ANSUL
SAPPHIRE ENGINEERED
CLEAN AGENT SYSTEM
DESIGN, INSTALLATION, RECHARGE AND MAINTENANCE MANUAL
ANSUL PART NO. 570590-04

UNDERWRITERS LABORATORIES FILE NO. EX-4510

SEPTEMBER 1, 2010

DATE	PAGE	REV. NO.
4-1-05	1-6	1
4-15-05	1-20	1
4-1-05	3-5	1
4-1-05	5-11	1
4-1-05	6-2	1
4-1-05	6-3	1
4-1-05	9-1	1
4-1-05	9-2	1
3-1-07	5-2	2
4-1-10	1-1	2
4-1-10	1-3	1
4-1-10	1-8	2
4-1-10	1-9	2
4-1-10	1-10	1
4-1-10	5-15	New
4-1-10	5-16	New
9-1-10	Table of Contents	3
9-1-10	1-2	3
9-1-10	1-4	2
9-1-10	1-7	1
9-1-10	1-11	2
9-1-10	1-15	3
9-1-10	1-19	1
9-1-10	Section II – MSDS	Updated
9-1-10	2-7	New
9-1-10	2-8	New

DATE	PAGE	REV. NO.
9-1-10	3-2	3
9-1-10	3-4	2
9-1-10	4-2	2
9-1-10	5-1	2
9-1-10	5-3	2
9-1-10	5-4	2
9-1-10	5-5	2
9-1-10	5-6	1
9-1-10	5-7	2
9-1-10	5-8	2
9-1-10	5-9	1
9-1-10	5-10	1
9-1-10	5-12	2
9-1-10	6-1	2
9-1-10	9-4	1
9-1-10	Section X – Example	Updated

LEGEND FOR MANUAL PAGE REVISION INDICATORS:

▸ Indicates revised information.

■ Indicates no change to text – change in page sequence only.

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Table of Contents

9-1-10 REV. 3

SAPPHIRE SUPPRESSION SYSTEMS

SAPPHIRE SUPPRESSION SYSTEMS

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. 570650 – 55 gallon (208.2 L) Drum Shipping Assembly

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

- For complete Material Safety Data Sheet (MSDS) information, visit ansul.com.

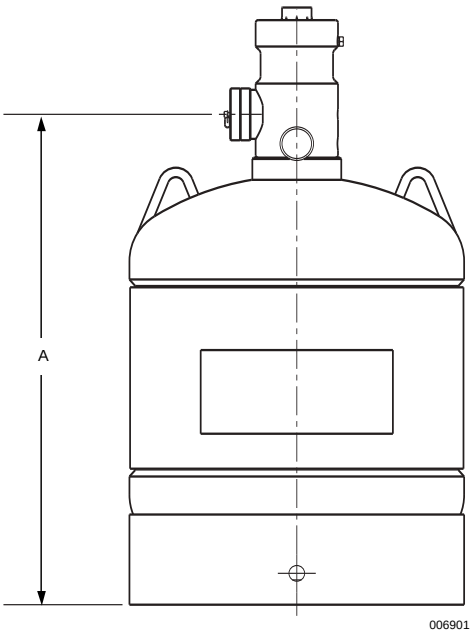
SAPPHIRE SUPPRESSION SYSTEMS

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	
Valve/Tank Assembly		UL Listed ULC Listed FM Approved

Shipping Assembly Part No./TC	Nominal Tank Size lb (kg)	Agent Quantity lb (kg)	Approximate Empty Weight lb (kg)	Dimension "A" in. (cm)	Diameter in. (cm)	Valve Size	Equivalent Length ft (m)
570635	20 (9.1)	9 to 21 (4.1 to 9.5)	33 (15)	12 (30.4)	10 (25.4)	1 in.	20 (6.096)
570633	50 (22.7)	18 to 42 (8.2 to 19.1)	41 (18.6)	19.8 (50.2)	10 (25.4)	1 in.	20 (6.096)
570634	90 (40.8)	36 to 84 (16.3 to 38.1)	57.5 (26)	32.8 (83.3)	10 (25.4)	1 in.	20 (6.096)
570638	140 (63.5)	58 to 137 (26 to 62.1)	108 (49)	23.5 (59.6)	16 (40.6)	2 in.	35 (10.668)
570639/570651	280 (127)	117 to 280 (53.1 to 127)	158 (71.7)	40.2 (102)	16 (40.6)	2 in.	35 (10.668)
570640/570652	390 (177)	163 to 388 (73.9 to 176)	198 (90)	53.3 (135)	16 (40.6)	2 in.	35 (10.668)
570641/570653	450 (204)	199 to 459 (90.3 to 204)	233 (106)	64.3 (163)	16 (40.6)	2 in.	35 (10.668)
570586/570654	850 (386)	379 to 851 (172 to 386)	456 (207)	57.7 (146.6)	24 (61)	3 in.	85 (25.91)

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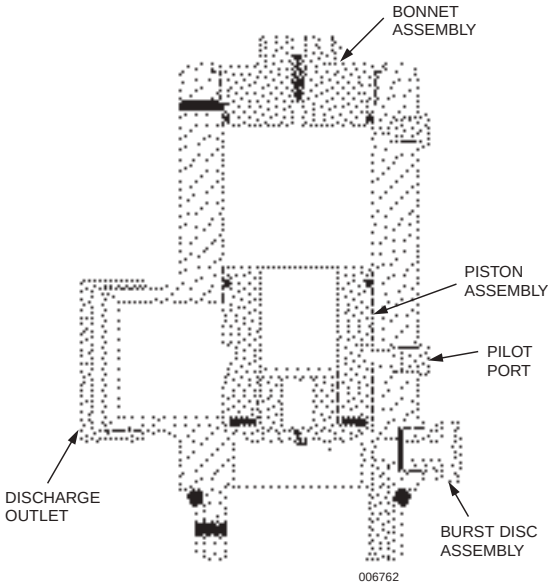
SAPPHIRE SUPPRESSION SYSTEMS

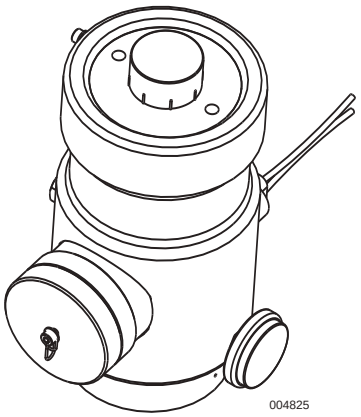
Discharge Valve Assembly

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	Approvals
Valve	Brass	UL Listed ULC Listed FM Approved

Shipping Assembly Part No.	Description	Equivalent Length
570535	1 in. Valve Shipping Assembly	20 ft (6.096 m)
570536	2 in. Valve Shipping Assembly	35 ft (10.668 m)
570588	3 in. Valve Shipping Assembly	85 ft (25.91 m)





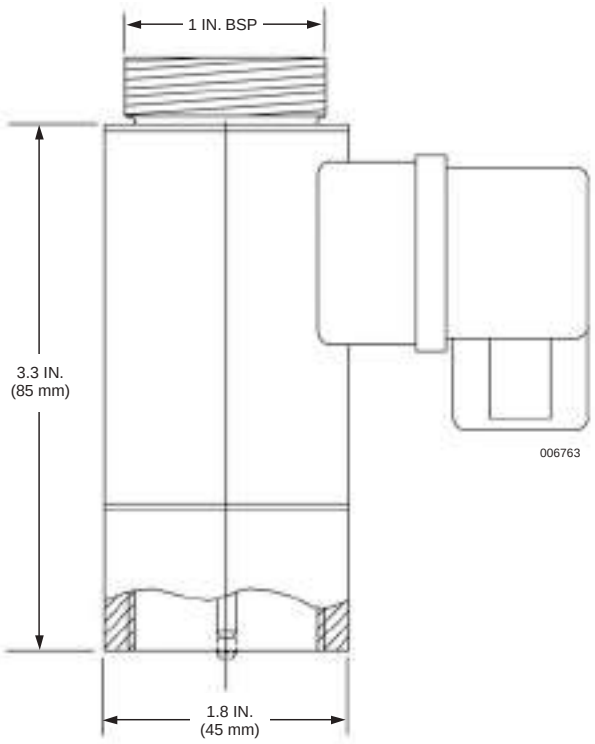
Electric Actuator – 24 VDC

The 24 VDC electric actuator is required to electrically actuate the tank valve. An electric signal is required from the AUTOPULSE Control panel which operates the solenoid in the actuator. This causes the actuator to open the tank valve and discharge the agent. On multiple tank systems, only one actuator is required, on the master valve. The remaining tanks will be actuated pneumatically through 1/4 in. stainless steel hose and a pneumatic actuator installed on the top of each tank valve.

- The actuator draw is 0.25A.

Note: Composite cap attached to actuator is used as the reset tool. To reset actuator, put cap in place and turn knurled swivel coupling until cap threads are completely engaged. A small “click” will be heard while resetting.

Note: Actuator has a 10-year shelf life.



Component	Material	Thread Type	Approvals
Electric Actuator	Body: Steel Swivel Nut: Brass Actuation Pin: Stainless Steel	1 in. BSPP	UL Listed ULC Listed FM Approved

Shipping Assembly Part No.	Description
570537	Electric Actuator

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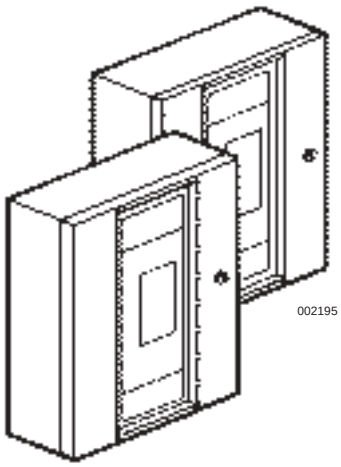
SAPPHIRE SUPPRESSION SYSTEMS

AUTOPULSE Control System

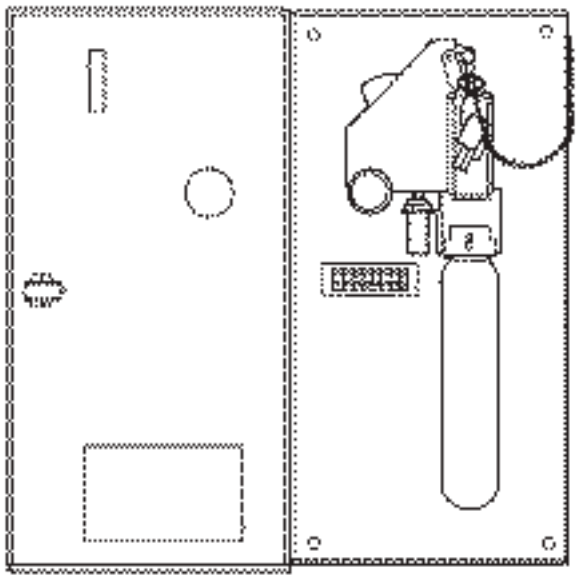
The AUTOPULSE Control System is designed to monitor fixed fire hazards. The control system can automatically actuate the fire suppression system after receiving an input signal from one or more initiating devices, i.e., manual pull station or detector. The control system incorporates an internal power supply, on-line emergency batteries, and solid state electronics. Refer to Detection and Control manual for additional information.



ANSUL AUTOMAN II-C Releasing Device (For Pneumatic Actuation)

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

The ANSUL AUTOMAN II-C releasing device requires an ▸ LT-30-R nitrogen cartridge for system actuation. Cartridge must be ordered separately.



Component	Approvals
ANSUL AUTOMAN II-C Releasing Device	UL Listed ULC Listed FM Approved

Shipping Assembly Part No.	Description
▸ 17728	ANSUL AUTOMAN II-C Releasing Device
▸ 5373	LT-30-R Nitrogen Cartridge (order separately)
26310	Cocking Lever (order separately)

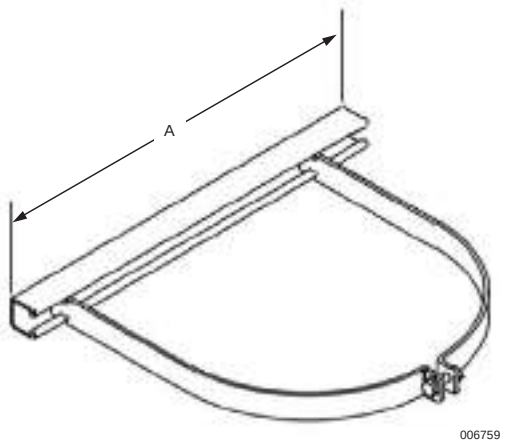
SAPPHIRE SUPPRESSION SYSTEMS

Mounting Bracket Assembly

The mounting bracket assembly consists of a nut, bolt, and two bracket straps (back channel must be supplied by others). Approved type of Unistrut Channel is series P1000T, 1.6 in. x 1.6 in. (41 mm x 41 mm).

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

A single bracket assembly is required for 20, 50, 90, 140, 280, 390, and 450 lb tank sizes. Two bracket assemblies are required for the 850 lb size tank.



Component	Material	Approvals
Mounting Bracket	Steel	UL Listed ULC Listed FM Approved

Shipping Assembly Part No.	Description	"A" Dimension in. (cm)
570085	Bracket Assembly for 20, 50, and 90 lb tanks (10 in. (25.4 cm) diameter)	15.7 (40)
570092	Bracket Assembly for 140, 280, 390, and 450 lb tanks (16 in. (40.6 cm) diameter)	23.6 (60)
570336	Bracket Assembly for 850 lb tank (24 in. (61.0 cm) diameter)	27.3 (69)

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SAPPHIRE SUPPRESSION SYSTEMS

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).

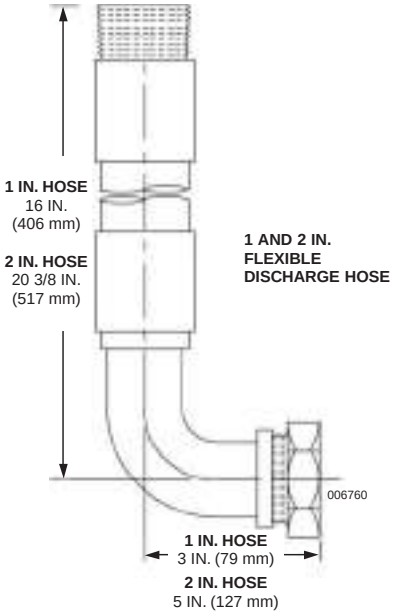
The 1 in. flexible hose or the adaptor, Part No. 570557, can be used to connect the valve outlet to rigid pipe.

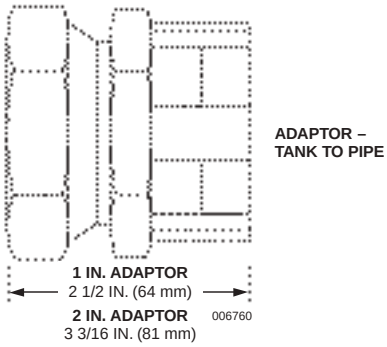
The 2 in. flexible hose or the adaptor, Part No. 570558, can be used to connect the valve outlet to rigid pipe.

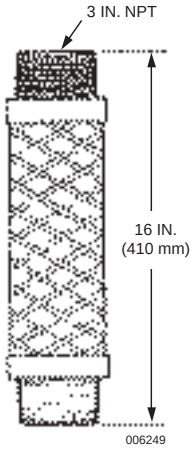
When using a 3 in. flexible discharge hose (without a manifold), three single tank swivel adaptors are available for connection from the valve outlet to the flexible discharge hose.

Component	Material	Approvals
1, 2, 3 in. Flexible Discharge Hose	Stainless Steel Tubing with Stainless Steel Braid Cover	UL Listed ULC Listed FM Approved

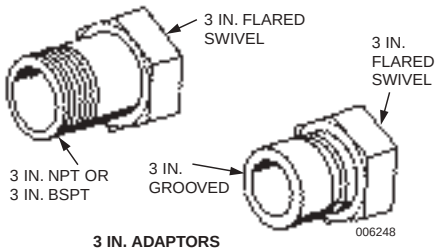
Shipping Assembly Part No.	Description	Equivalent Length
570539	1 in. Flexible Discharge Hose	10.3 ft (3.14 m)
570538	2 in. Flexible Discharge Hose	17.6 ft (5.36 m)
69990	3 in. Flexible Discharge Hose	5.1 ft (1.55 m)
570557	1 in. Single Tank Swivel Adaptor	0.6 ft (0.2 m)
570558	2 in. Single Tank Swivel Adaptor	1.2 ft (0.4 m)
69470	3 in. Flared to 3 in. NPT Single Tank Swivel Adaptor	1.8 ft (0.55 m)
69471	3 in. Flared to 3 in. Grooved Single Tank Swivel Adaptor	1.8 ft (0.55 m)
570363	3 in. Flared to 3 in. BSPT Single Tank Swivel Adaptor	1.8 ft (0.55 m)







3 IN. FLEXIBLE DISCHARGE HOSE



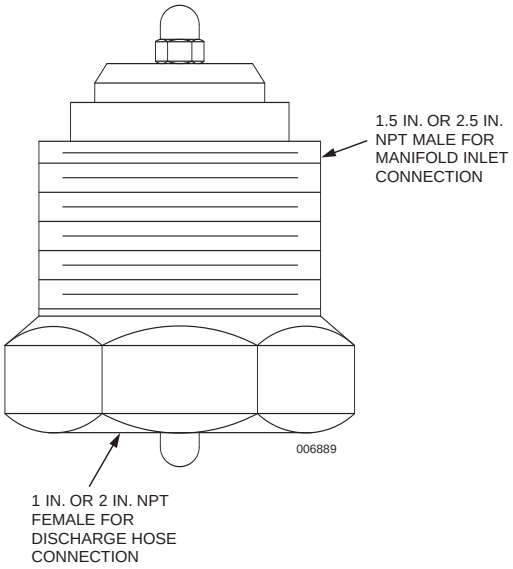
3 IN. ADAPTORS

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.



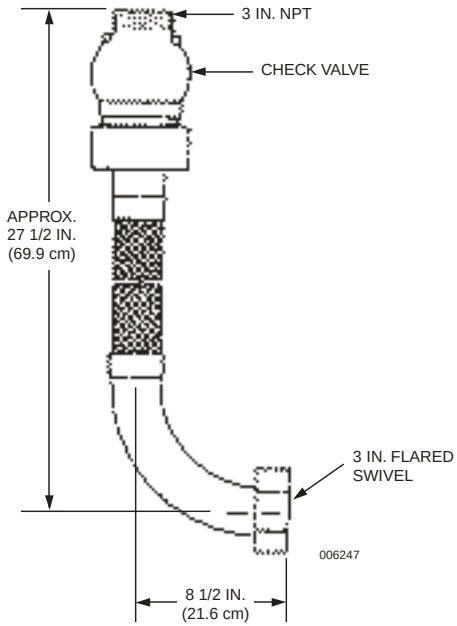
Component	Material	Approvals
Check Valve	Body: Brass Stem and Seal: Stainless Steel	UL Listed ULC Listed FM Approved

Shipping Assembly Part No.	Description	Equivalent Length
570566	1 in. Manifold Check Valve	1.3 ft (0.40 m)
570568	2 in. Manifold Check Valve	21.8 ft (6.66 m)

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	Approvals	Equivalent Length
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	UL Listed ULC Listed FM Approved	52 ft (15.85 m)



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

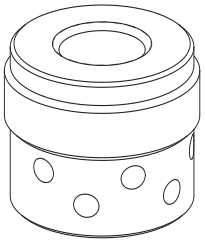
Discharge Nozzles

The discharge nozzles are available in a 180° and 360° pattern and are designed to uniformly distribute the Novec™ 1230 agent throughout the hazard area.

The 180° nozzle has seven ports and 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.



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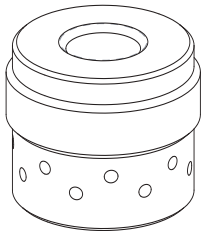

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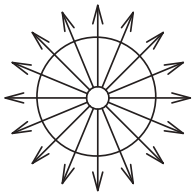
Component	Material	Threads	Approvals
1/2 in. Nozzle 3/4 in. Nozzle 1 in. Nozzle 1 1/4 in. Nozzle 1 1/2 in. Nozzle 2 in. Nozzle	Brass	1/2 in. NPT 3/4 in. NPT 1 in. NPT 1 1/4 in. NPT 1 1/2 in. NPT 2 in. NPT	UL Listed ULC Listed FM Approved

Shipping Assembly Part No.	Description
570515	1/2 in Nozzle – 180°
570516	3/4 in. Nozzle – 180°
570517	1 in. Nozzle – 180°
570518	1 1/4 in. Nozzle – 180°
570519	1 1/2 in. Nozzle – 180°
570520	2 in. Nozzle – 180°
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°

180° NOZZLE PATTERN



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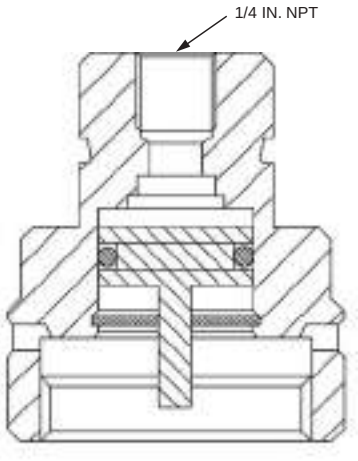
360° NOZZLE PATTERN

SAPPHIRE SUPPRESSION SYSTEMS

Pneumatic Actuator

The pneumatic actuator is required to pneumatically actuate the agent tanks. The actuator operates from pressure received from the nitrogen cartridge located in the ANSUL AUTOMAN II-C release. 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.



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Component	Material	Approvals
Pneumatic Actuator	Brass	UL Listed ULC Listed FM Approved

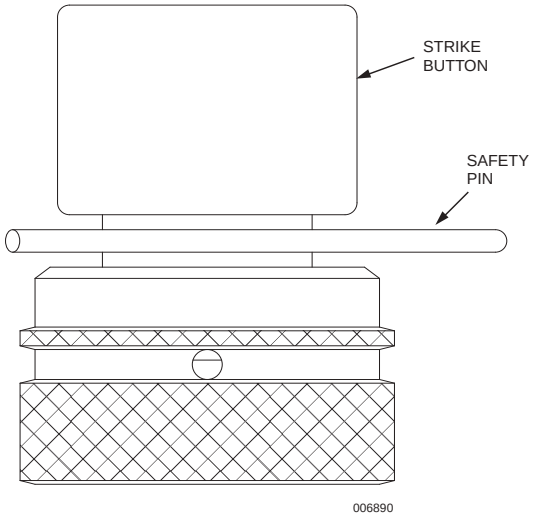
Shipping Assembly Part No.	Description
570550	Pneumatic Actuator

SAPPHIRE SUPPRESSION SYSTEMS

Local Manual Actuator

The local manual actuator is used to mechanically operate the tank. To prevent accidental actuation, the actuator contains a steel safety pin. The pin must be removed to operate the actuator. The actuator is operated by depressing the strike button.

The actuator can be mounted either on the top port of the tank valve or on top of the electric solenoid valve.



Component	Material	Approvals
Local Manual Actuator	Body: Brass Safety Pin: Steel Actuation Pin: Stainless Steel	UL Listed ULC Listed FM Approved

Shipping Assembly Part No.	Description
570549	Local Manual Actuator

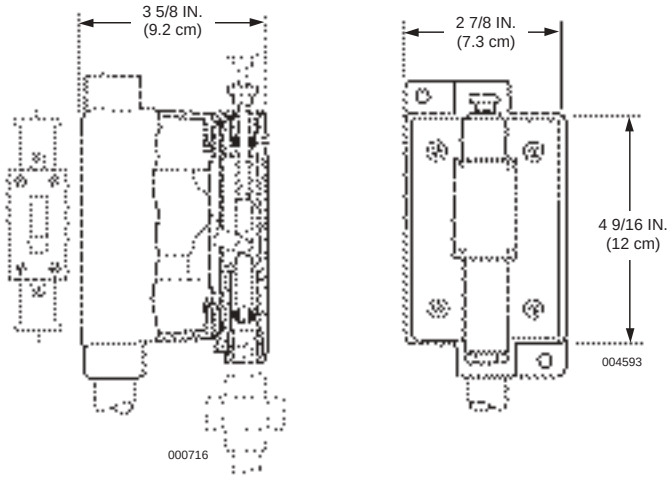
SAPPHIRE SUPPRESSION SYSTEMS

Pressure Switch – DPST

The pressure switch can be used to open or close electrical circuits to either shut down equipment or turn on lights and alarms. The double pole, single throw (DPST) pressure switch is constructed with a gasketed, water-tight housing. The housing is constructed of malleable iron. A 1/4 in. NPT pressure inlet is used to connect the pressure switch to the 1/4 in. actuation piping between the ANSUL AUTOMAN II-C release and the pneumatic actuator on the master SAPPHIRE tank valve.

Minimum operating pressure is 50 psi (3.5 bar)

Shipping Assembly Part No.	Description
46250	Pressure Switch – DPST



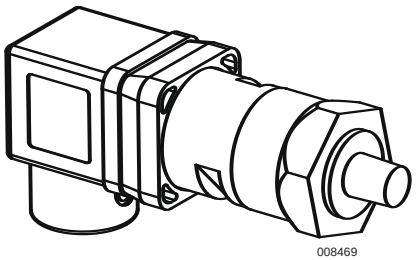
Component	Material	Thread Size/Type	Electrical Rating	Approvals
Pressure Switch DPST	Switch: BAKELITE Housing: Malleable Iron Piston: Brass Cover: Brass	Conduit Inlet: 3/4 in. NPT Female Pressure Inlet: 1/4 in. NPT Female	2 HP – 240 VAC/480 VAC 2 HP – 250 VDC 30A – 250V AC/DC 5A – 480V AC/DC	UL Listed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

SAPPHIRE SUPPRESSION SYSTEMS

Low Pressure Switch

The low pressure switch is used to indicate a pressure drop within the SAPPHIRE tank. The switch is mounted 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. The switch ordered will consist of one of the two options below.



Shipping Assembly Part No.	Description
570585	Low Pressure Switch

Option #1	Materials	Pressure Settings	Electrical Characteristics	Wiring
GEMS	Base: Zinc-plated Steel Diaphragm: Kapton O-ring: Nitrile	Transfers at: 294 psi +/– 10 psi Falling (20.3 bar +/– 0.7 bar) Resets by 350 psi Rising (24 bar) Maximum Operating Pressure: 1000 psi (68.9 bar)	Maximum Current: 5 A Nominal Voltage: 24 VDC	Normally-Open: PIN 3 Common: PIN 1 Normally-Closed: PIN 2

Option #2	Materials	Pressure Settings	Electrical Characteristics	Wiring
NASON	Base: C360 Brass Body: Blue Anodized Aluminum Diaphragm: Buna-N	Transfers at: 290 psi +/– 15 psi Falling (20 bar +/– 1.0 bar) Resets at: 330 psi +/– 10 psi Rising (22.8 bar +/– 0.7 bar) Maximum Operating Pressure: 2000 psi (137.9 bar)	Maximum Current: 5 A Nominal Voltage: 24 VDC	Normally-Open: PIN 3 Common: PIN 1 Normally-Closed: PIN 2

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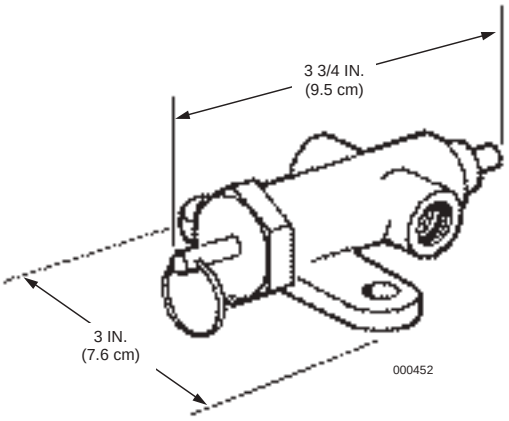
SAPPHIRE SUPPRESSION SYSTEMS

Pressure Trip

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

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

Note: Pressure trip **must not** be installed in agent discharge piping.



Component	Material	Thread Type	Approvals
Pressure Trip	Brass	1/4 in. NPT Female	UL Listed ULC Listed FM Approved

Shipping Assembly Part No.	Description
5156	Pressure Trip

SAPPHIRE SUPPRESSION SYSTEMS

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	Approvals
Warning Sign	Aluminum	UL Listed ULC Listed FM Approved

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

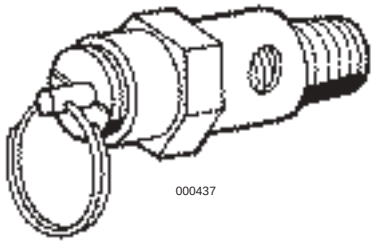
006894

006895

SAPPHIRE SUPPRESSION SYSTEMS

Safety Relief Valve

The safety relief valve is used to relieve the nitrogen pressure in the actuation line after the system has been actuated by an ANSUL AUTOMAN II-C release. After agent discharge, pulling the ring on the relief valve can relieve the pressure in the line.



Component	Material	Approvals
Safety Relief Valve	Brass	UL Listed ULC Listed FM Approved

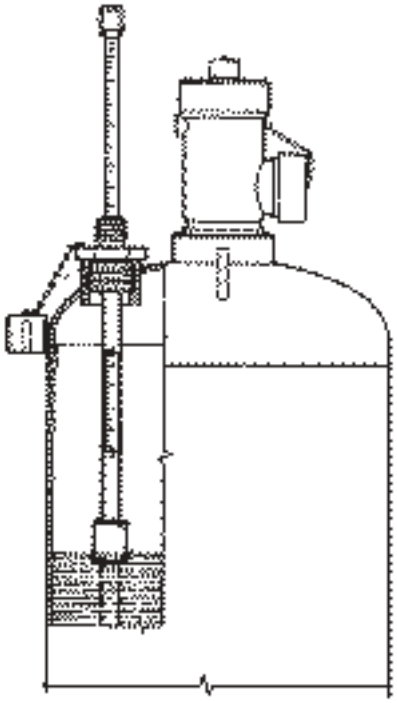
Shipping Assembly Part No.	Description
15677	Safety Relief Valve

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. (7.6 cm) 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.



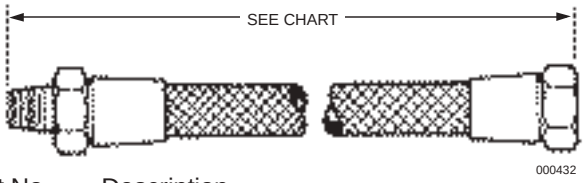
006255

Component	Material	Approvals
Liquid Level Indicator	Body: Brass Tape: Steel	UL Listed ULC Listed FM Approved

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

1/4 in. Actuation Hose

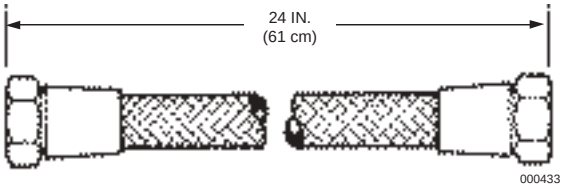
The 1/4 in. stainless steel actuation hose is used to connect the 1/4 in. actuation line to the pneumatic actuator located on the tank valve. The hose is used when the actuation line is rigid 1/4 in. pipe and fittings. The hose has a 1/4 in. NPT male thread on one end and a 7/16-20 female thread on the other end. A male straight adaptor, Part No. 32338, is required with this hose. Three lengths of hoses are available.



Part No.	Description
73597	16 in. (40.6 cm) Hose
415142	32 in. (81.3 cm) Hose
430815	42 in. (106.7 cm) Hose

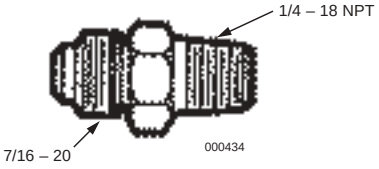
1/4 in. Female Actuation Hose – Part No. 32336

The 1/4 in. stainless steel, female 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.



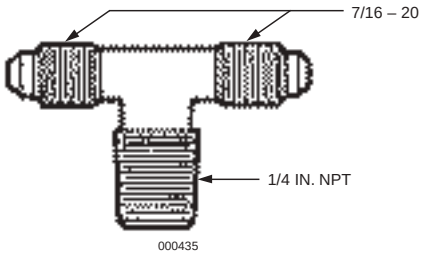
Male Actuation Connector – Part No. 32338

The male connector is used to connect the 1/4 in. female actuation hose to rigid 1/4 in. actuation fittings and also the pneumatic actuator. The connector has a 7/16-20 thread for connecting to the actuation hose and a 1/4 in. NPT thread for connecting to the actuation piping and pneumatic actuator.



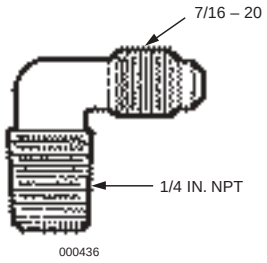
Male Actuation Tee – Part No. 31811

The male actuation tee is used to connect multiple actuation hoses together. The actuation tee has a 7/16-20 thread for connecting to the female actuation hose and a NPT thread for connecting to the pneumatic actuator on the tank valve.



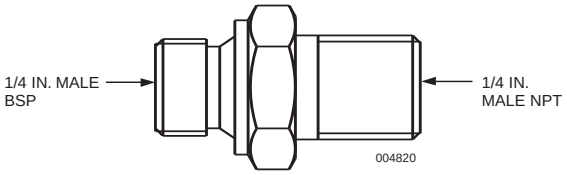
Male Actuation Elbow – Part No. 31810

The male actuation elbow is used to connect the actuation hose to a single or last tank in a multiple tank system. The elbow connects between the hose and the pneumatic actuator on the valve. The elbow has a 7/16-20 thread for connecting to the hose and a 1/4 in. NPT thread for connecting to the pneumatic actuator on the tank valve.



Male Adaptor – Part No. 570342

The male adaptor is required to attach the 1/4 in. actuation hose to the master tank pilot port. When using the male adaptor on the master tank pilot port, a 1/4 in. pipe coupling must be used between the adaptor and the male hose thread.



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

Material Safety Data Sheet

SECTION 1: PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: 3M(TM) Novec (TM) 1230 Fire Protection Fluid [FK-5-1-12]
MANUFACTURER: 3M
DIVISION: Electronics Markets Materials Division

ADDRESS: 3M Center
St. Paul, MN 55144-1000

EMERGENCY PHONE: 1-800-364-3577 or (651) 737-6501 (24 hours)

Issue Date: 04/09/2007
Supercedes Date: 09/11/2006

Document Group: 16-3425-2

Product Use:
Intended Use: STREAMING AND FLOODING FIRE PROTECTION

SECTION 2: INGREDIENTS

Ingredient	C.A.S. No.	% by Wt
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	756-13-8	> 99.9

SECTION 3: HAZARDS IDENTIFICATION

3.1 EMERGENCY OVERVIEW

Specific Physical Form: Liquid
Odor, Color, Grade: clear colorless, low odor.
General Physical Form: Liquid
Immediate health, physical, and environmental hazards:

3.2 POTENTIAL HEALTH EFFECTS

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:
If thermal decomposition occurs:
May be harmful if inhaled.

Ingestion:
No health effects are expected.

3.3 POTENTIAL ENVIRONMENTAL EFFECTS

This substance has a high Henry's Law constant and therefore will be primarily found in the atmosphere where photolysis will be the dominant reaction pathway. The ultimate degradation products of the photolysis reaction are HF, CO2 and trifluoroacetic acid (TFA).

This substance does not contribute to ozone depletion; it has an atmospheric lifetime of approximately 5 days and a Global Warming Potential (GWP) of 1 (IPCC 2001 Method).

SECTION 4: FIRST AID MEASURES

4.1 FIRST AID PROCEDURES

The following first aid recommendations are based on an assumption that appropriate personal and industrial hygiene practices are followed.

Eye Contact: No need for first aid is anticipated.

Skin Contact: No need for first aid is anticipated.

Inhalation: If signs/symptoms develop, remove person to fresh air. If signs/symptoms persist, get medical attention.

If Swallowed: No need for first aid is anticipated.

SECTION 5: FIRE FIGHTING MEASURES

5.1 FLAMMABLE PROPERTIES

Autoignition temperature	*Not Applicable*
Flash Point	*Not Applicable*
Flammable Limits - LEL	[*Details:* Nonflammable]
Flammable Limits - UEL	[*Details:* Nonflammable]

5.2 EXTINGUISHING MEDIA
Product is a fire-extinguishing agent.

5.3 PROTECTION OF FIRE FIGHTERS

Special Fire Fighting Procedures: Wear full protective equipment (Bunker Gear) and a self-contained breathing apparatus (SCBA).

Unusual Fire and Explosion Hazards: Not applicable.

Note: See STABILITY AND REACTIVITY (SECTION 10) for hazardous combustion and thermal decomposition information.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Accidental Release Measures: Observe precautions from other sections. Call 3M- HELPS line (1-800-364-3577) for more information on handling and managing the spill. Ventilate the area with fresh air. Contain spill. For larger spills, cover drains and build dikes to prevent entry into sewer systems or bodies of water. 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. Seal the container. Dispose of collected material as soon as possible.

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.

SECTION 7: HANDLING AND STORAGE

7.1 HANDLING

For industrial or professional use only. Contents may be under pressure, open carefully. Avoid breathing of vapors, mists or spray. Do not breathe thermal decomposition products.

7.2 STORAGE

Keep container in well-ventilated area. Store out of direct sunlight. Store away from heat. Store away from strong bases, amines, and alcohols.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 ENGINEERING CONTROLS

Provide appropriate local exhaust ventilation on open containers. Provide appropriate local exhaust when product is heated.

8.2 PERSONAL PROTECTIVE EQUIPMENT (PPE)

8.2.1 Eye/Face Protection

As a good industrial hygiene practice:

Avoid eye contact with vapors, mists, or spray.

8.2.2 Skin Protection

Gloves are not required.

8.2.3 Respiratory Protection

Under normal use conditions, airborne exposures are not expected to be significant enough to require respiratory protection. As a good industrial hygiene practice:

Material Safety Data Sheet

Avoid breathing of vapors, mists or spray.

If thermal decomposition occurs, wear supplied air respiratory protection.

8.2.4 Prevention of Swallowing
Not applicable.

8.3 EXPOSURE GUIDELINES

Ingredient	Authority	Type	Limit	Additional Information
1,1,1,2,2,4,5,5,5-NONAFLUORO-4-(TRIFLUOROMETHYL)-3-PENTANONE	3M	TWA	150 ppm	

SOURCE OF EXPOSURE LIMIT DATA:
ACGIH: American Conference of Governmental Industrial Hygienists
CMRG: Chemical Manufacturer Recommended Guideline
OSHA: Occupational Safety and Health Administration
AIHA: American Industrial Hygiene Association Workplace Environmental Exposure Level (WEEL)

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

Specific Physical Form:	Liquid
Odor, Color, Grade:	clear colorless, low odor.
General Physical Form:	Liquid
Autoignition temperature	*Not Applicable*
Flash Point	*Not Applicable*
Flammable Limits - LEL	[*Details:* Nonflammable]
Flammable Limits - UEL	[*Details:* Nonflammable]
Boiling point	49 °C
Vapor Density	11.6 [*Ref Std:* AIR=1]
Vapor Pressure	244 mmHg [@ 20 °C]
Specific Gravity	1.6 [*Ref Std:* WATER=1]
pH	*Not Applicable*
Melting point	-108 °C
Solubility in Water	Nil
Evaporation rate	> 1 [*Ref Std:* BUOAC=1]
Volatile Organic Compounds	1600 g/l [*Test Method:* calculated SCAQMD rule 443.1]
Percent volatile	100 %
VOC Less H2O & Exempt Solvents	1600 g/l [*Test Method:* calculated SCAQMD rule 443.1]
Viscosity	0.6 centipoise [@ 25 °C]

SECTION 10: STABILITY AND REACTIVITY

Stability: Stable.

Materials and Conditions to Avoid: Strong bases; Amines; Alcohols Additional Information: Listed materials to avoid should not be mixed with liquid Novec 1230 fluid. Avoid direct sunlight and ultraviolet light.

Hazardous Polymerization: Hazardous polymerization will not occur.

Hazardous Decomposition or By-Products

Substance	Condition
Carbon monoxide	During Combustion
Carbon dioxide	During Combustion
Hydrogen Fluoride	During Combustion

Hazardous Decomposition: Hydrogen fluoride has an ACGIH Threshold Limit Value of 3 parts per million (as fluoride) as a Ceiling Limit and an OSHA PEL of 3 ppm of fluoride as an eight hour Time-Weighted Average and 6 ppm of fluoride as a Short Term Exposure Limit. The odor threshold for HF is 0.04 ppm, providing good warning properties for exposure.

SECTION 11: TOXICOLOGICAL INFORMATION

Please contact the address listed on the first page of the MSDS for Toxicological Information on this material and/or its components.

SECTION 12: ECOLOGICAL INFORMATION

ECOTOXICOLOGICAL INFORMATION

Please refer to existing literature on TFA

CHEMICAL FATE INFORMATION

Photolytic half-life: 3-5 days.
Photolytic degradation products may include Trifluoroacetic acid (TFA)
NOTE: Hydrolysis is not expected to be a significant degradation pathway. Product is highly insoluble in water and volatile, and use as a clean extinguishing agent would not typically result in releases to aquatic environments.

SECTION 13: DISPOSAL CONSIDERATIONS

Waste Disposal Method: 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. Reclaim if feasible. For information on product return, contact your distributor.

EPA Hazardous Waste Number (RCRA): Not regulated

Since regulations vary, consult applicable regulations or authorities before disposal.

SECTION 14:TRANSPORT INFORMATION

ID Number(s):
98-0212-3031-7, 98-0212-3201-6, 98-0212-3203-2, 98-0212-3217-2, 98-0212-3371-7, 98-0212-3414-5

Material Safety Data Sheet

Please contact the emergency numbers listed on the first page of the MSDS for Transportation Information for this material.

SECTION 15: REGULATORY INFORMATION

US FEDERAL REGULATIONS
Contact 3M for more information.

311/312 Hazard Categories:
Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No Immediate Hazard - No Delayed Hazard - No

STATE REGULATIONS
Contact 3M for more information.

CHEMICAL INVENTORIES
The components of this product are in compliance with the chemical notification requirements of TSCA.

One or more of the components of this product have been notified to ELINCS (European List of Notified or New Chemical Substances). Certain restrictions apply. Contact the selling division for additional information.

All the components of this product are listed on China's Inventory of Chemical Substances.

The components of this material are in compliance with the new chemical notification requirements for the Korean Existing Chemicals Inventory.

Contact 3M for more information.

Additional Information: The components of this product are in compliance with the chemical notification requirements of the National Industrial Chemical Notification and Assessment Scheme (NICNAS) of Australia, the Canadian Environmental Protection Act (CEPA) and the Ministry of Economy, Trade and Industry of Japan.

INTERNATIONAL REGULATIONS
Contact 3M for more information.

ADDITIONAL INFORMATION

U.S. EPA. Significant New Alternatives Policy Program (SNAP) approved for uses is streaming and flooding fire protection

Material Safety Data Sheet

applications.

This MSDS has been prepared to meet the U.S. OSHA Hazard Communication Standard, 29 CFR 1910.1200.

SECTION 16: OTHER INFORMATION

NFPA Hazard Classification
Health: 2 Flammability: 0 Reactivity: 1 Special Hazards: None

National Fire Protection Association (NFPA) hazard ratings are designed for use by emergency response personnel to address the hazards that are presented by short term, acute exposure to a material under conditions of fire, spill, or similar emergencies. Hazard ratings are primarily based on the inherent physical and toxic properties of the material but also consider the toxic properties of combustion or decomposition products that are known to be generated in significant quantities.

HMIS Hazard Classification
Health: 0 Flammability: 0 Reactivity: 1 Protection: X - See PE section

Hazardous Material Identification System (HMIS®) hazard ratings are designed to inform employees of chemical hazards in the workplace. These ratings are based on the physical properties of the material under expected conditions of normal use and are not intended for use in emergency situations. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint and Coatings Association (NPCA)

Revision Changes:
Section 1: Product use information was modified.
Copyright was modified.
Section 14: ID Numbers(s) was modified

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3M MSDSs are available at www.3M.com

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Material Safety Data Sheet

NOTES:

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.

General Information

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

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 2001 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.

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 A, B, 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) and Underwriters Laboratories of Canada (CEX1151) as well as Factory Mutual (FM) as an engineered system for Class A, B, and C fire suppression, at temperatures between 32 °F to 130 °F (0 °C to 55 °C).

General Information

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 three basic types of actuation for the SAPPHIRE systems: pneumatic, mechanical, and electric.

Electrical

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

Mechanical

Mechanical actuation is accomplished by means of a local manual actuator mounted on top of the tank valve or on top of the electric actuator. The tank is actuated by removing the safety pin on the actuator and depressing the strike knob. 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 releasing device such as an ANSUL AUTOMAN II-C release. The gas pressure forces the pneumatic actuator, located on the tank valve, down, which in turn forces the cylinder valve open, releasing the Novec 1230 agent from the tank, through the piping and out the nozzles.

TYPES OF DETECTION

There are two approved types of detection available for the SAPPHIRE system: electronic control panel and electric releasing device.

Electronic Control Panel

Electric actuation of the SAPPHIRE system is obtained through the use of electronic control systems that monitor and control various system functions. All detection equipment must be installed according to NFPA 70 and NFPA 72. detection devices available are: ionization smoke detectors, photoelectric smoke detectors, flame detectors, and rate compensated heat detectors. Note: When designing the system, make certain the type of detector used is appropriate for the type of hazard so proper response is attained in a fire situation. When a detector senses a fire, a signal is sent to the control panel. The panel in turn sends an electrical signal to the actuator located on the master tank valve. The actuator opens the master valve, actuating that tank and causing pneumatic actuation of the remaining tanks from the pressure of the master tank.

Electric Release Device

The ANSUL AUTOMAN II-C electric releasing device uses approved thermal detectors and actuates the SAPPHIRE tanks pneumatically, utilizing high-pressure nitrogen to open the tank valve.

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.

General Information

SYSTEM LIMITATIONS (Continued)

Design/Flow Calculation Limitations

- System Operating Temperature: 32 °F to 130 °F (0 °C to 54 °C)
- Minimum Design Concentration: Class A, 4.2% – Class B, contact Ansul Technical Services for specific fuel design concentrations
- Fill Density: Maximum 75 lb/ft^3 (34.0 kg/m^3), Minimum 31.0 lb/ft^3 (14.1 kg/m^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:

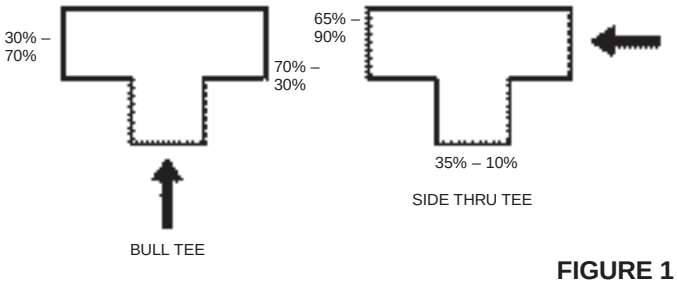


FIGURE 1
002201

- Maximum nozzle height above floor level for a single row of nozzles is 14 ft (4.3 m). For ceiling 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 ceiling, positioned vertically (either up or down). Exception: Sub-floor nozzles may be positioned either vertically down from the top of the sub-floor or vertically up from the bottom of the sub-floor.
- Maximum Area Nozzle Coverage: 1800 ft^2 (167.2 m^2)
- Minimum Ceiling Height: 12 in. (30.5 cm)
- Piping/Tee Orientation:

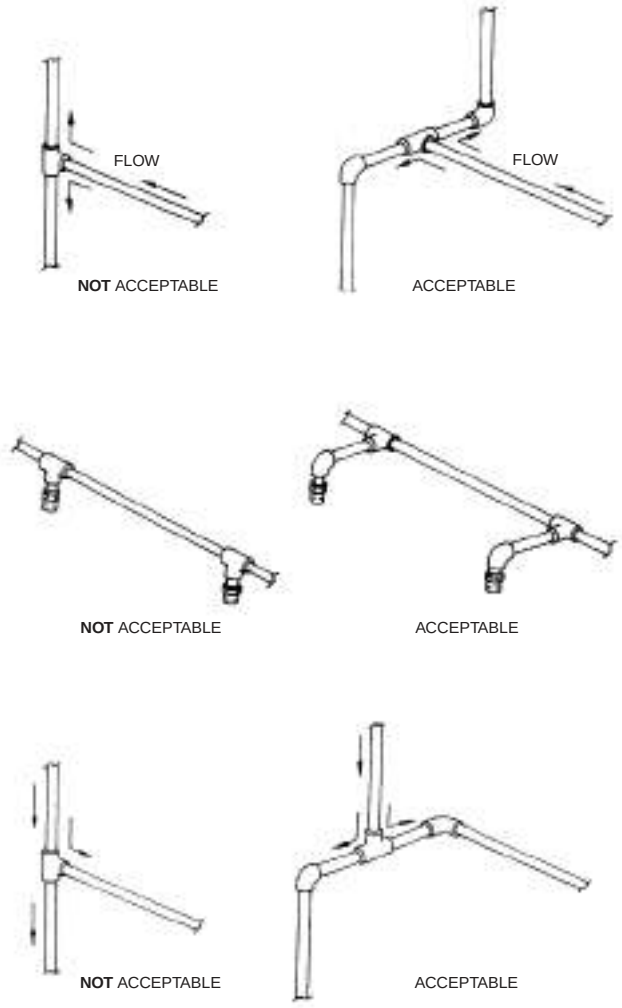


FIGURE 2
006903

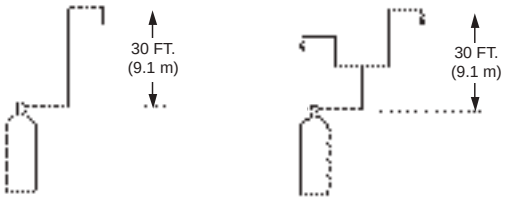
- Critical Pipe Length Before and After a Tee Split: Minimum of 10 pipe diameters

General Information

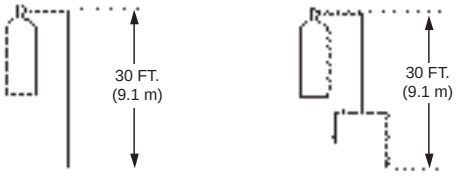
SYSTEM LIMITATIONS (Continued)

Design/Flow Calculation Limitations (Continued)

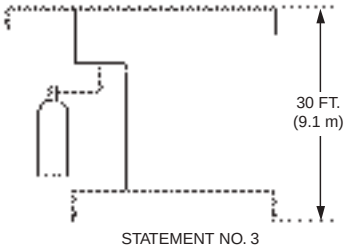
- Maximum Elevation Difference in Pipe Runs:
  - Statement No. 1. If nozzles are only located **above** the tank outlet, then the maximum elevation difference between the tank outlet and the furthest horizontal pipe run or discharge nozzle (whichever is furthest) shall not exceed 30 ft. (9.1 m). See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



STATEMENT NO. 1



STATEMENT NO. 2



STATEMENT NO. 3

FIGURE 3
006050

- Manifolding: All tanks on the same manifold must be the same size and fill weight.
- 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.
- Minimum Class A design concentration: 4.2%
- 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.

SAPPHIRE SUPPRESSION SYSTEMS

Planning

Planning for design and installation for a SAPPHIRE system should start when the customer is first contacted in regards to protecting his hazard with Novec 1230 agent. 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 SAPPHIRE 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 a system is listed in the following paragraphs.

Initial General Information:

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

Hazard Information:

- Secure the general arrangement drawings of the areas 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 areas such as length, width, ceiling 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 beams or columns, built-in cabinets, ducts, etc. which may allow a reduction of the hazard volume.
- 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.

Planning

Novec 1230 Supply Requirements:

- Will the cylinders be located in a dedicated space? If so, record dimensions of that space.
- Is the operating temperature range within 32° to 130° F (0° to 54° C)?
- Determine if the floor will support the cylinders and bracketing. Assume 500 lb/ft^2 for this requirement.
- Will the cylinder bracketing be secured to a wall? If so, is the wall strong enough to support it and the cylinders?
- 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?
- What type of manual actuation is required?
- Will multiple areas be protected by a single system? If so, will the areas be protected separately or simultaneously?
- Identify the locations for all Manual Pull Stations.
- If automatic detection is a part of the system, provide ceiling details.
- What types of 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 and Wiring Information:

- Determine the cylinder location.
- Identify preferred supply piping routes.
- Indicate any obstructions to the piping or wiring runs.

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.
- Will dampers be required for Inlet or Exhaust ducts? If so, how will they be operated, electrically or pneumatically?

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 understand the procedure. The example uses a computer room, subfloor, and storage room as shown below.

APPLICATION METHOD

Total flooding is the only approved application method for SAPPHIRE systems. Novec 1230™ agent is stored as a liquid and discharged as a gas; it does not create a liquid stream, therefore, local application of agent is not possible because the flow of gas cannot be accurately predicted once it exits the nozzles.

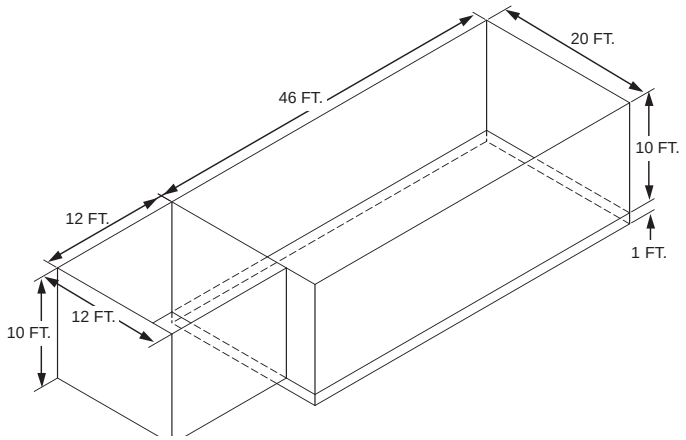


FIGURE 1
006891

Total Flooding

The following steps must be followed, in the order they are presented, to properly design an 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.

STEP NO. 1 – Determine hazard volume(s)

The first step in the design of an 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 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 ceiling height exceeds the maximum allowable ceiling 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:

- Computer Room = 46 ft x 20 ft x 10 ft = 9200 cu ft
- Subfloor = 46 ft x 20 ft x 1 ft = 920 cu ft
- Storage Room = 12 ft x 12 ft x 10 ft = 1440 cu ft

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 columns, beams, cut-out room sections, closets that will always be closed, ducts that pass completely through the area without any openings, and any other large, permanently fixed objects that cannot be removed from the hazard enclosure.

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

There are no solid, permanent structures or equipment to deduct from hazard areas.

Design

APPLICATION METHOD (Continued)

Total Flooding (Continued)

STEP NO. 3 – Calculate Reduced Volume

Subtract the volume of solid, permanent objects (Step No. 2) from each of the hazard's volumes (Step No. 1). The result is considered to be the Reduced Volume for the enclosure.

Volume – Solid Object Volume = Reduced Volume

Complete this step for each area protected by the system.

Example

There are no solid, permanent structures or equipment to deduct from hazard areas.

STEP NO. 4 – Determine minimum design concentration

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

The Minimum Design Concentration for various fuels is shown in the following table:

SAPPHIRE Minimum Design Concentrations

Class A Surface Fuels	4.2%
Class B Fuels	See Note 1*
Class C Fuels	4.2%

* NOTE 1: Design concentration for any Class B fuel must be a minimum of 4.2%. Many fuels require higher %. Contact Ansul Technical Services Department for Minimum Design Concentrations for all Class B fuels.

Class A, B (contact ANSUL for types), and C hazards are UL listed and FM approved for SAPPHIRE systems.

Complete this step for each area protected by the system.

Design Concentrations are determined by NFPA 2001, 2000 edition, Paragraph 3-4.2 and UL-2127, first edition, Paragraph 59.2(b).

STEP NO. 5 – Determine minimum quantity of Novec 1230 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 weight of agent required for a hazard can be calculated from the formula below:

First: The formula in NFPA 2001 can be used.

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

W = Weight of agent required – lb

V = Hazard volume – ft^3

S = Specific vapor volume – ft^3/lb where $S = 0.9856 + 0.002441T$

T = Design temperature in hazard area – F°

C = Required Novec 1230 design concentration (% by volume) at design temperature (T)

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

The second option for calculating the required quantity of Novec 1230 agent is to refer to the "Flooding Factor Chart" on Page 5-13 and 5-14 in 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 Reduced 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.

APPLICATION METHOD (Continued)

Total Flooding (Continued)

Example

Minimum Ambient Temperature = 60 °F.

Flooding Factor = 0.0387

Computer Room

- 9200 cu ft x 0.0387 = 356.0 lb of Novec 1230 agent

Subfloor

- 920 cu ft x 0.0387 = 35.6 lb of Novec 1230 agent

Storage Room

- 1440 cu ft x 0.0387 = 55.8 lb of Novec 1230 agent

Step No. 6 – Adjust Quantity of Agent with Altitude Correction Factor

It may be necessary at this point to adjust the required initial Novec 1230 agent quantity for altitude effects. An increase in altitude causes the agent to expand and occupy more space, which will lead to a higher concentration if the agent quantity is not reduced accordingly. A decrease in altitude will cause the opposite effect, increasing the quantity of agent required. This same effect will apply to increases or decreases in the ambient pressure as could be caused by ventilation systems designed to maintain a positive or negative pressure within the enclosure. To apply the proper adjustment, first look up the altitude or pressure of the hazard on the "Atmospheric Correction Factors Chart" on Page 5-10 in this section.

Determine the total Novec 1230 agent required by multiplying the quantity of agent required (see Step 5) by the Altitude Correction Factor. If the altitude is between 3000 ft below sea level and 3000 ft above sea level, use of the altitude correction factor is optional. Interpolation of the table may be necessary if the actual altitude or pressure is not listed.

Example

The hazard altitude is 4000 feet. Referring to the chart on Page 5-10, the altitude correction factor of 4000 ft is 0.86.

Computer Room

- 356.0 lb Novec 1230 agent x 0.86 = 306.2 lb of agent

Subfloor

- 35.6 lb Novec 1230 agent x 0.86 = 30.6 lb of agent

Storage Room

- 55.8 lb Novec 1230 agent x 0.86 = 47.9 lb of agent

STEP NO. 7 – Determine the total system agent quantity required

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

Example

Minimum Quantity Required:

306.2 + 30.6 + 47.9 = 384.7 lb of agent

STEP NO. 8 – Determine estimated number of tanks required

To determine the estimated number of tanks required, divide the quantity of Novec 1230 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 Actual 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	9-12 lb
50 lb	18-42 lb
90 lb	36-84 lb
140 lb	58-137 lb
280 lb	117-280 lb
390 lb	163-388 lb
450 lb	199-459 lb
850 lb	379-851 lb

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

Design

APPLICATION METHOD (Continued)

Total Flooding (Continued)

Calculate required agent for each hazard volume:

$$\% \text{ Hazard Agent} = \frac{\text{Individual Hazard Area}}{\text{Sum of Hazard Areas}}$$

- Computer Room $= \frac{9200 \text{ cu ft}}{11560 \text{ cu ft}} = 79.58\%$
- Subfloor $= \frac{920 \text{ cu ft}}{11560 \text{ cu ft}} = 7.95\%$
- Storage Room $= \frac{1440 \text{ cu ft}}{11560 \text{ cu ft}} = 12.45\%$

As the subfloor is less than 10% of the total volume, a separate tank may be required due to hydraulic limitations. Therefore:

- Computer Room $= \frac{9200 \text{ cu ft}}{10640 \text{ cu ft}} = 86.47\%$
- Storage Room $= \frac{1440 \text{ cu ft}}{10640 \text{ cu ft}} = 13.53\%$
- Subfloor $= \frac{920 \text{ cu ft}}{920 \text{ cu ft}} = 100\%$

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

- 306.2 lb (Computer Room) + 47.9 (Storage Room) = 354.1 lb (Rounded up to 355 lb)
- 30.6 lb (Subfloor) = 31 lb rounded up

STEP NO. 9 – 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 volume of agent caused by increased temperature.

Example

Maximum Ambient Temperature = 80 °F

The following calculation is used:

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

Where:

W = Weight of agent used – lbs

V = Volume of hazard – ft^3

S = Specific vapor volume – ft^3/lb where $S = 0.9856 + 0.002441T$

T = Maximum ambient temperature – °F

C = Design Novec 1230 concentration at maximum ambient temperature (T)

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

Example:

- Computer Room

$$C = \frac{100 (306.2 \text{ lb})}{\frac{9200 \text{ cu ft} + 306.2 \text{ lb}}{1.181 \text{ ft}^3/\text{lb}}}$$

$C = 3.8\%$

Design concentration = 3.8% ÷ 0.86 (altitude correction factor) = 4.4%

- Storage Room

$$C = \frac{100 (47.9 \text{ lb})}{\frac{1440 \text{ cu ft} + 47.9 \text{ lb}}{1.181 \text{ ft}^3/\text{lb}}}$$

$C = 3.8\%$

Design concentration = 3.8% ÷ 0.86 (altitude correction factor) = 4.4%

- Subfloor

$$C = \frac{100 (31 \text{ lb})}{\frac{920 \text{ cu ft} + 31 \text{ lb}}{1.181 \text{ ft}^3/\text{lb}}}$$

$C = 3.8\%$

Design concentration = 3.8% ÷ 0.86 (altitude correction factor) = 4.4%

Design

APPLICATION METHOD (Continued)

Total Flooding (Continued)

STEP NO. 10 – Verify that the actual Novec 1230 agent concentration is within the design concentration range of 4.2% to 10%

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..

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

Refer to NFPA 2001, Paragraph 1-6.1.3, for detailed exposure conditions.

Complete this step for each area protected by the system.

Example

4.4% and 4.5% are between 4.2% and 10%, therefore the system design is acceptable.

STEP NO. 11 – Determine the Design Concentration at Normal Ambient Temperature

Complete the same procedure as done in Step No. 9 using the Normal Ambient Temperature instead of the Maximum Ambient Temperature.

Complete this step for each area protected by the system.

Example

Normal Ambient Temperature = 70 °F.

- Computer Room

$$C = \frac{100\ (306.2\ lb)}{\frac{9200\ cu\ ft + 306.2\ lb}{1.157\ ft^3/lb}}$$

C = 3.7%

Design concentration = 3.7% ÷ 0.86 (altitude correction factor) = 4.3%

- Storage Room

$$C = \frac{100\ (47.9\ lb)}{\frac{1440\ cu\ ft + 47.9\ lb}{1.157\ ft^3/lb}}$$

C = 3.7%

Design concentration = 3.7% ÷ 0.86 (altitude correction factor) = 4.3%

- Subfloor

$$C = \frac{100\ (31\ lb)}{\frac{920\ cu\ ft + 31\ lb}{1.157\ ft^3/lb}}$$

C = 3.8%

Design concentration = 3.8% ÷ 0.86 (altitude correction factor) = 4.4%

STEP NO. 12 – 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.

Figures 2 and 3 in this step contain the possible lengths and widths each nozzle is capable of covering. The rectangles are determined by the maximum area of 1800 sq ft (167.2 m) with a radius of 30 ft (9.1 m) for the 360° nozzle and a radius of 49.25 ft (15.0 m) for the 180° nozzle. **Note:** Maximum of 20 nozzles per system.

Complete this step for each area protected by the system.

360° NOZZLE REQUIREMENTS:

- Maximum area coverage per nozzle – 1800 sq ft (167.2 sq m)
- Maximum radial distance per nozzle – 30 ft (9.1 m). The radial distance is defined as the distance from the nozzle to the farthest point of the area protected.
- 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.

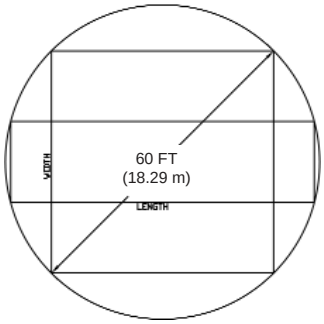


FIGURE 2
008629

Design

APPLICATION METHOD (Continued)

Total Flooding (Continued)

360° Nozzle Coverage Capability

Length ft	Width ft	Length ft	Width ft	Length ft	Width ft
6	60	24	55	42	43
7	60	25	55	43	42
8	59	26	54	44	41
9	59	27	54	45	40
10	59	28	53	46	39
11	59	29	53	47	37
12	59	30	52	48	36
13	59	31	51	49	35
14	58	32	51	50	33
15	58	33	50	51	32
16	58	34	49	52	30
17	58	35	49	53	28
18	57	36	48	54	26
19	57	37	47	55	24
20	57	38	46	56	22
21	56	39	46	57	19
22	56	40	45	58	15
23	55	41	44	59	11

180° NOZZLE REQUIREMENTS:

- Maximum area coverage per nozzle – 1800 sq ft (167.2 sq m)
- Maximum radial distance per nozzle – 49.25 ft (15.0 m). The radial distance is defined as the distance from the nozzle to the farthest point of the area protected.
- Nozzle must be located within 12 in. (305 mm) of the wall of the hazard.
- The index mark on the bottom of the nozzle must point at the center of the hazard.

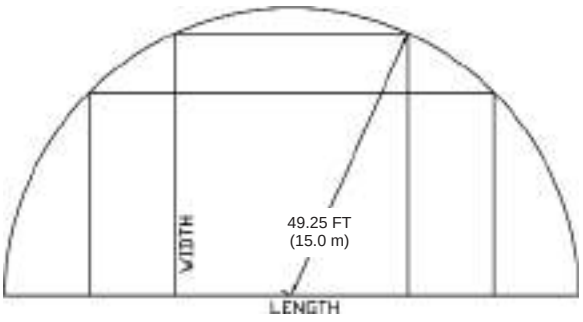


FIGURE 3

008630

180° Nozzle Coverage Capability

Length ft	Width ft	Length ft	Width ft	Length ft	Width ft
4	98	39	45	68	26
6	97	40	45	69	26
8	97	41	43	70	25
10	96	42	42	71	25
12	95	43	41	72	25
14	94	44	40	73	24
16	93	45	40	74	24
17	92	46	39	75	24
18	91	47	38	76	23
19	90	48	37	77	23
20	90	49	36	78	23
21	85	50	36	79	22
22	81	51	35	80	22
23	78	52	34	81	22
24	75	53	33	82	21
25	72	54	33	83	21
26	69	55	32	84	21
27	66	56	32	85	21
28	64	57	31	86	20
29	62	58	31	87	20
30	60	59	30	88	20
31	58	60	30	89	20
32	56	61	29	90	20
33	54	62	29	91	19
34	52	63	28	92	17
35	51	64	28	93	16
36	50	65	27	94	14
37	48	66	27	95	13
38	47	67	26	96	11

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 ceiling must be within 12 in. (305 mm) of the ceiling.

Design

APPLICATION METHOD (Continued)

Total Flooding (Continued)

Example

Computer Room

The computer room is 46 ft x 20 ft. Therefore, using the 360° chart, this can be covered using the 46 ft x 38.52 ft configuration:

- 46 ft Length / 46 = 1.00 = 1 nozzle
- 20 ft Width / 38.52 = 0.52 = 1 nozzle
- 1 nozzle x 1 nozzle = 1 nozzle required for computer room

Storage Room

The storage room is 12 ft x 12 ft. Therefore, using the 360° chart, this can be covered using the 12 ft x 58.78 ft configuration:

- 12 ft Length / 12 = 1.00 = 1 nozzle
- 12 ft Width / 58.78 = 0.20 = 1 nozzle
- 1 nozzle x 1 nozzle = 1 nozzle required for storage room

Subfloor

The subfloor is 33 ft x 15 ft. Therefore, using the 360° chart, this can be covered using the 33 ft x 50.10 ft configuration:

- 33 ft Length / 33 = 1.00 = 1 nozzle
- 15 ft Width / 50.10 = 0.30 = 1 nozzle
- 1 nozzle x 1 nozzle = 1 nozzle required for subfloor

STEP NO. 13 – Estimate Agent Flow Rate for Each Area

This step estimates the total flow rate into each protected space to allow the designer to estimate nozzle sizes for quotation purposes. **Note:** This is an estimate only. It is the designer's responsibility to assess the correctness of this estimate. If the flow rate approaches the top end of the allowable flow rate for a given size pipe, it may be in the Designer's best interest to increase the pipe size.

Complete this step for each area protected by the system.

Example

Computer Room

- 306.2 lb ÷ 10 seconds = 30.62 lb/sec

Storage Room

- 47.9 lb ÷ 10 seconds = 4.8 lb/sec

Subfloor

- 31 lb ÷ 10 seconds = 3.1 lb/sec

STEP NO. 14 – Estimate the Nozzle Flow Rates

If all of the nozzles within the hazard area will have the same flow rate, divide the Estimated Flow Rate for the Area (Step No. 13) by the nozzle quantity (Step No. 12).

If all of the nozzles within the hazard area will not have the same flow rate, perform a percentage calculation using the volume protected by each nozzle divided by the total volume for the area and then multiply the Flow Rate for the Area (Step No. 13) by the volume percent calculated previously to determine the flow rate for that nozzle. Complete this procedure for each nozzle in the system.

If the design includes multiple levels of nozzles, remember to include all nozzles on all levels in this step.

Complete this step for each area protected by the system.

Example

Computer Room

- 30.62 lb/sec ÷ 1 nozzle = 30.62 lb/sec per nozzle

Storage Room

- 4.8 lb/sec ÷ 1 nozzle = 4.8 lb/sec

Subfloor

- 3.1 lb/sec ÷ 1 nozzle = 3.1 lb/sec per nozzle

STEP NO. 15 – 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, aimed up or down. (Nozzles in subfloor can also 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 16 – Complete an Isometric Sketch of the Piping Layout

Create an isometric sketch of the piping for use in inputting the information in the SAPPHIRE Designer ANSL 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 another object such as a flex hose or check valve. Each node point is indicated on the isometric screen of the software by a circle.

APPLICATION METHOD (Continued)

Total Flooding (Continued)

STEP 16 – Complete an Isometric Sketch of the Piping Layout (Continued)

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 17 – Estimate Pipe Size for All Areas (Optional)

To complete this step, start by labeling all nozzle flow rates. Then, working backwards from the nozzles, determine the flow rate for each section of pipe using the flow rate limitations and design/calculation limitations.

The flow calculation program will estimate pipe sizes automatically; therefore this step is optional. The designer may wish to use the pipe size estimation charts to estimate the nozzle pipe sizes for quotation purposes. **Note:** This is an estimate only. It is the designer's responsibility to assess the correctness of this estimate. If the flow rate approaches the top end of the allowable flow rate for a given size, it may be in the designer's best interest to increase the pipe size.

Example

Computer Room

- 30.62 lb/sec per nozzle = 2 in.

Storage Room

- 4.8 lb/sec = 1 in.

Subfloor

- 3.1 lb/sec = 3/4 in.

STEP NO. 18 – Perform Flow Calculations

With the information developed in Steps No. 15 and 16, 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 Engineered Systems.

STEP NO. 19 – Verify Actual System Performance

Once a flow calculation has been completed and the Design Worksheet has been revised (optional), it is important that the designer review all results to verify system performance. The SAPPHIRE Flow program will flag most errors and prevent a completed flow calculation until they have been corrected. However, this does not guarantee that the systems performance will match what the designer expects. Careful review is an important step in the design of any Fire Protection system, which must be completed before final approval of the system.

Review the revised worksheet to verify that:

1. The agent concentration at maximum temperature is within acceptable limits (4.2% to 10% for occupied spaces).
2. The agent quantity is above the amount required in the Actual Quantity box (See Step No. 7).

STEP NO. 20 – Complete Layout of the System

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

STEP NO. 21 – Create Estimated Bill of Materials

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

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

STEP NO. 22 – Create Installation Drawings

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

SAMPLE APPLICATIONS

Refer to Section X (Typical Applications) for an example of a typical application. By reviewing this example, it may help answer some questions concerning the total design process.

Design

ACTUATION REQUIREMENTS

Three types of actuation are available for the SAPPHIRE system: manual, pneumatic, and electric.

Manual Actuation

Manual actuation can be used with or without automatic detection. When no detection is required, based on acceptance by the authority having jurisdiction, the manual actuator can be mounted on top of the tank valve. The manual release actuator provides a manual means of agent tank actuation by direct manual actuation. The master valve is the only one that requires a manual actuator. On two or more tank systems, the remaining tanks are actuated by the pressure from the master tank.

Pneumatic Actuation

Pneumatic actuation is accomplished by supplying pressure to the pneumatic actuator on the tank valve. The pressure is supplied from an LT-30-R nitrogen cartridge located in the ANSUL AUTOMAN II-C release. The cartridge pressure pneumatically opens the cylinder valve.

In Option 1 and Option 1a, one pilot valve is required in single or multiple cylinder systems. The rest of the cylinders will be actuated from the pressure of the pilot cylinder. In Option 2, all tank valves are actuated from the ANSUL AUTOMAN II-C. The maximum length of 1/4 in. Schedule 40 pipe is 100 ft (30.5 m) or 120 ft (36.6 m) depending on the option. See Figures 2 and 3 on Page 5-9. If it is necessary to have an actuation pipe run which exceeds the maximum allowable 1/4 in. pipe requirements, 1/4 in. O.D. stainless steel tubing with a wall thickness of 0.065 can be used for the actuation line. When this size tubing is used, a maximum of 300 ft (91.4 m), with no reductions for elbows or tees, is allowed. See NFPA 2001, Paragraph 2-3.4.2 for information on pneumatic control equipment.

Electric Actuation

One electric solenoid actuator can be used to electrically actuate the master valve. After the master valve is electrically actuated, agent pressure from that tank pneumatically actuates the remaining tanks through the pilot ports.

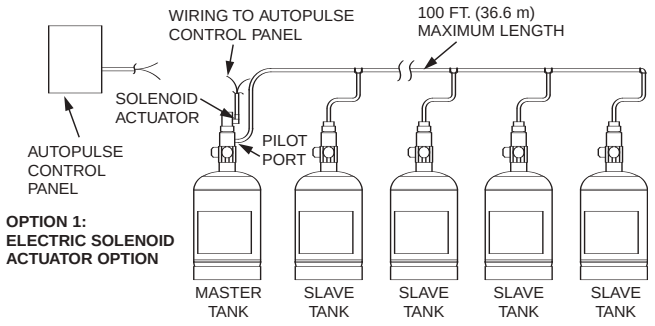
ACTUATION DETAILS

Pneumatic actuation can actuate up to 10 or 11 SAPPHIRE agent tanks depending on the type of actuation design chosen. Two options of pneumatic actuation are available: Option No. 1 – Master SAPPHIRE tank actuated electrically using a solenoid actuator with an AUTOPULSE control panel and then additional slave SAPPHIRE tanks pneumatically off the master tank valve pilot port or Option No. 1a – Master SAPPHIRE tank pneumatically off an ANSUL AUTOMAN II-C releasing device and then additional slave SAPPHIRE tanks pneumatically off the master tank valve pilot port.

Option No. 1 or No. 1a – Master/Slave option – This option allows 11 SAPPHIRE tanks to be simultaneous actuated. The first tank is actuated electrically or pneumatically via an actuator located on top of the tank valve. The remaining 10 tanks are actuated from the pilot pressure port on the master tank valve to the pneumatic actuator(s) on the slave tank valve(s).

The maximum actuation line length from the ANSUL AUTOMAN II-C release is 120 ft (36.6 m) of 1/4 in. Schedule 40 piping or stainless hose or tubing to the pneumatic actuator located on the master tank valve. See Figure 4.

The maximum actuation line length from the Master tank valve to the last Slave tank valve is 100 ft (30.5 m) (including all drops to the valves) of 1/4 in. stainless steel hose or stainless steel tubing. See Figure 4.



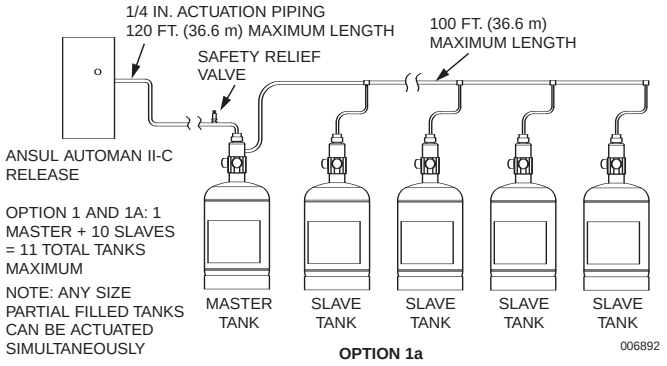


FIGURE 4

Design

ACTUATION DETAILS (Continued)

Option No. 2 – All tanks actuated directly from ANSUL AUTOMAN II-C option – This option allows 10 SAPPHIRE tanks to be simultaneous actuated from the nitrogen pressure from the ANSUL AUTOMAN II-C releasing device. All tanks are actuated pneumatically via a pneumatic actuator located on top of each tank valve.

The maximum length of 1/4 in. Schedule 40 piping or stainless hose or tubing that can be utilized from the ANSUL AUTOMAN II-C release to actuate one pneumatic valve actuator is 120 ft (36.6 m) (including all drops to the valves). When additional tanks are required, refer to Actuation Piping Table below for maximum actuation pipe length.

Actuation Piping Chart (For Option No. 2)

Quantity of Pneumatic Actuated Valves	Maximum Length of 1/4 in. Actuation Line
1	120 ft (36.6 m)
2	118 ft (35.9 m)
3	116 ft (35.4 m)
4	114 ft (34.7 m)
5	112 ft (34.1 m)
6	110 ft (33.5 m)
7	108 ft (32.9 m)
8	106 ft (32.3 m)
9	104 ft (31.7 m)
10	102 ft (31.1 m)

Note: It is important to note that the actuation lengths listed include branch lines to accessory items (pressure switches, pressure trips, etc.). For each actuation line accessory, deduct a foot from the above maximum lengths.

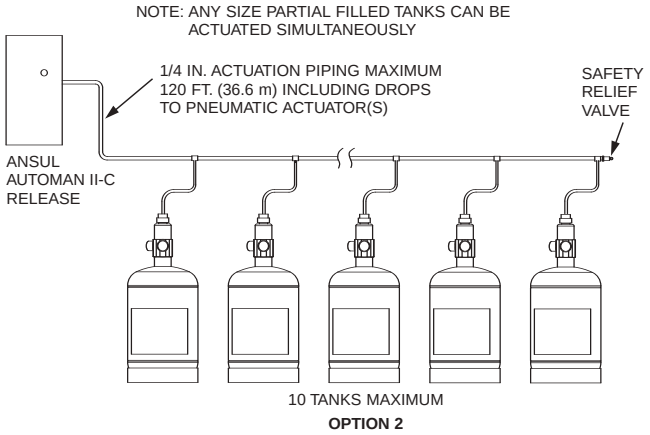


FIGURE 5
006774

NOVEC™ 1230 AGENT ATMOSPHERIC CORRECTION FACTORS (NFPA 2001)

Equivalent Altitude	Enclosure Pressure	Atmospheric Correction Factor
–3,000 ft (914 m)	16.25 psia (84.0 cm Hg)	1.11
–2,000 ft (609 m)	15.71 psia (81.2 cm Hg)	1.07
–1,000 ft (305 m)	15.23 psia (78.7 cm Hg)	1.04
0 ft (000 m)	14.71 psia (76.0 cm Hg)	1.00
1,000 ft (305 m)	14.18 psia (73.3 cm Hg)	0.96
2,000 ft (609 m)	13.64 psia (70.5 cm Hg)	0.93
*3,000 ft (914 m)	13.12 psia (67.8 cm Hg)	0.89
4,000 ft (1220 m)	12.58 psia (65.0 cm Hg)	0.86
5,000 ft (1524 m)	12.04 psia (62.2 cm Hg)	0.82
6,000 ft (1829 m)	11.53 psia (59.6 cm Hg)	0.78
7,000 ft (2133 m)	11.03 psia (57.0 cm Hg)	0.75
8,000 ft (2438 m)	10.64 psia (55.0 cm Hg)	0.72
9,000 ft (2743 m)	10.22 psia (52.8 cm Hg)	0.69
10,000 ft (3048 m)	9.77 psia (50.5 cm Hg)	0.66

*__Note:__ On systems between +3000 ft (914 m) and –3000 ft (914 m), using the Atmospheric Correction Factor is optional.

SAPPHIRE SYSTEM DESIGN CALCULATION WORKSHEET

DATE: _____

QUOTE/JOB NUMBER: _____

CUSTOMER: _____

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

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

ACTUAL NOVEC 1230 QUANTITY (lb):					
(Initial NOVEC 1230 Quantity x Altitude Correction Factor)					

TOTAL NOVEC 1230 QTY. (lb): _____

(Sum of all Actual NOVEC 1230 quantities)

TOTAL NOVEC 1230 QTY. (lb): _____

(From Page 1)

SAPPHIRE SYSTEM DESIGN CALCULATION WORKSHEET (Continued)

SAPPHIRE SYSTEM DESIGN CALCULATION WORKSHEET

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 FLOODING FACTOR:					

[(Actual NOVEC 1230 Qty. ÷ Total NOVEC 1230 Qty.) x NOVEC 1230 Agent Supplied]

[(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)

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 of hazard ÷ length from 180° or 360° Nozzle Coverage Capability Chart (Rounded to Next Highest Whole Number) x width of hazard ÷ width from 180° or 360° Nozzle Coverage Capability Chart (Rounded to Next Highest Whole Number)]*

Estimated Nozzle Pipe Size: Pipe Size:					

(Refer to Pipe Sizing Chart)

TOTAL FLOODING QUANTITY (English Units)

Temp. t (°F)[b]	Specific Vapor Volumes	Weight Requirements of Hazard Volume, W/V (lb/ft3)[a] Design Concentration (% by volume)													
	(ft3/lb)[c]	4.2	4.5	5	5.5	5.85	6	6.5	7	7.5	8	8.5	9	9.5	10
–20	0.9368	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 Volumes	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

Design

EQUIVALENT LENGTH FOR PIPE FITTINGS

Diameter		90° Elbow		45 °Elbow		Thru Tee		Side Tee		Union	
mm	(in)	m	(ft)	m	(ft)	m	(ft)	m	(ft)	m	(ft)
10	(3/8)	0.4	(1.2)	0.18	(0.5)	0.24	(0.7)	0.82	(2.5)	0.09	(0.3)
15	(1/2)	0.52	(1.6)	0.24	(0.7)	0.3	(0.9)	1.04	(3.2)	0.12	(0.4)
20	(3/4)	0.67	(2.0)	0.3	(0.9)	0.42	(1.3)	1.37	(4.2)	0.15	(0.5)
25	(1)	0.85	(2.6)	0.4	(1.2)	0.55	(1.7)	1.74	(5.3)	0.18	(0.6)
32	(1 1/4)	1.13	(3.4)	0.52	(1.6)	0.7	(2.1)	2.29	(7.0)	0.24	(0.7)
40	(1 1/2)	1.31	(4.0)	0.61	(1.7)	0.82	(2.5)	2.65	(8.0)	0.27	(0.8)
50	(2)	1.68	(5.1)	0.79	(2.4)	1.06	(3.2)	3.41	(10.4)	0.37	(1.1)
65	(2 1/2)	2.01	(6.1)	0.94	(1.5)	1.25	(3.8)	4.08	(12.4)	0.43	(1.3)
80	(3)	2.5	(7.6)	1.16	(3.5)	1.55	(4.7)	5.06	(15.4)	0.55	(1.7)
100	(4)	3.26	(10.0)	1.52	(4.6)	2.01	(6.1)	6.64	(20.2)	0.73	(2.2)
125	(5)	4.08	(12.4)	1.92	(5.9)	2.56	(7.8)	8.35	(25.5)	0.91	(2.8)
150	(6)	4.94	(15.0)	2.32	(7.1)	3.08	(9.4)	10	(30.5)	1.07	(3.3)

Equivalent Length Table for Pipe Fittings. Figures based upon schedule 40 ASTM A 106-77 pipe (nominal pipe size given in table)

EQUIVALENT LENGTH FOR OTHER SYSTEM COMPONENTS

Hardware Set	Size		Equivalent Length	
Valve	25 mm	(1 in.)	6.096 m	(20 ft)
	50 mm	(2 in.)	10.668 m	(35 ft)
	80 mm	(3 in.)	25.91 m	(85 ft)
Flex Hose	25 mm	(1 in.)	3.14 m	(10.3 ft)
	50 mm	(2 in.)	5.36 m	(17.6 ft)
	80 mm	(3 in.)	1.55 m	(5.1 ft)
Flex Hose and Check Valve Combination	25 mm	(1 in.)	3.54 m	(11.6 ft)
	50 mm	(2 in.)	12.02 m	(39.4 ft)
	80 mm	(3 in.)	15.85 m	(52 ft)
Valve Outlet Adaptor	25 mm	(1 in.)	0.18 m	(0.6 ft)
	50 mm	(2 in.)	0.37 m	(1.2 ft)
	80 mm Flared to NPT		0.55 m	(1.8 ft)
	80 mm Flared to Grooved		0.55 m	(1.8 ft)
	80 mm Flared to BSP		0.55 m	(1.8 ft)

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

Design

NOTES:

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.

⚠ CAUTION

If a hydrostatic testing of system piping is required, disconnect all actuator(s) (master and slaves) and cylinder(s) from piping before pressurizing system piping.

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, (refer to Piping and Actuation Requirements, located in SECTION V – DESIGN, for both actuation and distribution piping limitations.

For successful system performance, the SAPPHIRE system components must be installed within a temperature range of 32 °F to 130 °F (0 °C to 55 °C).

The hazard temperature is listed to a minimum temperature of 0 °F (–18 °C). For the maximum allowable hazard temperature, see “Total Flooding Quantity Tables,” stated in NFPA 2001, current edition.

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.

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.

Tank Size		No. of Brackets	Height from Floor to Bracket Centerline	
20 lb	(9.1 kg)	1	5 1/8 in.	(13 cm)
50 lb	(22.7 kg)	1	13 in.	(33 cm)
90 lb	(40.8 kg)	1	23 3/8 in.	(59 cm)
140 lb	(63.5 kg)	1	13 3/4 in.	(35 cm)
280 lb	(127 kg)	1	29 1/2 in.	(75 cm)
390 lb	(177 kg)	1	43 1/4 in.	(110 cm)
450 lb	(204 kg)	1	54 3/4 in.	(139 cm)
850 lb	(386 kg)	2	11 3/4 in. and 43 1/4 in. (30 cm and 110 cm)	

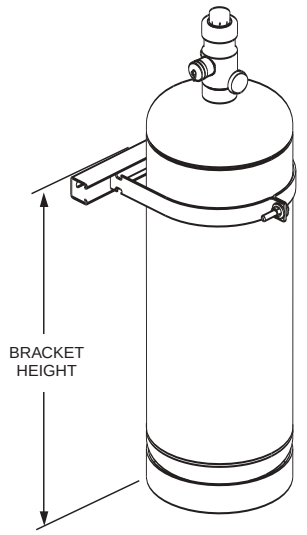


FIGURE 1
006732

⚠ 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 Figure1. 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 and back.
3. Insert the tank straps into the back channel and secure with the bolts provided.
4. If a connected reserve system is required, mount the reserve tanks directly next to the main system tanks.

Installation

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 and reducing fittings 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.

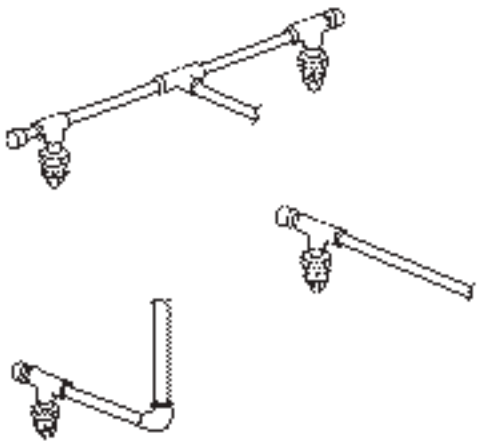


FIGURE 2
001876

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 DETECTION SYSTEM

All detection and control design and installation requirements are located on the AUTOPULSE Detection and Control Systems CD, No. 2001093.

See Design Section for information on solenoid actuation requirements.

INSTALLING ACTUATION PIPING

General Actuation Piping Requirements

When using AUTOPULSE Control Panel for detection and actuation, the panel is electrically wired to the solenoid actuator on the first (Master) tank. From the master tank’s pilot pressure port, 1/4 in. actuation piping is required to be run to the pneumatic actuators located on the remaining slave tanks.

When using an ANSUL AUTOMAN II-C releasing devise, two actuation options are available: See “Actuation Requirements, Section V – Design”, for detailed piping

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.

Installation

INSTALLING ACTUATION PIPING (Continued)

General Actuation Piping Requirements (Continued)

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, Option 1a and Option 2" in Design Section for detailed piping limitations.

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.

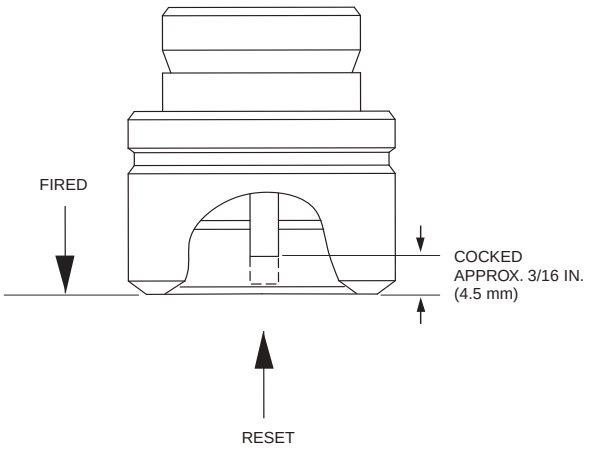


FIGURE 3
006775

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

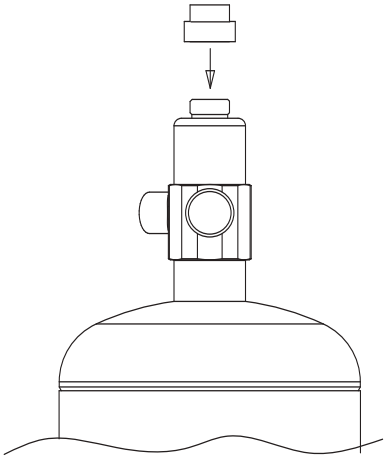


FIGURE 4
006776

3. Install 1/4 in. actuation piping from gas outlet port on the ANSUL AUTOMAN II-C release (if used) to the master tank location. If using Option 1a, safety relief valve, Part No. 15677, must be installed in the actuation piping between the ANSUL AUTOMAN II-C release and the first (master) SAPPHIRE tank.
4. If pneumatic operated accessories are required, branch off the 1/4 in. actuation piping and run to each accessory.
5. Complete actuation piping from the NPT pipe to the pneumatic actuators, using the 1/4 in. stainless steel hose and fittings listed in the Component Section. If using Option 2, the safety relief, Part No. 15677, must be installed in the last fitting of the actuation piping.

Installation

NOTES:

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.

Inspection

NOTES:

ANNUAL MAINTENANCE EXAMINATION

Systems shall be maintained at regular intervals, not more than one year apart, or when specifically indicated by an inspection. **Exception:** Tank pressure and agent quantity shall 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 tank. The procedures listed in this section are the minimum that are necessary to maintain a system. If circumstances warrant them, a more thorough procedure should be followed to assure system performance. Make certain that all people affected by the maintenance are informed before you start. This may include the owner, security personnel, the local Fire Department, and possibly local workers that may be affected by equipment shutdown or start up.

NOTICE

If the system includes an ANSUL AUTOMAN II-C releasing device, before proceeding with annual maintenance examination, insert lock pin in ANSUL AUTOMAN II-C release and remove nitrogen cartridge. 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. 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 (signs) throughout the area. Make certain they are in place, mounted securely, readable, and are not damaged.
5. Check all tank bracketing. Make certain all tanks are secured in the brackets. Check for corrosion, damage, or missing components.
6. Check the condition of all tanks. Look for signs of damage or corrosion, and check the tank’s last hydro 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.”) Refer to NFPA 2001, Chapter 4 Inspection, Maintenance, Testing, and Training, for hydro requirements.
7. Check condition of all tank 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, Chapter 4 Inspection, Maintenance, Testing, and Training, for detailed testing requirements.
8. Check condition of all actuators by completing the following:
   - Remove all actuators from the tank valves (electric, manual, and pneumatic) and leave them off until the final step in Maintenance Section.
   - For pneumatic actuators, check the condition of each actuator to make certain they operate freely. When finished, reset the pin in the up position. **Do not install on tank valves.**
   - For electric actuators, make certain all wires are properly connected. **Do not install on tank valves.**

NOTICE

Before proceeding with Step No. 9, make certain all electric actuators have been removed from all valves and that the nitrogen cartridge has been removed from the ANSUL AUTOMAN II-C release and that the locking pin in the release mechanism has also been removed.

Maintenance

ANNUAL MAINTENANCE EXAMINATION (Continued)

9. Tank Weighing – Option 1

   Tanks must be weighed (without liquid level indicator) to determine agent quantity. The weighing procedure is as follows:

   - Remove all manual controls, actuators and 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.

9a. Tank Weighing – Option 2

Determine agent quantity using liquid level indicator. The liquid level indicator is used to determine the liquid level in 280, 390, 450 and 850 lb. tanks. During a maintenance examination, the indicator 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 tank from the fire suppression system.

To measure the liquid agent level:

a. Remove the protective cap from the measuring device housing.

b. 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.

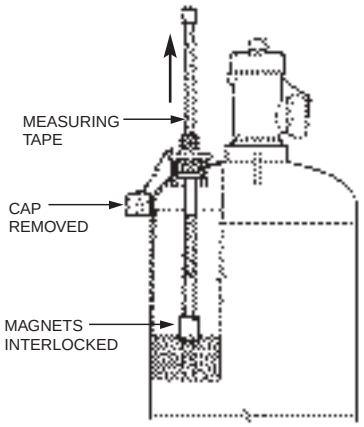


FIGURE 1
006255

c. 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.

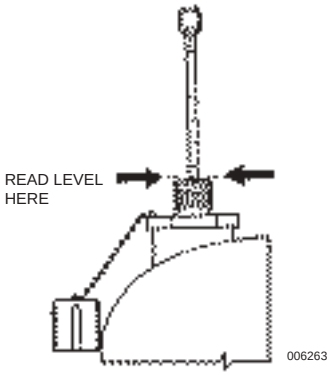


FIGURE 2
006263

d. 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.

Maintenance

ANNUAL MAINTENANCE EXAMINATION (Continued)

e. Using the Agent Quantity Table(s) located in this section, determine the weight of charge as follows:
   - Find the liquid level reading along the left hand vertical line of the table.
   - From that point, follow the horizontal line to the point where it intersects with the temperature column (using the tank temperature noted in Step c).
   - Read the weight of Novec 1230 agent at the level/temperature column intersection.

f. 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 weighed to verify the liquid level measurement. If the weight loss still exceeds 5% of the weight of charge, the tank requires recharging.

10. Check condition of control panel for tampering, corrosion, or damage. Test panel at this point by referring to the appropriate AUTOPULSE Control System manual. Note: If system includes an ANSUL AUTOMAN II-C release, make certain cartridge is removed, release is cocked, and locking pin is not in place before each test.
11. Check all detectors. Make certain they are in place, clean, and not damaged. If required, check the sensitivity of each per the instructions of the detector manufacturer. See appropriate AUTOPULSE Control System manual for detailed instructions.
12. 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 control panel. Reset each pull station.
13. While checking the detectors and electric pull stations, inspect each alarm device. Check the alarm's condition and verify that they operate properly when energized. Reset the alarm circuit after each test.
14. If the system includes an ANSUL AUTOMAN, check release by completing the following:
    - Make certain locking pin is not in place, and manually test release by operating the "STRIKE" button on the release mechanism.
    - Cock ANSUL AUTOMAN II-C release using cocking lever, Part No. 26310, and install locking pin.
    - Remove gasket from cartridge receiver in ANSUL AUTOMAN II-C release mechanism. Check gasket for elasticity or cuts and replace if necessary. Clean and coat gasket lightly with a good grade of extreme temperature grease such as Dow Corning No. 4. Reinstall gasket into cartridge receiver. **Do not install cartridge at this time.**
15. When all tests are complete, reset control panel and all accessory electrical equipment.
16. Make certain all electric and pneumatic actuators are reset.
17. Install all electric and pneumatic actuators on tank valves. Hand tighten.
18. Install nitrogen cartridge in ANSUL AUTOMAN II-C release by completing the following:
    - Make certain release mechanism is cocked and locking bar is in place.
    - Remove shipping cap and weigh nitrogen cartridge. Replace if weight is 1/2 oz. (14.2 g), or more, below the weight stamped on the cartridge.
    - Screw cartridge into release mechanism, hand tighten.
    - Remove locking pin.
    - Close cover on enclosure, install locking pin through "STRIKE" button, and secure with visual seal, Part No. 197.
19. Record annual maintenance date on tag attached to unit and/or in a permanent file.
20. Inform proper personnel that the system is back in service.

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 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)
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 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)
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 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)
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 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)
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 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)
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 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)
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 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)
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 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)
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

CLEARING ELECTRICAL EQUIPMENT

Refer to AUTOPULSE Installation, Operation, and Maintenance manuals for detailed instructions on resetting the electric detection system.

NOTICE

If AUTOPULSE Control System is utilizing an ANSUL AUTOMAN II-C releasing device for pneumatic actuation, AUTOPULSE panel will remain in trouble condition until ANSUL AUTOMAN II-C release is cocked.

CHECK MECHANICAL AND ELECTRICAL 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.

Electric Detection System

ANSUL AUTOMAN II-C RELEASING DEVICE – For complete resetting instructions, refer to Installation, Operation, and Maintenance manuals, Part No. 17788 and 31496. **Note: Before resetting release mechanism, bleed pressure from actuation piping by pulling ring on safety relief valve located on actuation piping.**

AUTOPULSE Control System – For complete resetting instructions, refer to the appropriate installation, operation, and maintenance manual.

RECHARGING

⚠ 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

Note: In order to maintain Factory Mutual approval, factory filled SAPPHIRE tanks must be used.

1. Remove empty SAPPHIRE tanks by removing the actuators (either electric or pneumatic).
2. Remove piping and discharge hose from valve outlet and 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.

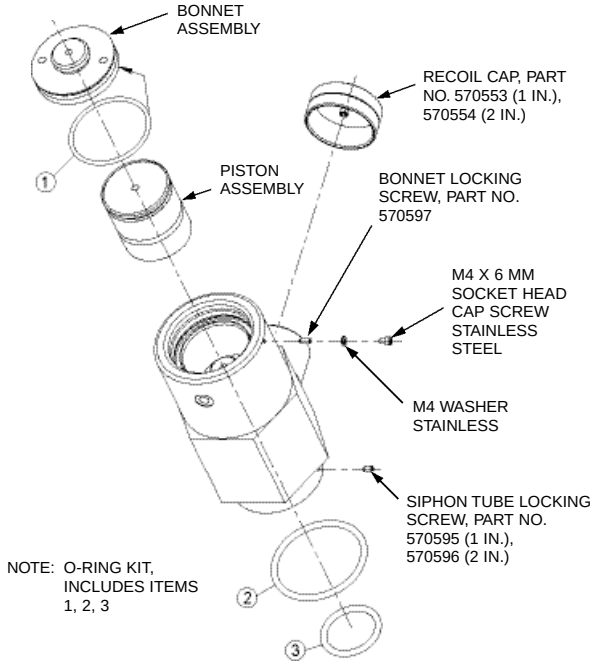
Resetting and Recharge

RECHARGING (Continued)

Valve Teardown (Continued)

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 "1g" in "Filling Instructions."



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.

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.

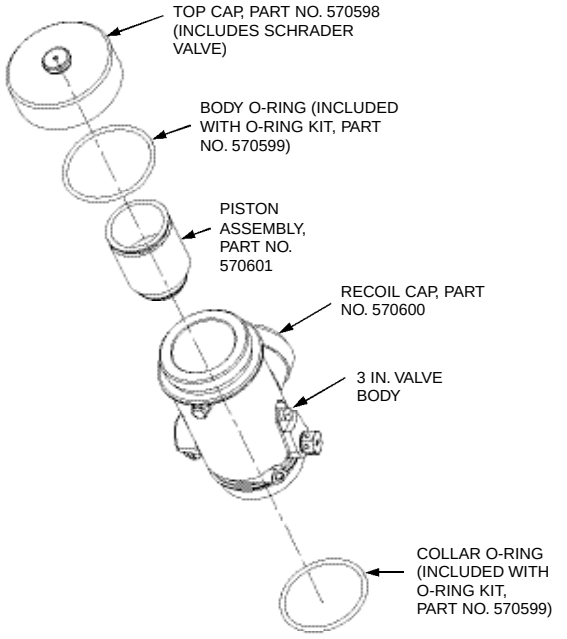


FIGURE 2
006904

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

Resetting and Recharge

TESTING (Continued)

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.

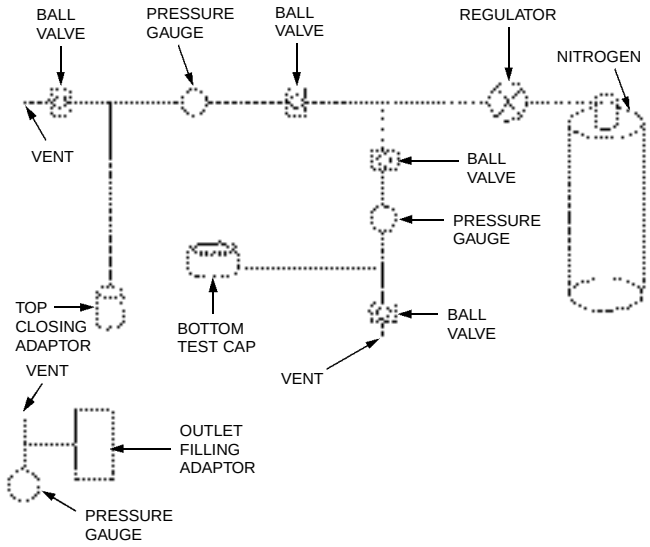


FIGURE 3
004977

FILLING INSTRUCTIONS

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 9-2) 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.
   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.

Resetting and Recharge

FILLING INSTRUCTIONS (Continued)

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 (0.6 bar). It takes 8 psi (0.6 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.

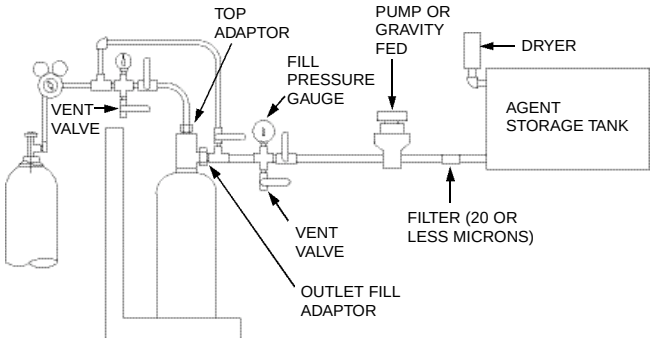
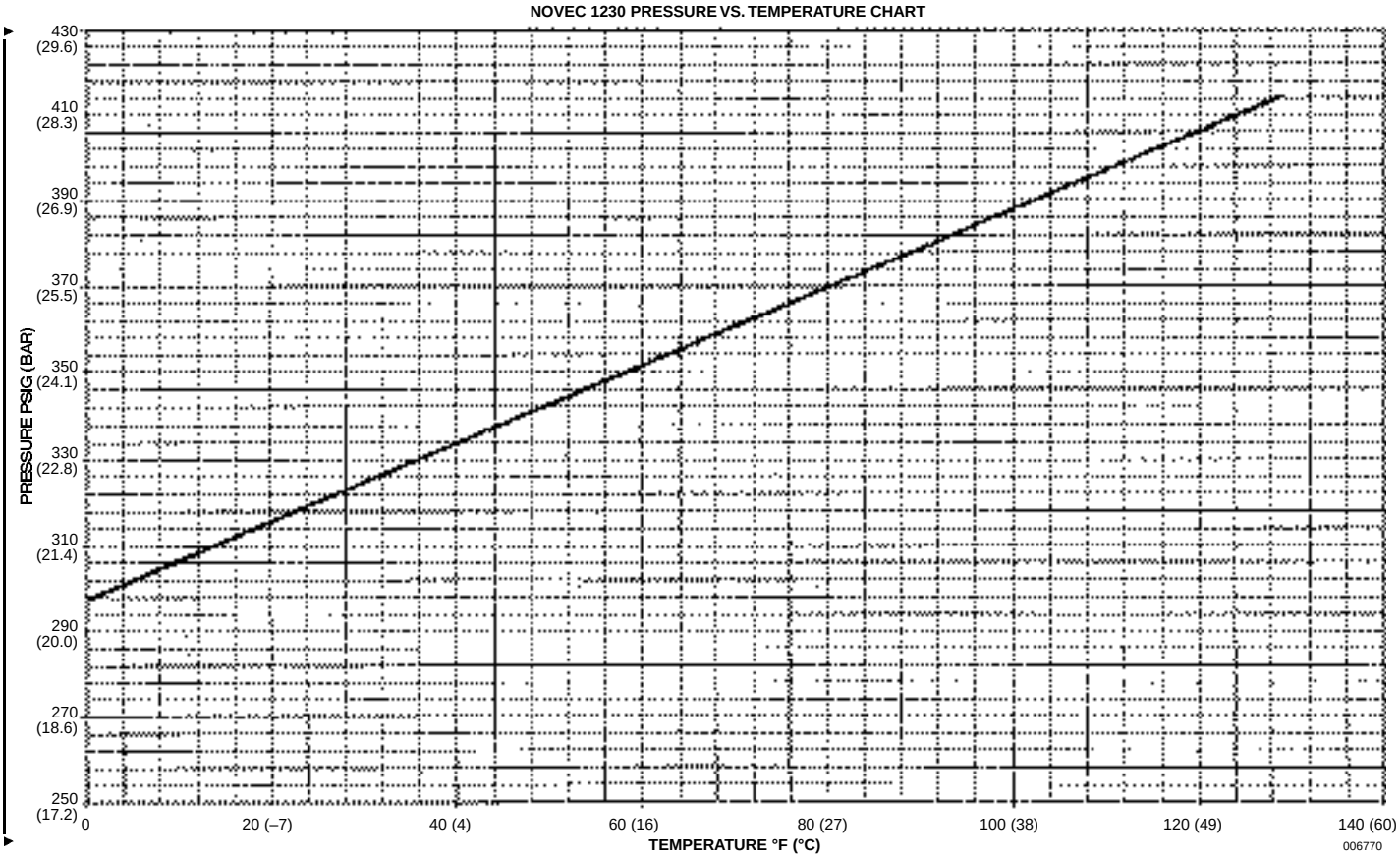


FIGURE 4
006767

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.



006770

Example – Computer Room, Storage Room, and Subfloor

Electronic data processing involves storage, recall and use of information via electronic equipment. Electronic data processing equipment is found in almost every industry today. The equipment is very sensitive and operates within minute tolerances. Additionally, many computer installations are designed with a subfloor area containing data and power cable bundles.

Because of the high dollar valve of the equipment, the data managed by that equipment and the productivity provided by electronic data processing, rapid detection and efficient fire protection are imperative. Time lost to cleanup and ventilation of a computer room means lost time throughout the company, so these areas require a clean, no residue gas agent that disperses easily.

The computer room and subfloor space can be protected with an SAPPHIRE suppression system, even when the computer room is normally occupied.

Fires can occur within the computer electrical insulation and in the cable bundles in the subfloor. Paper debris that has been allowed to accumulate in the subfloor is also a source of fuel.

Computer room/subfloor protection can be accomplished by installation of a total flood SAPPHIRE system. The system is designed in accordance with the ANSUL design, installation manual and NFPA Standard 2001, “Standard for Clean Agent Fire Extinguishing Systems.” It is important that an effective agent concentration not only be achieved, but shall be maintained for a sufficient period of time to allow effective emergency action by trained personnel.”

The SAPPHIRE system consists of a tank(s), a piping arrangement and discharge nozzles located in the computer room, storage room, and subfloor space.

Occasionally, drainage is installed in the subfloor area. Provisions must be made for making the drain piping a closed system unless water is present to assist in assuring the necessary concentration.

When the computer room is normally occupied, personnel safety is of first concern. Alarms or warning devices must be located in the room to provide sufficient annunciation of agent discharge. The rooms and subfloor must be tight to prevent loss of agent.

All air handling equipment must be shut down and dampered prior to system discharge.

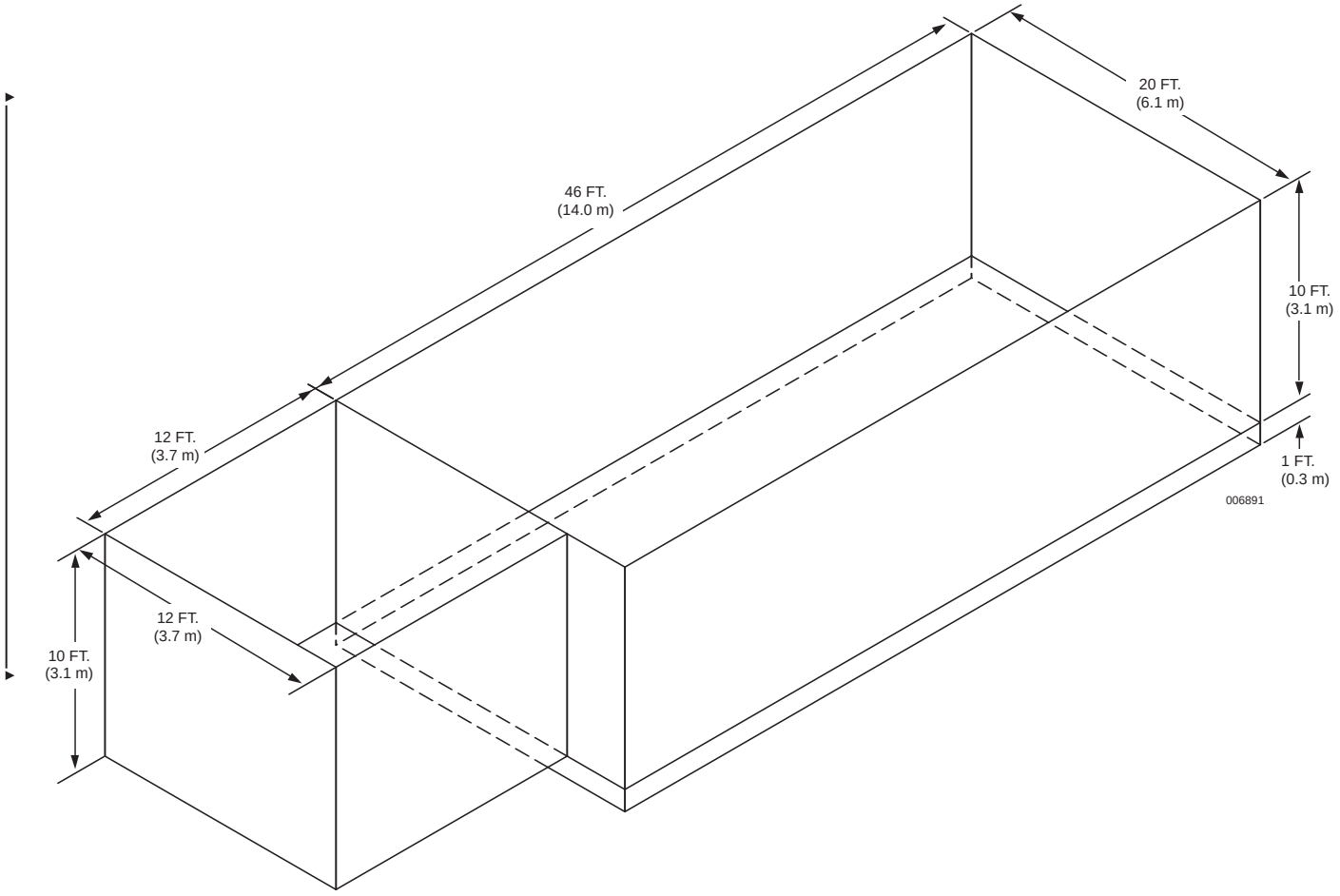
Smoke detectors, operated by an electronic control panel, are usually employed with a SAPPHIRE system to provide detection and thus suppression of a fire before it has a chance to do serious damage.

The authority having jurisdiction may have additional requirements.

HAZARD

- A computer room having dimensions of 46 ft x 20 ft x 10 ft (14.0 m x 6.1 m x 3.1 m)
- A storage room having dimensions of 12 ft x 12 ft x 10 ft (3.7 m x 3.7 m x 3.1 m)
- A subfloor having dimensions of 46 ft x 20 ft x 1 ft (14.0 m x 6.1 m x 0.3 m)
- No unclosable openings.
- Ventilation to be shut down at system actuation.

Example – Computer Room, Storage Room, and Subfloor



Example – Computer Room, Storage Room, and Subfloor

Sapphire™ Designer Program - ANSI.3.406
UL_EX4510 RM_3014148
File Name: Example - AnsiMetricCAMSR.PLC

Consolidated Report

Customer Information

Company Name: Tyco Fire Suppression and Building Products
Address: One Stanton Street
Marinette, WI 54143-2542

Phone: 715-738-7411
Contact:
Title:

Project Data

Project Name:
Designer:
Number:
Account:
Location:
Description:

Calculation Date/Time: Thursday, August 25, 2010, 11:52:29 AM

Example – Computer Room, Storage Room, and Subfloor

Consolidated Report
Enclosure Information

Elevation:	4000 ft (relative to sea level)
Atmospheric Correction Factor:	0.86
Enclosure Number:	1
Name:	Computer Room
Enclosure Temperature...	
Minimum:	70 F
Maximum:	70 F
Maximum Concentration:	4.204 %
Design Concentration...	
Adjusted:	4.204 %
Minimum:	4.200 %
Minimum Agent Required:	300.5 lbs
Width:	46.0 ft
Length:	20.0 ft
Height:	10.0 ft
Volume:	9200.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	9200.0 cubic ft
Adjusted Agent Required:	300.8 lbs
Number of Nozzles:	1

006905b

Example – Computer Room, Storage Room, and Subfloor

SAPPHIRE

Consolidated Report
Enclosure Information

Elevation:	4000 ft (relative to sea level)
Atmospheric Correction Factor:	0.88
Enclosure Number:	2
Name:	Storage Room
Enclosure Temperature...	
Minimum:	70 F
Maximum:	70 F
Maximum Concentration:	4.214 %
Design Concentration...	
Adjusted:	4.214 %
Minimum:	4.200 %
Minimum Agent Required:	47.1 lbs
Width:	12.0 ft
Length:	12.0 ft
Height:	10.0 ft
Volume:	1440.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	1440.0 cubic ft
Adjusted Agent Required:	47.2 lbs
Number of Nozzles:	1

Calculation Date/Time: Thursday, August 26, 2010, 11:52:26 AM

Example – Computer Room, Storage Room, and Subfloor

SAPPHIRE

Consolidated Report
Agent Information

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

Adjusted Agent Required:	348.0 lbs
Container Name:	450 lb Cylinder Assembly
Container Part Number:	570641
Number of Main Containers:	1
Number of Reserve Containers:	0
Manifold:	No Manifold
Starting Pressure:	360 psig
Pipe Take Off Direction:	Horizontal
Agent Per Container:	348.0 lbs
Fill Density:	54.7 lbs / cubic ft
Container Empty Weight:	233.2 lbs
Weight, All Containers + Agent:	581.2 lbs
Floor Area Per Container:	1.40 square ft
Floor Loading Per Container:	416 lbs / square ft

Pipe Network

Part 1 - Pipe

Description	Start	End	Pipe Type	Diameter	Length	Elevation
Main Cyl. X 1	0	1		2 in	5.36 ft	5.36 ft
Flex Hose	1	2		2 in	0.39 ft	0.00 ft
Flex Hose	2	3		2 in	1.71 ft	1.71 ft
Pipe	3	4	40T	2-1/2 in	4.45 ft	4.45 ft
Pipe	4	5	40T	2-1/2 in	2.50 ft	0.00 ft
Pipe	5	6	40T	2 in	2.50 ft	0.00 ft
Pipe	6	7	40T	2 in	21.00 ft	0.00 ft
Pipe	7	8	40T	2 in	4.00 ft	0.00 ft
Pipe/E1-N1	8	9	40T	1-1/2 in	0.25 ft	-0.25 ft
Pipe	5	10	40T	3/4 in	2.50 ft	0.50 ft

Calculation Date/Time: Thursday, August 26, 2010, 11:52:26 AM

006905d

Example – Computer Room, Storage Room, and Subfloor

SAPPHIRE

Consolidated Report

Part 1 - Pipe

Description	Start	End	Pipe Type	Pipe Diameter	Pipe Length	Pipe Elevation
Pipe	10	11	40T	3/4 in	5.20 ft	0.00 ft
Pipe	11	12	40T	3/4 in	5.80 ft	0.00 ft
Pipe/E2-N1	12	13	40T	3/4 in	0.75 ft	-0.75 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	35.0 ft
1	2	0	0	0	0	0	2inFlexN1	0.00 ft	0.4 ft
2	3	1	0	0	0	0	2inFlexN2	0.00 ft	17.2 ft
3	4	0	0	0	0	0		0.00 ft	4.5 ft
4	5	1	0	0	0	0		0.00 ft	9.1 ft
5	6	0	0	1	0	0		0.00 ft	6.0 ft
6	7	1	0	0	0	0		0.00 ft	26.5 ft
7	8	1	0	0	0	0		0.00 ft	9.5 ft
8	9	1	0	0	0	0		0.00 ft	4.6 ft
5	10	0	0	0	1	0		0.00 ft	7.0 ft
10	11	1	0	0	0	0		0.00 ft	7.4 ft
11	12	1	0	0	0	0		0.00 ft	6.0 ft
12	13	1	0	0	0	0		0.00 ft	3.0 ft

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
0	1	348.0 lbs				
1	2	348.0 lbs				
2	3	348.0 lbs				
3	4	348.0 lbs				
4	5	348.0 lbs				
5	6	300.8 lbs				
6	7	300.8 lbs				
7	8	300.8 lbs				
8	9	300.8 lbs	E1-N1	1-1/2 in	16 Port - BR	1.0350 square in
5	10	47.2 lbs				
10	11	47.2 lbs				
11	12	47.2 lbs				

Page: 5 of 5

Calculation Date/Time: Thursday, August 26, 2010, 11:52:26 AM

006905e

Example – Computer Room, Storage Room, and Subfloor

Consolidated Report

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
12	13	47.2 lbs	E2-N1	3/4 in	16 Port - BR	0.3436 square in

Parts Information

Total Agent Required: 346.0 lbs
Container Name: 460 lb Cylinder Assembly (Part: 570641)
Number Of Containers: 1
Field1

Nozzle	Type	Diameter	Nozzle Area	Part Number
E1-N1	16 Port - BR	1-1/2 in	1.0380 square in	570606
E2-N1	16 Port - BR	3/4 in	0.3436 square in	570503

Nozzle	Drill Diameter	Drill Size
E1-N1	0.2874 inches	7.30 mm
E2-N1	0.1654 inches	4.20 mm

Pipe:	Type	Diameter	Length
	40T	3/4 in	14.25 ft
	40T	1-1/2 in	0.25 ft
	40T	2 in	27.50 ft
	40T	2-1/2 in	5.95 ft

'Other' Items:
1 - 2 in Flexible Discharge Hose (Part: 570538)

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

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

Calculation Date/Time: Thursday, August 26, 2010, 11:52:26 AM

006905f

Example – Computer Room, Storage Room, and Subfloor

SAPPHIRE

Consolidated Report
System Acceptance

System Discharge Time: 9.5 seconds
Percent Agent In Pipe: 31.7%
Percent Agent Before First Tee: 11.7%

Enclosure Number: 1
Enclosure Name: Computer Room

Minimum Design Concentration: 4.200%
Adjusted Design Concentration: 4.204%
Predicted Concentration: 4.205%
Maximum Expected Agent Concentration: 4.205% (At 70 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E1-N1	300.5 lbs	300.6 lbs	300.6 lbs	112 psig

Enclosure Number: 2
Enclosure Name: Storage Room

Minimum Design Concentration: 4.200%
Adjusted Design Concentration: 4.214%
Predicted Concentration: 4.210%
Maximum Expected Agent Concentration: 4.210% (At 70 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E2-N1	47.1 lbs	47.2 lbs	47.2 lbs	75 psig

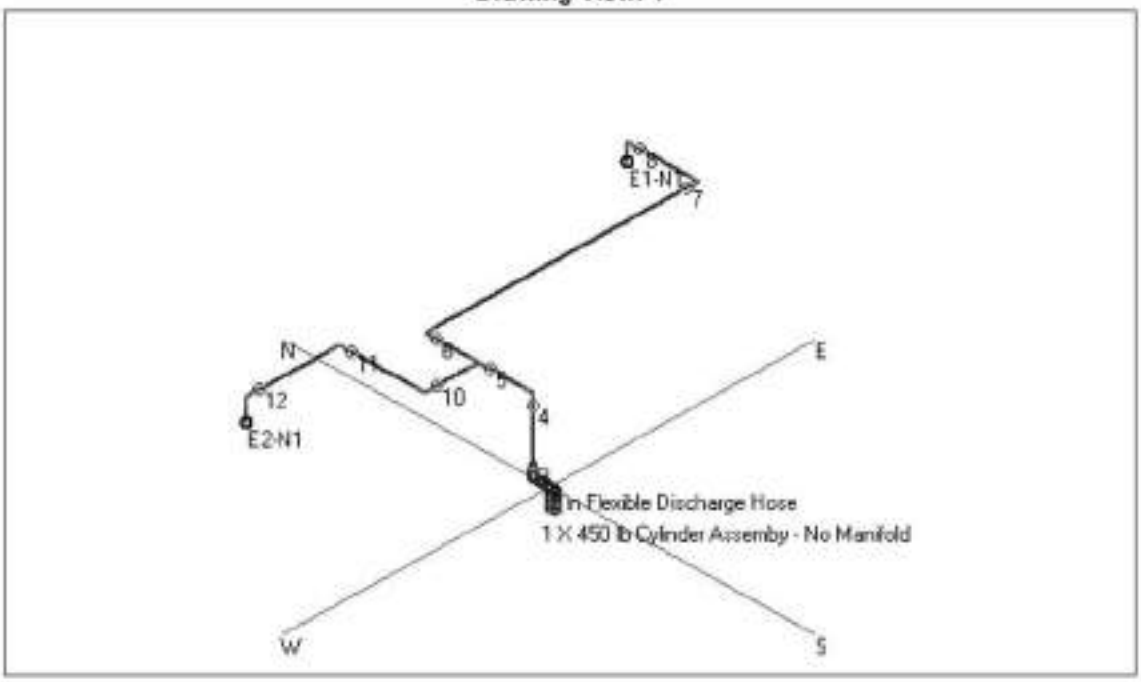
Calculation Date/Time: Thursday, August 26, 2010, 11:52:26 AM

Example – Computer Room, Storage Room, and Subfloor

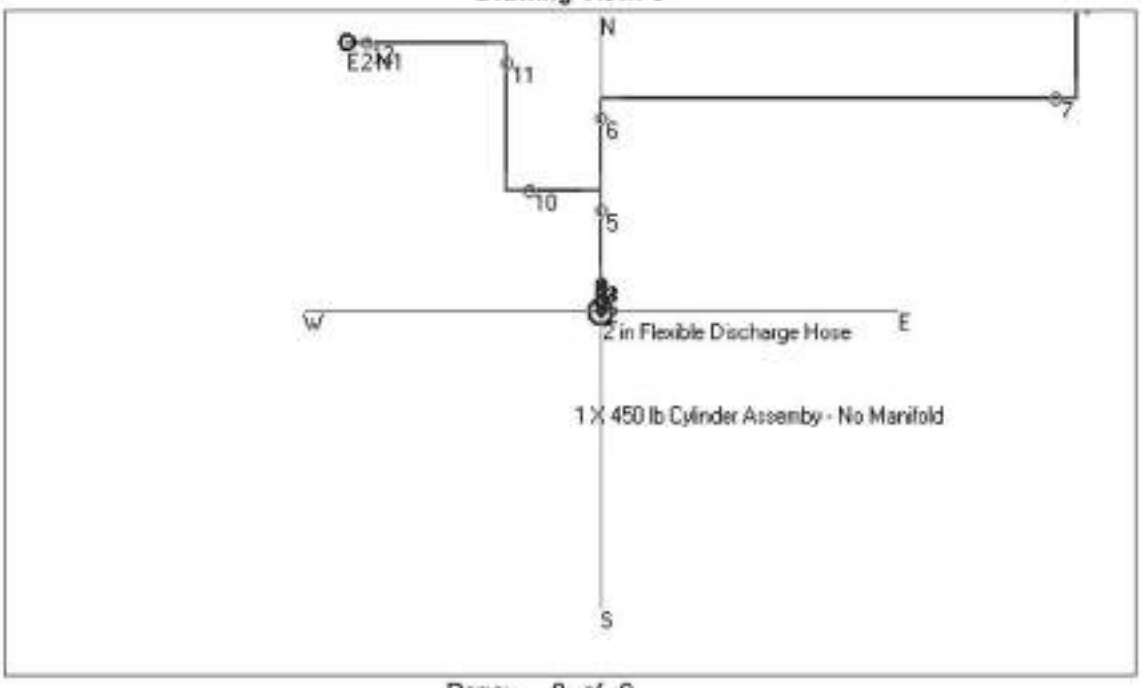
SAPPHIRE

Consolidated Report

Drawing View: 1



Drawing View: 5



Page: 8 of 9

Calculation Date/Time: Thursday, August 26, 2010, 11:52:26 AM

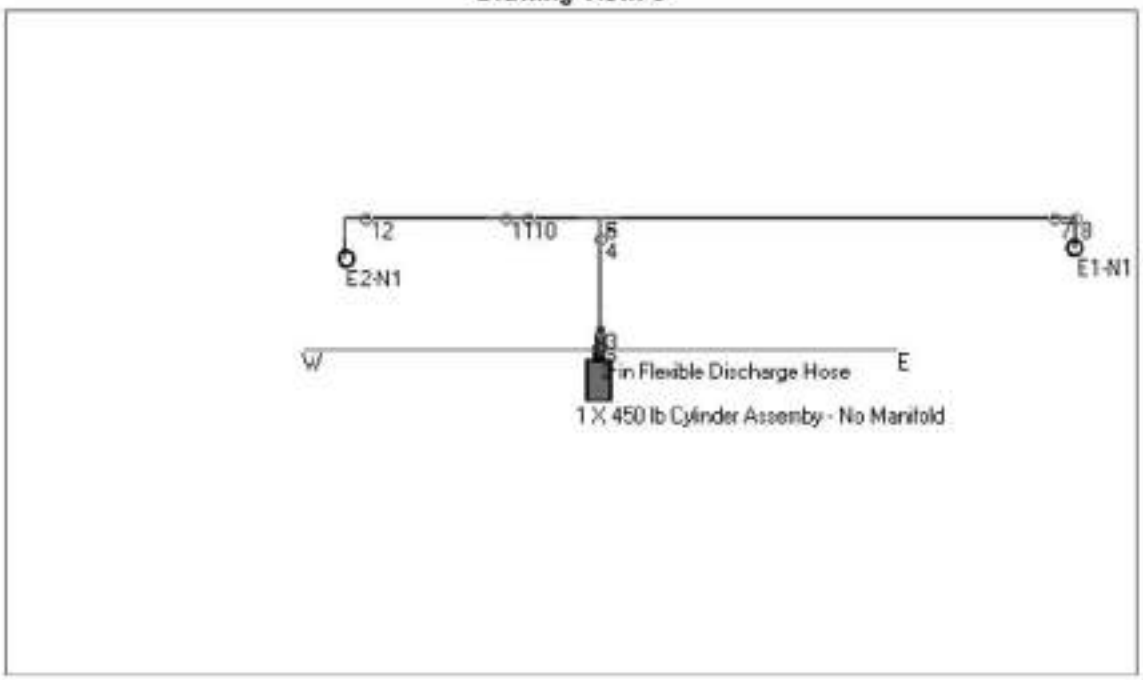
006905h

Example – Computer Room, Storage Room, and Subfloor

SAPPHIRE

Consolidated Report

Drawing View: 9



Calculation Date/Time: Thursday, August 26, 2010, 11:52:26 AM

Example – Computer Room, Storage Room, and Subfloor

Sapphire™ Designer Program - ANSL3.60b
UL: EX4510 FM: 3014140
File Name: Example - AnsulManualSF.FLC

Consolidated Report

Customer Information

Company Name: Tyco Fire Suppression and Building Products
Address: One Stanton Street
Marinette, WI 54143-2542

Phone: 715-735-7411
Contact:
Title:

Project Data

Project Name:
Designer:
Number:
Account:
Location:
Description:

Calculation Date/Time: Thursday, August 26, 2010, 11:53:23 AM

Example – Computer Room, Storage Room, and Subfloor

SAPPHIRE

Consolidated Report
Enclosure Information

Elevation:	4000 ft (relative to sea level)
Atmospheric Correction Factor:	0.86
Enclosure Number:	1
Name:	Subfloor
Enclosure Temperature...	
Minimum:	70 F
Maximum:	70 F
Maximum Concentration:	4.327 %
Design Concentration...	
Adjusted:	4.327 %
Minimum:	4.200 %
Minimum Agent Required:	30.1 lbs
Width:	46.0 ft
Length:	20.0 ft
Height:	1.0 ft
Volume:	920.0 cubic ft
Non-permeable:	0.0 cubic ft
Total Volume:	920.0 cubic ft
Adjusted Agent Required:	31.0 lbs
Number of Nozzles:	1

Calculation Date/Time: Thursday, August 26, 2010, 11:53:23 AM

Example – Computer Room, Storage Room, and Subfloor

SAPPHIRE

Consolidated Report
Agent Information

Agent:	Novec / Propellant N2
	(Novec is a trademark of 3M)
Adjusted Agent Required:	31.0 lbs
Container Name:	50 lb Cylinder Assemby
Container Part Number:	570633
Number of Main Containers:	1
Number of Reserve Containers:	0
Manifold:	No Manifold
Starting Pressure:	360 psig
Pipe Take Off Direction:	Horizontal
Agent Per Container:	31.0 lbs
Fill Density:	54.9 lbs / cubic ft
Container Empty Weight:	40.6 lbs
Weight, All Containers + Agent:	71.6 lbs
Floor Area Per Container:	0.55 square ft
Floor Loading Per Container:	131 lbs / square ft

Pipe Network

Part 1 - Pipe

Description	Start	End	Pipe Type	Pipe Diameter	Pipe Length	Pipe Elevation
Main Cyl. X 1	0	1		1 in	1.65 ft	1.65 ft
Adaptor	1	2		1 in	0.21 ft	0.00 ft
Pipe	2	3	40T	3/4 in	1.00 ft	0.00 ft
Pipe	3	4	40T	3/4 in	2.15 ft	-2.15 ft
Pipe	4	5	40T	3/4 in	3.75 ft	0.00 ft
Pipe	5	6	40T	3/4 in	17.00 ft	0.00 ft
Pipe	6	7	40T	3/4 in	1.25 ft	0.00 ft
Pipe/E1-N1	7	8	40T	1/2 in	0.25 ft	0.25 ft

Calculation Date/Time: Thursday, August 26, 2010, 11:53:23 AM

Example – Computer Room, Storage Room, and Subfloor

SAPPHIRE

Consolidated Report

Part 2 - Equivalent Length

Start	End	90	45	Thru	Side	Union	Other	Added	Total
0	1	0	0	0	0	0		0.00 ft	20.0 ft
1	2	0	0	0	0	0	1inadap	0.00 ft	0.6 ft
2	3	0	0	0	0	0		0.00 ft	1.0 ft
3	4	1	0	0	0	0		0.00 ft	4.4 ft
4	5	1	0	0	0	0		0.00 ft	6.0 ft
5	6	1	0	0	0	0		0.00 ft	19.2 ft
6	7	1	0	0	0	0		0.00 ft	3.5 ft
7	8	1	0	0	0	0		0.00 ft	2.0 ft

Part 3 - Nozzles

Start	End	Flow	Name	Size	Type	Nozzle Area
0	1	31.0 lbs				
1	2	31.0 lbs				
2	3	31.0 lbs				
3	4	31.0 lbs				
4	5	31.0 lbs				
5	6	31.0 lbs				
6	7	31.0 lbs				
7	8	31.0 lbs	E1-N1	1/2 in	16 Port - BR	0.1030 square in

Parts Information

Total Agent Required: 31.0 lbs
Container Name: 50 lb Cylinder Assemby (Part: 570633)
Number Of Containers: 1
Field1

Nozzle	Type	Diameter	Nozzle Area	Part Number
E1-N1	16 Port - BR	1/2 in	0.1030 square in	570602

Nozzle	Drill Diameter	Drill Size
E1-N1	0.0906 inches	2.30 mm

Calculation Date/Time: Thursday, August 26, 2010, 11:53:23 AM

006906d

Example – Computer Room, Storage Room, and Subfloor

SAPPHIRE

Consolidated Report

Pipe:	Type	Diameter	Length
	40T	1/2 in	0.25 ft
	40T	3/4 in	25.15 ft

'Other' Items:
1 - 1 in Union Adaptor (Part: 570557)

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

System Acceptance

System Discharge Time: 9.6 seconds
Percent Agent In Pipe: 33.9%
Percent Agent Before First Tee: 0.0%

Enclosure Number: 1
Enclosure Name: Subfloor

Minimum Design Concentration: 4.200%
Adjusted Design Concentration: 4.327%
Predicted Concentration: 4.327%
Maximum Expected Agent Concentration: 4.327% (At 70 F)

Nozzle	Minimum Agent Required	Adjusted Agent Required	Predicted Agent Delivered	Nozzle Pressure (Average)
E1-N1	30.1 lbs	31.0 lbs	31.0 lbs	143 psig

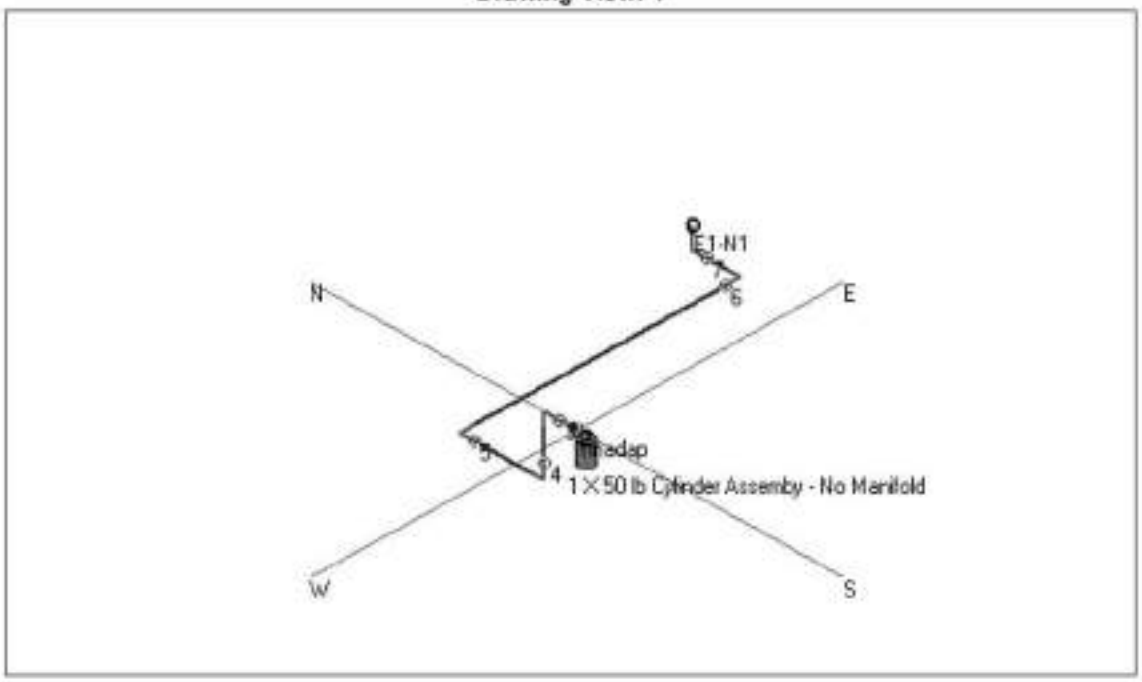
Calculation Date/Time: Thursday, August 26, 2010, 11:53:23 AM

Example – Computer Room, Storage Room, and Subfloor

SAPPHIRE

Consolidated Report

Drawing View: 1



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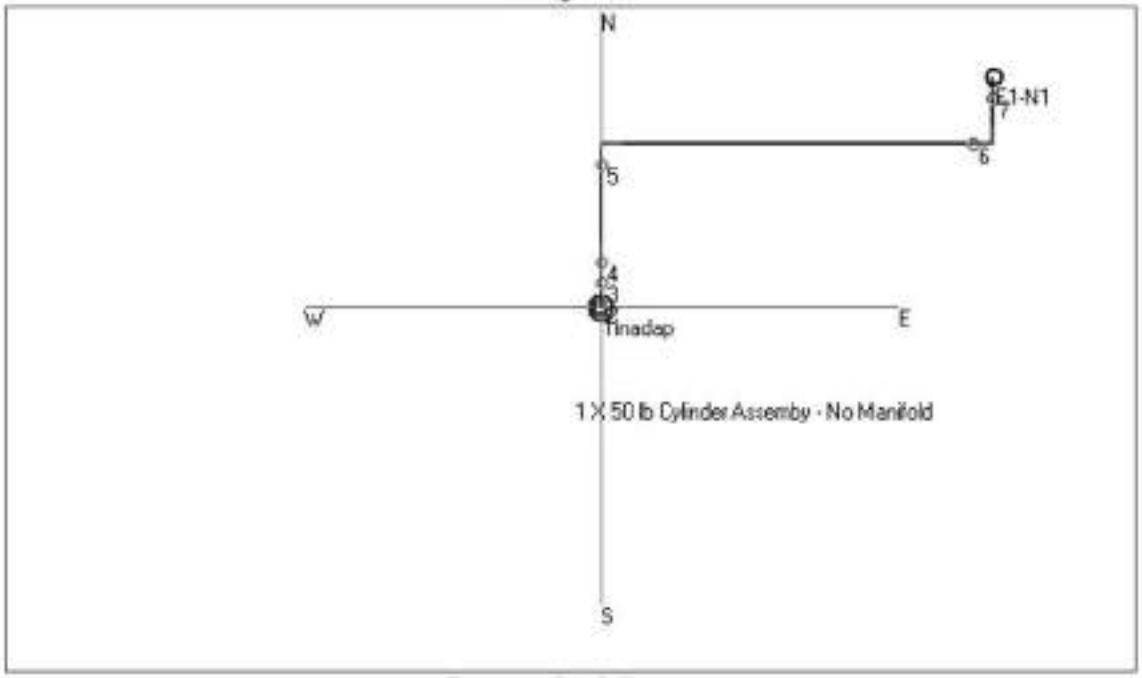


Page: 6 of 7

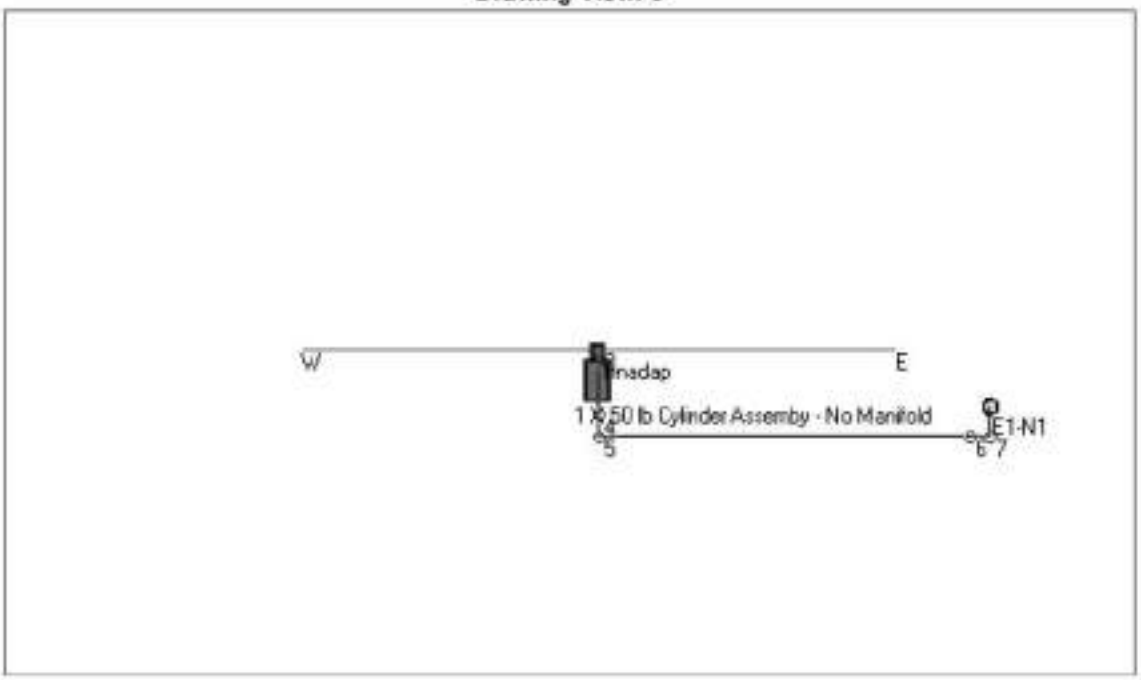
Calculation Date/Time: Thursday, August 26, 2010, 11:53:23 AM

Example – Computer Room, Storage Room, and Subfloor

SAPPHIRE

Consolidated Report

Drawing View: 9



Calculation Date/Time: Thursday, August 26, 2010, 11:53:23 AM

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