

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc.
 485 LEXINGTON AVENUE
 NEW YORK 17, N.Y.

**AEROSPACE
 INFORMATION REPORT**

AIR 860

AIRCRAFT ELECTRICAL HEATING SYSTEMS

Issued 1-10-65
 Revised

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1. INTRODUCTION	5
2. PURPOSE	5
3. SCOPE	5
4. GENERAL INFORMATION	5
4.1 General Design Considerations	5
4.1.1 Electrical Power Availability	5
4.1.2 Ground Power Sources	5
4.1.3 Reliability and Flexibility	5
4.1.4 Weight	5
4.1.5 Location	6
4.1.6 Control of Heating Elements	6
4.1.7 Heating System Integration	6
4.1.8 Heat Transmission	6

APPENDIX I - AIRCRAFT "A"

<u>Section</u>	
1. GENERAL AIRCRAFT INFORMATION	7
2. SPECIFIC DESIGN AND OPERATION INFORMATION	9
Passenger Compartment - Electrical Radiant Panels	9
- Floor Panels	9
- Wall and Window Heating Panels	11
Specific Design and Operation Information	13
- Cargo Compartment - Electric Radiant Panels	13
- Flight Station - Electric Duct Heater	14
- Cabin - Electrical Duct Heater	15

Section 8.3 of the SAE Technical Board rules provides that: "All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

SAEFORM.COM: Click to view the full PDF of air860

APPENDIX II - AIRCRAFT "A"

(Material Specification--Subject: Cable, Resistance Heating, Aluminum Jacket)

<u>Section</u>	<u>Page</u>
1. SCOPE	38
2. CLASSIFICATION	38
3. APPLICABLE DOCUMENTS	38
4. REQUIREMENTS	38
5. QUALITY ASSURANCE PROVISIONS	40
6. PREPARATION FOR DELIVERY	40

SAENORM.COM : Click to view the full PDF of air860

FIGURES

APPENDIX I - AIRCRAFT "A"

Section 2

<u>Figure</u>	<u>Title</u>	<u>Page</u>
1	Cabin Wall and Floor Radiant Panels	18
2	Radiant Heating Panels	19
2A	Cabin Wall and Floor Radiant Panels - Sect. View	20
2B	Wall Panel - Upper	21
3	Cabin Floor Radiant Panel Assembly	22
3A	Radiant Heat Panels Control	22
4	Section - Terminal Block - Floor Panel Installation	24
5	Section - Cabin Floor Radiant Panel Installation	25
6	Spacer - Screw - Radiant Panel	26
7	Terminal Block Details	27
8	Cargo Compartment Floor and Radiant Panel Installation	28
9	Cargo Compartment Radiant Panel - Typical	29
9A	Cargo Compartment Heating Circuit	30
10	Schematic Diagram - Air Conditioning	31
11	Flight Station Duct Heater and Recirculation Fan Circuits	32
12	Flight Station Duct Heater Details	33
13	Flight Station Duct Heater Functional Test Setup	34
14	Cabin Duct Heater Details	35
15	Cabin Duct Heater Electrical Circuit	36
16	Cabin Duct Heater Functional Test Setup	37

TABLES

APPENDIX I - AIRCRAFT "A"

Section 2

<u>Table</u>	<u>Title</u>	<u>Page</u>
I	Flight Station Duct Heater Functional Test.....	16
II	Cabin Duct Heater Functional Test.....	17

APPENDIX II - AIRCRAFT "A"

<u>Table</u>	<u>Title</u>	<u>Page</u>
I	Cable, Resistance Heating, Aluminum Jacket	38

SAENORM.COM : Click to view the full PDF of air860

1. INTRODUCTION - The modern air transport utilizing main propulsion engines of the turbo-prop or turbo-jet types generally provides speed characteristics suitable for the generation of large quantities of electrical power. Proper speed characteristics may be inherent in the main engine design or may be provided through constant speed devices. The electrical load of modern aircraft is generally large, requiring sufficient generating capacity to meet all normal and emergency electrical demands. The use of electrical heating may be attractive since the generating capacity designed into the system to meet the cooling cycle and other non-continuous electrical loads becomes available for heating when cooling is not required.
2. PURPOSE - This report is intended to furnish the aerospace industry with brief design information and data on cabin and cargo space electrical heating. The design information and data contained herein are applicable to modern aircraft utilizing main propulsion systems such as turbo-jet, turbo-fan, and turbo-prop.
3. SCOPE
 - 3.1 It is intended that the scope of this information report be limited to electrical heating of passenger, crew, and cargo compartments only.
 - 3.2 No attempt has been made to develop the complete electrical circuitry associated with the electrical heating components; however, the electrical circuitry required for heating component operation, safety, and monitoring will be included as available.
 - 3.3 Specific design information is given for various modern aircraft utilizing electrical heating. Each aircraft discussed will be identified by alphabetical letter designation and included in the appropriate appendix.
4. GENERAL INFORMATION
 - 4.1 General Design Considerations
 - 4.1.1 Electrical Power Availability - Electrical heating may be used to compliment other heating sources or used as a sole heating source, depending upon flight and ground operating mode, degree of system integration, control, and economic considerations of heat and power generation devices.
 - 4.1.2 Ground Power Sources - Ground power sources capable of supplying sufficient electrical power are available, thus permitting electrical heating of the aircraft on the ground without requiring main engine operation.
 - 4.1.3 Reliability and Flexibility - A high degree of reliability and flexibility may be attained in the use of electrical heating.
 - 4.1.4 Weight - The weight penalty incurred by using electrical heating may be small compared to other heat generating sources provided generator capacity is available as a requirement of meeting other electrical loads.

- 4.1.5 Location - The use of electrical heating may be more suitable when compared to other methods when the area or location of the area to be heated presents unusual heating design problems.
- 4.1.6 Control of Heating Elements - Control of electrical heating elements is simple.
- 4.1.7 Heating System Integration - Integration of electrical heating system with other heat sources can be accomplished. Proper integration and control can provide maximum passenger and crew comfort by the elimination of cold surfaces adjacent to passengers and the elimination of circulating air at uncomfortable air temperature gradients.
- 4.1.8 Heat Transmission - Heat may be transferred between various heat sources and heat sinks by one of the following, or a combination of the following, processes: convection, radiation, and conduction. In an aircraft cabin, heat transfer may take place in the following ways:
- a. Convection between the boundary layer and cabin outer skin.
 - b. Convection between the cabin interior surface and cabin air.
 - c. Convection between cabin air and passengers or equipment
 - d. Convection and radiation from internal heat sources, such as electrical and electronic equipment, internal surfaces, and passengers.
 - e. Conduction through structural members and cabin walls.

PREPARED BY SAE COMMITTEE AC-9,
AIRCRAFT ENVIRONMENTAL SYSTEMS

APPENDIX I

AIRCRAFT "A"

Section 1

GENERAL AIRCRAFT INFORMATION

TYPE	ENGINES		ALTITUDE	CABIN DIFF. PR.	FUSELAGE			
	Type	No.			Mat.	Max. Breadth Outside	Inside	Press. Vol.
Transport	Turbo- prop	4	S. L. to 30,000 ft	6.5 psig	Al.	136 in.	128 in.	8500 cu. ft.

FUSELAGE (continued)

Pr. Vol. Cargo Compt.		Pass. & Crew Compt.	Insulation			
Fwd.	Rear	Pr. Volume	Mat.	Density	Walls	Floor
254 cu. ft.	263 cu. ft.	8000 cu. ft. (app.)	Fiber- glass	0.60 lb/cu.ft	1-1/2 in. to 3 in.	3-1/2 in.

FUSELAGE (Continued)		CABIN PRESS. AIR SOURCES	CABIN COOLING	
Insulation	Air Supply Ducts	Engine Driven Compressor (EDC) 2 Used	Air Cycle	Vapor Cycle
Cargo Fl. 1-1/2 in.	Insulation 1-1/2 in. Fiber- glass - Mylar			2 Used

CABIN HEATING METHODS					CREW COMPARTMENT HEATING METHODS		
EDC Heat of Comp.	Elec. Rad. Floor Panels	Elec. Resist. Duct Heaters	Elec. Radiant Wall Panels	Elec. Radiant Window Panels	EDC Heat of Comp.	Elec. Resist. Duct Heaters	

APPENDIX I

CARGO COMPARTMENT HEATING METHODS	TEMPERATURE REQMTS. A/C SYSTEM					
	HEATING					
	In Flight			Ground Operation		
Elec. Resist. Panels, Floor	Amb.	Occ. Area	Cargo	Amb.	Cab & Flt.	Cargo
	-60°F.	75°F.	35°F. or more	-5°F.	75°F.	35°F. or more

STEADY STATE HEATING PERFORMANCE

Auto. Temp. Cont. Tolerance	Flight Cond.	Comp't.	Amb. Temp.	Comp't. Temp.	Req'd Elec. Cap.	Total Available Elec. Cap.
Less than $\pm 2^\circ\text{F}$. at any one point	Ground (Full Rec. Air.)	Flt. Sta.	-5°F.	75°F.	3.9 KW	10 KW (Duct Heater)
		Cabin	-5°F.	75°F.	5.9 KW	11.3 KW (Radiant Panels)
	Ground 15 lb Fresh Air	Flt. Sta.	-5°F.	75°F.	9.0 KW	10 KW (Duct Heater)
		Cabin	-5°F.	75°F.	23.0 KW	30 KW (Radiant Pan- els plus duct heater)
	30,000 ft Cruise with 8000 Ft. Cabin	Flt. Sta. Cabin	-60°F.	75°F.	5.6 KW	10.0 KW (Duct Heater)
			-60°F.	75°F.	7.6 KW	9.7 KW (Radiant Panels)

APPENDIX I

Section 2

SPECIFIC DESIGN AND OPERATION INFORMATION

PASSENGER COMPARTMENT - ELECTRIC RADIANT PANELS

FLOOR PANELS

LOCATION	TYPES USED			DETAILS - HONEYCOMB HEATED	
				CONSTRUCTION	
See Fig. 1 and Fig. 2	Plywood (Not heated) 3/8 in. thick	Honey- comb (Not heated) 3/8 in. thick	Honey- comb Heated 3/8 in. (approx.) thick 25 panels (Fig. 1)	Material and Size	
				Core	Plates
				Al. Al. 5052H Foil Spec. MIL-C-7438 Cell Size 1/8 in. Hex Thickness = .001 in. Cell Depth = .341 ± .003	<u>Top Cover Plate</u> Alclad 7075T6 Spec. QQ-A-287 .016 in thickness <u>Bottom Cover Plate</u> Alclad 7075T6 Spec. QQ-A-287 .012 in. thick- ness
See Figures 3 & 5					

FLOOR PANELS

DETAILS - HONEYCOMB HEATED

BONDING	CONSTRUCTION			INSTALLATION	
	ELECTRICAL RESIST. CABLE	ELEC.	MOUNTING	METHOD	
	Install. & Mat.	Capacity	TERMINAL	SPACERS	SCREWS
MIL-A-5090 Adhesive System	<u>Installation</u> See Fig. 3 Install in crushed groove <u>Material</u> See App. II	20 watts per sq. ft. <u>Power</u> 115/208 VAC 3 phase 400 cycle	See Fig. 7 Install per Fig. 4	See Fig. 6 See Fig. 5	No. 10 Flat Head

APPENDIX I

PASSENGER COMPARTMENT - ELECTRIC RADIANT PANELS (Continued)

FLOOR PANELS

DETAILS - HONEYCOMB HEATED

FUNCTIONAL TEST

DIELECTRIC TEST - HEATING ELEMENT TERMINALS

TEST EQUIPMENT	TEST CONNECTIONS	VOLTAGE	TIME	CRITERIA OF FAILURE	PANEL MARKING
Insulation Breakdown Tester	1. Either term. 2. Ground (on panel)	1250 AC 60 cycle	1 sec.	No indication of Insul. Breakdown	Mark Panel as having been "Dielectric tested OK"

DIELECTRIC TEST - TEMPERATURE SENSOR TERMINALS

TEST EQUIPMENT	TEST CONNECTIONS	VOLTAGE	TIME	CRITERIA OF FAILURE	PANEL MARKING
(Same as for heating element test above)	1. One sensor term. 2. Ground (to panel)	200 AC 60 cycle	1 sec.	No indication of Insul. Breakdown	Mark Panel as having been "Dielectric tested OK"

RESISTANCE TEST - HEATING ELEMENT

TEST EQUIPMENT	TEST CONNECTIONS	TEST REQUIREMENT	TEST TOLERANCE
1. Wheatstone Bridge 2. Detail Panel Dwg.	Both heating element terminals	Detail panel drawing to specify resistance cable length and resistance value per foot of length Total resist. = L' x R/ft	+ 10% from Resist. per detail drawing

APPENDIX I

PASSENGER COMPARTMENT - ELECTRIC RADIANT PANELS (continued)

WALL AND WINDOW HEATING PANELS				
LOCATION	TYPES USED	DETAILS, PANELS, WALL AND WINDOW		
See Figs. 2A and 2B	Honeycomb Heated 1/4 in. thick 32 Sidewall Panels 37 Windows	CONSTRUCTION		
		MATERIAL AND SIZE		BONDING
		Core	Plates	MIL-A-5090 Adhesive System
		Al. Al. 5052H Foil Spec. MIL-C-7438 Cell size 1/4 in. Hex. Thickness .001 Cell Depth 1/4 in.	<u>Inboard Cover Plate</u> Al. Al. .004 in. thick <u>Outboard Cover Plate</u> Al. Al. .004 in. thick	

CONSTRUCTION (continued)

Edging	Trim	Trim Padding	Elec. Resistance Cable	
Hardwood inserts on 4 edges	<u>Cabin Side</u> "Naughyde" or "Duratrim" vinyl coated fabrics. Cemented or stapled to panels	<u>Cabin Side</u> 1/2 in. Fiberglass 0.6 lbs. per cu. ft. Install between trim and panel	<u>Install. & Mat.</u> <u>Installation</u> See Fig. 1 Similar to Floor Panel Fig. 3 <u>Material</u> See App. II	<u>Capacity</u> 20 watts per sq ft. Power 115/208 VAC 3 phase 400 cycle

CONSTRUCTION (Continued)

Elec. Terminals	Installation	Functional Test
See Fig. 7	See Figs. 1, 2, 2A, 2B	Check Elec. & Dielectric Tests
Elec. Bond- ing per Fig. 2B	Special Extrusions and clips	

APPENDIX I

FUNCTIONAL TEST		
Dielectric Test Heating Elements	Dielectric Test Temp. Sensors	Resistance Test. Heating Elements

← Same as for floor panels →

SAENORM.COM : Click to view the full PDF of air860

APPENDIX I

SPECIFIC DESIGN AND OPERATION INFORMATION

CARGO COMPARTMENT - ELECTRIC RADIANT PANELS

CARGO HEATING PANELS

LOCATION	TYPE USED	CONSTRUCTION		
See Fig. 8 Below cargo structural floor. No. per comp't 42 panels fwd. 43 panels aft	See Fig. 9 Laminated - one layer of Al. alloy sheet, bonded to a layer of fiber- glass, with heating element wires between the two layers.	Material and Size		
		<u>Al. Alloy</u> .008 in. thick 5052-0 Spec. QQ-A-318	<u>Fiberglass Cloth</u> .010 thick Phenolic impregnated Spec. "Conolon 506-B-181" "Narmco" or "AF104#120" by 3M Co.	<u>Bonding</u> MIL-A-5090 Bonding System Liq. Adhesive Type III Tape Adhesive Type I Cure at 350°F for 45 min. with bag press. of 10 to 25 psig

CONSTRUCTION (continued)

BUMPERS SPACERS	ELECTRICAL RESIST. CABLE		ELEC. TERMINAL & CIRCUITS	INSTALLATION
Plastic Foam, Cellulose Acetate Rod	<u>Install. & Mat.</u>	<u>Capacity</u>	See Fig. 7 See Fig. 9A	See Figs. 8 & 9
	<u>Installation</u> See Fig. 9	61 watts per sq. ft.		
	<u>Material</u> See Appendix II	<u>Power</u> 115/208 VAC 3 phase 400 cycle		

FUNCTIONAL TEST

Dielectric Test	Resistance Test
Heating Element & Terminals	Heating Element
Same as floor panels	Same as for floor panels

- 14 -

APPENDIX I

SPECIFIC DESIGN AND OPERATION INFORMATION

FLIGHT STATION - ELECTRIC DUCT HEATER

LOCATION	TYPE AND CONSTRUCTION	ELECTRICAL
See Fig. 10 Located in flight station air supply duct	See Fig. 12	See Fig. 11 Total op. current 29 to 35 amps Capacity, 10 KW Power 115/208 VAC, 400 cycle, 3 phase Control Power, 26 VDC

FLIGHT STATION - ELECTRIC DUCT HEATER

FUNCTIONAL TEST	PERFORMANCE	
	At Sea Level	At 8000' Press. Alt.
See Fig. 13 for Test Setup		
1. Continuity test	Air Flow 30#/min.	22#/min.
	Air "In" Temp. 70°F	70°F.
2. Airflow distribution across face of heater must be uniform	Max. Temp. Rise 79°F	108°F.
	Max Pr. Drop .50 in. H ₂ O	.40 in. H ₂ O
	Max. Surface Temp. 300°F	350°F.
3. Electrical sequence per Table I.	Normal Surface Temp. 200 to 250°F.	200 to 250°F.
4. Overheat test - no airflow - Thermal protector to operate within 90 seconds.		

APPENDIX I

SPECIAL DESIGN AND OPERATION INFORMATION

CABIN - ELECTRICAL DUCT HEATER		
LOCATION	TYPE AND CONSTRUCTION	ELECTRICAL
See Fig. 10 located in cabin air supply duct	See Figure 14	See Figure 15 Total operating current 37 to 58 AMPS Power - 115/208 VAC, 400 cycle Capacity, 18 KW Control Power 26 VDC

CABIN - ELECTRICAL DUCT HEATER

FUNCTIONAL TEST	PERFORMANCE	
	At Sea Level	At 8000' Press. Alt.
See Fig. 16 for test setup		
1. Continuity test	Air Flow 151#/min.	116#/min.
2. Airflow distribution across face of heater	Air "In" Temp. 70°F. Max. Temp. Rise 28°F. Max. Pr. Drop .35" H ₂ O Max. Surface Temp. 300°F.	70°F. 36°F. .30 in. H ₂ O
3. Electrical sequence test per Table II	Normal Surface Temp. 150 to 200°F.	350°F.
4. Overheat test - no airflow - thermal protector to operate within 90 seconds		150 to 200°F.

TABLE I

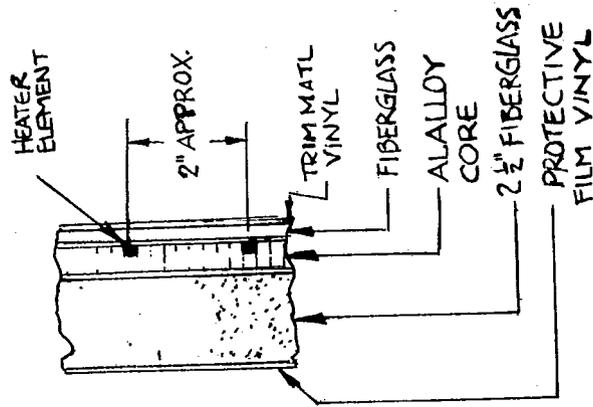
FLIGHT STATION DUCT HEATER FUNCTIONAL TEST

TEST INFORMATION					
Energizing Sequence Steps	Close Circuit Breaker	Current (amp)			
		Group 1	Group 2	Group 3	Group 4
1	CB1	2.9-3.5			
2	CB2		5.8-7.0		
3	CB3			8.7-10.5	
4	CB4				11.6-14.0
5	CB1, CB4	2.6-3.2*			11.3-13.7
6	CB2, CB4		5.5-6.7		11.3-13.7
7	CB3, CB4			8.1-9.9	11.0-13.4
8	CB1, CB3, CB4	2.6-3.2		8.1-9.9	10.7-13.1
9	CB2, CB3, CB4		5.2-6.4	7.8-9.6	10.7-13.1
10	CB1, CB2 CB3, CB4	2.6-3.2	5.2-6.4	7.8-9.6	10.4-12.8

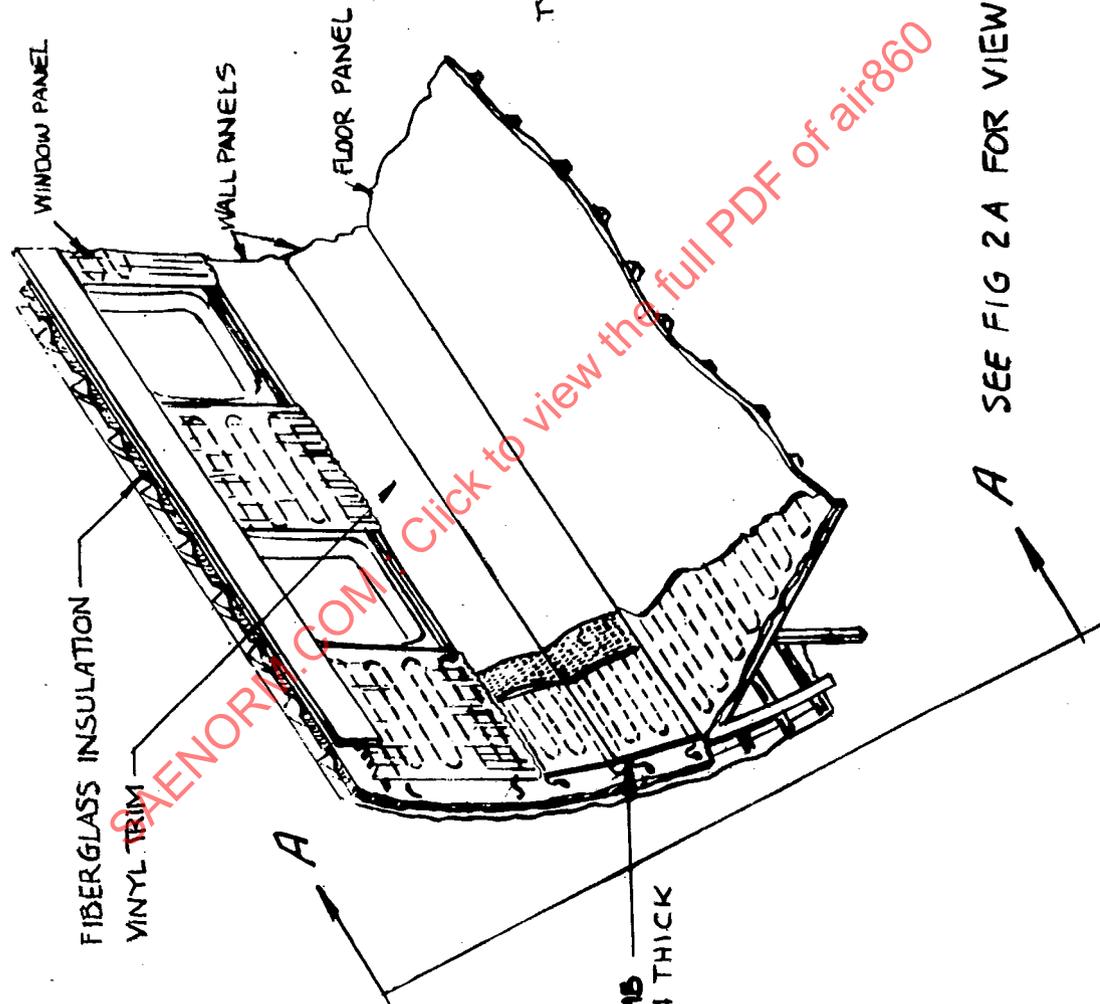
* Determine current value for each group in group combination by opening one circuit breaker at a time and noting current drop.

TABLE II
CABIN DUCT HEATER FUNCTIONAL TEST

Energizing Sequence Steps	Close Circuit Breaker	CURRENT (Amp)		
		Group 1	Group 2	Group 3
		1	CB1	7.8 to 9.6
2	CB2		15.6 to 19.2	
3	CB3			23.4 to 28.8
4	CB1, CB3	7.4 to 9.1		22.2 to 27.4
5	CB2, CB3		14.8 to 18.2	22.2 to 27.4
6	CB1, CB2, CB3	7.4 to 9.1	14 to 17.3	21 to 26



TYPICAL SECTION THROUGH WALL PANEL



AL. CORE .25 HONEY COMB
AL. COVER SHEETS .004 THICK

A SEE FIG 2A FOR VIEW "A-A"

SAENORIT.COM Click to view the full PDF of air860

Figure 1. Cabin Wall and Floor Radiant Panels

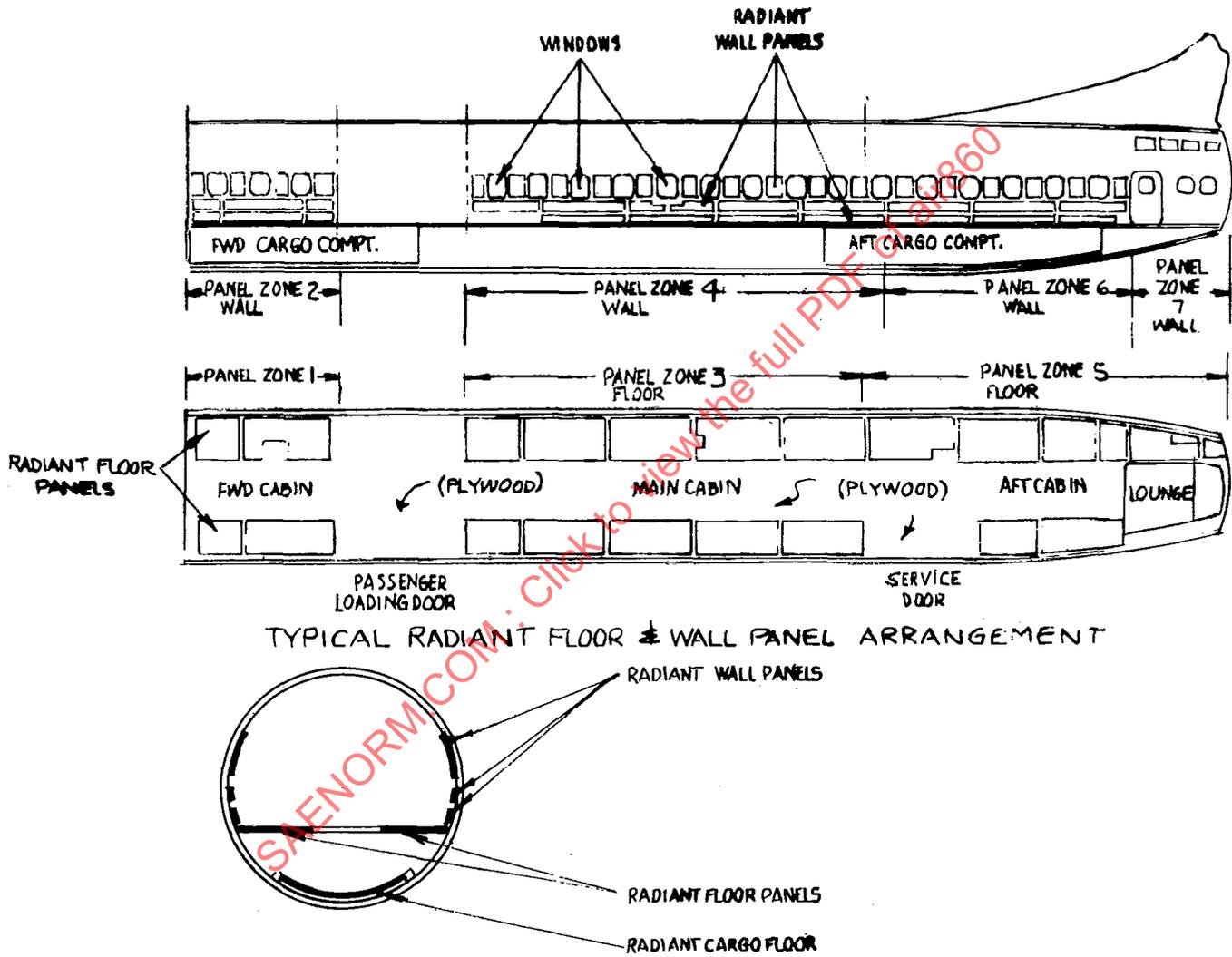


Figure 2. Radiant Heating Panels

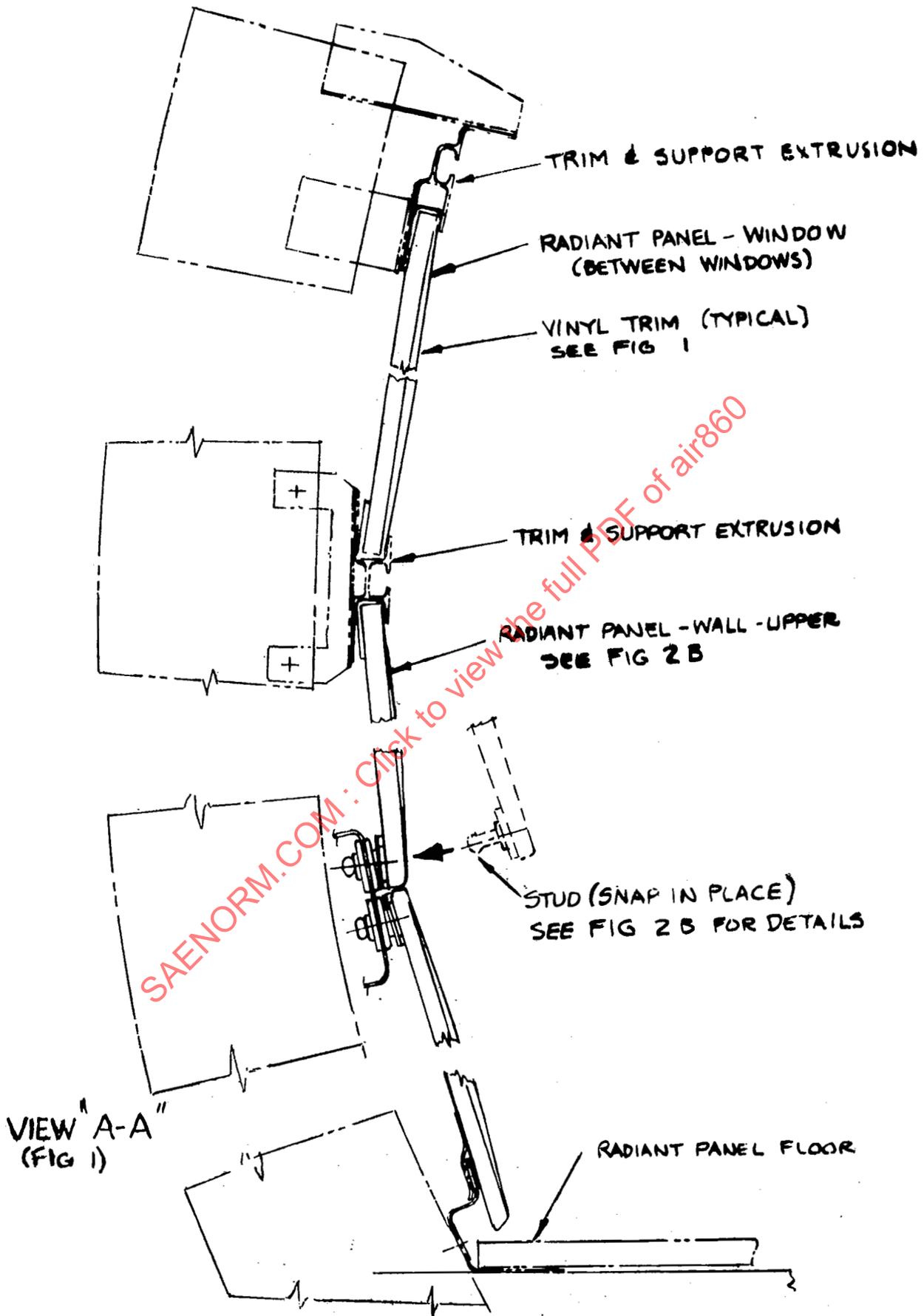
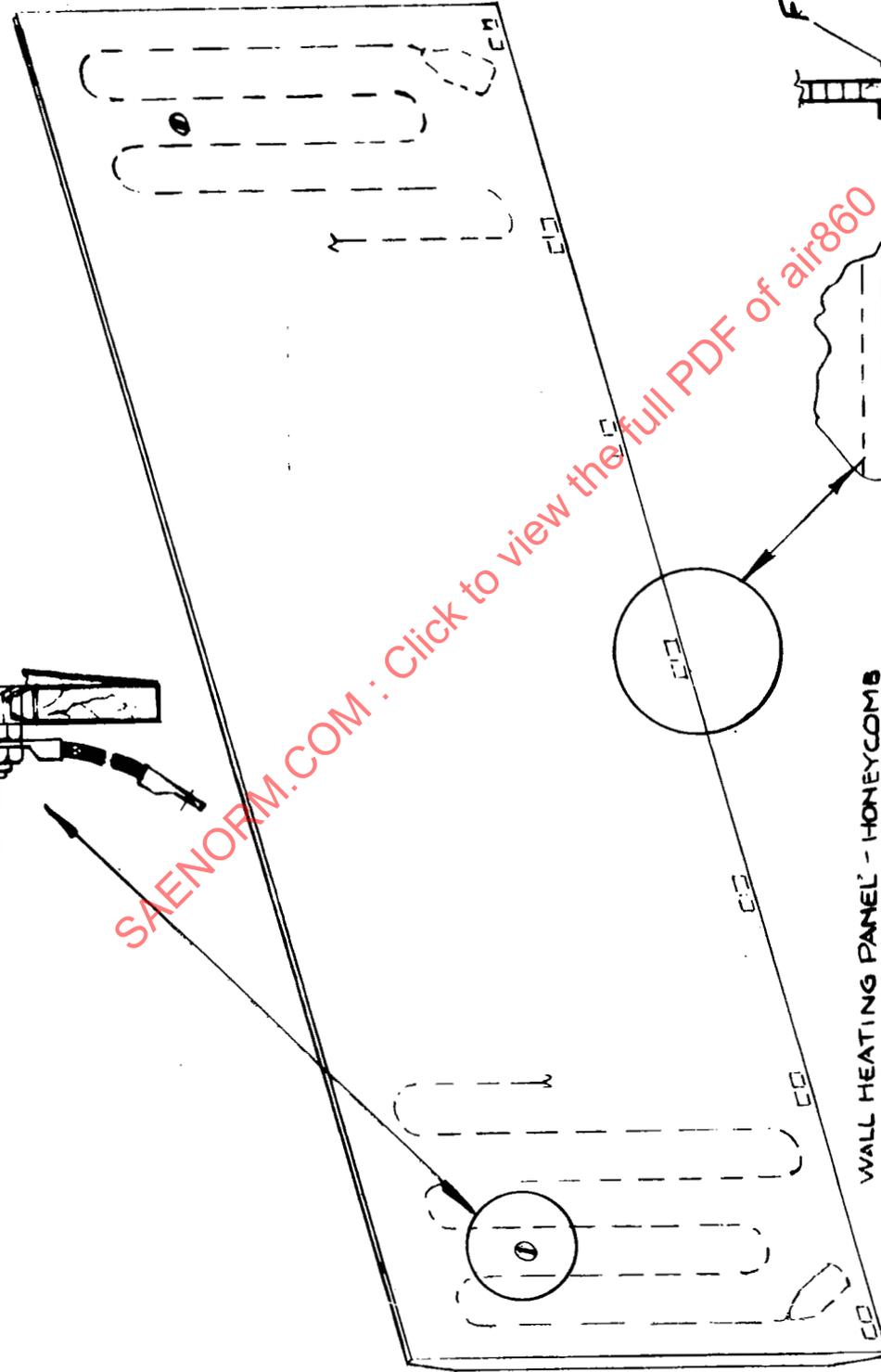


Figure 2A. Cabin Wall and Floor Radiant Panels - Sect. View

INSTALL. INSTR.
 DRILL HOLE .311 IN PANEL.
 PRESS IN PLUG & SLEEVE
 FLUSH WITH SKIN.
 NO DIMPLING REQD

ZC10-0 PLUG
S102D10-04 SLEEVE } **SEE FIG 6**
 AN 345-10 NUT
 MS 25003-10B-4 JUMPER, BONDING
 AN 960-10L WASHER
 NAS 679 A3 NUT
 AN 507-1032 R12 SCREW



SAENORM.COM : Click to view the full PDF of air860

WALL HEATING PANEL - HONEYCOMB
 MATL. SPEC - MIL-C-7438
 MATL. - ALLOY 5052 H FOIL CORE
 MATL THICKNESS = .001
 CELL SIZE = 1/4" HEXAGONAL
 COVER PLATE INBD. = .004" THICK
 " " OUTBD. = .004" "
 1/2" FIBERGLASS PADDING WEIGHING .6 LBS. FT³
 BEHIND TRIM FABRIC & TRIM PADDING WRAPPED
 AROUND ALL EDGES OF BASIC PANEL & FASTENED

Figure 2B. Wall Panel - Upper

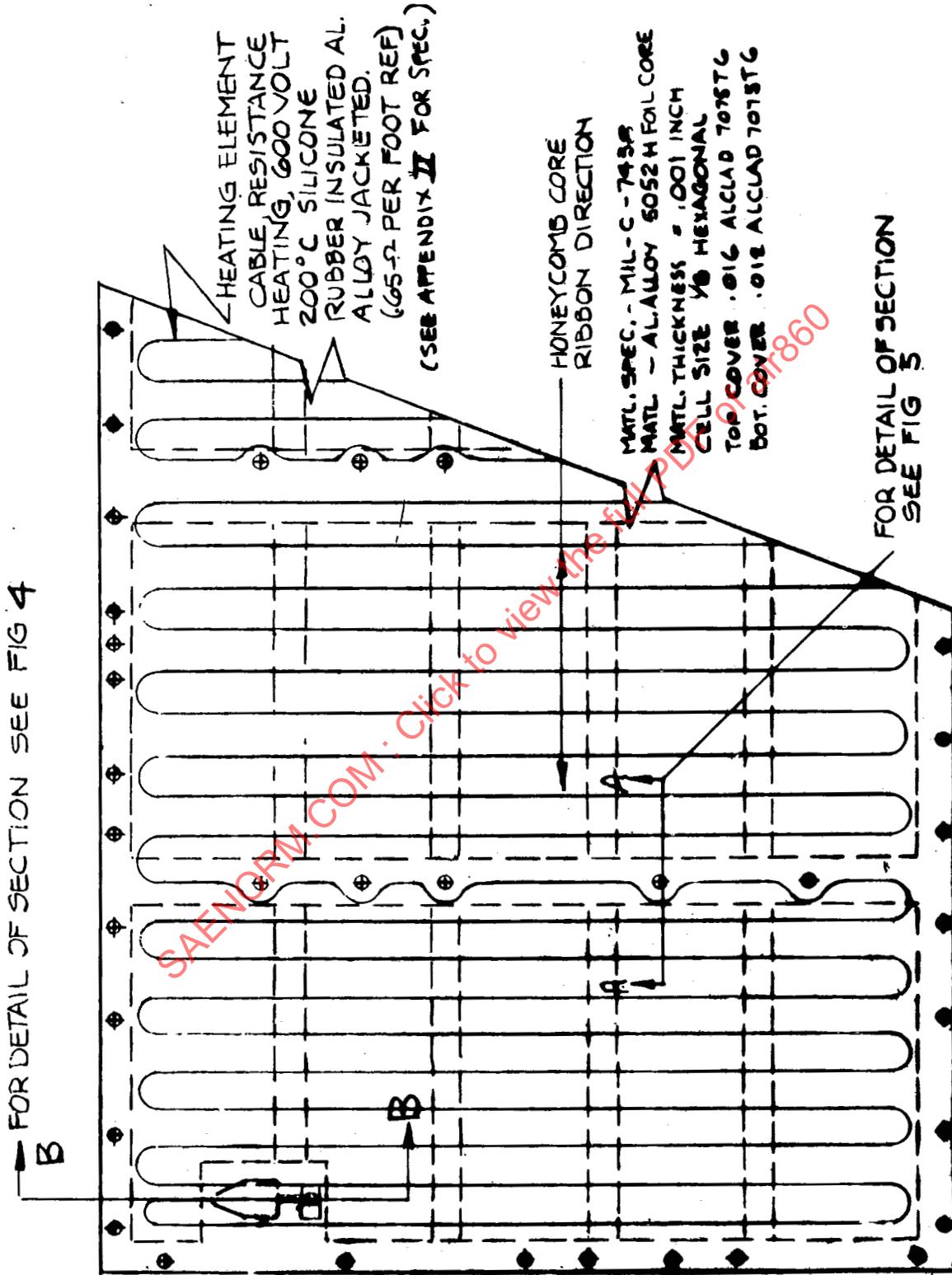


Figure 3. Cabin Floor Radiant Panel Assembly

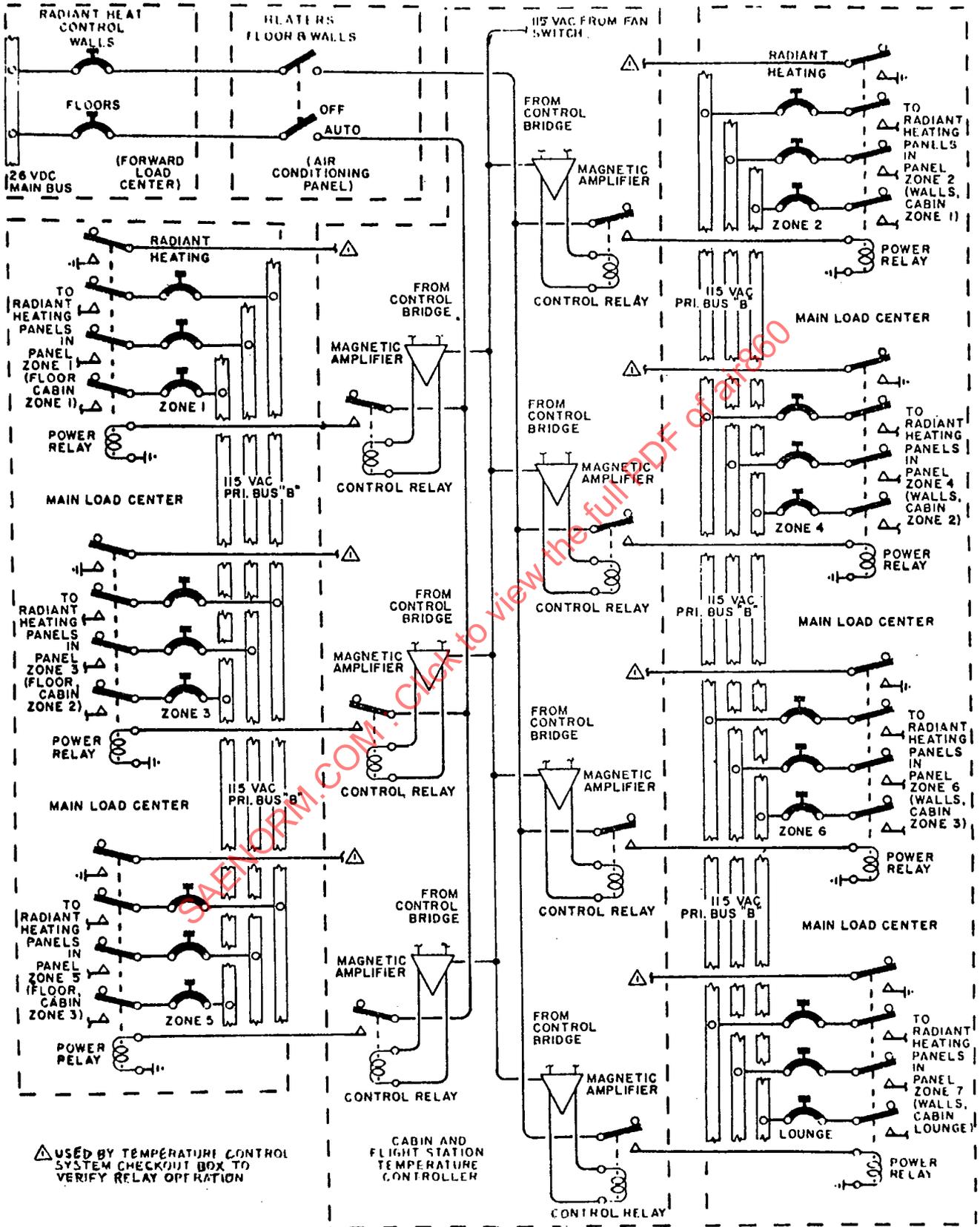


Figure 3A. Radiant Heat Panels Control

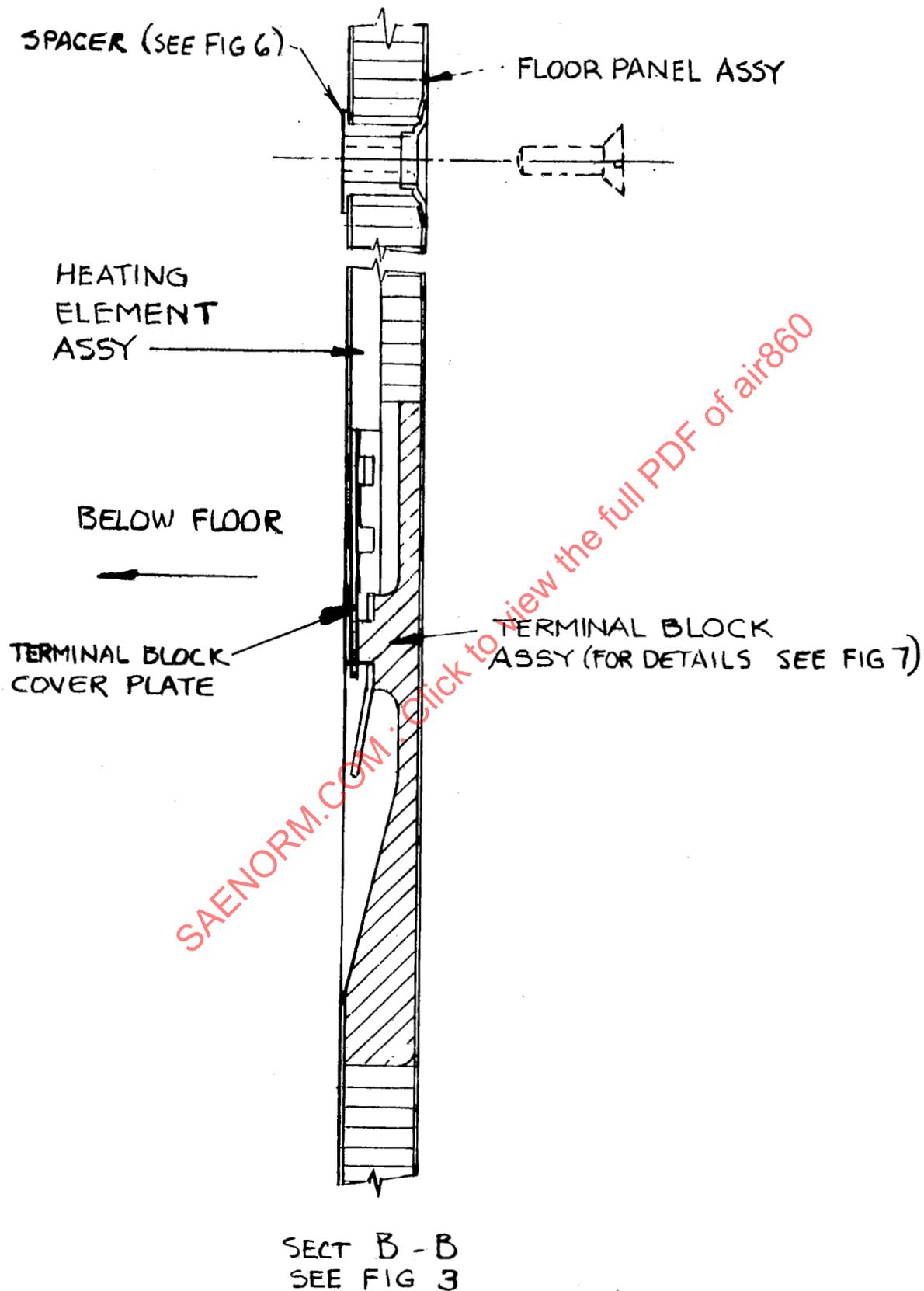
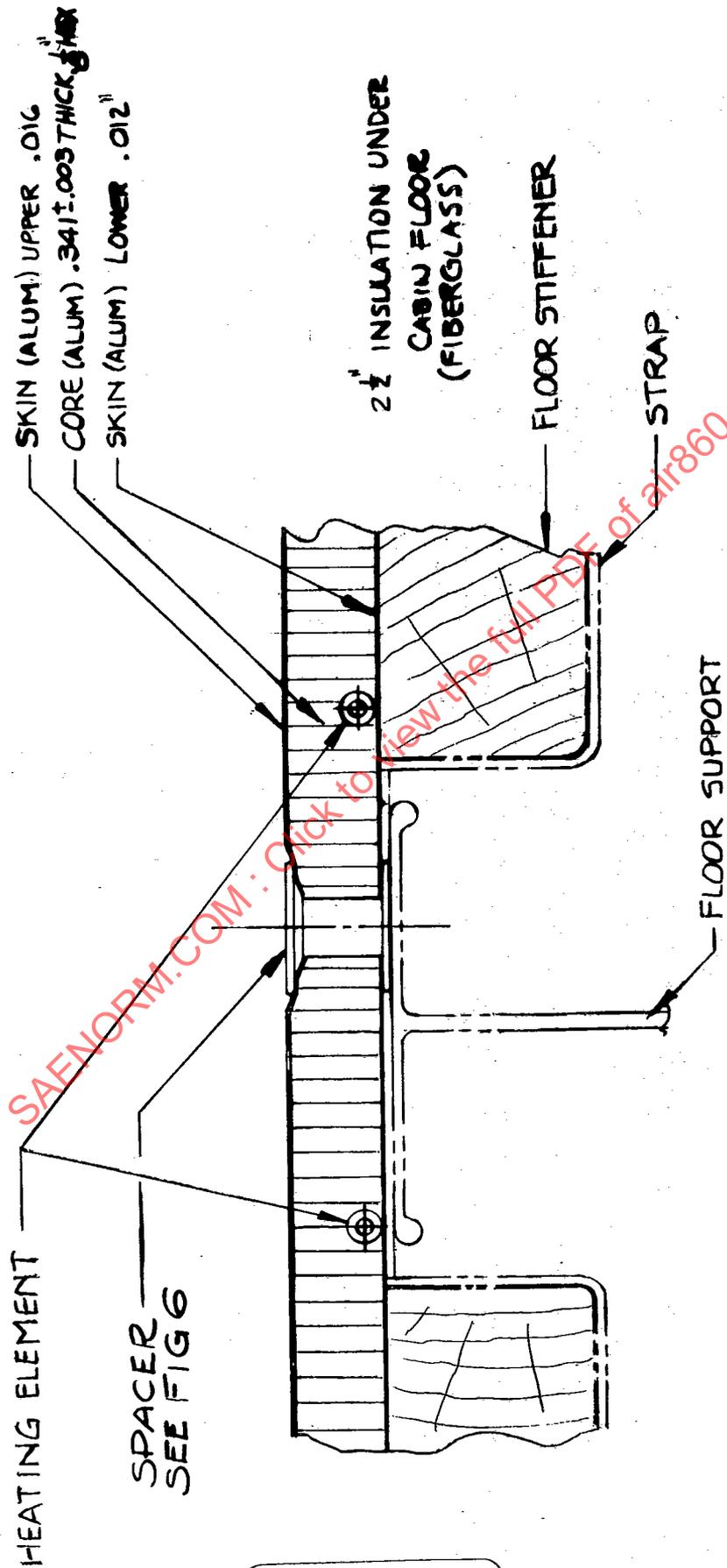


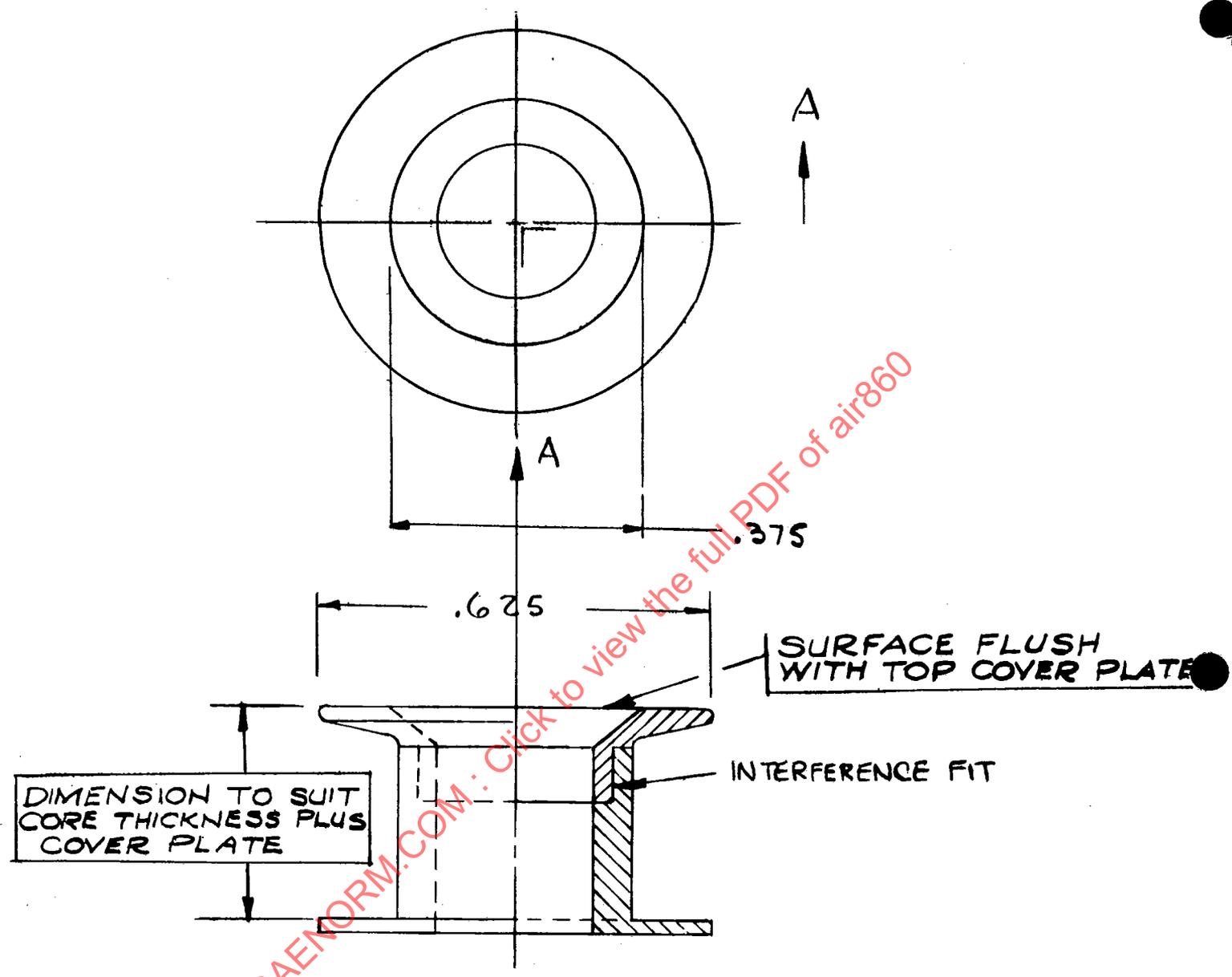
Figure 4. Section - Terminal Block - Floor Panel Installation

Distributed under license from the IHS Archive



SECTION "A-A" FIG 3

Figure 5. Section of Cabin Floor Radiant Panel Installation



SECT. "A-A"

TYPICAL FLOOR PANEL
SCREW SPACER
MATL AL. ALLOY

Figure 6. Spacer - Screw - Radiant Panel

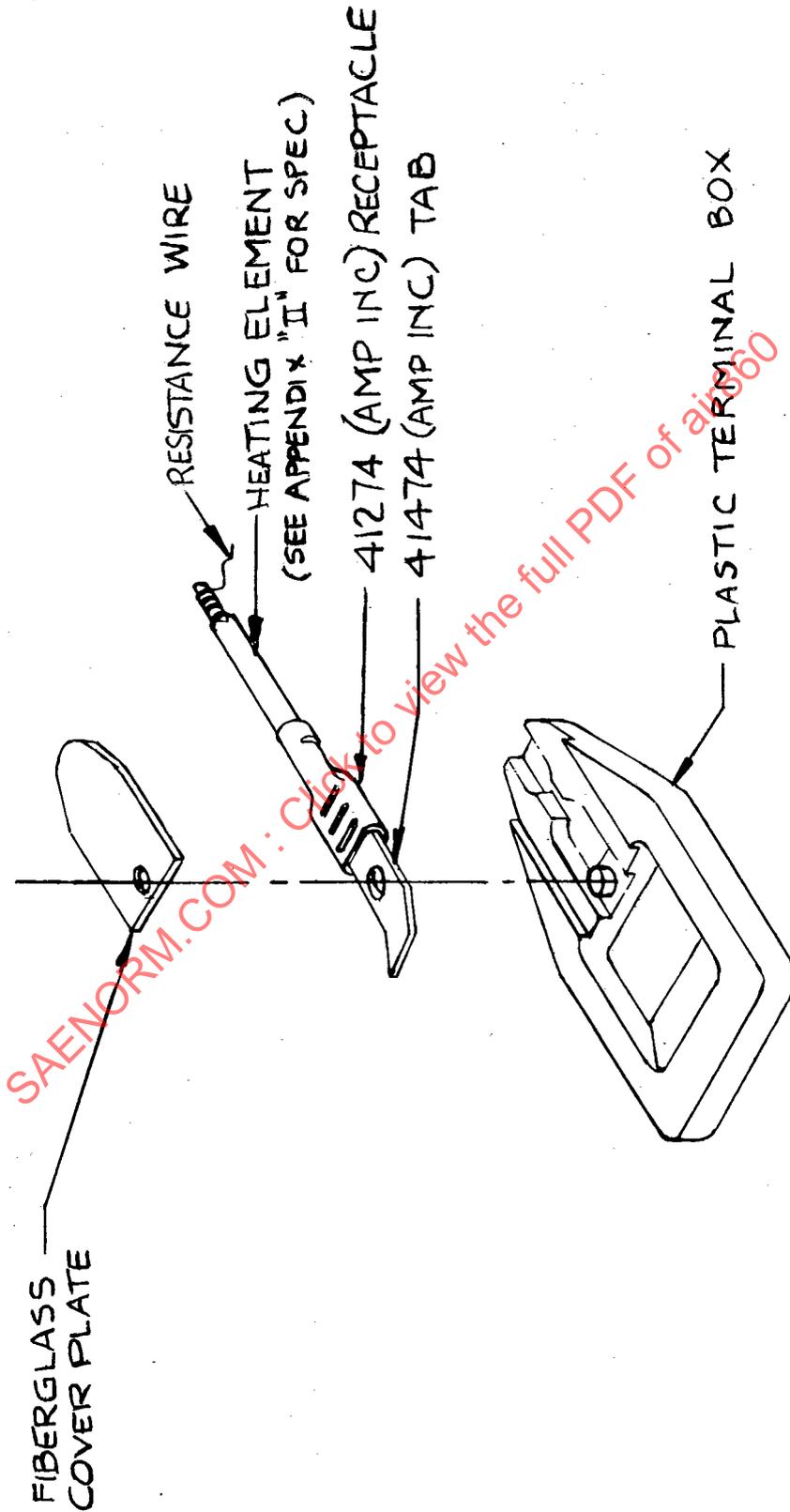
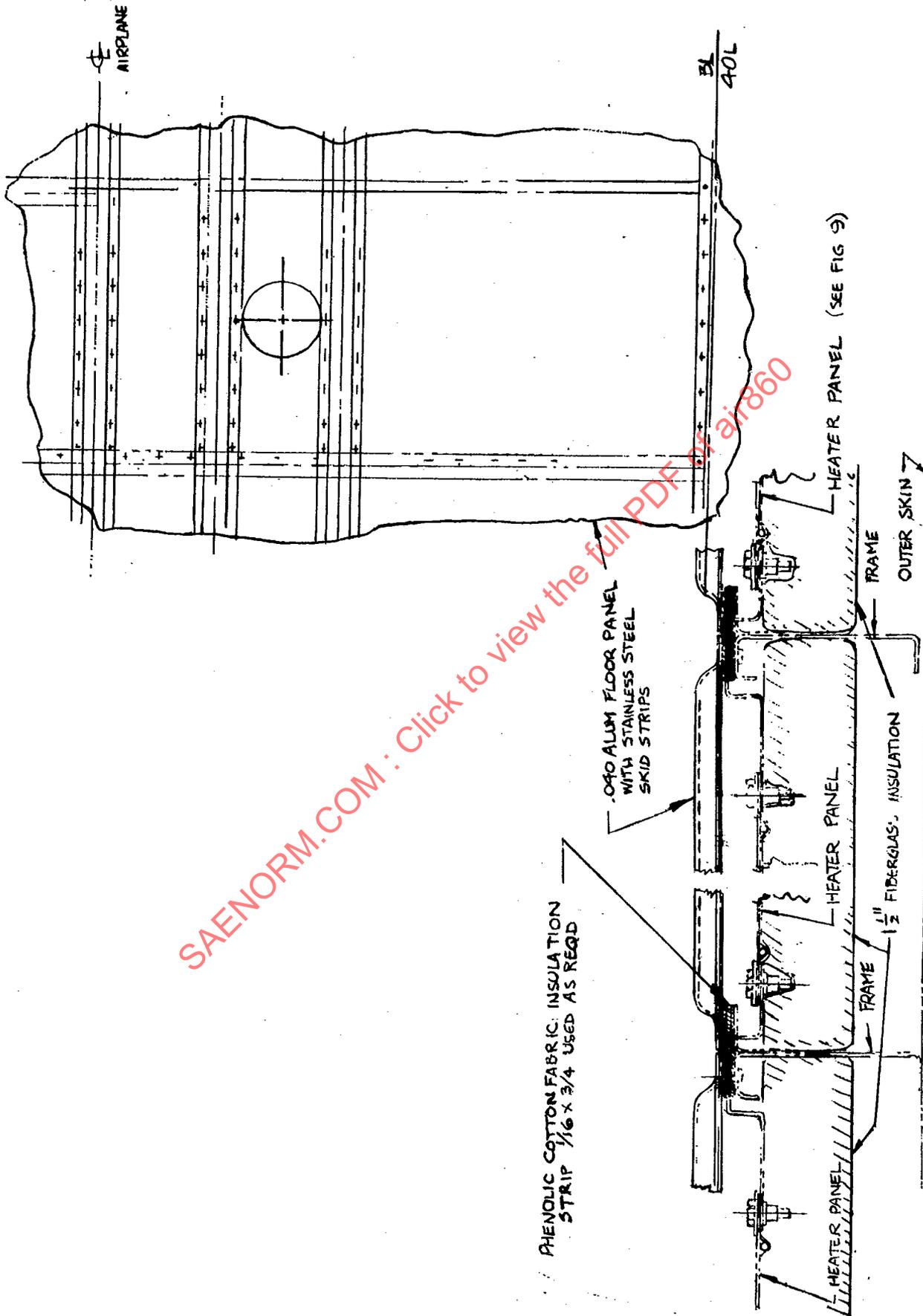


Figure 7. Terminal Block Details



SAENORM.COM : Click to view the full PDF of air860

Figure 8. Cargo Compartment Floor and Radiant Panel Installation

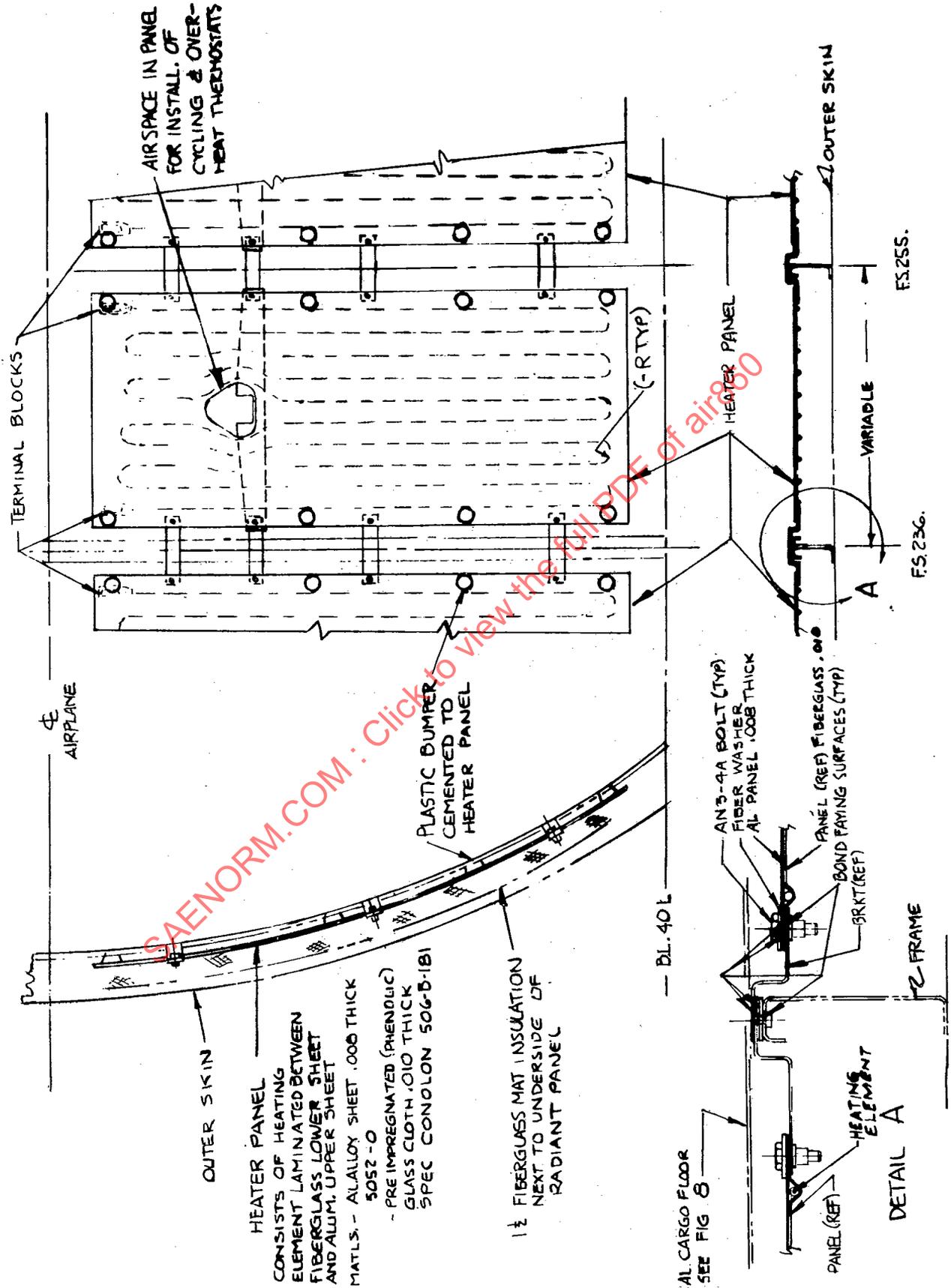


Figure 9. Cargo Compartment Radiant Panel (Typ)

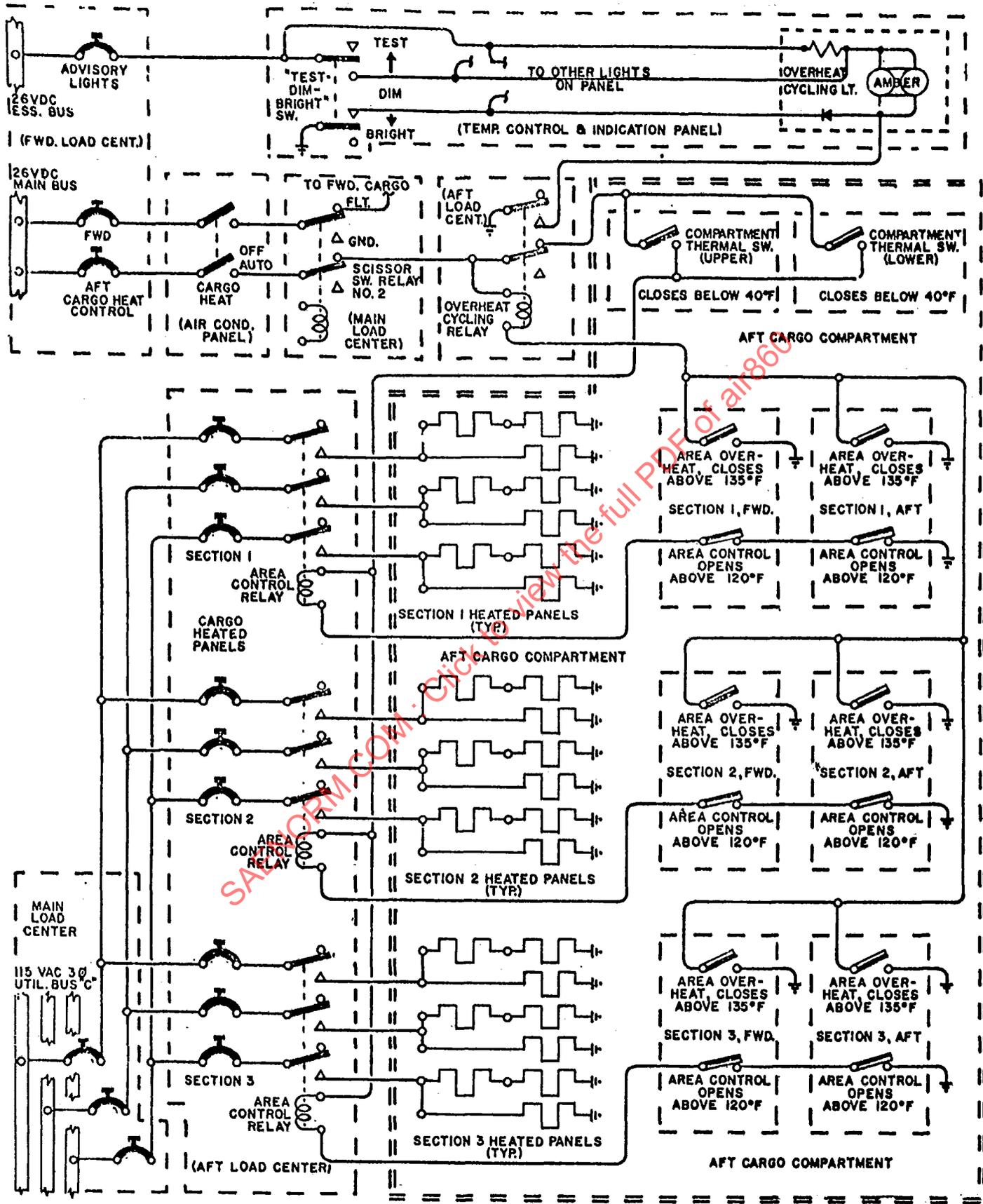


Figure 9A. Cargo Compartment Heating Circuit

KEY

- ⊙ - CHECK VALVE
- ⊠ - MOTOR DRIVEN VALVE

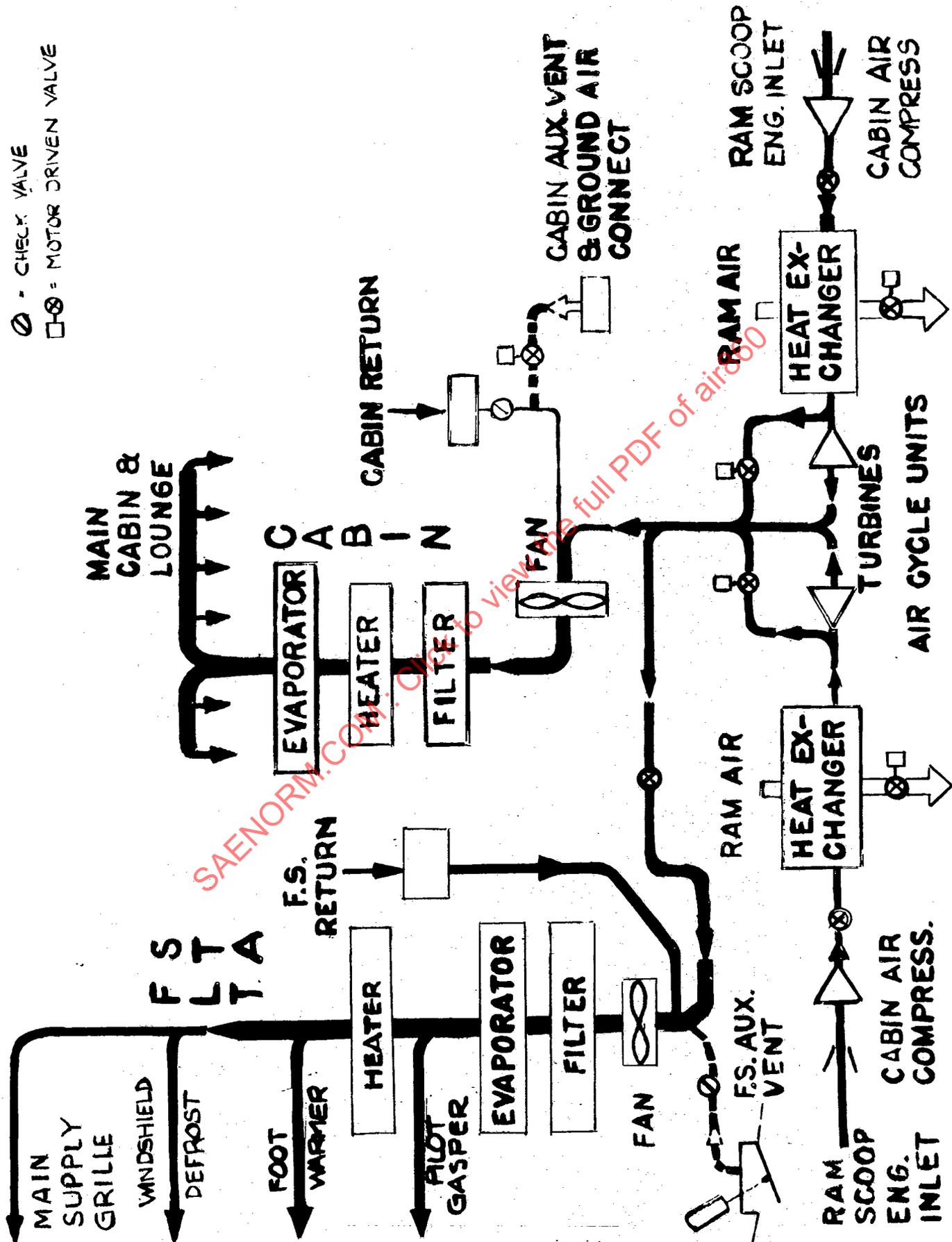


Figure 10. Schematic of Air Conditioning System

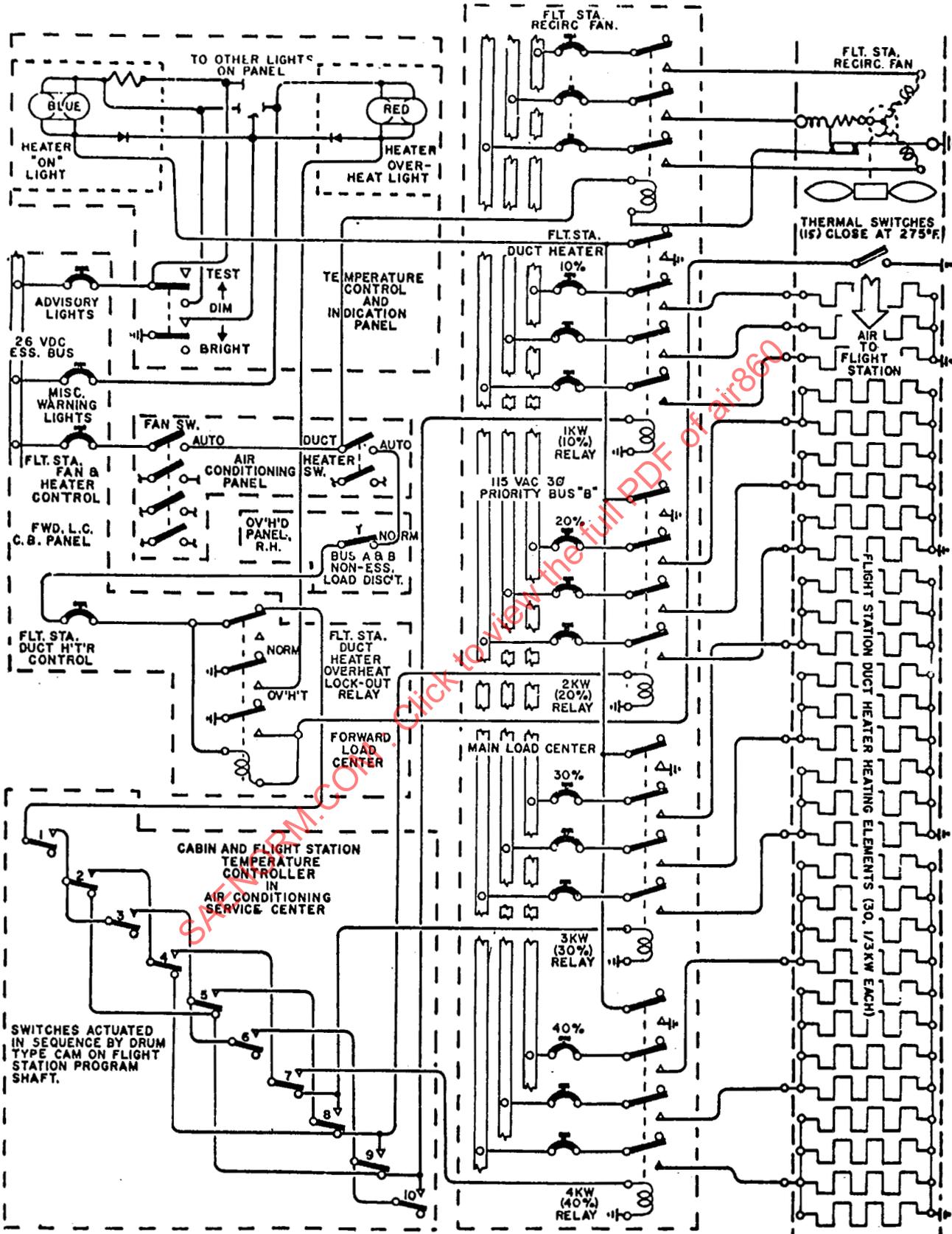


Figure 11. Flight Station Duct Heater and Recirculation Fan Circuits

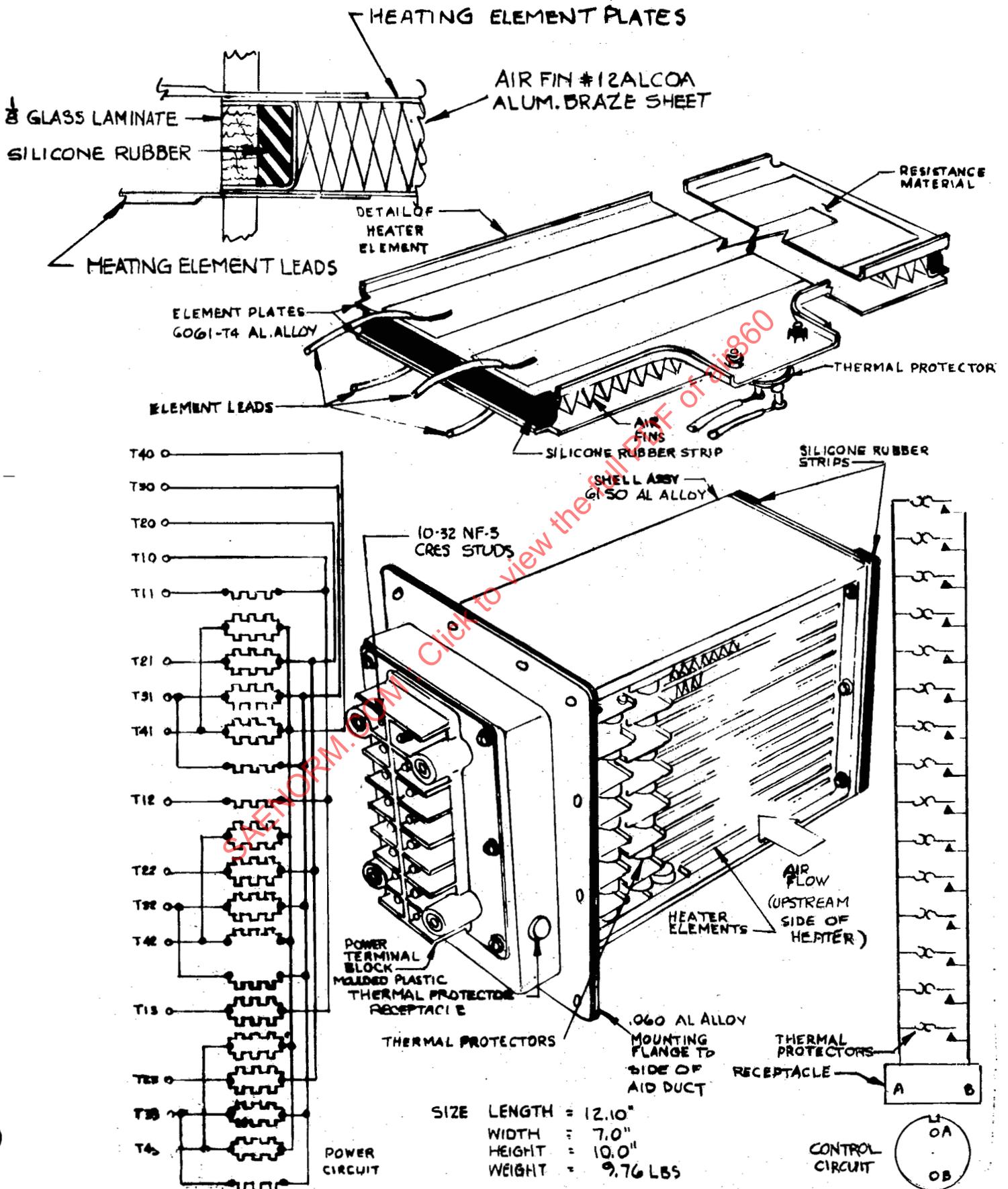


Figure 12. Flight Station Duct Heater Details

Distributed under license from the IHS Archive

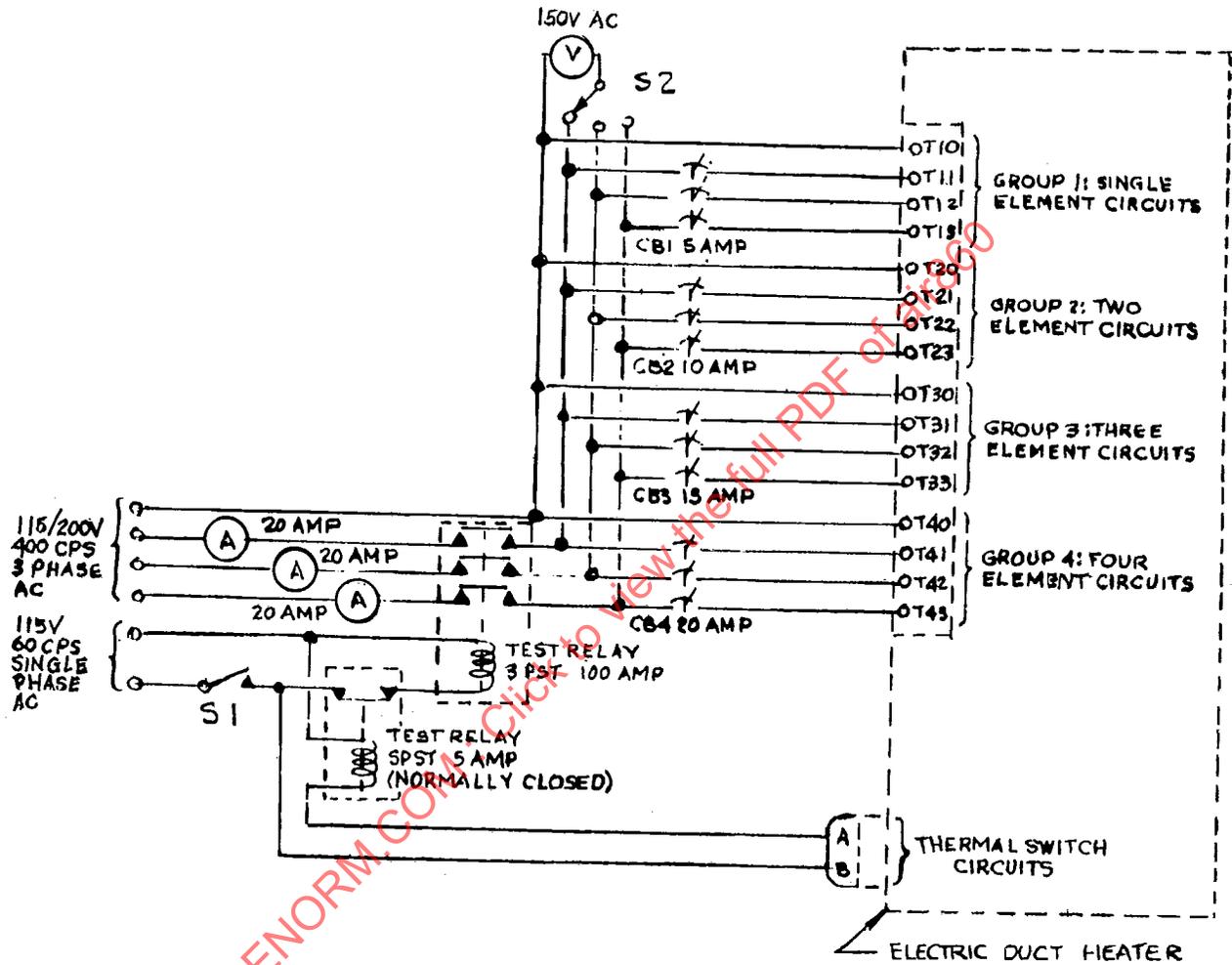


Figure 13. Flight Station Duct Heater Functional Test Setup

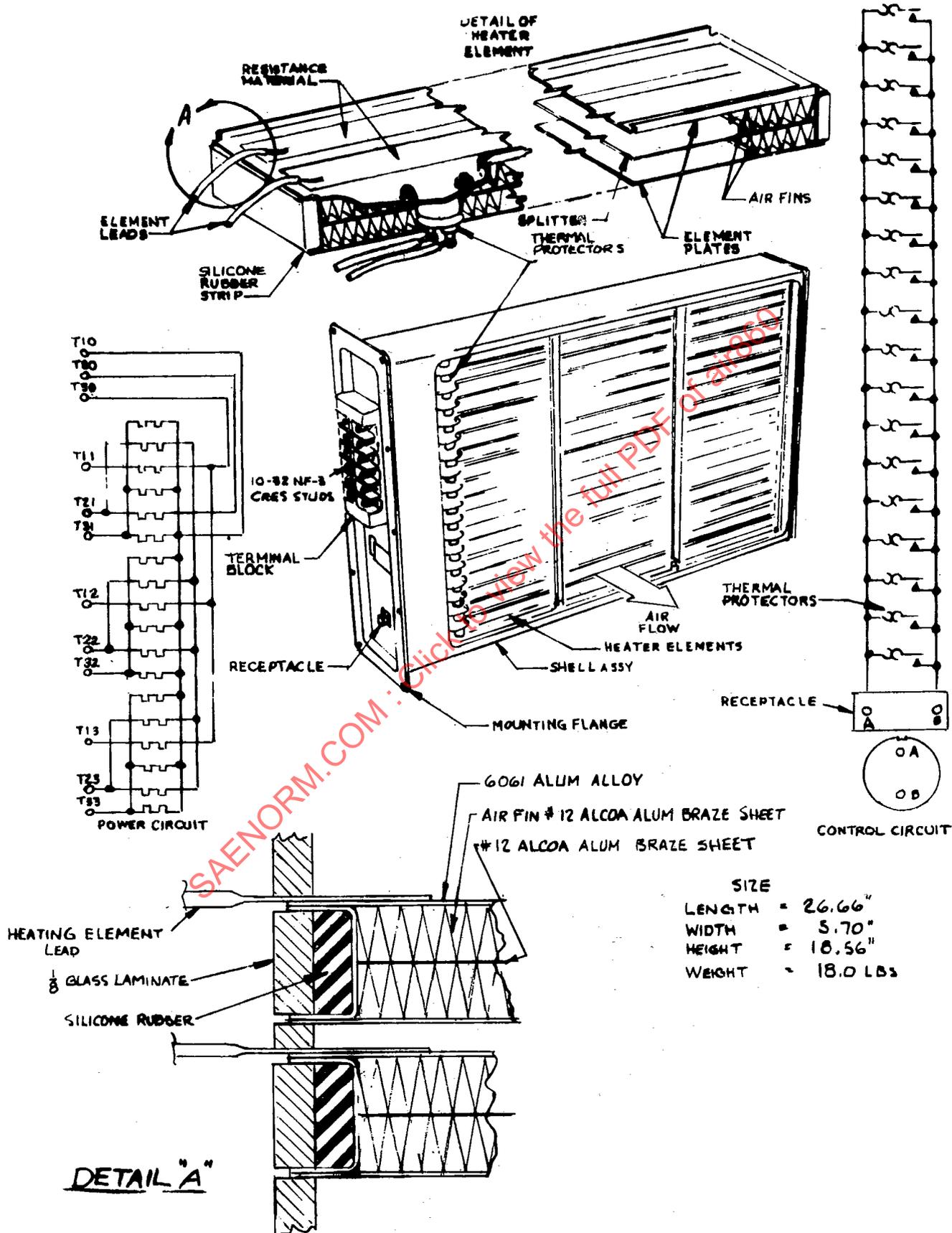


Figure 14. Cabin Duct Heater Details

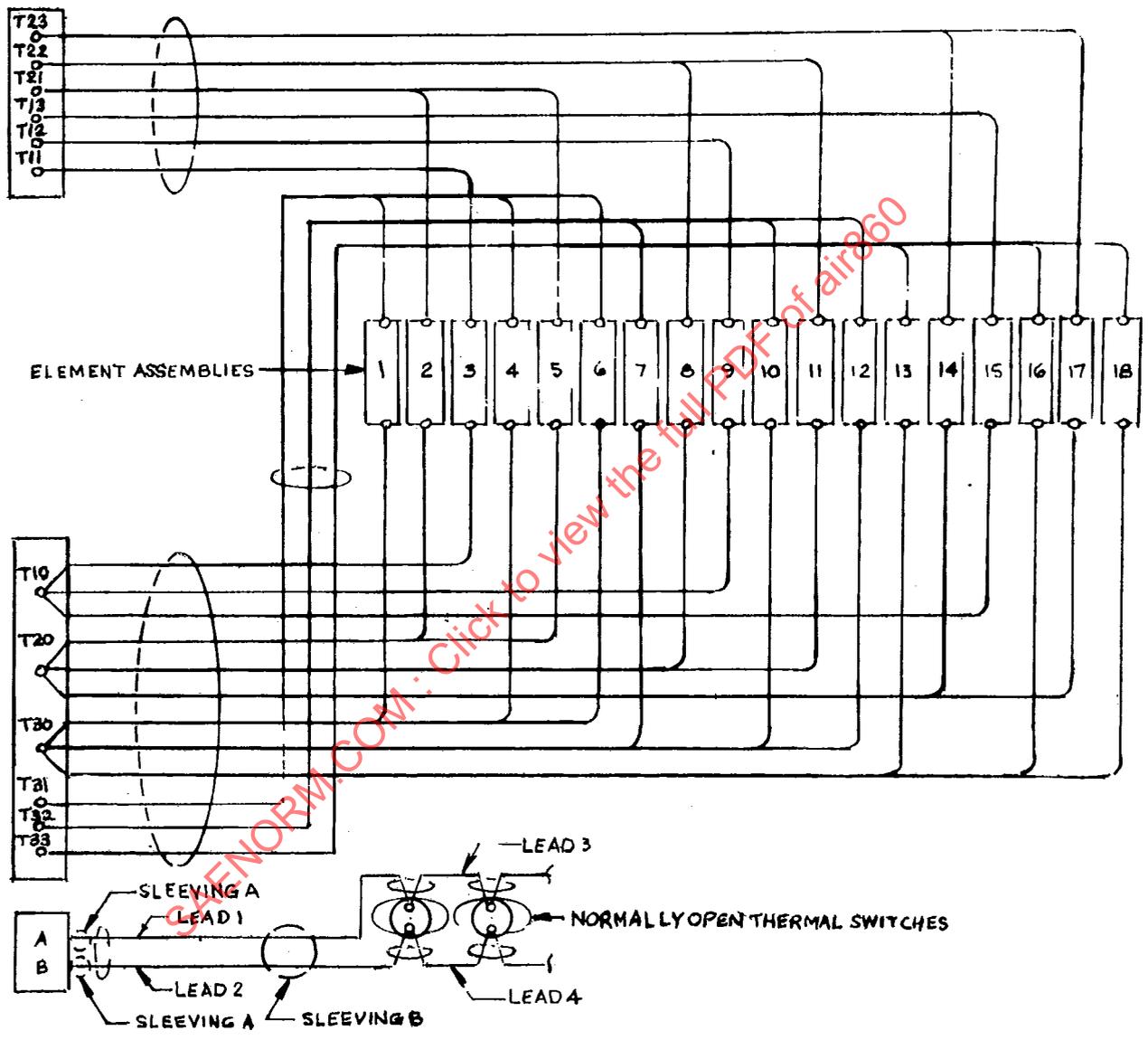


Figure 15. Cabin Duct Heater Electrical Circuit

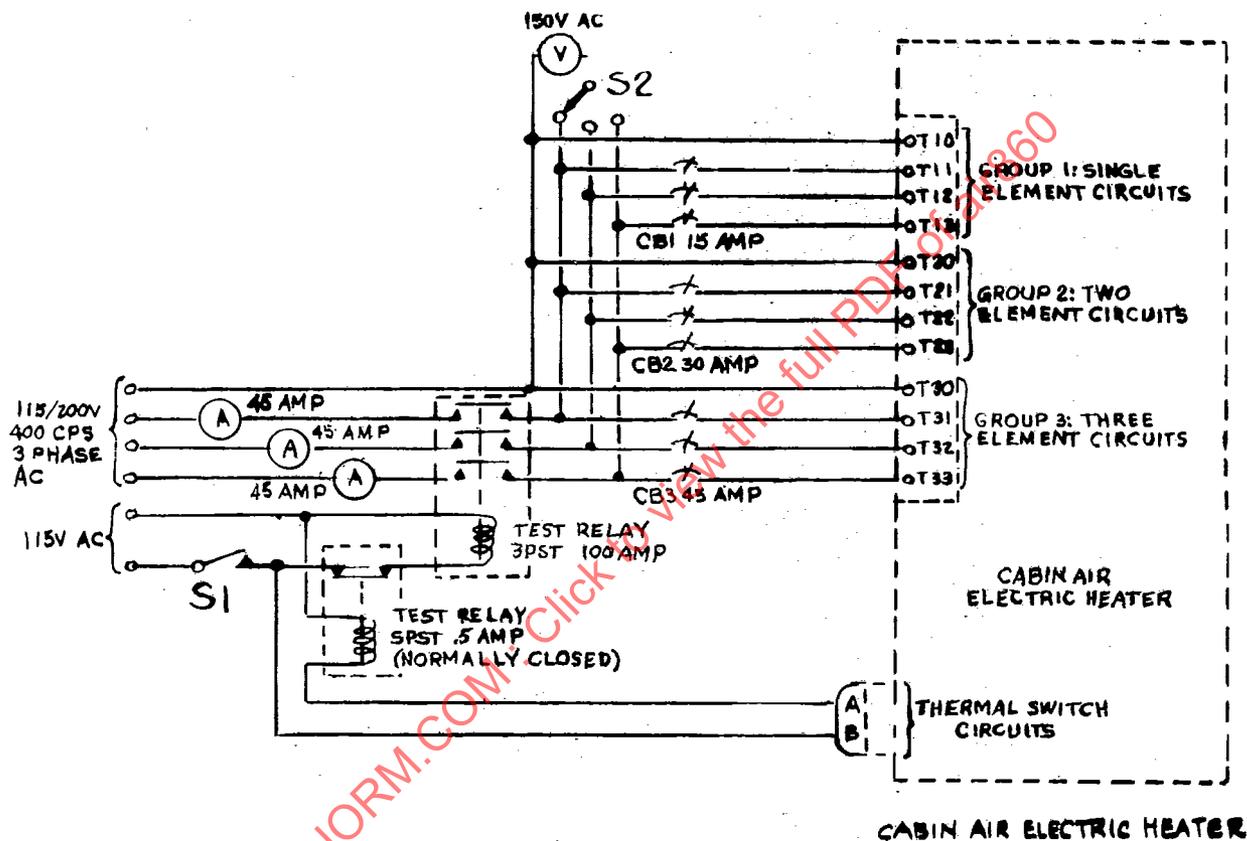


Figure 16. Cabin Duct Heater Functional Test Setup

MATERIAL SPECIFICATION

Subject: CABLE, RESISTANCE HEATING, ALUMINUM JACKET

1. SCOPE - This specification covers jacketed cables for use as heating elements in aircraft cabin and baggage compartments.
2. CLASSIFICATION - Cable shall be of the following types, as specified:

Table I - CABLE, RESISTANCE HEATING, ALUMINUM JACKET

Type	Resistance, Ohms, per foot	Color Code	
		Body	Tracer
I	13.75	Blue	White
II	12.60	White	White
III	6.95	Red	White
IV	4.00	Yellow	White
V	3.12	Green	White
VI	2.69	Blue	Blue
VII	4.60	Green	Blue
VIII	2.32	Yellow	Blue
IX	1.61	White	Blue
X	1.22	Blue	Red
XI	0.84	Yellow	Red
XII	0.65	White	Red
XIII	0.31	Green	Red
XIV	0.41	Red	Red

3. APPLICABLE DOCUMENTS

- 3.1 The following specifications and standards, of the issue in effect on the date of purchase order, form a part of this specification to the extent specified herein:

MIL-W-16878	Wire, Electrical Insulated, High Temperature
MIL-STD-104	Limits for Electrical Insulation Color

4. REQUIREMENTS

- 4.1 Materials - The materials and principal component parts for the cable shall be as specified herein. However, when a definite material is not specified, a material shall be used which will enable the cables to meet the requirements of this specification. Acceptance or approval of any constituent material shall not be construed as a guaranty of the acceptance of the finished product.
- 4.2 Conductor - The conductor shall be metallic and of such form as to meet the resistance requirements of Section 2. A center core with spirally wound conductor may be used.

- 4.2.1 Resistance - The conductor resistance specified in ohms per foot of finished cable measured at 70°F; allowable tolerance from the nominal resistance is $\pm 5\%$.
- 4.2.2 Termination - The conductor shall be capable of termination in a practical manner by mechanical methods.
- 4.3 Insulation - The conductor (or conductor and core) shall be continuously covered with a concentric layer of heat resistant and flexible insulating compound that shall be close-fitting, but with no adherence. The insulation shall provide protection against condensation moisture and shall be capable of accepting the identification required (paragraph 4.11).
- 4.4 Jacket - A close fitting aluminum braid jacket shall constitute the outer covering of the cable. There shall be no splices or loose ends permitted in the woven braid.
- 4.5 Cable Dimensions and Weight - The overall diameter of the finished cable shall not exceed 0.130 inch; the conductor (or conductor and core) diameter shall not exceed 0.050 inch. The weight of the finished cable shall not exceed 8.0 pounds per thousand feet determined for any piece of 100 feet or more in length. Unless otherwise specified on the purchase order, not more than 25% of the cable in each order and of each type may be delivered in lengths of 150 to 250 feet, and the remainder shall be in lengths over 250 feet.
- 4.6 Dielectric Strength - The dielectric strength of the cable shall be such that it withstands without failure a test potential of 1500 volts root mean square (rms) at commercial frequency applied for one minute between the cable conductor and a 5% salt solution, at a temperature of 68 to 77°F. The immersed length shall be twelve inches; the protruding ends shall not be stripped of insulation closer than 2 inches from the salt solution.
- 4.7 High Temperature - The cable shall show no indication of failure after 96 hours of operation with the conductor heated to 392°F by application of voltage to a test sample.
- 4.8 Aging - The same sample used in the high temperature test (paragraph 4.7) shall be subjected to five cycles of: (a) 18 hours at 347°F conductor temperature (by voltage application) and (b) six or more hours at ambient room temperature. After this aging test, the cable shall show no indication of failure or loss of specified dielectric strength (paragraph 4.6).
- 4.9 Bending - The completed cable shall withstand one tight turn around a 1/4 inch diameter mandrel without collapse or failure of the jacket. When this sample is returned to reasonable straightness by hand, it shall not break (either conductor or jacket) and it shall pass the test for dielectric strength (paragraph 4.6).
- 4.10 Jacket Strength - The jacket shall be sufficiently strong and dense to withstand lengthwise crushing of the cable against the sharp edges of a 0.001 inch aluminum honeycomb core with 1/8 inch cells. Any gashes or cuts that penetrate the insulation material may be cause for rejection.

- 4.10.1 Jacket Coverage - The woven braid shall be applied in a manner to cover not less than 90% of the underlying insulation. Coverage shall be determined in accordance with the procedure required in Spec. MIL-W-16878.
- 4.11 Type Identification - Identification of types shall follow the color code listed in Section 2. The colors in the finished cable shall fall within the light and dark limits of the applicable color chips of Standard MIL-STD-104.
- 4.11.1 Helical Striping - Coding shall be accomplished by the use of white insulation (paragraph 4.3) in conjunction with colored helical stripes. The width of each color stripe shall be not less than 0.015 inch, but the body stripe shall be at least twice the width of the tracer stripe.
- 4.11.2 Alternative - As an alternative to helical striping, and acceptable only if prior specific approval is granted (see paragraph 5.2), coding may be accomplished by the use of solid color insulation (body color) and colored core material (tracer color).
- 4.12 Workmanship - Cable shall be free of imperfections of manufacture which will materially affect the appearance or serviceability or will prevent satisfaction of requirements specified herein.

5. QUALITY ASSURANCE PROVISIONS

- 5.1 Reports - Unless otherwise specified, the vendor shall furnish two copies of a certified report of the results of tests to determine conformance to the requirements of this specification. This report shall include the purchase order number, material specification number, type, manufacturer's stock or lot number and date of tests.
- 5.2 Approval - A vendor shall not begin to supply material to this specification until samples are submitted to the Materials and Processes Group, and thereafter, the materials and methods of manufacture shall not be changed without prior approval from the Materials and Processes Group.

6. PREPARATION FOR DELIVERY

- 6.1 Shipping Reels - Each shipping reel shall be permanently and legibly marked to give the following information:

Cable, Resistance Heating, Aluminum Jacket
 Material Spec. _____
 Type _____ Length _____
 Purchase Order No. _____
 Manufacturer _____
 Date of Manufacture _____

- 6.1.1 Multiple Lengths - When more than one length is shipped on a reel (see paragraph 4.5), the individual piece lengths shall be marked on the reel.
- 6.1.2 Drum Diameter - The minimum drum diameter of each reel shall be 3-1/2 inches.

SOCIETY OF AUTOMOTIVE ENGINEERS, Inc.
 485 LEXINGTON AVENUE
 NEW YORK 17, N.Y.

**AEROSPACE
 INFORMATION REPORT**

AIR 860

AIRCRAFT ELECTRICAL HEATING SYSTEMS

**Issued 1-10-65
 Revised**

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1. INTRODUCTION	5
2. PURPOSE	5
3. SCOPE	5
4. GENERAL INFORMATION	5
4.1 General Design Considerations	5
4.1.1 Electrical Power Availability	5
4.1.2 Ground Power Sources	5
4.1.3 Reliability and Flexibility	5
4.1.4 Weight	5
4.1.5 Location	6
4.1.6 Control of Heating Elements	6
4.1.7 Heating System Integration	6
4.1.8 Heat Transmission	6

APPENDIX I - AIRCRAFT "A"

<u>Section</u>	
1. GENERAL AIRCRAFT INFORMATION	7
2. SPECIFIC DESIGN AND OPERATION INFORMATION	9
Passenger Compartment - Electrical Radiant Panels	9
- Floor Panels	9
- Wall and Window Heating Panels	11
Specific Design and Operation Information	13
- Cargo Compartment - Electric Radiant Panels	13
- Flight Station - Electric Duct Heater	14
- Cabin - Electrical Duct Heater	15

Section 8.3 of the SAE Technical Board rules provides that: "All technical reports, including standards approved and practices recommended, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

SAEFORM.COM: Click to view the full PDF of air860

APPENDIX II - AIRCRAFT "A"

(Material Specification--Subject: Cable, Resistance Heating, Aluminum Jacket)

<u>Section</u>	<u>Page</u>
1. SCOPE	38
2. CLASSIFICATION	38
3. APPLICABLE DOCUMENTS	38
4. REQUIREMENTS	38
5. QUALITY ASSURANCE PROVISIONS	40
6. PREPARATION FOR DELIVERY	40

SAENORM.COM : Click to view the full PDF of air860

FIGURES

APPENDIX I - AIRCRAFT "A"

Section 2

<u>Figure</u>	<u>Title</u>	<u>Page</u>
1	Cabin Wall and Floor Radiant Panels	18
2	Radiant Heating Panels	19
2A	Cabin Wall and Floor Radiant Panels - Sect. View	20
2B	Wall Panel - Upper	21
3	Cabin Floor Radiant Panel Assembly	22
3A	Radiant Heat Panels Control	22
4	Section - Terminal Block - Floor Panel Installation	24
5	Section - Cabin Floor Radiant Panel Installation	25
6	Spacer - Screw - Radiant Panel	26
7	Terminal Block Details	27
8	Cargo Compartment Floor and Radiant Panel Installation	28
9	Cargo Compartment Radiant Panel - Typical	29
9A	Cargo Compartment Heating Circuit	30
10	Schematic Diagram - Air Conditioning	31
11	Flight Station Duct Heater and Recirculation Fan Circuits	32
12	Flight Station Duct Heater Details	33
13	Flight Station Duct Heater Functional Test Setup	34
14	Cabin Duct Heater Details	35
15	Cabin Duct Heater Electrical Circuit	36
16	Cabin Duct Heater Functional Test Setup	37

TABLES

APPENDIX I - AIRCRAFT "A"

Section 2

<u>Table</u>	<u>Title</u>	<u>Page</u>
I	Flight Station Duct Heater Functional Test.....	16
II	Cabin Duct Heater Functional Test.....	17

APPENDIX II - AIRCRAFT "A"

<u>Table</u>	<u>Title</u>	<u>Page</u>
I	Cable, Resistance Heating, Aluminum Jacket	38

SAENORM.COM : Click to view the full PDF of air860

1. INTRODUCTION - The modern air transport utilizing main propulsion engines of the turbo-prop or turbo-jet types generally provides speed characteristics suitable for the generation of large quantities of electrical power. Proper speed characteristics may be inherent in the main engine design or may be provided through constant speed devices. The electrical load of modern aircraft is generally large, requiring sufficient generating capacity to meet all normal and emergency electrical demands. The use of electrical heating may be attractive since the generating capacity designed into the system to meet the cooling cycle and other non-continuous electrical loads becomes available for heating when cooling is not required.
2. PURPOSE - This report is intended to furnish the aerospace industry with brief design information and data on cabin and cargo space electrical heating. The design information and data contained herein are applicable to modern aircraft utilizing main propulsion systems such as turbo-jet, turbo-fan, and turbo-prop.
3. SCOPE
 - 3.1 It is intended that the scope of this information report be limited to electrical heating of passenger, crew, and cargo compartments only.
 - 3.2 No attempt has been made to develop the complete electrical circuitry associated with the electrical heating components; however, the electrical circuitry required for heating component operation, safety, and monitoring will be included as available.
 - 3.3 Specific design information is given for various modern aircraft utilizing electrical heating. Each aircraft discussed will be identified by alphabetical letter designation and included in the appropriate appendix.
4. GENERAL INFORMATION
 - 4.1 General Design Considerations
 - 4.1.1 Electrical Power Availability - Electrical heating may be used to compliment other heating sources or used as a sole heating source, depending upon flight and ground operating mode, degree of system integration, control, and economic considerations of heat and power generation devices.
 - 4.1.2 Ground Power Sources - Ground power sources capable of supplying sufficient electrical power are available, thus permitting electrical heating of the aircraft on the ground without requiring main engine operation.
 - 4.1.3 Reliability and Flexibility - A high degree of reliability and flexibility may be attained in the use of electrical heating.
 - 4.1.4 Weight - The weight penalty incurred by using electrical heating may be small compared to other heat generating sources provided generator capacity is available as a requirement of meeting other electrical loads.

- 4.1.5 Location - The use of electrical heating may be more suitable when compared to other methods when the area or location of the area to be heated presents unusual heating design problems.
- 4.1.6 Control of Heating Elements - Control of electrical heating elements is simple.
- 4.1.7 Heating System Integration - Integration of electrical heating system with other heat sources can be accomplished. Proper integration and control can provide maximum passenger and crew comfort by the elimination of cold surfaces adjacent to passengers and the elimination of circulating air at uncomfortable air temperature gradients.
- 4.1.8 Heat Transmission - Heat may be transferred between various heat sources and heat sinks by one of the following, or a combination of the following, processes: convection, radiation, and conduction. In an aircraft cabin, heat transfer may take place in the following ways:
- a. Convection between the boundary layer and cabin outer skin.
 - b. Convection between the cabin interior surface and cabin air.
 - c. Convection between cabin air and passengers or equipment
 - d. Convection and radiation from internal heat sources, such as electrical and electronic equipment, internal surfaces, and passengers.
 - e. Conduction through structural members and cabin walls.

PREPARED BY SAE COMMITTEE AC-9,
AIRCRAFT ENVIRONMENTAL SYSTEMS

APPENDIX I

AIRCRAFT "A"

Section 1

GENERAL AIRCRAFT INFORMATION

TYPE	ENGINES		ALTITUDE	CABIN DIFF. PR.	FUSELAGE			
	Type	No.			Mat.	Max. Breadth Outside	Inside	Press. Vol.
Transport	Turbo- prop	4	S. L. to 30,000 ft	6.5 psig	Al.	136 in.	128 in.	8500 cu. ft.

FUSELAGE (continued)

Pr. Vol. Cargo Compt.		Pass. & Crew Compt.	Insulation			
Fwd.	Rear	Pr. Volume	Mat.	Density	Walls	Floor
254 cu. ft.	263 cu. ft.	8000 cu. ft. (app.)	Fiber- glass	0.60 lb/cu.ft	1-1/2 in. to 3 in.	3-1/2 in.

FUSELAGE (Continued)		CABIN PRESS. AIR SOURCES	CABIN COOLING	
Insulation Cargo Fl.	Air Supply Ducts Insulation	Engine Driven Compressor (EDC) 2 Used	Air Cycle	Vapor Cycle
1-1/2 in.	1-1/2 in. Fiber- glass - Mylar			2 Used

CABIN HEATING METHODS					CREW COMPARTMENT HEATING METHODS		
EDC Heat of Comp.	Elec. Rad. Floor Panels	Elec. Resist. Duct Heaters	Elec. Radiant Wall Panels	Elec. Radiant Window Panels	EDC Heat of Comp.	Elec. Resist. Duct Heaters	

APPENDIX I

CARGO COMPARTMENT HEATING METHODS	TEMPERATURE REQMTS. A/C SYSTEM					
	HEATING					
	In Flight			Ground Operation		
Elec. Resist. Panels, Floor	Amb.	Occ. Area	Cargo	Amb.	Cab & Flt.	Cargo
	-60°F.	75°F.	35°F. or more	-5°F.	75°F.	35°F. or more

STEADY STATE HEATING PERFORMANCE

Auto. Temp. Cont. Tolerance	Flight Cond.	Comp't.	Amb. Temp.	Comp't. Temp.	Req'd Elec. Cap.	Total Available Elec. Cap.
Less than $\pm 2^\circ\text{F.}$ at any one point	Ground (Full Rec. Air.)	Flt. Sta.	-5°F.	75°F.	3.9 KW	10 KW (Duct Heater)
		Cabin	-5°F.	75°F.	5.9 KW	11.3 KW (Radiant Panels)
	Ground 15 lb Fresh Air	Flt. Sta.	-5°F.	75°F.	9.0 KW	10 KW (Duct Heater)
		Cabin	-5°F.	75°F.	23.0 KW	30 KW (Radiant Pan- els plus duct heater)
	30,000 ft Cruise with 8000 Ft. Cabin	Flt. Sta. Cabin	-60°F.	75°F.	5.6 KW	10.0 KW (Duct Heater)
			-60°F.	75°F.	7.6 KW	9.7 KW (Radiant Panels)

APPENDIX I

Section 2

SPECIFIC DESIGN AND OPERATION INFORMATION

PASSENGER COMPARTMENT - ELECTRIC RADIANT PANELS

FLOOR PANELS

LOCATION	TYPES USED			DETAILS - HONEYCOMB HEATED	
				CONSTRUCTION	
See Fig. 1 and Fig. 2	Plywood (Not heated) 3/8 in. thick	Honey- comb (Not heated) 3/8 in. thick	Honey- comb Heated 3/8 in. (approx.) thick 25 panels (Fig. 1)	Material and Size	
				Core	Plates
				Al. Al. 5052H Foil Spec. MIL-C-7438 Cell Size 1/8 in. Hex Thickness = .001 in. Cell Depth = .341 ± .003	<u>Top Cover Plate</u> Alclad 7075T6 Spec. QQ-A-287 .016 in thickness <u>Bottom Cover Plate</u> Alclad 7075T6 Spec. QQ-A-287 .012 in. thick- ness
				See Figures 3 & 5	

FLOOR PANELS

DETAILS - HONEYCOMB HEATED

BONDING	CONSTRUCTION			INSTALLATION	
	ELECTRICAL RESIST. CABLE	ELEC.	MOUNTING	METHOD	
	Install. & Mat.	Capacity	TERMINAL	SPACERS	SCREWS
MIL-A-5090 Adhesive System	<u>Installation</u> See Fig. 3 Install in crushed groove <u>Material</u> See App. II	20 watts per sq. ft. <u>Power</u> 115/208 VAC 3 phase 400 cycle	See Fig. 7 Install per Fig. 4	See Fig. 6 See Fig. 5	No. 10 Flat Head

APPENDIX I

PASSENGER COMPARTMENT - ELECTRIC RADIANT PANELS (Continued)

FLOOR PANELS

DETAILS - HONEYCOMB HEATED

FUNCTIONAL TEST

DIELECTRIC TEST - HEATING ELEMENT TERMINALS

TEST EQUIPMENT	TEST CONNECTIONS	VOLTAGE	TIME	CRITERIA OF FAILURE	PANEL MARKING
Insulation Breakdown Tester	1. Either term. 2. Ground (on panel)	1250 AC 60 cycle	1 sec.	No indication of Insul. Breakdown	Mark Panel as having been "Dielectric tested OK"

DIELECTRIC TEST - TEMPERATURE SENSOR TERMINALS

TEST EQUIPMENT	TEST CONNECTIONS	VOLTAGE	TIME	CRITERIA OF FAILURE	PANEL MARKING
(Same as for heating element test above)	1. One sensor term. 2. Ground (to panel)	200 AC 60 cycle	1 sec.	No indication of Insul. Breakdown	Mark Panel as having been "Dielectric tested OK"

RESISTANCE TEST - HEATING ELEMENT

TEST EQUIPMENT	TEST CONNECTIONS	TEST REQUIREMENT	TEST TOLERANCE
1. Wheatstone Bridge	Both heating element terminals	Detail panel drawing to specify resistance cable length and resistance value per foot of length	+ 10% from Resist. per detail drawing
2. Detail Panel Dwg.		Total resist. = L' x R/ft	

APPENDIX I

PASSENGER COMPARTMENT - ELECTRIC RADIANT PANELS (continued)

WALL AND WINDOW HEATING PANELS				
LOCATION	TYPES USED	DETAILS, PANELS, WALL AND WINDOW		
See Figs. 2A and 2B	Honeycomb Heated 1/4 in. thick 32 Sidewall Panels 37 Windows	CONSTRUCTION		
		MATERIAL AND SIZE		BONDING
		Core	Plates	MIL-A-5090 Adhesive System
		Al. Al. 5052H Foil Spec. MIL-C-7438 Cell size 1/4 in. Hex. Thickness .001 Cell Depth 1/4 in.	<u>Inboard Cover Plate</u> Al. Al. .004 in. thick <u>Outboard Cover Plate</u> Al. Al. .004 in. thick	

CONSTRUCTION (continued)

Edging	Trim	Trim Padding	Elec. Resistance Cable	
Hardwood inserts on 4 edges	<u>Cabin Side</u> "Naugahyde" or "Duratrim" vinyl coated fabrics. Cemented or stapled to panels	<u>Cabin Side</u> 1/2 in. Fiberglass 0.6 lbs. per cu. ft. Install between trim and panel	<u>Install. & Mat.</u> <u>Installation</u> See Fig. 1 Similar to Floor Panel Fig. 3 <u>Material</u> See App. II	<u>Capacity</u> 20 watts per sq ft. Power 115/208 VAC 3 phase 400 cycle

CONSTRUCTION (Continued)

Elec. Terminals	Installation	Functional Test
See Fig. 7	See Figs. 1, 2, 2A, 2B	Check Elec. & Dielectric Tests
Elec. Bond- ing per Fig. 2B	Special Extrusions and clips	

APPENDIX I

FUNCTIONAL TEST		
Dielectric Test Heating Elements	Dielectric Test Temp. Sensors	Resistance Test. Heating Elements

← Same as for floor panels →

SAENORM.COM : Click to view the full PDF of air860

APPENDIX I

SPECIFIC DESIGN AND OPERATION INFORMATION

CARGO COMPARTMENT - ELECTRIC RADIANT PANELS
CARGO HEATING PANELS

LOCATION	TYPE USED	CONSTRUCTION		
See Fig. 8 Below cargo structural floor. No. per comp't 42 panels fwd. 43 panels aft	See Fig. 9 Laminated - one layer of Al. alloy sheet, bonded to a layer of fiberglass, with heating element wires between the two layers.	Material and Size		
		<u>Al. Alloy</u> .008 in. thick 5052-0 Spec. QQ-A-318	<u>Fiberglass Cloth</u> .010 thick Phenolic impregnated Spec. "Conolon 506-B-181" "Narmco" or "AF104#120" by 3M Co.	<u>Bonding</u> MIL-A-5090 Bonding System Liq. Adhesive Type III Tape Adhesive Type I Cure at 350°F for 45 min. with bag press. of 10 to 25 psig

CONSTRUCTION (continued)

BUMPERS SPACERS	ELECTRICAL RESIST. CABLE		ELEC. TERMINAL & CIRCUITS	INSTALLATION
Plastic Foam, Cellulose Acetate Rod	<u>Install. & Mat.</u>	<u>Capacity</u>	See Fig. 7 See Fig. 9A	See Figs. 8 & 9
	<u>Installation</u> See Fig. 9	61 watts per sq. ft.		
	<u>Material</u> See Appendix II	<u>Power</u> 115/208 VAC 3 phase 400 cycle		

FUNCTIONAL TEST

Dielectric Test	Resistance Test
Heating Element & Terminals	Heating Element
Same as floor panels	Same as for floor panels

- 14 -

APPENDIX I

SPECIFIC DESIGN AND OPERATION INFORMATION

FLIGHT STATION - ELECTRIC DUCT HEATER

LOCATION	TYPE AND CONSTRUCTION	ELECTRICAL
See Fig. 10 Located in flight station air supply duct	See Fig. 12	See Fig. 11 Total op. current 29 to 35 amps Capacity, 10 KW Power 115/208 VAC, 400 cycle, 3 phase Control Power, 26 VDC

FLIGHT STATION - ELECTRIC DUCT HEATER

FUNCTIONAL TEST	PERFORMANCE	
	At Sea Level	At 8000' Press. Alt.
See Fig. 13 for Test Setup		
1. Continuity test	Air Flow 30#/min.	22#/min.
	Air "In" Temp. 70°F	70°F.
2. Airflow distribution across face of heater must be uniform	Max. Temp. Rise 79°F	108°F.
	Max Pr. Drop .50 in. H ₂ O	.40 in. H ₂ O
	Max. Surface Temp. 300°F	350°F.
3. Electrical sequence per Table I.	Normal Surface Temp. 200 to 250°F.	200 to 250°F.
4. Overheat test - no airflow - Thermal protector to operate within 90 seconds.		

APPENDIX I

SPECIAL DESIGN AND OPERATION INFORMATION

CABIN - ELECTRICAL DUCT HEATER		
LOCATION	TYPE AND CONSTRUCTION	ELECTRICAL
See Fig. 10 located in cabin air supply duct	See Figure 14	See Figure 15 Total operating current 37 to 58 AMPS Power - 115/208 VAC, 400 cycle Capacity, 18 KW Control Power 26 VDC

CABIN - ELECTRICAL DUCT HEATER

FUNCTIONAL TEST	PERFORMANCE	
	At Sea Level	At 8000' Press. Alt.
See Fig. 16 for test setup		
1. Continuity test	Air Flow 151#/min.	116#/min.
2. Airflow distribution across face of heater	Air "In" Temp. 70°F. Max. Temp. Rise 28°F. Max. Pr. Drop .35" H ₂ O Max. Surface Temp. 300°F.	70°F. 36°F. .30 in. H ₂ O
3. Electrical sequence test per Table II	Normal Surface Temp. 150 to 200°F.	350°F.
4. Overheat test - no airflow - thermal protector to operate within 90 seconds		150 to 200°F.

TABLE I

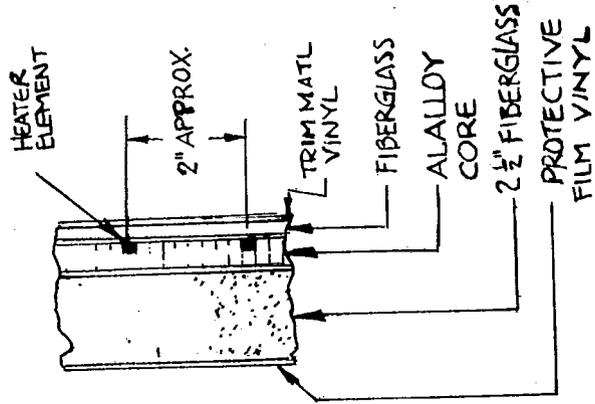
FLIGHT STATION DUCT HEATER FUNCTIONAL TEST

TEST INFORMATION					
Energizing Sequence Steps	Close Circuit Breaker	Current (amp)			
		Group 1	Group 2	Group 3	Group 4
1	CB1	2.9-3.5			
2	CB2		5.8-7.0		
3	CB3			8.7-10.5	
4	CB4				11.6-14.0
5	CB1, CB4	2.6-3.2*			11.3-13.7
6	CB2, CB4		5.5-6.7		11.3-13.7
7	CB3, CB4			8.1-9.9	11.0-13.4
8	CB1, CB3, CB4	2.6-3.2		8.1-9.9	10.7-13.1
9	CB2, CB3, CB4		5.2-6.4	7.8-9.6	10.7-13.1
10	CB1, CB2 CB3, CB4	2.6-3.2	5.2-6.4	7.8-9.6	10.4-12.8

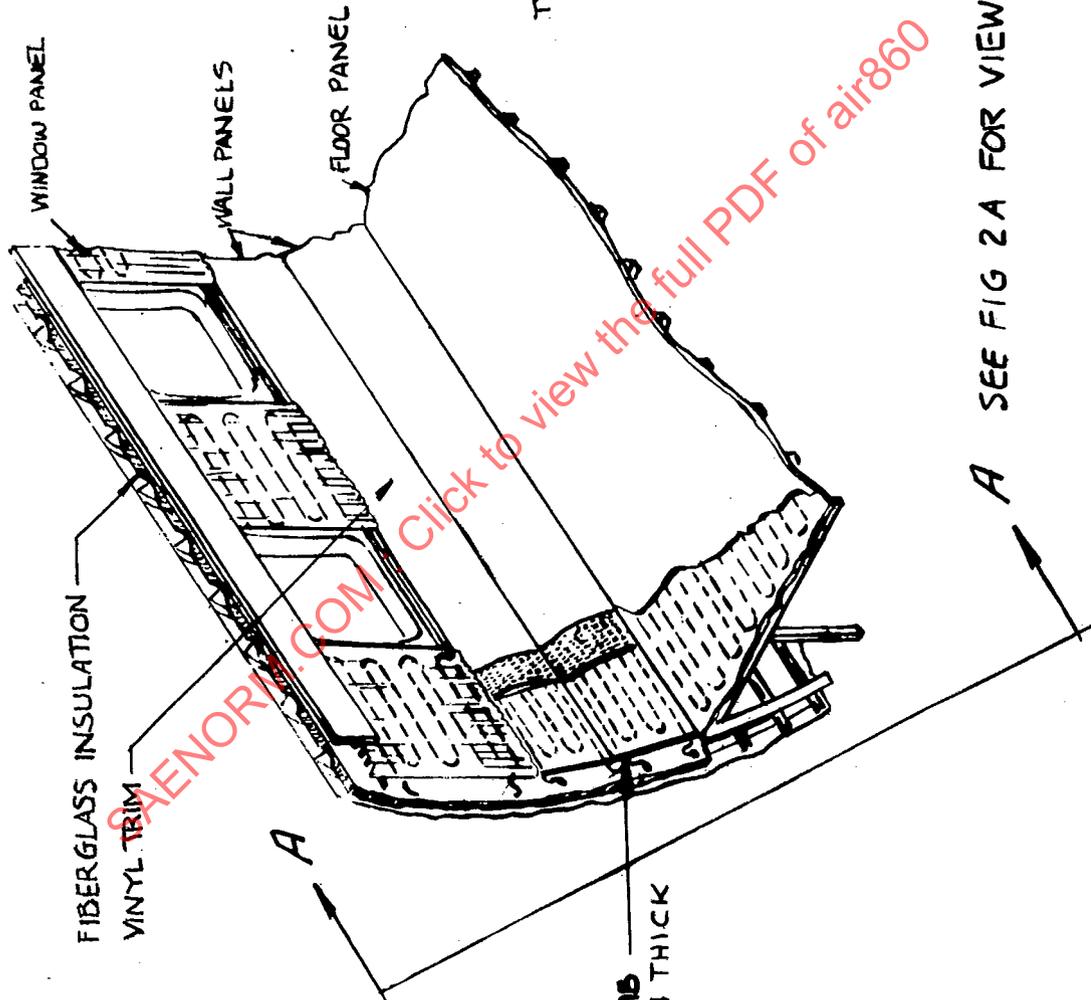
* Determine current value for each group in group combination by opening one circuit breaker at a time and noting current drop.

TABLE II
CABIN DUCT HEATER FUNCTIONAL TEST

Energizing Sequence Steps	Close Circuit Breaker	CURRENT (Amp)		
		Group 1	Group 2	Group 3
		1	CB1	7.8 to 9.6
2	CB2		15.6 to 19.2	
3	CB3			23.4 to 28.8
4	CB1, CB3	7.4 to 9.1		22.2 to 27.4
5	CB2, CB3		14.8 to 18.2	22.2 to 27.4
6	CB1, CB2, CB3	7.4 to 9.1	14 to 17.3	21 to 26



TYPICAL SECTION THROUGH WALL PANEL



AL. CORE .25 HONEY COMB
AL. COVER SHEETS .004 THICK

A SEE FIG 2A FOR VIEW "A-A"

SAENORIT.COM Click to view the full PDF of air860

Figure 1. Cabin Wall and Floor Radiant Panels

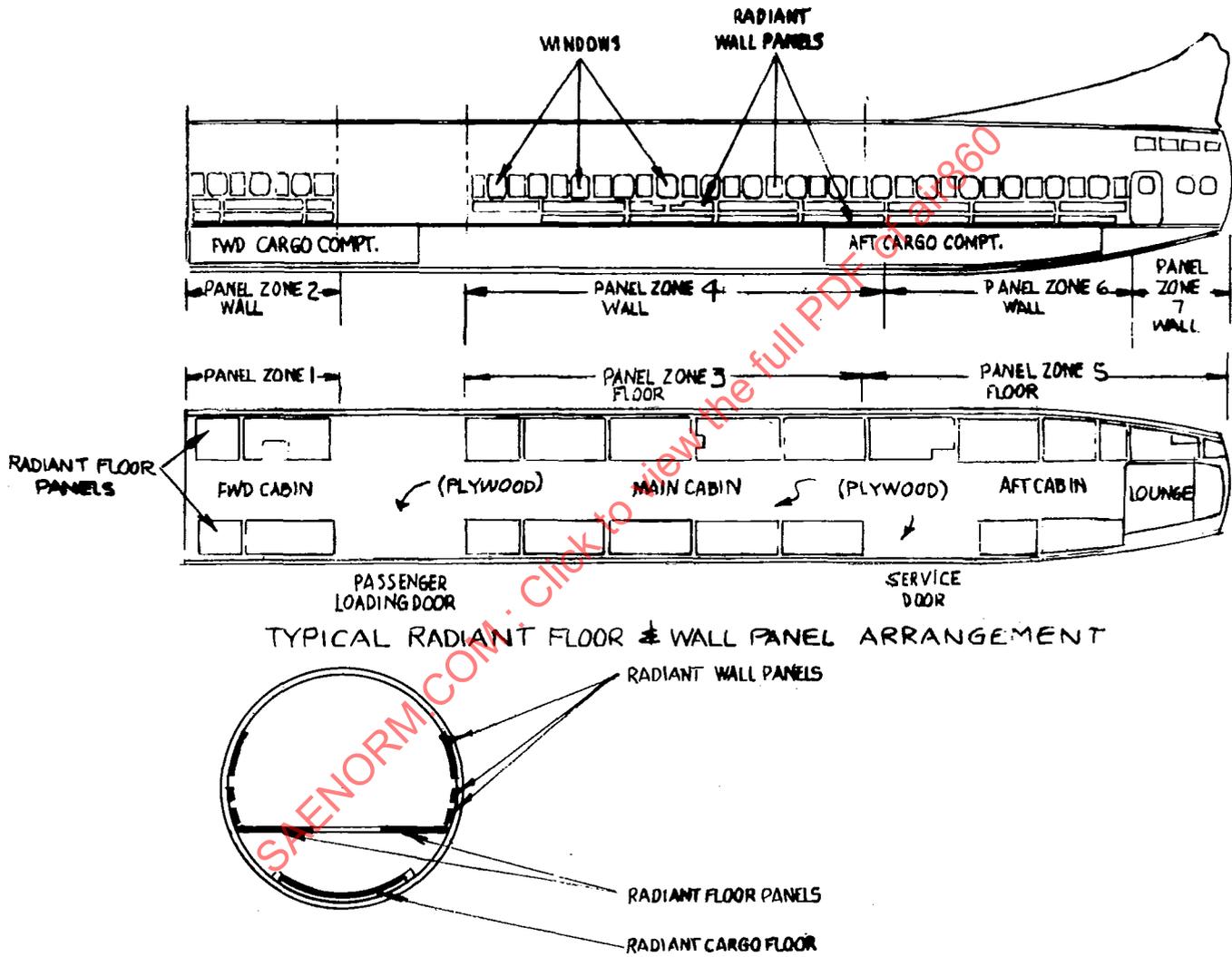


Figure 2. Radiant Heating Panels

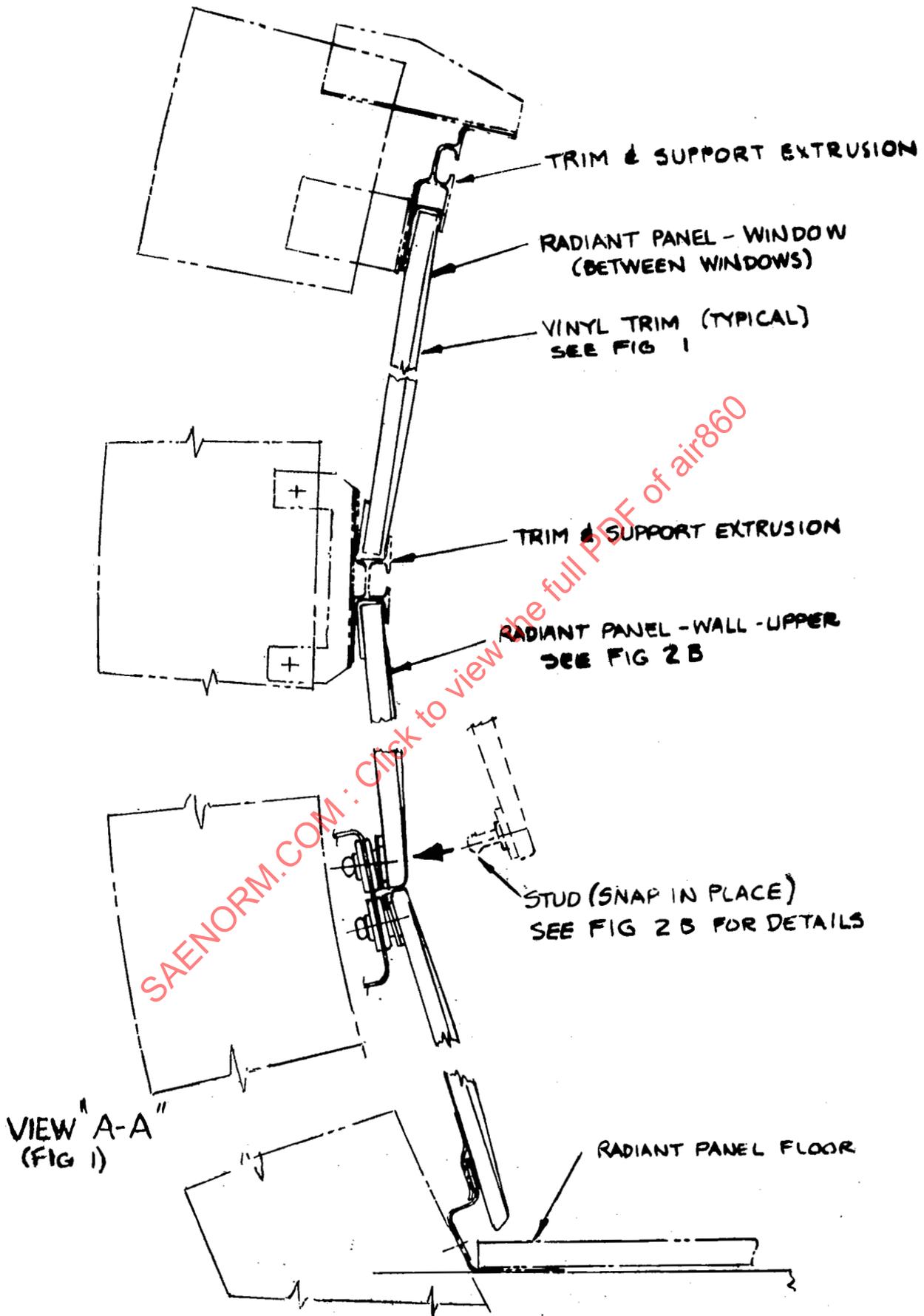
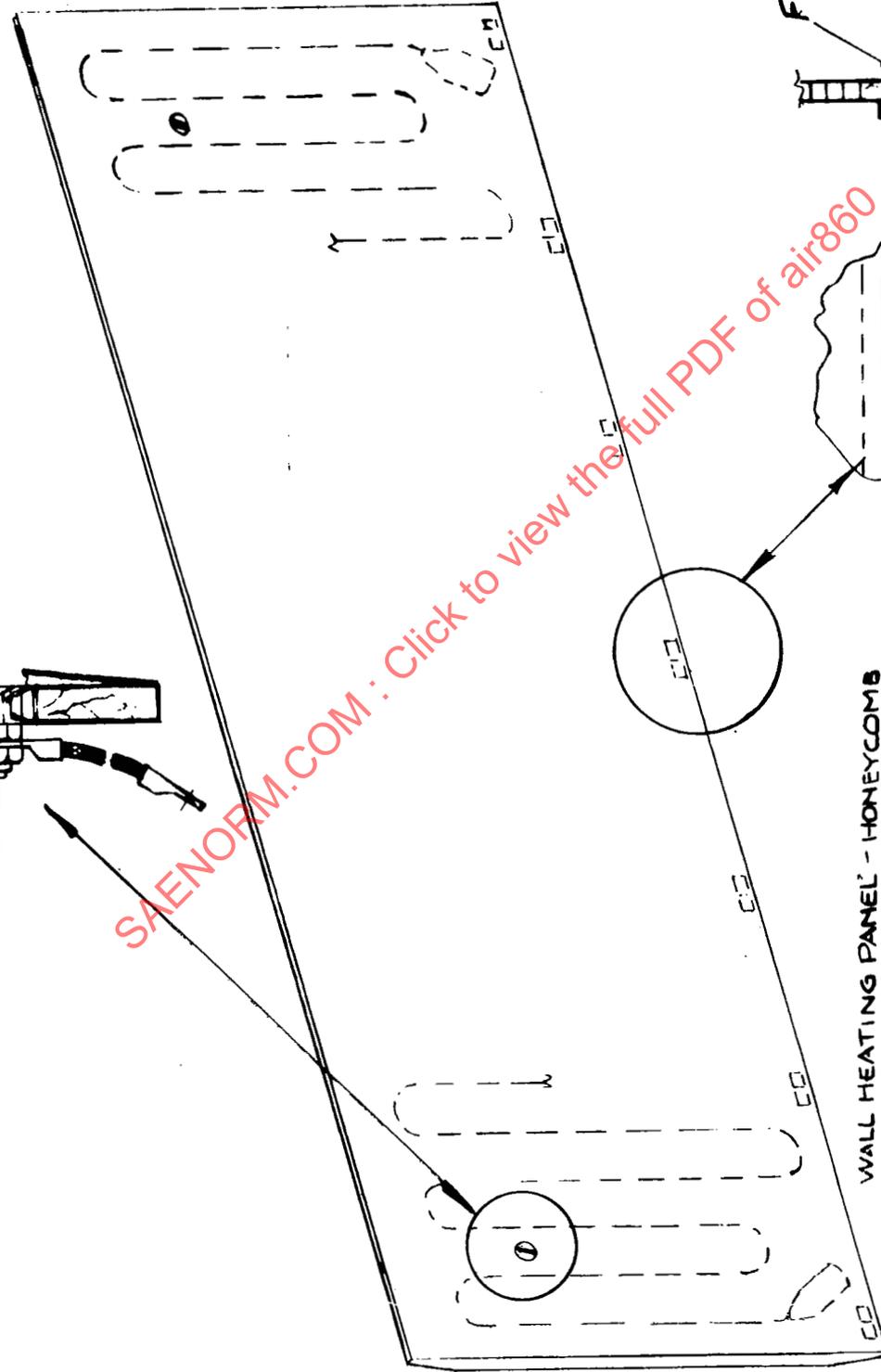


Figure 2A. Cabin Wall and Floor Radiant Panels - Sect. View

INSTALL. INSTR.
 DRILL HOLE .311 IN PANEL.
 PRESS IN PLUG & SLEEVE
 FLUSH WITH SKIN.
 NO DIMPLING REQD

ZC10-0 PLUG
 S102D10-04 SLEEVE } SEE FIG 6
 AN 345-10 NUT
 MS 25003-10B-4 JUMPER, BONDING
 AN 960-10L WASHER
 NAS 679 A3 NUT
 AN 507-1032 R12 SCREW



WALL HEATING PANEL - HONEYCOMB
 MATL. SPEC - MIL-C-7438
 MATL. - ALALLOY 5052 H FOIL CORE
 MATL THICKNESS = .001
 CELL SIZE = 1/4" HEXAGONAL
 COVER PLATE INBD. = .004" THICK
 " " OUTBD. = .004" "
 1/2" FIBERGLASS PADDING WEIGHING .6 LBS. FT³
 BEHIND TRIM FABRIC & TRIM PADDING WRAPPED
 AROUND ALL EDGES OF BASIC PANEL & FASTENED

FLUSH RIVET
 HARD WOOD EDGING
 4 SIDES
 STUD RETAINER AL ALLOY
 STUD MILD STEEL

Figure 2B. Wall Panel - Upper

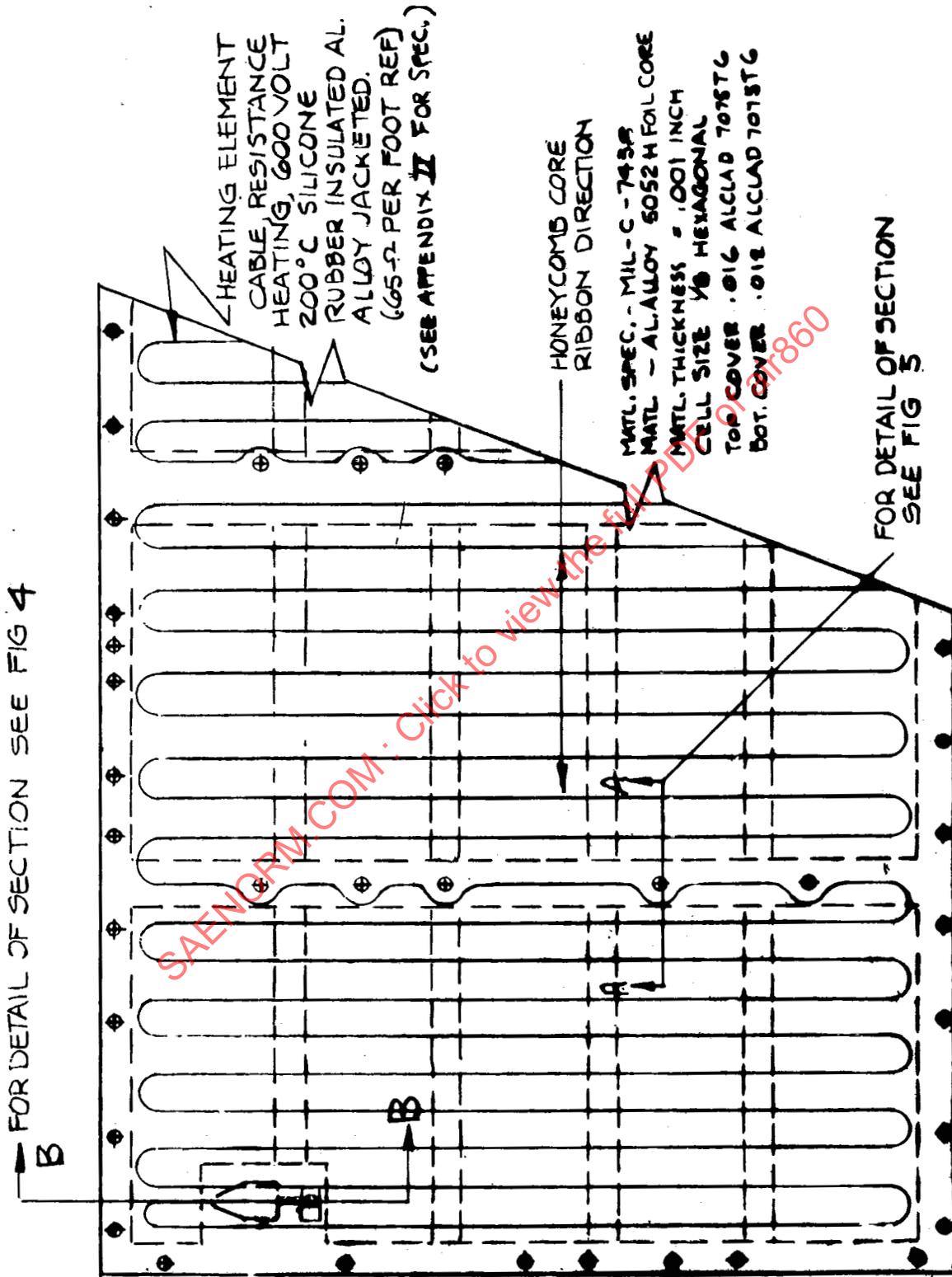


Figure 3. Cabin Floor Radiant Panel Assembly

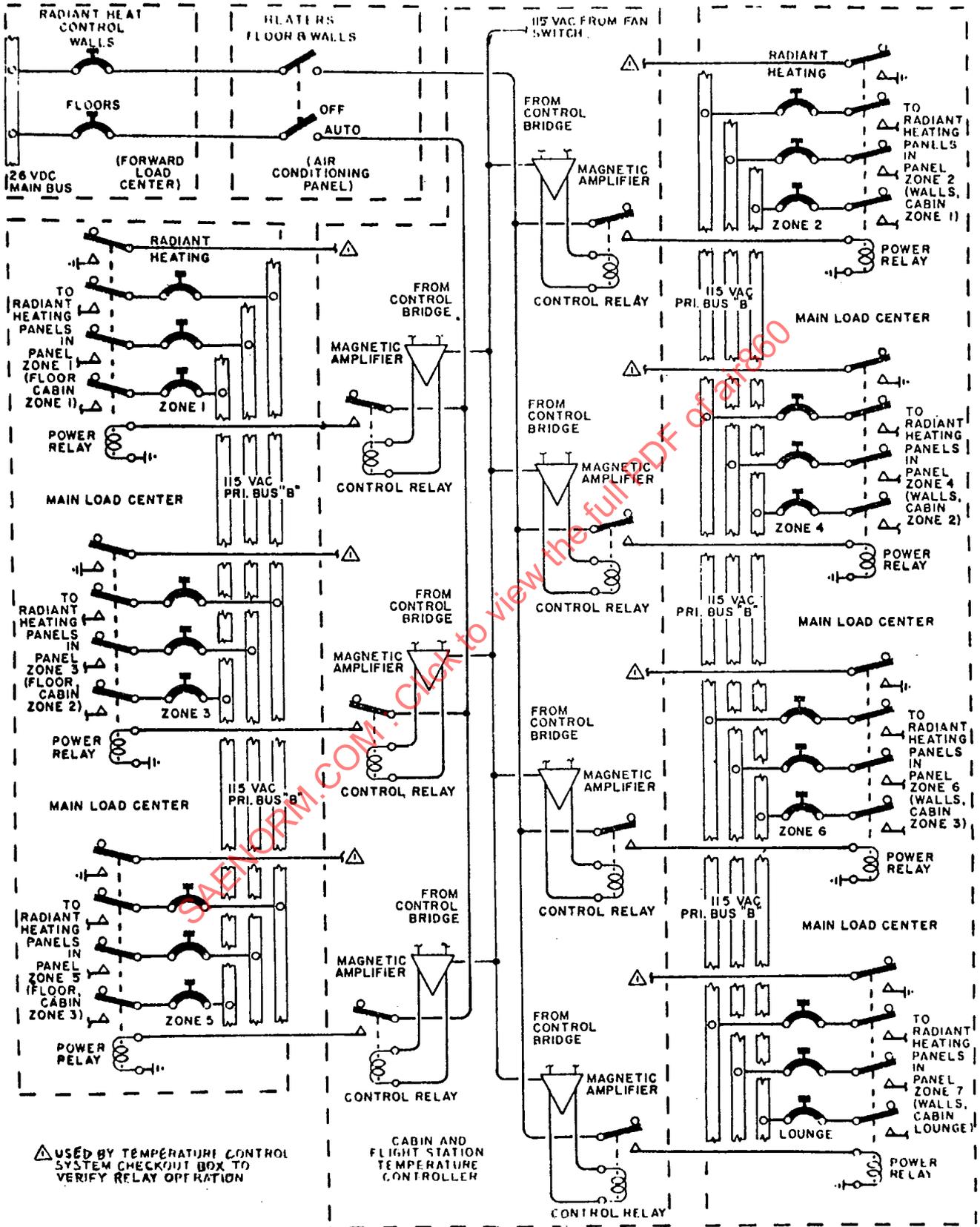
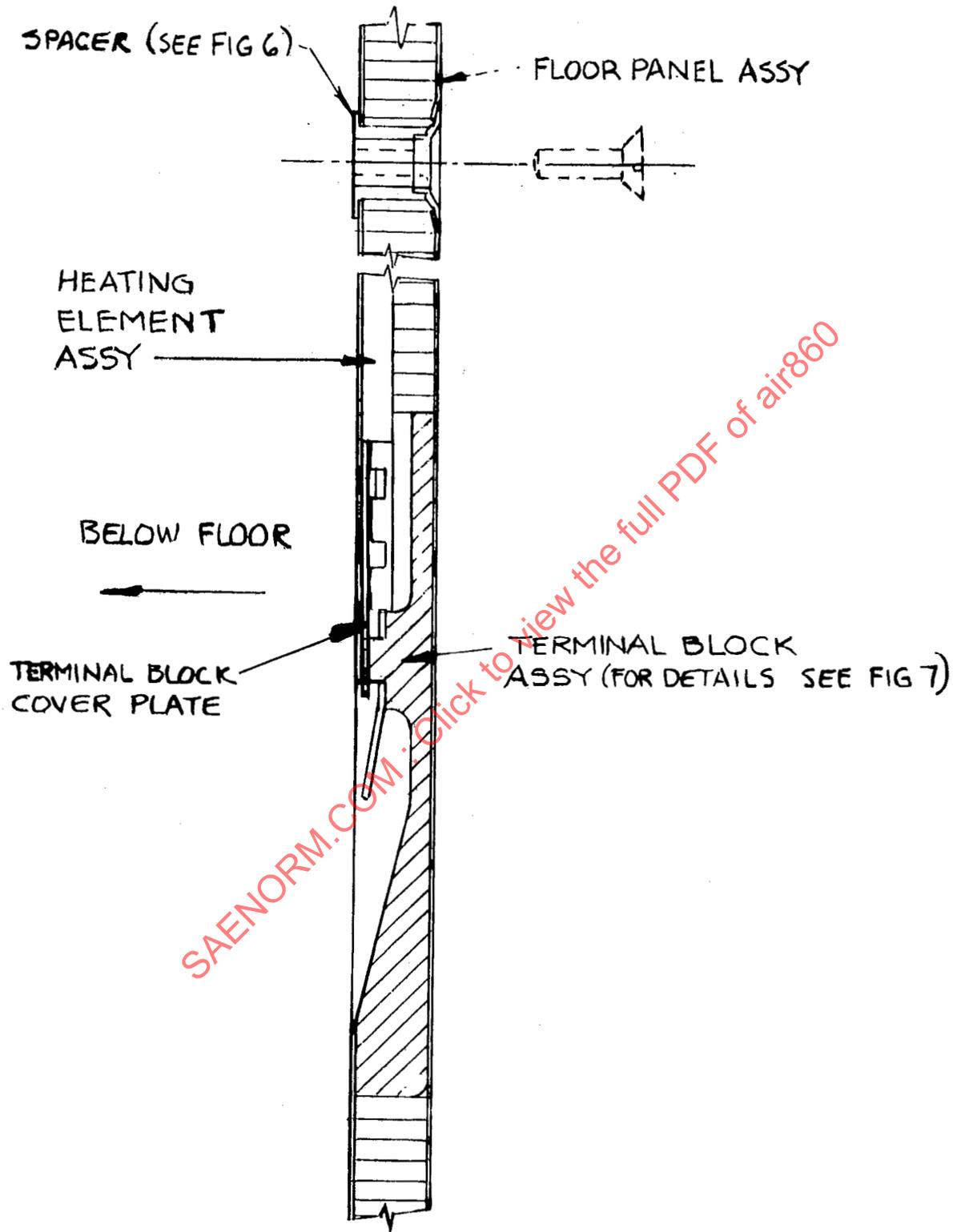


Figure 3A. Radiant Heat Panels Control



SECT B - B
SEE FIG 3

Figure 4. Section - Terminal Block - Floor Panel Installation

Distributed under license from the IHS Archive