	400.4	397.0	393.7	390.4	387.0	383.0	379.0	375.0	371.0	367.0	362.9
29.75	413.3	410.0	406.6	403.3	399.9	396.5	393.2	389.8	385.8	381.8	377.7	373.7	369.6	365.6
30	416.3	412.9	409.5	406.2	402.8	399.4	396.0	392.7	388.6	384.5	380.5	376.4	372.3	368.3
30.25	419.2	415.8	412.5	409.1	405.7	402.3	398.9	395.5	391.4	387.3	383.2	379.1	375.0	370.9
30.5	422.2	418.8	415.4	412.0	408.5	405.1	401.7	398.3	394.2	390.1	385.9	381.8	377.7	373.6
30.75	425.2	421.7	418.3	414.9	411.4	408.0	404.5	401.1	397.0	392.8	388.7	384.5	380.4	376.2
31	428.1	424.7	421.2	417.8	414.3	410.8	407.4	403.9	399.8	395.6	391.4	387.2	383.1	378.9
31.25	431.1	427.6	424.1	420.7	417.2	413.7	410.2	406.7	402.5	398.3	394.2	390.0	385.8	381.6
31.5	434.1	430.6	427.1	423.6	420.1	416.6	413.1	409.6	405.3	401.1	396.9	392.7	388.4	384.2
31.75	437.0	433.5	430.0	426.5	422.9	419.4	415.9	412.4	408.1	403.9	399.6	395.4	391.1	386.9
32	440.0	436.4	432.9	429.4	425.8	422.3	418.7	415.2	410.9	406.6	402.4	398.1	393.8	389.5
32.25	443.0	439.4	435.8	432.3	428.7	425.1	421.6	418.0	413.7	409.4	405.1	400.8	396.5	392.2
32.5	445.9	442.3	438.8	435.2	431.6	428.0	424.4	420.8	416.5	412.2	407.8	403.5	399.2	394.9
32.75	448.9	445.3	441.7	438.1	434.5	430.9	427.3	423.6	419.3	414.9	410.6	406.2	401.9	397.5
33	451.8	448.2	444.6	441.0	437.3	433.7	430.1	426.5	422.1	417.7	413.3	408.9	404.6	400.2
33.25	454.8	451.2	447.5	443.9	440.2	436.6	432.9	429.3	424.9	420.5	416.1	411.7	407.3	402.9
33.5	457.8	454.1	450.4	446.8	443.1	439.4	435.8	432.1	427.7	423.2	418.8	414.4	409.9	405.5
33.75	460.7	457.0	453.4	449.7	446.0	442.3	438.6	434.9	430.5	426.0	421.5	417.1	412.6	408.2
34	463.7	460.0	456.3	452.6	448.9	445.2	441.4	437.7	433.3	428.8	424.3	419.8	415.3	410.8
34.25	466.7	462.9	459.2	455.5	451.7	448.0	444.3	440.6	436.0	431.5	427.0	422.5	418.0	413.5
34.5	469.6	465.9	462.1	458.4	454.6	450.9	447.1	443.4	438.8	434.3	429.8	425.2	420.7	416.2

450 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level Inches	0 (-17.8)	10 (-12.2)	20 (-6.7)	30 (-1.1)	40 (4.4)	50 (10)	60 (15.6)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.8)	110 (43.3)	120 (48.9)	130 (54.4)
34.75	472.6	468.8	465.0	461.3	457.5	453.7	450.0	446.2	441.6	437.1	432.5	427.9	423.4	418.8
35	475.6	471.8	468.0	464.2	460.4	456.6	452.8	449.0	444.4	439.8	435.2	430.7	426.1	421.5
35.25	478.5	474.7	470.9	467.1	463.3	459.5	455.6	451.8	447.2	442.6	438.0	433.4	428.8	424.1
35.5	481.5	477.6	473.8	470.0	466.1	462.3	458.5	454.6	450.0	445.4	440.7	436.1	431.4	426.8
35.75	484.4	480.6	476.7	472.9	469.0	465.2	461.3	457.5	452.8	448.1	443.5	438.8	434.1	429.5
36	487.4	483.5	479.7	475.8	471.9	468.0	464.2	460.3	455.6	450.9	446.2	441.5	436.8	432.1
36.25	490.4	486.5	482.6	478.7	474.8	470.9	467.0	463.1	458.4	453.7	448.9	444.2	439.5	434.8
36.5	493.3	489.4	485.5	481.6	477.7	473.7	469.8	465.9	461.2	456.4	451.7	446.9	442.2	437.4
36.75	496.3	492.4	488.4	484.5	480.5	476.6	472.7	468.7	464.0	459.2	454.4	449.6	444.9	440.1
37	499.3	495.3	491.3	487.4	483.4	479.5	475.5	471.5	466.8	462.0	457.2	452.4	447.6	442.8
37.25	502.2	498.3	494.3	490.3	486.3	482.3	478.3	474.4	469.5	464.7	459.9	455.1	450.2	445.4
37.5	505.2	501.2	497.2	493.2	489.2	485.2	481.2	477.2	472.3	467.5	462.6	457.8	452.9	448.1
37.75	508.2	504.1	500.1	496.1	492.1	488.0	484.0	480.0	475.1	470.2	465.4	460.5	455.6	450.7
38	511.1	507.1	503.0	499.0	494.9	490.9	486.9	482.8	477.9	473.0	468.1	463.2	458.3	453.4
38.25	514.1	510.0	506.0	501.9	497.8	493.8	489.7	485.6	480.7	475.8	470.8	465.9	461.0	456.1
38.5	517.0	513.0	508.9	504.8	500.7	496.6	492.5	488.5	483.5	478.5	473.6	468.6	463.7	458.7
38.75	520.0	515.9	511.8	507.7	503.6	499.5	495.4	491.3	486.3	481.3	476.3	471.3	466.4	461.4
39	523.0	518.9	514.7	510.6	506.5	502.3	498.2	494.1	489.1	484.1	479.1	474.1	469.1	464.0
39.25	525.9	521.8	517.6	513.5	509.4	505.2	501.1	496.9	491.9	486.8	481.8	476.8	471.7	466.7
39.5	528.9	524.7	520.6	516.4	512.2	508.1	503.9	499.7	494.7	489.6	484.5	479.5	474.4	469.4
39.75	531.9	527.7	523.5	519.3	515.1	510.9	506.7	502.5	497.5	492.4	487.3	482.2	477.1	472.0
40	534.8	530.6	526.4	522.2	518.0	513.8	509.6	505.4	500.2	495.1	490.0	484.9	479.8	474.7
40.25	537.8	533.6	529.3	525.1	520.9	516.6	512.4	508.2	503.0	497.9	492.8	487.6	482.5	477.3
40.5	540.8	536.5	532.3	528.0	523.8	519.5	515.2	511.0	505.8	500.7	495.5	490.3	485.2	480.0
40.75	543.7	539.5	535.2	530.9	526.6	522.4	518.1	513.8	508.6	503.4	498.2	493.0	487.9	482.7
41	546.7	542.4	538.1	533.8	529.5	525.2	520.9	516.6	511.4	506.2	501.0	495.8	490.5	485.3
41.25	549.7	545.3	541.0	536.7	532.4	528.1	523.8	519.5	514.2	509.0	503.7	498.5	493.2	488.0
41.5	552.6	548.3	543.9	539.6	535.3	530.9	526.6	522.3	517.0	511.7	506.5	501.2	495.9	490.6
41.75	555.6	551.2	546.9	542.5	538.2	533.8	529.4	525.1	519.8	514.5	509.2	503.9	498.6	493.3
42	558.5	554.2	549.8	545.4	541.0	536.7	532.3	527.9	522.6	517.3	511.9	506.6	501.3	496.0

850 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level	0	10	20	30	40	50	60	70	80	90	100	110	120	130
Inches	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.8)	(43.3)	(48.9)	(54.4)
5	362.1	358.7	355.3	352.0	348.6	345.3	341.9	338.6	335.6	332.5	329.5	326.5	323.5	320.5
5.25	368.5	365.1	361.7	358.3	354.9	351.5	348.1	344.7	341.6	338.5	335.4	332.4	329.3	326.2
5.5	375.0	371.5	368.1	364.6	361.1	357.7	354.2	350.7	347.6	344.5	341.3	338.2	335.1	331.9
5.75	381.5	378.0	374.4	370.9	367.4	363.8	360.3	356.8	353.6	350.4	347.2	344.1	340.9	337.7
6	388.0	384.4	380.8	377.2	373.6	370.0	366.4	362.9	359.6	356.4	353.1	349.9	346.7	343.4
6.25	394.4	390.8	387.1	383.5	379.9	376.2	372.6	368.9	365.6	362.3	359.0	355.8	352.5	349.2
6.5	400.9	397.2	393.5	389.8	386.1	382.4	378.7	375.0	371.7	368.3	365.0	361.6	358.3	354.9
6.75	407.4	403.6	399.9	396.1	392.3	388.6	384.8	381.1	377.7	374.3	370.9	367.5	364.0	360.6
7	413.9	410.0	406.2	402.4	398.6	394.8	391.0	387.1	383.7	380.2	376.8	373.3	369.8	366.4
7.25	420.3	416.5	412.6	408.7	404.8	401.0	397.1	393.2	389.7	386.2	382.7	379.2	375.6	372.1
7.5	426.8	422.9	418.9	415.0	411.1	407.1	403.2	399.3	395.7	392.1	388.6	385.0	381.4	377.9
7.75	433.3	429.3	425.3	421.3	417.3	413.3	409.3	405.3	401.7	398.1	394.5	390.9	387.2	383.6
8	439.8	435.7	431.7	427.6	423.6	419.5	415.5	411.4	407.7	404.1	400.4	396.7	393.0	389.3
8.25	446.2	442.1	438.0	433.9	429.8	425.7	421.6	417.5	413.7	410.0	406.3	402.6	398.8	395.1
8.5	452.7	448.5	444.4	440.2	436.0	431.9	427.7	423.5	419.8	416.0	412.2	408.4	404.6	400.8
8.75	459.2	455.0	450.7	446.5	442.3	438.1	433.8	429.6	425.8	421.9	418.1	414.3	410.4	406.6
9	465.7	461.4	457.1	452.8	448.5	444.2	440.0	435.7	431.8	427.9	424.0	420.1	416.2	412.3
9.25	472.1	467.8	463.5	459.1	454.8	450.4	446.1	441.8	437.8	433.9	429.9	426.0	422.0	418.0
9.5	478.6	474.2	469.8	465.4	461.0	456.6	452.2	447.8	443.8	439.8	435.8	431.8	427.8	423.8
9.75	485.1	480.6	476.2	471.7	467.3	462.8	458.3	453.9	449.8	445.8	441.7	437.7	433.6	429.5
10	491.6	487.0	482.5	478.0	473.5	469.0	464.5	460.0	455.8	451.7	447.6	443.5	439.4	435.3
10.25	498.0	493.5	488.9	484.3	479.7	475.2	470.6	466.0	461.9	457.7	453.5	449.3	445.2	441.0
10.5	504.5	499.9	495.2	490.6	486.0	481.4	476.7	472.1	467.9	463.6	459.4	455.2	451.0	446.8
10.75	511.0	506.3	501.6	496.9	492.2	487.5	482.9	478.2	473.9	469.6	465.3	461.0	456.8	452.5
11	517.5	512.7	508.0	503.2	498.5	493.7	489.0	484.2	479.9	475.6	471.2	466.9	462.6	458.2
11.25	523.9	519.1	514.3	509.5	504.7	499.9	495.1	490.3	485.9	481.5	477.1	472.7	468.4	464.0
11.5	530.4	525.5	520.7	515.8	511.0	506.1	501.2	496.4	491.9	487.5	483.0	478.6	474.2	469.7
11.75	536.9	532.0	527.0	522.1	517.2	512.3	507.4	502.4	497.9	493.4	488.9	484.4	480.0	475.5
12	543.4	538.4	533.4	528.4	523.4	518.5	513.5	508.5	504.0	499.4	494.9	490.3	485.7	481.2
12.25	549.8	544.8	539.8	534.7	529.7	524.7	519.6	514.6	510.0	505.4	500.8	496.1	491.5	486.9
12.5	556.3	551.2	546.1	541.0	535.9	530.8	525.7	520.6	516.0	511.3	506.7	502.0	497.3	492.7
12.75	562.8	557.6	552.5	547.3	542.2	537.0	531.9	526.7	522.0	517.3	512.6	507.8	503.1	498.4
13	569.3	564.1	558.8	553.6	548.4	543.2	538.0	532.8	528.0	523.2	518.5	513.7	508.9	504.2

850 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level	0	10	20	30	40	50	60	70	80	90	100	110	120	130
Inches	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.8)	(43.3)	(48.9)	(54.4)
13.25	575.7	570.5	565.2	559.9	554.7	549.4	544.1	538.9	534.0	529.2	524.4	519.5	514.7	509.9
13.5	582.2	576.9	571.6	566.2	560.9	555.6	550.2	544.9	540.0	535.2	530.3	525.4	520.5	515.6
13.75	588.7	583.3	577.9	572.5	567.1	561.8	556.4	551.0	546.1	541.1	536.2	531.2	526.3	521.4
14	595.2	589.7	584.3	578.8	573.4	567.9	562.5	557.1	552.1	547.1	542.1	537.1	532.1	527.1
14.25	601.6	596.1	590.6	585.1	579.6	574.1	568.6	563.1	558.1	553.0	548.0	542.9	537.9	532.9
14.5	608.1	602.6	597.0	591.4	585.9	580.3	574.8	569.2	564.1	559.0	553.9	548.8	543.7	538.6
14.75	614.6	609.0	603.4	597.7	592.1	586.5	580.9	575.3	570.1	565.0	559.8	554.6	549.5	544.3
15	621.1	615.4	609.7	604.0	598.4	592.7	587.0	581.3	576.1	570.9	565.7	560.5	555.3	550.1
15.25	627.5	621.8	616.1	610.3	604.6	598.9	593.1	587.4	582.1	576.9	571.6	566.3	561.1	555.8
15.5	634.0	628.2	622.4	616.6	610.8	605.1	599.3	593.5	588.1	582.8	577.5	572.2	566.9	561.6
15.75	640.5	634.6	628.8	622.9	617.1	611.2	605.4	599.5	594.2	588.8	583.4	578.0	572.7	567.3
16	647.0	641.1	635.2	629.2	623.3	617.4	611.5	605.6	600.2	594.8	589.3	583.9	578.5	573.0
16.25	653.4	647.5	641.5	635.5	629.6	623.6	617.6	611.7	606.2	600.7	595.2	589.7	584.3	578.8
16.5	659.9	653.9	647.9	641.8	635.8	629.8	623.8	617.7	612.2	606.7	601.1	595.6	590.1	584.5
16.75	666.4	660.3	654.2	648.1	642.1	636.0	629.9	623.8	618.2	612.6	607.0	601.4	595.9	590.3
17	672.9	666.7	660.6	654.4	648.3	642.2	636.0	629.9	624.2	618.6	612.9	607.3	601.6	596.0
17.25	679.3	673.1	666.9	660.7	654.5	648.3	642.1	635.9	630.2	624.5	618.8	613.1	607.4	601.7
17.5	685.8	679.6	673.3	667.0	660.8	654.5	648.3	642.0	636.3	630.5	624.8	619.0	613.2	607.5
17.75	692.3	686.0	679.7	673.4	667.0	660.7	654.4	648.1	642.3	636.5	630.7	624.8	619.0	613.2
18	698.8	692.4	686.0	679.7	673.3	666.9	660.5	654.2	648.3	642.4	636.6	630.7	624.8	619.0
18.25	705.3	698.8	692.4	686.0	679.5	673.1	666.7	660.2	654.3	648.4	642.5	636.5	630.6	624.7
18.5	711.7	705.2	698.7	692.3	685.8	679.3	672.8	666.3	660.3	654.3	648.4	642.4	636.4	630.4
18.75	718.2	711.7	705.1	698.6	692.0	685.5	678.9	672.4	666.3	660.3	654.3	648.2	642.2	636.2
19	724.7	718.1	711.5	704.9	698.2	691.6	685.0	678.4	672.3	666.3	660.2	654.1	648.0	641.9
19.25	731.2	724.5	717.8	711.2	704.5	697.8	691.2	684.5	678.4	672.2	666.1	659.9	653.8	647.7
19.5	737.6	730.9	724.2	717.5	710.7	704.0	697.3	690.6	684.4	678.2	672.0	665.8	659.6	653.4
19.75	744.1	737.3	730.5	723.8	717.0	710.2	703.4	696.6	690.4	684.1	677.9	671.6	665.4	659.1
20	750.6	743.7	736.9	730.1	723.2	716.4	709.5	702.7	696.4	690.1	683.8	677.5	671.2	664.9
20.25	757.1	750.2	743.3	736.4	729.5	722.6	715.7	708.8	702.4	696.1	689.7	683.3	677.0	670.6
20.5	763.5	756.6	749.6	742.7	735.7	728.7	721.8	714.8	708.4	702.0	695.6	689.2	682.8	676.4
20.75	770.0	763.0	756.0	749.0	741.9	734.9	727.9	720.9	714.4	708.0	701.5	695.0	688.6	682.1
21	776.5	769.4	762.3	755.3	748.2	741.1	734.0	727.0	720.5	713.9	707.4	700.9	694.4	687.9
21.25	783.0	775.8	768.7	761.6	754.4	747.3	740.2	733.0	726.5	719.9	713.3	706.7	700.2	693.6

850 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level	0	10	20	30	40	50	60	70	80	90	100	110	120	130
Inches	(-17.8)	(-12.2)	(-6.7)	(-1.1)	(4.4)	(10)	(15.6)	(21.1)	(26.7)	(32.2)	(37.8)	(43.3)	(48.9)	(54.4)
21.5	789.4	782.2	775.1	767.9	760.7	753.5	746.3	739.1	732.5	725.9	719.2	712.6	706.0	699.3
21.75	795.9	788.7	781.4	774.2	766.9	759.7	752.4	745.2	738.5	731.8	725.1	718.4	711.8	705.1
22	802.4	795.1	787.8	780.5	773.2	765.9	758.6	751.2	744.5	737.8	731.0	724.3	717.6	710.8
22.25	808.9	801.5	794.1	786.8	779.4	772.0	764.7	757.3	750.5	743.7	736.9	730.1	723.3	716.6
22.5	815.3	807.9	800.5	793.1	785.6	778.2	770.8	763.4	756.5	749.7	742.8	736.0	729.1	722.3
22.75	821.8	814.3	806.9	799.4	791.9	784.4	776.9	769.5	762.6	755.6	748.7	741.8	734.9	728.0
23	828.3	820.7	813.2	805.7	798.1	790.6	783.1	775.5	768.6	761.6	754.6	747.7	740.7	733.8
23.25	834.8	827.2	819.6	812.0	804.4	796.8	789.2	781.6	774.6	767.6	760.6	753.5	746.5	739.5
23.5	841.2	833.6	825.9	818.3	810.6	803.0	795.3	787.7	780.6	773.5	766.5	759.4	752.3	745.3
23.75	847.7	840.0	832.3	824.6	816.9	809.2	801.4	793.7	786.6	779.5	772.4	765.2	758.1	751.0
24	854.2	846.4	838.6	830.9	823.1	815.3	807.6	799.8	792.6	785.4	778.3	771.1	763.9	756.7
24.25	860.7	852.8	845.0	837.2	829.3	821.5	813.7	805.9	798.6	791.4	784.2	776.9	769.7	762.5
24.5	867.1	859.3	851.4	843.5	835.6	827.7	819.8	811.9	804.6	797.4	790.1	782.8	775.5	768.2
24.75	873.6	865.7	857.7	849.8	841.8	833.9	825.9	818.0	810.7	803.3	796.0	788.6	781.3	774.0
25	880.1	872.1	864.1	856.1	848.1	840.1	832.1	824.1	816.7	809.3	801.9	794.5	787.1	779.7
25.25	886.6	878.5	870.4	862.4	854.3	846.3	838.2	830.1	822.7	815.2	807.8	800.3	792.9	785.4
25.5	893.0	884.9	876.8	868.7	860.6	852.4	844.3	836.2	828.7	821.2	813.7	806.2	798.7	791.2
25.75	899.5	891.3	883.2	875.0	866.8	858.6	850.5	842.3	834.7	827.2	819.6	812.0	804.5	796.9
26	906.0	897.8	889.5	881.3	873.1	864.8	856.6	848.3	840.7	833.1	825.5	817.9	810.3	802.7
26.25	912.5	904.2	895.9	887.6	879.3	871.0	862.7	854.4	846.7	839.1	831.4	823.7	816.1	808.4
26.5	918.9	910.6	902.2	893.9	885.5	877.2	868.8	860.5	852.8	845.0	837.3	829.6	821.9	814.1
26.75	925.4	917.0	908.6	900.2	891.8	883.4	875.0	866.5	858.8	851.0	843.2	835.4	827.7	819.9
27	931.9	923.4	915.0	906.5	898.0	889.6	881.1	872.6	864.8	857.0	849.1	841.3	833.5	825.6
27.25	938.4	929.8	921.3	912.8	904.3	895.7	887.2	878.7	870.8	862.9	855.0	847.1	839.3	831.4
27.5	944.8	936.3	927.7	919.1	910.5	901.9	893.3	884.8	876.8	868.9	860.9	853.0	845.0	837.1
27.75	951.3	942.7	934.0	925.4	916.8	908.1	899.5	890.8	882.8	874.8	866.8	858.8	850.8	842.8
28	957.8	949.1	940.4	931.7	923.0	914.3	905.6	896.9	888.8	880.8	872.7	864.7	856.6	848.6
28.25	964.3	955.5	946.8	938.0	929.2	920.5	911.7	903.0	894.9	886.7	878.6	870.5	862.4	854.3
28.5	970.7	961.9	953.1	944.3	935.5	926.7	917.8	909.0	900.9	892.7	884.5	876.4	868.2	860.1
28.75	977.2	968.3	959.5	950.6	941.7	932.8	924.0	915.1	906.9	898.7	890.5	882.2	874.0	865.8
29	983.7	974.8	965.8	956.9	948.0	939.0	930.1	921.2	912.9	904.6	896.4	888.1	879.8	871.5
29.25	990.2	981.2	972.2	963.2	954.2	945.2	936.2	927.2	918.9	910.6	902.3	893.9	885.6	877.3
29.5	996.6	987.6	978.6	969.5	960.5	951.4	942.4	933.3	924.9	916.5	908.2	899.8	891.4	883.0

850 POUND NOVEC TANK AGENT QUANTITY TABLES

Liquid	Temperature Degrees F (Degrees C)													
Level Inches	0 (-17.8)	10 (-12.2)	20 (-6.7)	30 (-1.1)	40 (4.4)	50 (10)	60 (15.6)	70 (21.1)	80 (26.7)	90 (32.2)	100 (37.8)	110 (43.3)	120 (48.9)	130 (54.4)
29.75	1003.1	994.0	984.9	975.8	966.7	957.6	948.5	939.4	930.9	922.5	914.1	905.6	897.2	888.8
30	1009.6	1000.4	991.3	982.1	972.9	963.8	954.6	945.4	937.0	928.5	920.0	911.5	903.0	894.5
30.25	1016.1	1006.9	997.6	988.4	979.2	970.0	960.7	951.5	943.0	934.4	925.9	917.3	908.8	900.3
30.5	1022.6	1013.3	1004.0	994.7	985.4	976.1	966.9	957.6	949.0	940.4	931.8	923.2	914.6	906.0
30.75	1029.0	1019.7	1010.3	1001.0	991.7	982.3	973.0	963.6	955.0	946.3	937.7	929.0	920.4	911.7
31	1035.5	1026.1	1016.7	1007.3	997.9	988.5	979.1	969.7	961.0	952.3	943.6	934.9	926.2	917.5

CHECK MECHANICAL EQUIPMENT

Piping and Nozzles

A fire condition could cause damage to the piping and nozzles and possibly support members. Check all rigid pipe supports and all fitting connections. Take the nozzles off the piping, inspect for damage, corrosion, or obstructions, clean and re-install.

RECHARGING AGENT TANKS

⚠ CAUTION

Make certain tanks contain no pressure before removing valves. If tank contains pressure, removing valve could cause violent tank movement, causing personnel injury or property damage.

Valve Teardown

1. Remove empty SAPPHIRE tanks by removing the actuators.
2. Remove empty tanks from brackets.
3. Tank valves must be rebuilt and all O-rings replaced prior to tanks being recharged. Follow instructions listed in Step No. 4 and 4a.
4. **1 in and 2 in. Valves –** Valve cleaning/O-ring replacement instructions. Refer to Figure 1 for component descriptions.

   The following components are required for valve rebuilding:

   - Bonnet assembly, Part No. 570543 for 1 in., Part No. 570541 for 2 in.
   - Piston assembly, Part No. 570551 for 1 in., Part No. 570552 for 2 in.
   - O-ring kit, Part No. 570559 for 1 in., Part No. 570584 for 2 in.
   - If necessary, recoil cap assembly, Part No. 570553 for 1 in., Part No. 570554 for 2 in.

   a. Remove the valve from the tank.

   b. Remove the siphon tube locking screw to allow removal of the siphon tube from the valve.

   c. Remove the socket head cap screw that holds the recoil cap chain to the valve body.

   d. Remove bonnet locking screw from the same port as socket head cap screw mentioned in Step "c" and unscrew the bonnet assembly, using the spanner wrench, Part No. 570574. Remove and discard O-ring from bonnet assembly.

   e. Remove the piston assembly by pushing up on it from the bottom of the valve. Discard complete piston assembly.

   f. Remove collar O-ring, and siphon tube O-ring. Discard both.

   g. Clean all internal valve surfaces. Use caution not to cause any scratching to surfaces.

   h. Use O-ring kit, Part No. 570559 for 1 in. or Part No. 570584 for 2 in., to replace with all new O-rings. Apply Dow Corning No. 4 lube to all O-rings before installing on components.

   i. Push in new piston assembly.

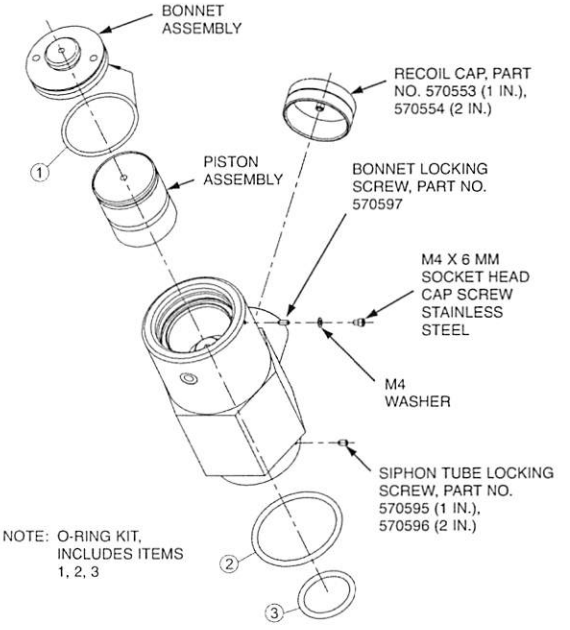
   j. Screw in bonnet assembly, including new O-ring. Tighten with spanner wrench.

   k. Thread in bonnet locking screw followed by washer, chain and socket head cap screw. The cap screw holds the recoil cap chain to the tank valve body.

   l. Install collar and siphon tube O-ring. Before installing, coat with Dow Corning No. 4 lube.

   m. Push siphon tube into base of valve and rotate until locking screw hole in the siphon tube is aligned with the siphon tube locking screw hole in the valve base. Install siphon tube locking screw.

   n. Do not install valve into tank until Step "g" in "Recharging Instructions, Step 5."



1 IN. AND 2 IN. VALVE COMPONENTS

FIGURE 1
006768

4a. **3 in. Valve –** Valve cleaning/O-ring replacement instructions. Refer to Figure 2 for component descriptions.

The following components are required for valve rebuilding:

- Top cap assembly, Part No. 570598
- Piston assembly, Part No. 570601
- O-ring kit, Part No. 570599
- If necessary, recoil cap assembly, Part No. 570600

a. Remove valve from tank. Note: Siphon tube for 3 in. valve stays in the tank collar.

b. Unscrew top cap.

c. Remove body and collar O-rings. Replace with new O-rings in a later Step.

d. Remove the piston from the valve body and discard.

e. Clean inside surfaces of valve body. Be careful not to scratch surface. Spray a small quantity of PTFE silicone into the inside of the valve.

f. Lubricate top cap O-ring with PTFE silicone and install into upper groove on valve body.

g. Lubricate collar O-ring with PTFE silicone and install on valve collar threads.

RECHARGING AGENT TANKS (Continued)

Valve Teardown (Continued)

h. Lubricate piston O-rings with PTFE silicone and install piston in valve body.

i. Install top cap on valve body. Hand tighten.

j. Valve assembly is now ready to be leak tested. See Testing Section.

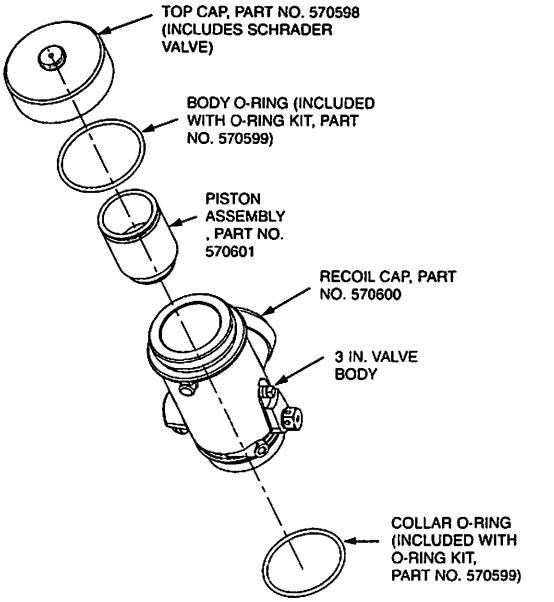


FIGURE 2
006904

TESTING

On completion of the valve tear down, the valve assembly requires two tests – Leak Test and Pre-Dome Test (Pre-Dome Test is required only if burst disc had been changed).

The tests must be conducted using a nitrogen source, a test bottom cap, close down adaptor, and an outlet filling adaptor. See Figure 3 for Test Station Component Layout.

Valve Size	Bottom Test Cap Part No.	Top Closing Adaptor Part No.	Outlet Filling Adaptor Part No.
1 in.	570272	570579	570576
2 in.	570276	570579	570592
3 in.	570374	570579	69891

1. The valve assembly is assembled to the test bottom cap. The outlet adaptor is assembled to the valve outlet. Attach the nitrogen line and make certain the vent valve on the outlet adaptor is closed.
2. Burst Disc Pre-Dome Procedure – Open the nitrogen regulator to 580 psi (40 bar) and slowly allow pressure to the valve through the bottom test cap. This is to pre-dome the burst disc. Hold this pressure for 1 minute to ensure that there is no drop in pressure indicted by the rest gauge on the nitrogen test set-up.
3. Pour water/soap solution into the top cap Schrader valve and apply leak detection spray to all ports on the valve. If no leaks are detected, the pressure to the valve must be reduced to 363 psi (25 bar) and the close down adaptor must be attached. To close the valve piston, increase the nitrogen pressure to the close down adaptor to 580 psi (40 bar).
4. Check for leaks.
5. Slowly release the gas pressure from the nitrogen test set-up, vent the close down adaptor, and make certain that the outlet filling adaptor is opened before removing the adaptors.
6. If a leak had been detected, it must be rectified and retested. If the leak persists, the valve assembly must be rejected.

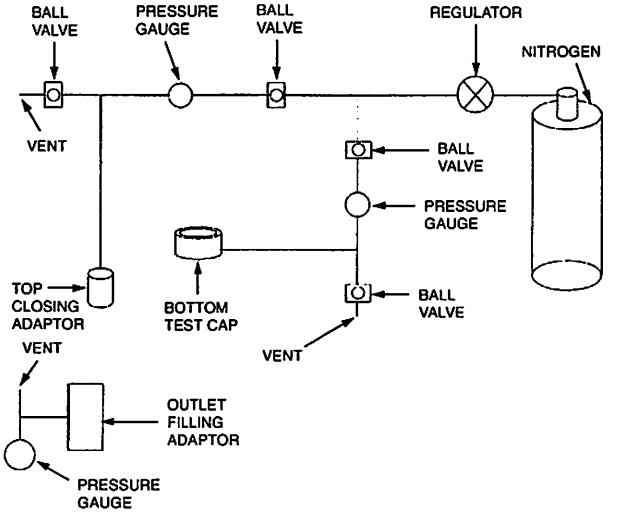


FIGURE 3
004977

FILLING INSTRUCTIONS – AGENT TANK

1. Recharging Instructions:
   a. See Figure 4 for a typical recharge station configuration.
   b. Install a drier (such as a Hammond DRIERITE filter) in a threaded port on the Novec 1230 agent container. A drier is required because humid air may cause the agent to convert to an acid.
   c. The outlet of the container requires an inline (20 micron or smaller) filter.
   d. The agent can either be pumped or gravity fed to the tank.
   e. Tank must be visually inspected and clean inside. IMPORTANT – No moisture is allowed in the tank. It must be completely dried. Water mixed with agent will cause acid.
   f. Rebuild valve. See "Valve Rebuild Instructions," Step 4 and 4a.
   g. Reinstall valve and siphon tube assembly into tank. Tighten securely.
   h. Purge tank by pressurizing through a Outlet Fill Adaptor Assembly (see chart on Page 10-2) to 100 psi (6.9 bar) with dry nitrogen, then vent pressure. This process will remove humid air from the tank.
   i. Fill tank with correct amount of agent by weight. See nameplate for this information.

FILLING INSTRUCTIONS – AGENT TANK(Continued)

j. Set regulator to 20 psi (1.4 bar) lower than the required tank pressure based on ambient temperature. Refer to pressure vs. temperature chart in this section. Pressurize tank. Agitate tank while pressurizing.

k. After correct pressure is reached, close valve near tank valve outlet.

l. Close tank valve by using Top Adaptor Assembly, Part No. 570579, as follows. Set regulator to 450 psi (31.0 bar). Pressure Top Adaptor Assembly. Open and close the valve rapidly to prevent over-pressurizing of tank.

m. Vent pressure from tank valve outlet.

n. Remove Fill Adaptor Assembly and install recoil cap on valve outlet.

o. Agitate tank by rolling or inverting so that the agent can absorb the nitrogen.

p. Add more nitrogen through the Top Adaptor Assembly. Using the pressure vs. temperature chart at ambient temperature, set the regulated pressure at the corresponding pressure plus 8 psi (.6 bar). It takes 8 psi (.6 bar) to overcome the spring force in the valve core. Note: Do not use gauge on valve to determine recharge pressure.

q. Repeat Steps "o" and "q" until the agent has fully absorbed the nitrogen.

r. Let tank assembly sit for 3 hours.

s. Check the tank valve for leaks by using soap and water solution.

t. Check tank gauge pressure based on pressure vs. temperature chart.

u. Repeat Step "o."

v. Recheck gauge pressure. If gauge reading decreased, repeat Step "p."

w. Once tank pressure is correct, remove from fill station.

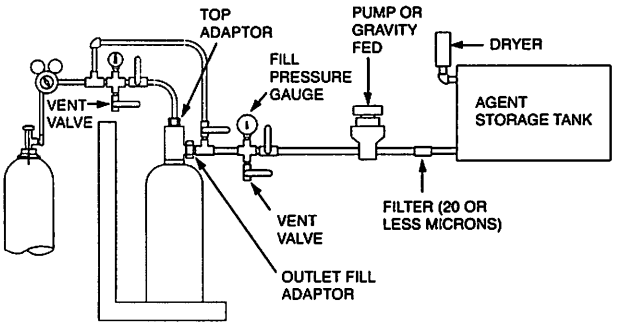
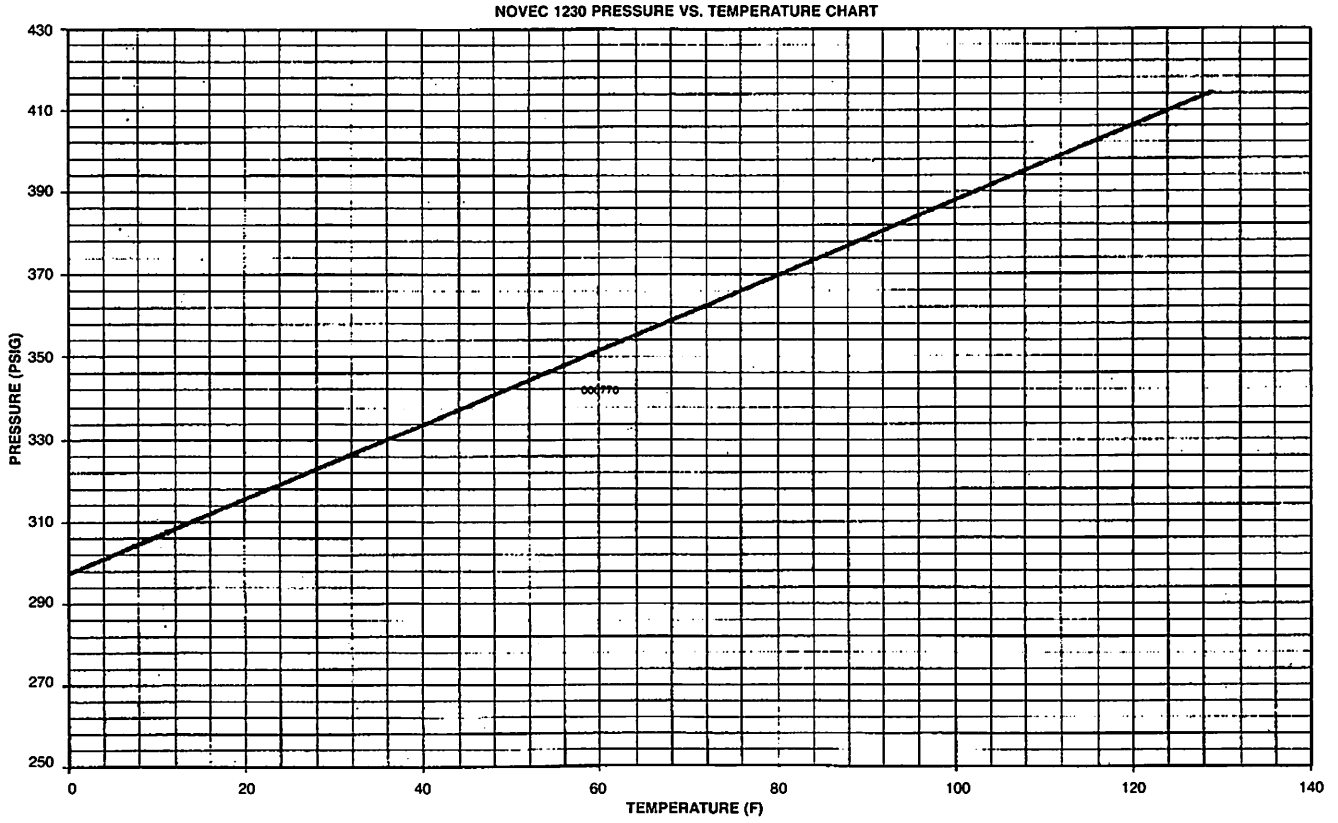


FIGURE 4
006767

2. Replace recharged tanks in bracket and follow "Installation" procedures to put system back in service.

3. Inform proper personnel that the system is back in service.



RECHARGE PILOT CYLINDER(S)

The following steps must be followed when removing discharged cylinders from the pilot actuation system:

1. Disconnect the flex bend from the cylinder(s) outlet.
2. Remove all actuators from the cylinder valves.
3. If necessary, remove 1/4 in. actuation hose from pneumatic actuation port.
4. If necessary, install plug, Part No. 42411, into pneumatic actuation port and wrench tighten.
5. With cylinder secured in bracket, relieve any remaining pressure in the cylinder by completing the following:
   a. Make certain discharge cap IS NOT on valve outlet. See Figure 5.

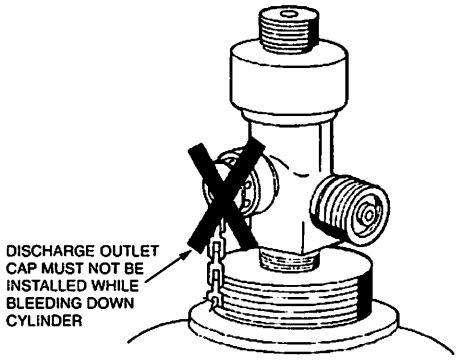


FIGURE 5
001515

CAUTION

Attach bleed down device, Part No. 426028, to fill inlet of discharged cylinders only. Never attach this device to fully charged cylinders as this will cause high pressure to discharge out of the fill inlet. Also, install device hand tight only. Do not wrench tighten. **Note:** Bleed-down device, Part No. 416656, CANNOT be used on CV-98 valve.

   b. Attach bleed down device, Part No. 426028, to valve fill inlet. See Figure 6.

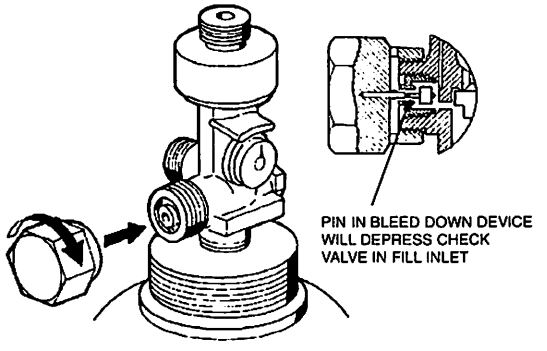


FIGURE 6
001853

   c. Bleed residue pressure from cylinder. Make certain cylinder is completely empty before removing bleed down device.
   d. With cylinder completely empty, remove bleed down device and install safety shipping cap.
   e. Complete Steps a. through d. on all discharged cylinders, both pilot and slave.
6. Determine if discharged cylinder requires hydro-testing prior to being recharged. Note last hydro date on cylinder collar. If cylinder does not have a star stamp, it requires hydro five (5) years from last hydro date. If cylinder has a star stamp, it requires a hydro-test ten (10) years from last date.
7. Recharge nitrogen pilot cylinders. See cylinder nameplate for fill adaptor Part No.

RESET OF EQUIPMENT

Manual Valve Actuator

Before installing manual actuator back unto cylinder valve, make certain manual actuator is in the "SET" position. The arrow on the lever points to the "SET" position and indicates standby. Check the pin to confirm it is in the upright position (fully retracted).

On manual actuator with ring pins, apply a small amount of lubricant, such as WD-40, to the pin between the handle and the body. Make certain ring pin is in position and secured with a visual inspection seal.

Pressure Switch

Reset the pressure switch by completing the following steps:

1. Verify equipment controlled by pressure switch is ready to be reset.
2. Make certain all pressure in the line to the switch has been properly relieved.
3. Push in red knob on end of pressure switch plunger.
4. Make certain electrical function has been correctly reset.

Marine Actuation Station

Verify the actuation pressure has been fully relieved. The actuation line vent plug will relieve pressure automatically. Restore the operating handle(s) to the ready position. Check that the puncture pin(s) is in the "up" position, then replace spent LT-20-L nitrogen cartridge with fully-charged cartridge, Part No. 7012. If required, attach tamper seal. Close door.

Manual Pull Station

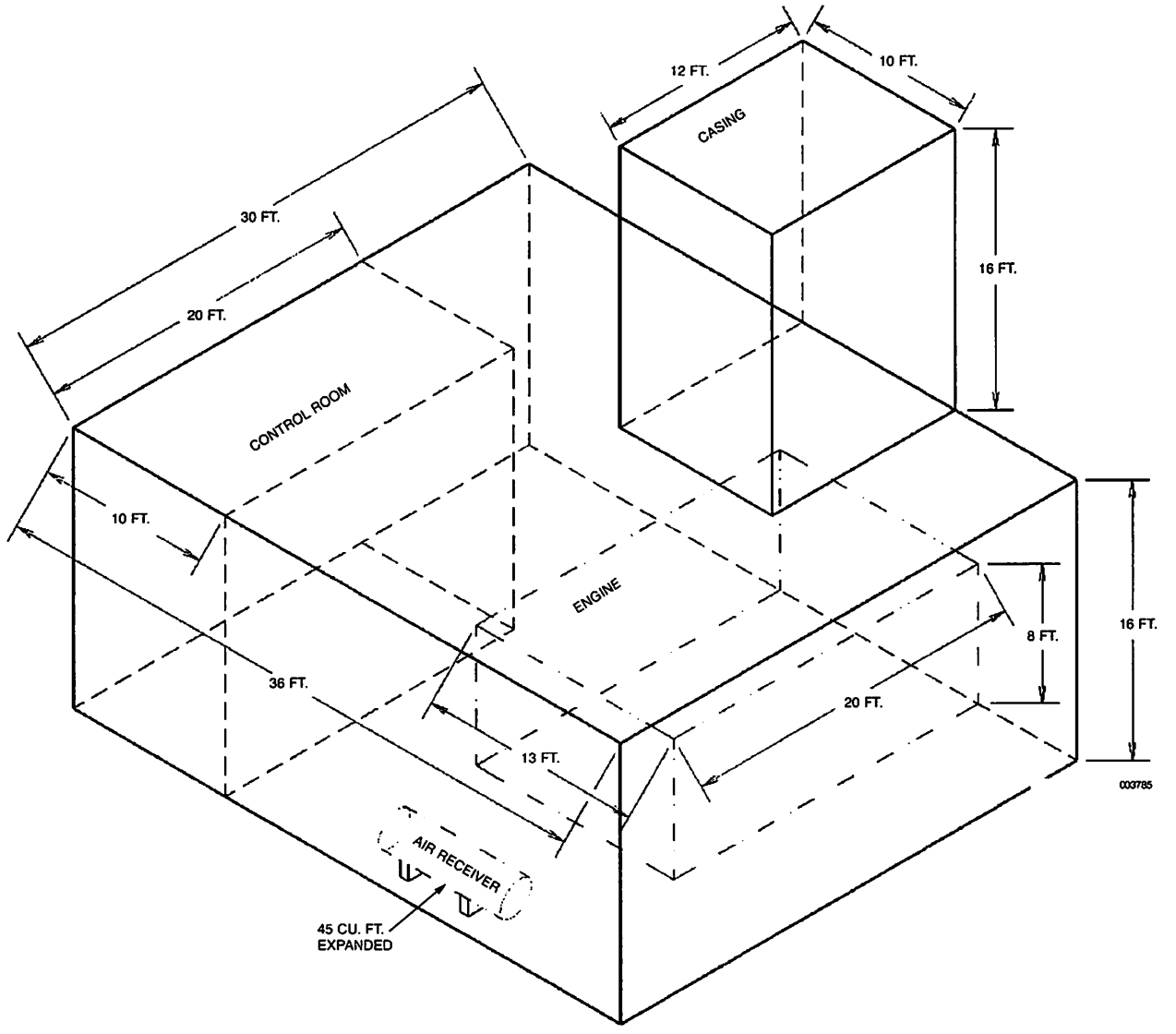
Reset remote manual pull station by completing the following steps:

1. If necessary, remove set screw that is retaining the break glass rod.
2. If necessary, carefully remove any remaining broken glass from station.
3. Press and position handle in proper location against cover and slide the replacement glass break rod, Part No. 4834, through stud and handle.
4. Tighten set screw into stud.

NOTIFY OWNER

Notify owner and/or authority having jurisdiction that the system has been recharged and placed back in service.

DESIGN EXAMPLE



SAPPHIRE
SUPPRESSION SYSTEMS

John M. Kehoe
1 Stanton Street
Marinette WI
Phone: 800-862-6785
Sapphire™ Designer Program
UL: EX4510 FM: 3014140
Project: Marine Manual Design Example
File Name: F:\Marine\Manual.FLC

Consolidated Report

Customer Information

Company Name:	Ansul
Address:	1 Stanton Street Marinette Wisconsin 54143
Phone:	1-800-862-6785
Contact:	
Title:	Designer

Project Data

Project Name:	Marine Manual Design Example
Designer:	Anybody Trained
Number:	12345
Account:	5678
Location:	Anywhere USA
Description:	The calculations for the Marine Sapphire manual

Calculation Date/Time: Wednesday, May 26, 2004, 9:37:19 AM

SAPPHIRE

Consolidated Report
Enclosure Information

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

Enclosure Number:	1
Name:	Engine Room
Enclosure Temperature...	
Minimum:	32 F
Maximum:	120 F
Maximum Concentration:	6.961 %
Design Concentration...	
Adjusted:	5.870 %
Minimum:	5.850 %
Minimum Agent Required:	598.7 lbs
Width:	0.0 ft
Length:	0.0 ft
Height:	0.0 ft
Volume:	10240.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	10240.0 cubic ft
Adjusted Agent Required:	600.9 lbs
Number of Nozzles:	3

Calculation Date/Time: Wednesday, May 26, 2004, 9:37:19 AM

SAPPHIRE

Consolidated Report
Enclosure Information

This system was developed using English units of measure. This report converts to Metric units of measure. Some minor discrepancies may be apparent in this report due to rounding.

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

Enclosure Number:	2
Name:	Control Room
Enclosure Temperature...	
Minimum:	32 F
Maximum:	120 F
Maximum Concentration:	6.964 %
Design Concentration...	
Adjusted:	5.873 %
Minimum:	5.850 %
Minimum Agent Required:	163.8 lbs
Width:	10.0 ft
Length:	20.0 ft
Height:	14.0 ft
Volume:	2800.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	2800.0 cubic ft
Adjusted Agent Required:	164.4 lbs
Number of Nozzles:	1

Calculation Date/Time: Wednesday, May 26, 2004, 9:37:19 AM

SAPPHIRE

Consolidated Report
Enclosure Information

This system was developed using English units of measure. This report converts to Metric units of measure. Some minor discrepancies may be apparent in this report due to rounding.

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

Enclosure Number:	3
Name:	Casing
Enclosure Temperature...	
Minimum:	32 F
Maximum:	120 F
Maximum Concentration:	6.968 %
Design Concentration...	
Adjusted:	5.876 %
Minimum:	5.850 %
Minimum Agent Required:	98.3 lbs
Width:	10.0 ft
Length:	12.0 ft
Height:	14.0 ft
Volume:	1680.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	1680.0 cubic ft
Adjusted Agent Required:	98.7 lbs
Number of Nozzles:	1

Calculation Date/Time: Wednesday, May 26, 2004, 9:37:19 AM

SAPPHIRE

Consolidated Report
Enclosure Information

This system was developed using English units of measure. This report converts to Metric units of measure. Some minor discrepancies may be apparent in this report due to rounding.

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

Enclosure Number:	1
Name:	Engine Room
Enclosure Temperature...	
Minimum:	0.0 C
Maximum:	48.9 C
Maximum Concentration:	6.961 %
Design Concentration...	
Adjusted:	5.870 %
Minimum:	5.850 %
Minimum Agent Required:	271.6 kg
Width:	0.00 m
Length:	0.00 m
Height:	0.00 m
Volume:	289.96 cubic m
Non-permeable:	0.00 cubic m
Total Volume:	289.96 cubic m
Adjusted Agent Required:	272.6 kg
Number of Nozzles:	3

Calculation Date/Time: Wednesday, May 26, 2004, 9:37:19 AM

SAPPHIRE

Consolidated Report
Enclosure Information

This system was developed using English units of measure. This report converts to Metric units of measure.
Some minor discrepancies may be apparent in this report due to rounding.

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

Enclosure Number:	2
Name:	Control Room
Enclosure Temperature...	
Minimum:	0.0 C
Maximum:	48.9 C
Maximum Concentration:	6.964 %
Design Concentration...	
Adjusted:	5.873 %
Minimum:	5.850 %
Minimum Agent Required:	74.3 kg
Width:	3.05 m
Length:	6.10 m
Height:	4.27 m
Volume:	79.29 cubic m
Non-permeable:	0.00 cubic m
Total Volume:	79.29 cubic m
Adjusted Agent Required:	74.6 kg
Number of Nozzles:	1

Calculation Date/Time: Wednesday, May 26, 2004, 9:37:19 AM

SAPPHIRE

Consolidated Report
Enclosure Information

This system was developed using English units of measure. This report converts to Metric units of measure. Some minor discrepancies may be apparent in this report due to rounding.

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

Enclosure Number:	3
Name:	Casing
Enclosure Temperature...	
Minimum:	0.0 C
Maximum:	48.9 C
Maximum Concentration:	6.968 %
Design Concentration...	
Adjusted:	5.876 %
Minimum:	5.850 %
Minimum Agent Required:	44.6 kg
Width:	3.05 m
Length:	3.66 m
Height:	4.27 m
Volume:	47.57 cubic m
Non-permeable:	0.00 cubic m
Total Volume:	47.57 cubic m
Adjusted Agent Required:	44.8 kg
Number of Nozzles:	1

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Consolidated Report
Agent Information

Agent: Novec / Propellant N2
(Novec is a trademark of 3M)

Adjusted Agent Required:	864.0 lbs
Container Name:	850 lb Cylinder Assemby
Container Part Number:	570586
Number of Main Containers:	2
Number of Reserve Containers:	0
Manifold:	2 Port 4 in. End Manifold Assy (screwed) - 850 lb
Starting Pressure:	360 psig
Pipe Take Off Direction:	Horizontal
Agent Per Container:	432.0 lbs
Fill Density:	35.8 lbs / cubic ft
Container Empty Weight:	456.0 lbs
Weight, All Containers + Agent:	1776.0 lbs
Floor Area Per Container:	3.14 square ft
Floor Loading Per Container:	283 lbs / square ft

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Agent Information

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Agent: Novec / Propellant N2
(Novec is a trademark of 3M)

Adjusted Agent Required:	391.9 kg
Container Name:	850 lb Cylinder Assemby
Container Part Number:	570586
Number of Main Containers:	2
Number of Reserve Containers:	0
Manifold:	2 Port 4 in. End Manifold Assy (screwed) - 850 lb
Starting Pressure:	24.8 bar
Pipe Take Off Direction:	Horizontal
Agent Per Container:	196.0 kg
Fill Density:	0.573 kg / l
Container Empty Weight:	206.8 kg
Weight, All Containers + Agent:	805.6 kg
Floor Area Per Container:	0.29 square m
Floor Loading Per Container:	1380 kg /square m

Pipe Network

Part 1 - Pipe

			Pipe			
Description	Start	End	Type	Diameter	Length	Elevation
Main Cyl. X 2	0	1		3 in	4.81 ft	4.81 ft
Manifold X 2	1	2	40T	3 in	2.67 ft	1.91 ft
Manifold X 1	2	3	80T	4 in	3.50 ft	0.00 ft
Pipe	3	4	40T	2-1/2 in	4.50 ft	0.00 ft
Pipe	4	5	40T	2-1/2 in	2.50 ft	0.00 ft
Pipe	5	6	40T	2-1/2 in	8.00 ft	-8.00 ft
Pipe	6	7	40T	2-1/2 in	3.00 ft	0.00 ft
Pipe	7	8	40T	2-1/2 in	9.00 ft	0.00 ft
Pipe	8	9	40T	2 in	7.50 ft	0.00 ft

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Part 1 - Pipe

Description	Start	End	Pipe Type	Pipe Diameter	Pipe Length	Pipe Elevation
Pipe/E1-N2	9	10	40T	2 in	0.33 ft	-0.33 ft
Pipe	8	11	40T	2 in	7.50 ft	0.00 ft
Pipe/E1-N3	11	12	40T	2 in	0.33 ft	-0.33 ft
Pipe	7	13	40T	1-1/2 in	13.00 ft	0.00 ft
Pipe	13	14	40T	1-1/2 in	5.00 ft	0.00 ft
Pipe/E2-N1	14	15	40T	1-1/2 in	0.33 ft	-0.33 ft
Pipe	13	16	40T	1-1/4 in	10.00 ft	0.00 ft
Pipe/E1-N1	16	17	40T	1-1/4 in	0.33 ft	-0.33 ft
Pipe	4	18	40T	1-1/4 in	1.25 ft	0.00 ft
Pipe	18	19	40T	1-1/4 in	7.00 ft	7.00 ft
Pipe	19	20	40T	1-1/4 in	6.50 ft	0.00 ft
Pipe/E3-N1	20	21	40T	1-1/4 in	0.33 ft	-0.33 ft

Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
0	1	0	0	0	0	0		0.00 ft	85.0 ft
1	2	0	0	0	0	0	3inDH&CV	0.00 ft	54.7 ft
2	3	0	0	1	1	0		0.00 ft	32.0 ft
3	4	1	0	0	0	0		0.00 ft	11.1 ft
4	5	0	0	1	0	0		0.00 ft	6.6 ft
5	6	1	0	0	0	0		0.00 ft	14.6 ft
6	7	1	0	0	0	0		0.00 ft	9.6 ft
7	8	0	0	0	1	0		0.00 ft	22.4 ft
8	9	0	0	0	1	0		0.00 ft	18.7 ft
9	10	1	0	0	0	0		0.00 ft	5.8 ft
8	11	0	0	0	1	0		0.00 ft	18.7 ft
11	12	1	0	0	0	0		0.00 ft	5.8 ft
7	13	0	0	0	1	0		0.00 ft	21.7 ft
13	14	0	0	0	1	0		0.00 ft	13.7 ft
14	15	1	0	0	0	0		0.00 ft	4.6 ft
13	16	0	0	0	1	0		0.00 ft	17.5 ft
16	17	1	0	0	0	0		0.00 ft	4.0 ft
4	18	0	0	0	1	0		0.00 ft	8.8 ft

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Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
18	19	1	0	0	0	0		0.00 ft	10.7 ft
19	20	1	0	0	0	0		0.00 ft	10.2 ft
20	21	1	0	0	0	0		0.00 ft	4.0 ft

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
0	1	432.0 lbs				
1	2	432.0 lbs				
2	3	864.0 lbs				
3	4	864.0 lbs				
4	5	765.3 lbs				
5	6	765.3 lbs				
6	7	765.3 lbs				
7	8	503.0 lbs				
8	9	251.5 lbs				
9	10	251.5 lbs	E1-N2	2 in	16 Port - BR	1.0097 square in
8	11	251.5 lbs				
11	12	251.5 lbs	E1-N3	2 in	16 Port - BR	1.0097 square in
7	13	262.3 lbs				
13	14	164.4 lbs				
14	15	164.4 lbs	E2-N1	1-1/2 in	16 Port - BR	0.6328 square in
13	16	97.9 lbs				
16	17	97.9 lbs	E1-N1	1-1/4 in	16 Port - BR	0.3436 square in
4	18	98.7 lbs				
18	19	98.7 lbs				
19	20	98.7 lbs				
20	21	98.7 lbs	E3-N1	1-1/4 in	16 Port - BR	0.3601 square in

Pipe Network

This system was developed using English units of measure. This report converts to Metric units of measure.
Some minor discrepancies may be apparent in this report due to rounding.

Part 1 - Pipe

Description	Start	End	Pipe Type	Pipe Diameter	Pipe Length	Pipe Elevation
Main Cyl. X 2	0	1		3 in	1.47 m	1.47 m

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Part 1 - Pipe

Description	Start	End	Pipe Type	Pipe Diameter	Pipe Length	Pipe Elevation
Manifold X 2	1	2	40T	3 in	0.81 m	0.58 m
Manifold X 1	2	3	80T	4 in	1.07 m	0.00 m
Pipe	3	4	40T	2-1/2 in	1.37 m	0.00 m
Pipe	4	5	40T	2-1/2 in	0.76 m	0.00 m
Pipe	5	6	40T	2-1/2 in	2.44 m	-2.44 m
Pipe	6	7	40T	2-1/2 in	0.91 m	0.00 m
Pipe	7	8	40T	2-1/2 in	2.74 m	0.00 m
Pipe	8	9	40T	2 in	2.29 m	0.00 m
Pipe/E1-N2	9	10	40T	2 in	0.10 m	-0.10 m
Pipe	8	11	40T	2 in	2.29 m	0.00 m
Pipe/E1-N3	11	12	40T	2 in	0.10 m	-0.10 m
Pipe	7	13	40T	1-1/2 in	3.96 m	0.00 m
Pipe	13	14	40T	1-1/2 in	1.52 m	0.00 m
Pipe/E2-N1	14	15	40T	1-1/2 in	0.10 m	-0.10 m
Pipe	13	16	40T	1-1/4 in	3.05 m	0.00 m
Pipe/E1-N1	16	17	40T	1-1/4 in	0.10 m	-0.10 m
Pipe	4	18	40T	1-1/4 in	0.38 m	0.00 m
Pipe	18	19	40T	1-1/4 in	2.13 m	2.13 m
Pipe	19	20	40T	1-1/4 in	1.98 m	0.00 m
Pipe/E3-N1	20	21	40T	1-1/4 in	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	25.91 m
1	2	0	0	0	0	0	3inDH&CV	0.00 m	16.67 m
2	3	0	0	1	1	0		0.00 m	9.75 m
3	4	1	0	0	0	0		0.00 m	3.38 m
4	5	0	0	1	0	0		0.00 m	2.01 m
5	6	1	0	0	0	0		0.00 m	4.45 m
6	7	1	0	0	0	0		0.00 m	2.93 m
7	8	0	0	0	1	0		0.00 m	6.83 m
8	9	0	0	0	1	0		0.00 m	5.70 m
9	10	1	0	0	0	0		0.00 m	1.77 m

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Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
8	11	0	0	0	1	0		0.00 m	5.70 m
11	12	1	0	0	0	0		0.00 m	1.77 m
7	13	0	0	0	1	0		0.00 m	6.61 m
13	14	0	0	0	1	0		0.00 m	4.18 m
14	15	1	0	0	0	0		0.00 m	1.40 m
13	16	0	0	0	1	0		0.00 m	5.33 m
16	17	1	0	0	0	0		0.00 m	1.22 m
4	18	0	0	0	1	0		0.00 m	2.68 m
18	19	1	0	0	0	0		0.00 m	3.26 m
19	20	1	0	0	0	0		0.00 m	3.11 m
20	21	1	0	0	0	0		0.00 m	1.22 m

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
0	1	196.0 kg				
1	2	196.0 kg				
2	3	391.9 kg				
3	4	391.9 kg				
4	5	347.1 kg				
5	6	347.1 kg				
6	7	347.1 kg				
7	8	228.2 kg				
8	9	114.1 kg				
9	10	114.1 kg	E1-N2	2 in	16 Port - BR	651.44 square mm
8	11	114.1 kg				
11	12	114.1 kg	E1-N3	2 in	16 Port - BR	651.44 square mm
7	13	119.0 kg				
13	14	74.6 kg				
14	15	74.6 kg	E2-N1	1-1/2 in	16 Port - BR	408.28 square mm
13	16	44.4 kg				
16	17	44.4 kg	E1-N1	1-1/4 in	16 Port - BR	221.67 square mm
4	18	44.8 kg				
18	19	44.8 kg				

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Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
19	20	44.8 kg				
20	21	44.8 kg	E3-N1	1-1/4 in	16 Port - BR	232.35 square mm

Parts Information

Total Agent Required: 864.0 lbs
Container Name: 850 lb Cylinder Assemby (Part: 570586)
Number Of Containers: 2
Manifold: 2 Port 4 in. End Manifold Assy (screwed) - 850 lb

Nozzle	Type	Diameter	Nozzle Area	Part Number
E1-N1	16 Port - BR	1-1/4 in	0.3436 square in	570605
E1-N2	16 Port - BR	2 in	1.0097 square in	570607
E1-N3	16 Port - BR	2 in	1.0097 square in	570607
E2-N1	16 Port - BR	1-1/2 in	0.6328 square in	570606
E3-N1	16 Port - BR	1-1/4 in	0.3601 square in	570605

Nozzle	Drill Diameter	Drill Size
E1-N1	0.1654 inches	4.20 mm
E1-N2	0.2835 inches	7.20 mm
E1-N3	0.2835 inches	7.20 mm
E2-N1	0.2244 inches	5.70 mm
E3-N1	0.1693 inches	4.30 mm

Pipe:	Type	Diameter	Length
	40T	1-1/4 in	25.41 ft
	40T	1-1/2 in	18.33 ft
	40T	2 in	15.66 ft
	40T	2-1/2 in	27.00 ft
	80T	4 in	3.50 ft

'Other' Items:
2 - 3 in Check&Flex (Part: 69841)

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List of 90 degree elbows:
1 - 1-1/2 in
4 - 1-1/4 in
2 - 2 in
3 - 2-1/2 in

List of Tees:
1 - 1-1/2 in
3 - 2-1/2 in

Parts Information

This system was developed using English units of measure. This report converts to Metric units of measure. Some minor discrepancies may be apparent in this report due to rounding.

Total Agent Required: 391.9 kg
Container Name: 850 lb Cylinder Assemby (Part: 570586)
Number Of Containers: 2
Manifold: 2 Port 4 in. End Manifold Assy (screwed) - 850 lb

Nozzle	Type	Diameter	Nozzle Area	Part Number
E1-N1	16 Port - BR	1-1/4 in	221.67 square mm	570605
E1-N2	16 Port - BR	2 in	651.44 square mm	570607
E1-N3	16 Port - BR	2 in	651.44 square mm	570607
E2-N1	16 Port - BR	1-1/2 in	408.28 square mm	570606
E3-N1	16 Port - BR	1-1/4 in	232.35 square mm	570605

Nozzle	Drill Diameter	Drill Size
E1-N1	4.2012 mm	4.20 mm
E1-N2	7.2009 mm	7.20 mm
E1-N3	7.2009 mm	7.20 mm
E2-N1	5.6998 mm	5.70 mm
E3-N1	4.3002 mm	4.30 mm

Pipe:	Type	Diameter	Length
	40T	1-1/4 in	7.74 m
	40T	1-1/2 in	5.59 m
	40T	2 in	4.77 m

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Pipe:	Type	Diameter	Length
	40T	2-1/2 in	8.23 m
	80T	4 in	1.07 m

'Other' Items:
2 - 3 in Check&Flex (Part: 69841)

List of 90 degree elbows:
1 - 1-1/2 in
4 - 1-1/4 in
2 - 2 in
3 - 2-1/2 in

List of Tees:
1 - 1-1/2 in
3 - 2-1/2 in

System Acceptance

System Discharge Time: 8.1 seconds
Percent Agent In Pipe: 32.9%
Percent Agent Before First Tee: 13.9%

Enclosure Number: 1
Enclosure Name: Engine Room

Minimum Design Concentration: 5.850%
Adjusted Design Concentration: 5.870%
Predicted Concentration: 5.870%
Maximum Expected Agent Concentration: 6.960% (At 120 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E1-N1	97.5 lbs	97.9 lbs	96.6 lbs	137 psig
E1-N2	250.6 lbs	251.5 lbs	252.1 lbs	148 psig
E1-N3	250.6 lbs	251.5 lbs	252.1 lbs	148 psig

Enclosure Number: 2
Enclosure Name: Control Room

Minimum Design Concentration: 5.850%
Adjusted Design Concentration: 5.873%

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Predicted Concentration: 5.850%
Maximum Expected Agent Concentration: 6.937% (At 120 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E2-N1	163.8 lbs	164.4 lbs	163.7 lbs	137 psig

Enclosure Number: 3
Enclosure Name: Casing

Minimum Design Concentration: 5.850%
Adjusted Design Concentration: 5.876%
Predicted Concentration: 5.919%
Maximum Expected Agent Concentration: 7.017% (At 120 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E3-N1	98.3 lbs	98.7 lbs	99.4 lbs	183 psig

System Acceptance

This system was developed using English units of measure. This report converts to Metric units of measure. Some minor discrepancies may be apparent in this report due to rounding.

System Discharge Time: 8.1 seconds
Percent Agent In Pipe: 32.9%
Percent Agent Before First Tee: 13.9%

Enclosure Number: 1
Enclosure Name: Engine Room

Minimum Design Concentration: 5.850%
Adjusted Design Concentration: 5.870%
Predicted Concentration: 5.870%
Maximum Expected Agent Concentration: 6.960% (At 48.9 C)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E1-N1	44.2 kg	44.4 kg	43.8 kg	9.457 bar
E1-N2	113.7 kg	114.1 kg	114.4 kg	10.227 bar
E1-N3	113.7 kg	114.1 kg	114.4 kg	10.227 bar

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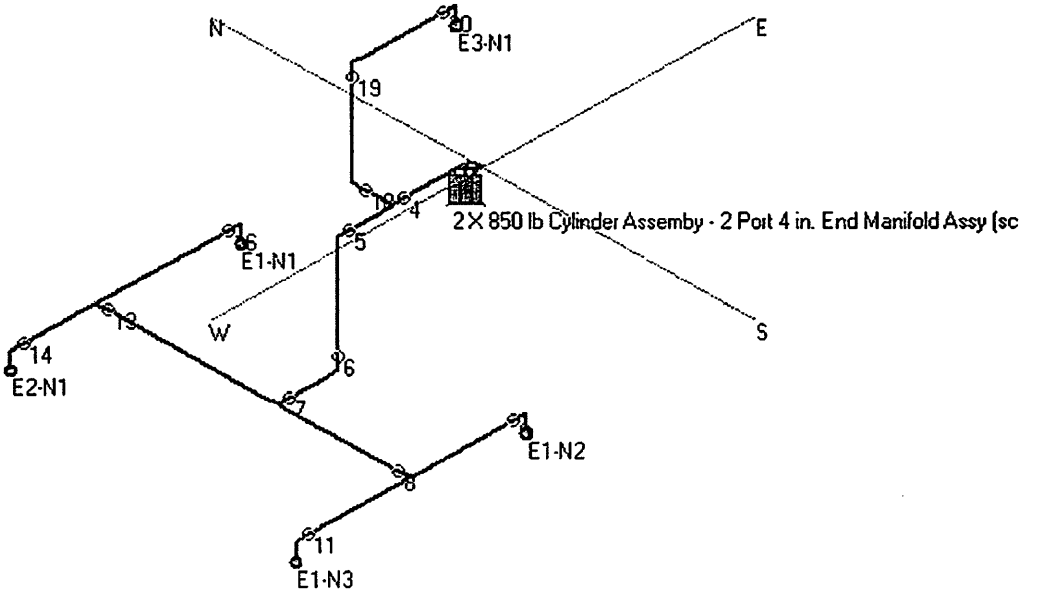
Drawing View: 1



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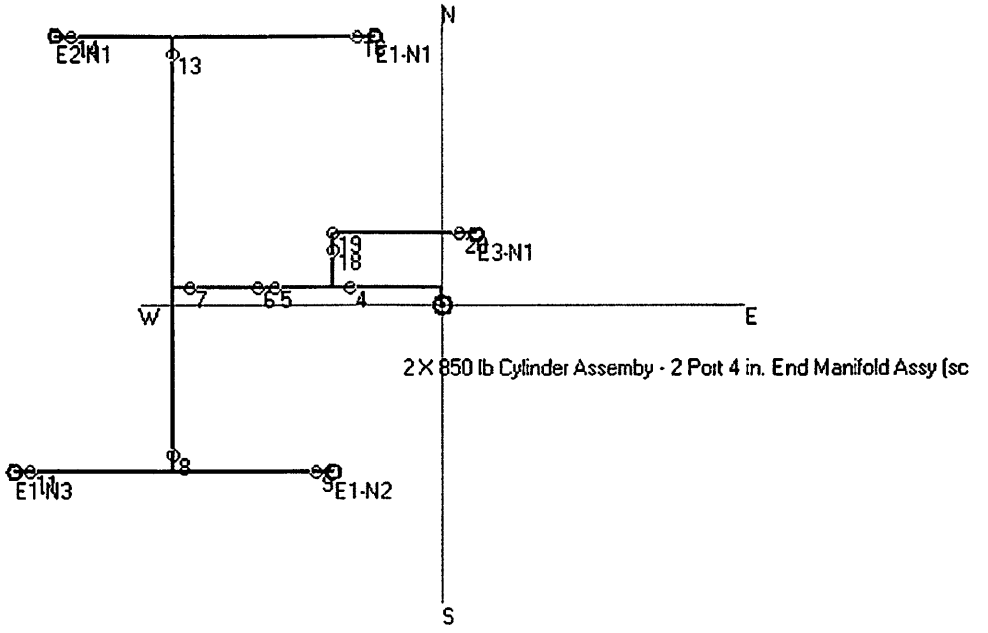

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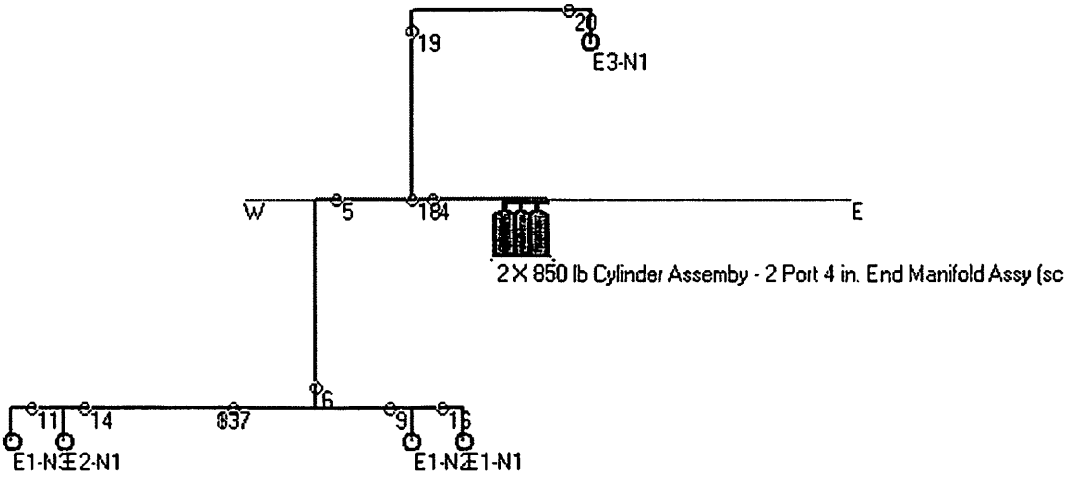
Drawing View: 9



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