TECHNICAL

PROPOSAL

FENWAL PS-274

CARGO MAIN-CABIN FIRE PROTECTION SYSTEM

DECEMBER 27, 1968

PRESENTED TO

TRANS WORLD AIRLINES
MID-CONTINENT INTERNATIONAL AIRPORT

KANSAS CITY, MO.

Fenwal®

FENWAL INCORPORATED · ASHLAND, MASSACHUSETTS

Division of Walter Kidde & Company, Inc.

CONTENTS

INTRODUCTION

Fenwal Incorporated, Ashland, Mass., a Division of Walter Kidde & Company Inc., presents this proposal to Trans World Airlines in response to letter request dated 11 July 1968. The proposal describes a CARGO-MAIN CABIN PROTECTION SYSTEM.

SUMMARY

The proposal system meets all the requirements noted in the TWA specification of the referenced letter request. Fenwal specifications SK-5552 CARGO-MAIN CABIN FIRE PROTECTION SYSTEM, is a part of this proposal and describes the system, specifies functions and outlines environmental criteria.

HIGHLIGHTS

Fenwal Incorporated has pioneered the use of Halon for fire extinguishing systems. Fenwal systems using Halon presently protect the surge tanks of TWA's Boeing 707 and 727 aircraft. Fenwal systems have been used successfully to protect modules of NASA Spacecraft and parts of the Saturn V service structure during and prior to blast-off. Our Firepac 360 is the first in a new concept of self-contained, portable, automatic fire suppression systems. The proposed system reflects over 5 years of Fenwal experience with Halon extinguishants and over 12 years of experience in the detection and suppression of fires and explosions in military and commercial aircraft and virtually every conceivable industrial application.

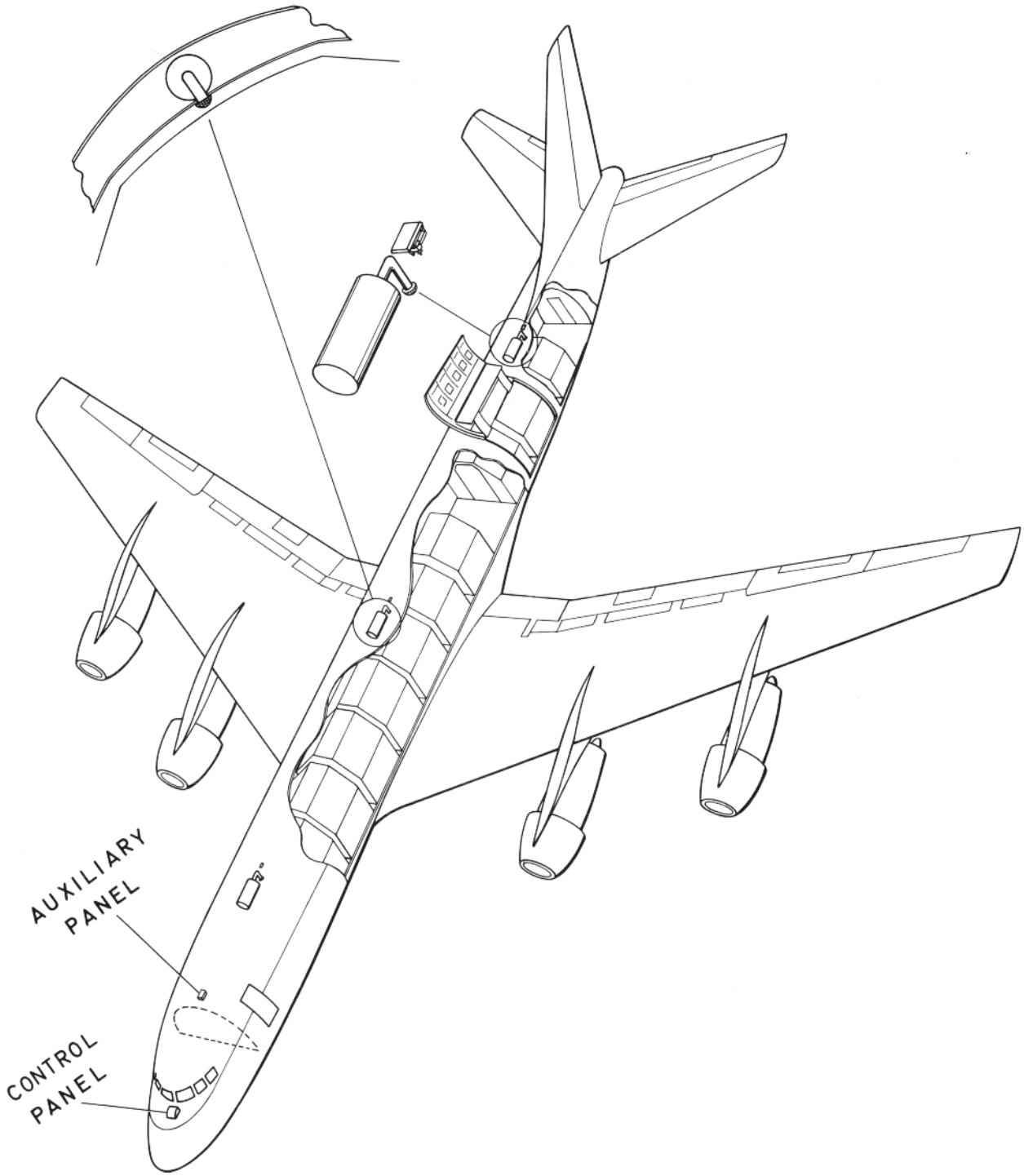


Figure 1

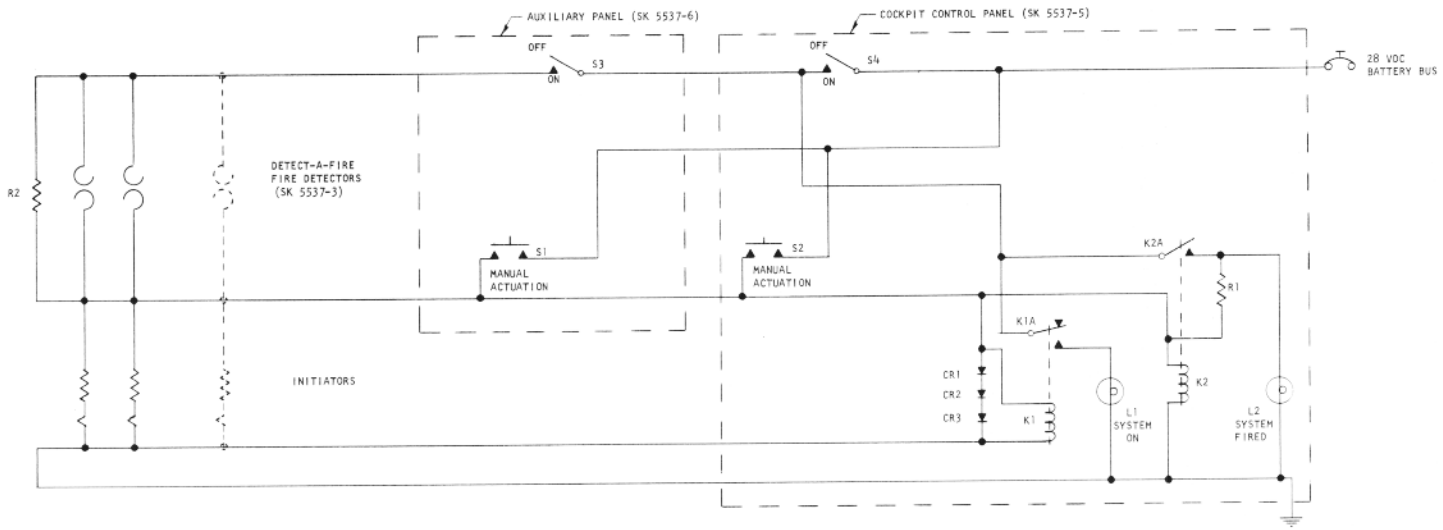
PROPOSED SYSTEM

Fire detection and suppression technology has reached the point where it is now possible to equip aircraft with the means to protect the aircraft from flammable cargoes and protect valuable cargoes from fires which occur in flight, on landing or take-off or while the aircraft is unattended.

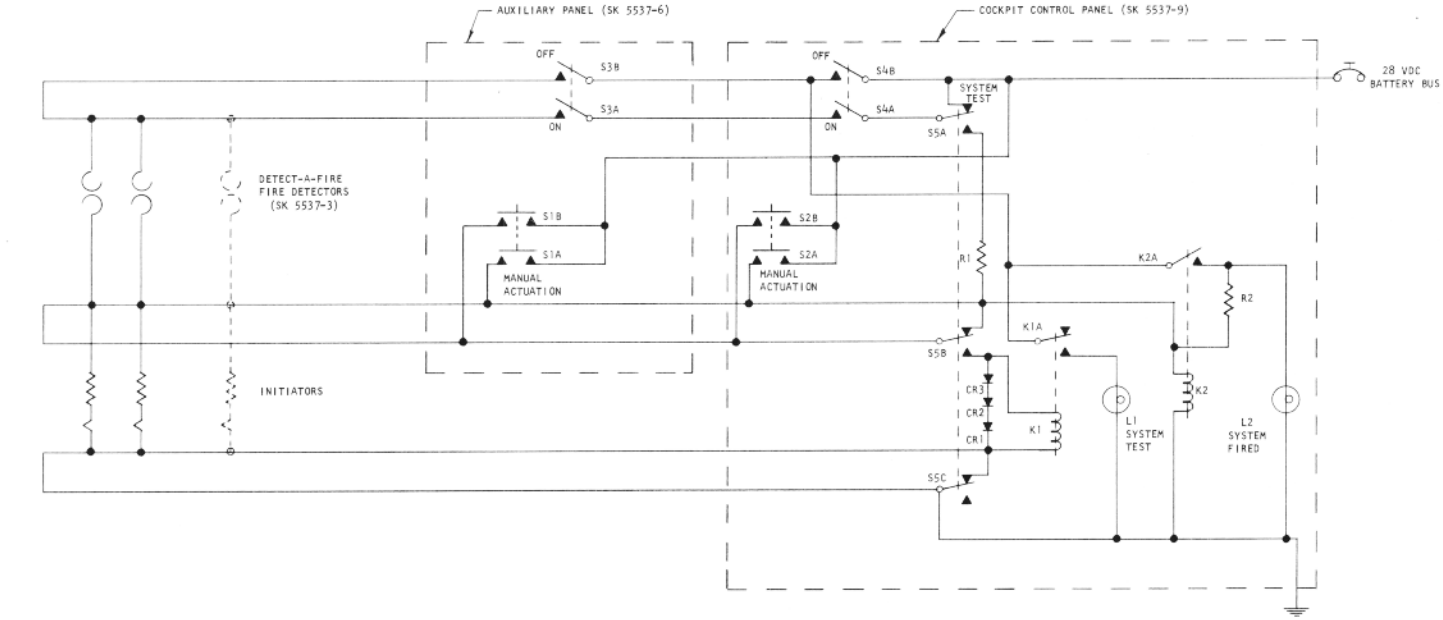
Figure 1 illustrates Fenwal's proposed system installation. Fire suppressor modules, regularly spaced, each protect about 20 feet of fuselage. Fenwal standard rate compensated thermal detectors located adjacent to the modules and mounted along the center line of the cabin overhead, sense fire and automatically discharge the extinguishant.

The extinguishant, Halon 1301, when used with Fenwal know-how provides the most effective fire extinguishing system in use today.

The system operates automatically and can be activated manually whenever necessary.



SK5537-7



SK5537-8

SYSTEM OPERATION

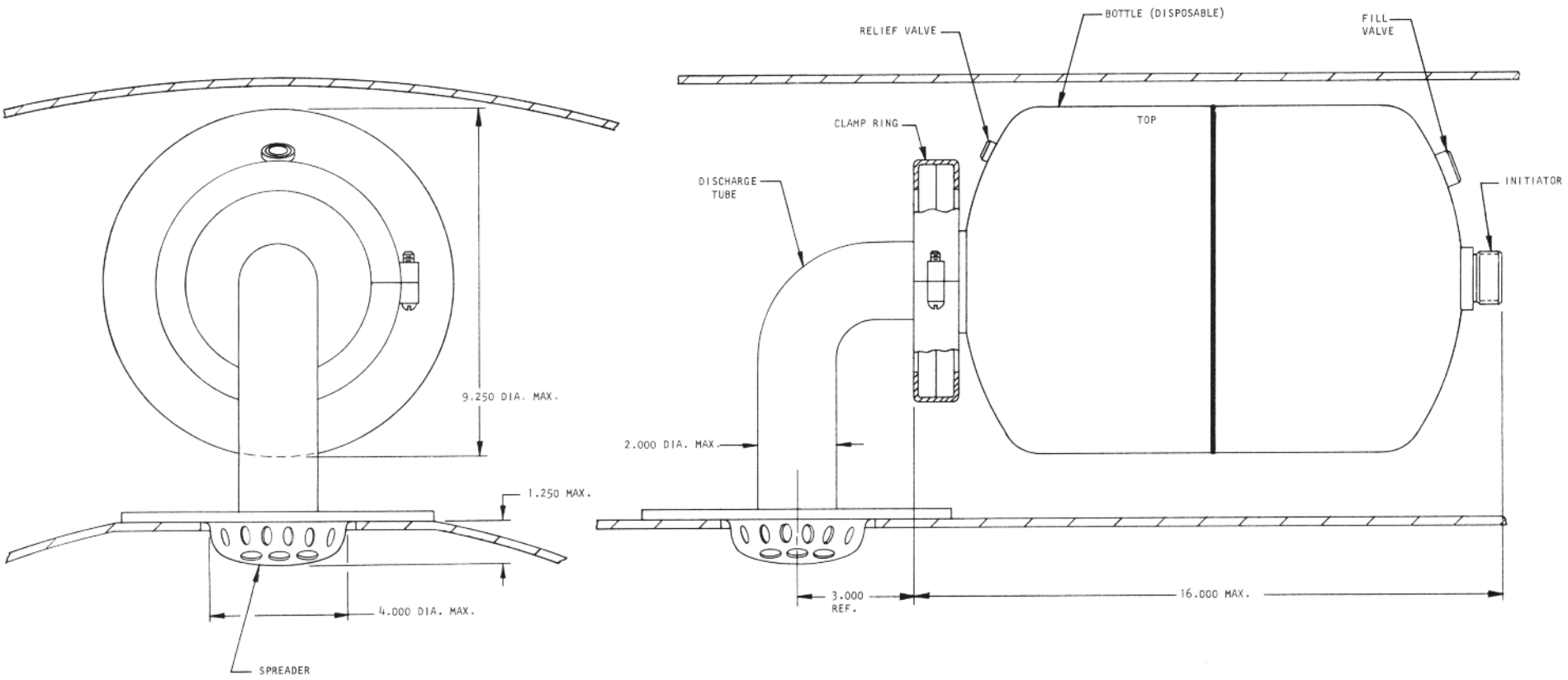
The system operates from the aircraft 28VDC Buss. Alternate wiring systems are proposed.

In the first, schematic SK5537-7, the integrity of system wiring is continuously noted by a SYSTEM ON lamp at both the cockpit and auxiliary panels. A break in wiring or power loss while the system is turned on immediately extinguishes the lamp and indicates a fault.

The alternate system, Schematic SK5537-8, a PRESS TO TEST switch is provided and a SYSTEM TEST lamp lights when the test switch is pressed if system wiring is sound and if power is applied.

System operation is basically the same for either wiring proposal. With power applied and the SYSTEM ON-OFF switch in the ON position the suppressor is triggered when a DETECT-A-FIRE sensor reaches its predetermined set-point. The system may be triggered manually at any time, regardless of the ON-OFF switch position by operating the MANUAL ACTUATION switch on either cockpit or auxiliary panel. A SYSTEM FIRED lamp on each control panel lights when the system is activated.

The initiator used to trigger the suppressors is similar to that used in the Boeing 707 Surge Tank Protection System. These initiators have an MTBF of 1,343,000 hours in this application. One reported failure, attributed to a wire crimping problem, has been resolved. Because the reliability of the initiator has proven excellent, a check of the initiator during system test is not considered necessary and would only complicate wiring and decrease reliability.

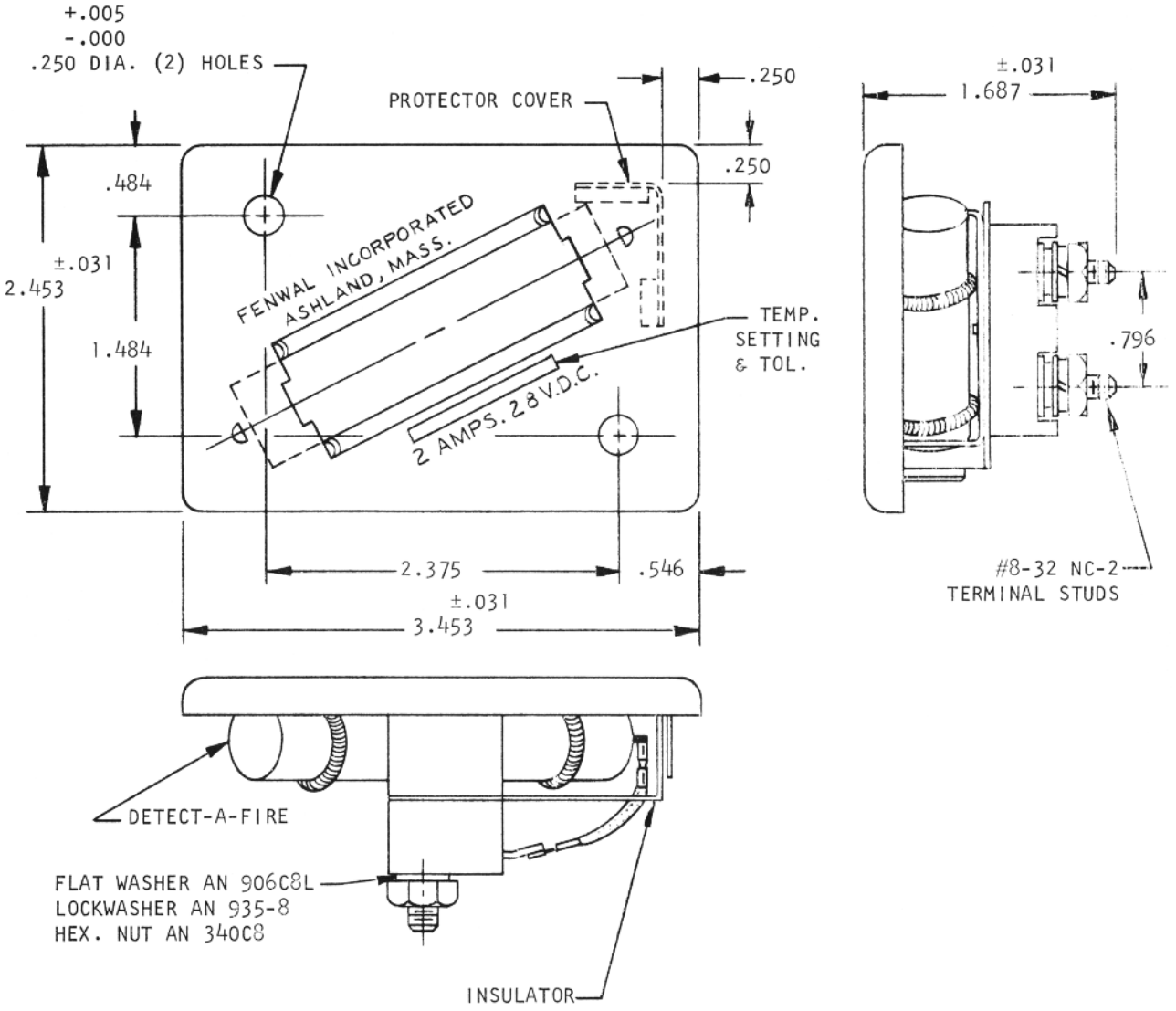

RELIEF VALVE
BOTTLE (DISPOSABLE)
FILL VALVE
CLAMP RING
TOP
DISCHARGE TUBE
INITIATOR
9.250 DIA. MAX.
2.000 DIA. MAX.
1.250 MAX.
4.000 DIA. MAX.
SPREADER
3.000 REF.
16.000 MAX.

SK5537-2

SUPPRESSOR MODULE

The dimensions of the proposed extinguishing module are shown on Fenwal Drawing SK5537-2. The units are designed so that after initial installation the necessary piping and spreader will remain in the aircraft. The disposable pressure vessel can be separated from the plumbing by unscrewing one fitting and removing the necessary fasteners securing the unit in the aircraft.

Fire extinguishment after detection is a function of agent selection and application within the fire zone. The agent release and dispersal means has been engineered for minimum discharge time and spray pattern required by the geometry of the aircraft cabin.

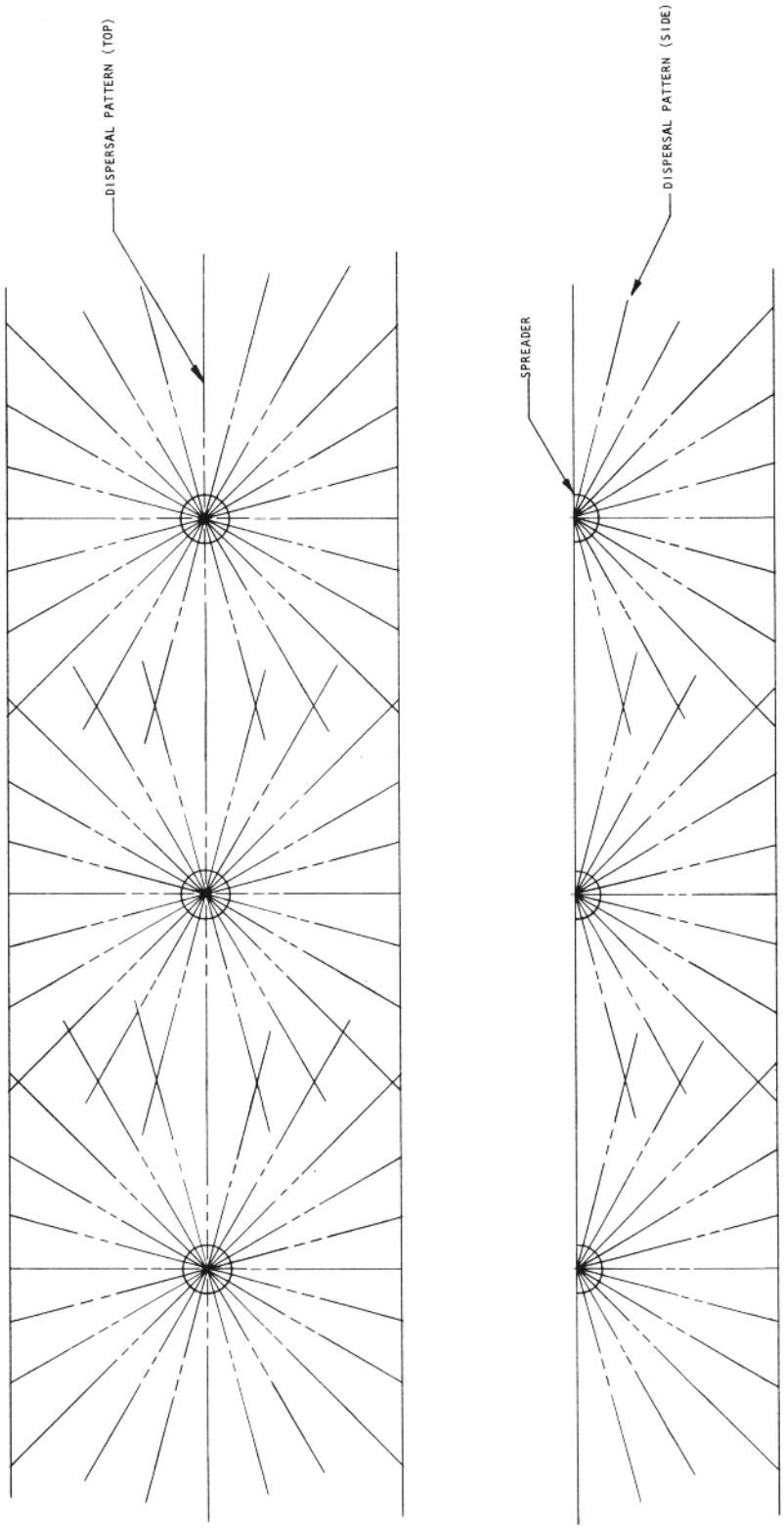

+.005
-.000
.250 DIA. (2) HOLES
PROTECTOR COVER
.250
.250
.484
±.031
2.453
1.484
FENWAL INCORPORATED
ASHLAND, MASS.
TEMP.
SETTING
& TOL.
2 AMPS. 28 V.D.C.
2.375
.546
±.031
3.453
±.031
1.687
.796
#8-32 NC-2
TERMINAL STUDS
DETECT-A-FIRE
FLAT WASHER AN 906C8L
LOCKWASHER AN 935-8
HEX. NUT AN 340C8
INSULATOR

SK5537-3

DETECTOR

The Fenwal Unit Fire Detector, SK5537-3, is a rate compensated thermal detector. The detector shell is temperature sensitive. It is always in contact with the surrounding air. Temperature changes cause the shell to expand or contract. This dimensional change is transmitted to the contacts within the hermetically sealed unit causing the contacts to close the instant the surrounding air reaches the 160°F set point of the detector.

These units are currently used in many aircraft fire and overheat detection systems.



SK5537-4

AGENT

Fenwal Drawing SK5537-4 depicts the agent dispersal pattern engineered for this application.

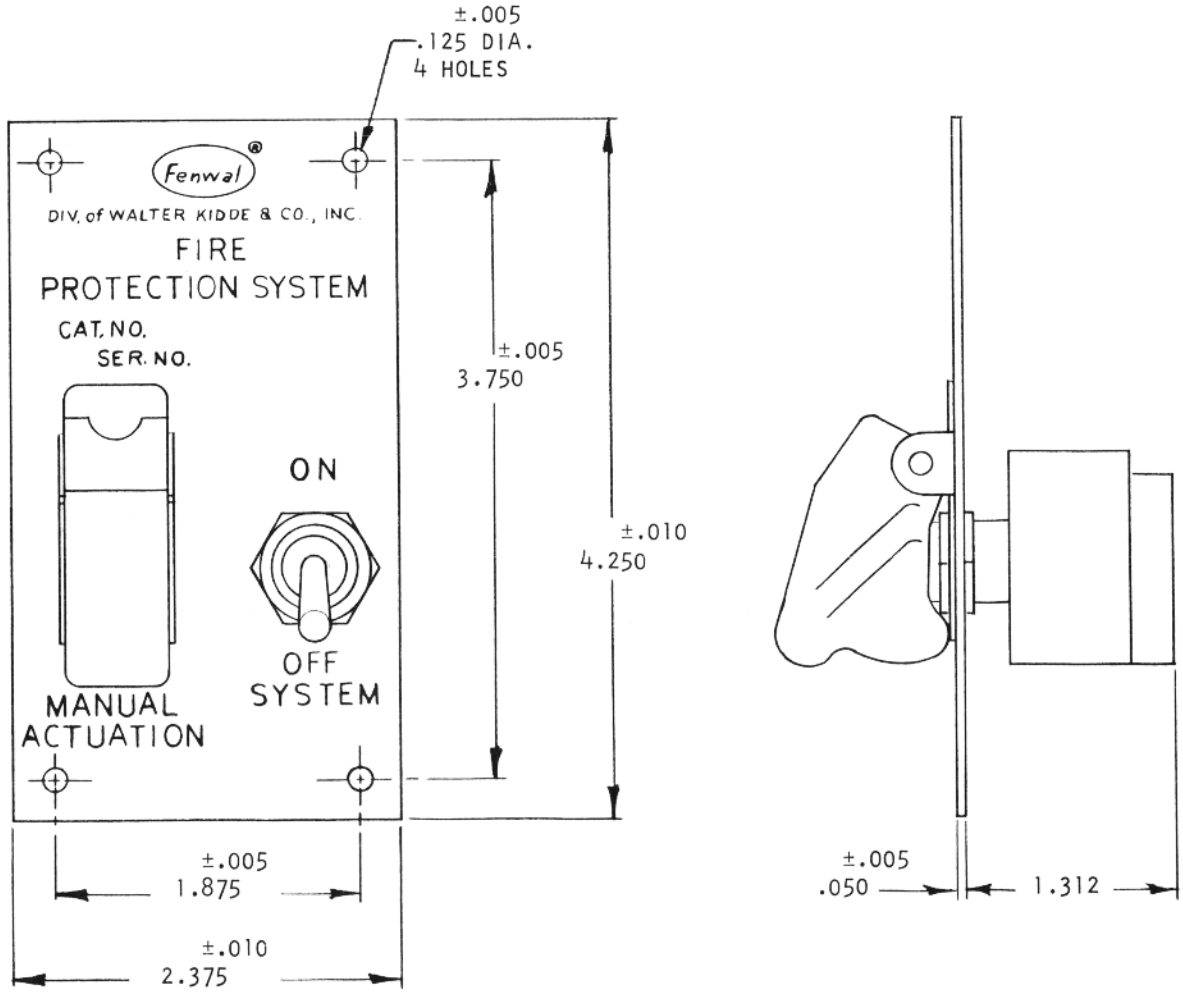
The cabin protection system is designed to protect aircraft cargo and personnel as well as preventing damage to the aircraft. Halon 1301 meets these criteria. This agent is now used by many industrial applications for protection of computer rooms and other similar inhabited facilities. The National Aeronautics and Space Administration is using Fenwal designed equipment with Halon 1301 around the Saturn V Service Structure during maintenance and fueling operations.

Based upon TWA's information to Fenwal we have determined the free volume to be protected as approximately 8000 cubic feet. Based upon a cargo loading density of 7-8 pounds per cubic foot and a cabin altitude of sea level to 7000 feet the five modules proposed will provide sufficient agent concentration for efficient fire extinguishment and yet maintain an atmosphere which will not be harmful to the aircraft crew.

COCKPIT CONTROL PANEL

Alternate cockpit control panels are proposed. Control Panel SK5537-9 is for use with the system wired in accordance with Schematic SK5537-8 and accomodates system test mode of operation.

Control Panel SK5537-5 is for use with the system wired in accordance with Schematic SK5537-7.


±.005
.125 DIA.
4 HOLES
Fenwal
DIV. of WALTER KIDDE & CO., INC.
FIRE
PROTECTION SYSTEM
CAT. NO.
SER. NO.
ON
OFF
SYSTEM
MANUAL
ACTUATION
±.005
3.750
±.010
4.250
±.005
1.875
±.010
2.375
±.005
.050
1.312

SK5537-6

AUXILIARY CONTROL PANEL

The Auxiliary Control Panel SK5537-6 is for use with either wiring configuration.

BILL OF MATERIALS

COMPONENT	PART NO.	WEIGHT	NO/ACFT	TOTAL
Suppressor Module	SK5537-2	36	5	180.00
Detector	SK5537-3	0.15	5	0.75
Cockpit Control Panel	SK5537-9			
or	SK5537-5	1.75	1	1.75
Auxiliary Control Panel	SK5537-6	1.0	1	1.00
		TOTAL SYSTEM WEIGHT		183.00 lbs

SPECIFICATIONS:

SK5552 - Cargo-Main Cabin Fire Protection System

DRAWINGS:

SK5537-7 System Schematic Cargo Main Cabin Fire Protection System

SK5537-8 System Schematic Cargo Main Cabin Fire Protection System

SK5537-2 Fire Extinguishing System

SK5537-3 Thermoswitch Detector - Cargo Compartment 160°F (21°C) Setting

SK5537-4 Spreader Dispersal Pattern (Typical)

SK5537-5 Cockpit Control Panel Cargo Main Cabin Fire Protection System

SK5537-9 Cockpit Control Panel Cargo Main Cabin Fire Protection System

SK5537-6 Auxiliary Panel Cargo Main Cabin Fire Protection System

Fenwal®

ENGINEERING SPECIFICATIONS

NUMBER SK 5552

NAME CARGO-MAIN CABIN FIRE PROTECTION SYSTEM

ORIGINATED BY

DATE November 27, 1968

CHECKED BY

SHEET NO. 1 OF 11 SHEETS

APPROVED BY

1. SCOPE

1.1 SCOPE - This specification covers the design, fabrication, performance and testing requirements for a cargo main cabin fire protection system used to prevent the development of a fire within the section of fuselage normally defined as the pressurized area.

2. APPLICABLE DOCUMENTS

2.1 GOVERNMENT - The following documents form a part of this drawing to the extent specified herein.

2.1.1 Military Specifications

MIL-B-5087B - Bonding, Electrical and Lightning Protection, for Aerospace Systems.

MIL-E-5272C - Environmental Testing, Aeronautical and Associated Equipment, General Specification for

MIL-S-6872A - Soldering Process, General Specification for

CHANGE	REVISIONS	DATE	CK.	AP.

FORM NO. E-1004-A

MIL-W-16878D - Wire, Electrical, Insulated, High Temperature

MIL-C-26500B - Connectors, General Purpose, Electrical, Miniature, Circular, Environment Resisting, 200°C Ambient Temperature.

MIL-B-12218B-- Bromotriflurormethane, Liquified

2.1.2 Military Standards

MIL-STD-143A - Specifications and Standards, Order of Precedence for the Section of,

MIL-STD-8C - Dimensioning and Tolerancing

3. REQUIREMENT

3.1 GENERAL - In the event of a conflict between the requirements of this document and any other referenced herein, the requirements of this document shall govern.

3.1.1 Reliability Objective

3.1.1.2 Design - A design objective of a mean time between failures (including failure to test) for each system shall be 50,000 hours.

3.2 DESIGN

3.2.1 General - The system shall comply with the following requirements.

3.2.2 Components - The system shall consist of the following components

3.2.2.1 A suppressor unit capable of distributing

a combustion inhibiting material upon sensing a fire condition. Remote actuation means shall be available using electrical power.

3.2.2.2 A system actuation and test unit located in the crew compartment.

3.2.2.3 A system actuation unit located in the main cabin forward section.

3.2.2.4 Thermal sensors to provide automatic system actuation when electrical power is available.

3.2.3 Materials

3.2.3.1 Nonmagnetic - The suppressor unit shall be constructed of nonmagnetic materials.

3.2.3.2 Suppressant - The suppressant shall be bromotrifluoromethane (Trade name Freon 1301) or equivalent.

3.2.4 Construction

3.2.4.1 Threaded Parts and Fittings - Threaded parts and fittings shall be positively locked or safetied by safety wiring or any other approved method.

3.2.4.2 Sealed Units - The individual components shall be capable of meeting the applicable immersion, leakage, and explosion proof requirements specified herein.

3.2.5 Weight - The weight shall be a minimum consistent with performance requirements and within the limitations of sound design practices.

3.2.6 Electrical - The electrical design of the system shall comply with MIL-D-9402B and the following.

3.2.6.1 Power Supply - The system shall operate satisfactorily from a supply voltage of 17 to 35 VDC conforming to MIL-STD-704, except that on Figure No. 6 of MIL-STD-704, transients of +80 to -40 volts for 5 milliseconds may appear. The minimum firing current shall be 2.0 ampere and the maximum no-fire current shall be 1.0 ampere.

3.2.6.2 Wiring - The external wires shall be high temperature, twisted, shielded, jacketed cables with the shields grounded at one point.

3.2.6.2.1 Connectors - Electrical connectors shall conform to MIL-C-26500B.

3.2.6.2.2 Continuity Test - A test feature shall be provided which checks continuity of the electrical circuit.

Visual indication of satisfactory condition shall be provided.

3.2.6.3 Bonding - Electrical bonding shall conform to MIL-B05087B.

3.2.6.4 Insulation Resistance. The insulation resistance measured at 500 ± 50 VDC between mutually insulated circuits and between these circuits and the case shall not be less than 20 megohms.

3.2.6.5 Dielectric Withstanding Voltage - A voltage of 1500 volts rms applied between mutually insulated circuits or between the circuits and case shall not cause arcing as evidenced by flashover, sparkover, insulation breakdown, or leakage current exceeding 0.5 milliampere.

3.2.6.6 Fail-Safe - System circuitry shall be fail safe in accordance with the following:

a. A fault in the circuitry shall not produce a source of ignition or explosion under normal operating conditions.

b. Opening or shorting to ground of any lead or group of leads shall not cause the system to operate.

3.2.7 Maintainability - The system shall not require maintenance or servicing except for periodic checks of system operability using the continuity test.

3.2.8 Shelf Life - All components except detonators shall have a shelf life of at least 36 months. Detonators shall have a shelf life of 24 months.

3.2.9 Workmanship - Workmanship and finish shall be in accordance with high grade manufacturing practice as used for this class of aircraft equipment. All parts shall be clean and free from dirt, sand, metal chips or other foreign matter, during and after assembly.

3.3 PERFORMANCE

3.3.1 Effectiveness - The system shall prevent the development of a fire within the section of fuselage normally defined as the pressurized area for a period of time from ignition of the contents.

3.3.2 Operating Time - System operating time from initial detection to complete distribution of the suppressing agent shall not exceed four seconds.

3.3.2.1 Automatic Operation - The system shall operate when the ceiling temperature has exceeded $160^{\circ}F$.

3.3.2.2 Manual Operation - The system shall operate when the system actuation unit in the crew or cabin compartment has been activated.

3.3.3 Duration of Protection - The in flight protection provided by the system actuation shall be effective under static airflow conditions for a period of time sufficient to allow the aircraft to land.

3.3.4 Hazards - The system shall not in any way create any of the following hazards:

a. Toxic effects on occupants to interfere with normal breathing or sight.

b. Ignition potential in the fuselage area.

c. Obstruction of vision to hinder evacuation of the aircraft.

3.3.5 Environmental Conditions - The system shall operate satisfactorily during and after exposure to the following environments as set forth in MIL-E-5272C.

a. Temperature

1. High Temperature

2. Low Temperature

3. Temperature Shock

b. Humidity

c. Altitude (Sea Level to 50,000 feet)

d. Salt Spray

e. Fungus

f. Shock (50G peak for 8.5 ms)

g. Acceleration (14g vertical, 6g lateral)

h. Vibration

3.3.6 Service Life - As specified in MIL-F-25648.

3.4 SUPPRESSOR

3.4.1 Function - The suppressor shall provide the following functions:

a. Automatic discharge of stored contents upon exposure to 160°F with electrical power.

b. Discharge of stored contents upon receipt of electrical signal specified in 3.2.6.1.

3.4.2 Discharge Time - The time for complete discharge of agent measured from receipt of electrical signal or the temperature sensor reaching 160°F, shall be less than four seconds.

3.4.3 Capacity - The suppressor shall have a minimum capacity of 30 pounds of bromotrifluoromethane at 70°F.

3.4.4 Strength - The suppressor shall comply with applicable ICC Regulations for design and marking.

3.4.5 Discharge Indicator - A device shall be incorporated on the unit to provide a visual indication of discharge from inside the compartment.

4. QUALITY ASSURANCE PROVISION

4.1 PREPRODUCTION TESTS

4.1.1 Test Conditions - Unless otherwise specified, test conditions for the tests herein shall be in accordance with MIL-E-5272C, paragraphs 3.1 through 3.8.

4.1.2 Test Sequence - The preproduction test sequence shall be as follows:

a. System Testing - The complete system shall be subjected to the following tests in the order specified.

Test

1. System Performance
2. Ignition Potential
3. Leakage
4. Burst Pressure
5. Sensitivity

4.1.3 System Tests

4.1.3.1 System Performance Tests - These tests shall demonstrate that the system is capable of preventing the development of a fire within the section of fuselage normally defined as the pressurized area.

4.1.3.1.1 Test Fixture - The system shall be installed in a section of fuselage furnished with the required instrumentation, combustible and test equipment.

4.1.3.1.2 Test Conditions - System performance tests shall be conducted under the following conditions. Five test runs shall be conducted using three 5 square feet open pan JP-4 fuel

fires in each test. All emergency exits shall be open during the test run.

4.1.3.1.3 Test Measurements and Results- For each of the test runs, the following measurements and observations shall be made and recorded.

a. The effectiveness of extinguishing the flames.

b. The time from detection to extinguishment shall be measured and shall not exceed four seconds.

c. The atmosphere inside the test fixture shall be continuously monitored to determine the maximum concentration of toxic gases achieved during the test. The concentration shall remain at non hazardous levels.

4.1.3.3 Environmental Tests - The following environmental tests shall be conducted in accordance with MIL-E-5272C.

a. High Temperature Test, Procedure II

b. Low Temperature Test, Procedure II

c. Temperature Shock Test, Procedure I

d. Humidity Test, Procedure I

e. Altitude Test, Procedure VI

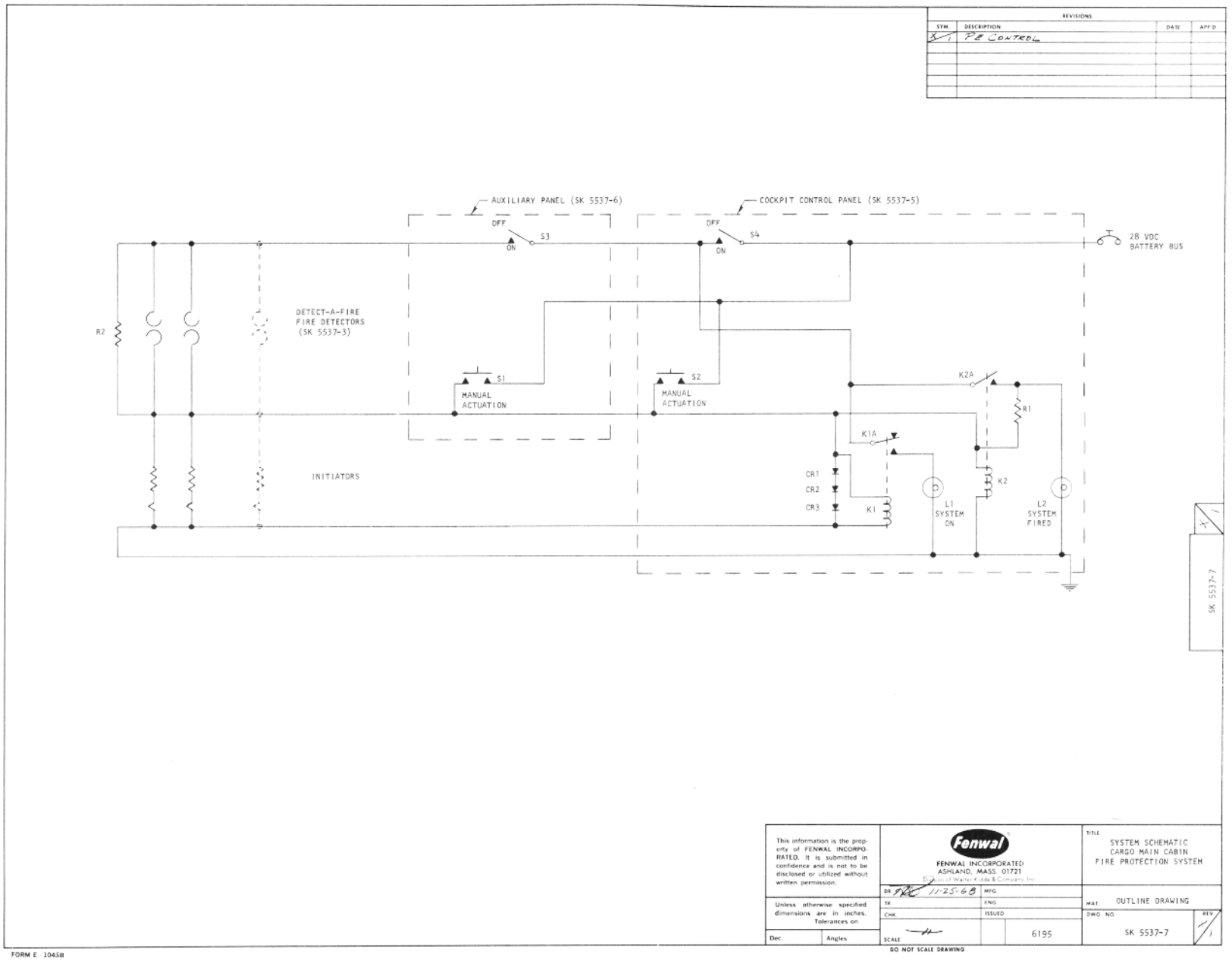
f. Salt Spray Test, Procedure I

g. Fungus Resistance Test, Procedure I

h. Shock Test, Procedure IV

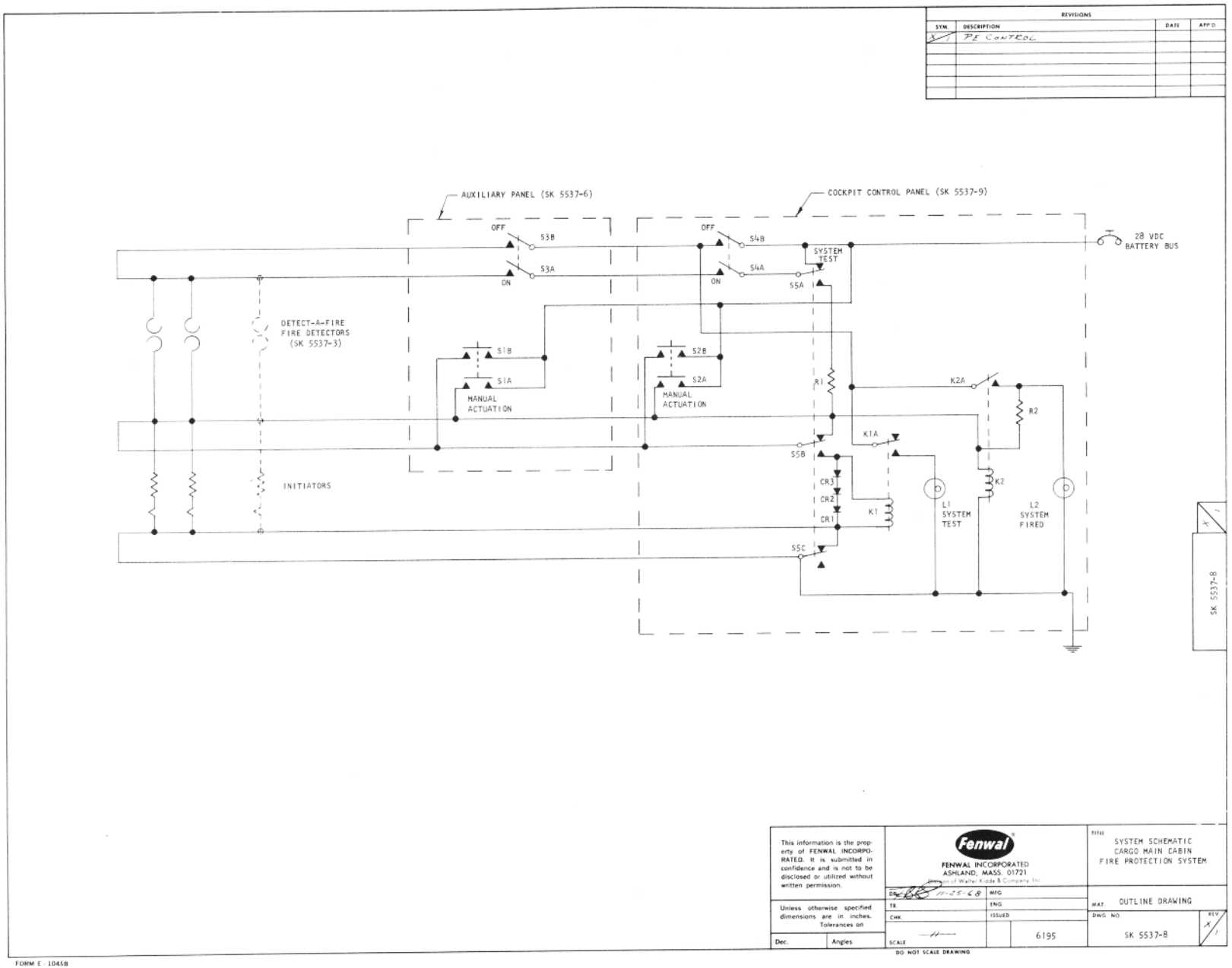
i. Acceleration Test, Procedure III

j. Vibration Test, Procedure XII



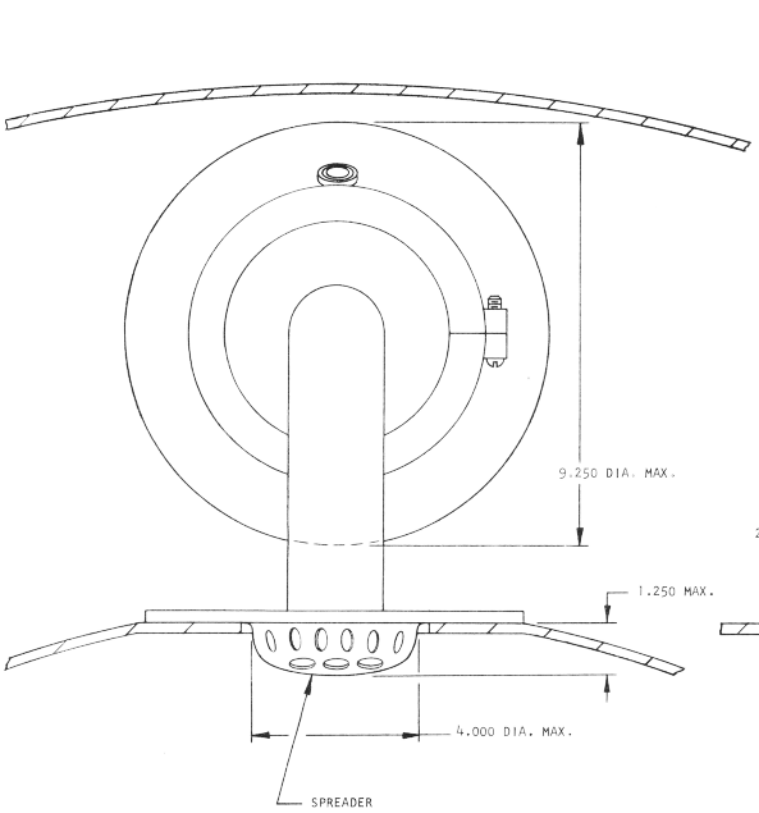
FORM E - 1045B

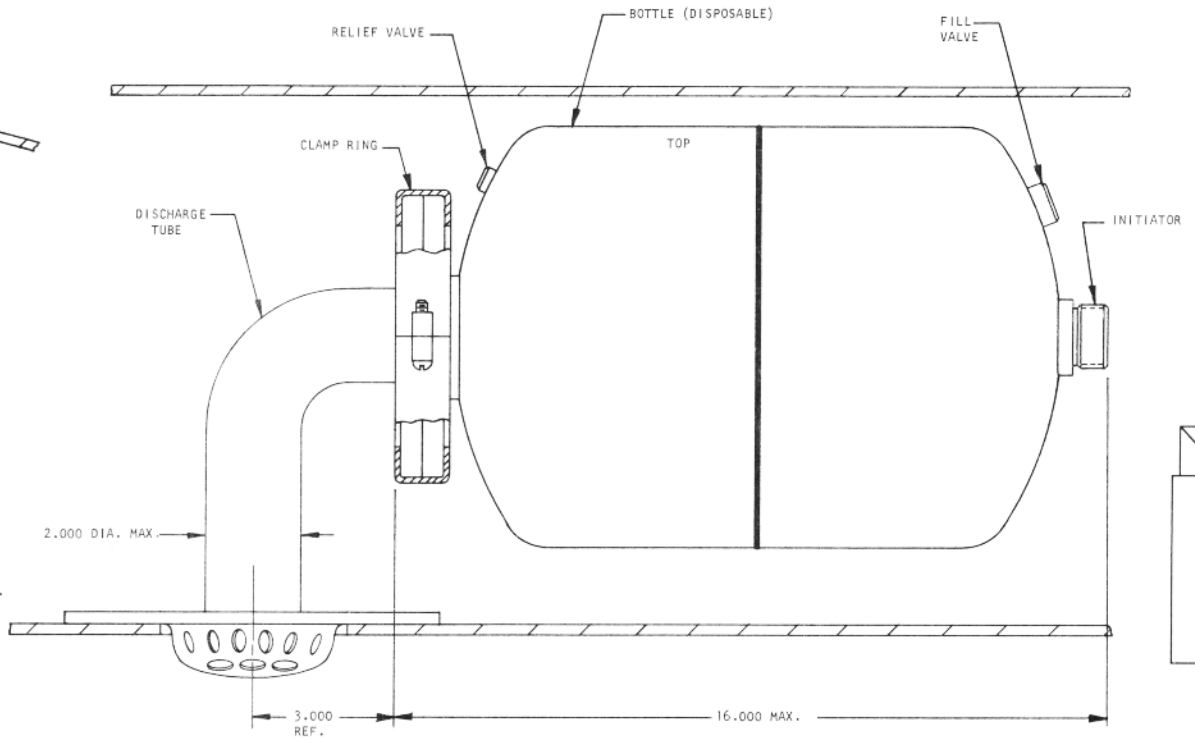
SK5537-7 Schematic Cargo Main Cabin Fire Protection



SK5537-8 System Schematic Cargo Main Fire Protection System

REVISIONS			
SYM.	DESCRIPTION	DATE	APP'D.





SK 5537-2

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Dec. | Angles

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ASHLAND, MASS. 01721
Division of Walter Kidde & Company, Inc.

DR. A.L.A. 10-22-68	MFG.
TR.	ENG.
CHK.	ISSUED
SCALE ~	6195

DO NOT SCALE DRAWING

TITLE: FIRE EXTINGUISHING SYSTEM

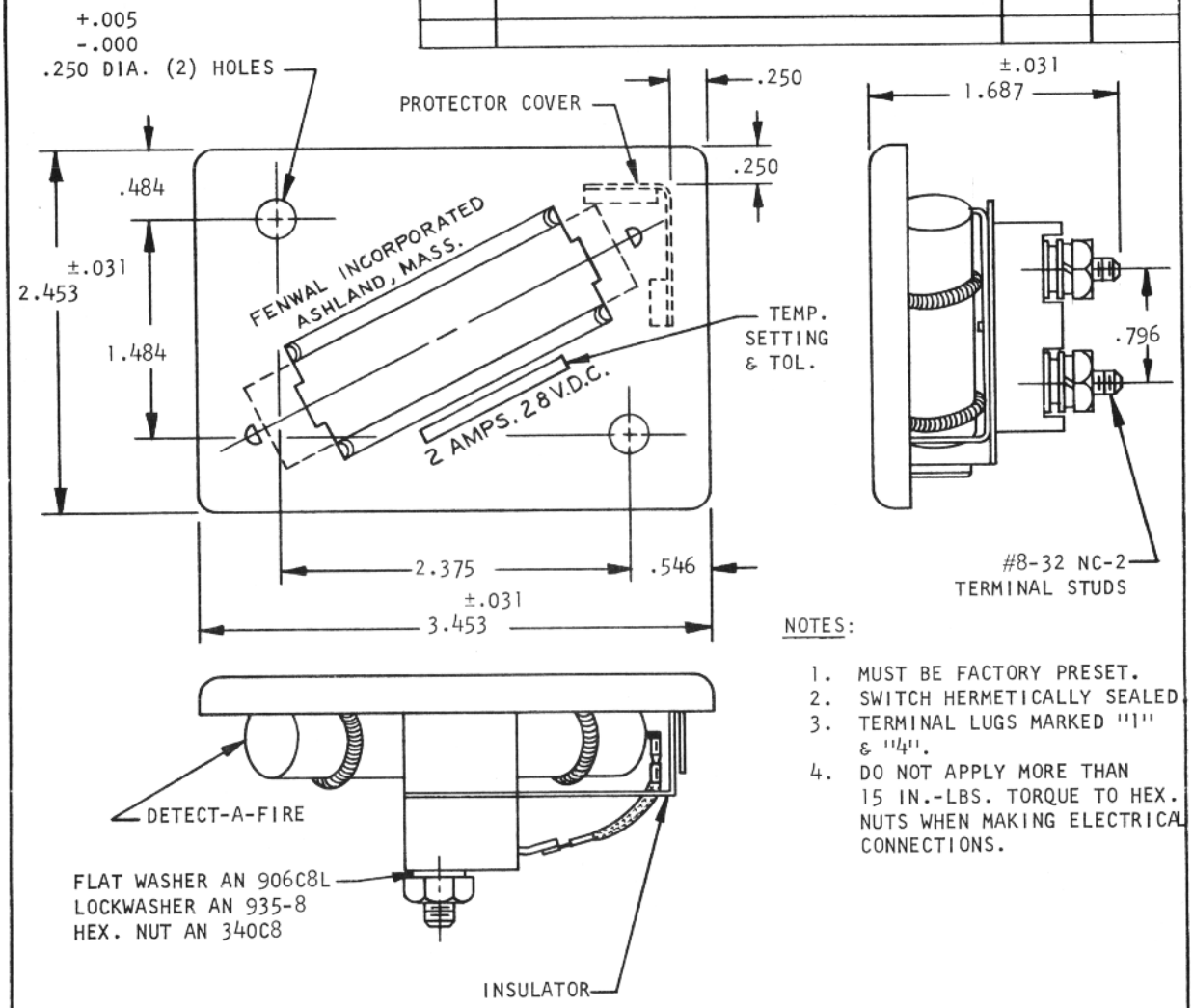
AIRCRAFT

DWG. NO. SK 5537-2 REV.

SK5537-2 Fire Extinguishing System

SK 5537-3 | 1/X

REVISIONS			
SYM.	DESCRIPTION	DATE	APP'D.
X/1	PE CONTROL		



NOTES:

1. MUST BE FACTORY PRESET.
2. SWITCH HERMETICALLY SEALED
3. TERMINAL LUGS MARKED "1" & "4".
4. DO NOT APPLY MORE THAN 15 IN.-LBS. TORQUE TO HEX. NUTS WHEN MAKING ELECTRICAL CONNECTIONS.

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Division of Walter Kidde & Company, Inc.

DR. G.L.G. 10-22-68	MFG.	
TR.	ENG.	
CHK.	ISSUED	
SCALE 1 : 1		6195

TITLE
THERMOSWITCH
DETECTOR - CARGO
COMPARTMENT
160°F (71°C) SETTING

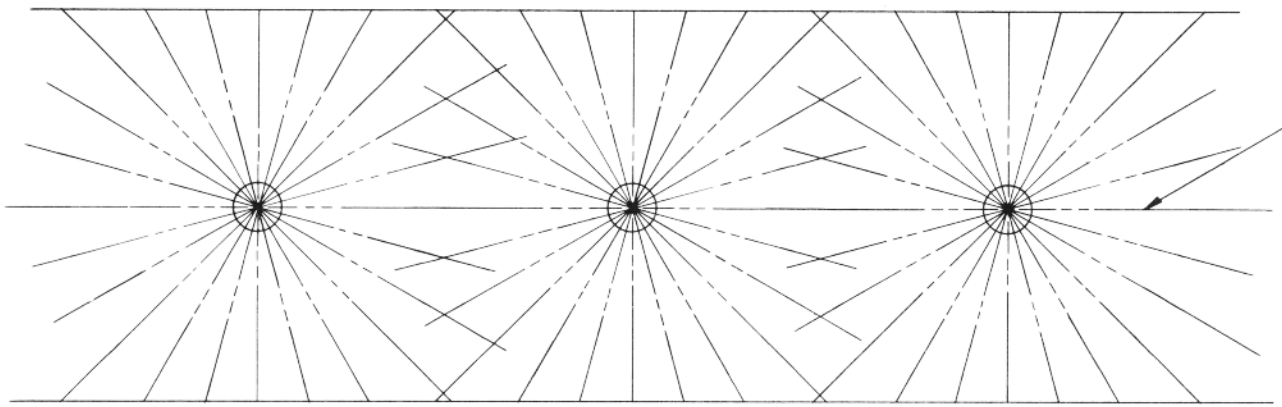
OUTLINE DRAWING

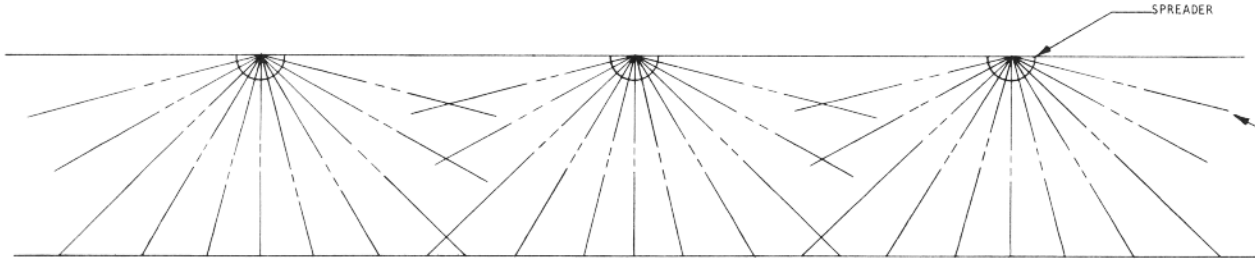
DWG. NO. SK 5537-3 | REV. X/1

FORM E - 1043B

SK5537-3 Thermoswitch Detector-Cargo Compartment 160°F (21°C) Setting

REVISIONS			
SYM.	DESCRIPTION	DATE	APP'D





SK 5537-4

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Division of Walter Kidde & Company, Inc.

DR. Q.L.Q. 10-24-68	MFG.
TR.	ENG.
CHK.	ISSUED
SCALE ~	6195

DO NOT SCALE DRAWING

TITLE: SPREADER DISPERSAL PATTERN (TYPICAL)

MAT.

DWG. NO. SK 5537-4 REV.

SK5537-4 Spreader Dispersal Pattern (Typical)

SK 5537-5 | 1/X

REVISIONS			
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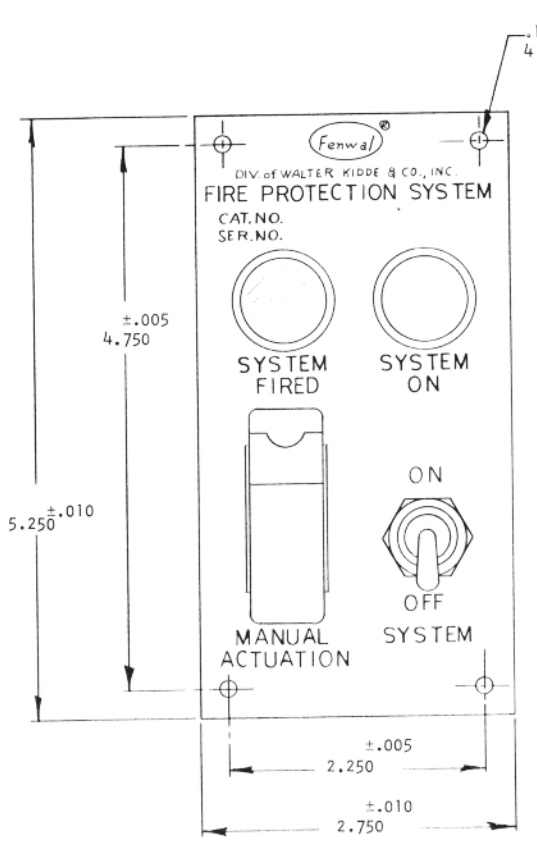
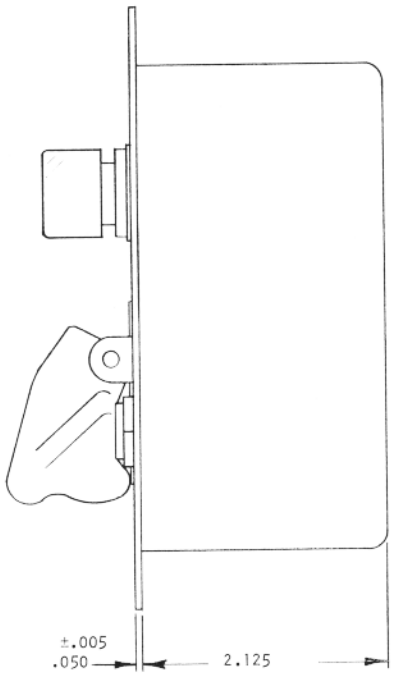
X/1	PE CONTROL		





NOTE:

1. WEIGHT: .25 LBS.

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Dec. ±.031 | Angles

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Division of Walter Kidde & Company, Inc.

DR.	11 26 68	MFG.	
TR.		ENG.	
CHK.		ISSUED	
SCALE	1 : 1		6195

TITLE
COCKPIT CONTROL PANEL
CARGO MAIN CABIN
FIRE PROTECTION SYSTEM

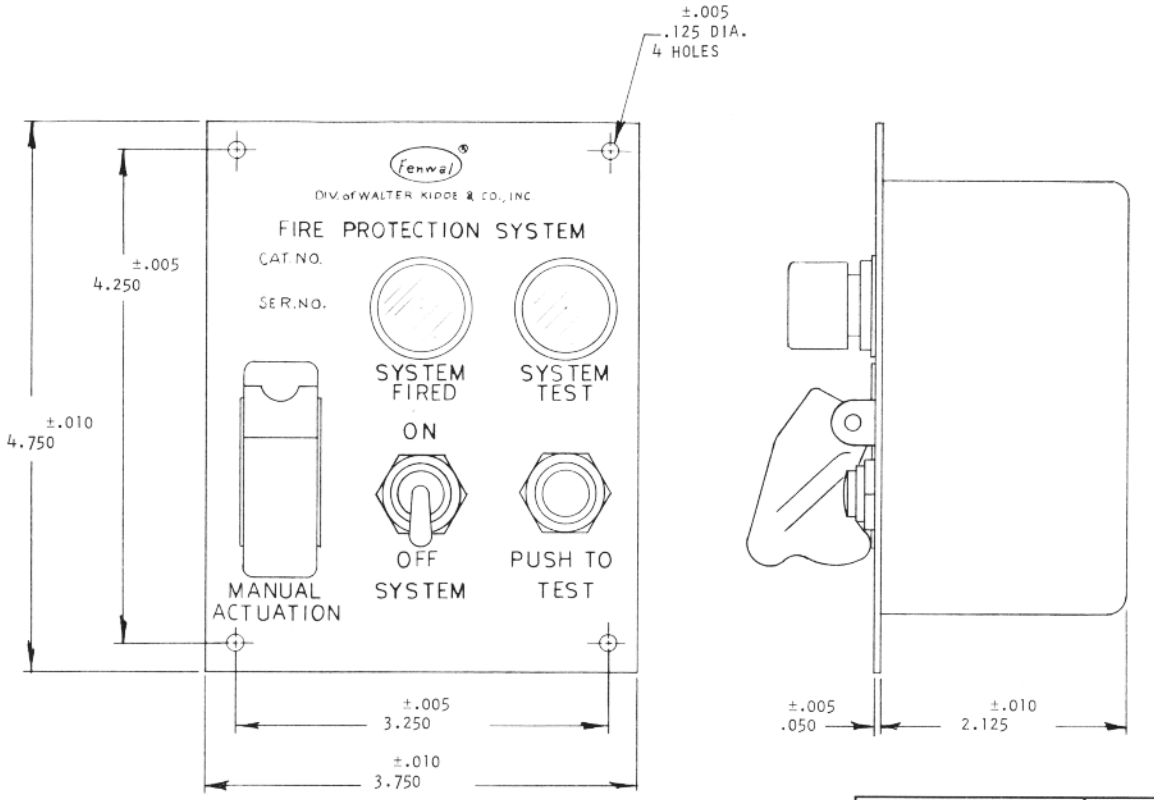
MAT. OUTLINE DRAWING

DWG. NO. SK 5537-5

REV. X/1

FORM E-1044 B 2-68

SK5537-5 Cockpit Control Panel Cargo Main Cabin Fire Protection System



NOTE:

1. WEIGHT: .30 LBS.

REVISIONS			
SYM.	DESCRIPTION	DATE	APP'D.
X/1	PE CONTROL		

SK 5537-9 | 1 | X

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Unless otherwise specified dimensions are in inches. Tolerances on Dec. ±.031 Angles

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Division of Walter Kidde & Company, Inc.

DR. 11-26-68 | MFG.
TR. | ENG.
CHK. | ISSUED
SCALE 1 : 1 | 6195

TITLE
COCKPIT CONTROL PANEL
CARGO MAIN CABIN
FIRE PROTECTION SYSTEM

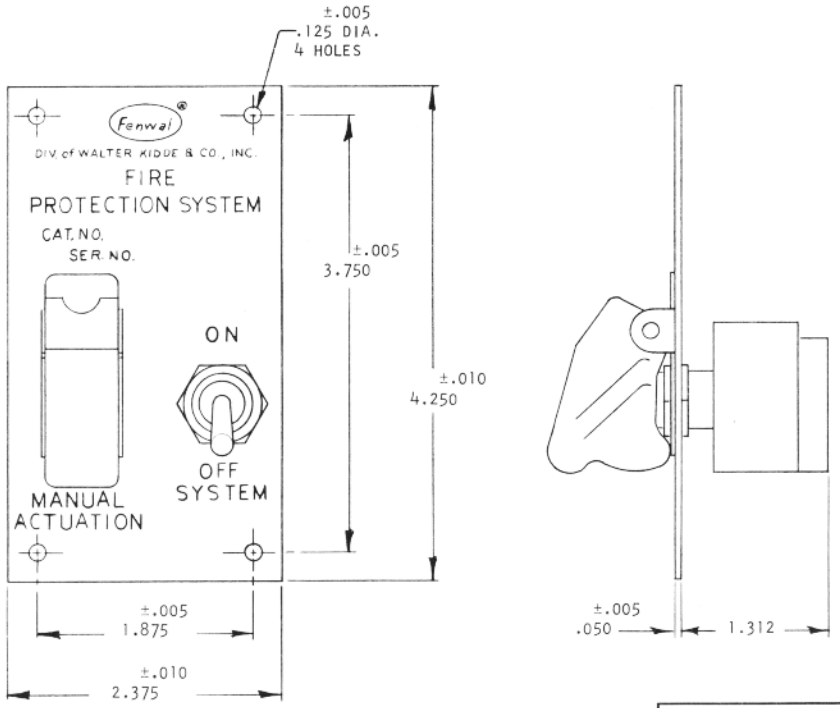
MAT. OUTLINE DRAWING
DWG. NO. SK 5537-9
REV. X/1

FORM E-1044 B 2-68

SK5537-9 Cockpit Control Panel Cargo Main Cabin Fire Protection System

SK 5537-6 | 1/X

REVISIONS			
SYM.	DESCRIPTION	DATE	APP'D.
X/1	PE CONTROL		



NOTE:

1. WEIGHT: .20 LBS.

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DR. RBB 11-26-68	MFG.		
TR.	ENG.		
CHK.	ISSUED		
SCALE 1 : 1		6195	

TITLE
AUXILIARY PANEL
CARGO MAIN CABIN
FIRE PROTECTION SYSTEM

MAT. OUTLINE DRAWING

DWG. NO. SK 5537-6 | REV. X/1

FORM E-1044 B 2-68

SK5537-6 Auxiliary Panel Cargo Main Cabin Fire Protection System