NEW MEXICO ENGINEERING RESEARCH INSTITUTE

HALON OPTIONS TECHNICAL WORKING CONFERENCE

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INERGEN™ SYSTEM DESIGN AND APPLICATION

Introduction

In order to help understand the design process, a typical example hazard is covered in this section. There may be different design approaches that can be taken for any given hazard. The example is only intended to show what has to be done to complete the design and hydraulic calculations.

Following is an outline of the example hazard. Each item is listed in the numerical order in which it should be performed.

HAZARD ANALYSIS

- **HAZARD TYPE**
  - Describe Type of Hazard Being Protected
- **HAZARD INTEGRITY SURVEY**
  - Unenclosable Openings, HVAC Considerations
- **HAZARD ATMOSPHERE**
  - Occupied, Non-Occupied, Explosion Proof
- **TYPE OF FIRE**
  - Class A, B, C or D
- **VENTILATION CONSIDERATIONS**
  - Ventilation Systems - Shutdown, Dampered
- **ELECTRICAL CONSIDERATION**
  - Power Sources Shutdown
- **TEMPERATURE RANGES**

  Determine Minimum and Maximum Temperatures

  Agent Cylinders
  Detection/Control System
- **VOLUME REDUCTIONS**
  - Moveable, Non-Moveable
- OTHER **FACTORS**
  - Handicapped Personnel
  - Response Time of Fire Service
  - Reserve System
  - Cylinder and Accessory Location

  Discharge Test
  - Authority Having Jurisdiction

Inergen

Example No. 1 – Control Room

Control rooms are found in all types of industry, housing transformers, motors. switch gear and other types of electronic devices necessary for energizing the various types of equipment.

Protection of control rooms can be accomplished by treating *it* as a total flood hazard in accordance with requirements of NFPA 2001, "Standard for Clean Agent Fire Extinguishing Systems."

The design of the INERGEN system should be in accordance with NFPA 2001, which states, "the design concentration must be achieved within 1 minute. 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."

Personnel safety is the first concern. The INERGEN system should incorporate a discharge alarm andlor predischarge alarm to warn personnel of a discharge. A time delay device is not needed due to the life supporting characteristics of INERGEN agent.

Electrical power and ventilation must be shut down prior to system actuation. Common A/C duct may require dampering to prevent INERGEN agent loss.

Smoke detection *is* recommended.

The authority having jurisdiction may have additional requirements.

HAZARD

A control room having dimensions of 30 ft. x 20 ft. x 10 ft. high.

No unclosable openings.

Ventilation to be shut down at system actuation.

ITEM NO. 1 – Sketch of Hazard. Do an accurate sketch of the hazard area and measure all solid, permanent objects.

ITEM NO. 2 – Design Calculation Sheet. Fill out the calculation sheet with the information required to determine total quantity of agent and percent of INERGEN agent concentration.

ITEM NO. 3 – Preliminary Drawing. Complete a drawing or sketch as accurate as possible to determine pipe lengths and number of fittings. Locate and number all node points and nozzles.

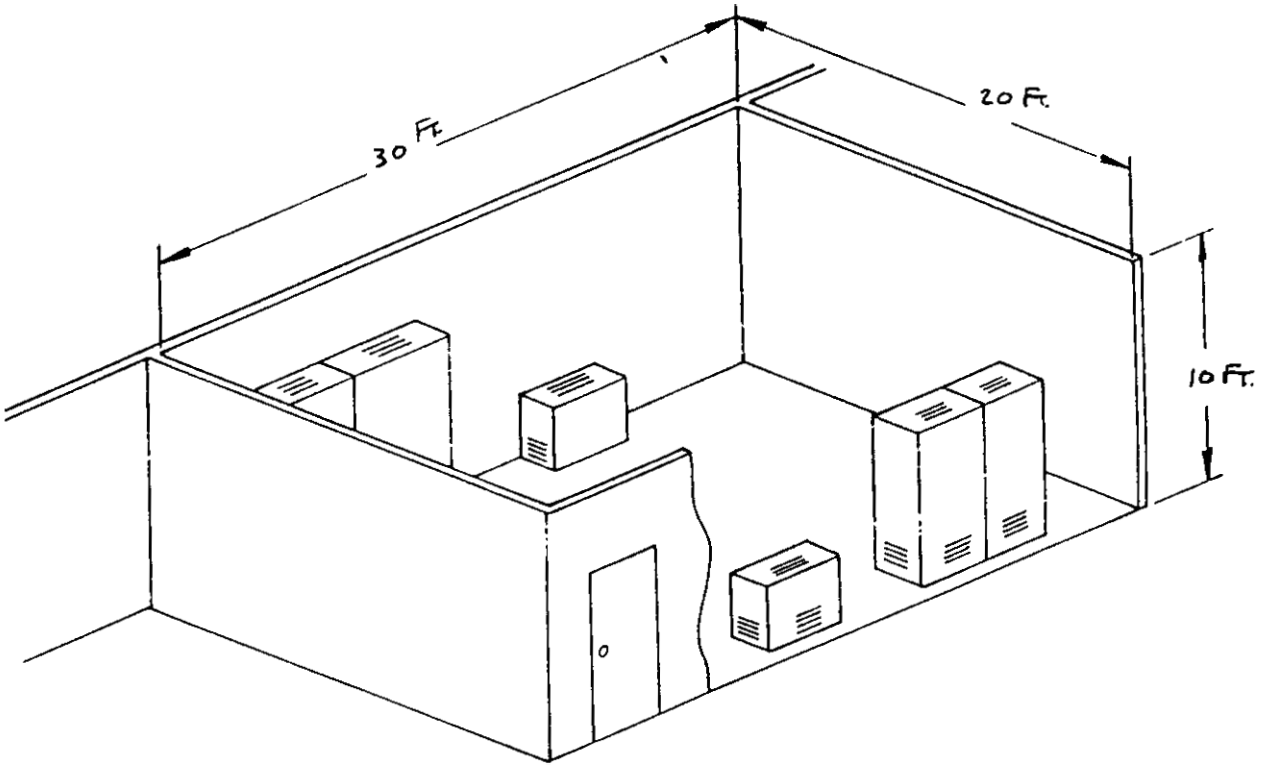
ITEM NO. 4 – Flow Calculation Input Form. With the information on pipe lengths, fittings, node points, and nozzles, fill in the input form.

ITEM NO. 5 – Computer Print Out. The computer print. out will compute discharge time. pipe sizes. union orifice size, and nozzle orifice sizes.

ITEM NO. 6 – Bill of Material. This should be generated to show the complete list of all required hardware.

ITEM NO. 7 – Application Drawing. This typical application drawing is an example of the type of drawing which is generated from Ansul Application Engineering Department. This drawing is normally used to secure approval from the local authority.

SKETCH OF HAZARD



DESIGN **CALCULATION SHEET**

INERGEN DESIGN CALCULATION WORKSHEET

DATE 12/9/93
QUOTE/JOB NUMBER: Example 1
CUSTOMER: Ansul Fire Protection

VOLUME CALCULATIONS:	AREA
Area Name:	Control Room
Length (ft.):	30.00
Width (ft.):	20.00
Height (ft.):	10.00
Area (sq. ft.):	600.00
Volume (cu. ft.):	6000.00
volume Reductions:	
Structural Reductions (cu. ft.):	
Reduced Volume: (Volume - Structural Reductions)	6000.00
Movable Object Reductions (cu. ft.): (If More Than 25% of Reduced Volume)	
Total Reduced Volume (cu. ft.): (Volume - reductions)	6000.00
ROOM MINIMUM AMBIENT TEMP.:	60
DESIGN CONCENTRATION:	37.5%
FLOODING FACTOR: (From Table)	0.479
INITIAL INERGEN QUANTITY CALC.:	
INERGEN Quantity (cu. ft.): (Total Reduced Volume x Flooding factor) or (Formula from Design Manual)	2876.26
ALTITUDE CORRECTION:	
Height Above or Below Sea Level:	3500
Factor: (From Design Manual Table)	0.89
ACTUAL INERGEN QUANTITY (cu. ft.): (Initial Inergen Quantity x Altitude Correction Factor)	2559.87

Inergen

Example No. 1 - Control Room
Item No. 2

DESIGN CALCULATION SHEET/2

ACTUAL INERGEN QUANTITY *(CU.* **ft.):** 2559.87
(From Page 1)

	CYLINDER REQUIREMENTS: *(INERGEN qty. ÷ cylinder capacity rounded to next whole number*	TOTAL CYLINDER CAPACITY: *(Cyl. qty. x Cyl. cap.)*
355 cu. ft. Cylinders:	8	2840
266 cu. ft. Cylinders:	10	2660
205 cu. ft. Cylinders:	13	2665

CYLINDER SIZE SELECTED: 355
INERGEN AGENT SUPPLIED: 2840
(Cylinder qty. x Cylinder capacity)

ACTUAL INERGEN FLOODING FACTOR: 0.532
[(INERGEN Agent Supplied ÷ Alt. Correction Factor) ÷ Total Reduced Volume]

CONCENTRATION RANGE CHECK:
(Design Conc. Must be Between **37.5%** *- 42.8% For Occupied Spaces)*

Room Max. Ambient Temp.: 80
Design Concentration at Max. Temp: 41.8%
(Locate Actual INERGEN Conc. at Max. Temp. on Table, or Use Calc. in Design Manual]

DISCHARGE TIME:
Normal Ambient Temperature: 70.00
Design Concentralion at Ambient Temp.: 41.2%
(Locate Actual INERGEN Conc. at Amb. Temp. on Table, or Use Calc in Design Manual)
90% of Agent Discharge Time (Sec.): 61.0
(Time from Table in Design Manual)

90% *of Agent Discharge Time (Min):* 1.02
(Discharge Time (Sec.)/60)

ESTIMATED *FLOW* **RATES:**
Estimated System **Flow** Rate: 2512
[(INERGEN Agent Supplied x .9) ÷ Discharge Time (Min.)]

Estimated Orifice Union Pipe Size: 1
(Refer to Pipe Sizing Chart)

Nozzle Quantity: 1
(length ÷ **32** *(Rounded to Next Highest Whole Number)*
x width ÷ **32** *(Rounded to Next Highest Whole Number)]*

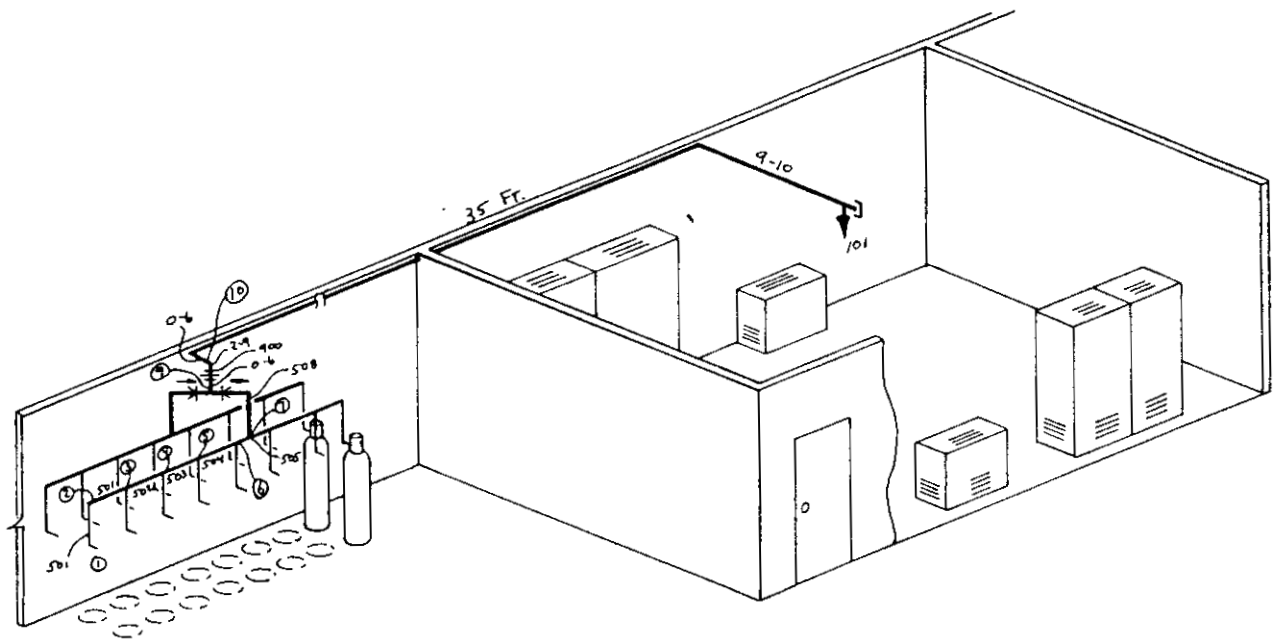
Estimated Nozzle Flow Rate: 2512.36
(System Flow Rate ÷ Nozzle Quantity)

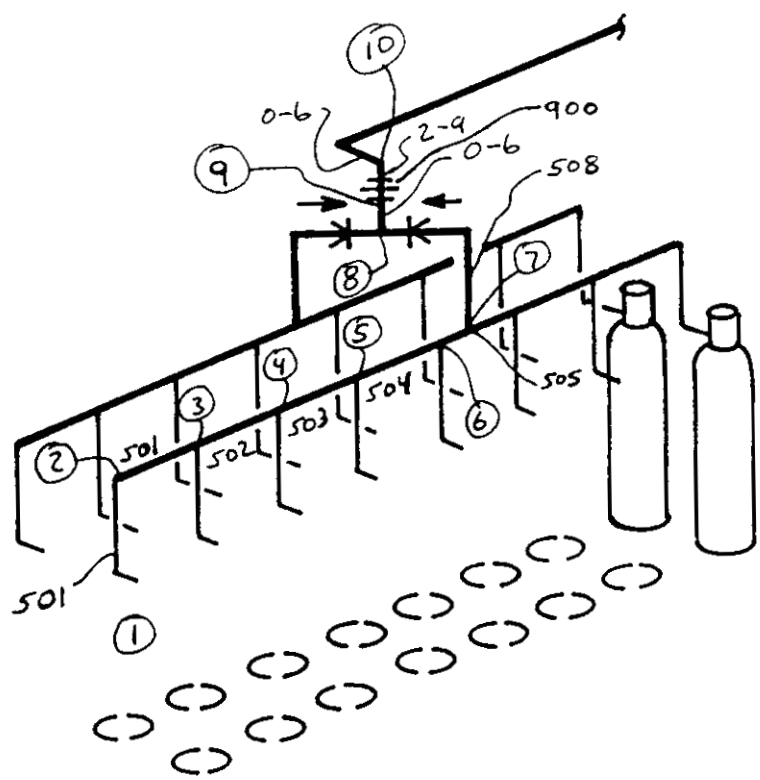
Estimated Nozzle Pipe Size: 1
(Refer to Pipe Sizing Chart)

Inergen™ FIRE EXTINGUISHING AGENT

Example No. 1 – Control Room
Item No. 3

PRELIMINARY DRAWING





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Example No. 1 - Control Room
Item No. 4

FLOW CALCULATION INPUT FORM

ANSUL. ANSUL FIRE PROTECTION MARINETTE, WI 54143-2542

INERGEN System Flow Calculation Input Form

Metric Option	Data File Name
No	Example 1.dTA

Page 1 of 1

Job Number	Customer Number	Customer Address	City, State, Zip	Remarks
1	Ansul Fire	1 STANTON	MARINETTE WI	Control Room
	Protection	ST.	54143	

Discharge Time	Cylinder Capacity (Actual)	Cylinder Qty.
67.5	355	8

Section I.D. From	Section I.D. To	Length or Orif.Un.ID	Elevation Change	Pipe Size	Elbows	Thru Tee	Side Tee	Cplg or Union	Manifold ID or Agent Qty.	Equiv. Length	NOTES
1	2										
2	3	1			1				501		
3	4	1				1			502		
4	5	1				1			503		
5	6	1				1			504		
6	7	.5				1			505		
7	8	1	.5		1		1		508	CV	
8	9	.5	.5				1		508		950 MAX. Pressure
9	10	90C									950 MAX. Pressure
10	101	48	2.75		4				2840		
9-1-1											

Form No F-93243 1993 Wormald U.S., Inc. Litho in U.S.A.

COMPUTER PRINT OUT – ORIFICE CALCULATION INPUT

Prepared by: ANSUL FIRE PROTECTION
Location: DALE EDLEECK.

ANSUL INERGEN FLOW CALCULATION vl.O
U.L. LISTED EX4510 12/1/93
Date: 12-08-1993

DATA INPUT FILE NAME IS B:EXAMPLE1.DOC

DATA INPUT FILE

SEC	SEC	LENGTH	ELEV	PIPE CODE	90'S	THRU TEE	SIDE TEE	CPLG UNION	INERGEN QTY	EQL
1	2	0.0	0	.500-40T	0	0	0	0	501.0	38
2	3	1.0	0	1.00-60T	1	0	0	0	501.0	0
3	4	1.0	0	1.00-80T	0	1	0	0	502.0	0
4	5	1.0	0	1.00-80T	0	1	0	0	503.0	0
5	6	1.0	0	1.00-80T	0	1	0	0	504.0	0
6	7	0.5	0	1.00-80T	0	1	0	0	505.0	0
7	8	1.0	1	1.25-80T	1	0	1	0	508.0	0
8	9	0.5	1	1.25-80T	0	0	1	0	508.0	0
9	10	900.0	950		0	0	0	0	0.0	0
10	101	48.0	3	1.25-40T	4	0	0	0	2840.0	0

Inergen™ FIRE EXTINGUISHING AGENT

Example No. 1 – Control Room
Item No. 5

COMPUTER PRINT OUT – ORIFICE CALCULATION PRESSURE LOSS OUTPUT

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Prepared by:  ANSUL FIRE PROTECTION
Location: DALE EDLBECK.

ANSUL INERGEN FLOW CALCULATION V1.0
 U.L.  LISTED EX4510 12/1/93
Date:  12-08-1993


DATA INPUT FILE NAME IS B:EXAMPLE1.DOC
JOB NUMBER 1
CUSTOMER NAME ANSUL FIRE PROTECTION
ADDRESS       : 1 STANTON STREET
                MARINETTE. WI 54143
REMARKS: CONTROL ROOM

                          AGENT STORAGE CONDITIONS

  8 - 355 CU FT CYLINDERS OF INERGEN
TOTAL AGENT IN STORAGE IS   2840 CU FT
STORAGE PRESSURE IS NOMINAL 2200 PSI at 70 DEG F


                          PRESSURE DROP CALCULATION

                NOMINAL        LEN   EQL    EL          START   TERM   FLOWRATE
SEC   SEC     PIPE SIZE       (FT)  (FT)   (FT)  TEE   PSIA    PSIA   (CFM)

 1     2    1/2     40 T      0    38.0     0   MFLD   1033    1003     464
 2     3    1       80 T      1     3.4     0   MFLD   1003    1005     464
 3     4    1       80 T      1     2.6     0   MFLD   1005    1004     927

 4     5    1       80 T      1     2.6     0   MFLD   1004    1002    1391
 5     6    1       80 T      1     2.6     0   MFLD   1002     997    1854
 6     7    1       80 T      1     2.1     0   MFLD    997     990    2318

 7     8    1 1/4   80 T      1    10.6     1   MFLD    990     979    3709
 8     9    1 1/4   80 T      1     6.9     1   MFLD    979     912    3709
 9    10   ORIFICE 0.582 INCHES                        972     563    3709

10   101   1 1/4   40 T     48    61.8     3           563     584    3709

HIGHEST CALCULATED PRESSURE DOWNSTREAM OF ORIFICE IS 1089 PSIA
INITIAL PIPELINE TEMPERATURE IS 70 DEGREES F.
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Example No. 1 – Control Room
Item No. 6

BILL OF MATERIALS

BILL OF MATERIALS

Quote No.: Example 1
Customer Name: Ansul Fire Protection
Customer Address: 1 Stanton Street
Marinette. WI 54143

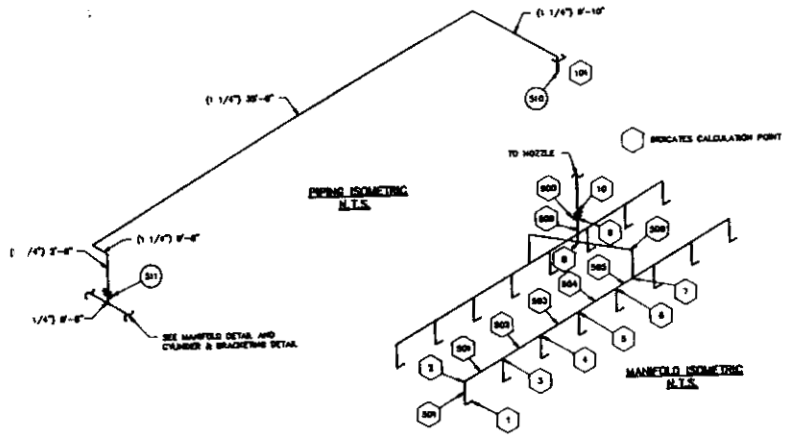
Phone No.: 715-735-7411
Fax No.: 715-732-3479
Contact Name:

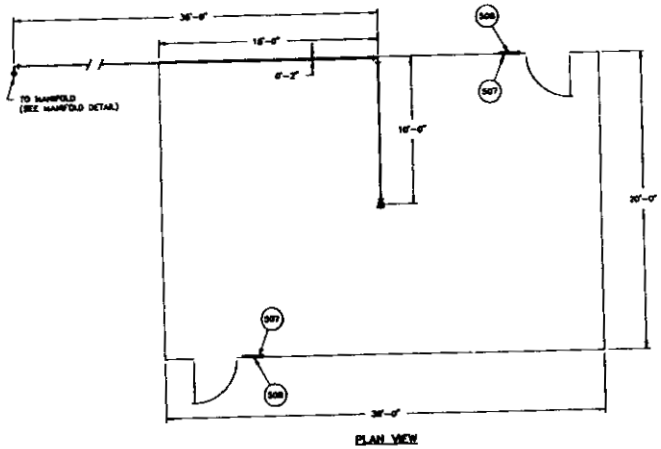
Dale: 11/19/93
Page: 1 of 1
Product Line: WMGEN

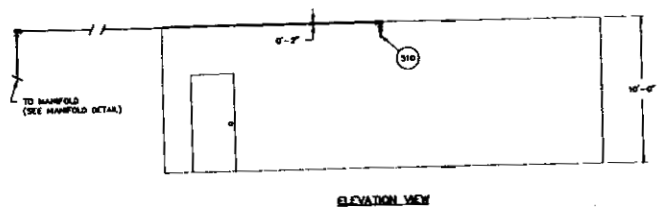
Project: Design Manual
Control Room
Example

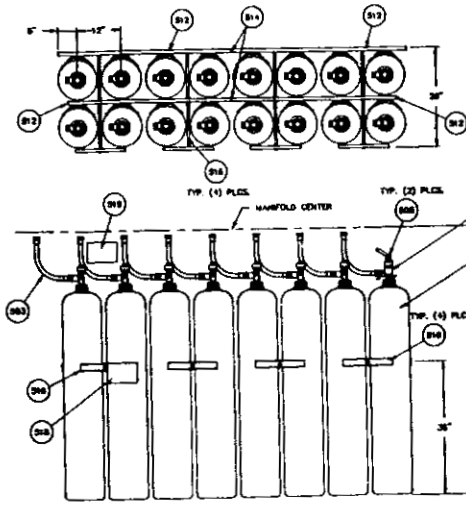
ITEM NO.	QTY.	PART NO.	DESCRIPTION
	16	416447	350 CU. FT MASTER CYLINDER W/ CV90 VALVE
	16	842424	DISCHARGE HOSE
	2	873111	ELECTRIC SOLENOID VALVE ACTUATOR
	2	870846	LEVER RELEASE, W/ HANDLE & PIN
	1	416680-35	1 1/4" NPT ORIFICE UNION
	2	840309	HEADERVEMPLUG
	1	846250	PNEUMATIC SWITCH DPST
	1	841942	NAMEPLATE - "MAIN"
	1	841943	NAMEPLATE. "RESERVE
	2	416265	WARNING PLATE - INSIDE W/ ALARM
	2	416266	WARNING PLATE - OUTSIDE W/ ALARM
	1	417365-58	1 1/4" NPT INERGEN NOZZLE
	1	841549	1.1/4" CHECK VALVE - THREADED
	4	879640	BACK FRAME ASSEMBLY (4 CYLINDER)
	4	873255	25" CARRIAGE BOLT a NUT (DEL ROW 350)
	4	873091	CYLINDER CLAMP (2 CYLINDER)
	2	879413	CONNECTOR (7 OR MORE CYL. IN A ROW)

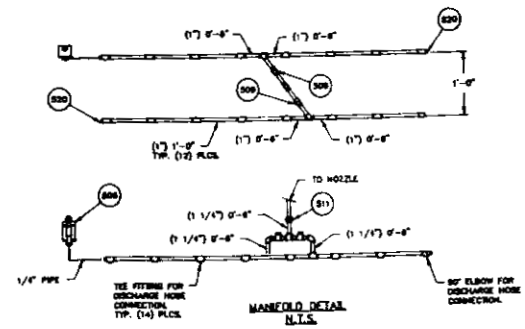
TOTAL WEIGHT: 3654 Ibs.
TOTAL VOLUME: 85 cu. ft.











BILL OF MATERIALS

ITEM	QTY	PART No.	DESCRIPTION
501	16	018417	350 CU. FT. CYLINDER - MASTER
503			
503	16	842424	DISCHARGE HOSE
504	2	872611	SOLENOID VALVE ACTUATOR
505	2	870846	MANUAL RELEASE, WITH HANDLE & PIN
506	1	842230	PNEUMATIC SWITCH (PS1)
507	2	018286	MARKING PLATE - INERGEN
508	2	042261	MARKING PLATE - OUTDOOR
509	2	842260	1 1/2" CHECK VALVE
510	1	617349-09	1 1/2" NOZZLE
511	1	610880-35	1 1/2" ORIFICE UNION
512	9	872810	RACK FRAME ASSEMBLY (4 CYLINDER)
513			
514	2	870413	CONNECTOR (7 OR MORE CYLINDERS IN A ROW)
515	4	872256	3/8" CHANNEL BOLT & NUT (DBL. ROW 350 CU. FT. CYLINDER)
516	1	873091	CYLINDER CLAMP (2 CYLINDER)
517			
518	1	841243	NAMEPLATE - "MAIN"
519	1	841943	NAMEPLATE - "RESERVE"
520	2	843289	HEADED VENT PLUG

INSTALLATION NOTES FOR INERGEN SYSTEM

THESE SPECIFICATIONS ARE TO APPLY TO ALL INSTALLATIONS OF INERGEN FIRE EXTINGUISHER SYSTEMS.

NOTE: PIPE SHALL CONFORM TO ASTM SPECIFICATIONS FOR A53 OR A106 PIPE. A120 SHALL NOT BE USED.

1. ALL THREADED PIPE BEYOND THE ORIFICE UNION TO BE BLACK OR GALVANIZED STEEL OF THE FOLLOWING PIPE SIZE AND GRADE COMBINATIONS.

ASTM A-106 SEAMLESS, GRADE C	SCH. 40- THRU 8"
ASTM A-106/A-53 SEAMLESS, GRADE B	SCH. 40- THRU 8"
ASTM A-106/A-53 SEAMLESS, GRADE A	SCH. 40- THRU 2.5"
ASTM A-53 ERW, GRADE B	SCH. 40- THRU 3"
ASTM A-53 ERW, GRADE A	SCH. 40- THRU 1.25"

2. ALL THREADED PIPE USED TO CONSTRUCT THE MANIFOLD, INCLUDING PIPE BEFORE THE ORIFICE UNION TO BE BLACK OR GALVANIZED STEEL OF THE FOLLOWING PIPE SIZE AND GRADE COMBINATIONS.

ASTM A-106 SEAMLESS, GRADE C	SCH. 80- THRU 2.5"
ASTM A-106/A-53 SEAMLESS, GRADE B	SCH. 80- THRU 1.25"
ASTM A-106/A-53 SEAMLESS, GRADE A	SCH. 80- THRU 1.0"
ASTM A-53 ERW, GRADE B	SCH. 80- THRU 1.0"
ASTM A-53 ERW, GRADE A	SCH. 80- THRU .5"

3. PIPE GRADES MUST BE SUITABLE FOR THE PRESSURES CALCULATED BY ANSUL'S INERGEN PNEUMATIC CALCULATION PROGRAM. CONSULT THE CHART IN ANSUL'S DESIGN MANUAL OR NFPA 2001, A-2.2.1, FOR MAXIMUM PIPE PRESSURES FOR THE DIFFERENT PIPE GRADES.

4. ALL FITTINGS BEYOND THE ORIFICE UNION TO BE 3000# ANSI B-16.3 BLACK OR GALVANIZED MALLEABLE IRON THREADED FITTINGS THROUGH 3" SIZE. FORGED STEEL FITTINGS TO BE USED FOR LARGER SIZES. FLANGED JOINTS TO BE CLASS 300 LB. CLASS 300 MALLEABLE IRON UNIONS OR STREET ELBOWS SHALL NOT BE USED.

5. ALL FITTINGS USED TO CONSTRUCT THE MANIFOLD, INCLUDING FITTINGS BEFORE THE ORIFICE UNION TO BE BLACK OR GALVANIZED FORGED STEEL 3000# OR 3000# ANSI B-16.11.

6. ALL PIPE, FITTINGS AND MANIFOLDS TO BE SUPPLIED BY OTHERS.

7. PIPE LENGTHS GIVEN ARE FROM CENTER TO CENTER OF FITTINGS.

8. ALL DIMENSIONS ARE TO FIELD CHECKED. ANY DEVIATIONS FROM THE ARRANGEMENT SHOWN WILL REQUIRE COMPLETE REVIEW OF THE NOZZLE AND LINE PRESSURE CALCULATIONS BY THE DESIGNER.

9. BLOW AND CLEAN EACH PIPE SECTION INTERNALLY AFTER PREPARATION AND BEFORE ASSEMBLY BY MEANS OF SWABBING, UTILIZING A SUITABLE NON-FLAMMABLE CLEANER. THE PIPING NETWORK SHALL BE FREE OF PARTICULATE MATTER AND OIL RESIDUE BEFORE INSTALLATION OF NOZZLES OR BRANCH-LINE DEVICES.

10. THE USE OF PIPE DOPE OR TEFLON TAPE IS RECOMMENDED. APPLY SPARINGLY TO MALE THREADS ONLY.

11. CYLINDERS AND PIPE TO BE SECURELY BRACKETED- ESPECIALLY AT FITTINGS AND NOZZLES.

12. ALL DEAD END PIPE LINES TO BE PROVIDED WITH A 1/2" CAPPED NIPPLE 2" LONG.

13. DETECTOR CABLE TO BE RUN IN 1/2" EMT WALL CONDUIT (E.M.T.)

14. USE CORNER PULLEYS AT ALL CHANGES IN DIRECTION IN 1/2" E.M.T. USED FOR CONDUCTING DETECTOR CABLE. BENDS OR OFFSETS WILL NOT BE ACCEPTABLE.

INERGEN FIRE SUPPRESION SYSTEM
CONTROL ROOM
MAIN/RESERVE SYSTEM
EXAMPLE DRAWING WITH DETAILS

ANSUL

DRAWN	DATE	SCALE	DRAWING NUMBER
T. DAVIS	10/19/93	1/4"=1'-0"	AE-70003
			SHEET 1 OF 1