

CHAPTER

21

Air Conditioning

CHAPTER 21
AIR CONDITIONING

Subject/Page	Date	COC	Subject/Page	Date	COC
21-EFFECTIVE PAGES			21-00-00 (cont.)		
1 thru 12	Sep 05/2018		7	May 05/2015	
21-CONTENTS			8	May 05/2015	
1	Jul 25/2018		9	May 05/2015	
2	Jul 25/2018		10	May 05/2015	
3	Jul 25/2018		11	May 05/2015	
4	Jul 25/2018		12	BLANK	
O 5	Sep 05/2018		21-20-00		
6	Jul 25/2018		1	May 05/2015	
7	Jul 25/2018		2	May 05/2015	
8	Jul 25/2018		3	May 05/2015	
9	Jul 25/2018		4	May 05/2015	
10	Jul 25/2018		5	May 05/2015	
11	Jul 25/2018		6	May 05/2015	
12	Jul 25/2018		7	May 05/2015	
13	Jul 25/2018		8	May 05/2015	
14	BLANK		9	May 05/2015	
21-00-00			10	BLANK	
1	Sep 05/2016		21-21-00		
2	Sep 05/2016		1	May 05/2015	
3	May 05/2015		2	May 05/2015	
4	May 05/2015		3	May 05/2015	
5	May 05/2015		4	May 05/2015	
6	May 05/2015		5	May 05/2015	
			6	BLANK	

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21-EFFECTIVE PAGES

D633W101-ARO

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**CHAPTER 21
AIR CONDITIONING**

Subject/Page	Date	COC	Subject/Page	Date	COC
21-22-00			21-25-00 (cont.)		
1	May 05/2015		11	Jul 25/2018	
2	May 05/2015		12	Jul 25/2018	
3	May 05/2015		13	Jul 25/2018	
4	BLANK		14	BLANK	
21-23-00			21-26-00		
1	May 05/2015		1	Sep 05/2016	
2	May 05/2015		2	Sep 05/2016	
3	May 05/2015		3	May 05/2015	
4	May 05/2015		4	Sep 05/2016	
5	May 05/2018		5	Sep 05/2016	
6	May 05/2018		6	Sep 05/2016	
7	May 05/2015		7	Sep 05/2016	
8	BLANK		8	Jul 25/2018	
21-25-00			9	Sep 05/2016	
1	May 05/2015		10	Sep 05/2016	
2	Jul 25/2018		11	Sep 05/2016	
3	May 05/2015		12	Jul 25/2018	
4	May 05/2015		13	Sep 05/2016	
5	May 05/2015		14	Sep 05/2016	
6	May 05/2015		15	May 05/2015	
7	May 05/2015		16	Jul 25/2018	
8	Jul 25/2018		17	Jul 25/2018	
9	Jul 25/2018		18	Jul 25/2018	
10	Jul 25/2018				

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21-EFFECTIVE PAGES

D633W101-ARO

ECCN 9E991 BOEING PROPRIETARY - Copyright © Unpublished Work - See title page for details

**CHAPTER 21
AIR CONDITIONING**

Subject/Page	Date	COC	Subject/Page	Date	COC
21-26-00 (cont.)			21-27-00 (cont.)		
19	Jul 25/2018		9	Jul 25/2018	
20	Jul 25/2018		10	May 05/2015	
21	Jul 25/2018		11	May 05/2015	
22	Jul 25/2018		12	Jul 25/2018	
23	Jul 25/2018		13	Jul 25/2018	
24	Jul 25/2018		14	May 05/2015	
25	Jul 25/2018		15	May 05/2015	
26	Jul 25/2018		16	Jul 25/2018	
27	Jul 25/2018		17	Jul 25/2018	
28	Jul 25/2018		18	May 05/2015	
29	Jul 25/2018		19	May 05/2015	
30	Jul 25/2018		20	Sep 05/2016	
31	Jul 25/2018		21	Sep 05/2016	
32	BLANK		22	Sep 05/2016	
21-27-00			23	May 05/2015	
1	May 05/2015		24	Jul 25/2018	
2	May 05/2015		25	Jul 25/2018	
3	May 05/2015		26	May 05/2015	
4	Jul 25/2018		27	May 05/2015	
5	Jul 25/2018		28	May 05/2015	
6	May 05/2015		29	May 05/2015	
7	May 05/2015		30	May 05/2015	
8	Jul 25/2018				

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21-EFFECTIVE PAGES

D633W101-ARO

ECCN 9E991 BOEING PROPRIETARY - Copyright © Unpublished Work - See title page for details

**CHAPTER 21**
AIR CONDITIONING

Subject/Page	Date	COC	Subject/Page	Date	COC
21-27-00 (cont.)			21-27-00 (cont.)		
31	May 05/2015		53	May 05/2015	
32	May 05/2015		54	May 05/2015	
33	May 05/2015		55	May 05/2015	
34	May 05/2015		56	May 05/2015	
35	May 05/2015		57	May 05/2015	
36	May 05/2015		58	May 05/2015	
37	May 05/2015		59	May 05/2015	
38	May 05/2015		60	May 05/2015	
39	May 05/2015		61	May 05/2015	
40	May 05/2015		62	May 05/2015	
41	May 05/2015		63	May 05/2015	
42	Jan 05/2016		64	May 05/2015	
43	May 05/2015		65	May 05/2015	
44	May 05/2015		66	May 05/2015	
45	May 05/2015		67	May 05/2018	
46	May 05/2015		68	May 05/2018	
47	May 05/2015		69	May 05/2015	
48	May 05/2015		70	May 05/2015	
49	May 05/2015		71	Sep 05/2016	
50	May 05/2015		72	Sep 05/2016	
51	May 05/2015		73	May 05/2015	
52	May 05/2015		74	May 05/2015	

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21-EFFECTIVE PAGES

D633W101-ARO

ECCN 9E991 BOEING PROPRIETARY - Copyright © Unpublished Work - See title page for details

**CHAPTER 21
AIR CONDITIONING**

Subject/Page	Date	COC	Subject/Page	Date	COC
21-27-00 (cont.)			21-27-00 (cont.)		
75	May 05/2015		97	Sep 05/2016	
76	May 05/2015		98	Sep 05/2016	
77	May 05/2015		98.1	Sep 05/2016	
78	May 05/2015		O 98.2	Sep 05/2018	
79	May 05/2015		R 98.3	Sep 05/2018	
80	May 05/2015		R 98.4	Sep 05/2018	
81	May 05/2015		O 98.5	Sep 05/2018	
82	Sep 05/2016		O 98.6	Sep 05/2018	
83	Sep 05/2016		O 98.7	Sep 05/2018	
84	Sep 05/2016		O 98.8	Sep 05/2018	
85	Sep 05/2016		O 98.9	Sep 05/2018	
86	Sep 05/2016		O 98.10	Sep 05/2018	
87	Sep 05/2016		O 98.11	Sep 05/2018	
88	Sep 05/2016		O 98.12	Sep 05/2018	
89	Sep 05/2016		R 98.13	Sep 05/2018	
90	Sep 05/2016		R 98.14	Sep 05/2018	
91	Sep 05/2016		O 98.15	Sep 05/2018	
92	Sep 05/2016		O 98.16	Sep 05/2018	
93	Sep 05/2016		A 98.17	Sep 05/2018	
94	Sep 05/2016		A 98.18	BLANK	
95	Sep 05/2016		21-28-00		
96	Sep 05/2016		1	May 05/2015	
			2	May 05/2017	

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21-EFFECTIVE PAGES

D633W101-ARO

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CHAPTER 21
AIR CONDITIONING

Subject/Page	Date	COC	Subject/Page	Date	COC
21-28-00 (cont.)			21-31-00 (cont.)		
3	May 05/2015		3	Sep 05/2016	
4	May 05/2015		4	Sep 05/2016	
5	May 05/2015		5	Sep 05/2016	
6	May 05/2015		6	Sep 05/2016	
7	May 05/2015		7	Sep 05/2016	
8	May 05/2015		8	Sep 05/2016	
9	May 05/2015		9	Sep 05/2016	
10	BLANK		10	Sep 05/2016	
21-30-00			11	Sep 05/2016	
1	May 05/2015		12	Sep 05/2016	
2	May 05/2015		13	Sep 05/2016	
3	May 05/2015		14	Sep 05/2016	
4	May 05/2015		15	Sep 05/2016	
5	May 05/2015		16	Sep 05/2016	
6	May 05/2015		17	Sep 05/2016	
7	May 05/2015		18	Sep 05/2016	
8	May 05/2015		19	Sep 05/2016	
9	May 05/2015		20	Sep 05/2016	
10	Sep 05/2017		21	Sep 05/2016	
11	May 05/2015		22	Sep 05/2016	
12	BLANK		23	Sep 05/2016	
21-31-00			24	May 05/2015	
1	Sep 05/2016		25	Sep 05/2016	
2	Sep 05/2016				

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21-EFFECTIVE PAGES

**CHAPTER 21
AIR CONDITIONING**

Subject/Page	Date	COC	Subject/Page	Date	COC
21-31-00 (cont.)			21-32-00 (cont.)		
26	Sep 05/2016		9	May 05/2015	
27	Sep 05/2016		10	BLANK	
28	May 05/2018		21-40-00		
29	May 05/2018		1	May 05/2015	
30	May 05/2018		2	May 05/2015	
31	Sep 05/2016		3	May 05/2015	
32	Sep 05/2016		4	May 05/2015	
33	Sep 05/2016		5	May 05/2015	
34	Sep 05/2016		6	May 05/2015	
35	Sep 05/2016		7	May 05/2015	
36	Sep 05/2016		8	BLANK	
37	Sep 05/2016		21-41-00		
38	Sep 05/2016		1	May 05/2015	
39	Sep 05/2016		2	May 05/2015	
40	BLANK		3	May 05/2015	
21-32-00			4	May 05/2015	
1	May 05/2015		5	May 05/2015	
2	May 05/2015		6	May 05/2015	
3	May 05/2015		7	May 05/2015	
4	May 05/2015		8	May 05/2015	
5	May 05/2015		9	May 05/2015	
6	May 05/2015		10	May 05/2015	
7	May 05/2015		11	May 05/2015	
8	May 05/2015		12	BLANK	

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21-EFFECTIVE PAGES

D633W101-ARO

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CHAPTER 21
AIR CONDITIONING

Subject/Page	Date	COC	Subject/Page	Date	COC
21-43-00			21-44-00 (cont.)		
1	Sep 05/2016		11	Sep 05/2016	
2	Sep 05/2016		12	BLANK	
3	May 05/2015		21-45-00		
4	May 05/2015		1	May 05/2015	
5	May 05/2015		2	May 05/2015	
6	May 05/2015		3	May 05/2015	
7	May 05/2015		4	May 05/2015	
8	May 05/2015		5	May 05/2015	
9	May 05/2015		6	May 05/2015	
10	May 05/2015		7	May 05/2015	
11	May 05/2015		8	May 05/2015	
12	BLANK		9	May 05/2015	
21-44-00			10	May 05/2015	
1	May 05/2015		11	May 05/2015	
2	May 05/2015		12	May 05/2015	
3	May 05/2015		13	May 05/2015	
4	May 05/2015		14	May 05/2015	
5	May 05/2015		15	May 05/2015	
6	May 05/2015		16	BLANK	
7	May 05/2015		21-50-00		
8	May 05/2015		1	May 05/2015	
9	May 05/2015		2	May 05/2015	
10	Sep 05/2016		3	May 05/2015	
			4	May 05/2015	

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21-EFFECTIVE PAGES

D633W101-ARO

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**CHAPTER 21
AIR CONDITIONING**

Subject/Page	Date	COC	Subject/Page	Date	COC
21-50-00 (cont.)			21-51-00 (cont.)		
5	May 05/2015		13	May 05/2015	
6	May 05/2015		14	May 05/2016	
7	May 05/2015		15	Sep 05/2017	
8	May 05/2015		16	May 05/2016	
9	May 05/2015		17	Sep 05/2016	
10	May 05/2015		18	Sep 05/2016	
11	May 05/2015		19	May 05/2015	
12	May 05/2015		20	May 05/2015	
13	May 05/2015		21	May 05/2015	
14	BLANK		22	May 05/2015	
21-51-00			23	May 05/2015	
1	May 05/2015		24	BLANK	
2	May 05/2015		21-52-00		
3	May 05/2015		1	May 05/2015	
4	May 05/2015		2	May 05/2015	
5	May 05/2015		3	May 05/2015	
6	May 05/2015		4	May 05/2015	
7	May 05/2015		5	May 05/2015	
8	May 05/2015		6	May 05/2015	
9	May 05/2015		7	May 05/2015	
10	May 05/2015		8	May 05/2015	
11	May 05/2015		9	May 05/2015	
12	May 05/2015		10	May 05/2015	

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21-EFFECTIVE PAGES

D633W101-ARO

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CHAPTER 21
AIR CONDITIONING

Subject/Page	Date	COC	Subject/Page	Date	COC
21-52-00 (cont.)			21-52-00 (cont.)		
11	May 05/2015		33	May 05/2015	
12	May 05/2015		34	Sep 05/2016	
13	May 05/2015		35	Sep 05/2016	
14	May 05/2015		36	Sep 05/2016	
15	May 05/2015		37	May 05/2015	
16	May 05/2015		38	Sep 05/2016	
17	May 05/2015		39	Sep 05/2016	
18	May 05/2015		40	Sep 05/2016	
19	May 05/2015		41	Sep 05/2016	
20	May 05/2015		42	Sep 05/2016	
21	May 05/2015		43	May 05/2015	
22	May 05/2015		44	BLANK	
23	May 05/2015		21-60-00		
24	May 05/2015		1	May 05/2015	
25	May 05/2015		2	May 05/2015	
26	May 05/2015		3	May 05/2015	
27	May 05/2015		4	May 05/2015	
28	May 05/2015		5	May 05/2015	
29	May 05/2015		6	May 05/2015	
30	Sep 05/2017		7	May 05/2015	
31	May 05/2015		8	May 05/2015	
32	May 05/2015		9	May 05/2015	
			10	May 05/2015	
			11	Sep 05/2016	

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21-EFFECTIVE PAGES

D633W101-ARO

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**CHAPTER 21
AIR CONDITIONING**

Subject/Page	Date	COC	Subject/Page	Date	COC
21-60-00 (cont.)			21-61-00 (cont.)		
12	Sep 05/2016		11	May 05/2015	
13	May 05/2015		12	May 05/2015	
14	May 05/2015		13	May 05/2015	
15	Sep 05/2016		14	May 05/2015	
16	Sep 05/2016		15	May 05/2015	
17	May 05/2015		16	May 05/2015	
18	May 05/2015		17	May 05/2015	
19	May 05/2015		18	May 05/2015	
20	May 05/2015		19	May 05/2015	
21	May 05/2015		20	May 05/2015	
22	May 05/2015		21	May 05/2015	
23	May 05/2015		22	May 05/2015	
24	BLANK		23	May 05/2015	
21-61-00			24	May 05/2015	
1	Sep 05/2016		25	May 05/2015	
2	Sep 05/2016		26	May 05/2015	
3	May 05/2015		27	May 05/2015	
4	May 05/2015		28	May 05/2015	
5	May 05/2015		29	May 05/2018	
6	May 05/2015		30	May 05/2018	
7	Sep 05/2016		31	May 05/2015	
8	Sep 05/2016		32	May 05/2015	
9	May 05/2015				
10	May 05/2015				

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21-EFFECTIVE PAGES

D633W101-ARO

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CHAPTER 21
AIR CONDITIONING

Subject/Page	Date	COC	Subject/Page	Date	COC
21-61-00 (cont.)					
33	May 05/2015				
34	May 05/2015				
35	Sep 05/2016				
36	Sep 05/2016				
37	May 05/2015				
38	BLANK				
21-62-00					
1	May 05/2015				
2	May 05/2015				
3	May 05/2015				
4	May 05/2015				
5	May 05/2015				
6	May 05/2015				
7	May 05/2015				
8	Sep 05/2016				
9	Sep 05/2016				
10	BLANK				
21-73-00					
1	May 05/2015				
2	May 05/2015				
3	May 05/2015				
4	BLANK				

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21-EFFECTIVE PAGES

D633W101-ARO

ECCN 9E991 BOEING PROPRIETARY - Copyright © Unpublished Work - See title page for details

CHAPTER 21
AIR CONDITIONING

CH-SC-SU	SUBJECT	PAGE	EFFECT
21-00-00	AIR CONDITIONING - INTRODUCTION	1	ARO ALL
21-00-00	AIR CONDITIONING - GENERAL DESCRIPTION - CONTROL	4	ARO ALL
21-00-00	AIR CONDITIONING - FLIGHT DECK CONTROLS	6	ARO ALL
21-00-00	AIR CONDITIONING - CONTROLLERS	8	ARO ALL
21-00-00	AIR CONDITIONING - ECS BAY	10	ARO ALL
21-20-00	AIR CONDITIONING - DISTRIBUTION - INTRODUCTION	2	ARO ALL
21-20-00	AIR CONDITIONING - DISTRIBUTION - GENERAL DESCRIPTION	4	ARO ALL
21-20-00	AIR CONDITIONING - DISTRIBUTION - OPERATION	6	ARO ALL
21-20-00	AIR CONDITIONING - DISTRIBUTION - GROUND TESTS	8	ARO ALL
21-21-00	AIR CONDITIONING - MAIN AIR DISTRIBUTION - DUCT	2	ARO ALL
21-21-00	AIR CONDITIONING - MAIN AIR DISTRIBUTION - MIX MANIFOLD	4	ARO ALL
21-22-00	AIR CONDITIONING - FLIGHT DECK CONDITIONED AIR DISTRIBUTION	2	ARO ALL
21-23-00	AIR CONDITIONING - PASSENGER CABIN CONDITIONED AIR DISTRIBUTION - LOWER LOBE AREA	2	ARO ALL
21-23-00	AIR CONDITIONING - PASSENGER CABIN CONDITIONED AIR DISTRIBUTION - PASSENGER CABIN AREA	5	ARO ALL
21-25-00	AIR CONDITIONING - RECIRCULATION - INTRODUCTION	2	ARO ALL
21-25-00	AIR CONDITIONING - RECIRCULATION - LOWER RECIRCULATION FANS AND FILTERS	4	ARO ALL
21-25-00	AIR CONDITIONING - RECIRCULATION - UPPER RECIRCULATION FANS AND FILTERS	6	ARO ALL

21-CONTENTS

D633W101-ARO

ECCN 9E991 BOEING PROPRIETARY - Copyright © Unpublished Work - See title page for details

CHAPTER 21
AIR CONDITIONING

CH-SC-SU	SUBJECT	PAGE	EFFECT
21-25-00	AIR CONDITIONING - RECIRCULATION - RECIRCULATION FANS VIBRATION MONITOR UNITS	8	ARO 001-016 POST SB 777-21-0189
21-25-00	AIR CONDITIONING - RECIRCULATION - FUNCTIONAL DESCRIPTION	11	ARO ALL
21-26-00	AIR CONDITIONING - VENTILATION - GENERAL DESCRIPTION - MECHANICAL	2	ARO ALL
21-26-00	AIR CONDITIONING - VENTILATION - GENERAL DESCRIPTION - ELECTRICAL	4	ARO ALL
21-26-00	AIR CONDITIONING - VENTILATION - GALLEY CHILLER CONDENSER EXHAUST SYSTEM	8	ARO ALL
21-26-00	AIR CONDITIONING - VENTILATION - CHILLER BOOST FAN - FUNCTIONAL DESCRIPTION	12	ARO ALL
21-26-00	AIR CONDITIONING - VENTILATION - CHILLER BOOST FAN VIBRATION MONITOR UNIT - FUNCTIONAL DESCRIPTION	16	ARO 001-016 POST SB 777-21-0189
21-26-00	AIR CONDITIONING - VENTILATION - FORWARD CARGO EXHAUST FAN	18	ARO ALL
21-26-00	AIR CONDITIONING - VENTILATION - FORWARD CARGO EXHAUST FAN - FUNCTIONAL DESCRIPTION	20	ARO ALL
21-26-00	AIR CONDITIONING - VENTILATION - BULK CARGO VENTILATION FAN	22	ARO ALL
21-26-00	AIR CONDITIONING - VENTILATION - BULK CARGO VENTILATION - FUNCTIONAL DESCRIPTION	24	ARO ALL
21-26-00	AIR CONDITIONING - VENTILATION - LAVATORY GALLEY VENTILATION FANS, INLET DUCT AND SCREEN	26	ARO ALL
21-26-00	AIR CONDITIONING - VENTILATION - GALLEY VENTILATION FILTERS	28	ARO ALL
21-26-00	AIR CONDITIONING - VENTILATION - LAVATORY GALLEY VENTILATION - FUNCTIONAL DESCRIPTION	30	ARO ALL
21-27-00	AIR CONDITIONING (A/C) - EQUIPMENT COOLING - INTRODUCTION	2	ARO ALL

21-CONTENTS

**CHAPTER 21
AIR CONDITIONING**

CH-SC-SU	SUBJECT	PAGE	EFFECT
21-27-00	A/C - EQUIPMENT COOLING - AFT SYSTEM - GENERAL DESCRIPTION - MECHANICAL	4	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - PASSENGER COMPARTMENT COMPONENT LOCATIONS	8	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - SATCOM BACKUP COOLING FAN AND CHECK VALVE	12	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - SATCOM BACKUP COOLING FAN	16	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FWD SYS - GENERAL DESCRIPTION - MECHANICAL	20	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - GENERAL DESCRIPTION - ELECTRICAL	24	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - INTERFACES	28	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FORWARD EQUIPMENT CENTER COMPONENT LOCATION	30	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - MAIN EQUIPMENT CENTER COMPONENT LOCATIONS	32	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FORWARD CARGO COMPARTMENT COMPONENT LOCATIONS - 1	34	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FORWARD CARGO COMPARTMENT COMPONENT LOCATIONS - 2	36	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FORWARD CARGO COMPARTMENT COMPONENT LOCATIONS - 3	38	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - AIR FILTER	40	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - SUPPLY FANS	42	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - OVERRIDE VALVE	44	ARO ALL

21-CONTENTS

**CHAPTER 21
AIR CONDITIONING**

CH-SC-SU	SUBJECT	PAGE	EFFECT
21-27-00	A/C - EQUIPMENT COOLING - DUCT PRESSURE SENSORS	46	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - LOW FLOW SENSORS	48	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - CONVERTER SUPPLEMENTAL COOLING CHECK VALVE (VSCF)	50	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - VENT FAN	52	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - VENT VALVE AND FORWARD CARGO HEAT VALVE	54	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - EQUIPMENT DIVERT VALVE	56	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - EQUIPMENT INBOARD VALVE	58	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - DUCTING	60	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - CONTROLLER	62	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - LOW FLOW SENSORS	64	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - OVERRIDE MODE	67	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - CONTROLLER	71	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - SUPPLY FANS	74	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - OVERRIDE VALVE	76	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - DUCT PRESSURE SENSORS	78	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - VENT FAN - FUNCTIONAL DESCRIPTION	80	ARO ALL

21-CONTENTS

CHAPTER 21 AIR CONDITIONING

<u>CH-SC-SU</u>	<u>SUBJECT</u>	<u>PAGE</u>	<u>EFFECT</u>
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - EQUIPMENT INBOARD VALVE	82	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - EQUIPMENT DIVERT VALVE	84	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FWD CGO HT & VENT VLVS - FUNCTIONAL DESCRIPTION	86	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE SELECTION LOGIC	88	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE - FWD CARGO AIR CONDITIONING	90	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE - VENT / FWD CARGO HEAT	92	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE - OVRD / EQPT COOLING SMOKE	94	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE - FWD CARGO FIRE	96	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - IFE - INTRODUCTION	98	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - IFE - GENERAL DESCRIPTION	98.3	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - IFE - COOLING FAN AND SMOKE DETECTOR	98.6	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - IFE - CHECK VALVE	98.8	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - IFE - VIBRATION MONITOR UNIT	98.10	ARO 001-016 POST SB 777-21-0189
21-27-00	A/C - EQUIPMENT COOLING - IFE - FUNCTIONAL DESCRIPTION	98.13	ARO ALL
21-27-00	A/C - EQUIPMENT COOLING - GROUND TESTS	98.16	ARO ALL

21-CONTENTS

CHAPTER 21
AIR CONDITIONING

CH-SC-SU	SUBJECT	PAGE	EFFECT
21-28-00	AIR CONDITIONING - FWD CARGO COMPARTMENT CONDITIONED AIR DISTRIBUTION - GENERAL DESCRIPTION	2	ARO ALL
21-28-00	AIR CONDITIONING - FWD CARGO COMPARTMENT CONDITIONED AIR DISTRIBUTION - A/C SHUTOFF VALVE	4	ARO ALL
21-28-00	AIR CONDITIONING - FWD CARGO COMPARTMENT CONDITIONED AIR DISTRIBUTION - DUCTING AND AIR OUTLETS	6	ARO ALL
21-28-00	AIR CONDITIONING - FWD CARGO COMPARTMENT CONDITIONED AIR DISTRIBUTION - FUNCTIONAL DESCRIPTION	8	ARO ALL
21-30-00	AIR CONDITIONING - PRESSURIZATION - INTRODUCTION	2	ARO ALL
21-30-00	AIR CONDITIONING - PRESSURIZATION - GENERAL DESCRIPTION	4	ARO ALL
21-30-00	AIR CONDITIONING - PRESSURIZATION - INDICATIONS - EICAS DISPLAY	6	ARO ALL
21-30-00	AIR CONDITIONING - PRESSURIZATION - INDICATIONS - AIR SUPPLY MAINTENANCE PAGE FORMAT	8	ARO ALL
21-30-00	AIR CONDITIONING - PRESSURIZATION - SYSTEM TESTS	10	ARO ALL
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - INTRODUCTION	1	ARO ALL
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - AIR SUPPLY CABIN PRESSURE CONTROLLER	4	ARO ALL
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - OUTFLOW VALVE - INTRODUCTION	8	ARO ALL; AIRPLANES WITH OUTFLOW VALVE P/N 2214420
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - OUTFLOW VALVE - FUNCTIONAL DESCRIPTION	10	ARO ALL; AIRPLANES WITH OUTFLOW VALVE P/N 2214420
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - CABIN PRESSURE OUTFLOW VALVE - INTRODUCTION	12	ARO ALL; AIRPLANES WITH OUTFLOW VALVE P/N 2119160
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - CABIN PRESSURE OUTFLOW VALVE - FUNCTIONAL DESCRIPTION	14	ARO ALL; AIRPLANES WITH OUTFLOW VALVE P/N 2119160

21-CONTENTS

**CHAPTER 21
AIR CONDITIONING**

CH-SC-SU	SUBJECT	PAGE	EFFECT
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - REMOTE CABIN PRESSURE SENSOR	16	ARO ALL
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - BLEED AIR/PRESSURIZATION PANEL	18	ARO ALL
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - MINIMUM RATE CONTROL MODE	21	ARO ALL
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - FIXED RATE CONTROL MODE	25	ARO ALL
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILE - MINIMUM RATE CONTROL MODE	28	ARO ALL
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILE - FIXED RATE CONTROL MODE	33	ARO ALL
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILES - MINIMUM RATE CONTROL MODE	36	ARO ALL
21-31-00	AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILES - FIXED RATE CONTROL MODE	38	ARO ALL
21-32-00	AIR CONDITIONING - CABIN PRESSURE RELIEF SYSTEM - INTRODUCTION	2	ARO ALL
21-32-00	AIR CONDITIONING - CABIN PRESSURE RELIEF SYSTEM - COMPONENT LOCATIONS	4	ARO ALL
21-32-00	AIR CONDITIONING - CABIN PRESSURE RELIEF SYSTEM - POSITIVE PRESS RELIEF VALVE AND FILTER	6	ARO ALL
21-32-00	AIR CONDITIONING - CABIN PRESSURE RELIEF SYSTEM - NEGATIVE PRESS RELIEF VENT	8	ARO ALL
21-40-00	AIR CONDITIONING - HEATING - INTRODUCTION	2	ARO ALL
21-40-00	AIR CONDITIONING - HEATING - AIR SYNOPTIC DISPLAY AND MAINTENANCE PAGE	4	ARO ALL

21-CONTENTS

CHAPTER 21
AIR CONDITIONING

<u>CH-SC-SU</u>	<u>SUBJECT</u>	<u>PAGE</u>	<u>EFFECT</u>
21-40-00	AIR CONDITIONING - HEATING - GROUND TESTS	6	ARO ALL
21-41-00	AIR CONDITIONING - CREW REST AREA HEATING - INTRODUCTION	2	ARO ALL
21-41-00	AIR CONDITIONING - CREW REST AREA HEATING - FLIGHT CREW REST - INTRODUCTION	4	ARO ALL
21-41-00	AIR CONDITIONING - CREW REST AREA HEATING - FLIGHT CREW REST - COMPONENT LOCATIONS	6	ARO ALL
21-41-00	AIR CONDITIONING - CREW REST AREA HEATING - FLIGHT CREW REST - FUNCTIONAL DESCRIPTION	8	ARO ALL
21-41-00	AIR CONDITIONING - CREW REST AREA HEATING - FLIGHT CREW REST - OPERATION	10	ARO ALL
21-43-00	AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - INTRODUCTION	2	ARO ALL
21-43-00	AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - HEAT DUCT	4	ARO ALL
21-43-00	AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - HEATER	6	ARO ALL
21-43-00	AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - TEMPERATURE SENSOR	8	ARO ALL
21-43-00	AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - FUNCTIONAL DESCRIPTION	10	ARO ALL
21-44-00	AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - INTRODUCTION	2	ARO ALL
21-44-00	AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - HEAT VALVES	4	ARO ALL
21-44-00	AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - TEMPERATURE SENSORS	6	ARO ALL

21-CONTENTS

CHAPTER 21

AIR CONDITIONING

<u>CH-SC-SU</u>	<u>SUBJECT</u>	<u>PAGE</u>	<u>EFFECT</u>
21-44-00	AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - TEMPERATURE SELECTORS	8	ARO ALL
21-44-00	AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - FUNCTIONAL DESCRIPTION	10	ARO ALL
21-45-00	AIR CONDITIONING - SUPPLEMENTAL HEATING - INTRODUCTION	2	ARO ALL
21-45-00	AIR CONDITIONING - SUPPLEMENTAL HEATING - FLIGHT DECK FOOT HEATERS	4	ARO ALL
21-45-00	AIR CONDITIONING - SUPPLEMENTAL HEATING - FLIGHT DECK SHOULDER HEATERS	6	ARO ALL
21-45-00	AIR CONDITIONING - SUPPLEMENTAL HEATING - DOOR AREA HEATERS	8	ARO ALL
21-45-00	AIR CONDITIONING - SUPPLEMENTAL HEATING - GALLEY HEATERS	10	ARO ALL
21-45-00	A/C - SUPPLEMENTAL HEATING - DOOR AREA HEATERS - FUNCTIONAL DESCRIPTION	12	ARO ALL
21-45-00	A/C - SUPPLEMENTAL HEATING - GALLEY AND FLIGHT DECK HEATERS - FUNCTIONAL DESCRIPTION	14	ARO ALL
21-50-00	AIR CONDITIONING - COOLING - INTRODUCTION	2	ARO ALL
21-50-00	AIR CONDITIONING - COOLING - GENERAL DESCRIPTION - CONTROL	4	ARO ALL
21-50-00	AIR CONDITIONING - COOLING - INTERFACES	6	ARO ALL
21-50-00	AIR CONDITIONING - COOLING - OPERATION	8	ARO ALL
21-50-00	AIR CONDITIONING - COOLING - AIR SYNOPTIC DISPLAY AND AIR CONDITIONING MAINTENANCE PAGE	10	ARO ALL
21-50-00	AIR CONDITIONING - COOLING - GROUND TESTS	12	ARO ALL
21-51-00	AIR CONDITIONING - PACK FLOW CONTROL - INTRODUCTION	2	ARO ALL
21-51-00	AIR CONDITIONING - PACK FLOW CONTROL - GENERAL DESCRIPTION	4	ARO ALL

21-CONTENTS

CHAPTER 21 AIR CONDITIONING

<u>CH-SC-SU</u>	<u>SUBJECT</u>	<u>PAGE</u>	<u>EFFECT</u>
21-51-00	AIR CONDITIONING - PACK FLOW CONTROL - COMPONENT LOCATIONS	6	ARO ALL
21-51-00	AIR CONDITIONING - PACK FLOW CONTROL - FLOW CONTROL AND SHUTOFF VALVES	8	ARO ALL
21-51-00	AIR CONDITIONING - PACK FLOW CONTROL - FLOW SENSOR	10	ARO ALL
21-51-00	AIR CONDITIONING - PACK FLOW CONTROL - PRIMARY HEAT EXCHANGER INLET TEMPERATURE SENSOR	12	ARO ALL
21-51-00	AIR CONDITIONING - PACK FLOW CONTROL - FUNCTIONAL DESCRIPTION - ASCPC FLOW SCHEDULES	14	ARO ALL
21-51-00	AIR CONDITIONING - PACK FLOW CONTROL - FUNCTIONAL DESCRIPTION - CTC FLOW CONTROL	17	ARO ALL
21-51-00	AIR CONDITIONING - PACK FLOW CONTROL - FUNCTIONAL DESCRIPTION - START-UP AND SHUTDOWN	20	ARO ALL
21-51-00	AIR CONDITIONING - PACK FLOW CONTROL - FUNCTIONAL DESCRIPTION - ASCPC FLOW CONTROL	22	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - INTRODUCTION	2	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - COMPONENT LOCATIONS	4	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - RAM AIR - COMPONENT LOCATIONS	6	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - DUAL HEAT EXCHANGER	8	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - ECONOMY COOLING CHECK VALVE	10	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - AIR CYCLE MACHINE	12	ARO ALL

21-CONTENTS

CHAPTER 21
AIR CONDITIONING

CH-SC-SU	SUBJECT	PAGE	EFFECT
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - CONDENSER/REHEATER	14	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - WATER COLLECTOR AND SPRAY NOZZLE	16	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - LOW LIMIT AND TURBINE BYPASS VLVS	18	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - ECONOMY COOLING VALVE	20	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - CONDITIONED AIR CHECK VALVE	22	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - PACK COOLING TEMP SENSORS	24	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - MANIFOLD TEMP SENSORS	26	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - RAM AIR INLET DOOR AND ACTUATOR	28	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - RAM AIR EXHAUST HOUSING ASSEMBLY AND ACTUATOR	30	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FAN INLET DIFFUSER HOUSING AND CK VLV	32	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FUNCTIONAL DESCRIPTION - CONTROL	34	ARO ALL
21-52-00	AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FUNCTIONAL DESCRIPTION - PACKS	38	ARO ALL
21-60-00	AIR CONDITIONING - TEMPERATURE CONTROL - INTRODUCTION	2	ARO ALL
21-60-00	AIR CONDITIONING - TEMPERATURE CONTROL - GENERAL DESCRIPTION - CONTROL	4	ARO ALL

21-CONTENTS

CHAPTER 21
AIR CONDITIONING

CH-SC-SU	SUBJECT	PAGE	EFFECT
21-60-00	AIR CONDITIONING - TEMPERATURE CONTROL - GENERAL DESCRIPTION - MECHANICAL	6	ARO ALL
21-60-00	AIR CONDITIONING - TEMPERATURE CONTROL - INTERFACES	8	ARO ALL
21-60-00	AIR CONDITIONING - TEMPERATURE CONTROL - FUNCTIONAL DESCRIPTION	11	ARO ALL
21-60-00	AIR CONDITIONING - TEMPERATURE CONTROL - OPERATION - FLIGHT DECK	15	ARO ALL
21-60-00	AIR CONDITIONING - TEMPERATURE CONTROL - OPERATION - CABIN CONTROLS	18	ARO ALL
21-60-00	AIR CONDITIONING - TEMPERATURE CONTROL - AIR SYNOPTIC DISPLAY AND AIR CONDITIONING MAINT PAGE	20	ARO ALL
21-60-00	AIR CONDITIONING - TEMPERATURE CONTROL - GROUND TESTS	22	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - INTRODUCTION	1	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CTC - PHYSICAL DESCRIPTION	4	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CTC - INTERFACES 1	6	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CTC - INTERFACES 2	10	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - ZONE TRIM AIR MODULATING VALVES AND MUFFLERS	12	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FLIGHT DECK ZONE DUCT TEMP SENSORS	14	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CABIN ZONE DUCT TEMP SENSORS	16	ARO ALL

21-CONTENTS

CHAPTER 21
AIR CONDITIONING

<u>CH-SC-SU</u>	<u>SUBJECT</u>	<u>PAGE</u>	<u>EFFECT</u>
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FORWARD CARGO ZONE DUCT TEMP SENSORS	18	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FLIGHT DECK ZONE AIR TEMP SENSORS	20	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CABIN ZONE AIR TEMP SENSORS	22	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FORWARD CARGO ZONE AIR TEMP SENSORS	24	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FLIGHT DECK FUNCTIONAL DESCRIPTION	26	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CABIN ZONE FUNCTIONAL DESCRIPTION	29	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - ZONE TEMPERATURE CALCULATION	32	ARO ALL
21-61-00	AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FORWARD CARGO ZONE FUNCTIONAL DESCRIPTION	35	ARO ALL
21-62-00	AIR CONDITIONING - TRIM AIR PRESS REGULATION AND SHUTOFF CTRL - INTRODUCTION	2	ARO ALL
21-62-00	AIR CONDITIONING - TRIM AIR PRESS REGULATION AND SHUTOFF CTRL - TRIM AIR PRSOV	4	ARO ALL
21-62-00	AIR CONDITIONING - TRIM AIR PRESS REGULATION AND SHUTOFF CTRL - TRIM AIR PRESSURE SENSOR	6	ARO ALL
21-62-00	AIR CONDITIONING - TRIM AIR PRESS REGULATION AND SHUTOFF CTRL - FUNCTIONAL DESCRIPTION	8	ARO ALL
21-73-00	AIR CONDITIONING - OZONE CONTROL	2	ARO ALL

21-CONTENTS



AIR CONDITIONING - INTRODUCTION

General

The air conditioning system controls the interior environment of the airplane for flight crew, passengers, and equipment. The air conditioning system includes these subsystems:

- Air Distribution
- Equipment cooling
- Cabin pressurization
- Heating
- Cooling
- Temperature control.

Abbreviations and Acronyms

- A/C - air conditioning
- ADIRS - air data inertial reference system
- ADIRU - air data inertial reference unit
- AGS - air/ground system
- AIMS - airplane information management system
- ARINC - Aeronautical Radio, Inc.
- ASCPC - air supply cabin pressure controller
- ASG - ARINC signal gateway
- CACP - cabin area control panel
- capt - captain
- CCU - computing and communications unit
- cgo - cargo
- ckt - circuit
- clg - cooling
- CMCS - central maintenance computing system
- CPOV - cabin pressure outflow valve
- CRA - crew rest area
- CSS - cabin services system

- CSCP - cabin system control panel
- CSDS - cargo smoke detection system
- CTC - cabin temperature controller
- ctrl - control
- CUR - current
- E/E - electrical and electronic
- ECS - environmental control system
- ECSMC - environmental control system miscellaneous card
- elcx - electronics
- ELCU - electrical load control unit
- ELMS - electrical load management system
- ENRGZ - energize
- eqpt - equipment
- exh - exhaust
- FCAC - forward cargo air conditioning
- F/D - flight deck
- F/O - first officer
- fwd - forward
- gly - galley
- htr - heater
- IMMTE - integrated mix manifold temperature error
- LLAR - lower lobe attendants rest
- MFD - multi-function display
- manf - manifold
- mgmt - management
- OFV - outflow valve
- OPAS - overhead panel arinc 629 system
- OVHT - overheat
- pnl - panel
- pwr - power

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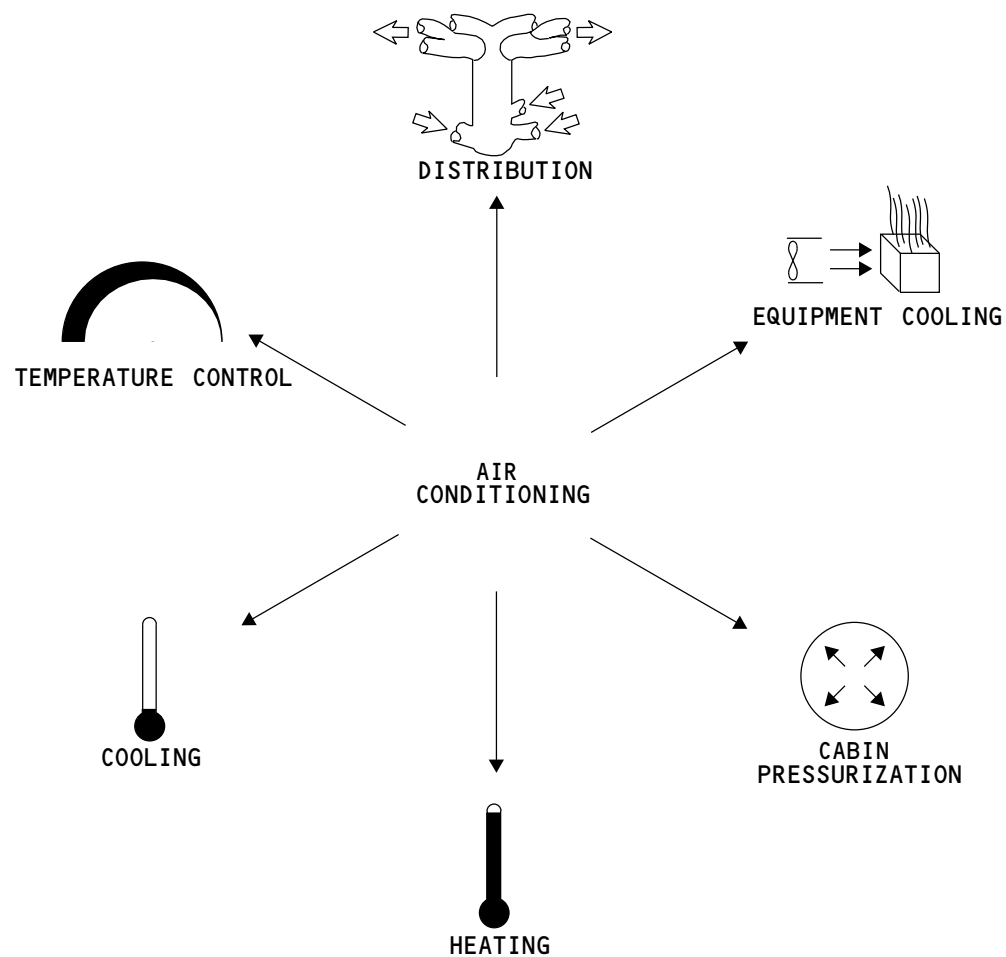
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AIR CONDITIONING - INTRODUCTION

- recirc - recirculation
- rly - relay
- SIU - signal interface unit
- snsr - sensor
- SOV - shutoff valve
- TAT - total air temperature
- TCV - temperature control valve
- temp - temperature
- util - utility
- vlv - valve
- WOW - weight-on-wheels



AIR CONDITIONING - INTRODUCTION

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**AIR CONDITIONING - GENERAL DESCRIPTION - CONTROL****General**

These flight deck panels let you control the air conditioning system:

- Air conditioning panel
- Bleed air/pressurization panel
- Cargo temperature select panel
- Sidewall panels (Capt and F/O foot and shoulder heater controls).
- Miscellaneous switching panel.

These passenger compartment panels let you control the air conditioning system:

- Cabin system control panel (CSCP)
- Cabin area control panels (CACPs)
- Galley heat controls in the galleys.

You use the temperature control on the attendant panel to control the temperature in the flight crew rest (FCR).

These components in the MEC control the functions of the air conditioning system:

- Two cabin temperature controllers (CTCs)
- Two air supply cabin pressure controllers (ASCPCs)
- Two environmental control system miscellaneous cards (ECSMCs)
- Two equipment cooling controllers (ECCs).

Cabin Temperature Controller

The CTCs control these functions of the air conditioning system:

- Pack flow, regulation (on) or off
- Pack cooling/mix manifold temperature
- Trim air, regulation (on) or off
- Zone temperature
- Recirculation air.

Air Supply Cabin Pressure Controller

The ASCPCs control these functions:

- Pack flow schedule
- Pack flow, on or off
- Backup pack flow (CTC failed)
- Trim air, on or off
- Pressurization system
- Pneumatic system.

Environmental Control System Miscellaneous Cards

The ECSMCs control these functions of the air conditioning system:

- Air distribution and ventilation
- Equipment cooling
- Cargo heating
- Supplemental heating.

Equipment Cooling Controller

The ECCs control the supply fans and override valve in the equipment cooling system.

Interfaces

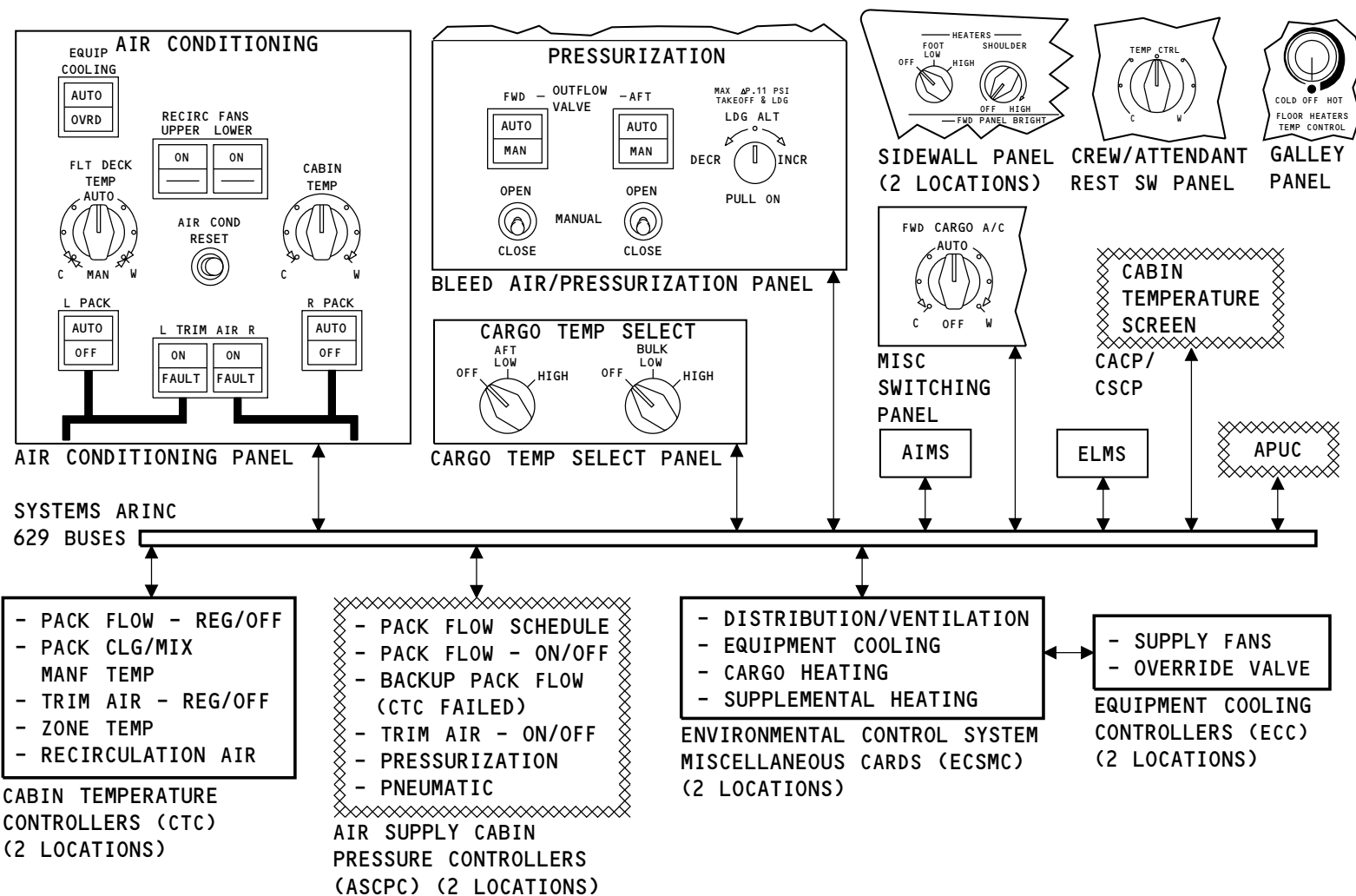
The air conditioning controls have interfaces with each other, the AIMS, the electrical load management system (ELMS), and the auxiliary power unit controller (APUC).

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AIR CONDITIONING - GENERAL DESCRIPTION - CONTROL

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AIR CONDITIONING - FLIGHT DECK CONTROLS**General**

These flight deck panels give the flight crew control of the air conditioning subsystems:

- Air conditioning panel on the P5 overhead panel
- Bleed air/pressurization panel on the P5 overhead panel
- Cargo temperature select panel on the P61 overhead maintenance panel.

Cargo Temperature Select Panel

These controls are on the cargo temperature select panel:

- Aft cargo temperature selector
- Bulk cargo temperature selector.

Miscellaneous Switching Panel

The miscellaneous switching panel has the forward cargo air conditioning control.

Air Conditioning Panel

These controls are on the air conditioning panel:

- Equipment cooling switch
- Upper and lower recirculation fan switches
- Cabin temperature control
- Flight deck temperature control
- Air conditioning reset switch
- Left and right pack switches
- Left and right trim air switches.

Sidewall Panels

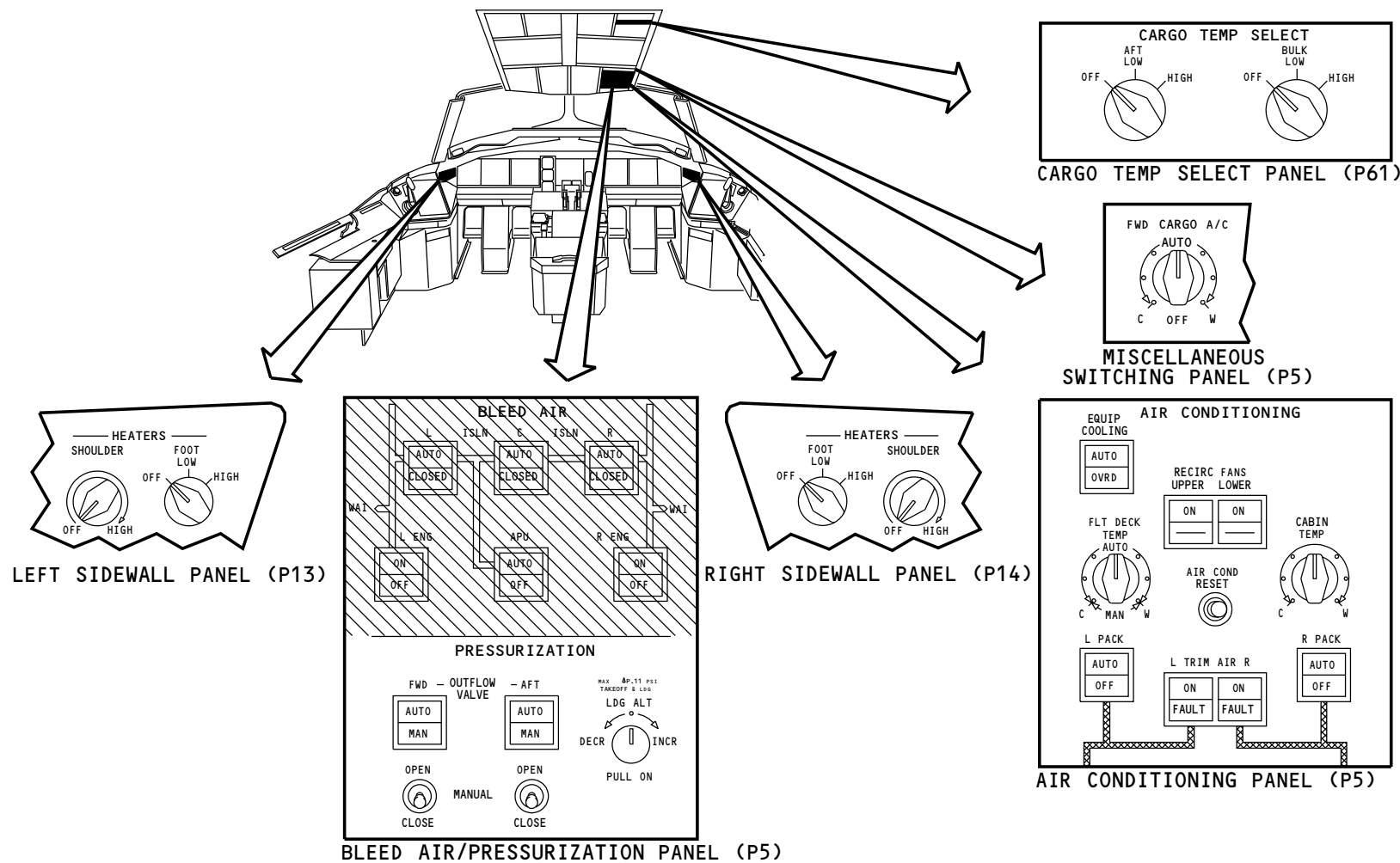
These controls, related to the air conditioning system are on the left and right sidewall panels:

- Captain foot heater selector (left sidewall panel)
- Captain shoulder heater control (left sidewall panel)
- First officer foot heater selector (right sidewall panel)
- First officer shoulder heater control (right sidewall panel).

Bleed Air/Pressurization Panel

These controls are on the pressurization part of the bleed air/pressurization panel:

- Forward and aft outflow valve AUTO switches
- Forward and aft outflow valve manual switches
- Landing altitude selector.



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AIR CONDITIONING - FLIGHT DECK CONTROLS

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AIR CONDITIONING - CONTROLLERS

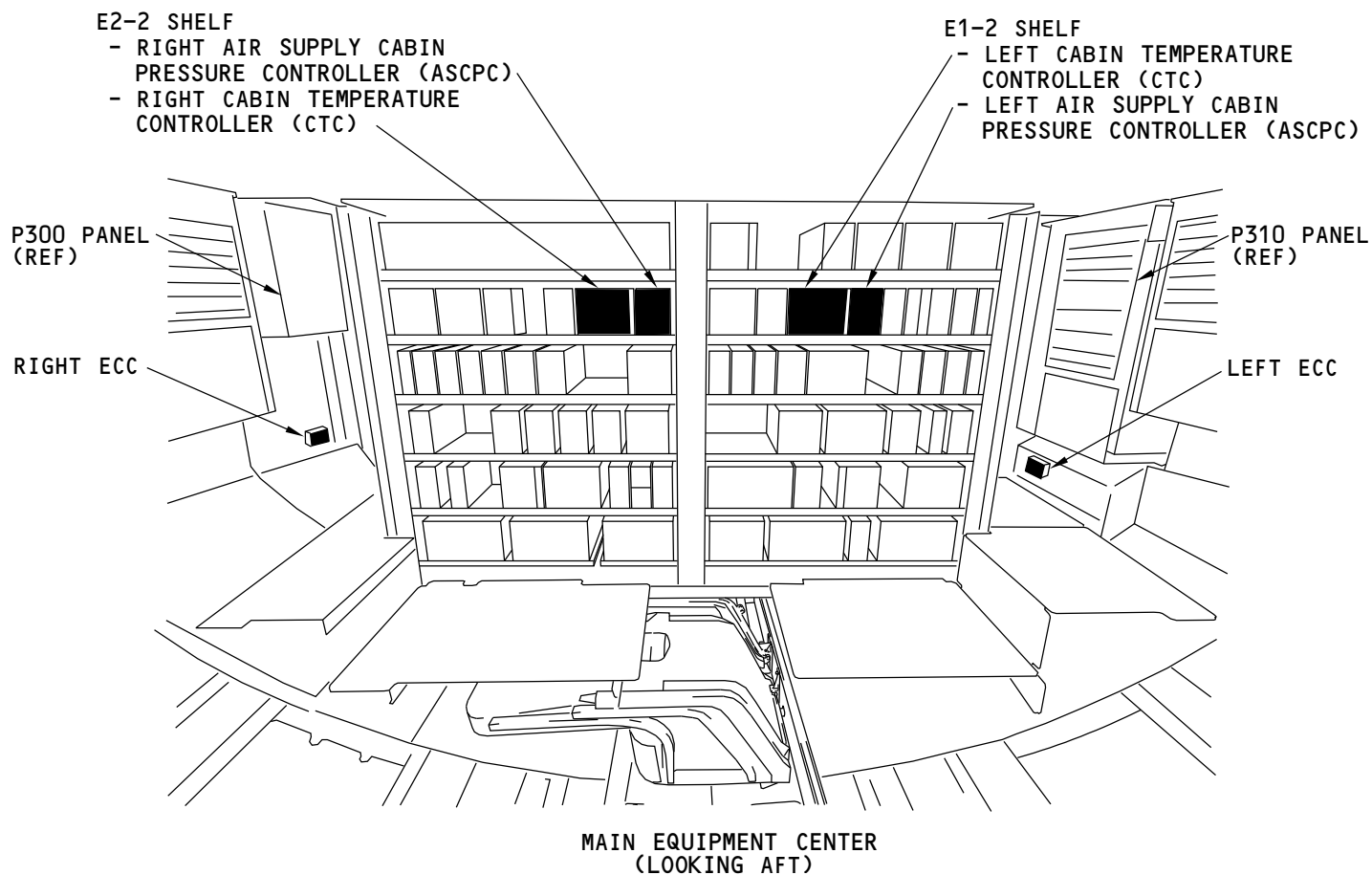
General

The air conditioning system uses these controllers:

- Cabin temperature controllers (CTCs)
- Air supply cabin pressure controllers (ASCPCs)
- Equipment cooling controllers (ECCs).

These controllers are in the main equipment center.

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AIR CONDITIONING - CONTROLLERS

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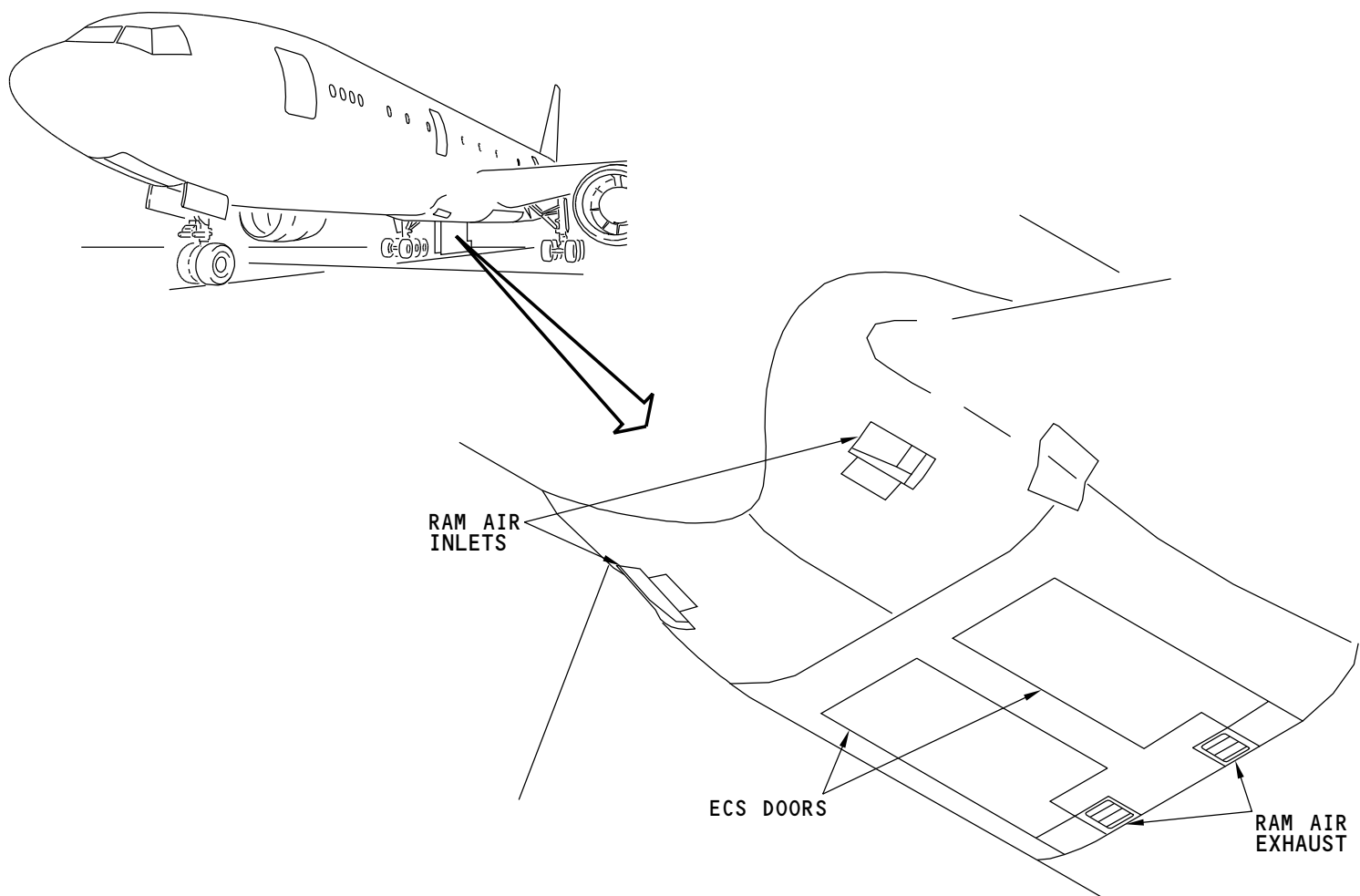


AIR CONDITIONING - ECS BAY

General

The left and right cooling packs are in the ECS bay. Access to the ECS bay is through the ECS doors in the wing-to-body fairing.

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AIR CONDITIONING - ECS BAY

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AIR CONDITIONING - DISTRIBUTION - INTRODUCTION

General

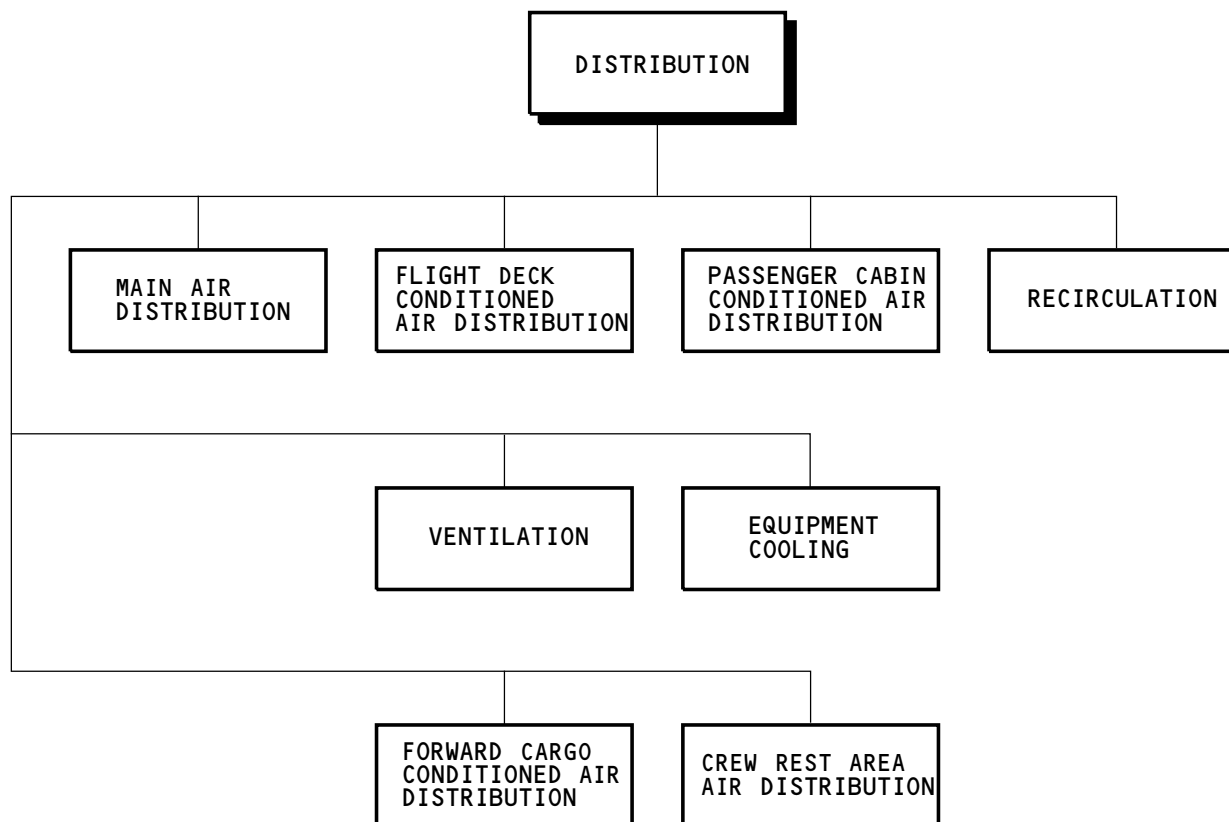
The distribution system has these parts:

- Main air
- Flight deck conditioned air
- Crew rest area air
- Forward cargo compartment conditioned air
- Passenger cabin conditioned air
- Recirculation
- Ventilation
- Equipment cooling.

The distribution system lets air from the packs and mix manifold flow to locations in the flight deck, crew rest area, forward cargo compartment, and passenger compartment. The ventilation part of the system removes odors from the lavatories and galleys. The equipment cooling part of the system cools electrical and electronic equipment.

See the distribution - ventilation section for more information about the ventilation in the airplane (SECTION 21-26).

See the equipment cooling section for more information about the forward and aft equipment cooling systems (SECTION 21-27).



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AIR CONDITIONING - DISTRIBUTION - INTRODUCTION

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AIR CONDITIONING - DISTRIBUTION - GENERAL DESCRIPTION

General

The distribution system includes ducts and fans that move conditioned and recirculated air through the airplane.

Main Air Distribution

Air from the packs flow through the main air distribution ducts to these locations:

- Flight deck distribution
- Crew rest area air distribution
- Mix manifold.

Mix Manifold

The usual flow of air from the mix manifold goes to the passenger cabin conditioned air distribution and the forward cargo air conditioning air distribution. The mix manifold gives air to the flight deck conditioned air distribution and to the attendants rest conditioned air distribution if the left air conditioning pack is off. See the main air distribution section for more information about the mix manifold (SECTION 21-21).

Flight Deck Conditioned Air Distribution

The flight deck distribution duct lets conditioned air go from the left pack to the flight deck and to the flight crew rest area. See the flight deck conditioned air distribution section for more information about air distribution to the flight deck and to the flight crew rest area (SECTION 21-22).

Lower Lobe Attendants Rest Conditioned Air Distribution

An air distribution duct for the optional lower lobe attendants rest attaches to the left pack outlet duct, upstream of the mix manifold.

Passenger Cabin Conditioned Air Distribution

Eight risers carry air from the mix manifold, below the passenger cabin floor to the overhead distribution ducts above the passenger cabin ceiling. The overhead distribution ducts carry the air to the air outlet ducts in each of the passenger zones. See the passenger cabin conditioned air distribution section for more information about air distribution to the passenger cabin (SECTION 21-23).

Forward Cargo Air Conditioning Air Distribution

The forward cargo distribution duct lets conditioned air from the mix manifold go into the forward cargo compartment. See the forward cargo compartment conditioned air distribution section for more information about air distribution to the forward cargo compartment (SECTION 21-28).

Recirculation

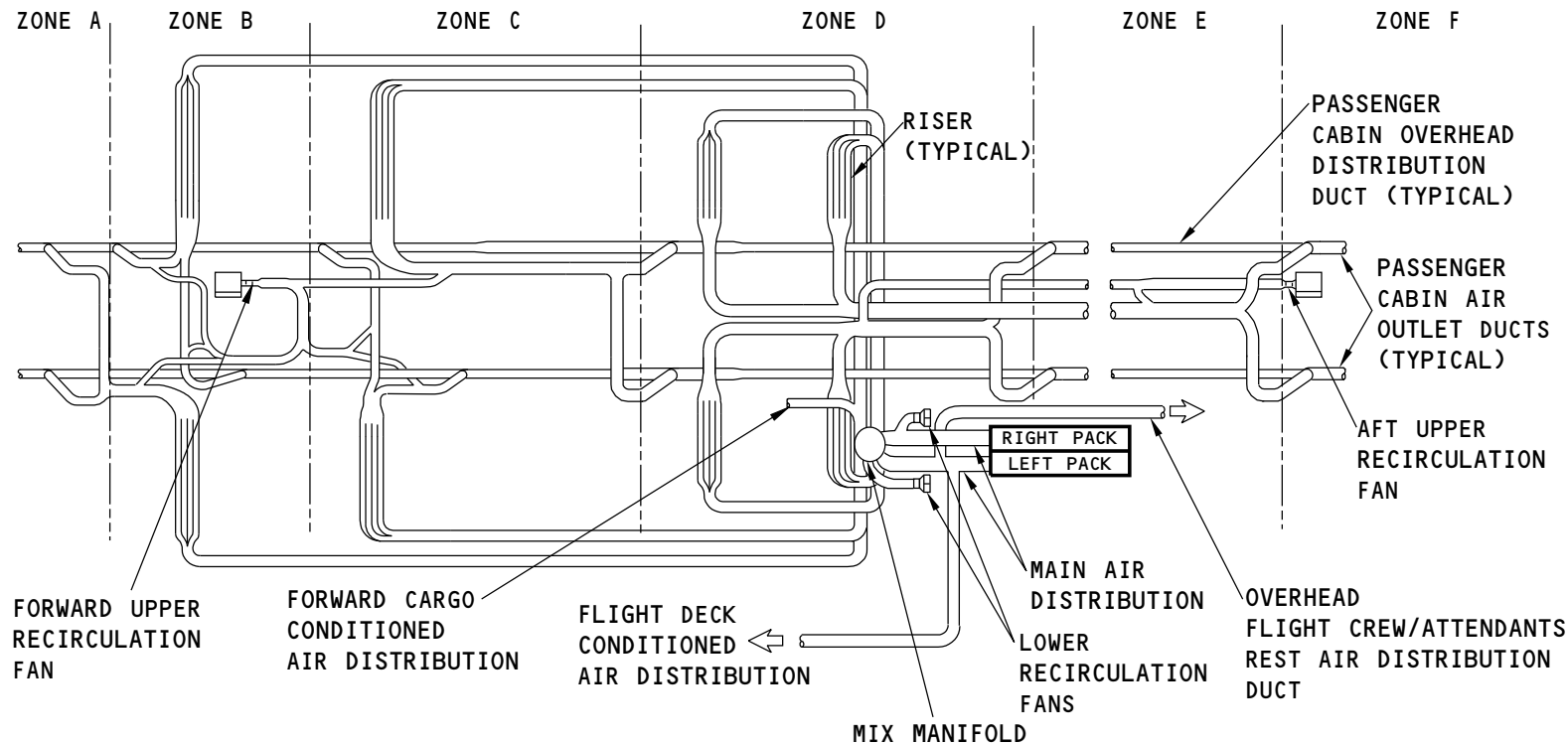
Air from the lower recirculation fans mix with the conditioned air in the mix manifold. Air from the upper recirculation fans mix with the conditioned air in the overhead distribution ducts. See the recirculation system section for more information about the recirculation air distribution (SECTION 21-25).

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PASSENGER CABIN CONDITIONED AIR DISTRIBUTION

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AIR CONDITIONING - DISTRIBUTION - GENERAL DESCRIPTION

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AIR CONDITIONING - DISTRIBUTION - OPERATION**General**

The miscellaneous switching panel has the control for the forward cargo ventilation system. The ventilation system uses the forward cargo air conditioning control.

The cargo temperature select panel has the control for the bulk cargo ventilation system. The ventilation system uses the bulk cargo heat selector.

The air conditioning panel has these controls for distribution:

- Equipment cooling control
- Upper and lower recirculation fan controls
- Air conditioning reset control.

Control of these ventilation systems are automatic and have no flight deck controls:

- Galley chiller unit ventilation
- Lavatory/galley ventilation (aft equipment cooling).

See the distribution - ventilation section for more information about the ventilation systems that do not have controls in the flight deck (SECTION 21-26).

Forward Cargo Ventilation Operation

The forward cargo air conditioning control enables the forward cargo air conditioning system and the forward cargo ventilation system. The control also sets the target temperature for the forward cargo compartment. The AUTO position enables the ventilation system. See the zone temperature control and indication section for more information about the forward cargo air conditioning system (SECTION 21-61). See the distribution - ventilation section for more information about the forward cargo ventilation system (SECTION 21-26).

Bulk Cargo Ventilation Operation

The bulk cargo heat selector is a three position selector. The selector enables the bulk cargo heating and ventilation systems. The HIGH position enables the ventilation system. The LOW or OFF position sets the ventilation system off. See the aft and bulk cargo compartment heating section for more information about the bulk cargo heating system (SECTION 21-44). See the ventilation section for more information about the bulk cargo ventilation system (SECTION 21-26).

Equipment Cooling Operation

The equipment cooling switch sets the mode of operation for the forward equipment cooling system. The AUTO position on the switch shows that the system is set to automatic operation. The OVRD indication shows that the system is in the override mode of operation. See the equipment cooling section for more information about the operation of the forward equipment cooling system (SECTION 21-27).

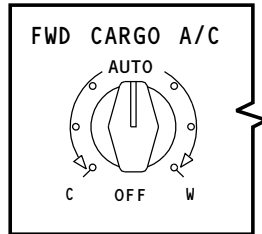
Recirculation Fan Operation

The UPPER and LOWER RECIRC FANS switches are alternate-action switches. The ON indication on the switch shows the fan is set to automatic operation. When the ON indication does not show, the fan is off. See the recirculation section for more information about the recirculation fans (SECTION 21-25).

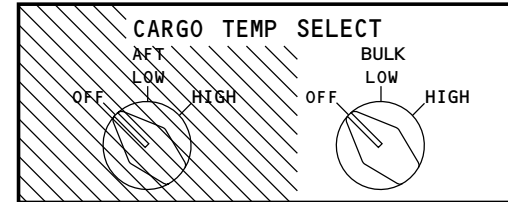
Air Conditioning Reset Operation

The AIR COND RESET switch is a momentary-action switch. This switch starts the system after a failure.

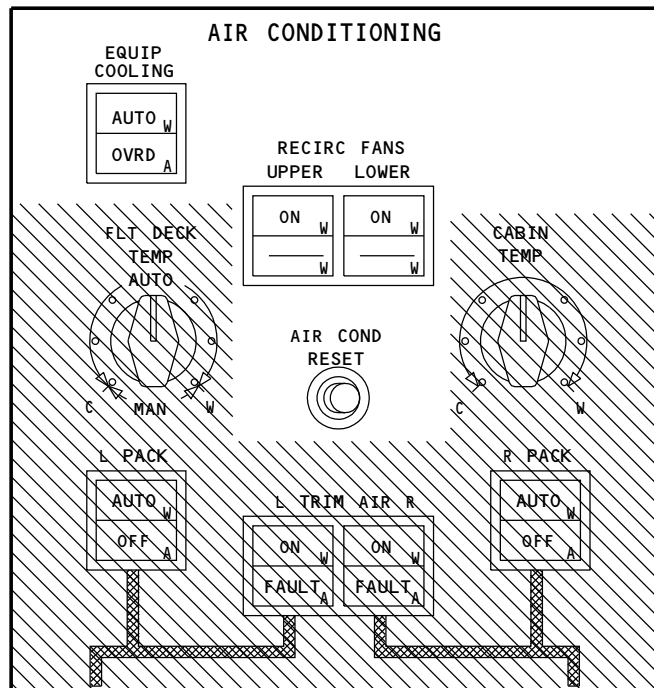
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MISCELLANEOUS SWITCHING PANEL (P5)



CARGO TEMPERATURE SELECT PANEL (P61)



AIR CONDITIONING PANEL (P5)

AIR CONDITIONING - DISTRIBUTION - OPERATION

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AIR CONDITIONING - DISTRIBUTION - GROUND TESTS**General**

These are the air conditioning distribution ground tests that show when you select ATA 21 Environmental Control System:

- Chiller boost fan
- Lavatory/galley ventilation fan.

The recirculation fan system ground test shows when you select ATA 21 Cabin Temperature Control System.

Chiller Boost Fan

This test makes sure that the chiller boost fan installation is correct.

The test takes approximately 1-2 minutes.

This test shows for these ground test types:

- System test
- LRU replacement test.

Lavatory/Galley Ventilation Fan

This test makes sure that these LRU installations are correct:

- Left lavatory/galley ventilation fan
- Right lavatory/galley ventilation fan
- Bulk cargo compartment ventilation fan.

During this test, there will be airflow from the lavatory/galley ventilation fans.
The test takes 2 to 3 minutes.

This test shows for these ground test types:

- System test
- LRU replacement test.

Recirculation Fan System

This test makes sure that the cabin temperature controller can control these LRUs:

- Forward upper recirculation fan
- Aft upper recirculation fan
- Left lower recirculation fan
- Right lower recirculation fan.

The electrical load management system P110 and P210 energize these fans. The test takes approximately 2-3 minutes.

This test shows for these ground test types:

- System test
- Operational test
- LRU replacement test.

GROUND TESTS

SELECT ATA SYSTEM (48)

21 ENVIRONMENTAL CONTROL SYSTEM
21 CABIN PRESSURE CONTROL SYSTEM
21 CABIN TEMPERATURE CONTROL SYSTEM
22 AUTOPILOT FLIGHT DIRECTOR SYSTEM
22 AIMS - AUTO THROTTLE
23 HF COMMUNICATION SYSTEM
23 VHF COMMUNICATION SYSTEM
23 SATELLITE COMMUNICATIONS (SATCOM) SYSTEM
23 AIMS - DATA COMMUNICATION MANAGEMENT

SELECT TEST TYPE

SYSTEM TEST
LRU REPLACEMENT TEST

SELECT SYSTEM TEST (6)

AFT CARGO HEAT
BULK CARGO HEAT
CHILLER BOOST FAN
DOOR AREA HEATER
EQUIPMENT COOLING
LAVATORY/GALLEY VENTILATION FAN

CONTINUE HELP GO BACK

SELECT SYSTEM TEST (6)

AFT CARGO HEAT
BULK CARGO HEAT
CHILLER BOOST FAN
DOOR AREA HEATER
EQUIPMENT COOLING
LAVATORY/GALLEY VENTILATION FAN

NOTE: SYSTEM TESTS SHOW.
LRU REPLACEMENT TESTS ARE THE SAME.

GROUND TESTS

SELECT ATA SYSTEM (48)

21 ENVIRONMENTAL CONTROL SYSTEM
21 CABIN PRESSURE CONTROL SYSTEM
21 CABIN TEMPERATURE CONTROL SYSTEM
22 AUTOPILOT FLIGHT DIRECTOR SYSTEM
22 AIMS - AUTO THROTTLE
23 HF COMMUNICATION SYSTEM
23 VHF COMMUNICATION SYSTEM
23 SATELLITE COMMUNICATIONS (SATCOM) SYSTEM
23 AIMS - DATA COMMUNICATION MANAGEMENT

SELECT TEST TYPE

SYSTEM TEST
OPERATIONAL TEST
LRU REPLACEMENT TEST

SELECT SYSTEM TEST (9)

LEFT PACK ACTUATORS
LEFT SYSTEM AIR ON
LEFT SYSTEM AIR OFF
LEFT TRIM AIR SYSTEM
RIGHT PACK ACTUATORS
RIGHT SYSTEM AIR ON
RIGHT SYSTEM AIR OFF
RIGHT TRIM AIR SYSTEM
RECIRCULATION FAN SYSTEM

CONTINUE HELP GO BACK

SELECT SYSTEM TEST (9)

LEFT PACK ACTUATORS
LEFT SYSTEM AIR ON
LEFT SYSTEM AIR OFF
LEFT TRIM AIR SYSTEM
RIGHT PACK ACTUATORS
RIGHT SYSTEM AIR ON
RIGHT SYSTEM AIR OFF
RIGHT TRIM AIR SYSTEM
RECIRCULATION FAN SYSTEM

NOTE: SYSTEM TESTS SHOW. OPERATIONAL AND
LRU REPLACEMENT TESTS ARE SIMILAR.

THESE ARE THE AIR CONDITIONING - DISTRIBUTION TESTS.

AIR CONDITIONING - DISTRIBUTION - GROUND TESTS

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**AIR CONDITIONING - MAIN AIR DISTRIBUTION - DUCT****General**

The main air distribution system moves air from the pack or ground conditioned air connector to the mix manifold. It then goes to the flight deck conditioned air distribution duct and to the attendants rest air distribution duct.

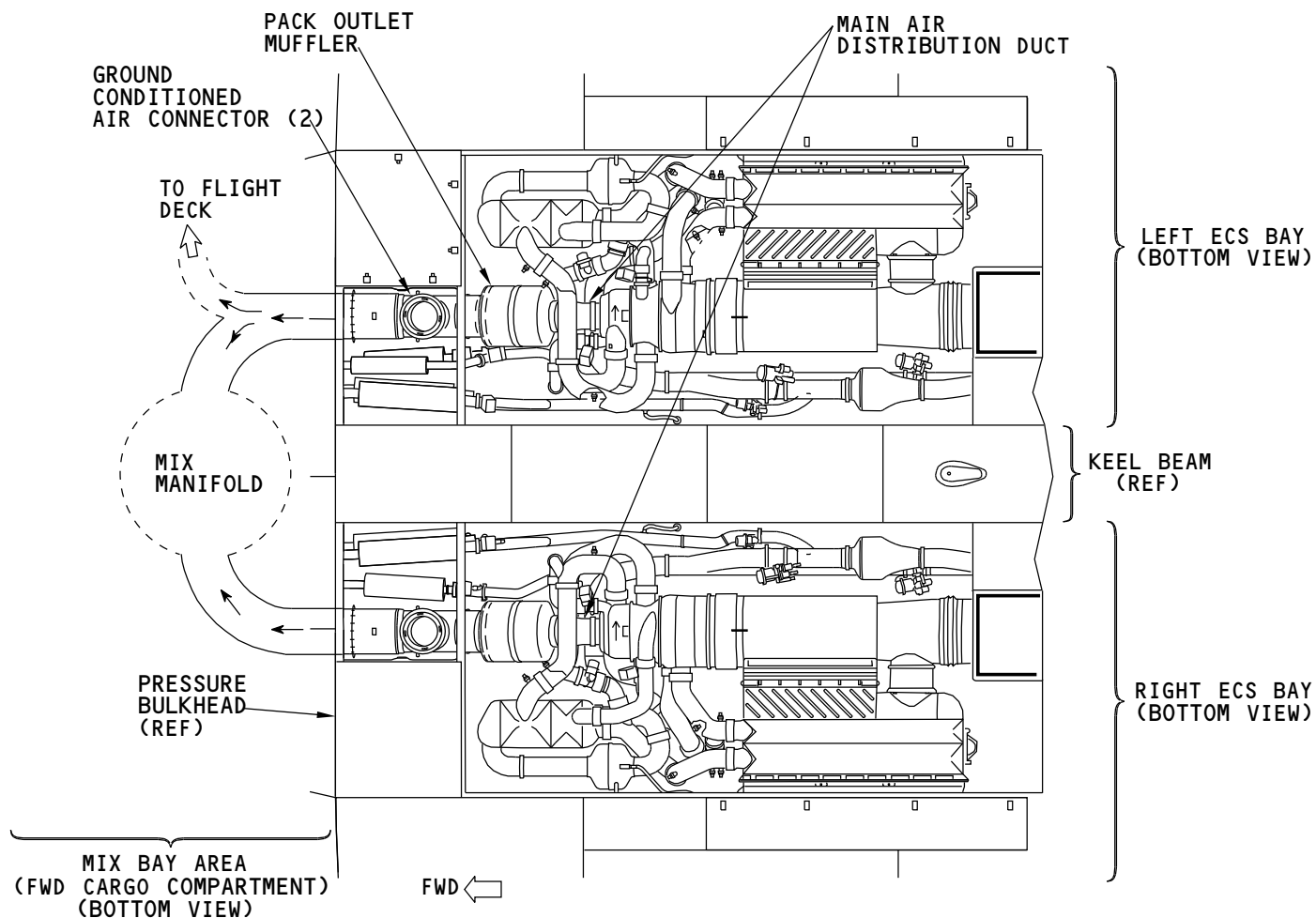
Pack Outlet Muffler

A muffler in the pack outlet duct decreases noise in the main air distribution system.

Ground Conditioned Air Connector

The ground conditioned air connector lets ground carts supply conditioned air to the cabin zones and the flight deck. A check valve in the connector closes the opening when the pack supplies conditioned air.

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AIR CONDITIONING - MAIN AIR DISTRIBUTION - DUCT

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AIR CONDITIONING - MAIN AIR DISTRIBUTION - MIX MANIFOLD

Purpose

The mix manifold mixes fresh air from the main air distribution duct (ground conditioned air or pack air) and cabin air from the lower recirculation system.

The manifold usually gives air to the passenger cabin and forward cargo conditioned air distribution ducts. The manifold can also give air to the attendants rest air distribution duct and to the flight deck conditioned air distribution duct when the left air conditioning pack is off.

Location

The mix manifold is aft of the forward cargo compartment in the mix bay area. You remove the cargo compartment end wall to get access to the manifold.

Physical Description

The outer diameter of the mix manifold is approximately 26 inches (66 cm) and is approximately 85 inches (216 cm) high. The manifold has a lower and upper part. The lower part has these features:

- A connection that is the same for the right main air distribution duct and right lower air recirculation system
- A connection for the left main air distribution duct
- A connection for the left lower air recirculation system
- Ice collection screen (internal)
- Water collector (internal)
- Water drain (3 places).

The ice collection screen is in the bottom part of the manifold. It collects ice that can form when the fresh air from the packs or a ground conditioned air source mix with hot humid recirculated air.

The manifold has three water drains at these locations:

- Forward side
- Aft side (not shown)
- Bottom (not shown).

The water drains let water move from inside the manifold to the bilge area below the manifold.

The upper part has these features:

- Four connectors for the passenger cabin conditioned air distribution ducts
- A connection for the forward cargo conditioned air distribution duct
- Temperature sensors for the air conditioning pack and mix manifold temperature control system.

See the pack cooling and mix manifold temperature control section for more information about the mix manifold temperature sensors (SECTION 21-52).

The manifold is kevlar.

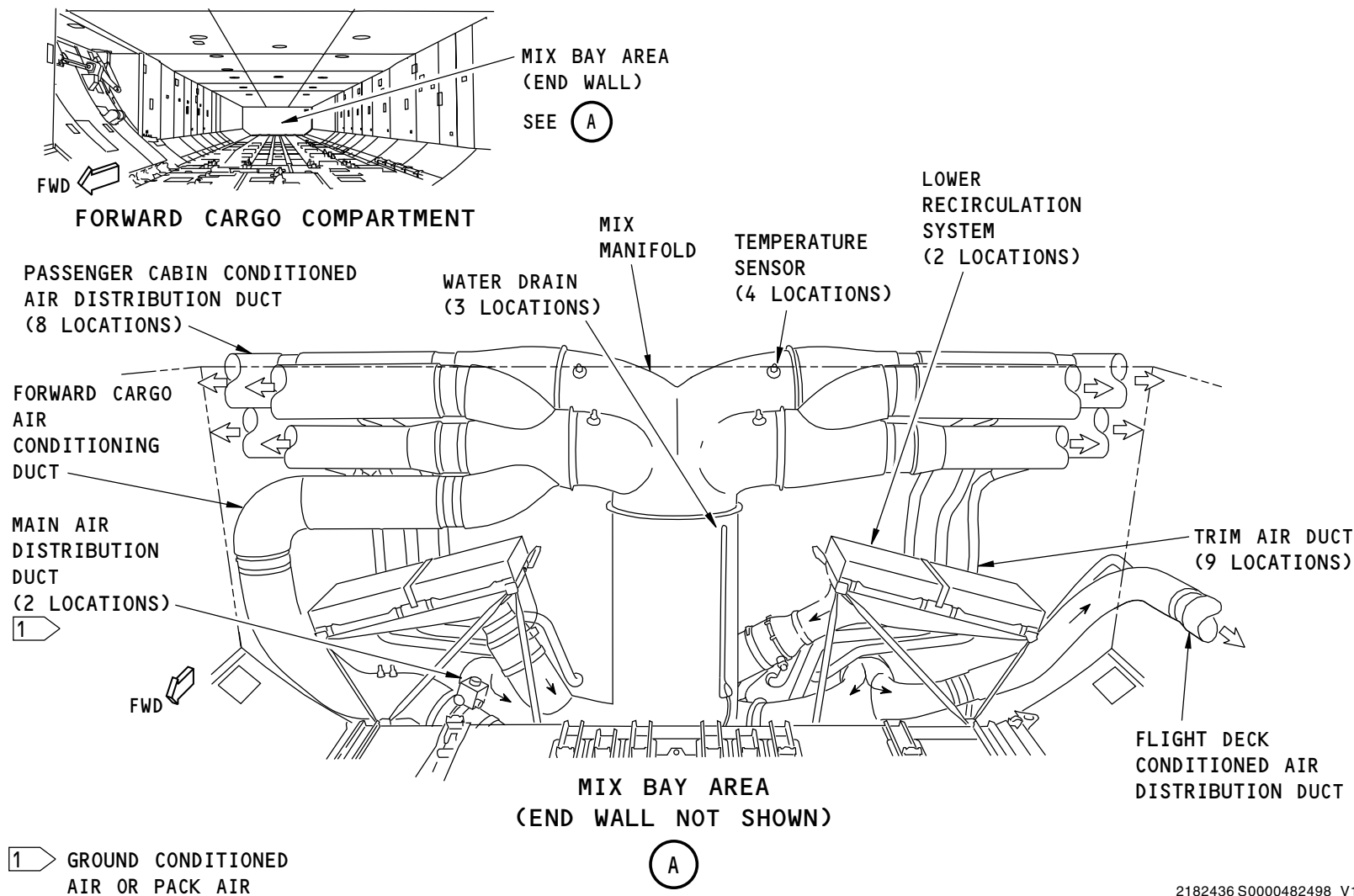
The left main air distribution duct (air from left pack or a ground conditioned air source) gives air to the mix manifold, to the attendants rest air distribution duct and to the flight deck conditioned air distribution duct.

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AIR CONDITIONING - MAIN AIR DISTRIBUTION - MIX MANIFOLD

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**AIR CONDITIONING - FLIGHT DECK CONDITIONED AIR DISTRIBUTION****Purpose**

The flight deck conditioned air distribution system moves air from the left pack to the flight compartment. If the left pack is off, the system moves air from the mix manifold to the flight compartment.

Conditioned air for the flight crew rest area comes from the flight deck conditioned air distribution system.

Physical Description

The flight deck conditioned air distribution system has these components:

- Ducts
- Muffler (2)
- P5 air outlet (2)
- P11 air outlet
- Windows 2 and 3 air outlet (4)
- Sidewall air outlet (3)
- Adjustable air outlet (6).

Location

Components are in these areas:

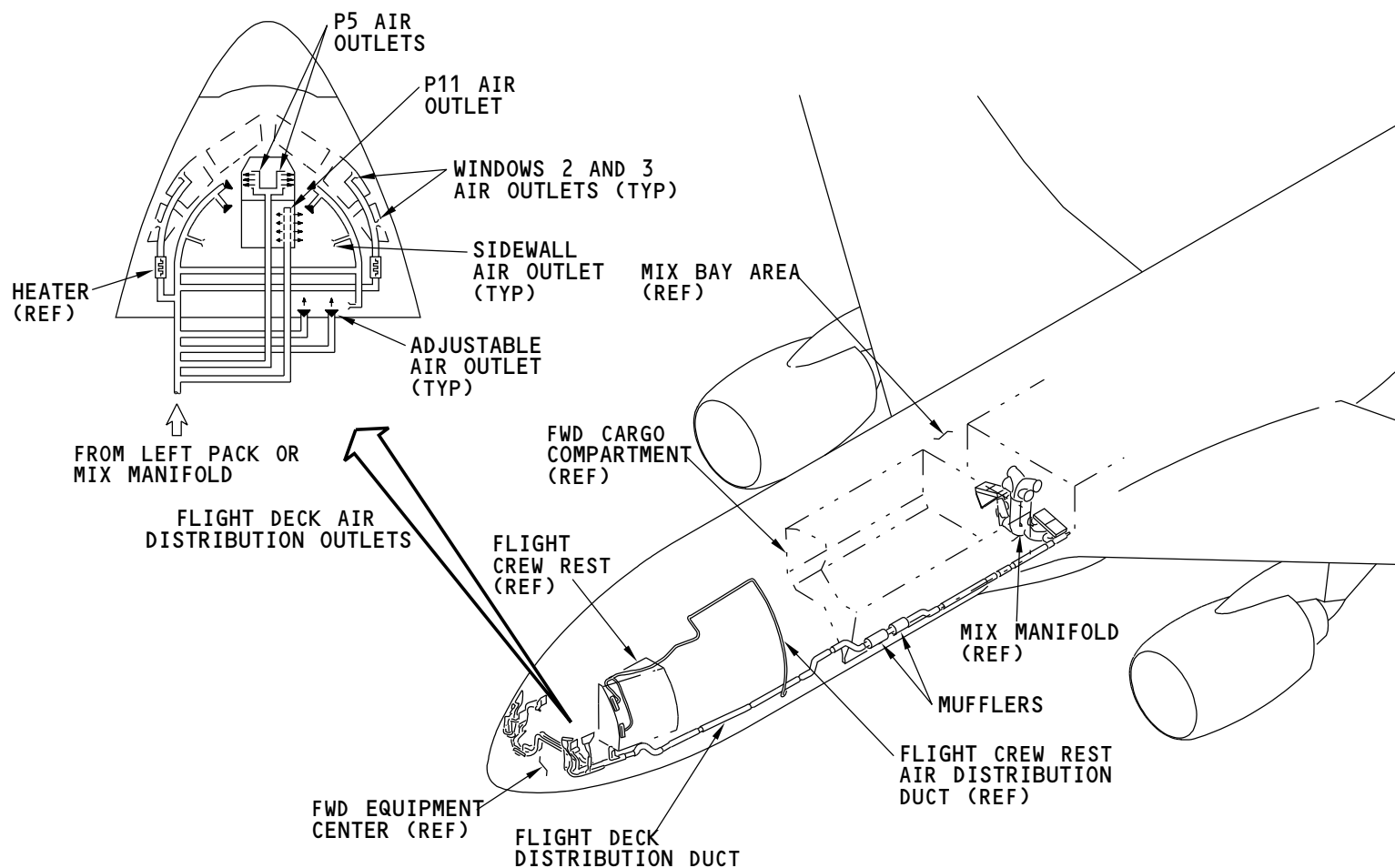
- Mix bay
- Forward cargo compartment, left sidewall area
- Left side of the main equipment center
- Forward equipment center
- Flight deck.

There are ducts in all areas. Two mufflers are in the left sidewall area of the forward cargo compartment, aft of the cargo door. Air outlets are in the flight compartment.

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AIR CONDITIONING - FLIGHT DECK CONDITIONED AIR DISTRIBUTION

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**AIR CONDITIONING - PASSENGER CABIN CONDITIONED AIR DISTRIBUTION - LOWER LOBE AREA****General**

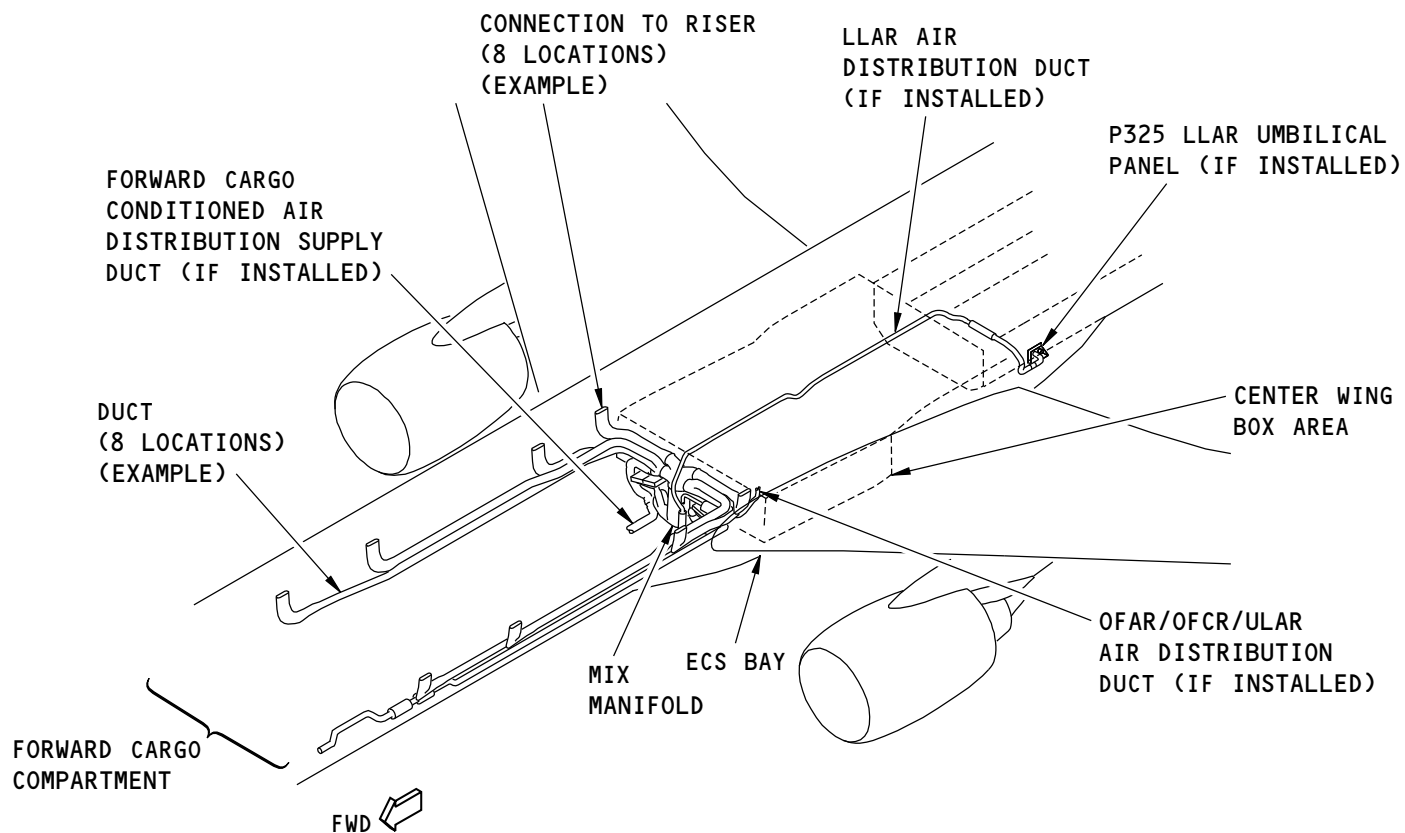
The passenger cabin air distribution system moves air from the mix manifold to the passenger cabin area.

In the lower lobe area, conditioned air moves from the mix manifold through eight ducts that connect to risers. These ducts are outboard of the forward cargo compartment, four on each side.

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AIR CONDITIONING - PASSENGER CABIN CONDITIONED AIR DISTRIBUTION - LOWER LOBE AREA

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AIR CONDITIONING - PASSENGER CABIN CONDITIONED AIR DISTRIBUTION - PASSENGER CABIN AREA**General**

In the cabin area, the system moves conditioned air to the passenger cabin from the ducts in the lower lobe area (not shown).

The system has these components in the cabin area:

- Risers
- Overhead distribution ducts
- Air outlets.

Riser

There are eight risers, four on each side of the cabin. The risers connect the conditioned air ducts (not shown) in the lower lobe area to conditioned air ducts above the passenger cabin ceiling. To decrease noise, each riser has four round ducts that have insulation over them. The insulation also decreases the collection of water on the outside of the ducts. The risers are identified by the zone that they give air to. These are the risers:

- Zone A, first riser on the left
- Zone B, first riser on the right
- Zone C, second riser on the left
- Zone D, second riser on the right
- Zone E, third and fourth risers on the left
- Zone F, third and fourth risers on the right.

Overhead Distribution Ducts

The overhead distribution ducts connect the risers to the conditioned air outlet ducts. The ducts have different sizes and shapes. Insulation on the ducts decrease noise and the collection of water on the outside of the ducts. The ducts have connections for the upper recirculation system (not shown) and the door area heating system (not shown). See the recirculation section for more information about the upper recirculation system (SECTION 21-25). See the supplemental heating section for more information about the door heating system (SECTION 21-45).

- Upper recirculation system (not shown)
- Gasper air system (not shown)
- Door area heating system (not shown).

Air Outlet Ducts

There are two air outlet ducts for each passenger cabin temperature control zone. Each zone has a duct above the left and right passenger aisles. The air outlet ducts control the flow of conditioned air into the passenger cabin zones. The air outlets ducts collect water that can be in the air from the recirculation system. Insulation on the ducts decrease noise and the collection of water on the outside of the ducts. Each duct has these parts:

- Flow straightener
- Baffle tube
- Antifungal felt
- Plenum sidewall
- Plenum duct.

Ceiling panels and the air outlet grill attach to the lower part of the air outlet duct. See the passenger compartment section for more information about the ceiling panels and the air outlet grill (SECTION 21-20).

**AIR CONDITIONING - PASSENGER CABIN CONDITIONED AIR DISTRIBUTION - PASSENGER CABIN AREA****Return Air Grills**

Return air grills (not shown) below the sidewall panels in the passenger cabin let air move from the passenger cabin area to the lower lobe area. Cabin air in the lower lobe can flow out of the airplane through the outflow valves or into these systems:

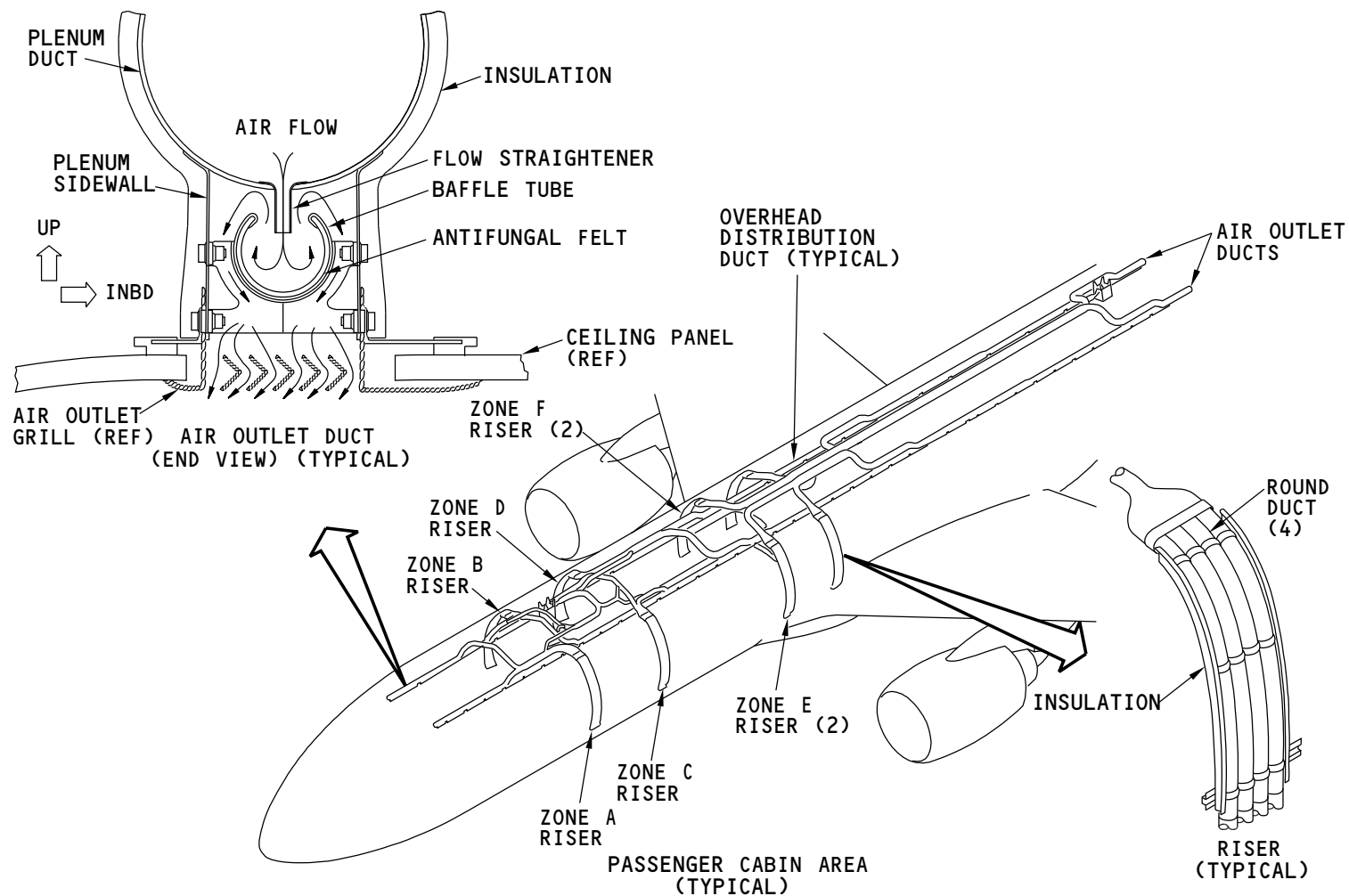
- Lower recirculation system
- Forward equipment cooling system
- Bulk cargo ventilation system.

See the passenger compartment section for more information about the return air grills and sidewall panels (SECTION 21-20).

Gasper Air Outlets

The passenger cabin air distribution system supplies additional air flow to the galleys through gasper air outlets in the ceiling panels.

The passenger cabin air distribution system supplies additional air flow to the flight attendant seats through gasper air outlets in the ceiling panels near the flight attendant seats.



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AIR CONDITIONING - PASSENGER CABIN CONDITIONED AIR DISTRIBUTION - PASSENGER CABIN AREA

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**AIR CONDITIONING - RECIRCULATION - INTRODUCTION****Purpose**

The recirculation system puts cabin air back in the air conditioning distribution system.

General Description

Upper recirculation fans, above the passenger compartment ceiling pull in cabin air and put the air back in the overhead distribution ducts. Lower recirculation fans, aft of the forward cargo compartment pull in cabin air and put the air in the mix manifold.

The upper and lower recirculation fan switches on the air conditioning panel enable the operation of these fans.

The right cabin temperature controller (CTC) supplies usual control for all recirculation fans. The left CTC supplies backup control.

The left and right ECSMCs monitor for fan overheat conditions.

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A vibration monitor unit is installed on each of the fans.

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ELMS controls power to the fans. If the forward or aft cargo fire arm switches are in the ARMED position, the ELMS and the CTC turn off the lower fans.

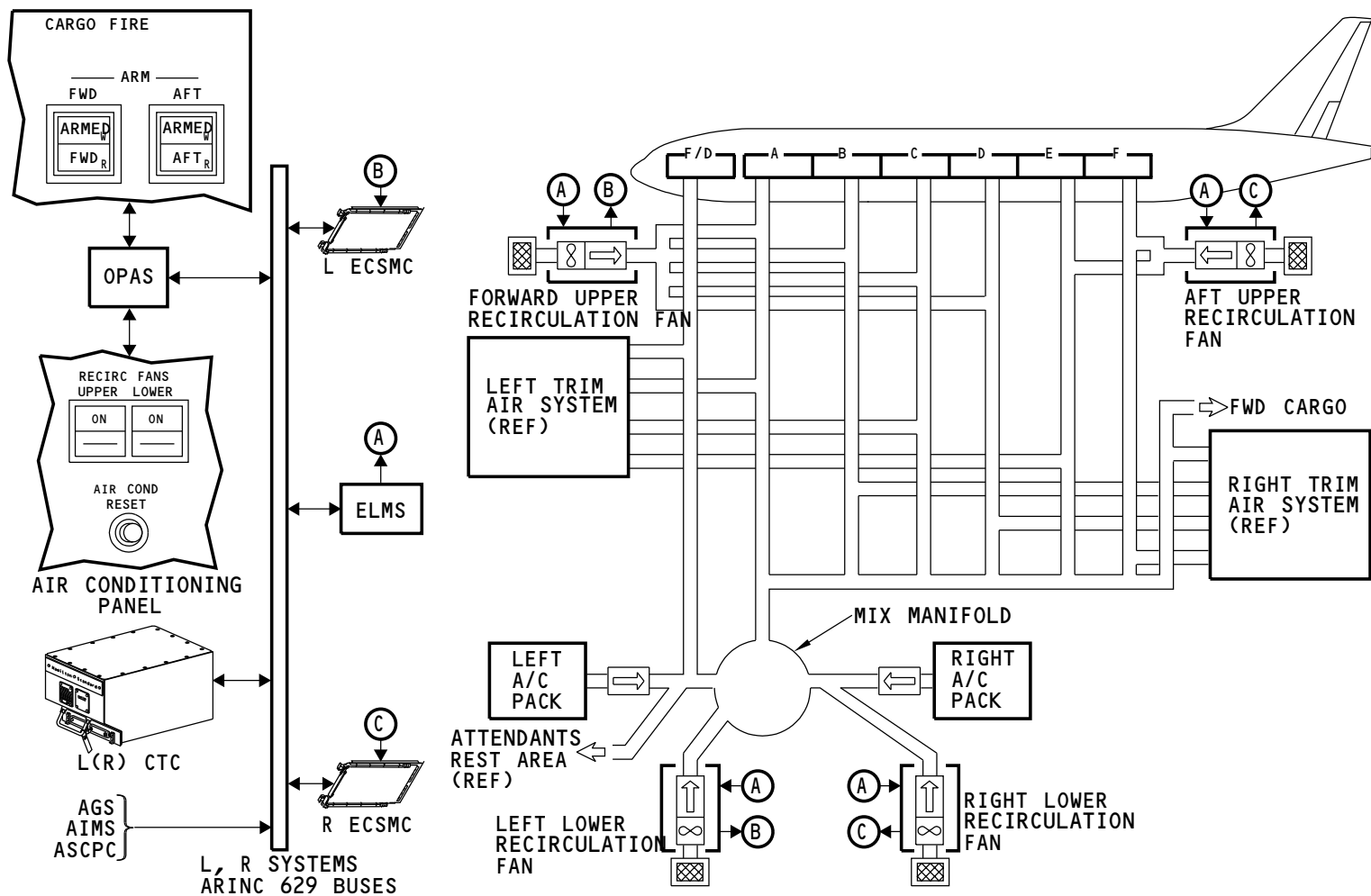
The CTCs get information about airplane conditions from these systems/components:

- Air ground system (AGS)
- Electrical load management system (ELMS), load shed and power status
- Airplane information management system (AIMS), cruise clamp information
- Air supply cabin pressure controllers (ASCPC), pack flow schedule.

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AIR CONDITIONING - RECIRCULATION - INTRODUCTION

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**AIR CONDITIONING - RECIRCULATION - LOWER RECIRCULATION FANS AND FILTERS****Purpose**

The lower recirculation fans put cabin air back in the distribution system. The air goes through filters at the inlets of the fans.

Physical Description

The fans are axial flow type with a three-phase electric motor. A check valve is part of the fan.

There are four interchangeable lower recirculation fan filters. The filters are a paper type. The filters for the upper and lower recirculation fans are interchangeable.

Location

The fans and filters are aft of the forward cargo compartment in the mix bay area. You remove the cargo compartment end wall to get access to the fans and filters.

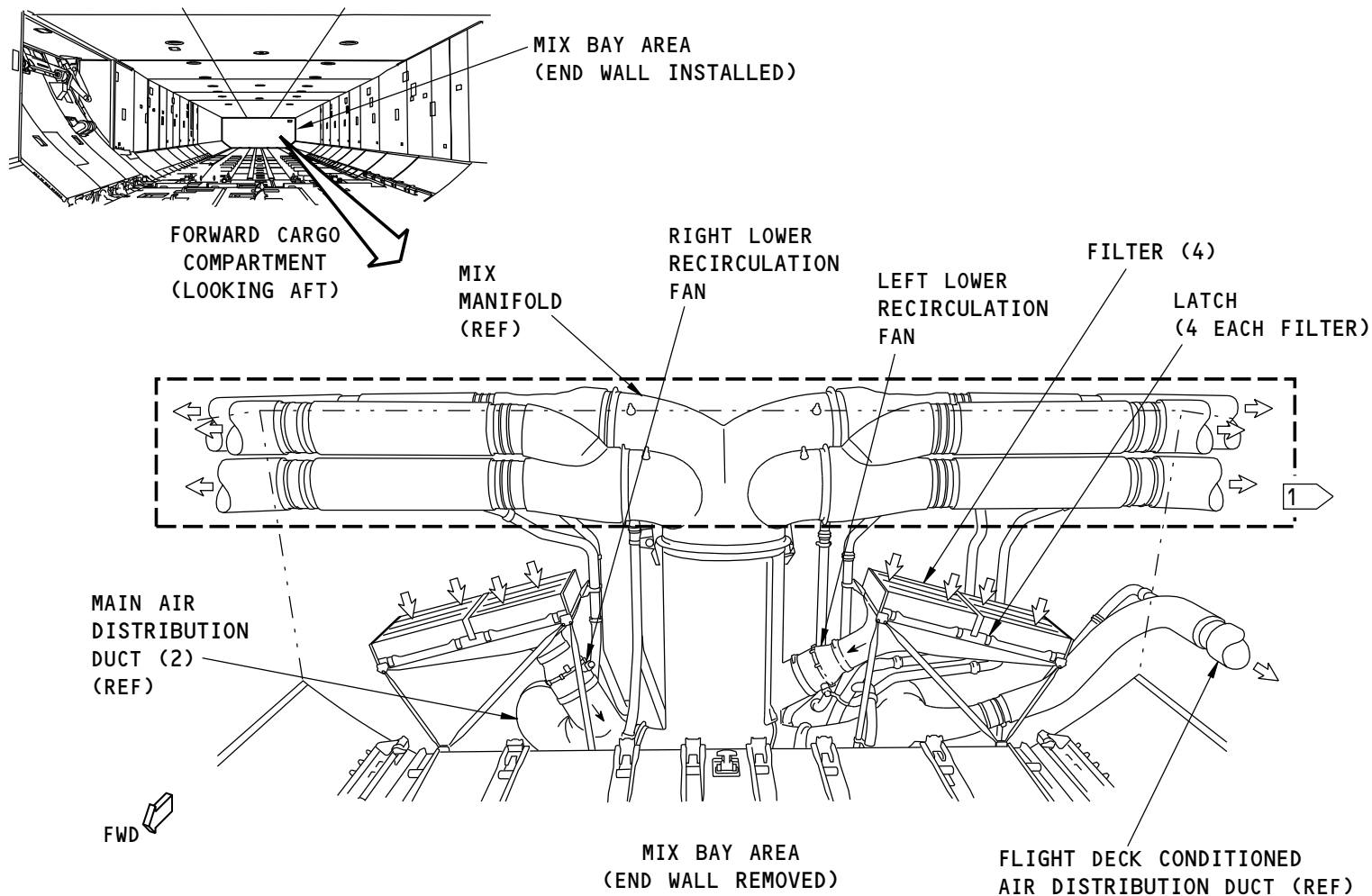
Training Information Point

The two fans are not interchangeable with each other. The right fan gives more air flow than the left. Additional air flow is necessary to make sure sufficient air is available to the forward cargo compartment.

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1 OPTIONAL EQUIPMENT NOT SHOWN

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AIR CONDITIONING- RECIRCULATION - LOWER RECIRCULATION FANS AND FILTERS

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**AIR CONDITIONING - RECIRCULATION - UPPER RECIRCULATION FANS AND FILTERS****Purpose**

The upper recirculation fans put cabin air back in the overhead conditioned air distribution ducts. The air goes through filters at the inlets of the fans.

Physical Description

The fans are axial flow type with a three-phase electric motor. A check valve is part of the fan.

There are four interchangeable upper recirculation fan filters. The filters are a paper type. The filters for the upper and lower recirculation fans are interchangeable.

Location

The upper recirculation fans and filters are on the right side of the airplane above the passenger compartment ceiling.

The forward upper recirculation fan and filters are aft of door 2 above the center overhead bins.

The aft upper recirculation fan and filters are aft of door 3 above the center overhead bins.

The fans attach to the outlet of a filter plenum assembly and to an overhead passenger cabin conditioned air distribution duct.

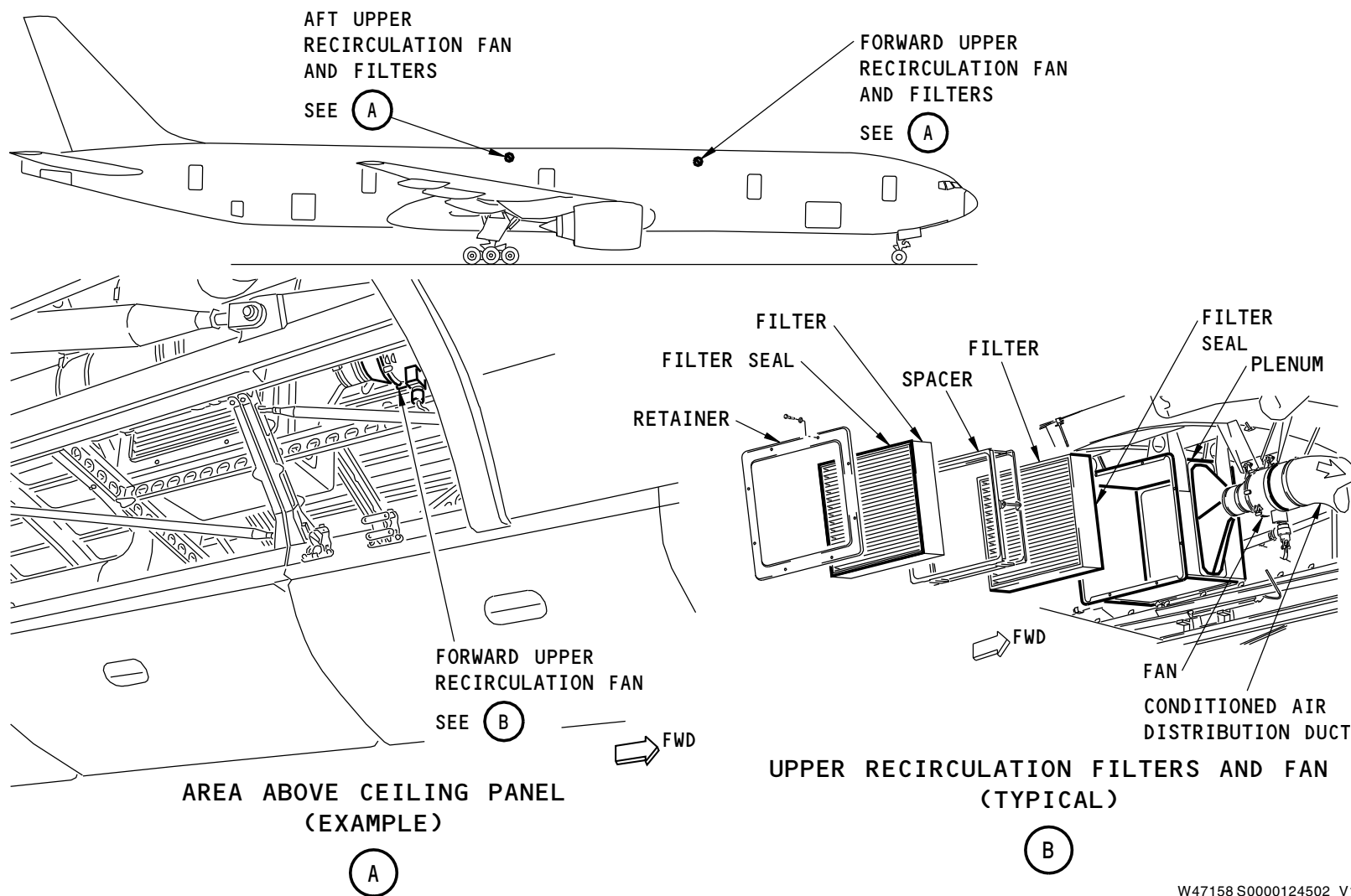
The filters are attached inside the filter plenum assembly.

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AIR CONDITIONING - RECIRCULATION - UPPER RECIRCULATION FANS AND FILTER

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**AIR CONDITIONING - RECIRCULATION - RECIRCULATION FANS VIBRATION MONITOR UNITS****Purpose**

A vibration monitor unit provides early detection of fan mechanical failure and contains diagnostic capability to monitor malfunction via a status LED. There is no change to the airplane systems behaviour due to the presence of the vibration monitor units.

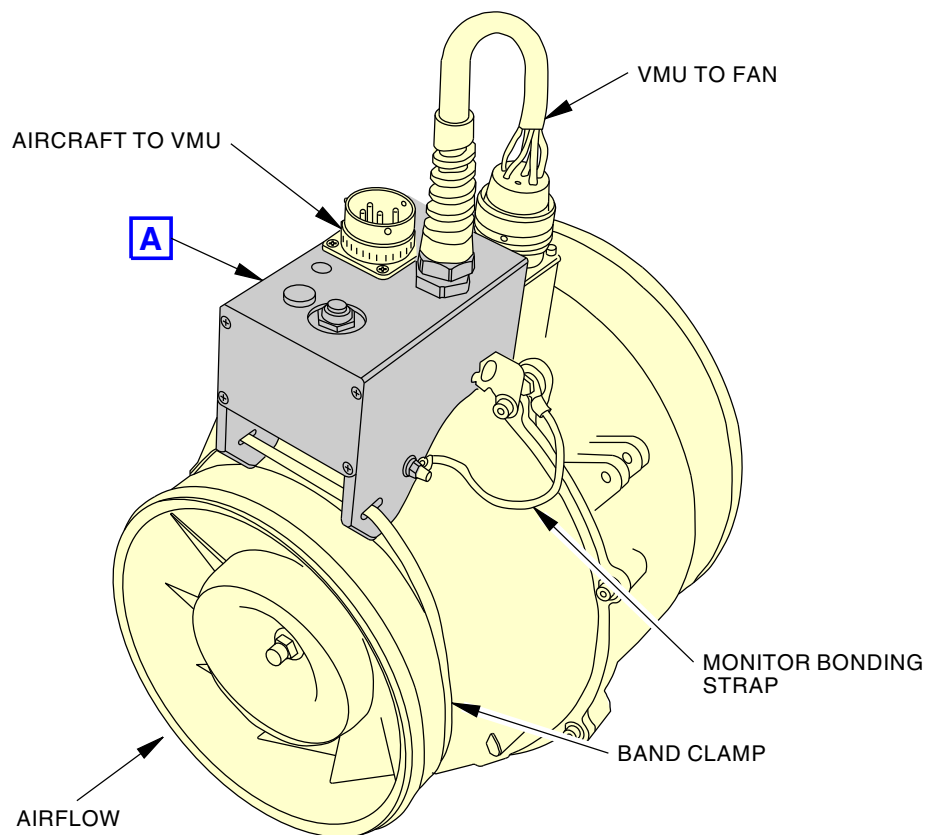
Physical Description

The vibration monitor units are fitted to the fans. They are electronically installed between the fan and power source. They are equipped with a test button and a status LED to monitor the fan and vibration monitor unit condition.

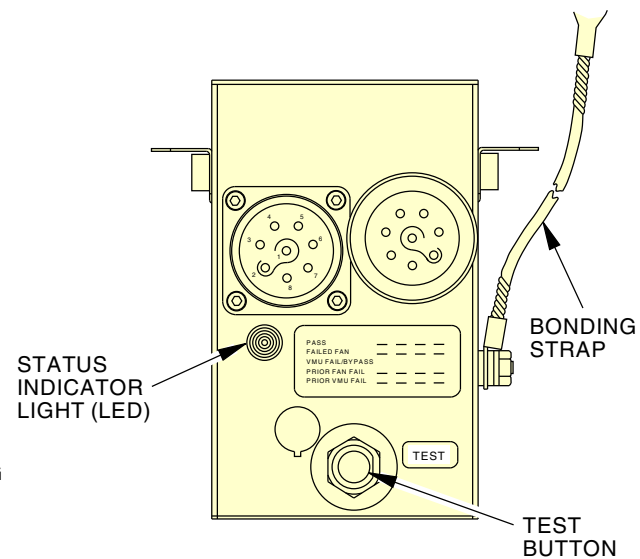
The vibration monitor units are interchangeable.

Location

The vibration monitor units are fitted to each recirculation fan.



FAN/MONITOR MOUNTING
(EXAMPLE)



VIBRATION MONITOR UNIT

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AIR CONDITIONING - RECIRCULATION - RECIRCULATION FANS VIBRATION MONITOR UNITS

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AIR CONDITIONING - RECIRCULATION - FUNCTIONAL DESCRIPTION

Functional Description - Normal

When the two recirculation fan switches on the P5 are ON, the OPAS sends signals to the CTCs. This sets the fans for automatic operation. The right CTC is the primary controller for the recirculation fans. If both channels of the right CTC fail, the left CTC controls the fans.

The CTC sends fan on signals to the ELMS signal interface units (SIUs) in the left and right power management panels. The SIUs supply grounds to energize the recirculation fan relays. The relays supply power to each recirculation fan. The CTC turns the fans on and off with a 5 second delay between fans. This helps prevent a sudden load.

ARO 001-016 POST SB 777-21-0189

A vibration monitor unit is fitted to each of the recirculation fans. They provide early detection of fan mechanical failure and contain diagnostic capability to monitor malfunction via a status LED.

ARO ALL

Power is supplied to the lower right recirculation fan by an ELCU to handle the current requirement of the high capacity fan. The ELCU is energized directly from the ELMS without an intermediate control relay.

Functional Description - Overheat

The ECSMCs monitor overheat switches in the recirculation fans. The left ECSMC monitors the left lower and forward upper fans. The right ECSMC monitors the right lower and aft upper fans (not shown). If an overheat switch opens, the ECSMC sends an overheat signal to the CTC. The CTC latches the fan off. The CTC also latches the related fans off if there is a loss of data from an ECSMC.

ARO 001-016 POST SB 777-21-0189

Each fan is monitored by a vibration monitor unit. In the case of imminent fan bearing failure, the vibration monitor unit simulates an open fan overheat switch to prevent fan failure. Additional visual indication of fan and vibration monitor units condition is provided by the vibration monitor unit status LED.

ARO ALL

Operation - Normal

The lower and upper recirculation fan switches are alternate-action switches. When the switches are off, the recirculation fans are off. When the switches are on, operation of the recirculation fans is automatic.

The upper and lower fans usually operate continuously on the ground and in flight. Single pack ground operation with high ambient temperature may cause a lower fan to stop. The CTC turns off the fan on the same side as the unserviceable pack. This decreases the amount of warm air put into the mix manifold and helps cool the airplane.

ARO 001-016 POST SB 777-21-0189

The fan vibration monitor units are physically and electronically installed between the fan power source and the fan itself. The power supplied passes through the vibration monitor unit unaltered. There is no change to the airplane systems behaviour due to the presence of the vibration monitor units.

ARO ALL

See the pack cooling and mix manifold temperature control section for more information (SECTION 21-52).

Operation - Non-normal

If the forward or aft cargo fire arm switches are in the ARMED position, the ELMS and the CTC turn off the lower fans.

If an upper or lower fan has a failure and pack flow schedule 1 is in effect, the pack flow rate increases 67 lbs/min (33.5 lbs/min per pack). This keeps the total cabin ventilation rate constant. The increased bleed air flow causes a small increase in fuel consumption, approximately .3% for each failed fan.

ARO 017-999; ARO 001-016 PRE SB 777-21-0189

A status message shows if a recirculation fan has a failure. If the fan latches off because of an overheat condition, you can cycle the recirculation fan switch OFF then ON to release the latch. You can also use the AIR COND RESET switch to release the latch.

21-25-00

EFFECTIVITY

ARO ALL

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**AIR CONDITIONING - RECIRCULATION - FUNCTIONAL DESCRIPTION****ARO 001-016 POST SB 777-21-0189**

A status message shows if a recirculation fan has a failure or if the vibration monitor unit has simulated an open overheat switch. If the fan latches off because of an overheat condition, you can cycle the recirculation fan switch OFF then ON to release the latch. You can also use the AIR COND RESET switch to release the latch. The vibration monitor unit can be reset by removing and applying power to it.

ARO ALL**Indications**

Current sensors monitor fan current during operation. These indications go to the ECSMCs:

- Valid fan current
- ELCU energized
- ELCU open.

Training Information Point

You can test the operation of the fan with a ground test from the MAT.

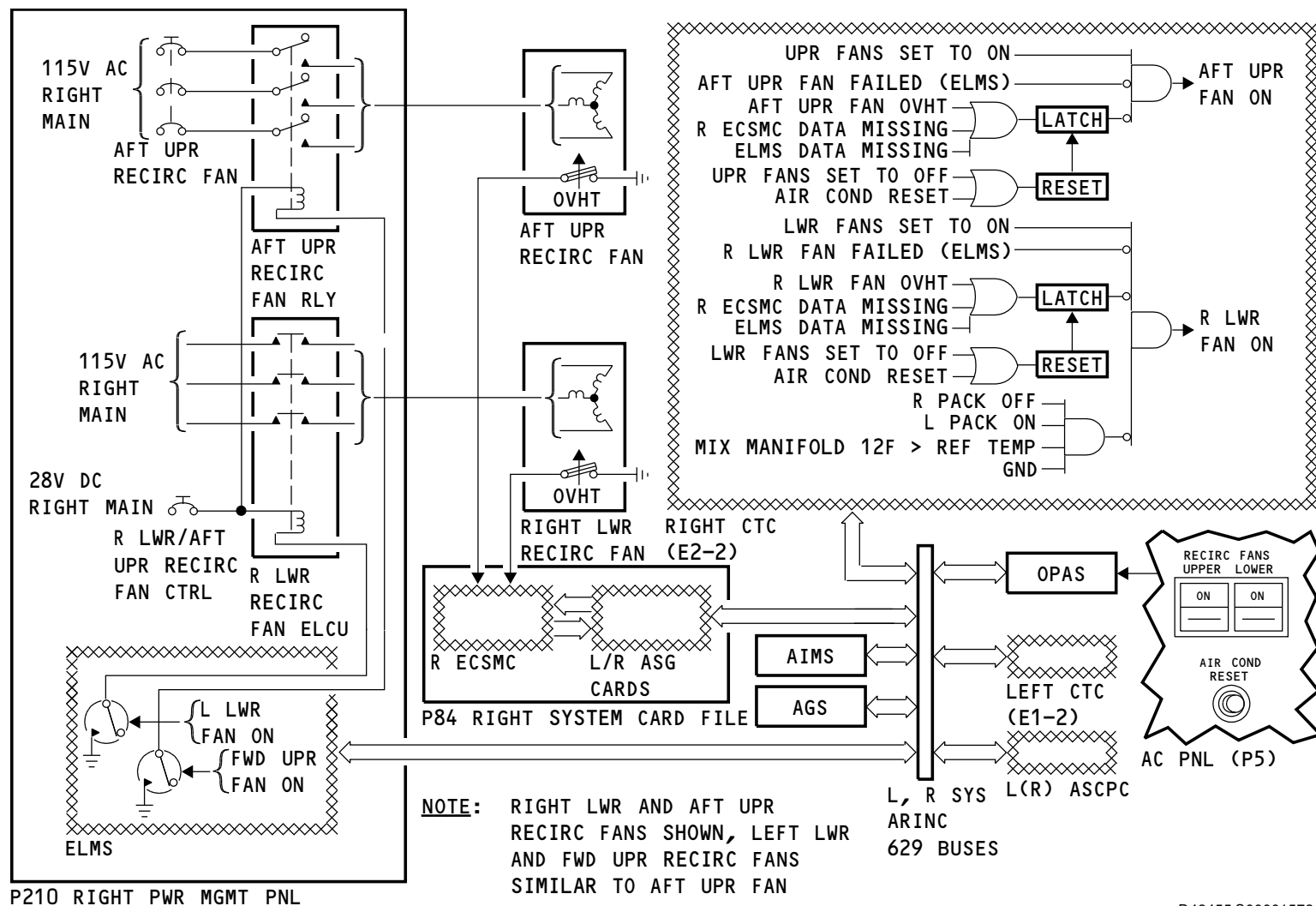
Fuel usage increases when one or more recirculation fans are inoperative. See the Dispatch Deviation Guide to find the fuel usage increase to use for flight planning.

The lower right fan power is controlled by a solid state ELCU. The ELCU is connected directly to the 115V AC main bus. The fan must be disconnected or the ELCU must be removed to ensure that power is removed from the fan for maintenance.

21-25-00**ARO ALL** **EFFECTIVITY**

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D43455 S0000157344_V2

AIR CONDITIONING - RECIRCULATION - FUNCTIONAL DESCRIPTION

21-25-00

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AIR CONDITIONING - VENTILATION - GENERAL DESCRIPTION - MECHANICAL

Purpose

The ventilation system has these functions:

- Removes odors from the lavatories and galleys
- Causes air flow across the zone temperature sensors for the flight, passenger, and cargo compartments
- Removes odors from the forward cargo compartment
- Removes warm air from above the passenger compartment ceiling and from the galley chiller units in the forward part of the airplane
- Supplies air flow into the bulk cargo compartment
- Causes air flow through electrical and electronic equipment.

These are the types of ventilation:

- Forward cargo ventilation
- Galley chiller unit ventilation
- Bulk cargo ventilation
- Lavatory/galley ventilation.

Forward Cargo Ventilation

The forward cargo ventilation system prevents the movement of odors from the cargo compartment into the flight deck and passenger cabin.

The exhaust fan pulls air from the compartment through the cargo heating duct. Air moves from the fan through the forward equipment cooling vent valve and vent ducting to the area next to the forward pressurization outflow valve. The fan operates when the forward cargo air conditioning system is set to AUTO. See the forward cargo compartment heating section for more information about the operation of the forward cargo heating system (SECTION 21-43). See the equipment cooling section for more information about the operation of the forward equipment cooling system (SECTION 21-27). See the zone temperature control and indication section for more information about the operation of the forward cargo air conditioning system (SECTION 21-61).

Galley Chiller Unit Ventilation

The chiller boost fan removes warm air from galley chillers and the area above the passenger compartment ceiling. Only chillers in the passenger compartment ceiling area above the galleys and forward of the wings connect to the fan.

The air from the chiller boost fan goes to the mix bay area. The lower recirculation fans (not shown) move the air to the mix manifold part of the air conditioning distribution system.

Holes in the duct let hot air from the chiller exhaust go into the ceiling when the fan is off.

The chiller boost fan operates automatically.

Bulk Cargo Ventilation

The bulk cargo ventilation fan increases the ventilation when there are animals in the bulk cargo compartment. The fan pulls air from the passenger compartment and moves it into the bulk cargo compartment. The fan operates when the bulk cargo heating system is set to HIGH.

Lavatory/Galley Ventilation

There are two lavatory/galley ventilation fans. Only one fan operates at a time. The right fan is primary and the left fan is the backup. At airplane power up, the left fan comes on, does a test, and goes off. The right fan then comes on, does a test, and stays on. The fan that operates pulls air from these areas and components:

- Lavatories
- Galleys
- Zone temperature sensors
- Cargo temperature sensors
- Electrical and electronic equipment.

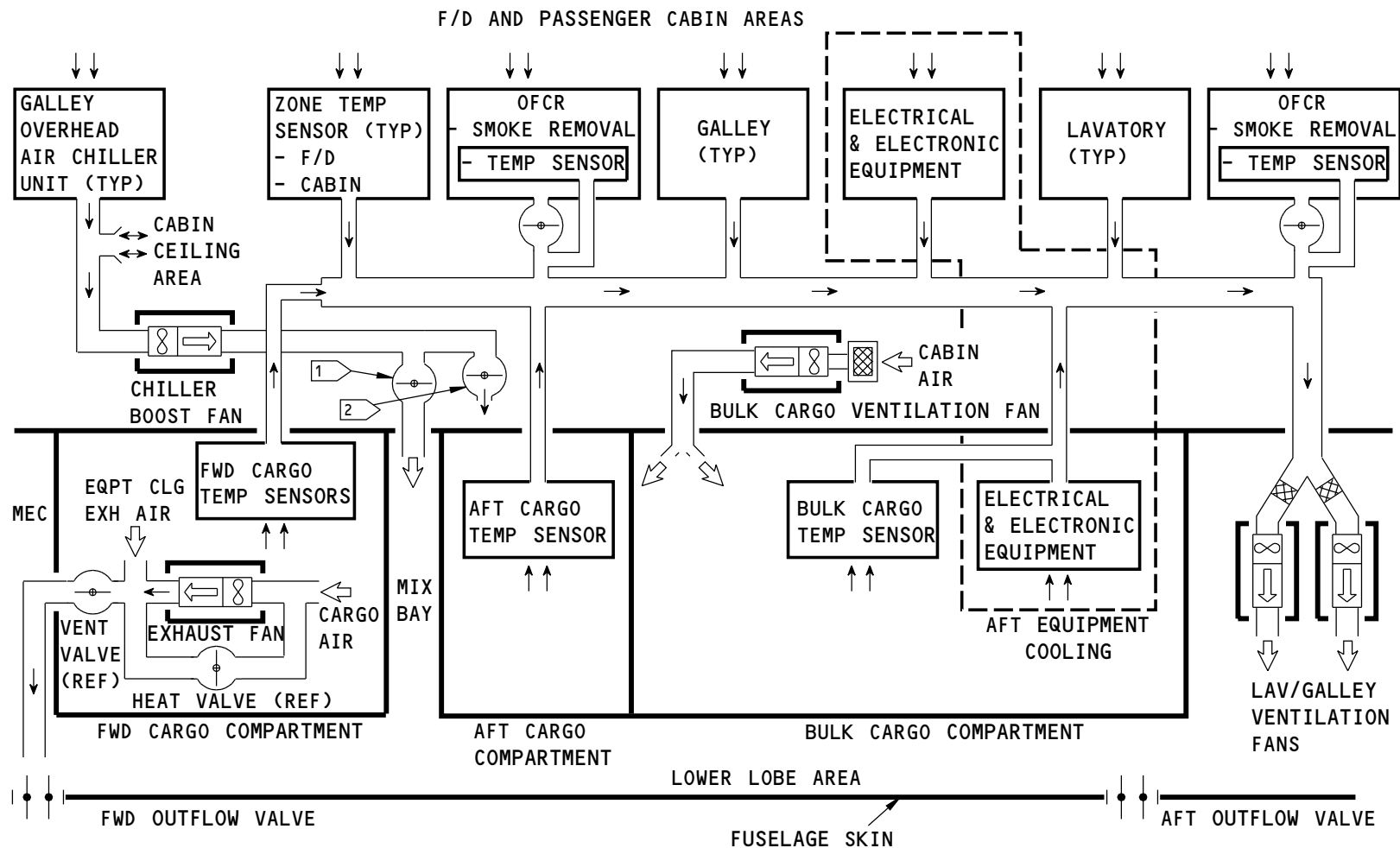
The air from the lavatory/galley ventilation fan goes to the area next to the aft pressurization outflow valve.

21-26-00

EFFECTIVITY
ARO ALL

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1 LOWER LOBE EXHAUST VALVE - DISCONNECTED OPEN

2 CROWN EXHAUST VALVE - DISCONNECTED CLOSED

AIR CONDITIONING - VENTILATION - GENERAL DESCRIPTION - MECHANICAL

D38954 S0000154847_V1

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ARO ALL EFFECTIVITY

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AIR CONDITIONING - VENTILATION - GENERAL DESCRIPTION - ELECTRICAL

General

The environmental control system miscellaneous cards (ECSMCs) in the system card files control the ventilation fans. At power-up, the right ECSMC controls the fans. The left ECSMC gives backup. Each time the airplane goes from air to ground, the card in control changes.

Interfaces

The ECSMCs make decisions about operation and indications for the ventilation fans based on these inputs:

- Airplane in the air or on the ground (WOW)
- Fan overheat switches
- AC power available for fan operation (ELMS)
- Fan load shed status (ELMS)
- Fan control relay status, energized or not (ELMS)
- Valid current for fan on or off status (ELMS)
- Forward and aft cargo fire switches, ARMED or not armed (OPAS)
- Equipment cooling switch position (OPAS)
- Left and right air conditioning packs on or off (CTC)
- Forward cargo air conditioning control selector position, OFF or AUTO (OPAS)
- Bulk cargo heat selector position, OFF, LOW, HIGH (OPAS).

The ECSMCs interface with AIMS. The primary display system gives an advisory message if both lavatory/galley ventilation fans fail. AIMS gives a status message for a failed ventilation fan. The central maintenance computing function gives a maintenance message for any failed fan and lets you do a ground test for the ventilation fans.

The ECSMCs interface with the CTCs. The ECSMCs give on/off information about the lavatory/galley ventilation fans. If both fans are off, the CTCs use an alternate mode to calculate the necessary duct and mix manifold temperatures for zone temperature control. See the zone temperature control and indication section for more information about the alternate mode (SECTION 21-61).

Lavatory/Galley Ventilation

Control of the fans is automatic and requires no crew action for fan operation.

There are two lavatory/galley ventilation fans. Only one fan operates at a time. The right fan is primary and the left fan is the backup. At airplane power up, the left fan comes on, is tested, and goes off. The right fan then comes on, is tested, and stays on.

Galley Overhead Air Chiller Unit Ventilation

Control of the chiller boost fan is automatic and no crew action for fan operation is necessary.

The fan comes on when these conditions occur:

- Airplane is on the ground
- One or two packs are on
- FWD cargo fire switch is not armed.
- AFT cargo fire switch is not armed.

The fan will go off when the airplane is in the air.

Forward Cargo Ventilation

The forward cargo exhaust fan operates when the crew sets the forward cargo air conditioning control to the AUTO position.

Selection of the forward cargo fire switch to the ARMED position inhibits the operation of the fan.

Bulk Cargo Ventilation

The bulk cargo ventilation fan operates when the crew sets the bulk cargo heating system to HIGH.

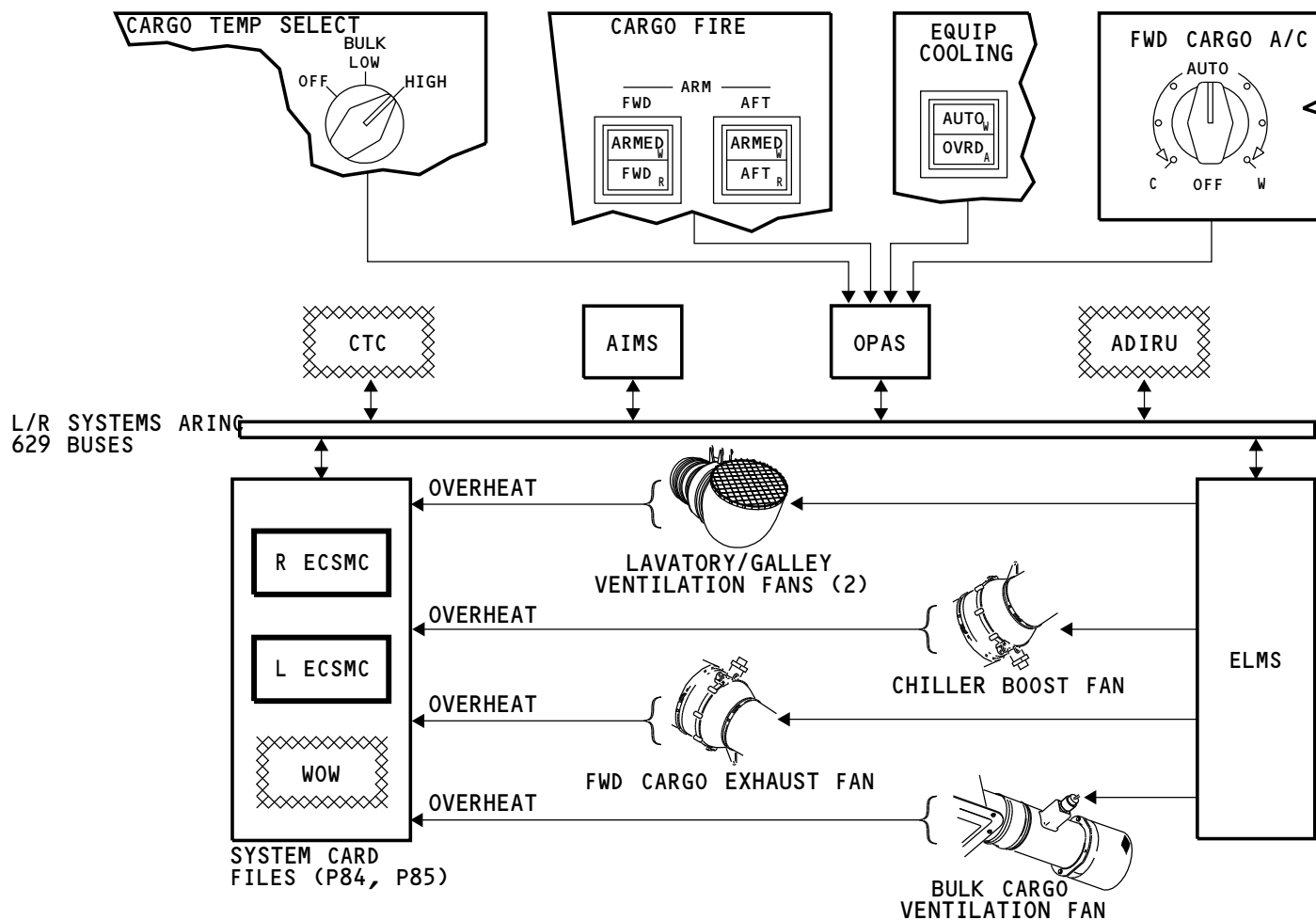
Selection of the equipment cooling switch to the OVRD position or the selection of the aft cargo fire switch to ARMED inhibits the operation of the fan.

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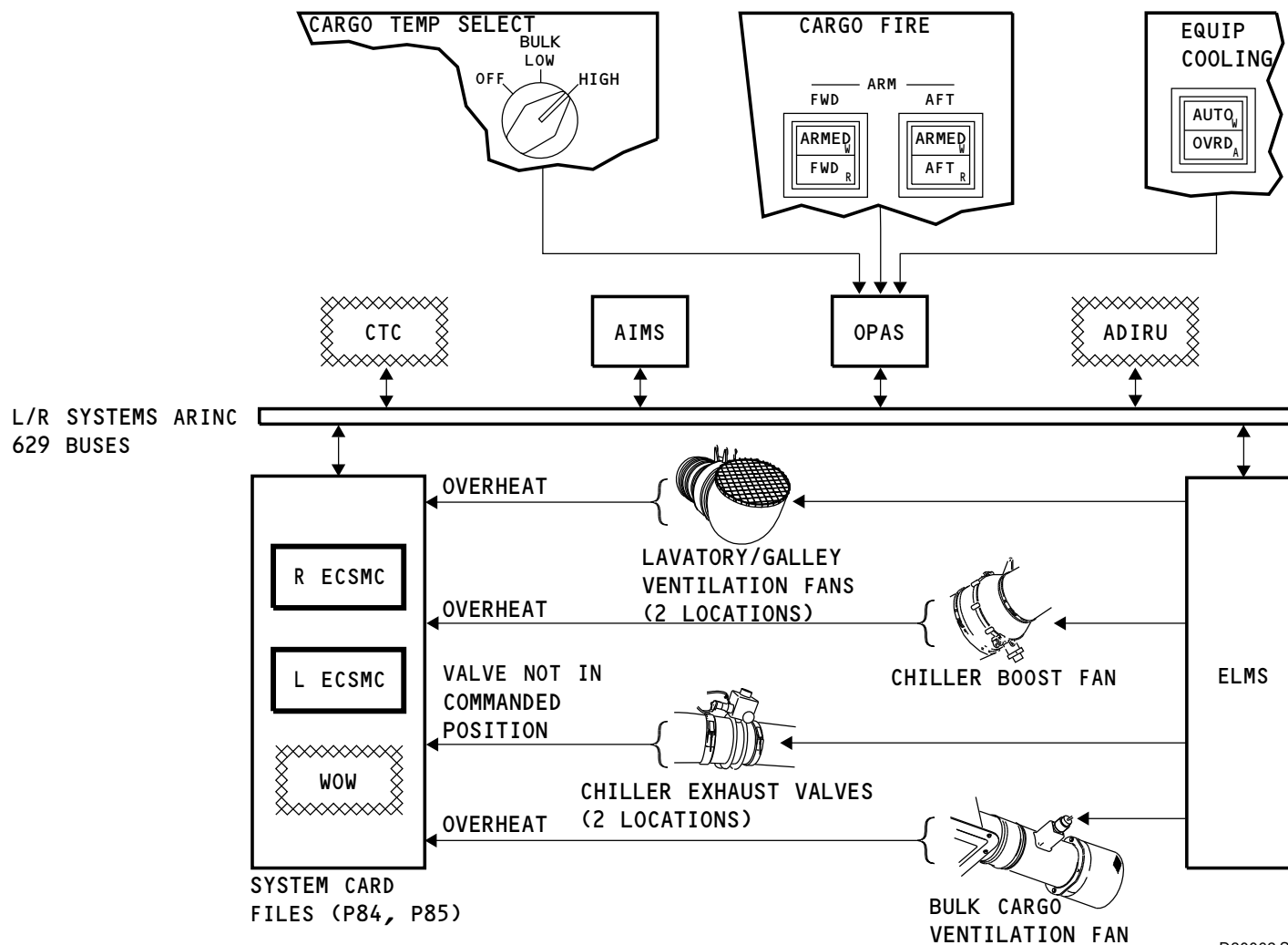
AIR CONDITIONING - VENTILATION - GENERAL DESCRIPTION - ELECTRICAL

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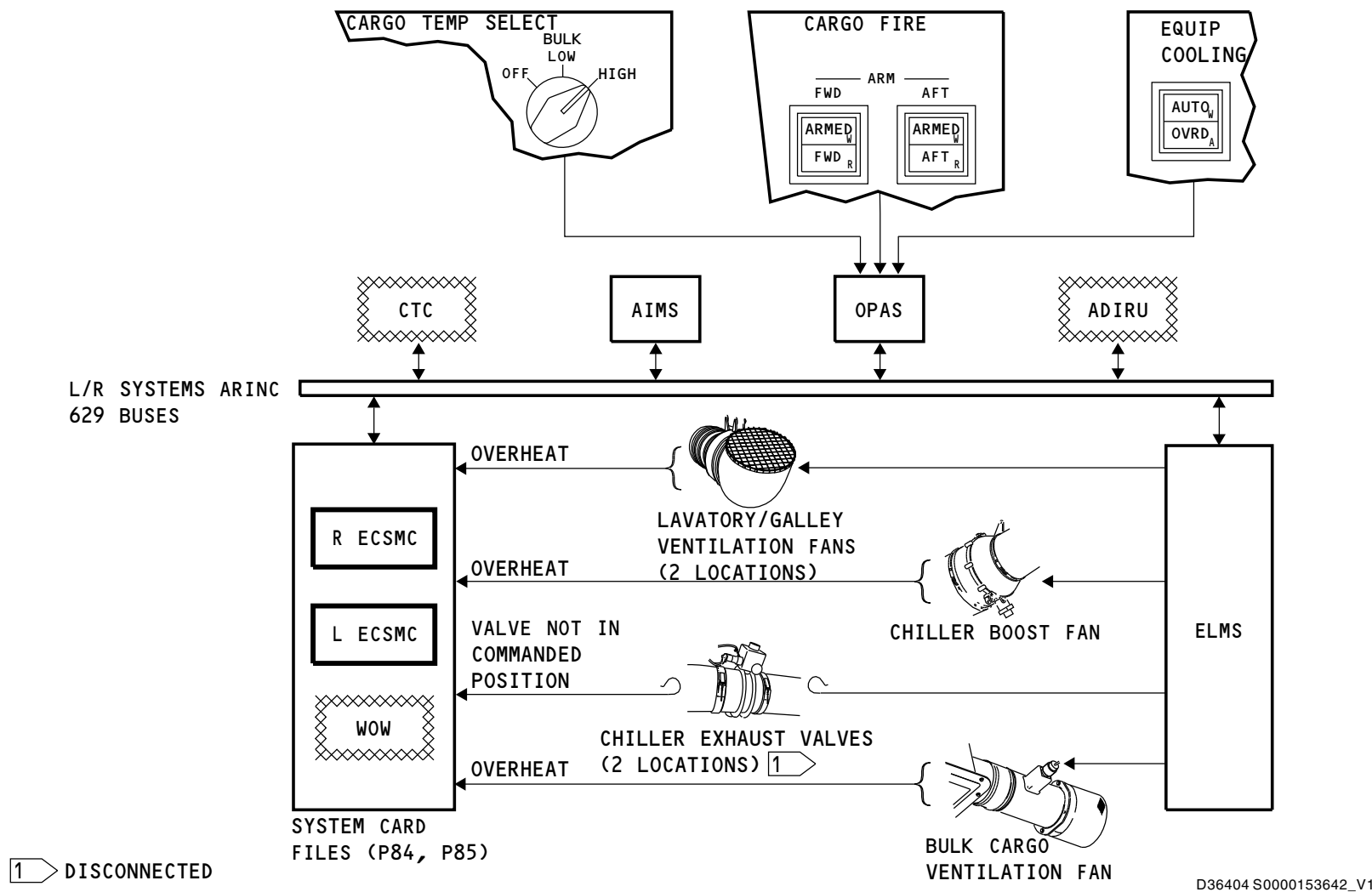
AIR CONDITIONING - VENTILATION - GENERAL DESCRIPTION - ELECTRICAL

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AIR CONDITIONING - VENTILATION - GENERAL DESCRIPTION - ELECTRICAL

21-26-00



AIR CONDITIONING - VENTILATION - GALLEY CHILLER CONDENSER EXHAUST SYSTEM

Purpose

The system moves the air from the chiller condenser exhaust to the area of the mix bay. This reduces the demand on the air conditioning system to keep the temperature in the forward part of the cabin at a comfortable level when the airplane is on the ground.

For ground operations the warm air goes through the galley chiller ducts and exhausts into the lower cheek area at the aft end of the forward cargo compartment. In flight the warm air exhausts into the crown area between door 2 and door 3.

There is no in flight mode of operation. On the ground, the warm air goes through the galley chiller ducts and exits into the lower cheek area at the aft end of the forward cargo compartment.

The system removes the warm air from the chillers above these galleys, if installed (see SECTION 25-30 for a description of the installed galleys):

- F1 galley
- F2 galley
- M1 galley
- M2 galley.

General Description

The galley chiller condenser exhaust system has these parts:

- Main manifold
- Chiller exhaust duct
- Chiller boost fan
- Sidewall duct (12).

The ECSMCs give automatic control for the chiller boost fan. The fan operates if all of these conditions occur:

- The airplane is on the ground
- One or both air conditioning packs are on
- Forward cargo fire system is not armed

- Aft cargo fire system is not armed
- There is no smoke detected in the overhead crew rest(s).

Main Manifold

The main manifold is above the passenger cabin ceiling, near the center. The manifold starts in the area above the forward galley complex and ends in the area above the mix bay.

The main manifold is a rigid type with multiple connections for each chiller. The extra connections make it easy to connect to the manifold if you add a chiller or move a galley that has a chiller.

Chiller Exhaust Duct

The chiller exhaust duct is a rigid type. It connects to a galley mounted bracket above the chiller and to the main manifold. The duct has a vent that lets the warm air from the condenser part of the chiller go into ceiling area when the chiller boost fan is off.

Chiller Boost Fan

The chiller boost fan connects to the main manifold. The fan is 20 inches (50.8 cm) to the right of the airplane center-line, near the inboard ceiling panel adjacent to the seventh window aft of door 2 right.

The fan is an axial flow type with a three-phase electric motor. A check valve is part of the fan.

ARO 001-016 POST SB 777-21-0189

A vibration monitor unit is installed on the chiller boost fan.

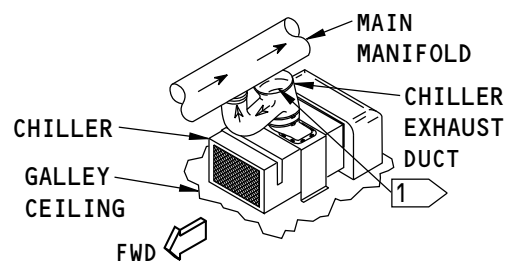
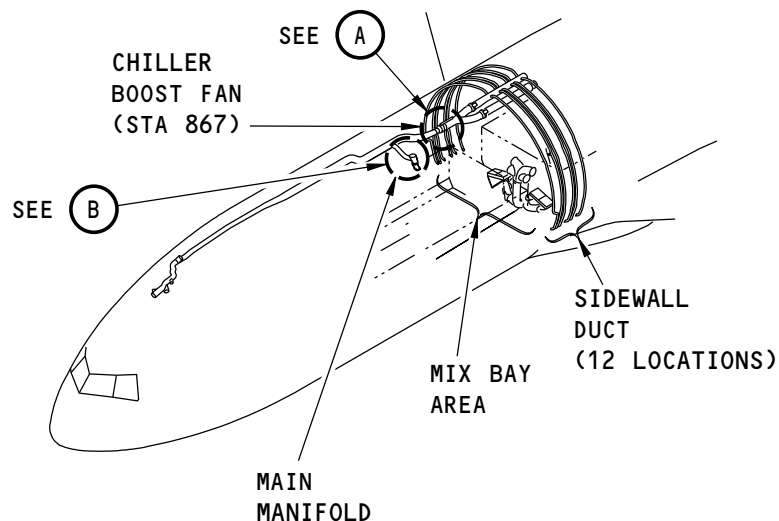
ARO ALL**Sidewall Duct**

There are 12 sidewall ducts, 6 on each side of the airplane. The ducts are approximately 2 inches (5 cm) in diameter. The ducts connect to the main manifold above the passenger cabin ceiling. The ducts are open on the ends that are in the mix bay area.

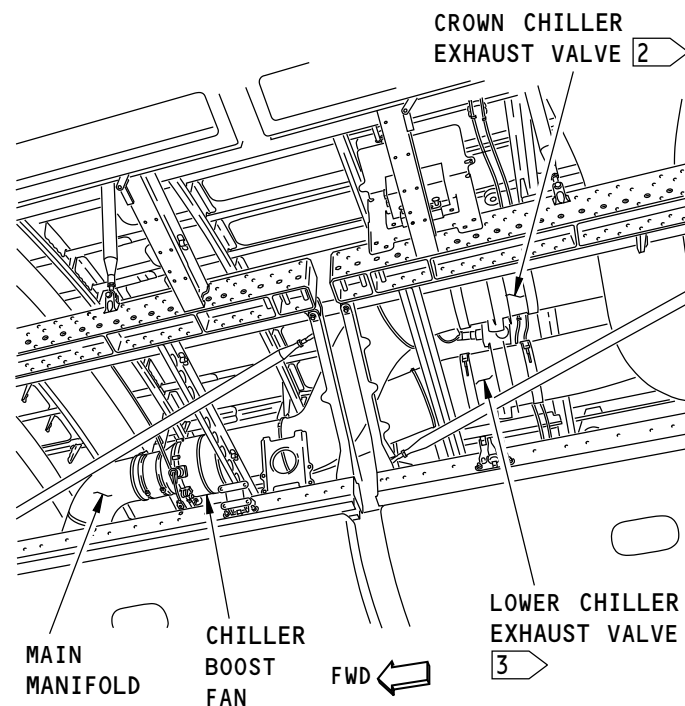
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- 1 VENT MUST REMAIN OPEN
- 2 DISCONNECTED CLOSED
- 3 DISCONNECTED OPEN



AIR CONDITIONING - VENTILATION - GALLEY CHILLER CONDENSER EXHAUST SYST

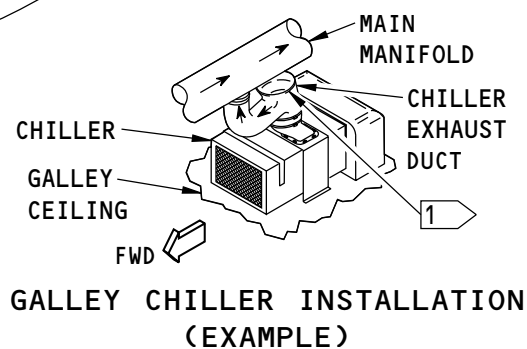
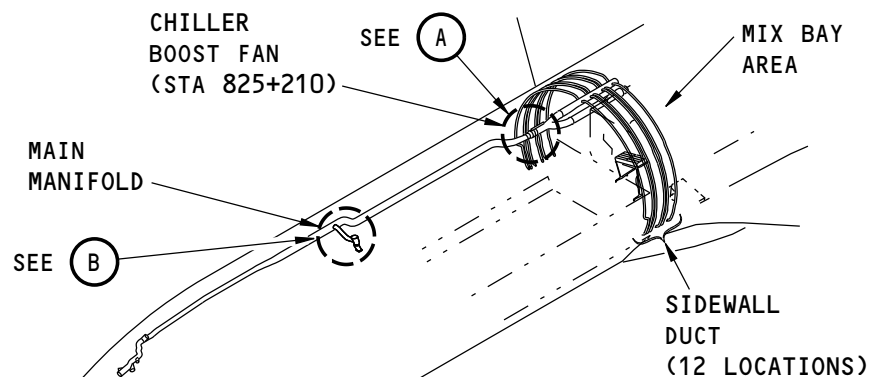
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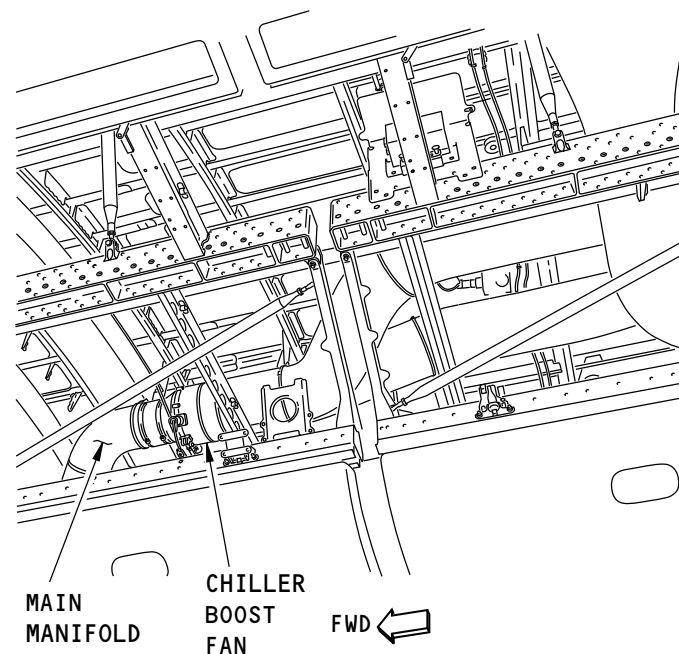
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(B)



**AREA ABOVE THE CENTER OVERHEAD BINS
AT STATIONS 825 + 210
(INBOARD CEILING PANEL REMOVED)**

(A)

1 VENT MUST REMAIN OPEN

AIR CONDITIONING- VENTILATION- GALLEY CHILLER CONDENSER EXHAUST SYSTEM

1911142 S0000355026_V1

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AIR CONDITIONING - VENTILATION - CHILLER BOOST FAN - FUNCTIONAL DESCRIPTION

General

The environmental control system miscellaneous cards (ECSMCs) in the system card files control the chiller boost fan. One control card at a time controls the fan. At power up, the right card controls the fan. The left card is a backup. Each time the airplane goes from air to ground, the card in control changes. The card in control sends a fan on signal to the P210 power management panel. A switch in the electrical load management system (ELMS) signal interface unit (SIU) supplies a ground to energize the chiller boost fan relay. The relay connects power to the fan.

ARO 001-016 POST SB 777-21-0189

A vibration monitor unit is installed on the chiller boost fan. It provides early detection of fan mechanical failure and contains diagnostic capability to monitor malfunction via a status LED. There is no change to the airplane systems behaviour due to the presence of the vibration monitor units.

ARO ALL**Indications**

Current sensors monitor fan current during operation. These indications go to the ECSMCs:

- Valid fan current
- Fan relay energized.

ARO 017-999; ARO 001-016 PRE SB 777-21-0189

A switch in the fan supplies an overheat indication to the right ECSMC. The ECSMCs contain fault logic for the fan.

ARO 001-016 POST SB 777-21-0189

The fan overheat switch or the fan vibration monitor supply an overheat indication to the right ECSMC. The ECSMCs contain fault logic for the fan.

ARO ALL**Chiller Boost Fan Inhibits**

The chiller boost fan comes on when all of these conditions are true:

- The airplane is on the ground
- At least one of the air conditioning packs are on
- Total Air Temperature is equal to or more than 45F (7C)
- Forward cargo fire system is not armed.

ARO 017-999; ARO 001-016 PRE SB 777-21-0189

The chiller boost fan goes off when the fan overheats, the forward cargo system is armed, the left and right packs are off, or the airplane is in the air.

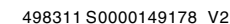
ARO 001-016 POST SB 777-21-0189

The chiller boost fan goes off when the fan overheats, the vibration monitor unit fails or detects excessive vibration, the forward cargo system is armed, the left and right packs are off, or the airplane is in the air.

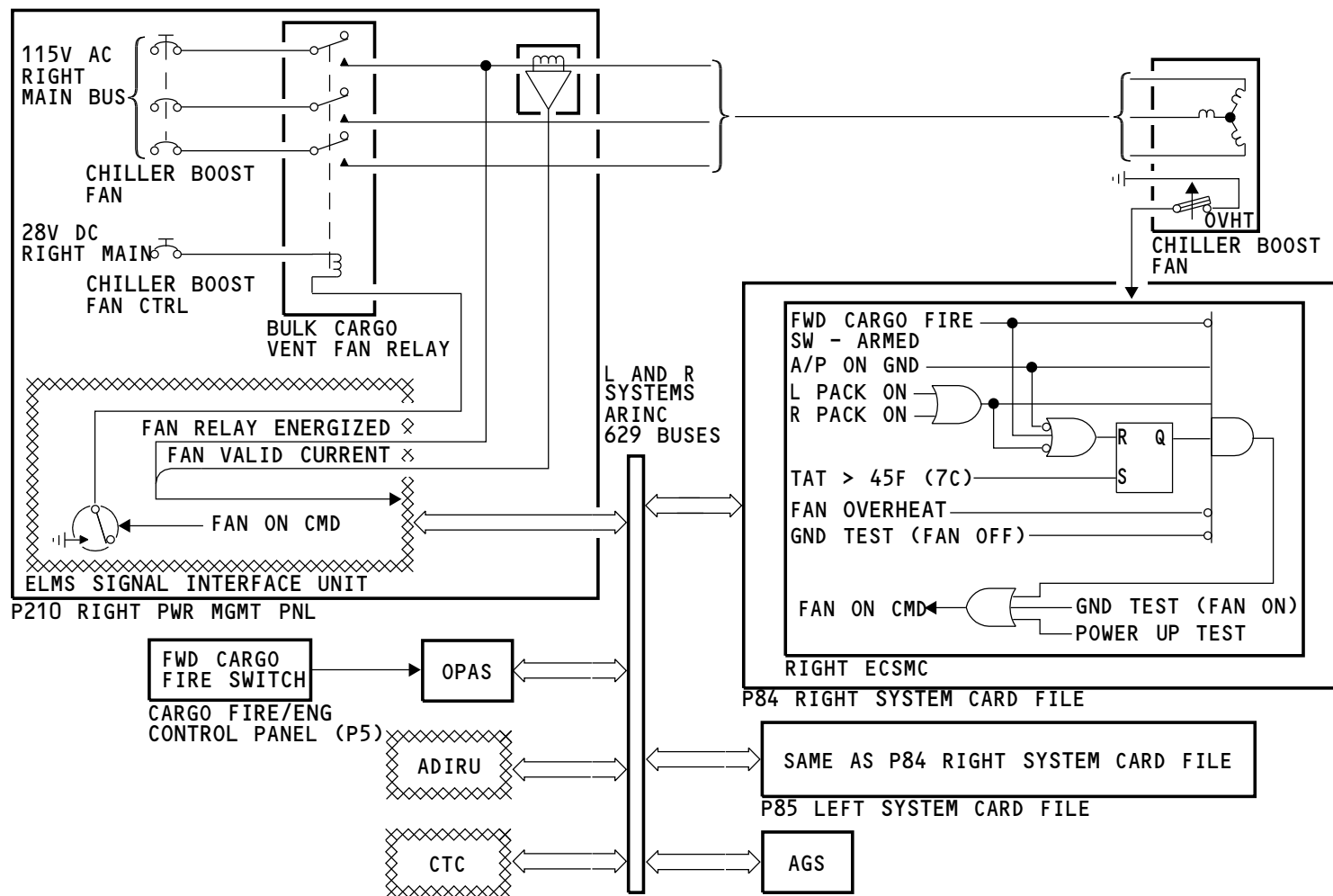
ARO ALL**21-26-00**EFFECTIVITY
ARO ALL

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A/C - VENTILATION - CHILLER BOOST FAN - FUNCTIONAL DESCRIPTION



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A/C - VENTILATION - CHILLER BOOST FAN - FUNCTIONAL DESCRIPTION

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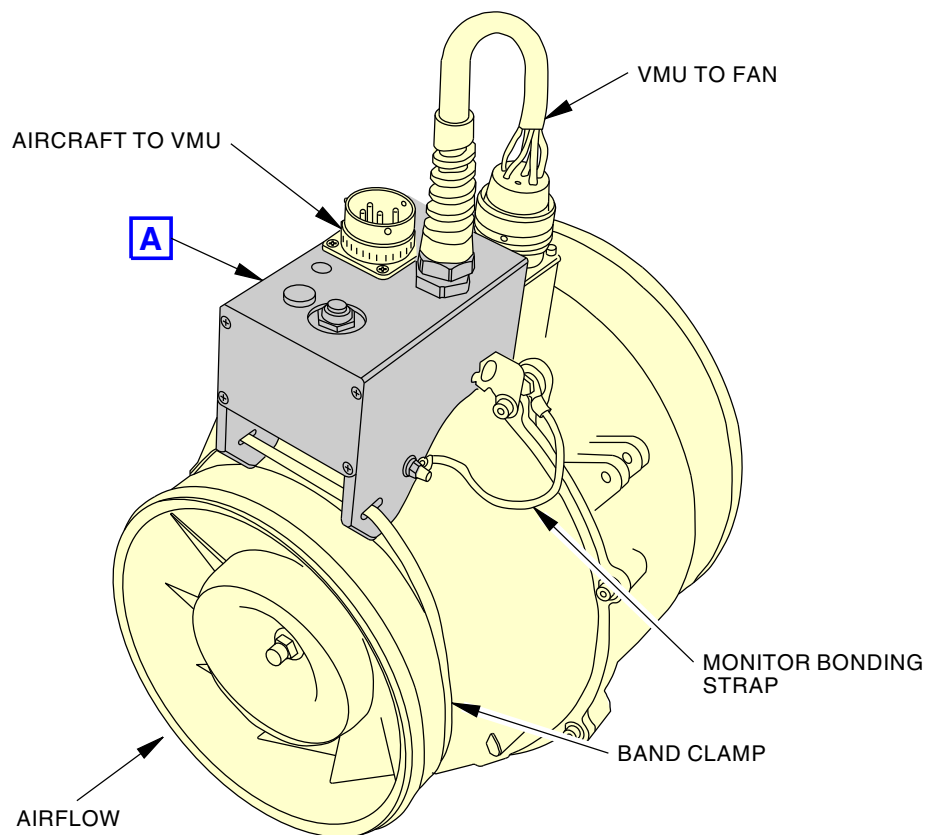
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**AIR CONDITIONING - VENTILATION - CHILLER BOOST FAN VIBRATION MONITOR UNIT - FUNCTIONAL DESCRIPTION****Functional Description**

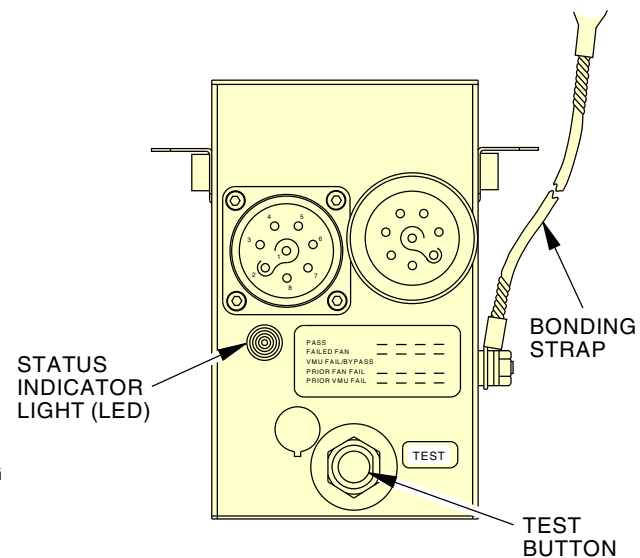
Each fan is monitored by a vibration monitor unit. The vibration monitor unit provides early detection of fan mechanical failure. In the case of imminent fan bearing failure, the vibration monitor unit simulates an open fan overheat switch. Visual indication of fan and vibration monitor units is provided by the vibration monitor unit status LED.

Operation

The fan vibration monitor units are physically and electronically installed between the fan power source and the fan itself. The power supplied passes through the vibration monitor unit unaltered. There is no change to the airplane systems behaviour due to the presence of the vibration monitor units. A status message shows if the chiller boost fan has a failure or if the vibration monitor unit has simulated an open overheat switch. The vibration monitor unit can be reset by removing and applying power to it.



**FAN/MONITOR MOUNTING
(EXAMPLE)**



VIBRATION MONITOR UNIT

AIR CONDITIONING - VENTILATION - CHILLER BOOST FAN VIBRATION MONITOR UNIT

2831121 S0000657604_V1

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EFFECTIVITY
ARO 001-016 POST SB 777-21-0189

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**AIR CONDITIONING - VENTILATION - FORWARD CARGO EXHAUST FAN****Purpose**

The forward cargo exhaust fan pulls air from the cargo compartment and moves it to an area near the forward pressurization outflow valve (not shown).

Physical Description

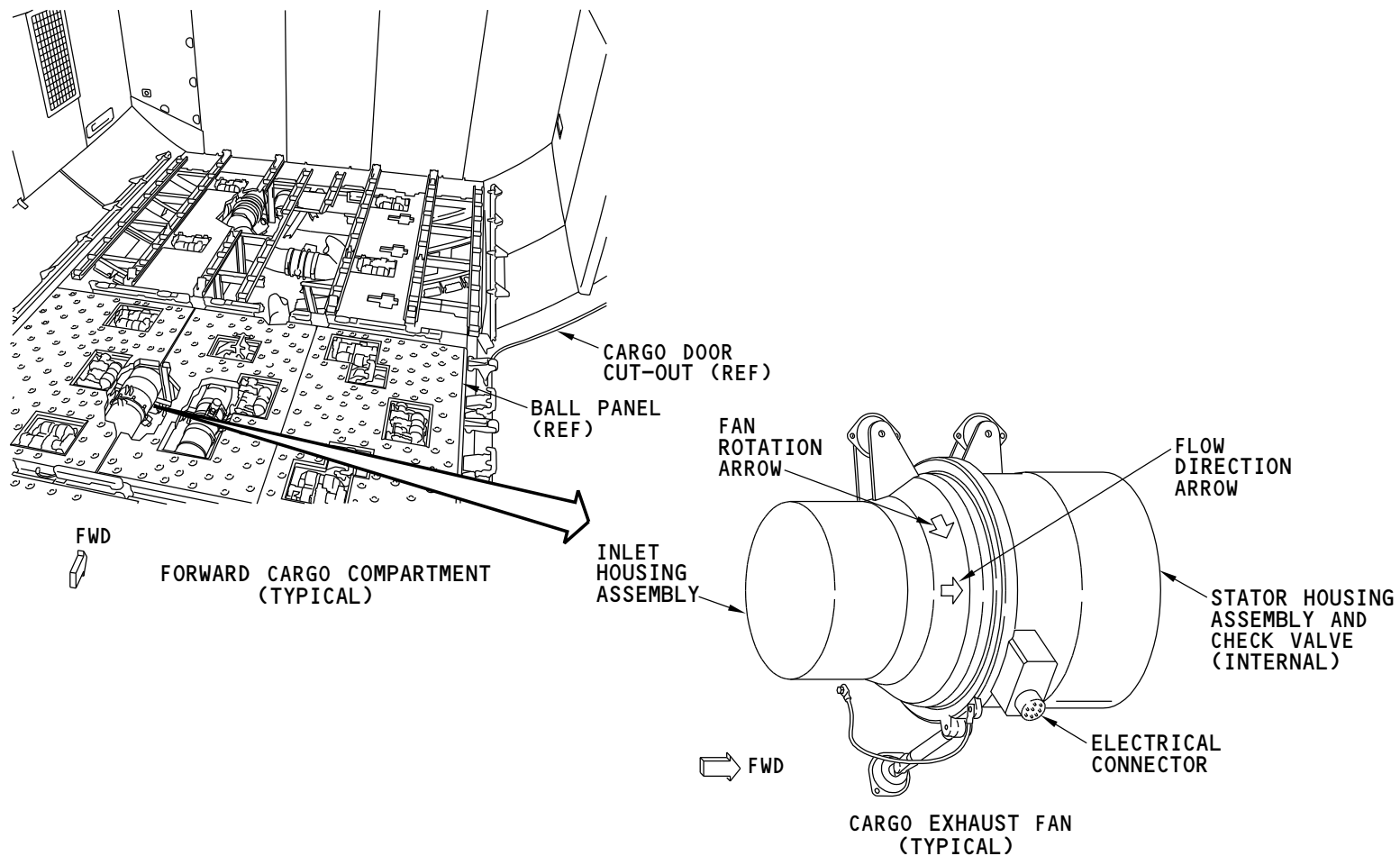
The fan is an axial flow type with a three-phase electric motor. A check valve is part of the fan. The fan have these components:

- Fan rotation arrow
- Flow direction arrow
- Stator housing assembly and check valve
- Electrical connector
- Inlet housing assembly.

Location

The fan is under the forward set of ball panels in the forward cargo compartment. The fan is approximately 21 inches (53 cm) to the left of center. You remove the forward left ball panel to access the fan.

ARO ALL	EFFECTIVITY
	D633W101-ARO



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AIR CONDITIONING - VENTILATION - FORWARD CARGO EXHAUST FAN

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ARO ALL EFFECTIVITY

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**AIR CONDITIONING - VENTILATION - FORWARD CARGO EXHAUST FAN - FUNCTIONAL DESCRIPTION****General**

The environmental control system miscellaneous cards (ECSMCs) control the forward cargo exhaust fan. One control card controls the fan at a time. On power up, the right card controls the fan. The left card is the backup. Each time the airplane goes from air to ground, the card in control changes. The card in control sends a fan on signal to the left power management panel. This supplies power to the fan.

Indications

A current sensor monitors the fan current. These indications go to the ECSMCs:

- Valid fan current
- Cargo exhaust fan relay energized.

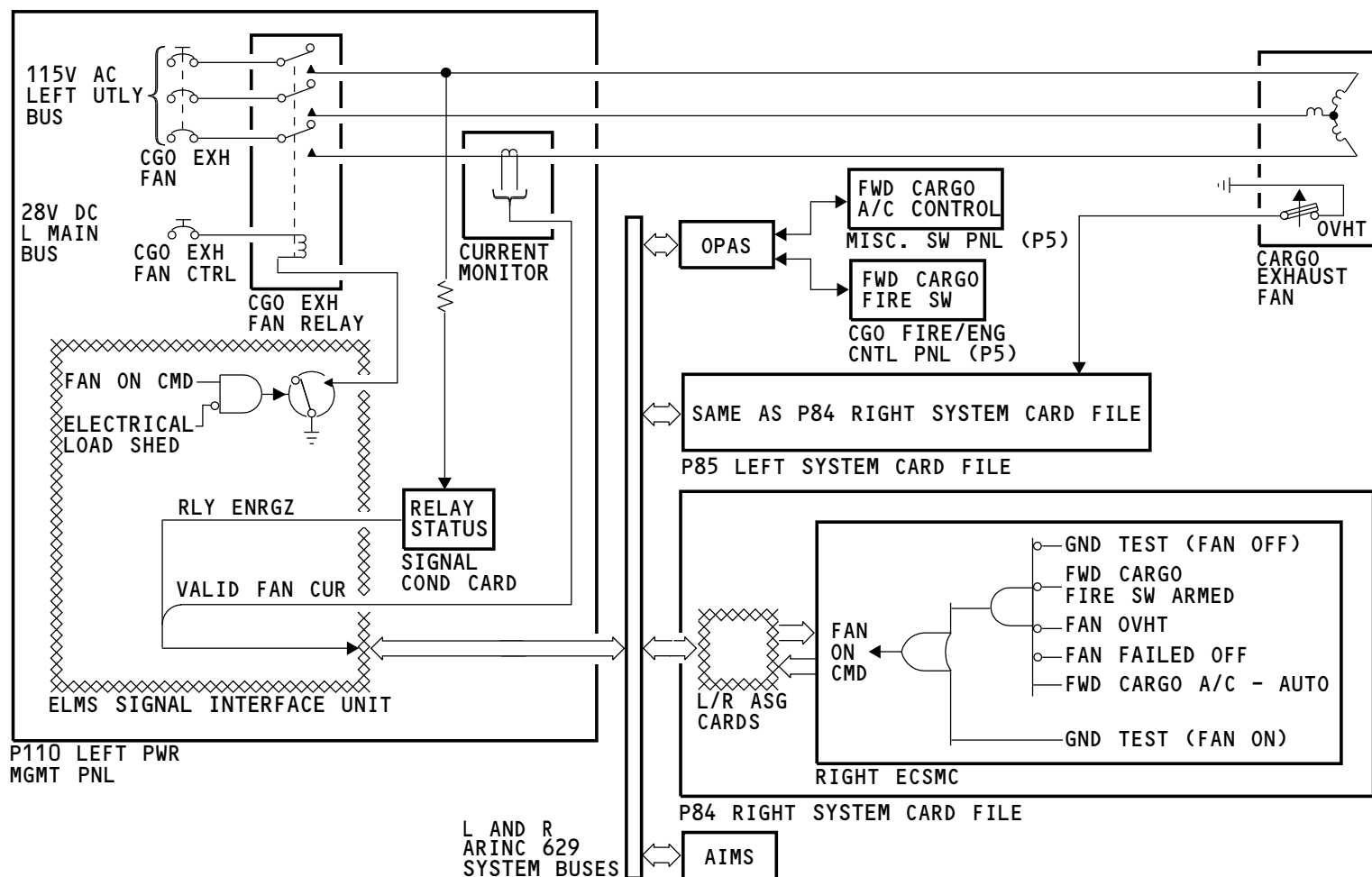
Switches in the fan supply an overheat indication to the left ECSMC. The ECSMCs contain fault logic for the fan.

The ECSMCs interface with AIMS. The primary display system gives a status message for a failed fan. The central maintenance computing function gives a maintenance message for a failed fan or for a failed fan circuit. The central maintenance computing function lets you do a ground test for the fan.

Inhibits

These conditions inhibit fan operation:

- Ground test (FAN OFF test condition)
- Fwd cargo fire switch armed
- Fan overheat
- Fan failed off
- Forward cargo air conditioning control set to OFF
- Electrical load shed (ELMS).



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AIR CONDITIONING - VENTILATION - FORWARD CARGO EXHAUST FAN - FUNCTIONAL DESCRIPTION

21-26-00

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Page 21
Jul 25/2018



AIR CONDITIONING - VENTILATION - BULK CARGO VENTILATION FAN

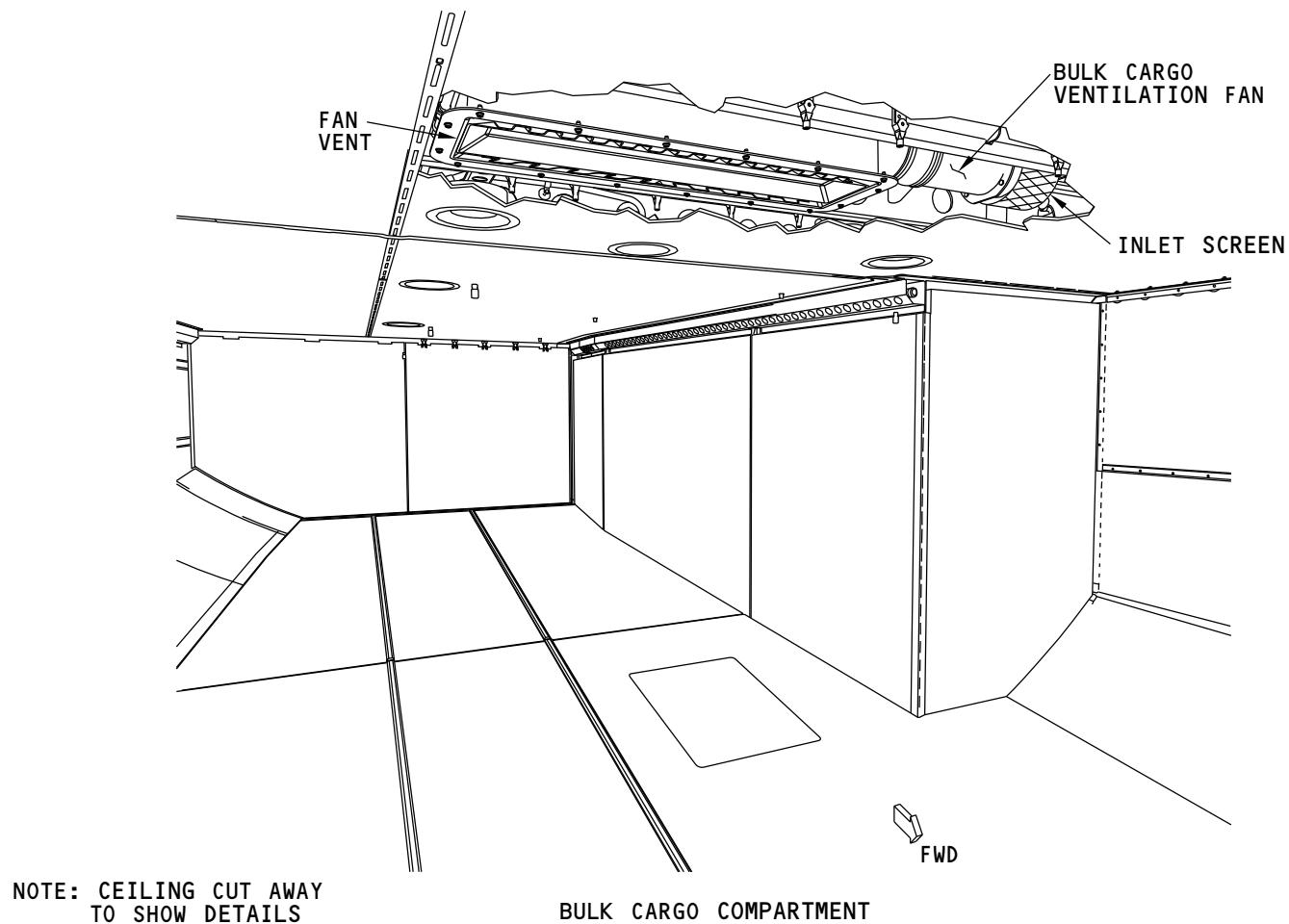
Purpose

The bulk cargo ventilation fan pulls air from the passenger cabin above into the bulk cargo compartment.

Location

Access to the fan is through the ceiling liner of the bulk cargo compartment.

ARO ALL	EFFECTIVITY
	D633W101-ARO



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AIR CONDITIONING - VENTILATION - BULK CARGO VENTILATION FAN

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ARO ALL	EFFECTIVITY
	D633W101-ARO

**AIR CONDITIONING - VENTILATION - BULK CARGO VENTILATION - FUNCTIONAL DESCRIPTION****General**

The environmental control system miscellaneous cards (ECSMCs) in the system card files control the bulk cargo ventilation fan. One card at a time controls the fan. At power up, the right card controls the fan. Each time the airplane goes from air to ground, the card in control changes. The card in control sends a signal to the P210 power management panel. A switch in the electrical load management system (ELMS) signal interface unit (SIU) supplies a ground to energize the bulk cargo vent fan relay. The relay connects power to the fan.

Indications

Current sensors monitor fan current during operation. These indications go to the ECSMCs:

- Valid fan current
- Fan relay energized.

A switch in the fan supplies an overheat indication to the right ECSMC. The ECSMCs contain fault logic for the fan. The ECSMCs give fault data to AIMS. AIMS shows the status message, CARGO VENT FAN BULK if the bulk cargo ventilation fan fails.

Bulk Cargo Ventilation Fan Inhibits

These conditions inhibit the fan on signal to the bulk cargo ventilation fan:

- Fan overheat
- Aft cargo fire arm
- Equipment cooling switch in the OVRD position
- Bulk cargo heat switch off or low.

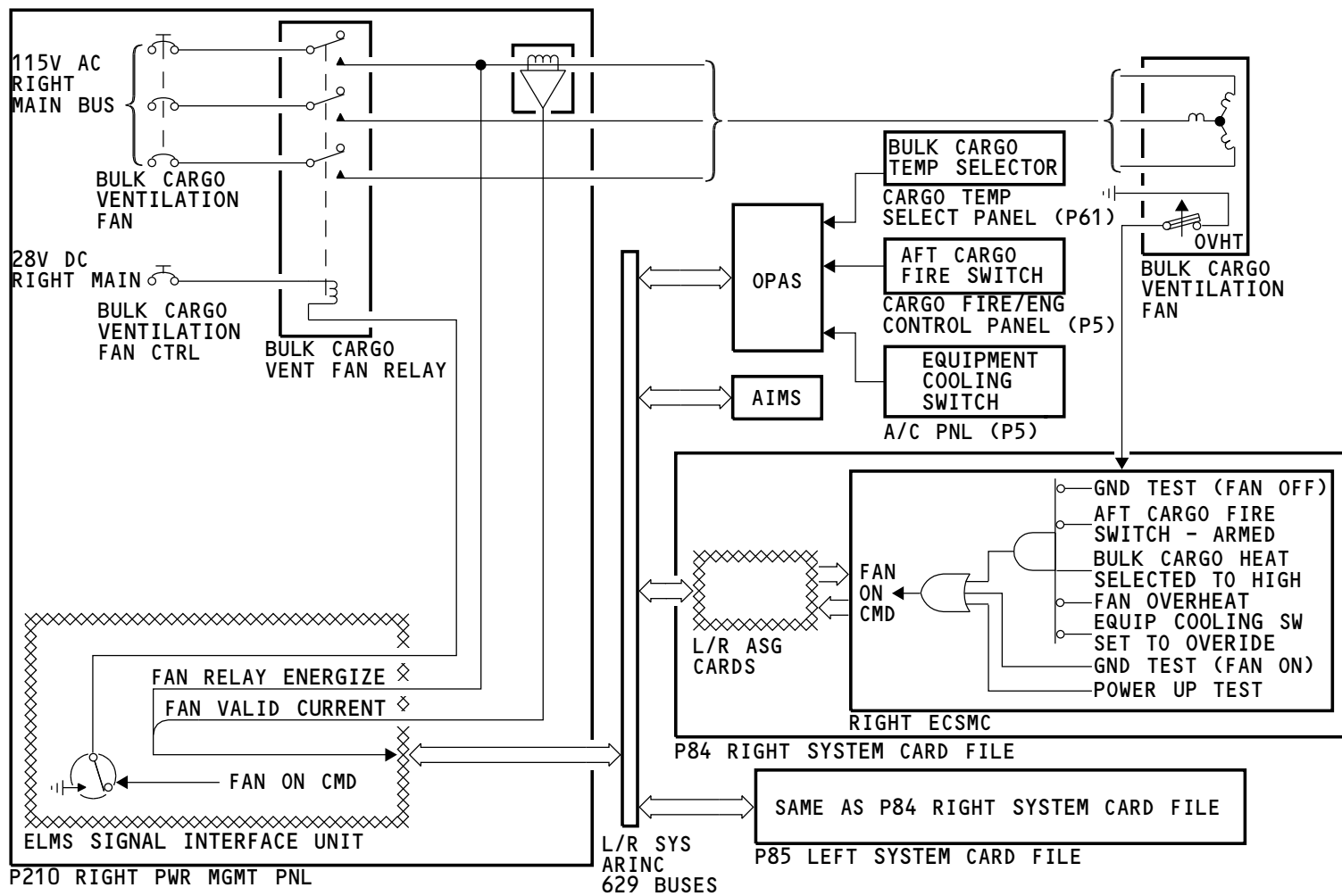
The fan stops when the equipment cooling switch is set to OVRD. This makes sure smoke from the passenger cabin area does not go into the bulk cargo area. If smoke from the passenger cabin goes into the bulk cargo area, it will cause the aft cargo smoke detector to turn on the flight deck effects for an aft cargo fire.

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A/C - VENTILATION - BULK CARGO VENTILATION - FUNCTIONAL DESCRIPTION

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AIR CONDITIONING - VENTILATION - LAVATORY GALLEY VENTILATION FANS, INLET DUCT AND SCREEN**Purpose**

The lavatory galley ventilation fans pull air from the lavatories and galleys in the passenger cabin. A single ventilation duct (not shown) above the ceiling connects the lavatories and galleys to the fans. The fans are aft of the bulk cargo compartment end wall. Hoses (not shown) from the ventilation duct pull air across the zone temperature sensors in these areas:

- Passenger cabin
- Forward, aft and bulk cargo compartments
- Flight deck.

Lavatory Galley Ventilation Fans

The lavatory galley ventilation fans are aft of the bulk cargo compartment endwall. The fans pull air from the lavatories and galleys. The fans have these components:

- Fan rotation arrow
- Flow direction arrow
- Stator housing assembly and check valve
- Electrical connector
- Inlet housing assembly.

Inlet Duct and Screen

There is an inlet duct and screen on the aft side of the two lavatory galley ventilation fans. The screen prevents unwanted material from going through the lavatory galley ventilation fans.

Training Information Point

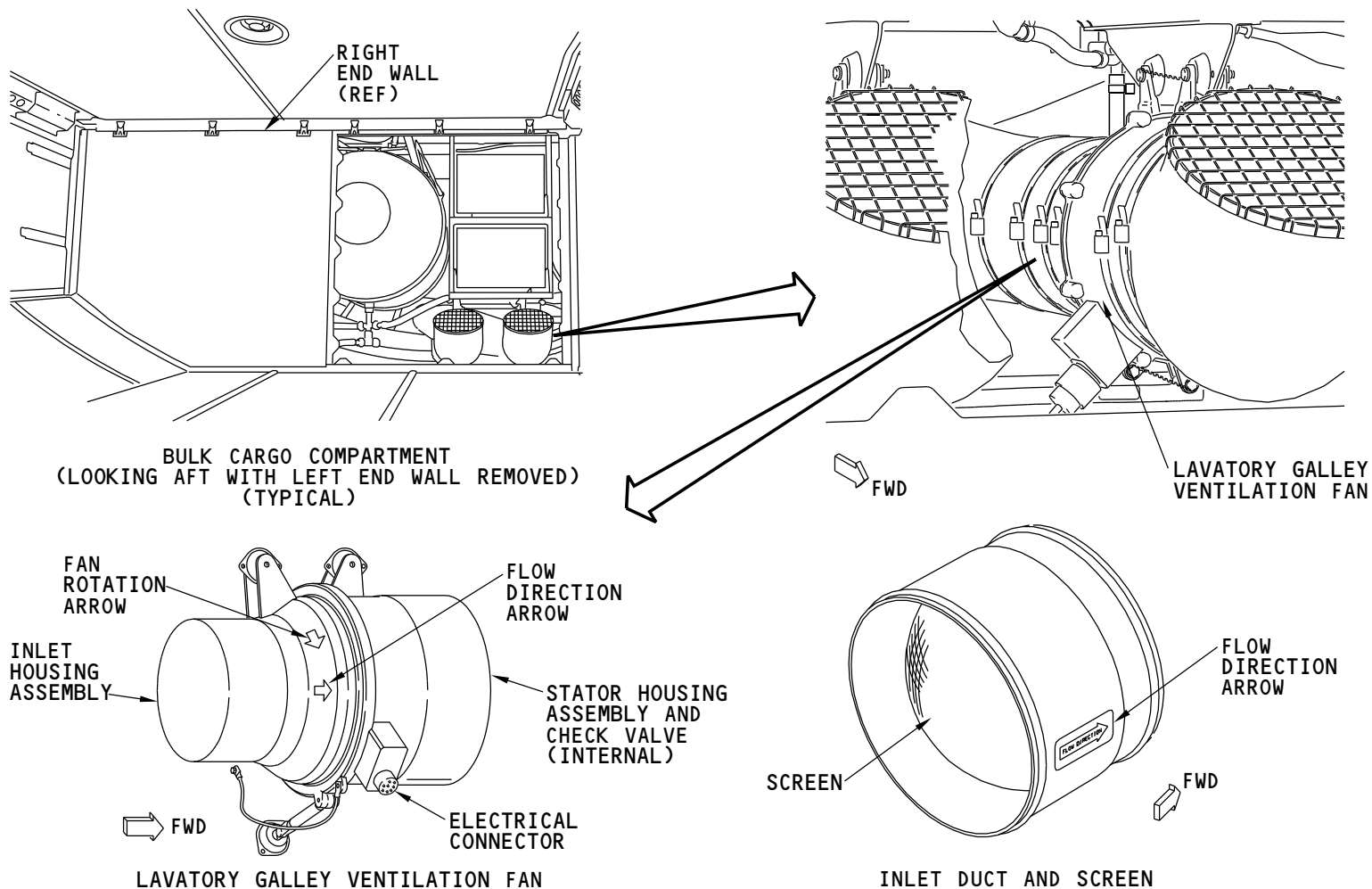
The lavatory galley ventilation fans are interchangeable with the equipment cooling supply fans and the right lower recirculation fan.

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AIR CONDITIONING - VENTILATION - LAVATORY GALLEY VENTILATION FANS, INLET DUCT AND SCREEN

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**AIR CONDITIONING - VENTILATION - GALLEY VENTILATION FILTERS****Purpose**

The galley ventilation filters remove particles from the galley air before the air goes into the ventilation duct. The air then moves through the ventilation duct to the lavatory galley ventilation fans.

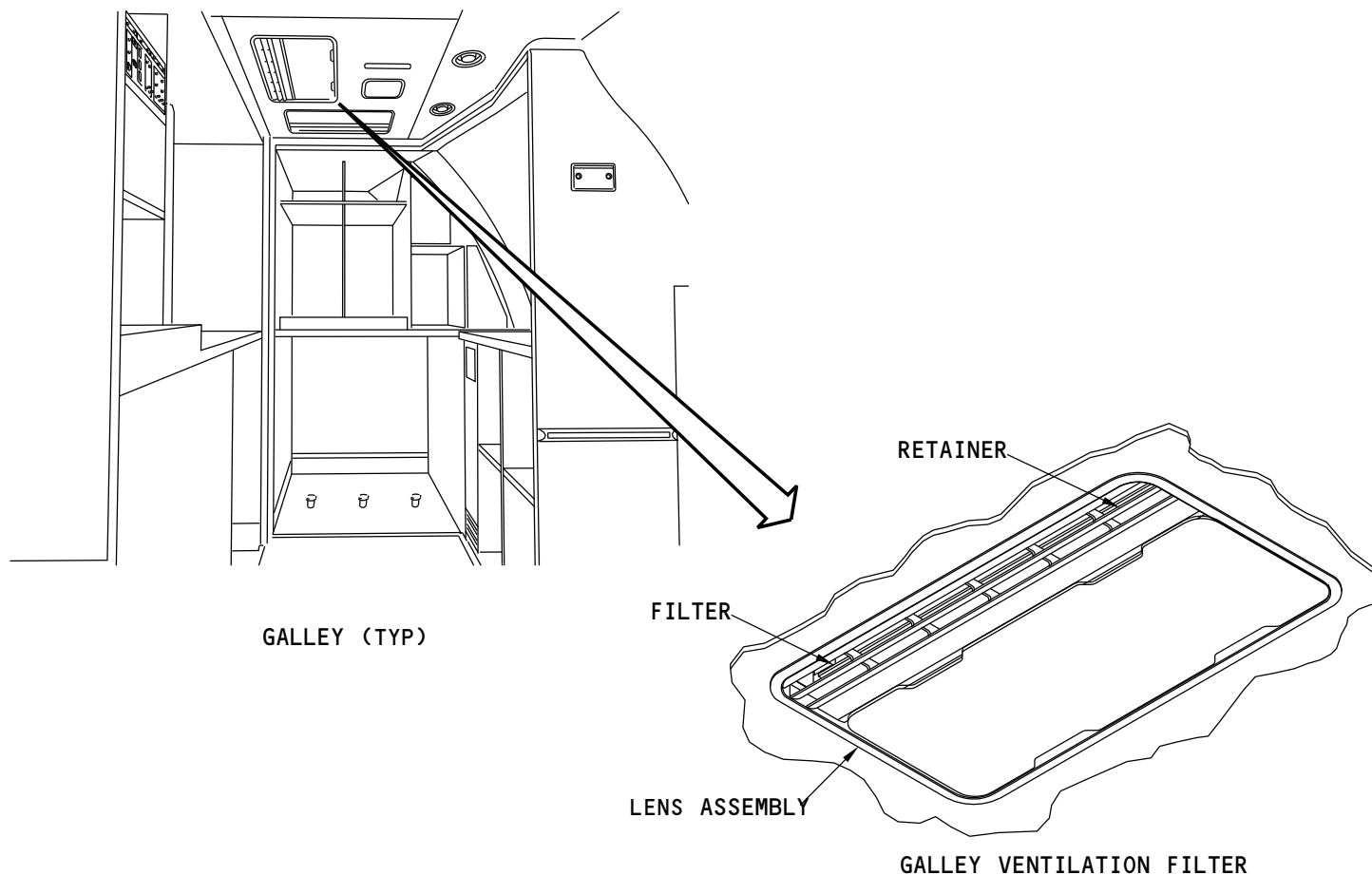
Location

Each ventilation inlet at the galleys has a ventilation filter.

Training Information Point

Galley ventilation filters are line replaceable. Remove the lens assembly and the retainer to remove the filter.

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AIR CONDITIONING - VENTILATION - GALLEY VENTILATION FILTERS

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AIR CONDITIONING - VENTILATION - LAVATORY GALLEY VENTILATION - FUNCTIONAL DESCRIPTION

General

The environmental control system miscellaneous cards (ECSMCs) control the lavatory galley ventilation fans. One control card at a time controls the two fans. On power up, the right card controls the fans. The left card is the backup. Each time the airplane goes from air to ground, the card in control changes. The card in control sends a fan on signal to the related power management panel. If there is no load shed condition, a switch in the electrical load management system (ELMS) signal interface unit (SIU) supplies a ground to energize the electrical load control unit (ELCU). The ELCU connects power to the fan.

Only one of the two fans operate at a time. The right fan is primary and the left fan is the backup. Each time the airplane gets power, the ECSMC that is in control (usually the right ECSMC) does a test of the left fan. The right fan goes off and the left fan comes on for 20 seconds. At the end of the test of the left fan, it goes off and the right fan comes on and is tested.

Indications

Current sensors monitor fan current during operation. These indications go to the ECSMCs:

- Valid fan current
- ELCU energized
- ELCU open.

Switches in the fans supply an overheat indication to the applicable ECSMCs. The left fan overheat switches connect to the left card and the right fan overheat switches connect to the right card. The ECSMCs contain fault logic for the fan.

Inhibits

These conditions inhibit fan operation:

- Ground test (FAN OFF test condition)
- Aft cargo fire switch armed
- Fwd cargo fire switch armed

- Fan failed on and relay is energized
- Fan overheat
- Fan failed off
- Electrical load shed (ELMS).

Training Information Point

You can test the operation of the fan with a ground test from the MAT.

If both of the lavatory galley ventilation fans are off, no air flows around the zone temperature sensors. This causes these conditions to occur:

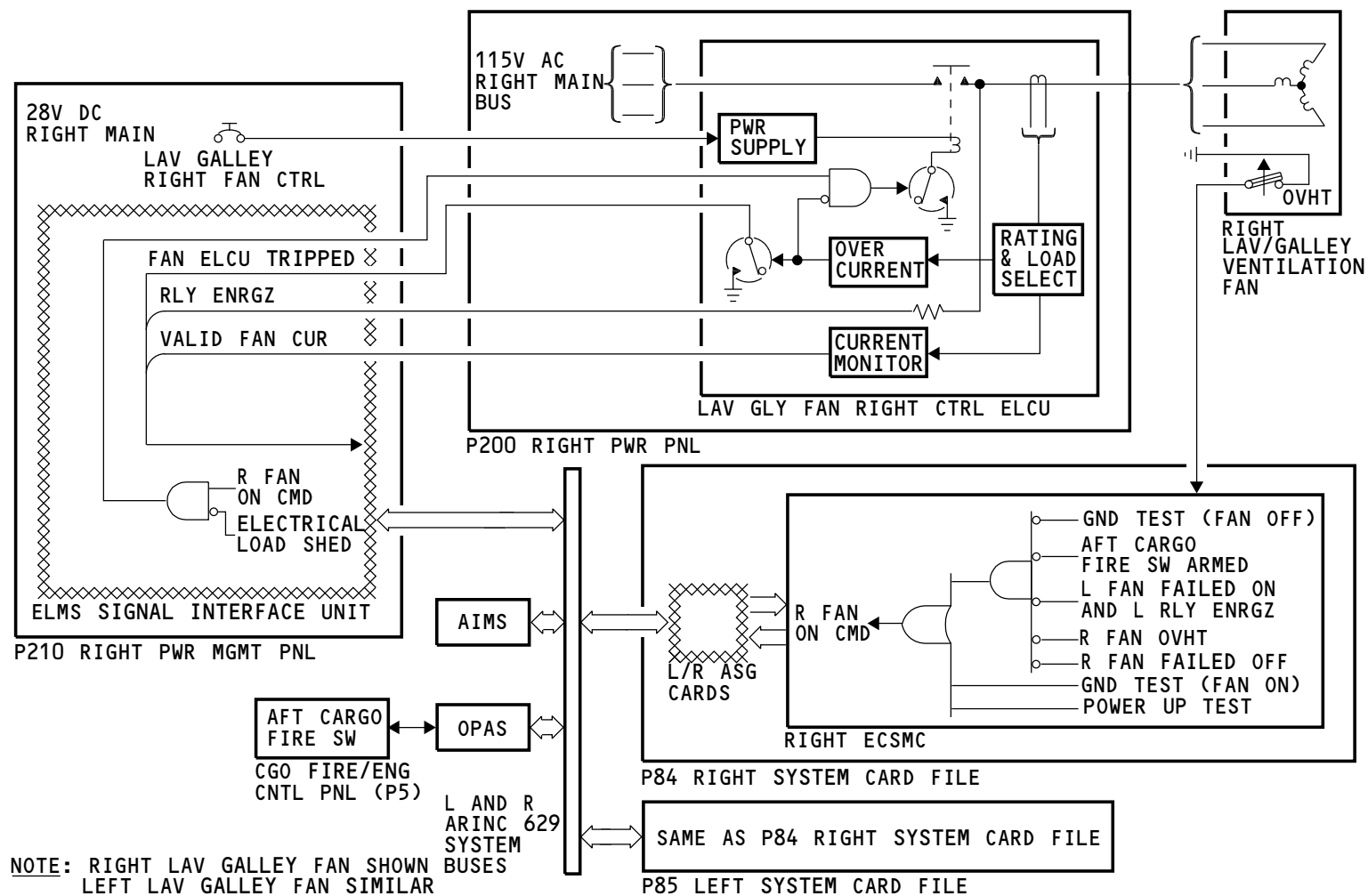
- The cabin temperature controllers (CTCs) change to the alternate control mode. This control mode uses the duct temperature sensors to maintain a constant air supply temperature to the flight deck, passenger cabin, and forward cargo compartment zones.
- The environmental control system miscellaneous cards turn off the aft and bulk cargo heat.

See the zone temperature control and indication section for more information about the alternate temperature control mode (SECTION 21-61). See the aft and bulk cargo compartment heating section for more information about the cargo heating (SECTION 21-44).

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AIR CONDITIONING - VENTILATION - LAVATORY GALLEY VENTILATION - FUNCTIONAL DESCRIPTION

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AIR CONDITIONING (A/C) - EQUIPMENT COOLING - INTRODUCTION

Purpose

The equipment cooling system keeps the electronic and electrical equipment cool. Equipment in the forward part of the airplane and equipment in the aft part of the airplane have separate cooling systems.

Abbreviations and Acronyms

- ADIRU - air data inertial reference unit
- AIMS - airplane information management system
- AGS - air ground system
- bat - battery
- BIT - built-in-test
- CCU - computing and communications unit
- cgo - cargo
- clg - cooling
- CSS - cabin services system
- conv - converter
- ctrl - control
- det - detection
- ECS - environmental control system
- ECSMC - ECS miscellaneous card
- ECC - equipment cooling controller
- E/E - electrical and electronic
- EICAS - engine indication and crew alerting system
- ELCU - electronic load control unit
- elec - electronic
- ELMS - electrical load management system
- eqpt - equipment
- FCAC - forward cargo air conditioning
- F/D - flight deck
- FEC - forward equipment center
- flt - flight
- fwd - forward
- gnd - ground
- ht - heat
- IFE - inflight entertainment
- LSCF - left system card file
- mgmt - management
- MEC - main equipment center
- mot - motor
- OPAS - overhead panel ARINC 629 system
- ovrd - override
- pnl - panel
- pos - position
- press - pressure
- PSEU - proximity sensor electronic unit
- pwr - power
- RSCF - right system card file
- SATCOM - satellite communications
- smk - smoke
- stby - standby
- sys - system
- TAT - total air temperature
- temp - temperature
- typ - typical
- vlv - valve
- VSCF - variable speed constant frequency
- wxr - weather radar
- xdcr - transducer

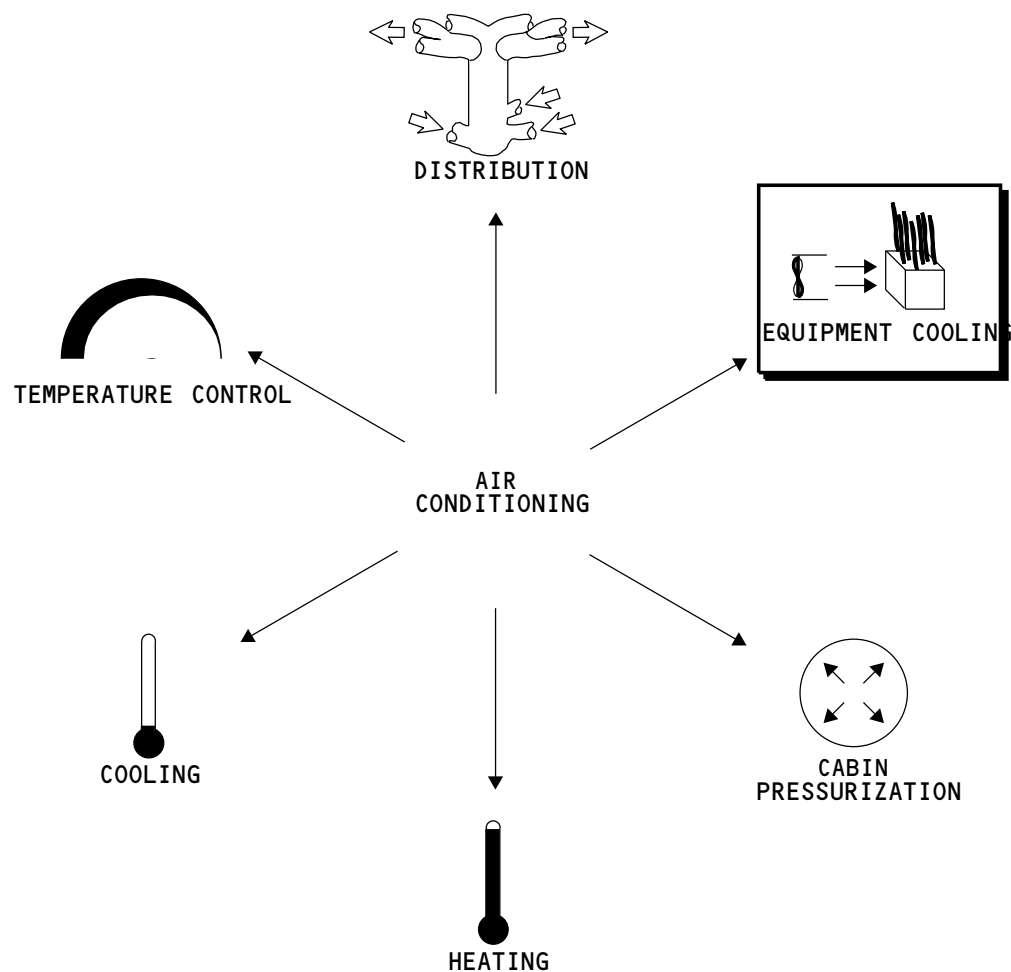
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AIR CONDITIONING (A/C) - EQUIPMENT COOLING - INTRODUCTION

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**A/C - EQUIPMENT COOLING - AFT SYSTEM - GENERAL DESCRIPTION - MECHANICAL****Purpose**

The aft part of the equipment cooling system gives pull-through cooling for equipment in the aft part of the airplane that needs active cooling. The system also gives backup cooling for SATCOM equipment.

General Description**ARO 011-999**

The aft part of the system has these components:

- Satellite communications (SATCOM) backup fan
- SATCOM check valve
- Ducts and hoses.

ARO ALL

The aft part of the system has these components:

- Satellite communications (SATCOM) backup fans
- SATCOM check valves
- Ducts and hoses.

The system has interfaces with the lavatory/galley ventilation system. The ventilation system pulls cabin air through the equipment to cool it.

The lavatory/galley ventilation fans are part of the air conditioning system. One fan operates at a time.

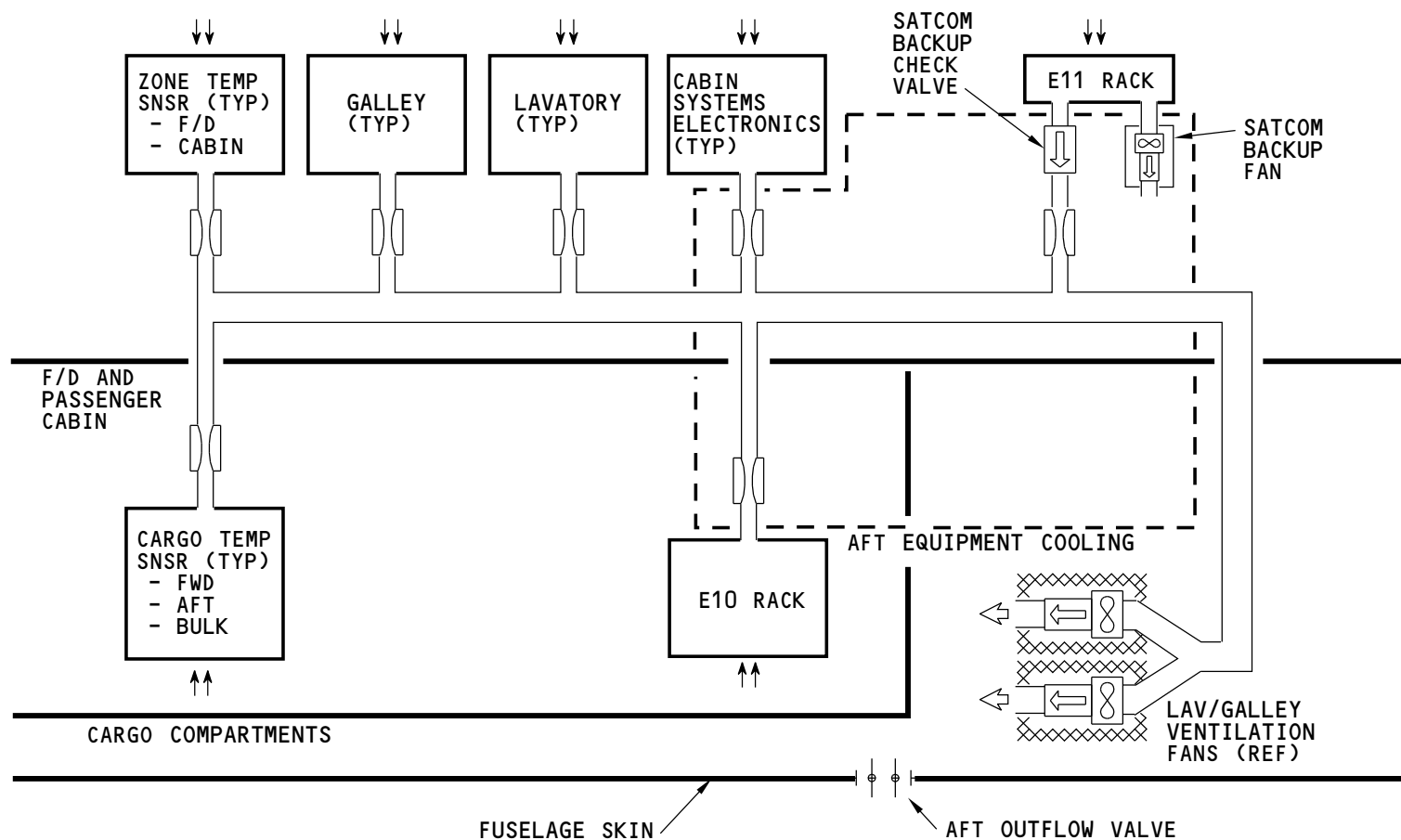
See the ventilation system for more information about the lavatory/galley vent fans (SECTION 21-26).

ARO 011-999

The SATCOM fan comes on if both lavatory/galley ventilation fans do not operate. It pulls cabin air through the SATCOM equipment on the E11 rack.

ARO ALL

The SATCOM fans come on if both lavatory/galley ventilation fans do not operate. The fans pull cabin air through the SATCOM equipment on the E11 and E13 racks.



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A/C - EQUIPMENT COOLING - AFT SYSTEM - GENERAL DESCRIPTION - MECHANICAL

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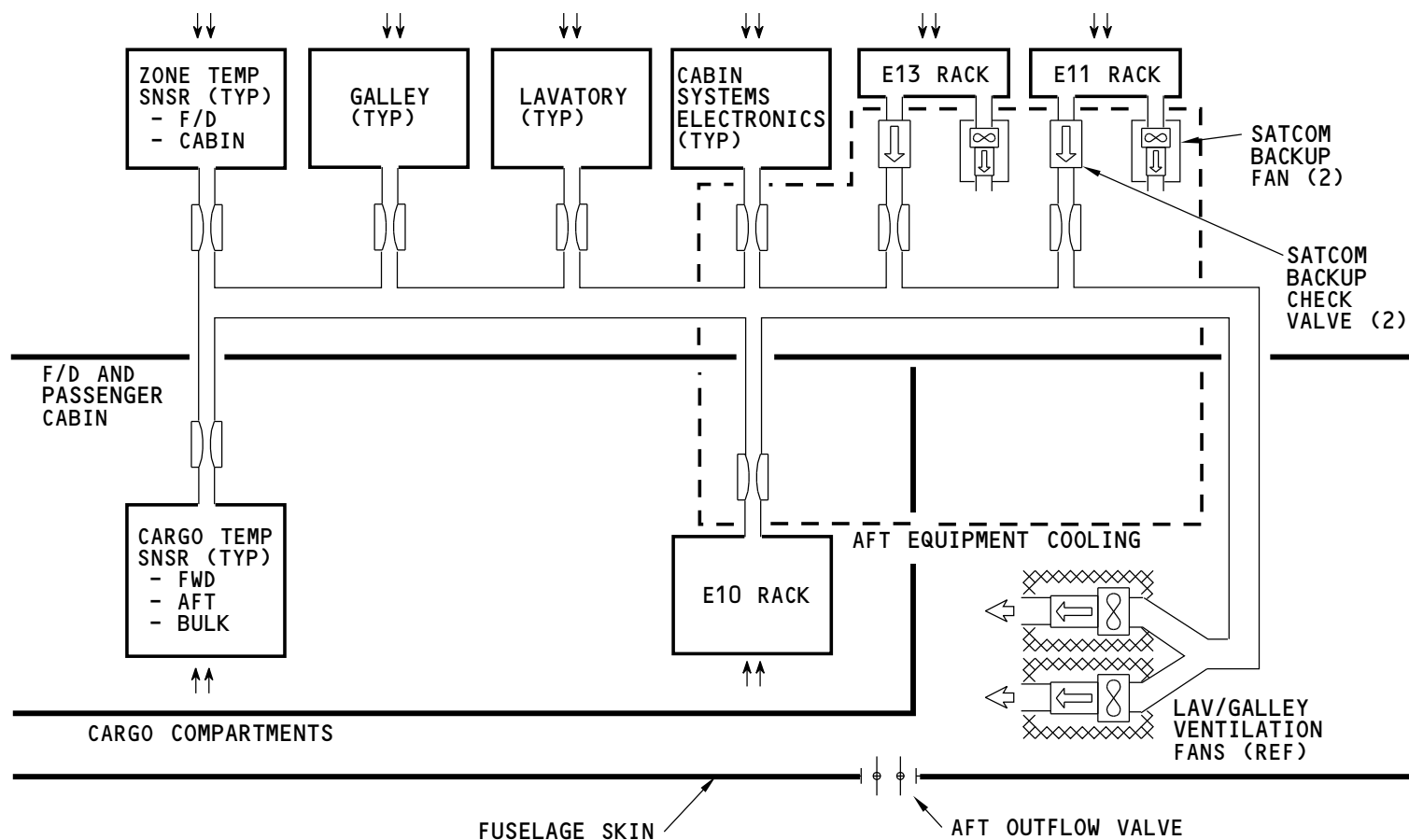
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Page 5
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A/C - EQUIPMENT COOLING - AFT SYSTEM - GENERAL DESCRIPTION - MECHANICAL

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**A/C - EQUIPMENT COOLING - PASSENGER COMPARTMENT COMPONENT LOCATIONS****ARO 011-999****Component Locations**

These components are above the passenger compartment ceiling:

- Satellite communications (SATCOM) backup cooling fan
- SATCOM backup cooling check valve.

The SATCOM backup cooling fan attaches to the bottom aft side of the E11 rack. The rack is near door 4 left, above the passenger compartment ceiling.

The SATCOM backup cooling check valve is in the vent duct that connects the rack to the lavatory/galley ventilation system. The duct is on the forward end of the equipment rack.

ARO ALL**Component Locations**

These components are above the passenger compartment ceiling:

- Two satellite communications (SATCOM) backup cooling fans
- Two SATCOM backup cooling check valves.

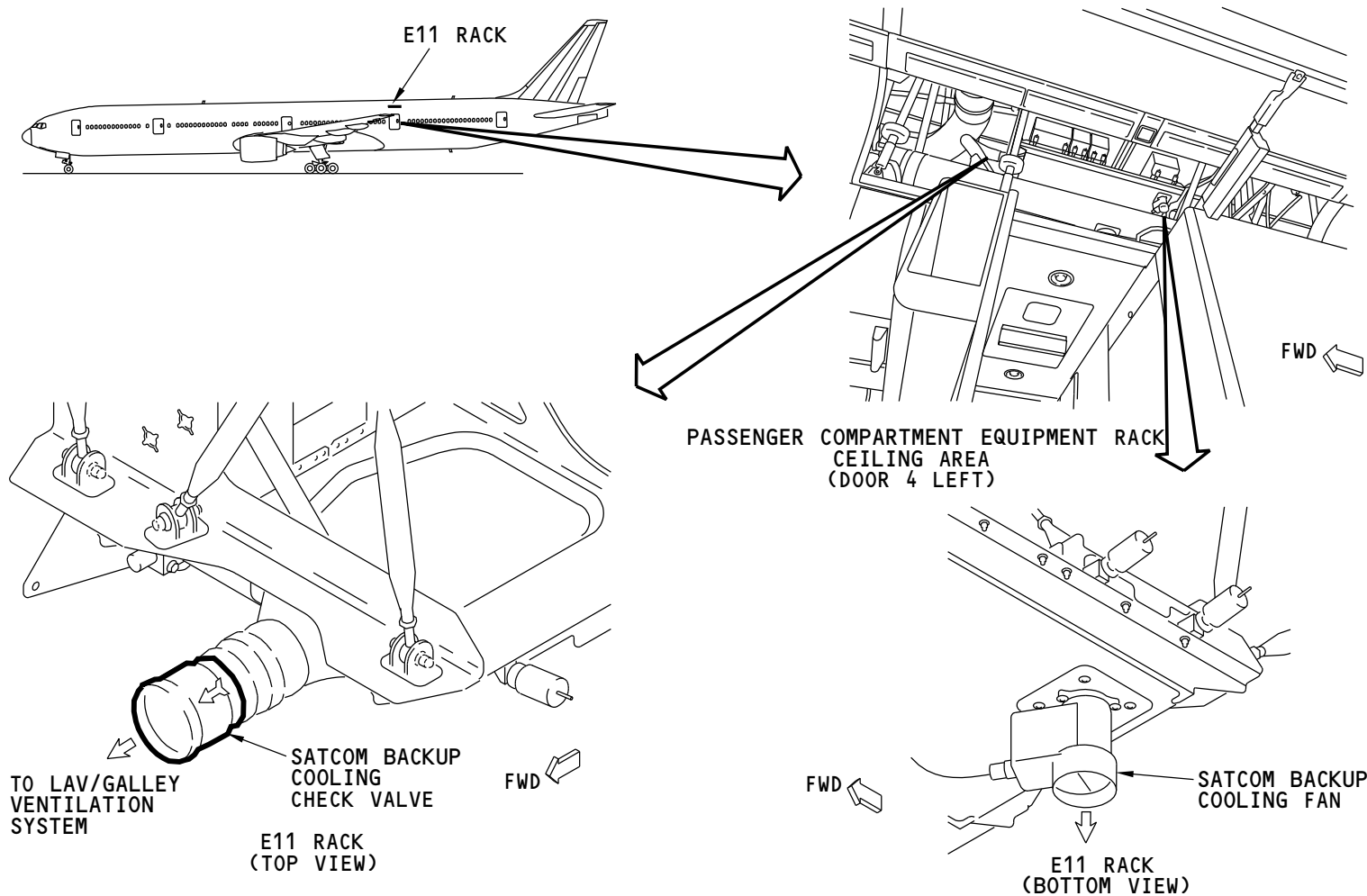
The SATCOM backup cooling fans attach to the bottom of the E11 and E13 racks. E11 rack has the fan near the aft end and the E13 has the fan near the forward end. The E11 rack is near door four left. The E13 rack is at station 1054, right buttock line 24. This position is two windows aft of the fourth air conditioning riser on the right side.

The SATCOM backup cooling check valves are in the vent duct that connects the racks to the lavatory/galley ventilation system. The duct is on the opposite end of the equipment racks as the fans.

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A/C - EQUIPMENT COOLING - PASSENGER COMPARTMENT COMPONENT LOCATIONS

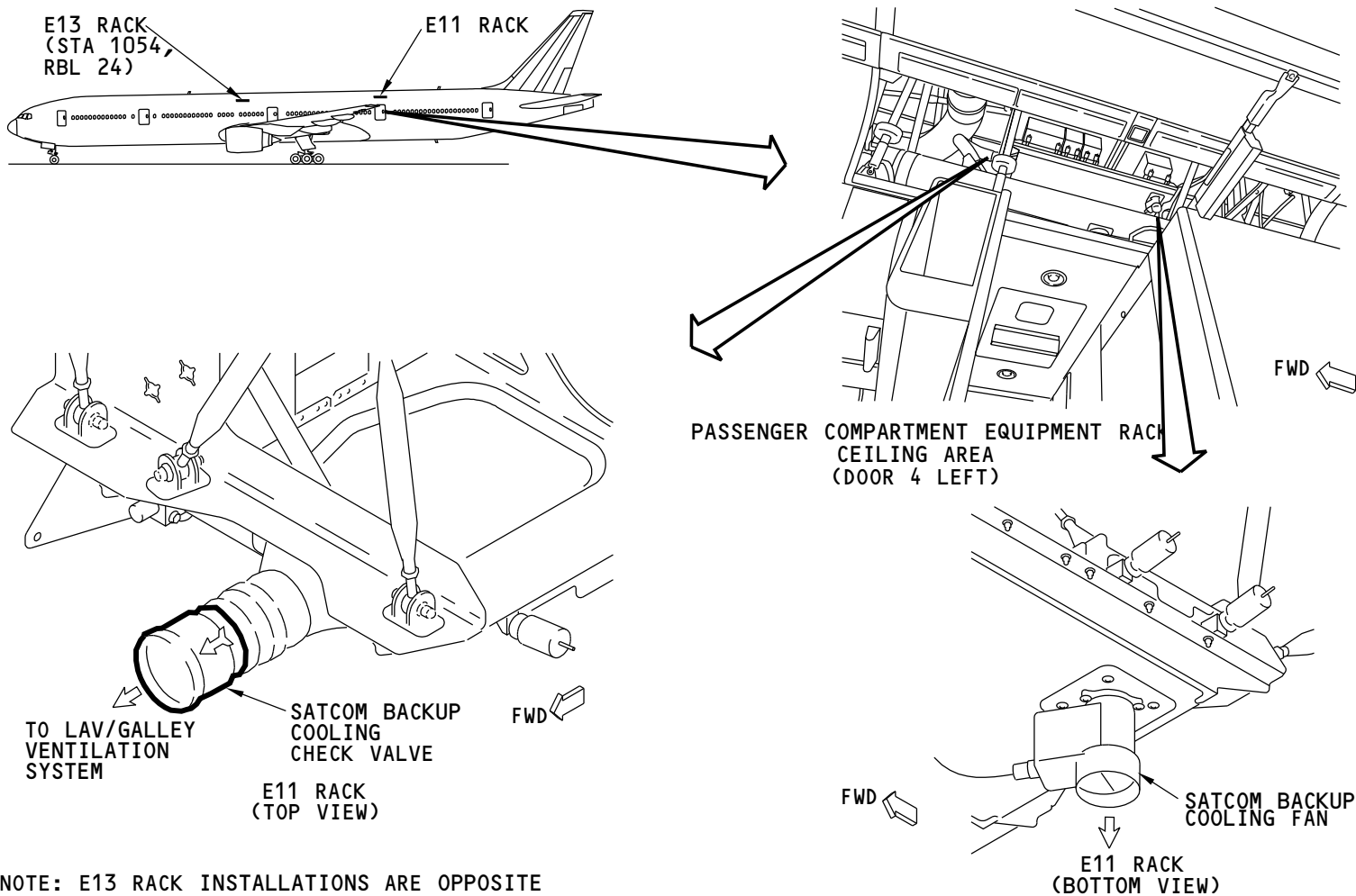
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A/C - EQUIPMENT COOLING - PASSENGER COMPARTMENT COMPONENT LOCATIONS

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A/C - EQUIPMENT COOLING - SATCOM BACKUP COOLING FAN AND CHECK VALVE

ARO 011-999

Purpose

The SATCOM backup cooling fan pulls air through the E11 rack if the lavatory/galley ventilation system does not operate.

The SATCOM backup cooling check valve makes sure that the fan pulls air through the SATCOM equipment on the rack and not out of the duct to the lavatory/galley ventilation system.

ARO ALL

Purpose

The SATCOM backup cooling fans pull air through the E11 and E13 racks if the lavatory/galley ventilation system does not operate.

The SATCOM backup cooling check valve makes sure that the fans pull air through the SATCOM equipment on the racks and not out of the duct to the lavatory/galley ventilation system.

ARO 011-999

Location

The SATCOM fan and check valve are above the passenger compartment ceiling.

The SATCOM backup cooling fan attaches to the bottom aft side of the E11 rack. The E11 rack is near door 4 left.

The SATCOM backup cooling check valve is in the vent duct that connects the rack to the lavatory/galley ventilation system. The duct attaches to the top of the equipment rack adjacent to the fan.

ARO ALL

Location

Two SATCOM fans and check valves are above the passenger compartment ceiling.

The SATCOM backup cooling check valves are in the vent duct that connects the racks to the lavatory/galley ventilation system. The duct is on the opposite end of the equipment racks as the fans.

Physical Description

The SATCOM backup cooling fan has these components:

- Fan assembly (not shown)
- Housing
- Check valve
- Electrical connector.

The SATCOM backup cooling check valve has a valve body and a set of flapper doors (not shown).

Training Information Point

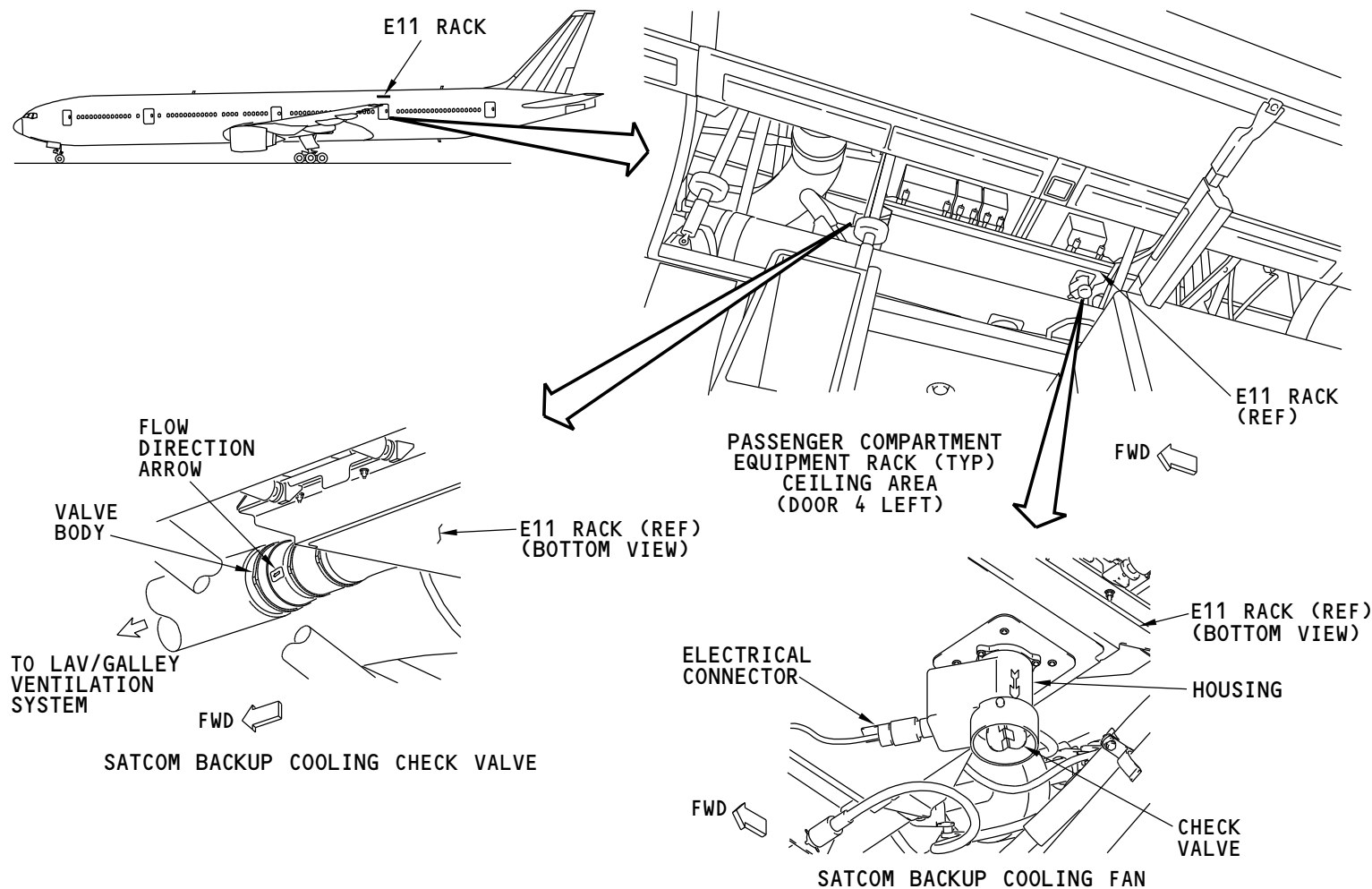
The check valve has a small inlet and a larger outlet and has an air flow direction arrow on it to help install the valve correctly.

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A/C - EQUIPMENT COOLING - SATCOM BACKUP COOLING FAN AND CHECK VALVE

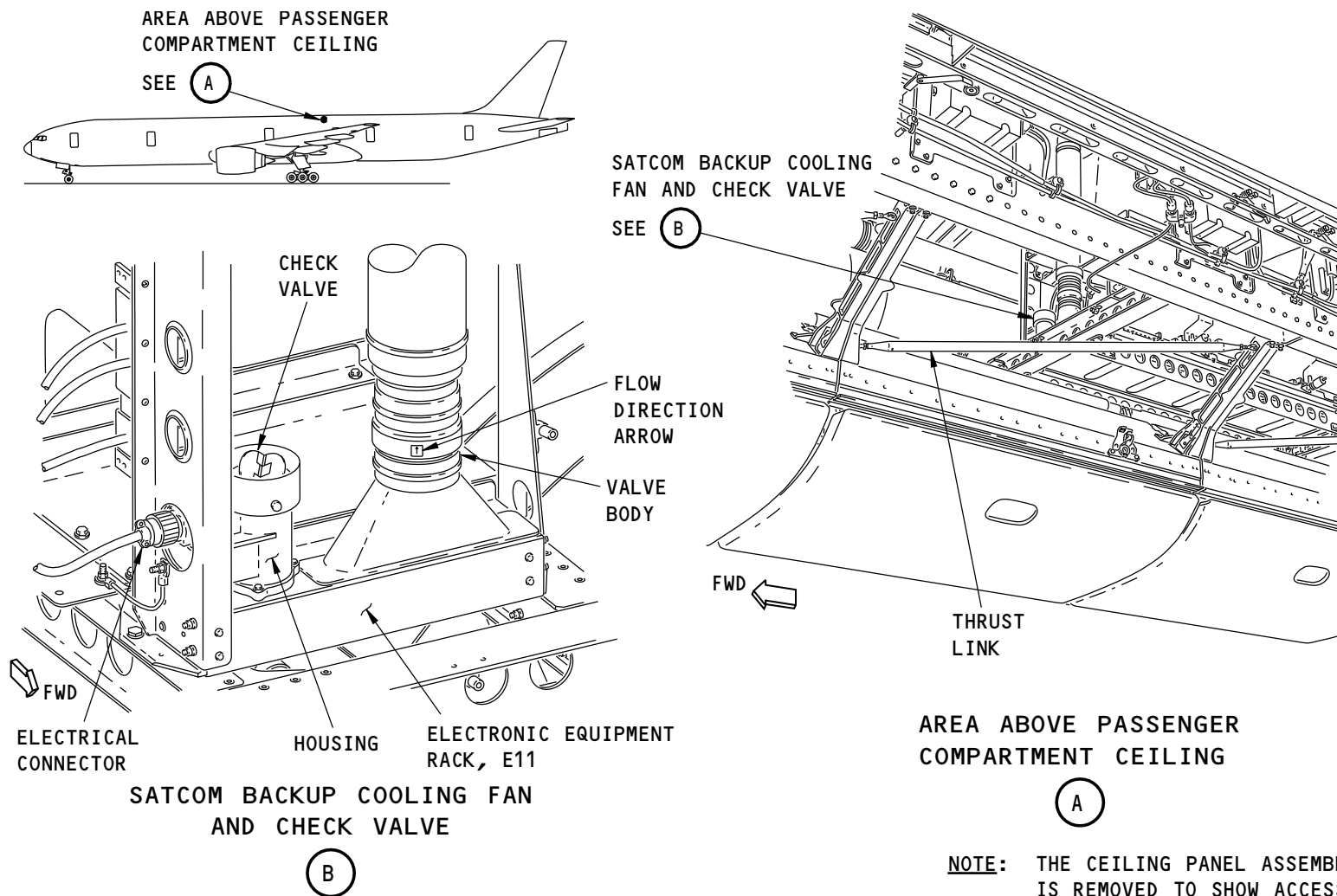
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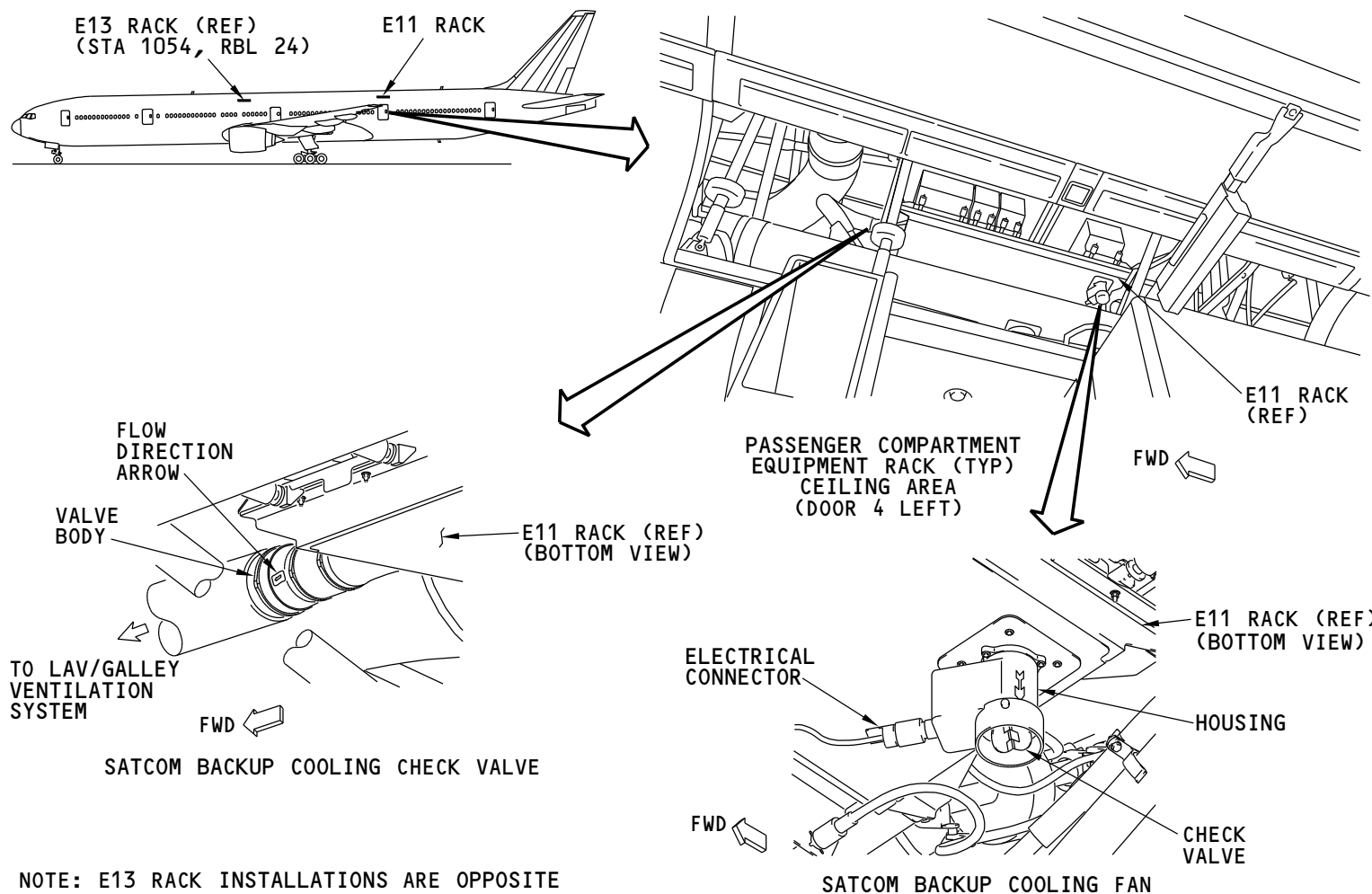
A/C - EQUIPMENT COOLING - SATCOM BACKUP COOLING FAN AND CHECK VALVE

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NOTE: E13 RACK INSTALLATIONS ARE OPPOSITE

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A/C - EQUIPMENT COOLING - SATCOM BACKUP COOLING FAN AND CHECK VALVE

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**A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - SATCOM BACKUP COOLING FAN****General**

The SATCOM backup cooling fan gives backup pull-through cooling to the SATCOM equipment. The right ECSMC gives primary control when the airplane gets power and the left ECSMC gives backup control. When the airplane changes from air to ground, the card in control changes.

Fan Control**ARO 011-999**

The ECSMCs control the fan through the signal interface unit (SIU) in the P110 left power management panel. The cards use the ARINC 629 buses to send the FAN ON CMD signal to the SIU.

ARO ALL

The ECSMCs control the fans through the signal interface units (SIUs) in the P110 left power management panel and P210 right power management panel. The cards use the ARINC 629 buses to send the FAN ON CMD signal to the SIUs.

The ECSMC in control sends the FAN ON CMD signal if both lavatory/galley ventilation fans are off for more than 10 seconds.

Fan operation also occurs during ground test. See the section on equipment cooling ground test for more information on ground tests.

Fault Indication

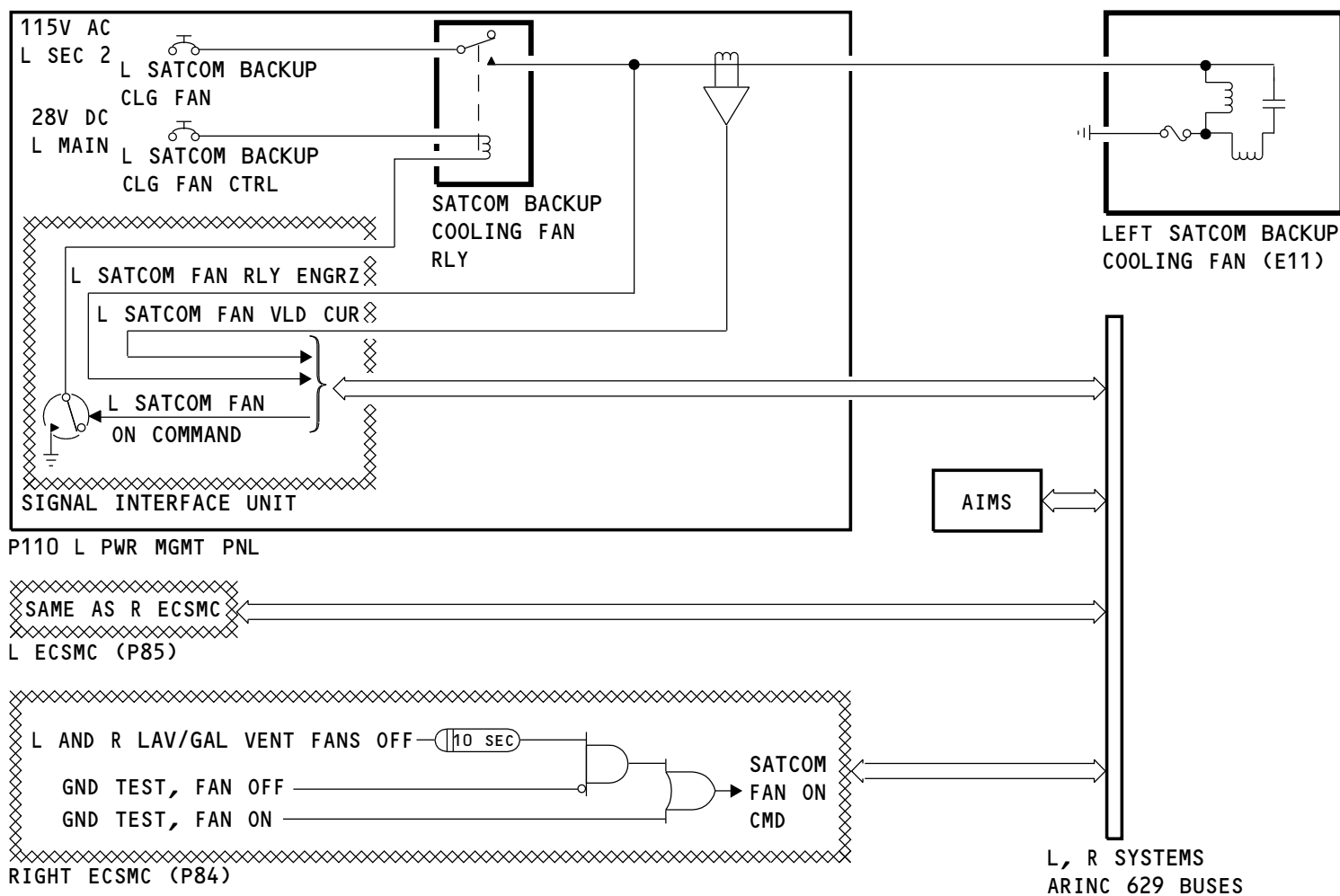
Status messages show when a SATCOM backup fan or the circuit that controls it has a malfunction.

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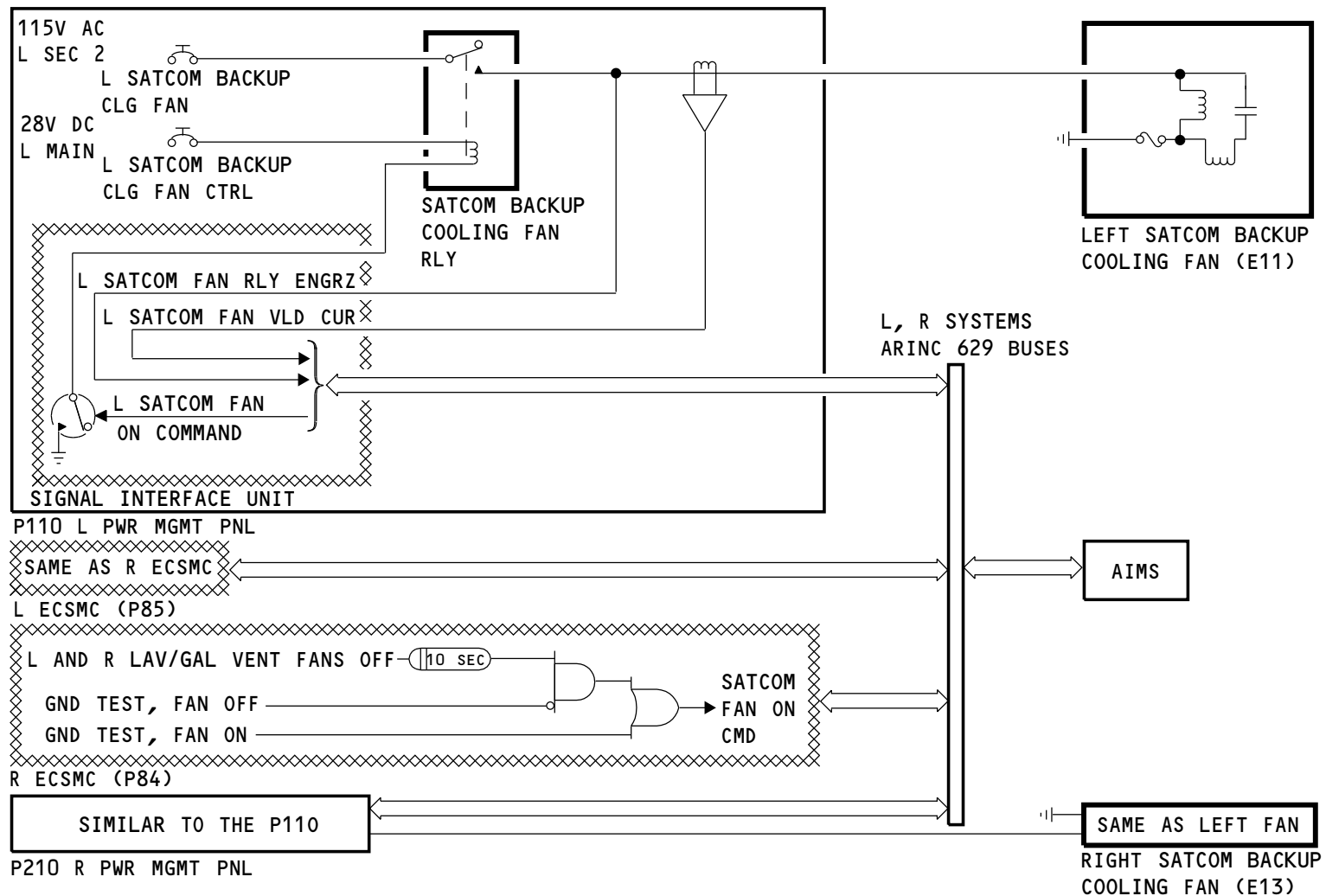
A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - SATCOM BACKUP COOLING FAN

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - SATCOM BACKUP COOLING FAN

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Page 19
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A/C - EQUIPMENT COOLING - FWD SYS - GENERAL DESCRIPTION - MECHANICAL

General

The forward part of the equipment cooling system cools the equipment that needs active cooling and removes smoke from the flight deck. The system also gives cooling to some rack-installed passively cooled equipment.

The forward equipment cooling system uses cabin air to cool electrical and electronic equipment. The system has two parts: supply and vent (exhaust). The supply part gives blow-through cooling (supply fans). The vent part gives pull-through cooling (vent fan). The system uses cabin differential pressure and the override valve to remove smoke from the flight deck.

The in-flight entertainment (IFE) cooling system uses cabin air to give pull-through cooling for the entertainment equipment. Exhaust air from the system goes into the mix bay. See the IFE - General Description page in this section for more information about the IFE cooling system.

Forward Equipment Cooling Components

The forward part of the system has these components:

- Vent fan
- Equipment inboard valve
- Equipment divert valve
- Forward cargo heat valve
- Vent valve
- Air filter
- Supply fan (2)
- Override valve
- Duct pressure sensor (4)
- Low flow sensor (2)
- Converter supplemental cooling check valve
- Equipment cooling controller (2) (not shown).

The left and right ECS miscellaneous cards (ECSMCs) (not shown) give control, BIT, and indications for the system. The right card gives primary control when the airplane gets power and the left gives backup control. When the airplane changes from air to ground, the card that is in control changes. Two equipment cooling controllers (ECC) (not shown) control the supply fans and the override valve.

The low flow sensors supply both flow and temperature information.

The converter supplemental cooling check valve is part of the equipment cooling system. The converter supplemental cooling fan is part of the electrical system. See the AC generation section for more information on the converter (SECTION 24-20).

The smoke detector is part of the fire protection system. See the electrical and electronic cooling smoke detection section for more information about the equipment cooling smoke detector (SECTION 26-19).

The forward part of the equipment cooling system has two modes of operation: auto and override (OVRD).

Forward Equipment Cooling Auto Mode

One supply fan operates. The right fan is primary. The left fan gives automatic backup. The fan that operates pulls cabin air through the air filter and pushes it through the override valve.

The override valve is closed to ambient and open (NORM position) to let the cabin air from the supply fan go to these areas:

- Forward cargo compartment - E5 and E16 racks
- Main equipment center (MEC) - E1, E2, E3, and E4 racks
- Main equipment center (MEC) - P200 and P300 Panels
- Forward equipment center - weather radar (WXR)
- Flight deck - instrument, center aisle stand, and overhead panels and the maintenance access terminal (MAT).

The vent fan pulls air from these areas:

- Main equipment center (MEC) - E1, E2, E3, and E4 racks

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**A/C - EQUIPMENT COOLING - FWD SYS - GENERAL DESCRIPTION - MECHANICAL**

- Flight deck - instrument, overhead panels and the MAT.

When electrical power is available, the vent fan operates most of the time. The fan is off for engine start. This logic helps to keep fumes from outside the aft pressurization outflow valve out of the airplane during engine start.

The air from the vent fan goes to one of these places:

- Mix bay area through the equipment inboard valve
- Forward cargo compartment through the equipment divert valve and the forward cargo heat valve
- Overboard through the equipment divert valve, vent valve and the forward outflow valve.

Air from the vent fan goes to the mix bay area if the FWD CARGO A/C control (not shown) is set to AUTO. If the control is set to OFF, the air can go to the cargo compartment or overboard. When the total air temperature (TAT) goes above 55F (12.8C), the vent valve opens and the cargo heat valve closes. The air goes to the area near the forward outflow valve in the MEC. When TAT goes below 50F (10C), the forward cargo heat valve opens and the vent valve closes. The air goes to heat the forward cargo compartment.

Forward Equipment Cooling Override Mode

The override mode cools the equipment without the supply and vent fans. This mode uses cabin differential pressure to cause air flow through the equipment. The override mode gives sufficient cooling when the airplane is pressurized and above 25,000 feet (7625 meters). The flight crew also selects this mode when they want to clear smoke from the flight compartment.

Any of these conditions causes the system to operate in the override mode:

- Equipment cooling switch on the air conditioning panel (not shown) set to OVRD
- Low flow in MEC and F/D supply ducts and airspeed more than 150 knots
- Left and right supply fans failed off

- Smoke in supply or vent duct
- Forward cargo fire extinguishing system armed.

The override mode causes these effects:

- The bulk cargo ventilation fan goes off (only with equipment cooling switch in the OVRD position)
- Both supply fans stop
- The override valve goes to the OVRD position which opens the supply duct to ambient
- Cabin differential pressure pushes cabin air through the components and out of the airplane
- The converter supplemental cooling fan comes on
- The vent fan stops
- The inboard valve closes
- The divert valve closes
- The forward cargo exhaust fan continues to operate if the FWD CARGO A/C control is set to AUTO
- The forward cargo heat valve closes if it is open (low flow does not cause the valve to change position)
- The vent valve stays open if the FWD CARGO A/C control is set to AUTO and the forward cargo fire system is not armed. The valve closes if the forward cargo fire system is armed. The valve closes if the FWD CARGO A/C control is set to OFF and equipment cooling smoke is detected. The valve closes if the FWD CARGO A/C control is set to OFF and the OVRD switch is set to out. A low flow condition does not cause the valve to change position.

Ground Operation

Operation of the system on the ground normally does not require any inputs from you except to make sure that AUTO is selected.

If ambient temperature is equal to or greater than 110F (43C), you must supply conditioned air to the airplane.

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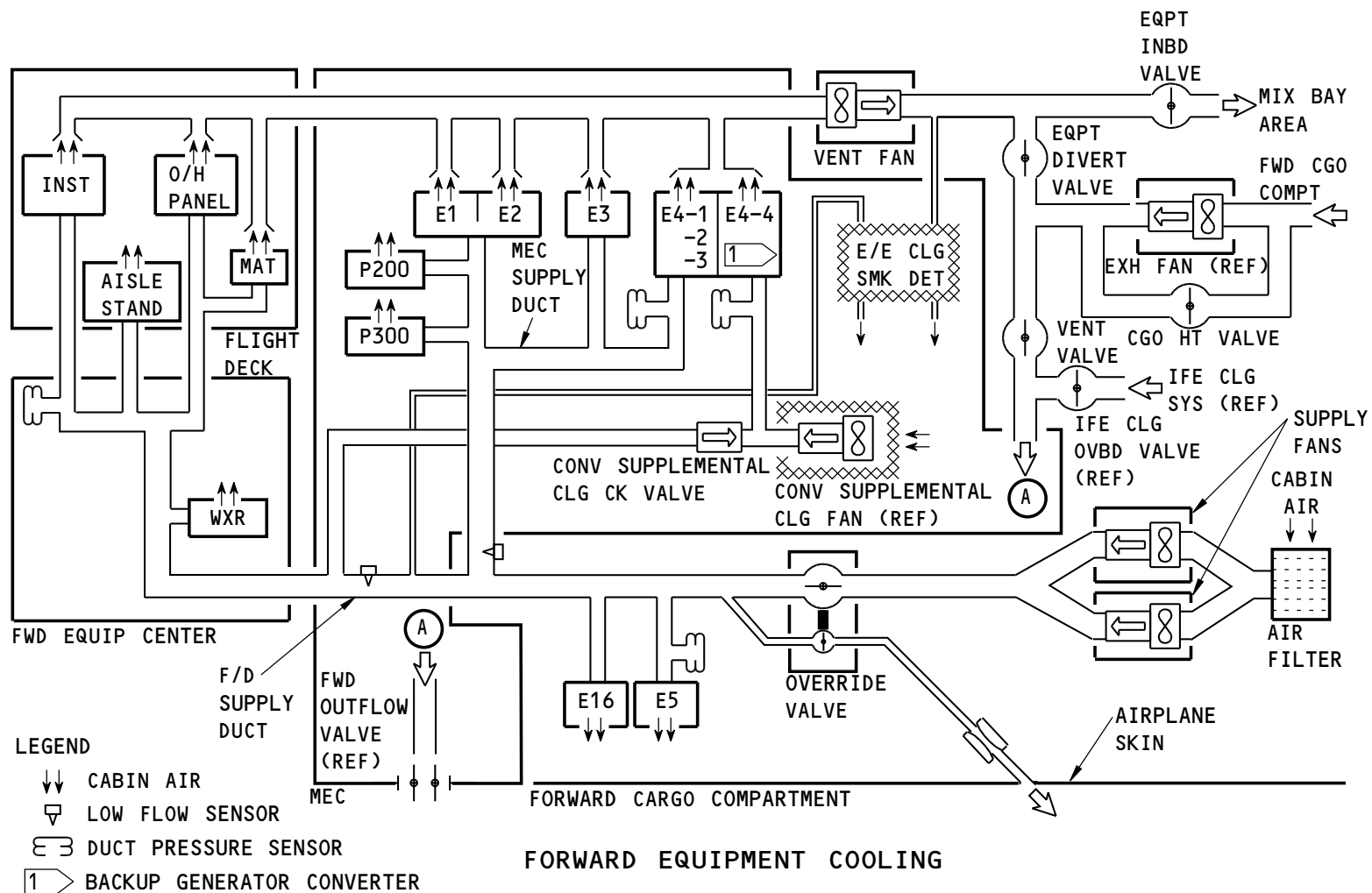


A/C - EQUIPMENT COOLING - FWD SYS - GENERAL DESCRIPTION - MECHANICAL

Training Information Point

You can operate the system on the ground with a malfunction of the vent fan as long as ambient temperature is below 86F (30C). If the temperature goes above 86F (30C), then you must supply conditioned air to the airplane.

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A/C - EQUIPMENT COOLING - FWD SYS - GENERAL DESCRIPTION - MECHANICAL

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A/C - EQUIPMENT COOLING - GENERAL DESCRIPTION - ELECTRICAL**General**

Equipment cooling control components supply automatic or manual mode selection (AUTO/OVRD), indications, and BIT for the system. These are the control components:

- Equipment cooling switch
- Forward cargo air conditioning control
- Left and right environmental control system miscellaneous cards (ECSMC)
- Left and right equipment cooling controllers (ECC).

The equipment cooling switch gives indication for mode selection and lets you manually set the mode of operation to AUTO or OVRD.

The forward cargo air conditioning control gives on/off data to the ECSMCs.

The left and right ECSMCs give automatic control (AUTO or OVRD), indications (AIMS and equipment cooling switch), and BIT for the equipment cooling system. The cards control:

- Which supply fan is primary and which is backup
- When the supply and the vent fans operate.
- The direction of air flow for the equipment cooling exhaust air. Directs the air to the cargo compartment for heating or to the mix bay area for cargo cooling or vents the air overboard
- When to set the system to the override mode

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- When to turn on the SATCOM cooling fan

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- When to turn on the SATCOM cooling fans
- When to give indications for mode selection and malfunctions.

The left and right equipment cooling controllers (ECCs) usually control the left and right equipment cooling supply fans and the override valve with inputs from the ECSMCs. The ECCs take control of the fans and valve if the airplane is in the air and the ECCs find low flow for an extended time (6.5 min in supply fan mode or 20 min in OVRD mode).

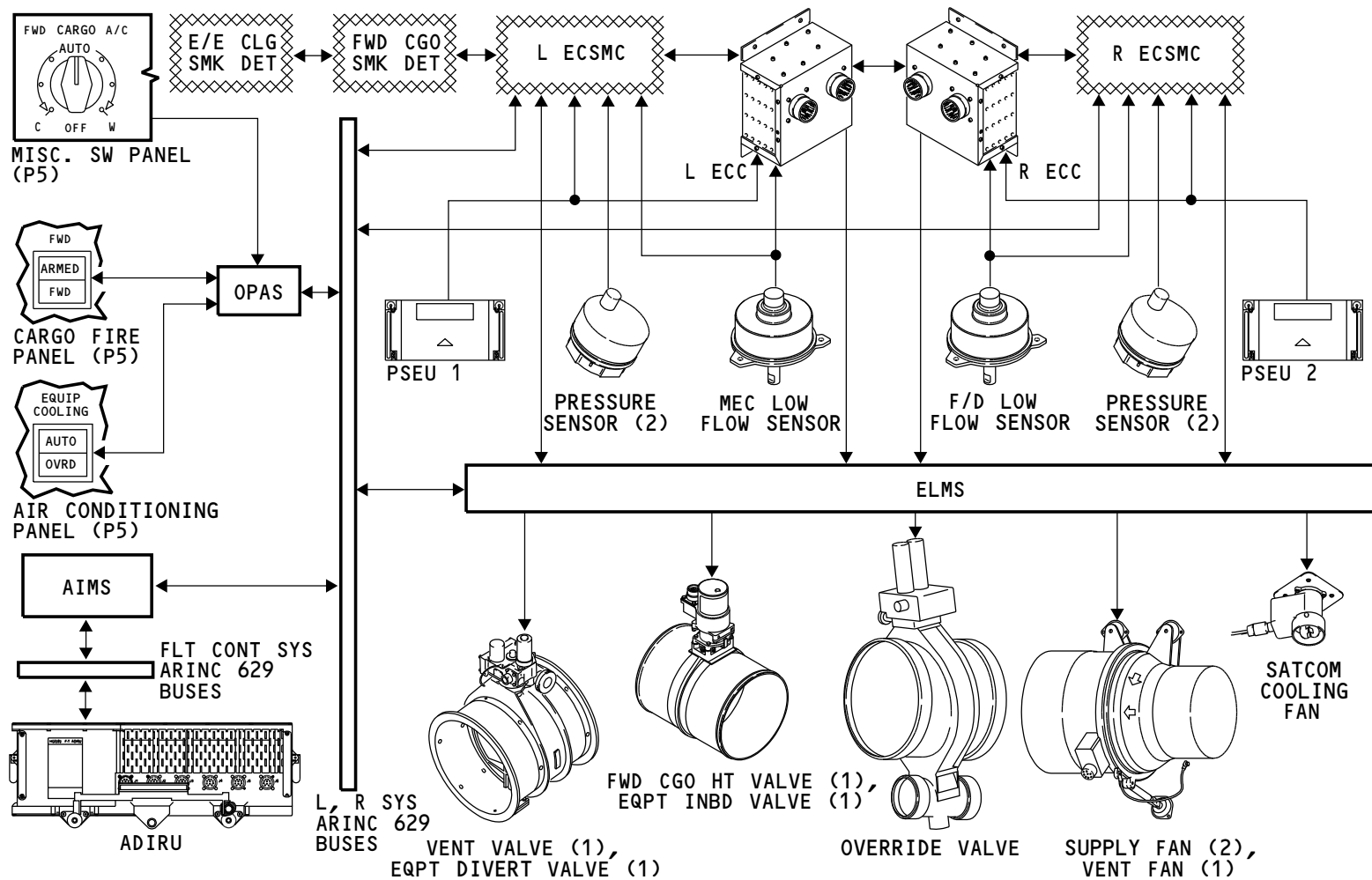
Interfaces

The ECSMCs have three types of input/output interfaces with system components and with other systems. One is through the left and right system ARINC 629 buses. These are the ARINC 629 interfaces:

- OPAS
- AIMS
- ELMS.

The second type is through hard-wired inputs to ELMS. The third type is by hard-wired inputs/outputs from system components and the PSEUs 1 and 2.

See the INTERFACES page in this section for more information about the system components that are hard-wired to the ECSMCs.



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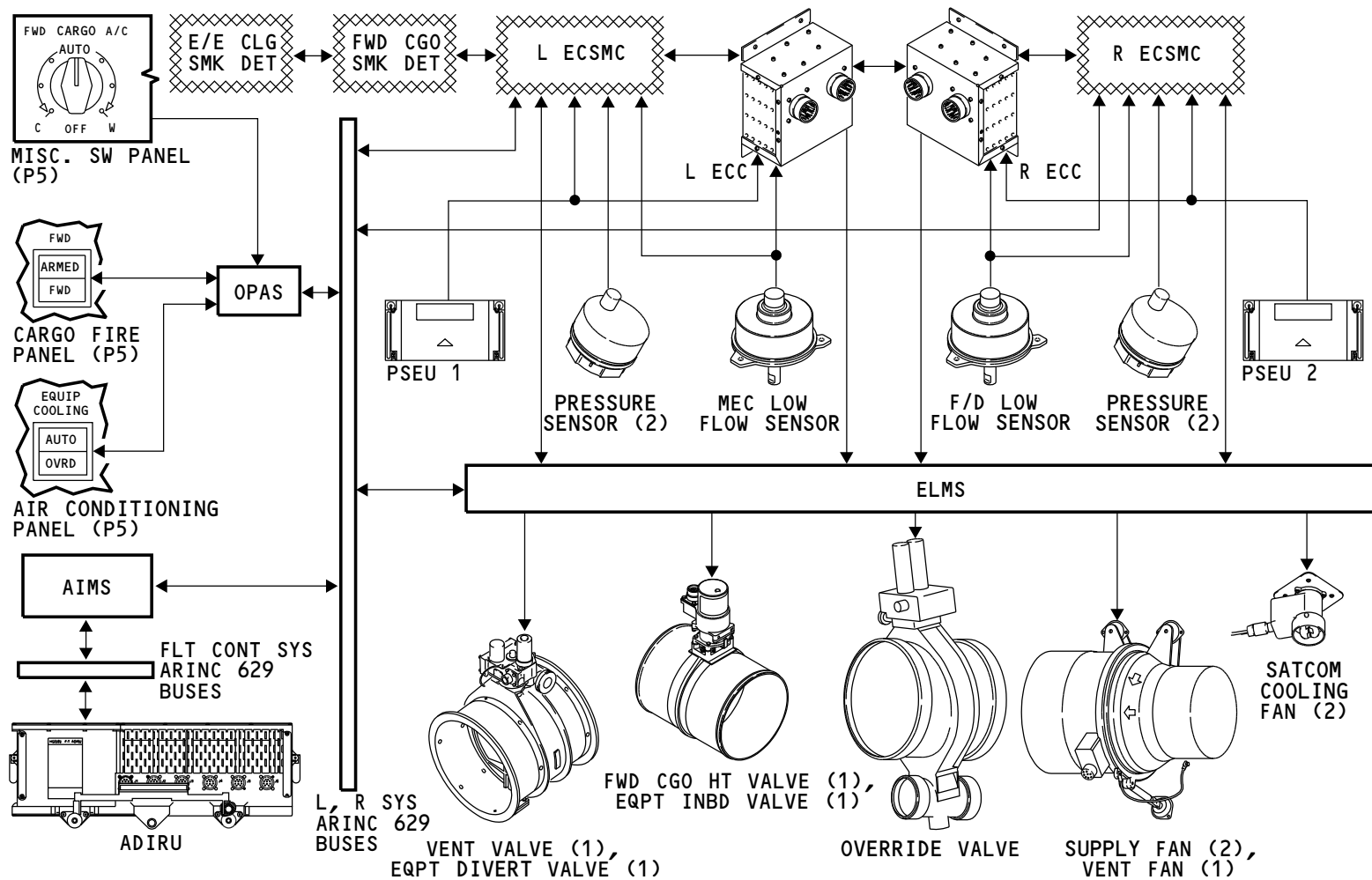
A/C - EQUIPMENT COOLING - GENERAL DESCRIPTION - ELECTRICAL

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A/C - EQUIPMENT COOLING - GENERAL DESCRIPTION - ELECTRICAL

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A/C - EQUIPMENT COOLING - INTERFACES

Left ECSMC Interfaces

The left ECSMC has hard-wire interfaces with these equipment cooling system components:

- Duct pressure sensor for the E4-1, E4-2, and E4-3 shelves
- Duct pressure sensor for the flight deck
- Low (air) flow sensor for the main equipment center
- Overheat switches for the left equipment cooling supply fan
- Overheat switches for the equipment cooling vent fan
- Open/close limit switches for the equipment cooling vent valve
- Norm/ovrd limit switches for the left motor of the override valve
- MEC equipment cooling low flow sensor
- Left equipment cooling controller.

Right ECSMC Interfaces

The right ECSMC has a hard-wire interface with these equipment cooling system components:

- Right equipment cooling controller.
- Low (air) flow sensor for the flight deck
- Open/close limit switches for the forward cargo heat valve
- Norm/ovrd limit switches for the right motor of the override valve
- Overheat switches for the right equipment cooling supply fan
- Duct pressure sensor for the backup generator converter (E4-4 shelf)
- Duct pressure sensor for the E5 equipment rack

Non Equipment Cooling ECSMC Interfaces

The ECSMCs have hard-wire interfaces for components that are not part of the equipment cooling system. See these sections for more information on ECSMC interfaces:

- Air conditioning (21-00)
- Recirculation system (21-25)

- Ventilation system (21-26)
- Aft and bulk cargo compartment heating system (21-44)
- Supplemental heating system (21-45).

ECC Interfaces

The equipment cooling controllers (ECC) have hard-wire interfaces with each other (cross talk), the related ECSMC and with some of the same components as the ESCMCs. These are the components:

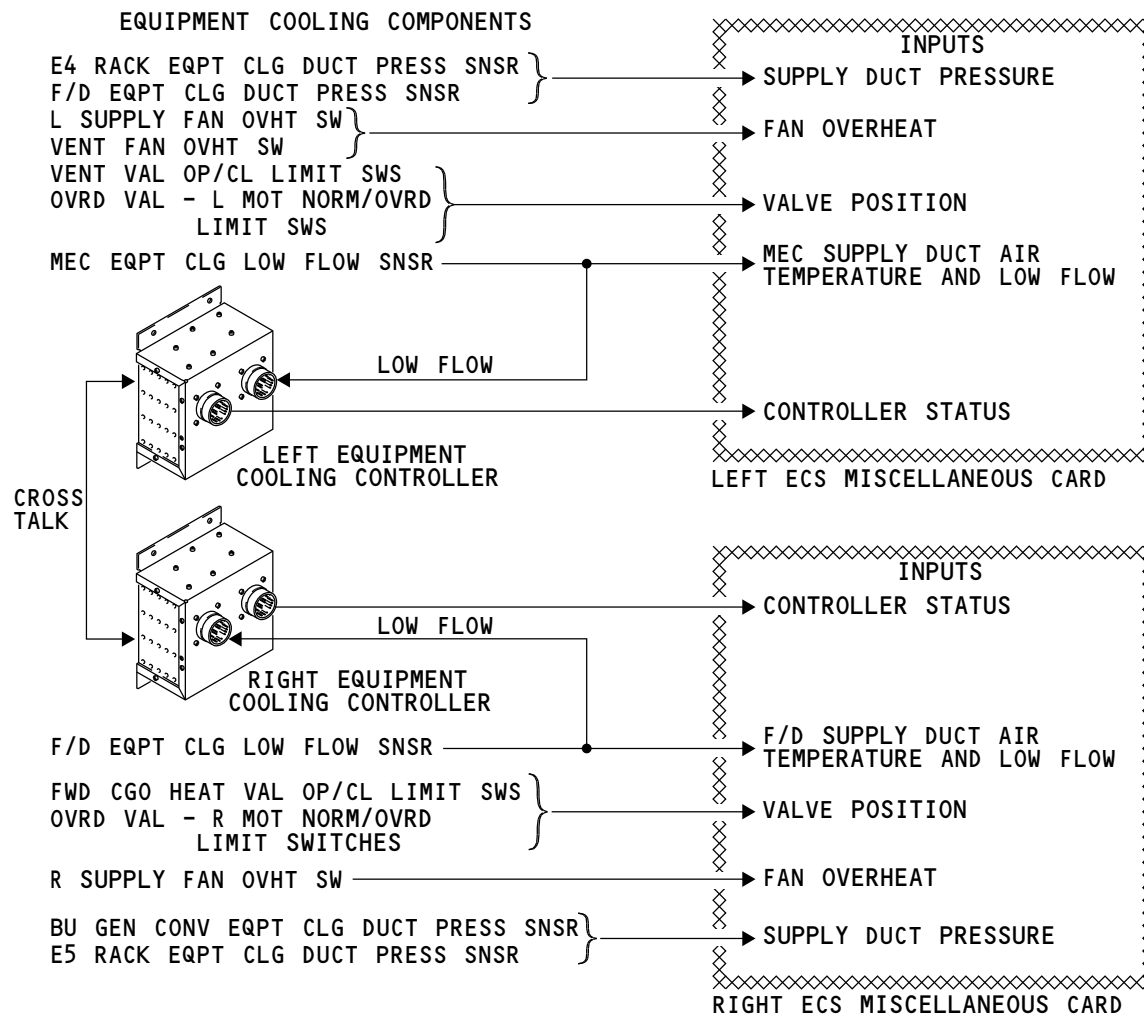
- Low (air) flow sensor for the main equipment center
- Low (air) flow sensor for the flight deck.

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A/C - EQUIPMENT COOLING - INTERFACES

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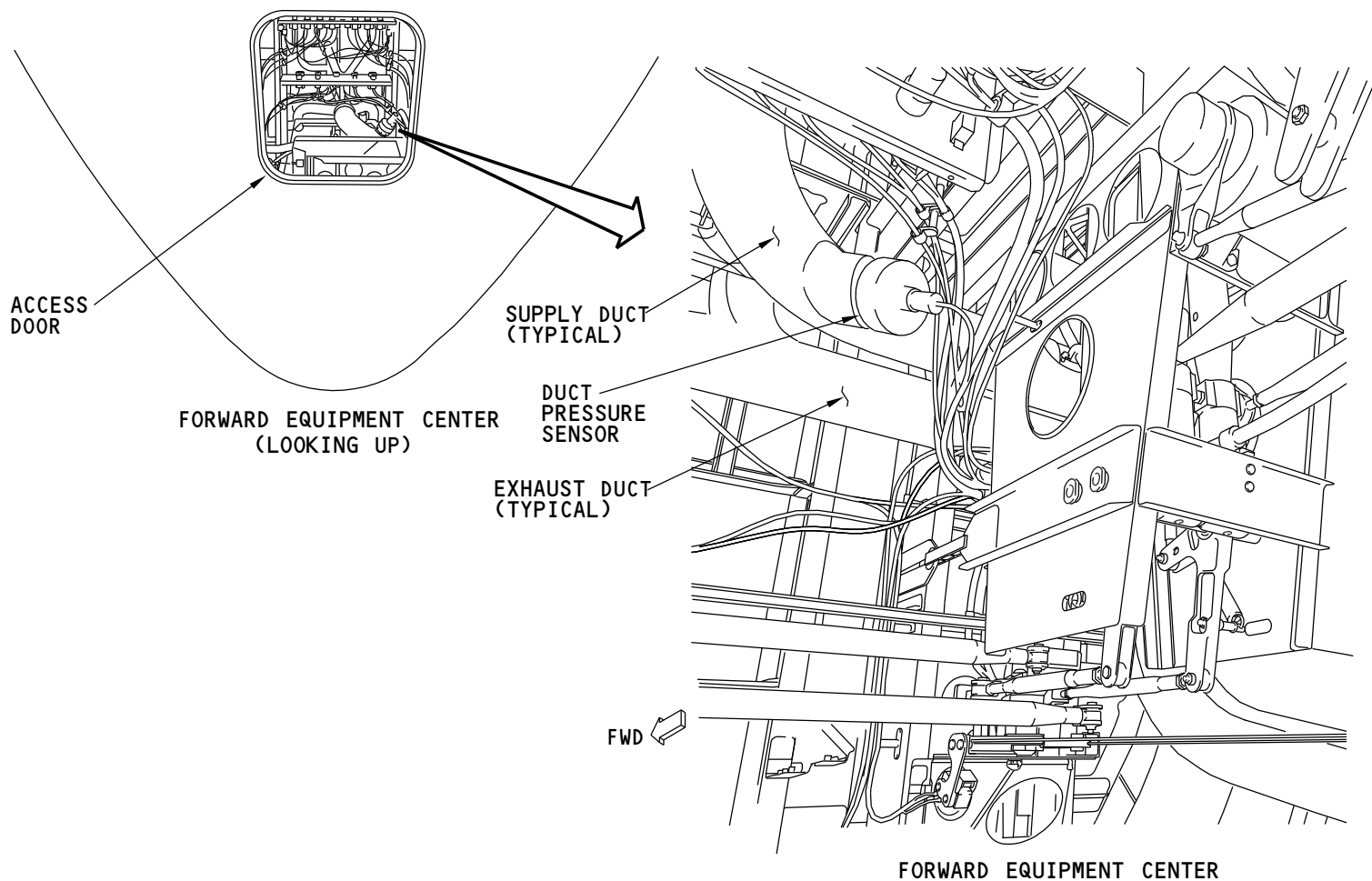
**A/C - EQUIPMENT COOLING - FORWARD EQUIPMENT CENTER COMPONENT LOCATION****Component Location**

These equipment cooling system components are in the forward equipment center:

- Supply duct
- Duct pressure sensor
- Exhaust (vent) duct.

The sensor attaches to the supply duct, forward and to the right of the access door cutout.

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A/C - EQUIPMENT COOLING - FORWARD EQUIPMENT CENTER COMPONENT LOCATION

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A/C - EQUIPMENT COOLING - MAIN EQUIPMENT CENTER COMPONENT LOCATIONS**Component Locations**

These equipment cooling components are in the main equipment center (MEC):

- Equipment cooling controller (ECC)(2)
- Converter supplemental cooling check valve
- Flight deck low flow sensor
- VSCF duct pressure sensor
- E4 rack duct pressure sensor
- Supply ducts
- Exhaust (vent) ducts.

The left controller is below the P310 standby power management panel on the left side of the MEC. The right controller is below the P300 auxiliary power panel, near the flight deck low flow sensor.

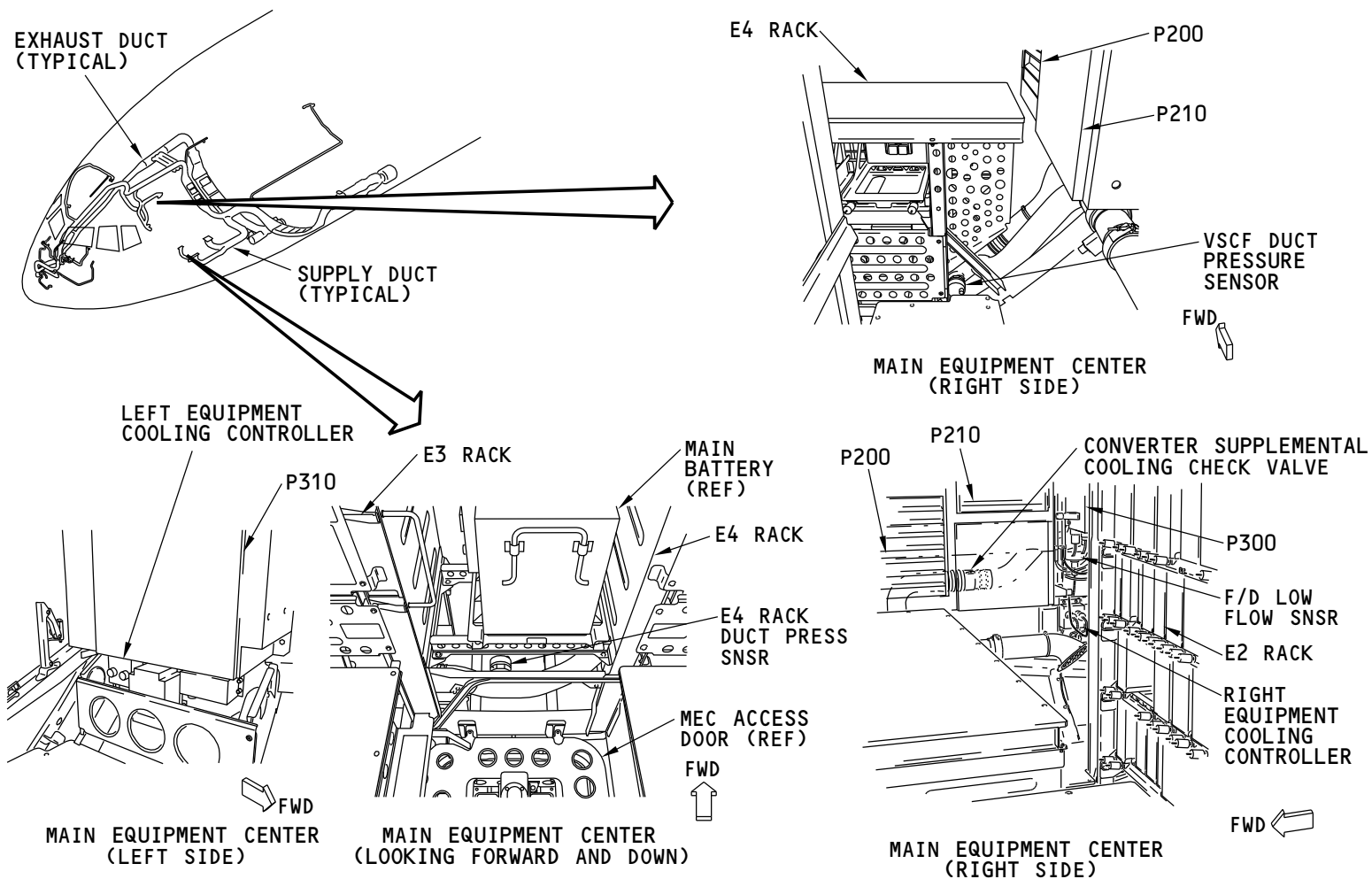
The converter supplemental cooling check valve is behind the lower end of the P210 right power management panel.

The low flow sensor is below and at the forward corner of the P300 auxiliary power panel.

The duct pressure sensor for the backup generator converter is to the right side and below the E4 rack. The duct pressure sensor for the E4 rack is immediately forward of the MEC access door, below the main battery.

The supply ducts are under the floor panels and in the right side-wall area of the MEC. The exhaust duct is in the right side-wall area and in the ceiling area of the MEC.

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A/C - EQUIPMENT COOLING - MAIN EQUIPMENT CENTER COMPONENT LOCATIONS

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**A/C - EQUIPMENT COOLING - FORWARD CARGO COMPARTMENT COMPONENT LOCATIONS - 1****Component Locations**

Equipment cooling components are in three places in the forward cargo compartment: left sidewall area, under the floor, and right sidewall area (not shown).

These are the components in the left sidewall area, outboard of the cargo handling ball panels:

- Air filter
- Supply ducts
- Smoke clearance duct
- Supply fan (2)
- Override valve.

Remove the sidewall lining to get access to the air filter, supply ducts, supply fans, and override valve.

These are the components in the area below the compartment floor, forward of the cargo handling ball panels:

- Vent valve
- MEC low flow sensor
- Equipment divert valve
- Exhaust duct
- Supply ducts.

Remove the floor panel that is forward of the ball panels and inboard of the left PDU to get access to the vent valve. Remove the floor panel forward of the cargo handling ball panels and to the left of the right PDUs to get access to the MEC low flow sensor.

These are the components in the area below the cargo handling ball panels:

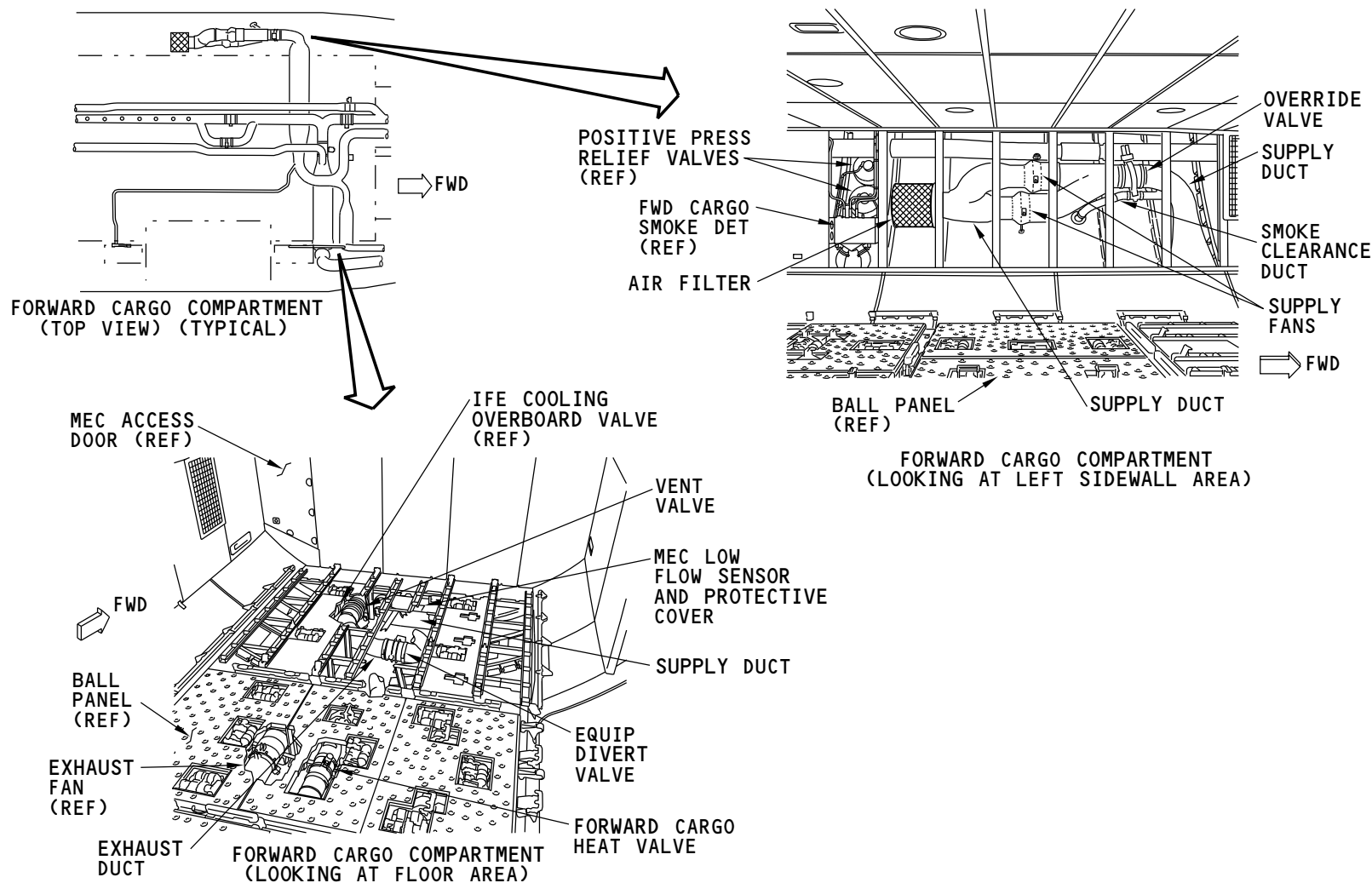
- Forward cargo heat valve
- Exhaust duct.

Remove the center forward ball panel to get access to the forward cargo heat valve.

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A/C - EQUIPMENT COOLING - FORWARD CARGO COMPARTMENT COMPONENT LOCATIONS - 1

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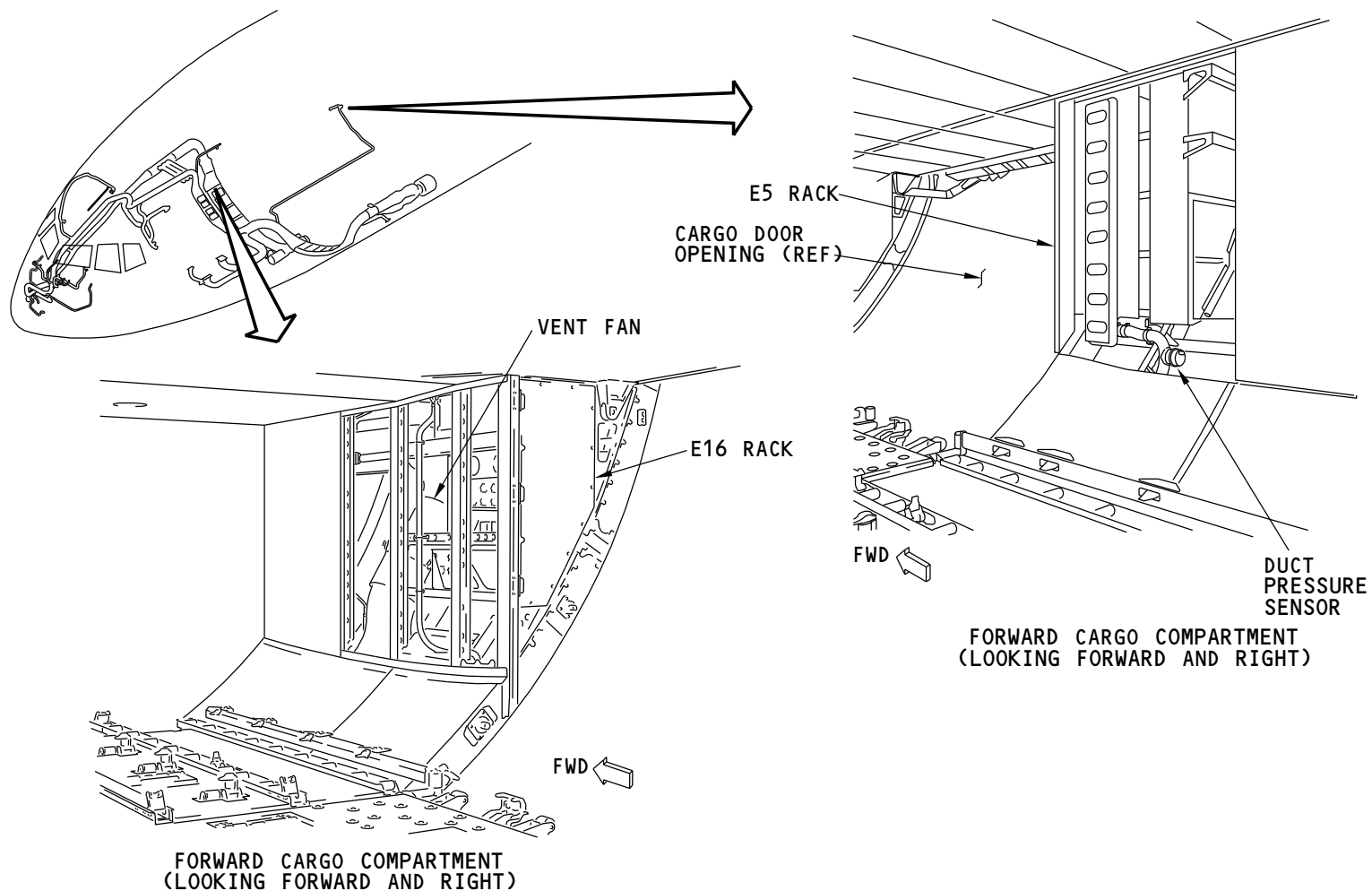
**A/C - EQUIPMENT COOLING - FORWARD CARGO COMPARTMENT COMPONENT LOCATIONS - 2****Component Locations**

The duct pressure sensor and vent fan are in the forward cargo compartment.

The duct pressure sensor for the E5 rack is in the forward cargo compartment on the right side aft of the forward cargo door. The duct pressure sensor is aft and below the E5 rack. Remove the sidewall panel to get access to the duct pressure sensor.

The vent fan is in the forward cargo compartment on the right side forward of the forward cargo door. The vent fan is forward of the E16 rack. Remove the sidewall panel to get access to the vent fan.

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A/C - EQUIPMENT COOLING - FORWARD CARGO COMPARTMENT COMPONENT LOCATIONS - 2

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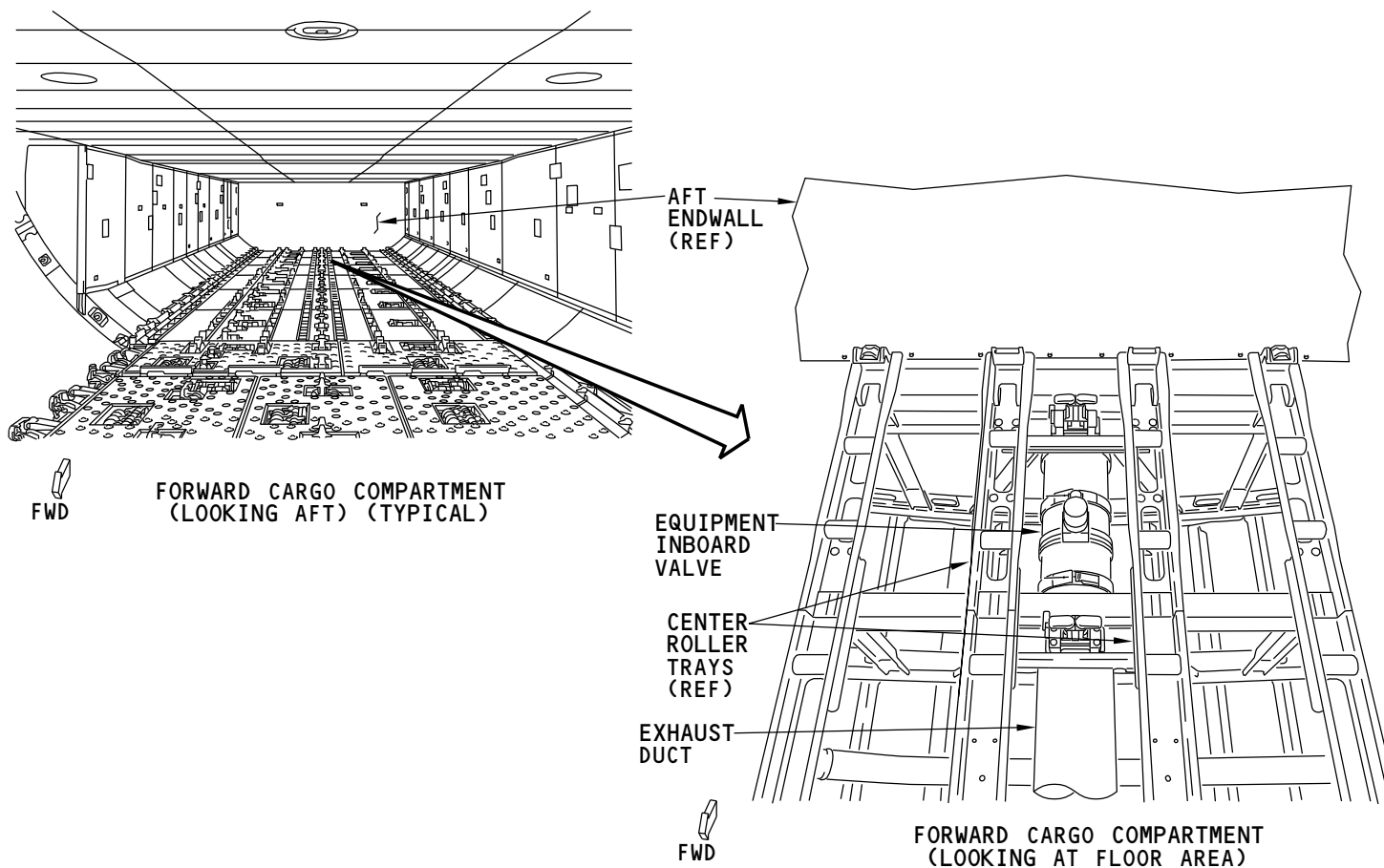
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**A/C - EQUIPMENT COOLING - FORWARD CARGO COMPARTMENT COMPONENT LOCATIONS - 3****Component Locations**

The equipment inboard valve is in the area below the compartment floor, near the aft endwall.

Remove the floor panel that is next to the aft endwall panel and between the center roller trays to get access to the valve.

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A/C - EQUIPMENT COOLING - FORWARD CARGO COMPARTMENT COMPONENT LOCATIONS - 3

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**A/C - EQUIPMENT COOLING - AIR FILTER****Purpose**

The air filter removes particles from the air before the air cools the equipment.

Physical Description

The filter is a nonwoven fabric and is made of polyester and glass fibers.

Location

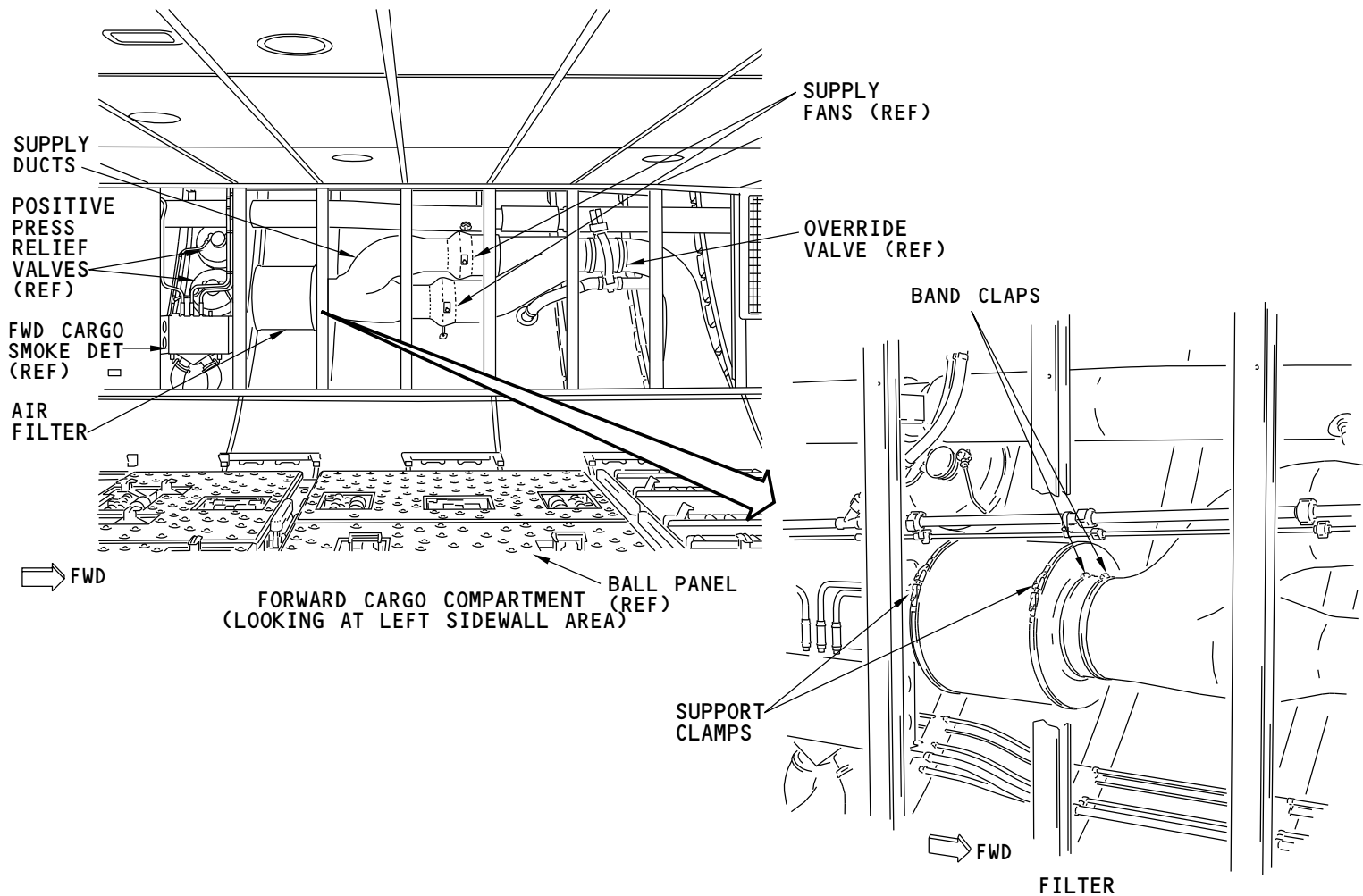
The air filter is outboard of the left sidewall panel. It is near the forward ball panel in the forward cargo compartment.

Training Information Point

Remove the sidewall lining to get access to the air filter.

You clean the filter with detergent. You can also blow air from the inside out to clean the filter. You remove two band clamps that attach to the duct and two support clamps to remove the filter from the airplane.

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A/C - EQUIPMENT COOLING - AIR FILTER

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**A/C - EQUIPMENT COOLING - SUPPLY FANS****Purpose**

The two supply fans give air to the supply part of the forward equipment cooling system for blow-through cooling.

Physical Description

The supply fan has these components:

- Stator housing assembly
- Check valve (not shown)
- Electrical connector
- Electric motor (not shown)
- Inlet housing assembly.

Location

The two supply fans are outboard of the left sidewall panel near the forward ball panel in the forward cargo compartment. The supply fans are between the override valve and the air filter. The left supply fan is above the right supply fan.

Training Information Point

One fan operates at a time. The right fan is primary and the left fan is secondary.

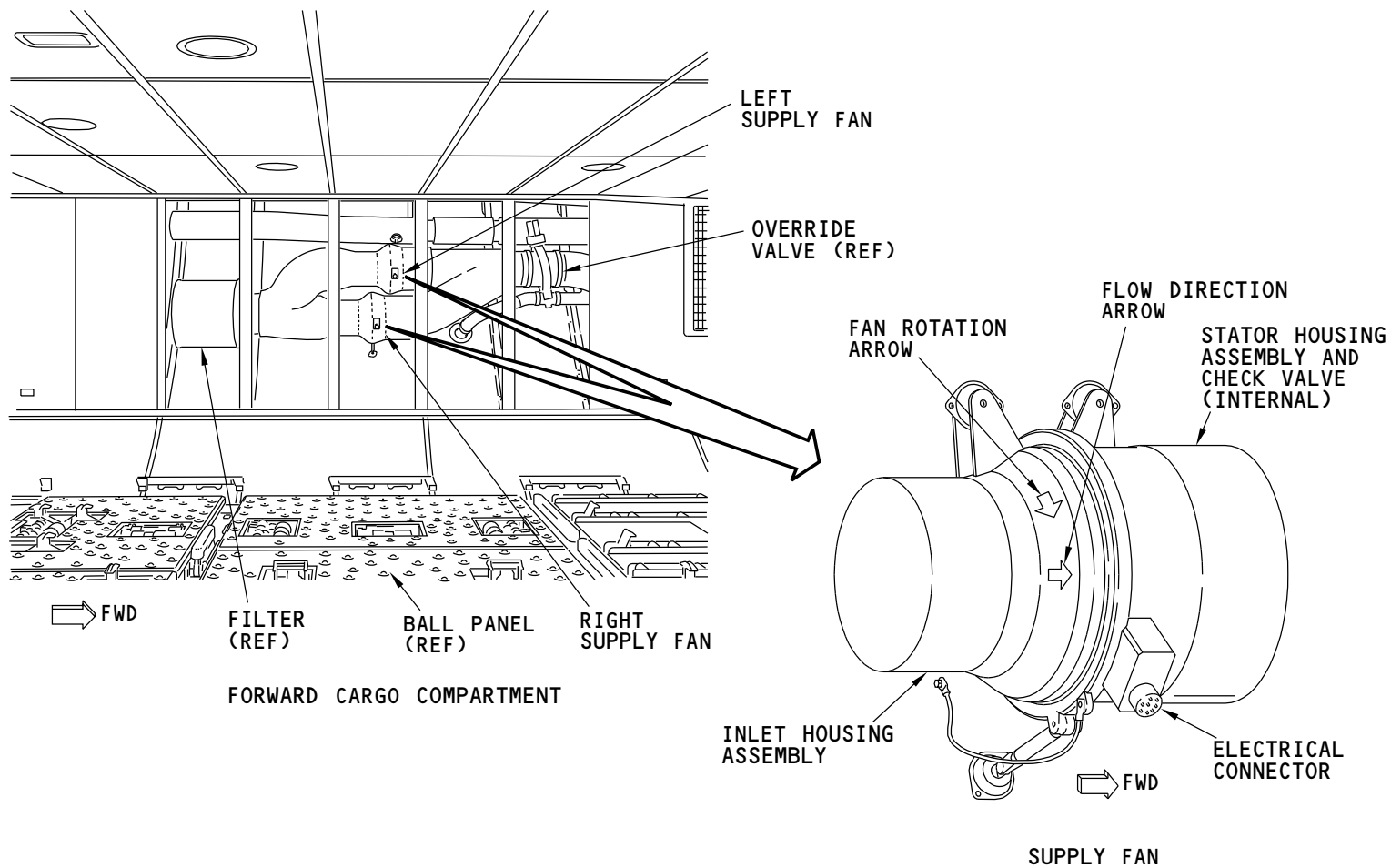
The fans have flow and rotation arrows. The arrows help install the fans correctly.

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A/C - EQUIPMENT COOLING - SUPPLY FANS

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A/C - EQUIPMENT COOLING - OVERRIDE VALVE

Purpose

The override valve permits differential cabin pressure to remove smoke and cool the electronic and electrical components.

Location

The override valve is outboard of the left sidewall panel near the forward ball panel in the forward cargo compartment.

Physical Description

The override valve has these three primary components:

- Actuator
- Cooling valve
- Smoke removal valve.

The actuator has these components:

- Electric motor (2)
- Position indicator
- Electrical connector (2)
- Manual override knob.

Each motor can operate the override valve.

The cooling valve has a valve body and a butterfly plate assembly (not shown).

The smoke removal valve has a valve body and a butterfly plate assembly (not shown).

Functional Description

A shaft connects the two valves. When one valve is open the other is closed. The override valve has two positions: normal and override. In the normal position, the cooling valve is open and the smoke removal valve is closed. In the override position, the cooling valve is closed and the smoke removal valve is open.

Training Information Point

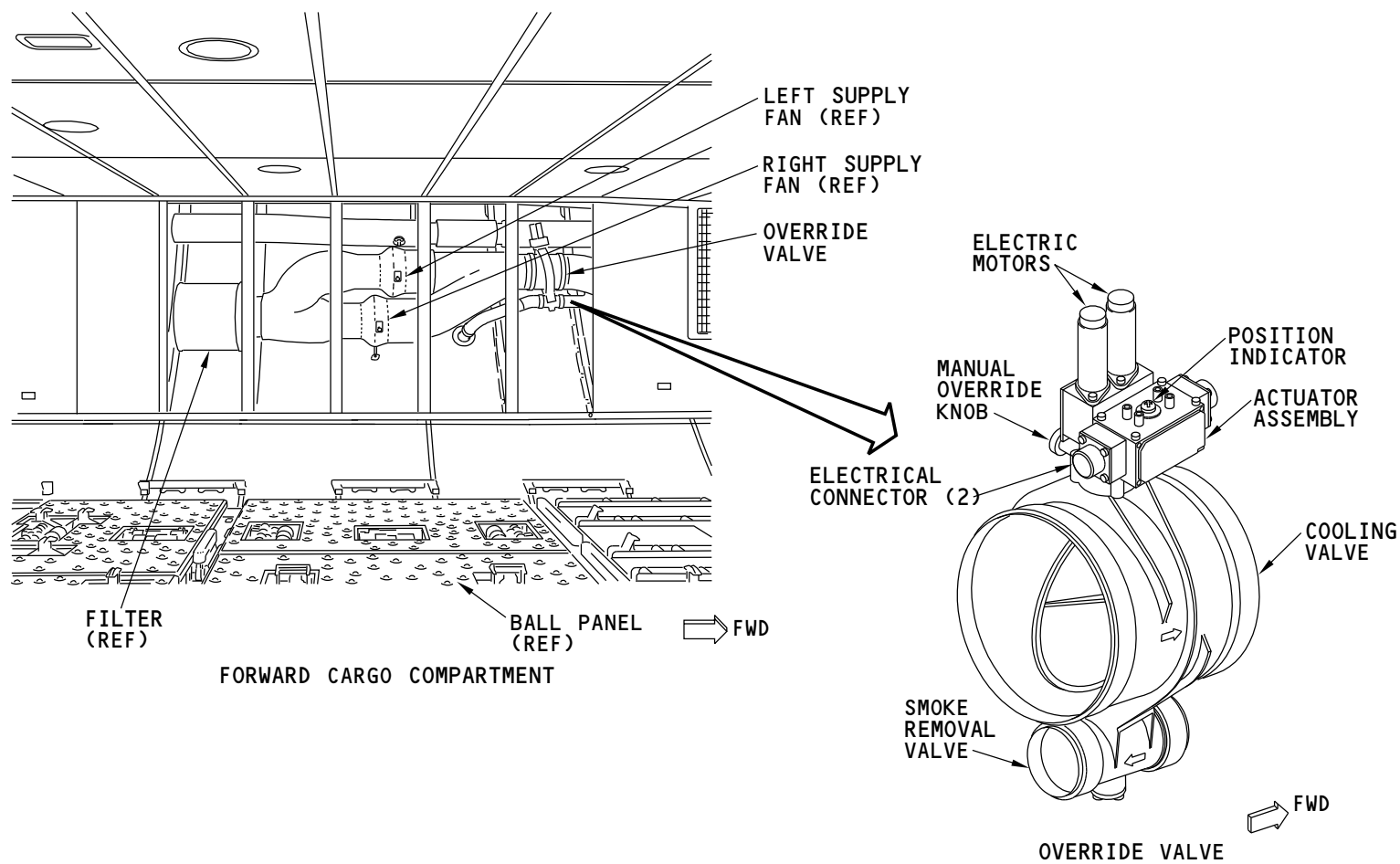
The override valve has two air flow direction arrows. The arrows help you install the valve correctly.

A position indicator shows the position of the valve. You can use the manual override knob to change the position of the override valve when there is no electric power to the valve.

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A/C - EQUIPMENT COOLING - OVERRIDE VALVE

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**A/C - EQUIPMENT COOLING - DUCT PRESSURE SENSORS****Purpose**

Four duct pressure sensors tell the ECSMCs the pressure at each sensor location.

Physical Description

Each duct pressure sensor has these components:

- Sense port
- Electrical connector
- Sensor housing.

Location

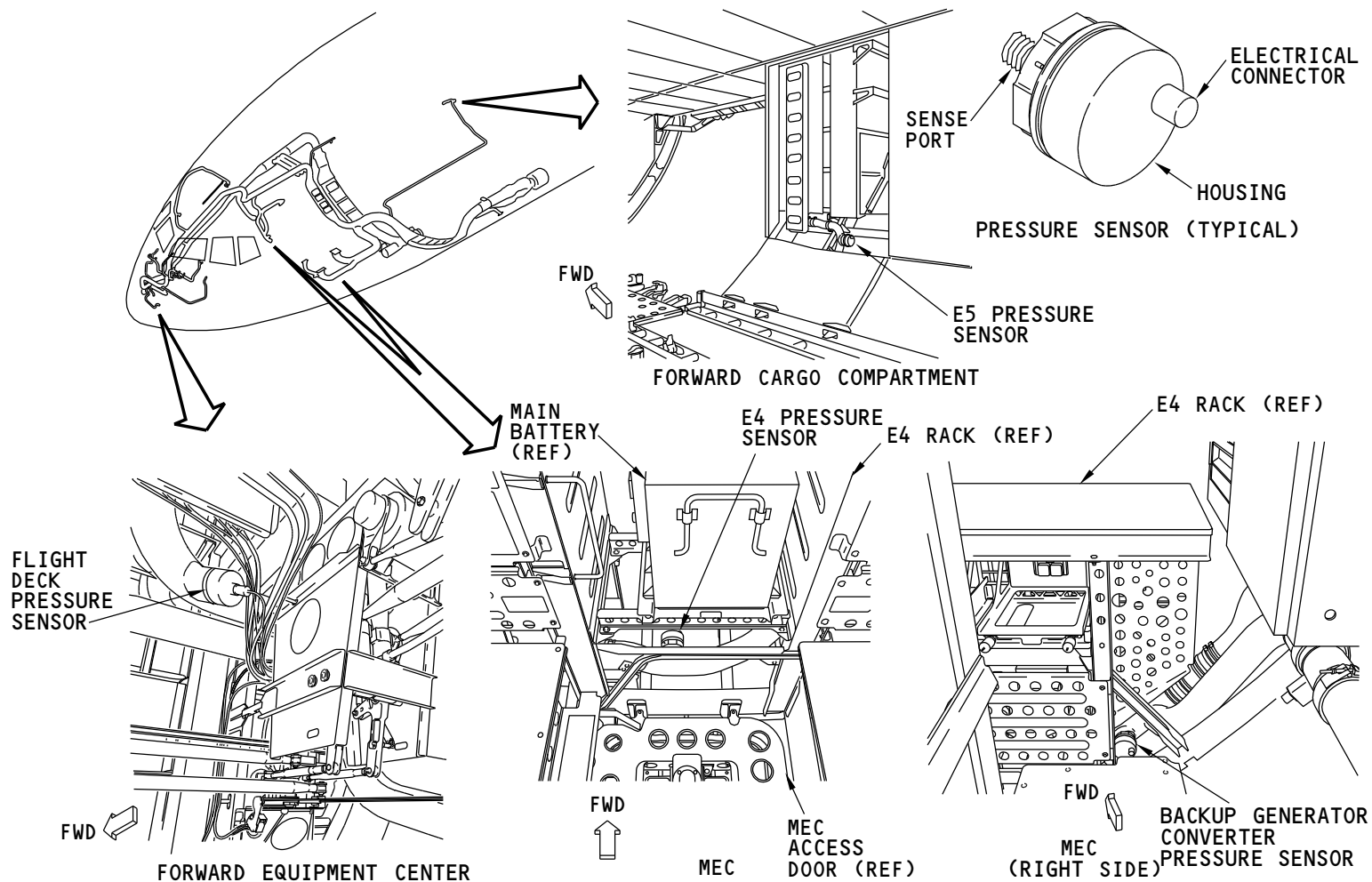
These are the four duct pressure sensor locations.

The sensor for the E5 rack is aft and below the E5 rack. Access is through the forward cargo compartment right sidewall panel, aft of the cargo door.

The duct pressure sensor for the backup generator converter (E4-4 shelf) is to the right side and below the E4 rack.

The duct pressure sensor for the E4-1, E4-2 and E4-3 shelves is just forward of the MEC access door, below the main battery.

The duct pressure sensor for the flight deck is in the forward equipment center. It is directly forward of the cutout for the forward access door



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A/C - EQUIPMENT COOLING - DUCT PRESSURE SENSORS

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**A/C - EQUIPMENT COOLING - LOW FLOW SENSORS****Purpose**

The two low flow sensors tell the ECSMCs if there is low air flow or high air temperature in the equipment cooling air.

Physical Description

The low flow sensor has these components:

- Probe
- Body
- Electrical connector.

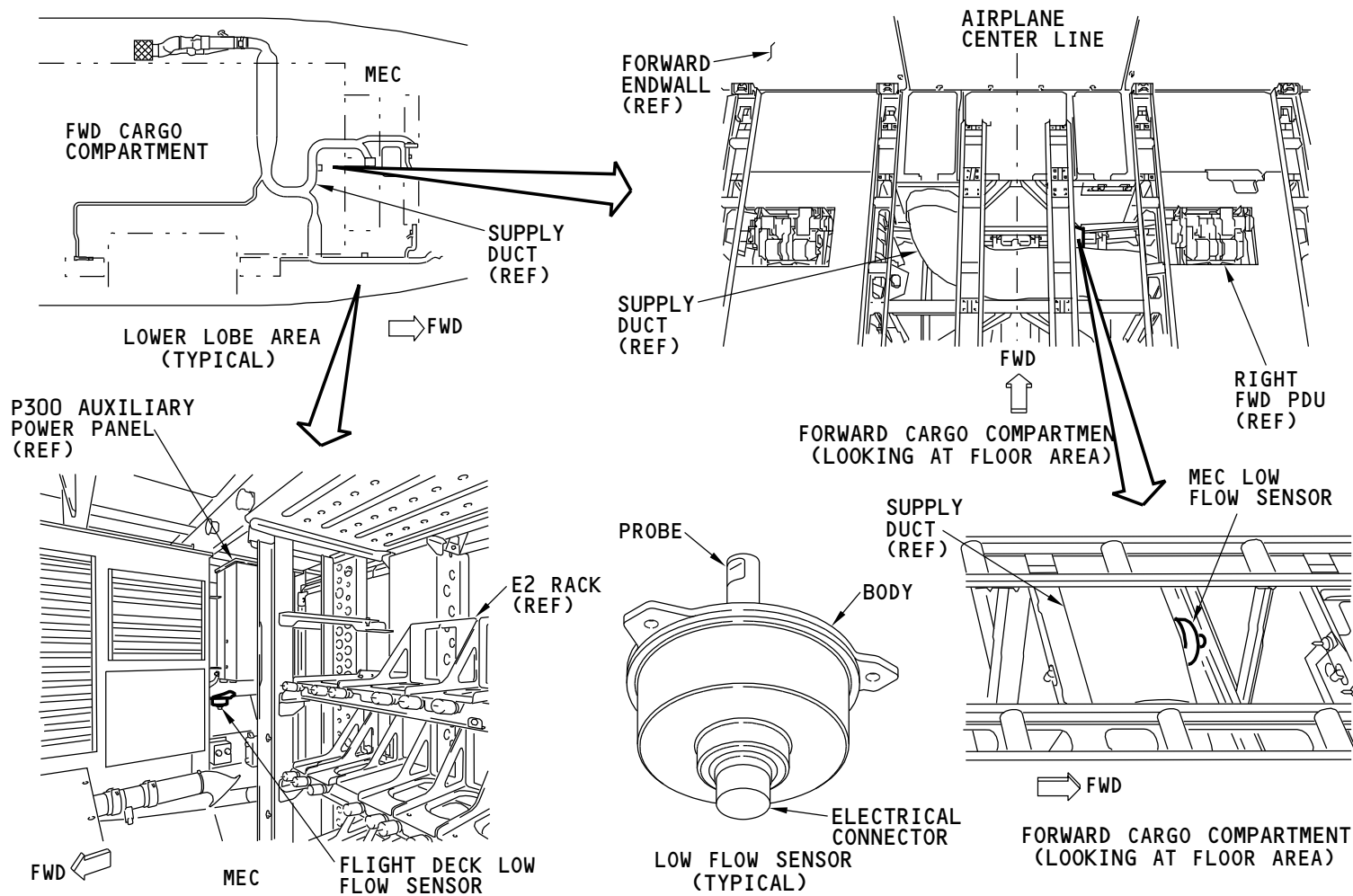
Location

The flight deck low flow sensor is in the MEC. The sensor is below and outboard of the forward corner of the P300 auxiliary power panel.

The MEC low flow sensor is in the forward cargo compartment below the floor. The sensor is inboard of the forward right powered drive unit.

Remove the floor panel inboard of the right forward powered drive unit (PDU) to get access to the MEC low flow sensor.

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A/C - EQUIPMENT COOLING - LOW FLOW SENSORS

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**A/C - EQUIPMENT COOLING - CONVERTER SUPPLEMENTAL COOLING CHECK VALVE (VSCF)****Purpose**

The converter supplemental cooling check valve makes sure the air from the converter supplemental cooling fan goes to E4-4 shelf and does not go into the equipment cooling supply duct.

Physical Description

The check valve is a flapper-type valve. The valve is spring-loaded to the closed position.

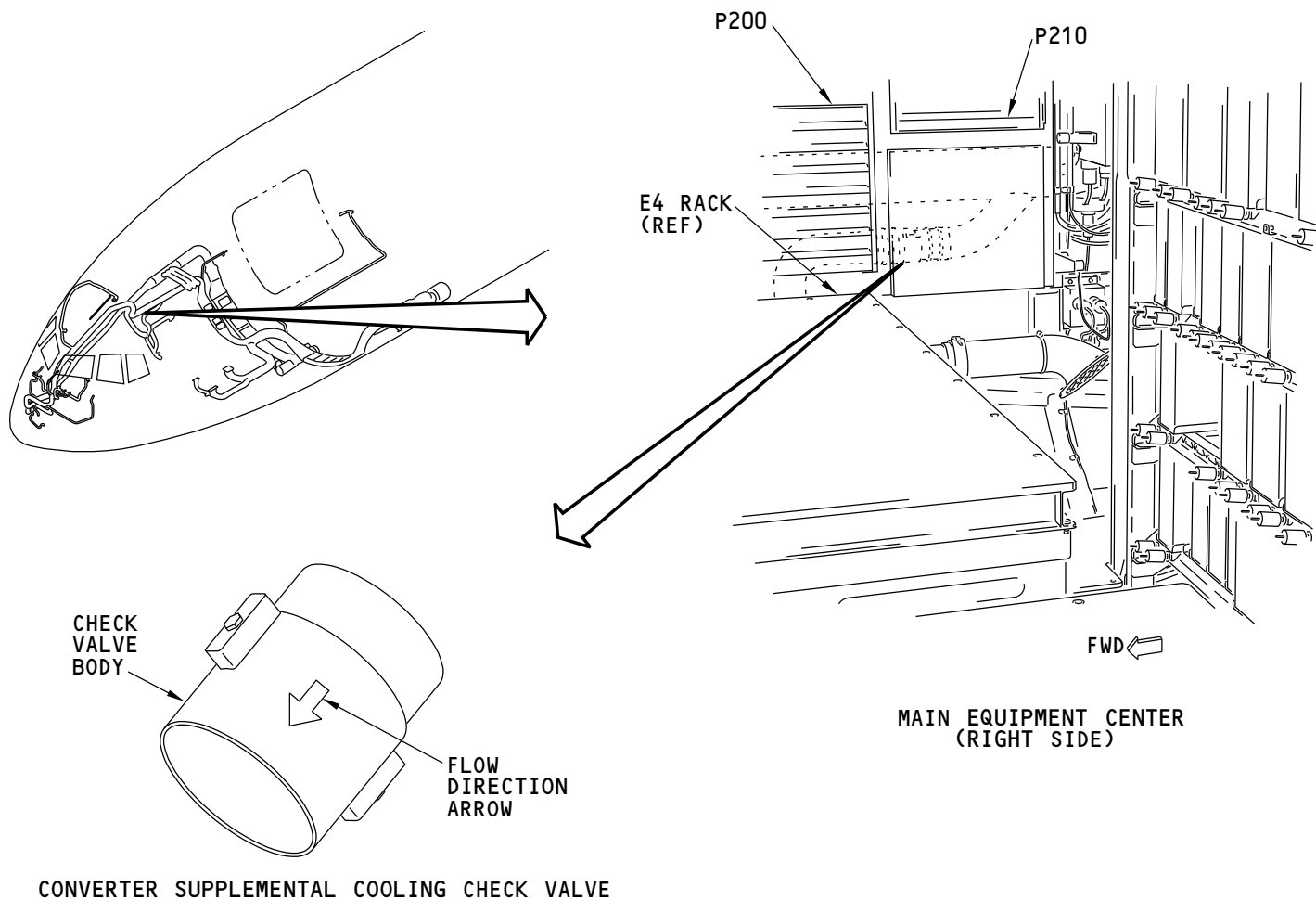
Location

The check valve is on the right side of the MEC behind the P210 panel. The valve is in the supply duct that gives air to the E4-4 shelf.

Training Information Point

The check valve has an air flow direction arrow on the valve to help you install the valve correctly.

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A/C - EQUIPMENT COOLING - CONVERTER SUPPLEMENTAL COOLING CHECK VALVE (VSCF)

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A/C - EQUIPMENT COOLING - VENT FAN**Purpose**

The vent fan pulls air from the vent part of the forward equipment cooling system to give cooling. It sends the air to the forward cargo heat valve and the vent valve.

Physical Description

The vent fan has these components:

- Stator housing assembly
- Check valve (not shown)
- Electrical connector
- Electric motor (not shown)
- Inlet housing assembly.

Location

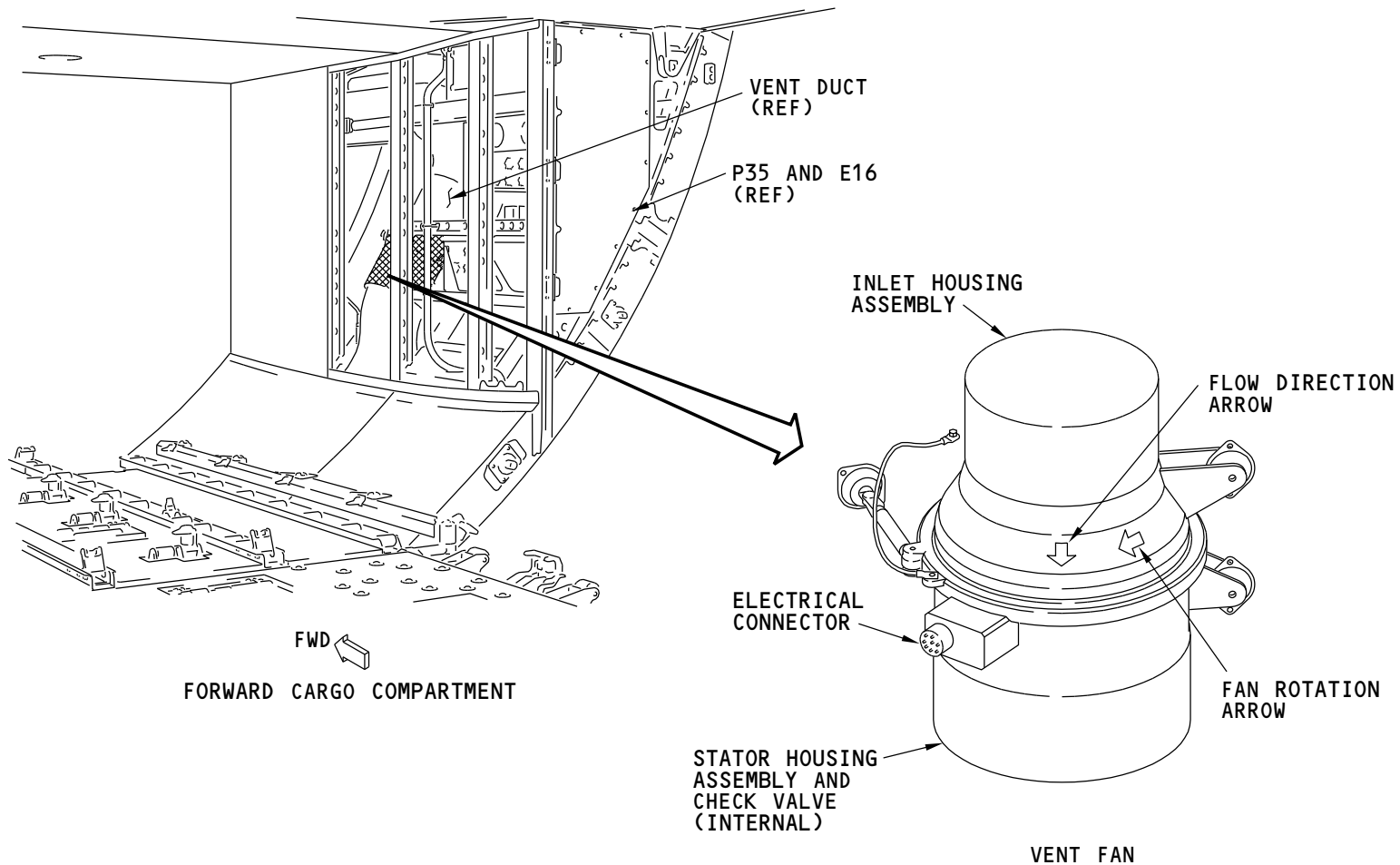
The vent fan is in the forward cargo compartment forward of the P35 and the E16 rack in the right sidewall area.

Training Information Point

Remove the sidewall panel to get access to the vent fan.

The vent fan has an air flow direction arrow on the fan to help you install the fan correctly.

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A/C - EQUIPMENT COOLING - VENT FAN

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A/C - EQUIPMENT COOLING - VENT VALVE AND FORWARD CARGO HEAT VALVE**Purpose**

The vent valve lets equipment cooling vent (exhaust) air go to the area near the forward pressurization outflow valve.

The forward cargo heat valve lets equipment cooling vent (exhaust) air flow to the forward cargo compartment.

Install the valves with the manual override knob or the manual override lever up. This permits better access to the knob or lever.

The valves are not interchangeable.

Physical Description

The vent valve has these components:

- Valve body
- Electrical connector
- Actuator
- Position indicator
- Manual override knob.

The diameter of the vent valve body is nine inches (23 cm).

The forward cargo heat valve has these components:

- Valve body
- Electrical connector
- Motor
- Position indicator/manual override lever.

The diameter of the heat valve body is seven inches (17.8 cm).

Location

The valves are in the floor area of the forward cargo compartment. The vent valve is forward of the ball panels, below the forward left powered drive unit.

The forward cargo heat valve is below the forward center ball panel.

Training Information Point

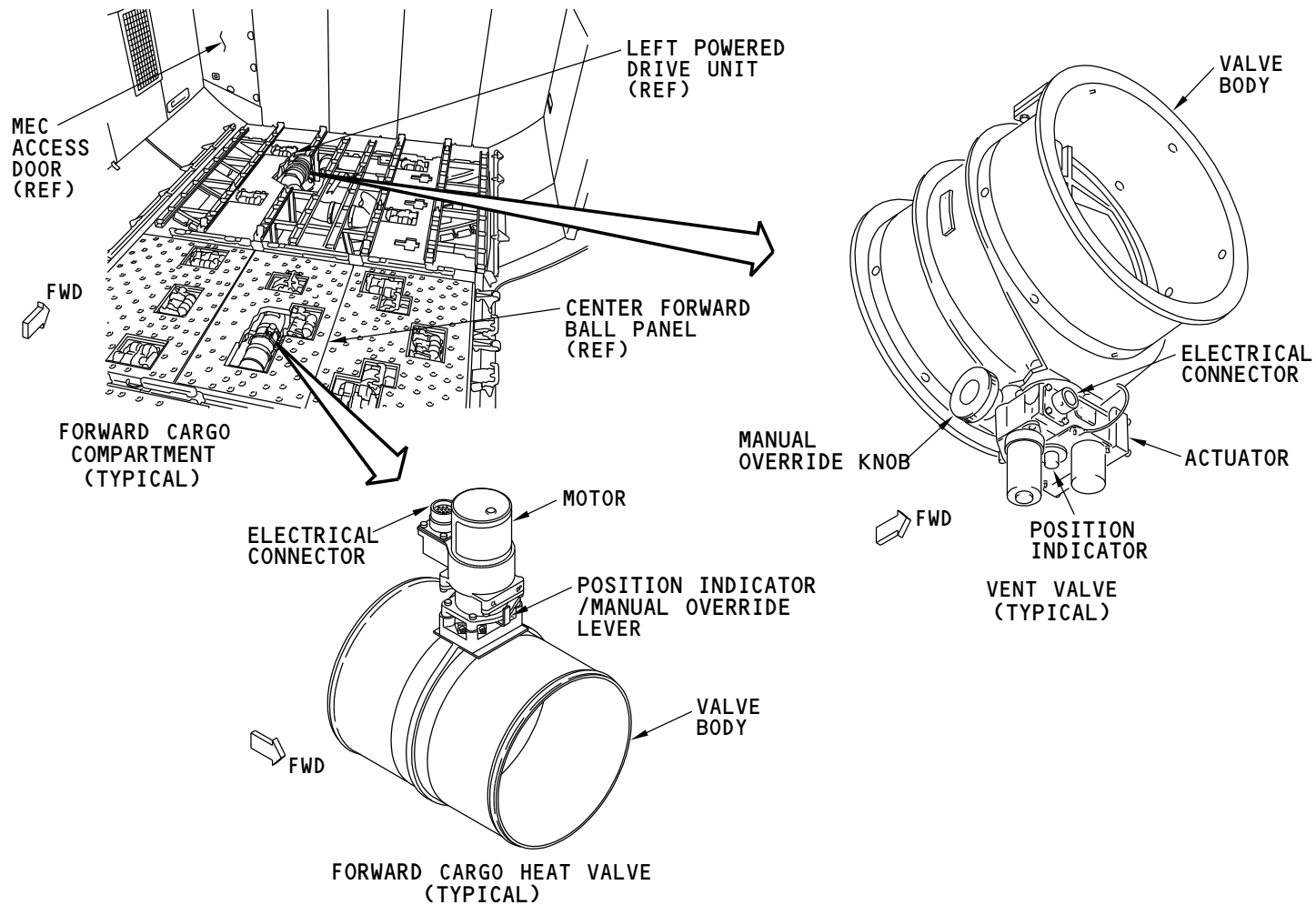
Remove the floor panel inboard of the left forward powered drive unit to get access to the vent valve.

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A/C - EQUIPMENT COOLING - VENT VALVE AND FORWARD CARGO HEAT VALVE

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**A/C - EQUIPMENT COOLING - EQUIPMENT DIVERT VALVE****Purpose**

The equipment divert valve lets equipment cooling exhaust air go to the equipment cooling vent duct.

Physical Description

The equipment divert valve has these components:

- Electrical connector
- Position indicator
- Actuator
- Manual override knob
- Valve body.

The diameter of the valve body is nine inches (23 cm).

Location

The valve is in the floor area of the forward cargo compartment, forward of the center ball panel.

Training Information Point

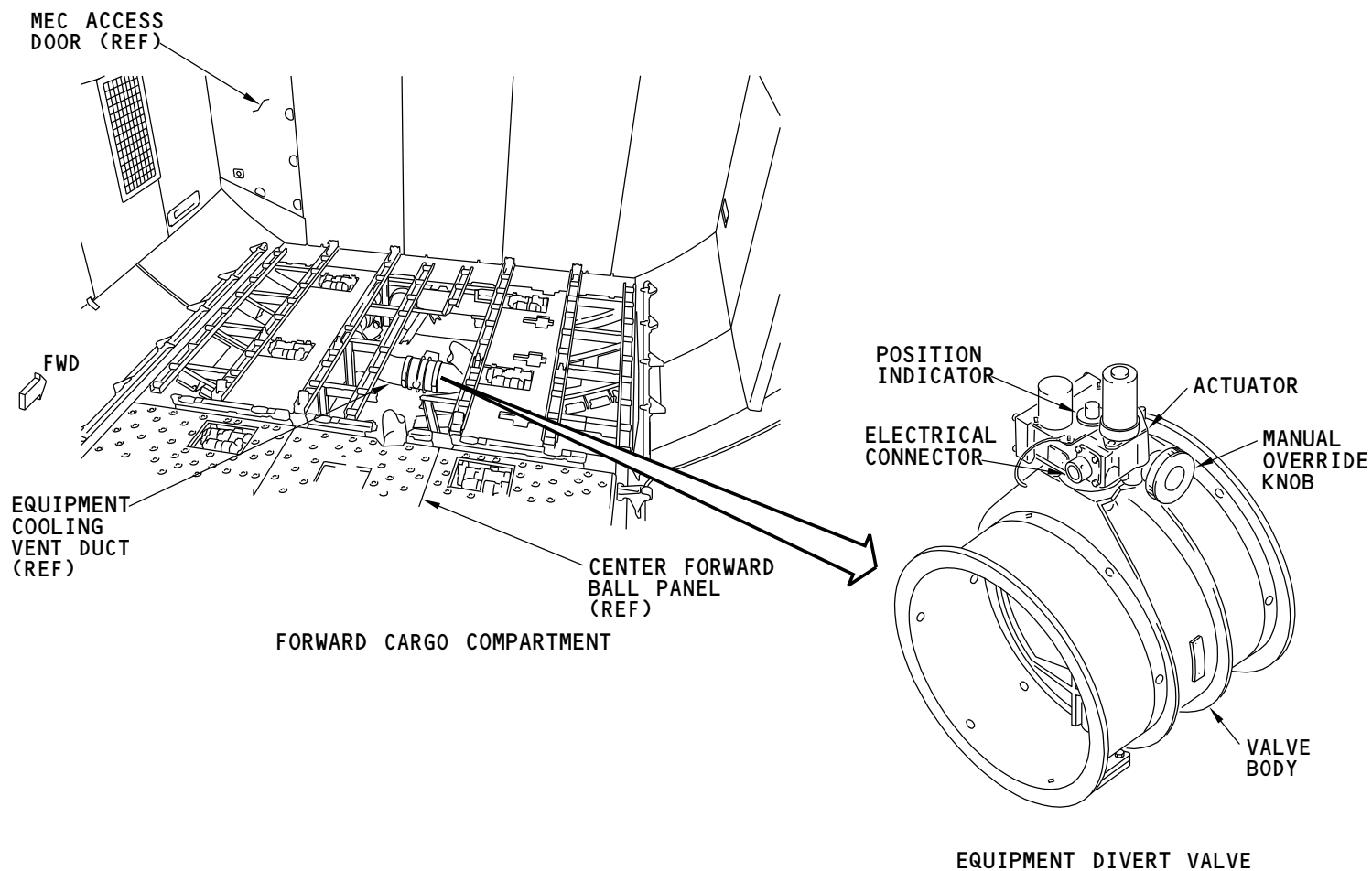
Remove the floor panel forward of the center ball panel to get access to the valve.

The valve is interchangeable with the equipment cooling vent valve (not shown).

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A/C - EQUIPMENT COOLING - EQUIPMENT DIVERT VALVE

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**A/C - EQUIPMENT COOLING - EQUIPMENT INBOARD VALVE****Purpose**

The equipment inboard valve lets equipment cooling vent (exhaust) air go to the mix bay area near the lower recirculation fans.

Physical Description

The equipment inboard valve has these components:

- Valve body
- Electrical connector
- Motor
- Position indicator/manual override lever.

The diameter of the vent valve body is seven inches (17.8 cm).

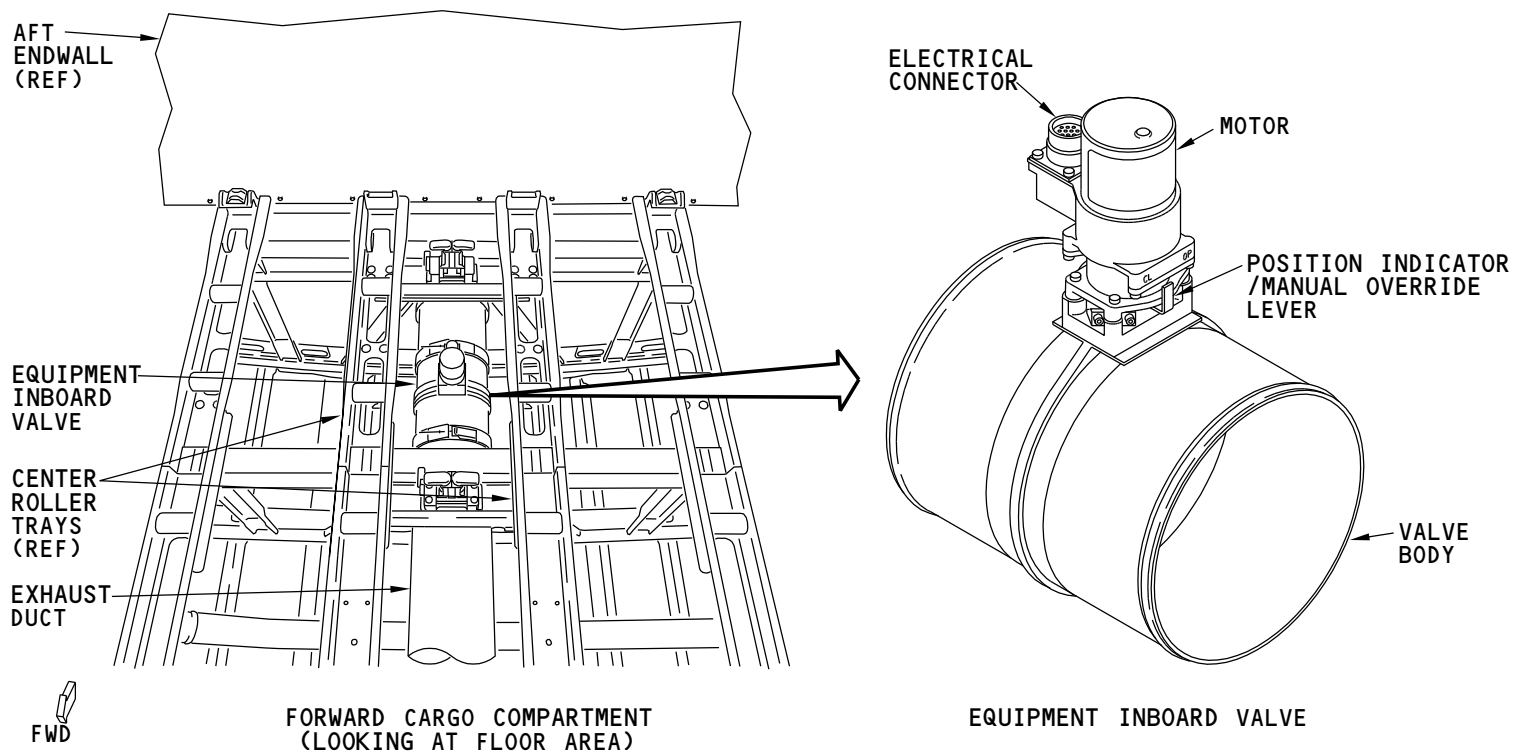
Location

The equipment inboard valve is in the floor area of the forward cargo compartment. The valve is in center part of the floor area, near the aft endwall.

Training Information Point

Remove the floor panel forward of the aft endwall to get access to the valve.

The valve is interchangeable with the forward cargo heat valve (not shown).



A/C - EQUIPMENT COOLING - EQUIPMENT INBOARD VALVE

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A/C - EQUIPMENT COOLING - DUCTING

General

The equipment cooling system has these ducts:

- Supply ducts
- Smoke clearance duct
- Exhaust ducts
- Vent duct

The supply ducts give cabin air to equipment and areas that need blow-through cooling.

The smoke clearance duct moves smoke from the supply part of the system or vents the system for differential cooling when necessary.

The exhaust ducts move air from equipment and areas that need pull-through cooling.

The vent duct moves air from the exhaust duct to the area next to the forward pressurization outflow valve.

Physical Description

There are different types of equipment cooling ducts. Some are flexible and some are rigid. The ducts can have different shapes; round, oval, and rectangle.

Location

The supply ducts are in these locations:

- Forward cargo compartment, left sidewall area
- Forward cargo compartment, under the floor area
- Forward cargo compartment, right sidewall area
- Main equipment center (MEC)
- Forward equipment center (FEC)
- Flight deck (not shown).

The smoke clearance duct is in the left sidewall area of the forward cargo compartment.

The exhaust ducts are in these locations:

- Flight deck (not shown)
- Forward equipment center (FEC)
- Main equipment center (MEC)
- Forward cargo compartment, right sidewall area
- Forward cargo compartment, under the floor area.

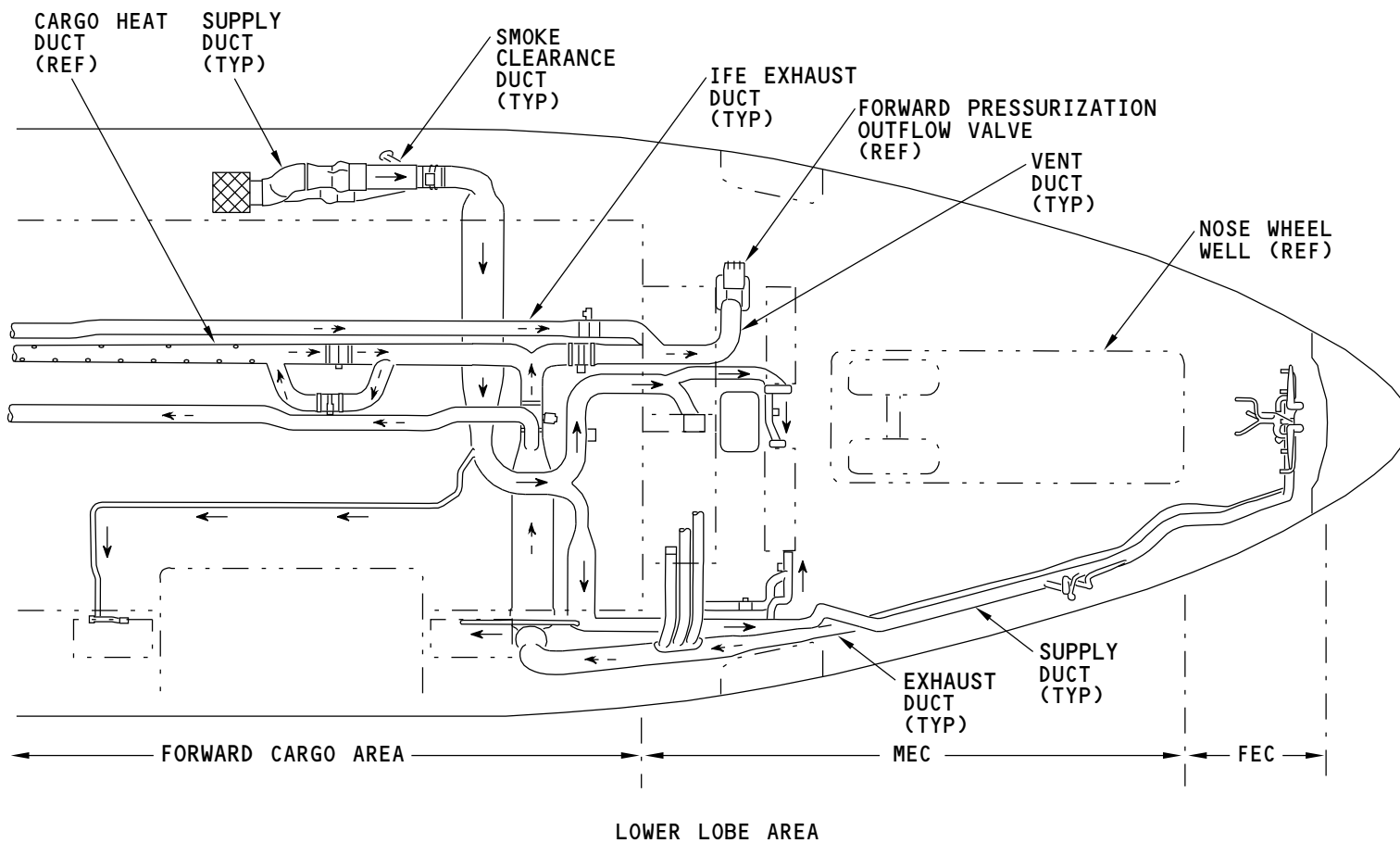
The vent duct is under the floor of the forward cargo compartment and the MEC.

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A/C - EQUIPMENT COOLING - DUCTING

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**A/C - EQUIPMENT COOLING - CONTROLLER****Purpose**

The equipment cooling controllers (ECC) supply control of the supply fans and the override valve.

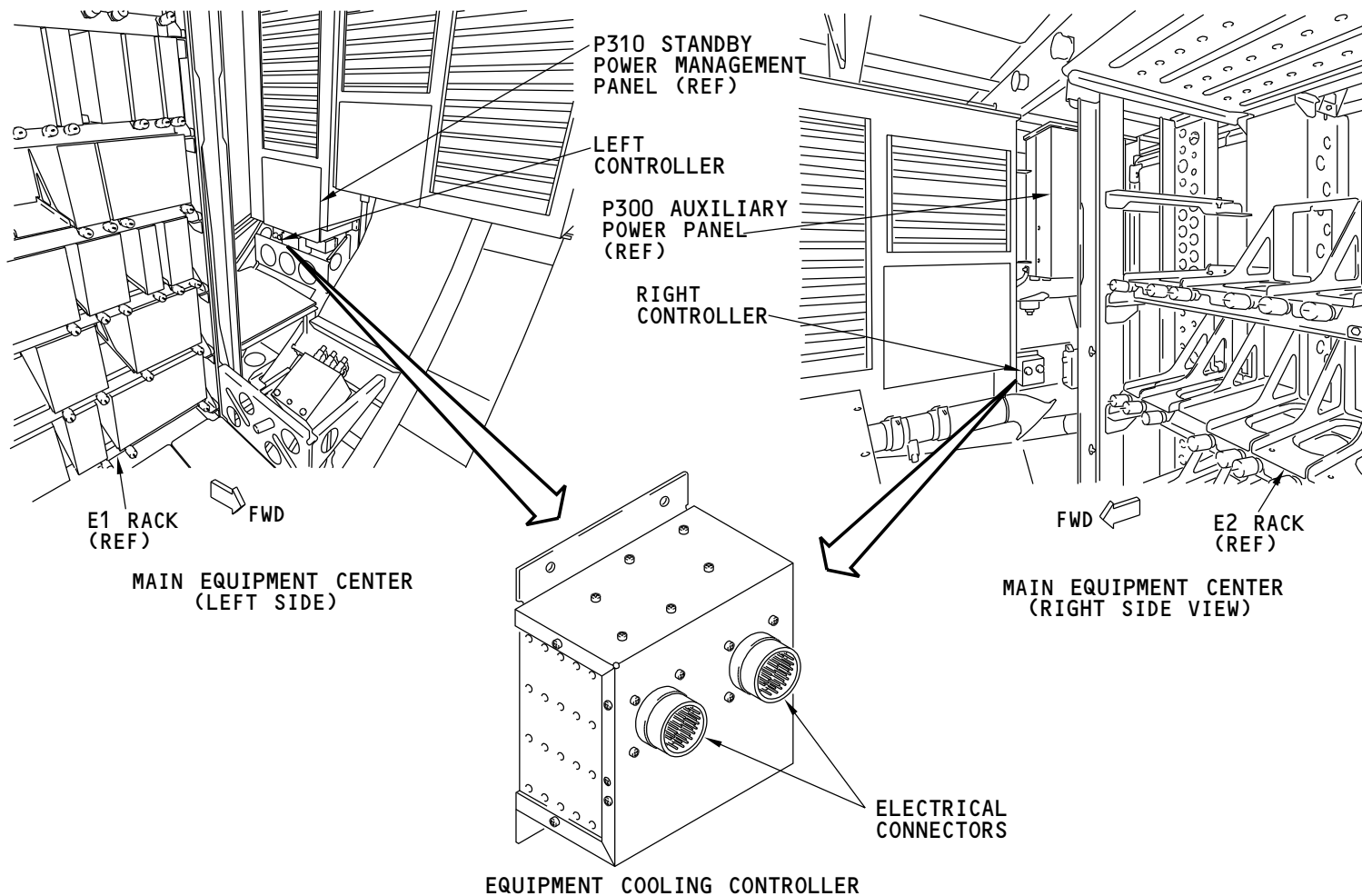
Location

Both controllers are in the main equipment center (MEC). The left controller is below the P310 standby power management panel. The right controller is below the P300 auxiliary power panel.

Physical Description

The controllers are identical, solid state units. Each ECC has two independent channels, one for supply fan control and one for override valve control. The controllers have two electrical connectors.

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A/C - EQUIPMENT COOLING - CONTROLLER

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - LOW FLOW SENSORS**General**

The sensors calculate when the flow of air is below the amount necessary to cool the electrical and electronic equipment.

The flight deck (F/D) low flow sensor sends low flow information to the right ECC and to the right ECSMC. The sensor sends air temperature information to the right ECSMC.

The main equipment center (MEC) low flow sensor sends low flow information to the left ECC and to the left ECSMC. The sensor air temperature information to the left ECSMC.

Power

The sensors get power from the P210 right power management panel and the P310 standby power management panel.

ECC

The ECCs use low flow information in their takeover control logic. See the section on the controller for more information how the ECCs use low flow information.

The ECCs share low flow information through a cross talk connection.

ECSMC

The ECSMC in control uses the flow and temperature information to make low flow override mode signals and low flow indication signals.

The left and right ECSMCs share the signals for low flow and give it to the AIMS and the P310 standby power management panel through the ARINC 629 buses. The low flow logic is different when the airplane is on the ground than when it is in the air.

On the ground, only the low flow indication signal goes to the AIMS and P310. The cards do not give the low flow override mode signal on the ground. The override mode needs the airplane to be pressurized for it to cool the equipment. The low flow indication signal is sent if any of these conditions occur for more than five minutes:

- F/D or MEC duct air temperature more than 136F (58C)
- F/D or MEC duct air flow is low.

In the air, both the low flow indication signal (5 minute delay) and low flow override mode signal (60 second delay) are sent if all of these conditions occur:

- F/D air flow is low or the F/D sensor circuit has a malfunction
- MEC air flow is low or the MEC sensor circuit has a malfunction.

Flight Deck Indication

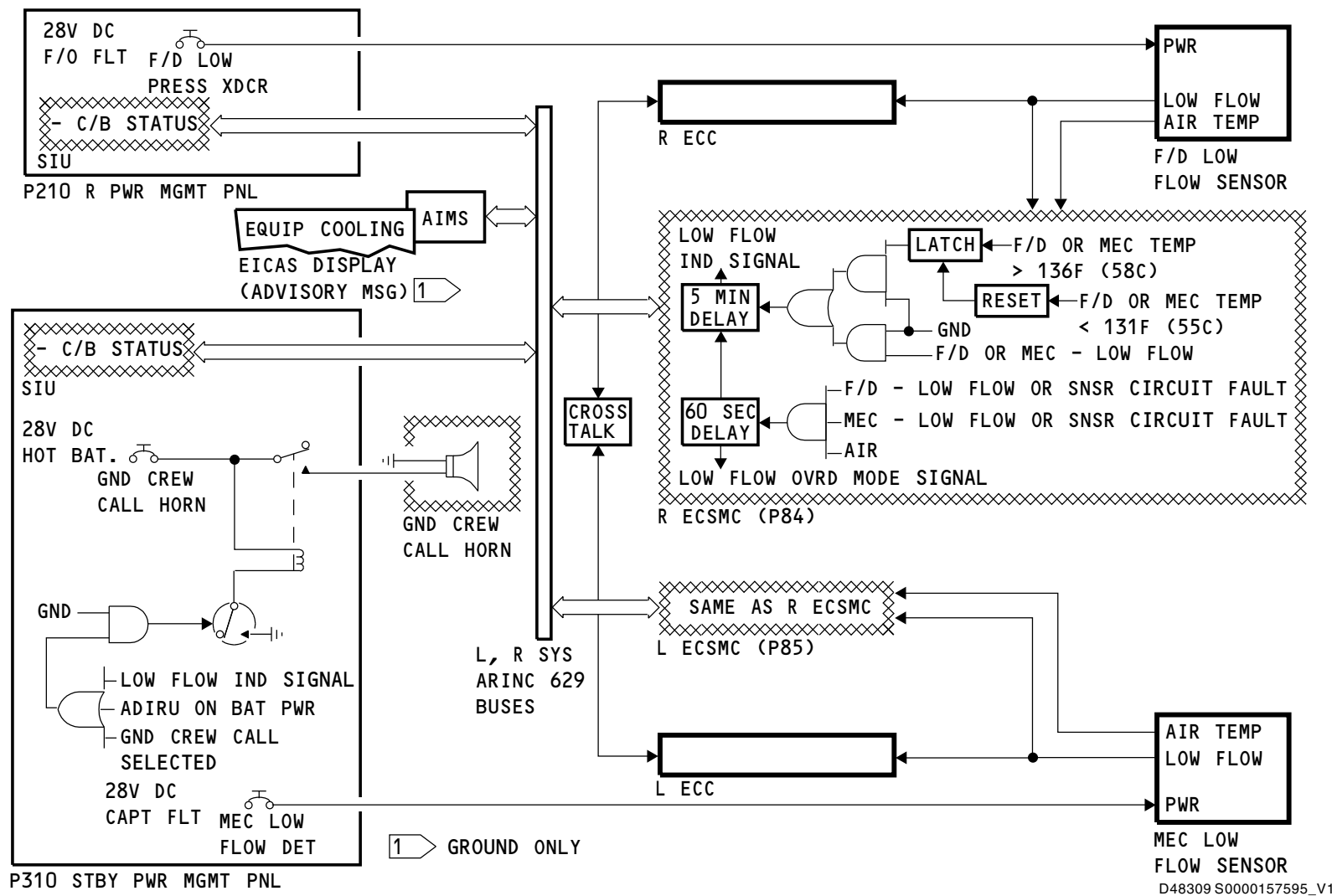
The low flow indication signal causes the EQUIP COOLING advisory message. The advisory message is inhibited in the air.

If a sensor fails, status messages show to tell you which sensor has a malfunction.

Ground Crew Call Horn

The ground crew call horn operates if the airplane is on the ground and any one of these conditions occur:

- Low flow - indication
- ADIRU on battery power
- Ground crew call selected (center CDU or flight deck hand set).



A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - LOW FLOW SENSORS

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Page 66
May 05/2015

A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - OVERRIDE MODE

General

The ECSMCs control the override (OVRD) mode. The card in control puts the forward equipment cooling system into the override mode. The override mode occurs if any of these conditions occur:

- The left and right supply fans failed off and the airspeed is more than 150 knots
- LOW FLOW - OVRD MODE signal when the airspeed is more than 150 knots
- Smoke alarm from the equipment cooling smoke detector
- Forward cargo fire switch in the ARMED position
- Equipment cooling switch in the OVRD position.

Supply Fans Malfunction

The ECSMC in control latches the system to the override mode if the airspeed is more than 150 knots and the two supply fans are off because of a malfunction.

For more information on the supply fans, see the functional description of the supply fans in this section.

Low Air Flow

The ECSMCs use special logic to find a low air flow condition. See the section on the low flow sensors for more information. If a LOW FLOW - OVRD MODE signal occurs and the airspeed is more than 150 knots, the ECSMC in control latches the system to the override mode.

Smoke Alarm

The ECSMC in control latches the system to the override mode if it gets a smoke alarm signal from the equipment cooling smoke detector.

Reset

The latch caused by the failure of both supply fans or the LOW FLOW - OVRD MODE signal or a smoke alarm resets if the condition that caused it goes away and any of these conditions occur:

- Airspeed is less than 70 knots
- Nose gear compressed (PSEU 2)
- Power cycled off then to on
- Forward cargo fire switch in the ARMED position
- Equipment cooling switch in the out position.

Forward Cargo Fire Switch Set to ARMED

The ECSMC in control puts the system into the override mode when the forward cargo fire switch is in the ARMED position. The system stays in this mode as long as the switch is set to ARMED.

Equipment Cooling Switch to Out

The ECSMC in control puts the system into the override mode when the equipment cooling switch is set to the out position. The system stays in this mode as long as the switch is in the out position.

Override Mode

The override mode causes the forward part of the equipment cooling system to make these changes:

- Both supply fans and the vent fan go to off
- The override valve goes to the OVRD position
- Forward cargo heat valve closes (except low flow does not effect the valve position)
- The bulk cargo ventilation fan goes off (only if the equipment cooling switch is in the OVRD position)

**A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - OVERRIDE MODE**

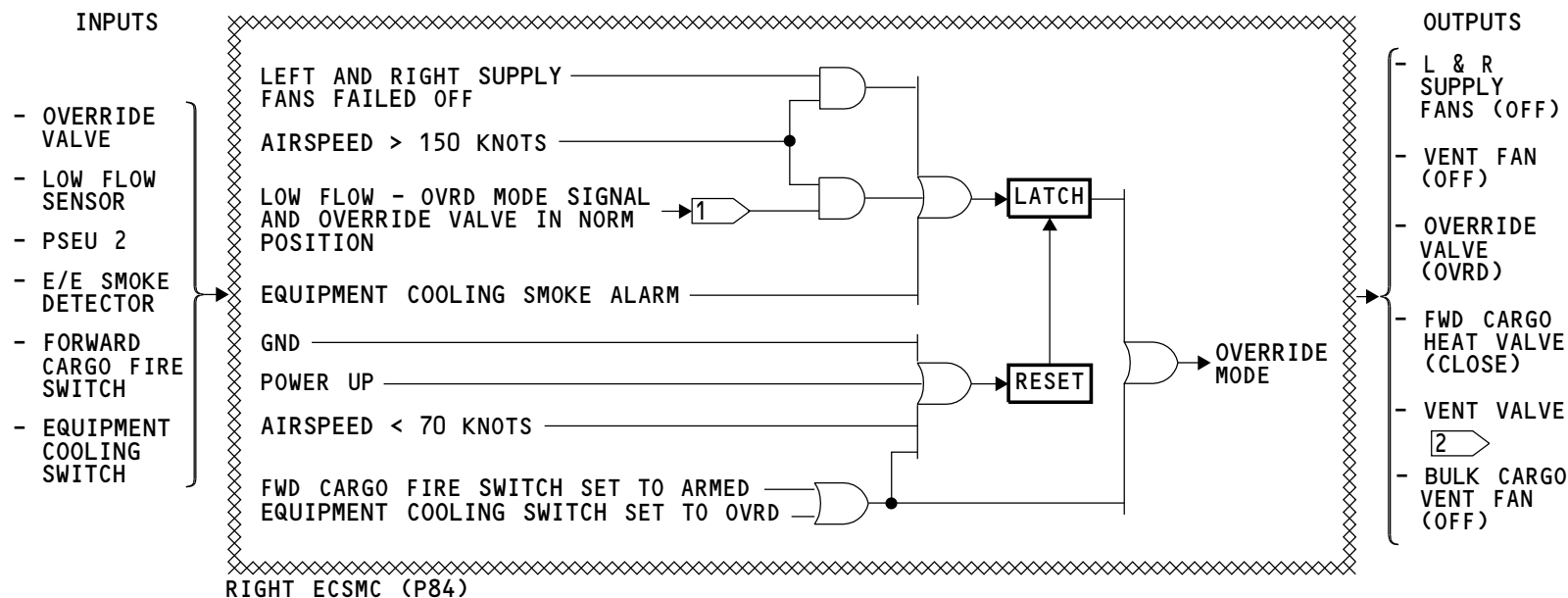
- The ECSMCs use special logic to control the position of the vent valve for the override mode. See the functional description of the forward cargo heat and vent valves in this section for more information about vent valve control logic.

The LOW FLOW - OVRD MODE signal applies only to the supply fans, vent fan, and the override valve. The signal does not effect the operation of the forward cargo heat valve or the vent valve.

Flight deck effects that relate to the override mode are controlled by the position of the override valve. When the valve is in the override position, these flight deck effects show:

- OVRD light in the override switch
- EQPT COOLING OVRD advisory message.

If the override valve does not go the override position, the flight deck effects for the override mode do not show. See the functional description of the override valve in this section for more information about the override valve.



NOTE: RIGHT ECSMC SHOWN, LEFT SIMILAR.

1 THIS CONDITION APPLIES TO L & R SUPPLY FANS, VENT FAN, AND OVERRIDE VALVE. DOES NOT EFFECT THE FWD CARGO HEAT VALVE OR THE VENT VALVE.

2 THE FWD CARGO FIRE SW AND THE FWD CARGO A/C SW EFFECT VALVE POSITION. SEE THE FUNCTIONAL DESCRIPTION OF THE FORWARD CARGO HEAT AND VENT VALVES IN THIS SECTION FOR MORE INFORMATION ABOUT VENT VALVE CONTROL LOGIC.

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - OVERRIDE MODE

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - CONTROLLER

General

Control logic for the right equipment cooling controller (ECC) is shown; the left is similar.

The right ECC gives control for the supply fans and the override valve. The ECC normally controls the fans and valve with inputs from the right or left ECSMC. The ECC does not use the inputs from the ECSMC if takeover control logic (see below) is true.

Inputs

The right ECC gets control power from the P210 right power management power. The controller gets inputs from these components for takeover control logic and to control the fans and the valve:

- Right ECSMC
- Left ECC, L ECSMC and MEC low flow sensor through the ECC cross talk
- PSEU 2
- Flight deck low flow sensor.

The controller uses the inputs to calculate if it should control the fans and override valve. It can use ECSMC inputs for normal control, or it can takeover control and use ECC fan/valve control logic.

Takeover Control Logic

The ECC takes control away from the ECSMCs when the airplane is in the air and any one of the following sets of conditions occur:

- Both ECSMCs try to control the fans and valve at the same time and both ECCs operate normally
- Left ECC is failed or there is low flow in the MEC supply duct and in the flight deck supply duct and the override valve is in the NORM position for more than 6.5 minutes
- Left ECC is failed or there is low flow in the MEC supply duct and in the flight deck supply duct and the override valve is in the OVRD position for more than 20 minutes.

Once the controller takes control it will not return control to the ECSMCs until the airplane is on the ground.

ECC Fan/Valve Control Logic

The controller uses the ECC fan/valve control logic to make the low flow condition go away. The controller uses a combination of supply fans on/off and override valve positions to do this. There are six combinations (modes). The controller tries each mode for 60 seconds. After 60 seconds the controller will try the next mode. If the low flow goes away the controller stays in that mode. If the low flow condition returns, the controller will select the next mode. After all modes have been tried, the controller starts over with mode 1. These are the six sets of modes:

- Left supply fan off, right supply fan off, and left override valve motor selected to the OVRD position
- Left supply fan off, right supply fan off, and right override valve motor selected to the OVRD position
- Left supply fan on, right supply fan off, and left override valve motor selected to the NORM position
- Left supply fan on, right supply fan off, and right override valve motor selected to the NORM position
- Left supply fan off, right supply fan on, and left override valve motor selected to the NORM position
- Left supply fan off, right supply fan on, and right override valve motor selected to the NORM position.

Outputs

The ECC controls the supply fans and the override valve through separate control channels. The right ECC sends output control signals to these items:

- Right supply fan ON/OFF (through the P100 left power panel)
- Selection of which override valve motor to use (through the P310 standby power management panel)
- Control of the position (OVRD/NORM) of the right motor in the override valve (through the P310 standby power management panel).

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - CONTROLLER

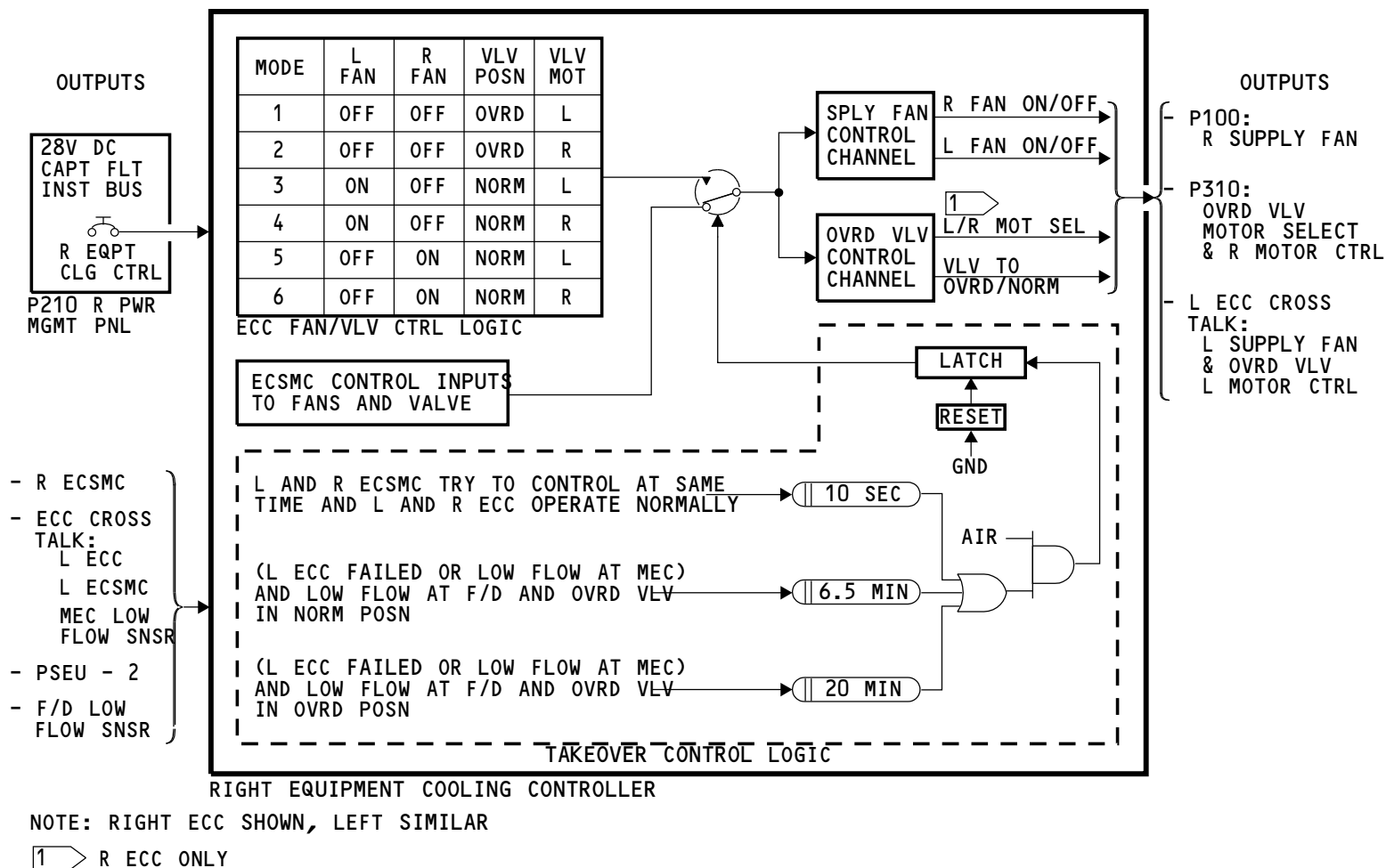
- Left supply fan ON/OFF and left motor of the override valve OVRD/NORM position (through the left ECC cross talk)

The left ECC outputs are similar except it does not control which motor of the override valve to use.

Fault Indication

Status messages show if a controller has a malfunction.

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - CONTROLLER

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - SUPPLY FANS

General

Only one of the two fans operate at a time. The right fan is primary and the left fan is the backup. Each time the airplane gets power, the right ECSMC does a test of the left fan. The right fan is set to off and the left fan is set to on. At the end of the test of the left fan, it is set to off and the right fan is set to on and tested.

The right ECSMC gives primary control of the supply fans when the airplane gets power and the left card gives backup control. When the airplane changes from air to ground, the card in control changes.

Supply Fan Control

The ECSMCs control through the right and left ECCs and the right and left power panels. Either card can control both fans. For example, these signals occur when the right card wants to turn on the left fan:

- Right ECSMC sends FAN ON signal to right ECC
- Right ECC sends FAN ON signal to left ECC (cross talk)
- Left ECC sends FAN ON signal to left power panel
- Left power panel turns on the left fan if no overcurrent condition is detected.

Both cards get information about the left and right fan overheat switches either directly from the fan or from the other card through the ARINC 629 buses.

During ground test the fans operate in the ground test sequence. See the section on equipment cooling - ground test for more information.

During normal conditions, the right fan operates if none of these conditions are true:

- System commanded to override
- Override valve in the override position
- ELMS detected fault conditions (no power, open circuit breaker, overcurrent, no current, or failed relay)
- Supply fan motor overheat

- Converter supplemental cooling fan (VSCF fan) in test (automatic)
- Ground test - fan off command.

If the right fan stops, the left fan starts automatically.

Fault Indication

Status messages show if a fan or the circuit that controls a fan has a malfunction.

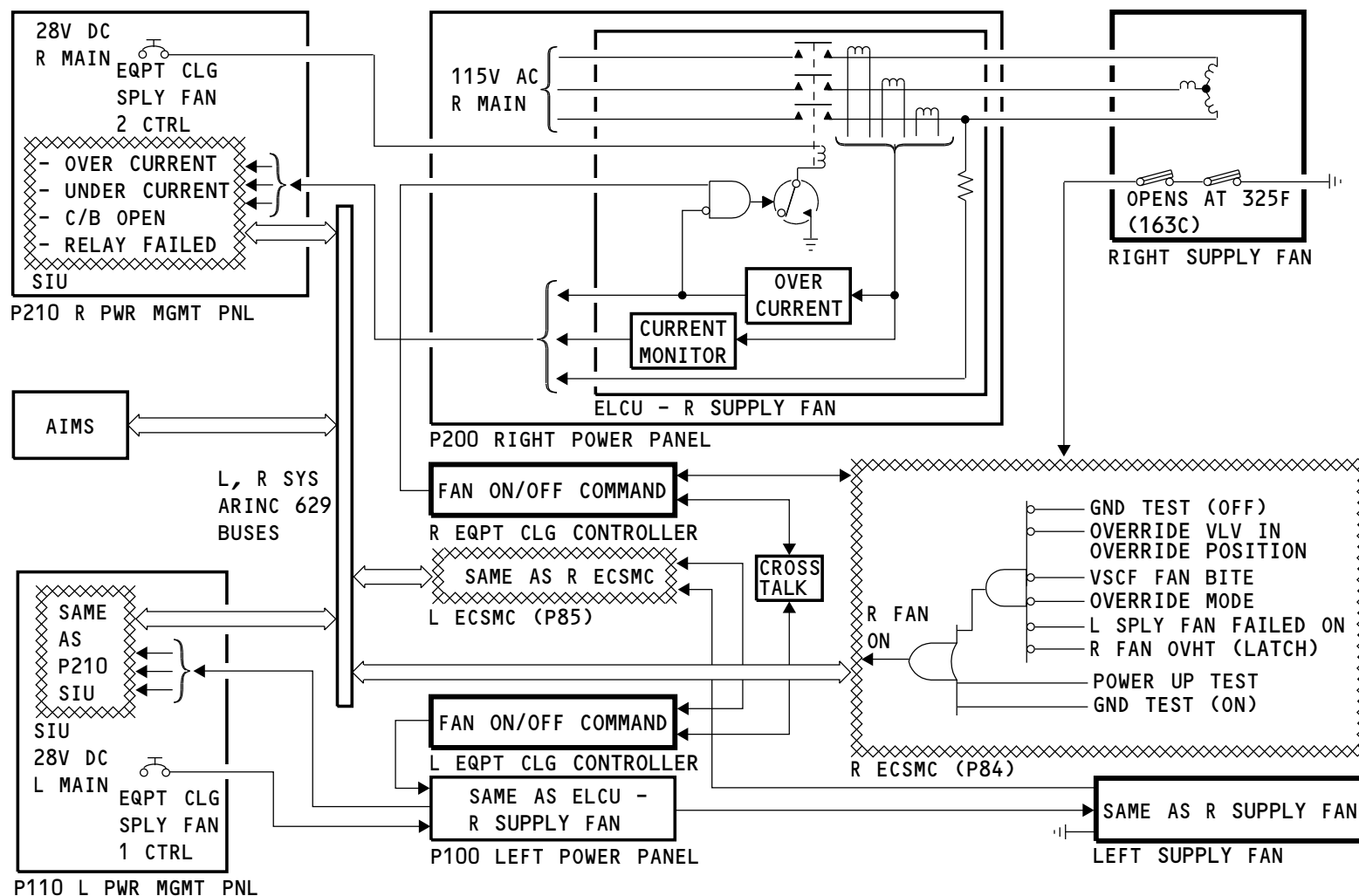
The ECSMCs monitor information from ELMS. This information helps the cards isolate supply fan malfunctions.

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - SUPPLY FANS

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - OVERRIDE VALVE

General

The override valve has two positions: NORM and OVRD. The valve is usually in the NORM position. The override valve has two motors: left and right. Only one motor will operate the valve at a time.

The right ECSMC gives primary control of the override valve when the airplane gets power and the left card gives backup control. When the airplane changes from air to ground, the card in control changes.

Normal Control

The ECSMC controls the primary motor through the left and right equipment cooling controllers and the P310 standby power management panel. Either card can control both motors and can set which motor is primary. For example, these signals occur when the right card wants to set the left motor as primary and make it go to the NORM position:

- The right ECSMC sends L MOTOR PRIMARY and NORM signals to the right ECC
- The right ECC sets the left motor as the primary motor through a relay in the standby power management panel.
- The right ECC sends the NORM signal to left ECC (through cross talk)
- The left ECC sets the override valve to the NORM position through a relay in the standby power management panel
- The standby power management panel gives power so that the left motor moves the valve to NORM.

Limit switches (not shown) in each motor remove power from the motor when the valve gets to the commanded position. The same limit switches give valve position feedback directly to the ECSMCs.

The valve will stay in the NORM position if none of these conditions occur:

- System commanded to override
- Right and left equipment cooling supply fans off
- Ground test command to override.

The override valve relays in P310 standby power management panel are fail safe to make the valve go to the OVRD position. This makes sure the override valve will go the OVRD position if the ECCs or the ECSMCs have a malfunction.

Override Indication

The EQUIP COOLING OVRD advisory message shows and the OVRD light comes on when the equipment cooling override valve is in the OVRD position.

Fault Indication

Status messages show when a motor or the circuit that controls the motor have a malfunction.

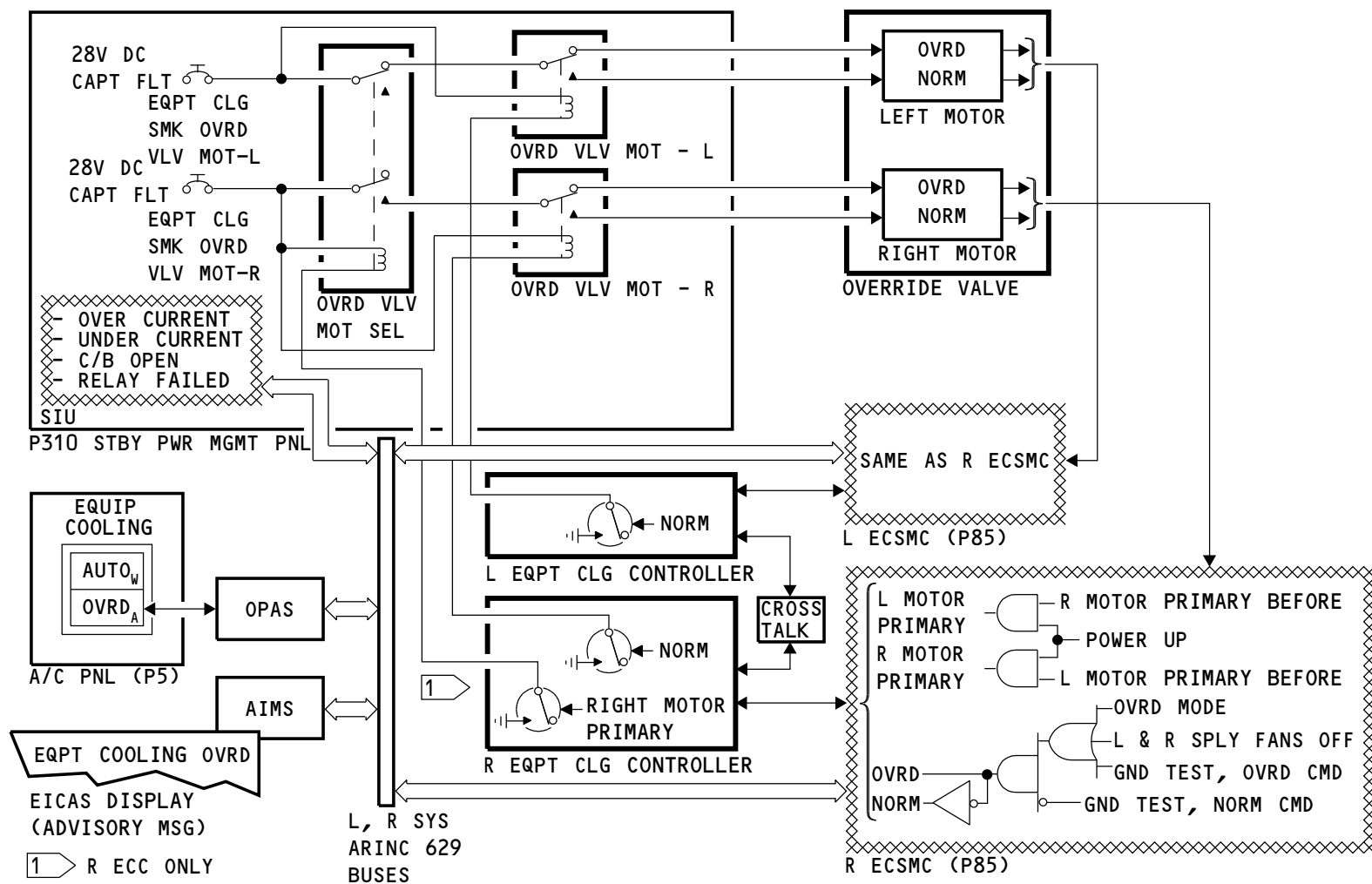
The ECSMCs monitor information from ELMS. This information helps the ECSMCs isolate malfunctions with the override valve.

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - OVERRIDE VALVE

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**A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - DUCT PRESSURE SENSORS****Functional Description**

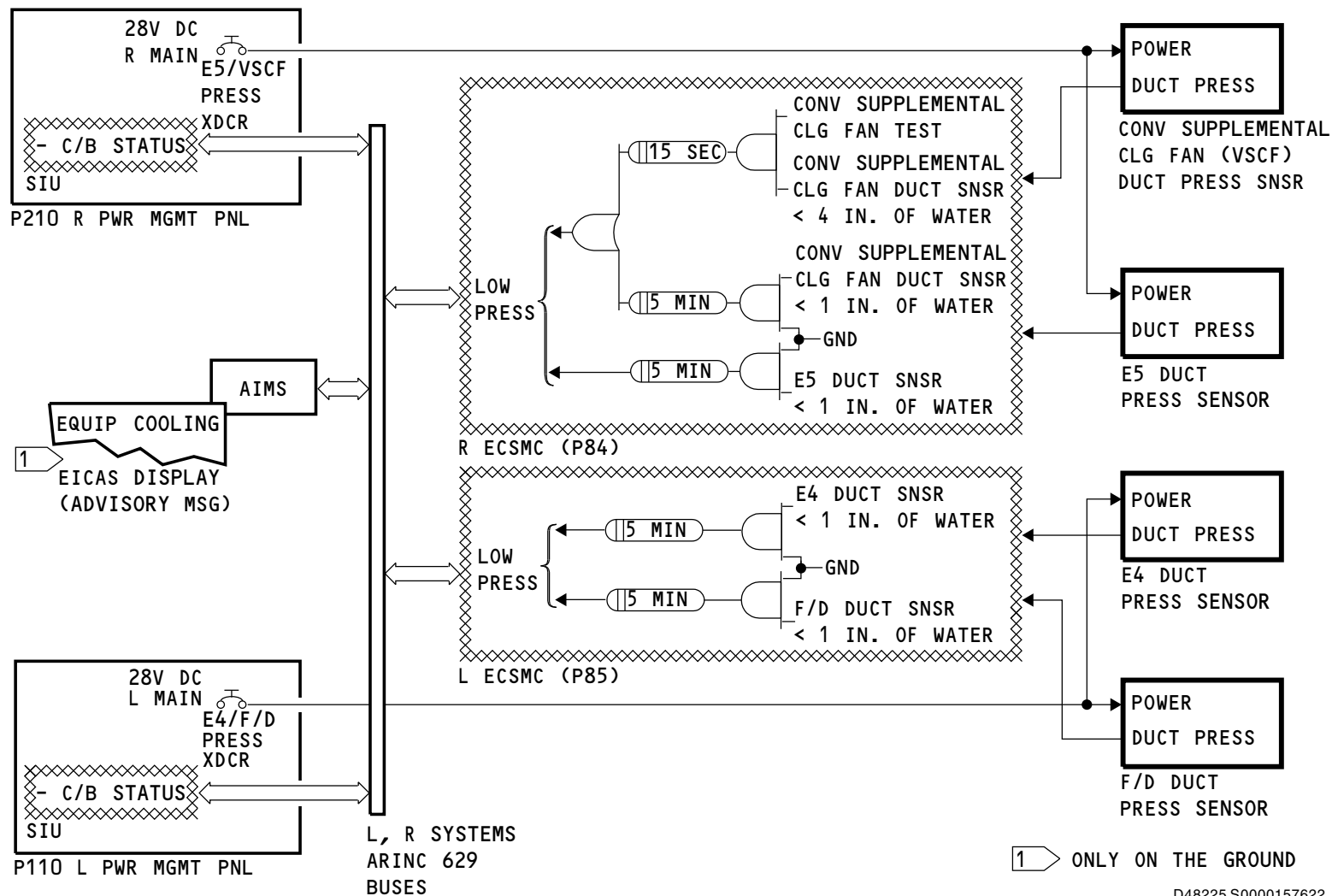
The duct pressure sensors measures the pressure in the equipment cooling ducts. The E5 and converter supplemental cooling fan duct pressure sensors send information to the right ECSMC. The E4 and flight deck duct sensors send information to the left ECSMC. The cards use the low pressure information for indication purposes only.

Low Pressure Indication

The EQUIP COOLING advisory message shows when there is a low pressure condition on the ground for more than five minutes. The advisory message also shows when there is a test of the converter (CONV) supplemental cooling fan and there is a low pressure condition for more than fifteen seconds. There are no flight deck indications for a low pressure condition when the airplane is in the air.

Fault Indication

Status messages show when a sensor has a malfunction.



A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - DUCT PRESSURE SENSORS

**A/C - EQUIPMENT COOLING - VENT FAN - FUNCTIONAL DESCRIPTION****General**

The vent fan gets primary control from the right ECSMC when the airplane gets power and backup control from the left ECSMC. When the airplane changes from air to ground, the card in control changes.

Control

The ECSMCs control the fan through the computing and communications unit (CCU) in the left power management panel and the ELCU in the left power panel. Either card can control the fan. These signals occur when the right card controls the vent fan on:

- The right ECSMC sends a FAN ON CMD signal to the CCU in the left power management panel
- If the CCU does not find a malfunction, it sends a FAN ON CMD signal to the ELCU in the left power panel
- The ELCU turns on the vent fan.

Both cards get information about the fan overheat switches. The left card gets it directly from the fan. The left card shares the information with the right card through the ARINC 629 buses.

During a ground test, the test controls fan on/off control logic. See the section on equipment cooling ground tests for more information on the ground test.

During normal conditions, the fan operates continuously if all of these conditions are true:

- Vent valve or forward cargo heat valve is open
- No vent fan motor overheat
- System is not commanded to OVRD
- Override valve is in the NORM position
- Left or right supply fan is on
- Ground test does not command the fan off
- ELMS does not find a malfunction (no power, open circuit breaker, overcurrent, under current, failed relay).

Fault Indication

Status messages show when a fan motor overheats or the circuit that controls the fan has a malfunction.

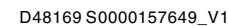
The ECSMCs monitor information from the ELMS. This information helps the cards isolate malfunctions with the vent fan.

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A/C - EQUIPMENT COOLING - VENT FAN - FUNCTIONAL DESCRIPTION

Page 81
May 05/2015

**A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - EQUIPMENT INBOARD VALVE****General**

The ECSMCs give control for the equipment inboard valve.

The right ECSMC gives primary control of the valve when the airplane gets power and the left card gives backup control. When the airplane changes from air to ground, the card in control changes.

The ECSMCs control the equipment inboard valve through a signal interface unit (SIU) in the P210 right power management power. The SIU monitors for these conditions:

- Circuit malfunctions
- Open circuit breakers
- Failed relays
- Valid current.

If the SIU finds no malfunctions and gets an open command, it energizes a relay in the power management panel to open the valve.

The valve has a motor and two sets of limit switches (not shown). One set of switches removes power from the motor when the valve gets to the commanded position. The other set of switches give valve position feedback directly to right ECSMC. The right card supplies valve position data to the left card on the ARINC 629 buses.

Forward Cargo A/C Control Set to AUTO

On the ground with the forward cargo A/C control set to AUTO, the usual position of the equipment inboard valve is closed. The valve can open if there are no inhibits, and any of these conditions occur:

- The equipment divert valve fails closed
- The vent valve fails closed.

In the air with the forward cargo A/C control set to AUTO, the usual position of the equipment inboard valve is open. The valve can close if the equipment divert valve fails open, or there is an inhibit.

Forward Cargo A/C Control Set to OFF

On the ground or in the air with the forward cargo A/C set to OFF, the usual position of the equipment inboard valve is closed. The valve can open if there are no inhibits and any of these conditions occur:

- The equipment divert valve fails closed
- The vent valve and the forward cargo heat valve fail closed.

Inhibits

If any of these conditions occur, the equipment inboard valve is set to closed:

- Smoke is detected by the E/E cooling smoke detector
- The forward cargo fire switch is set to ARMED
- The equipment cooling switch is set to OVRD.

Fail Safe Control

The relay that supplies power to the valve is set so that it always supplies power to close the valve. This makes sure the valve closes if the right and left ECSMCs have malfunctions.

Indication

A status message shows when the valve has a malfunction, or the circuit that controls the valve has a malfunction.

The ECSMCs monitor information from the ELMS. This information helps the ECSMCs isolate malfunctions with the valve.

Training Information Point

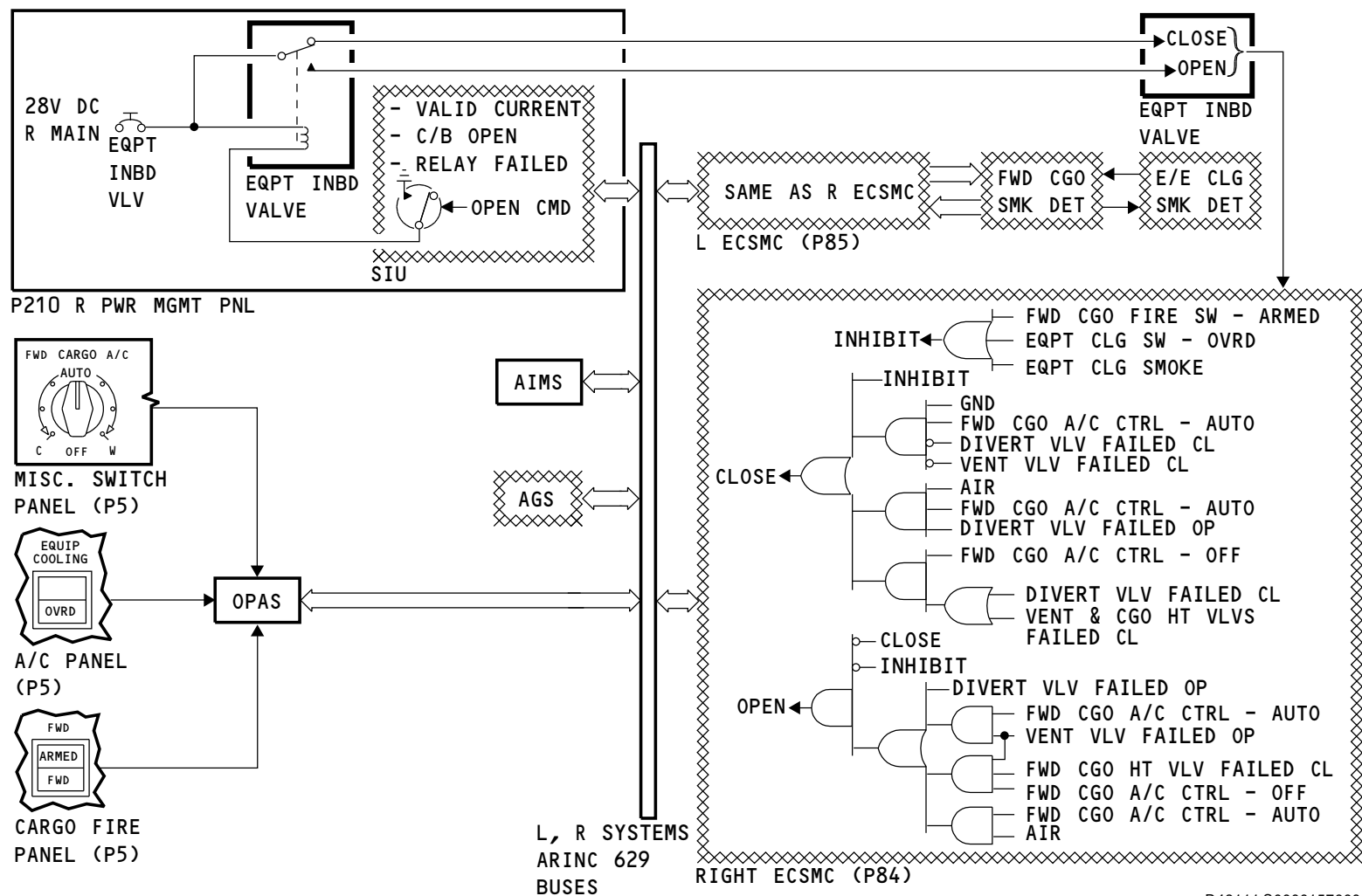
You can use the MAT to do a ground test of the valve.

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - EQUIPMENT INBOARD VALVE

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**A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - EQUIPMENT DIVERT VALVE****General**

The ECSMCs give control for the equipment divert valve.

The right ECSMC gives primary control of the valve when the airplane gets power and the left card gives backup control. When the airplane changes from air to ground, the card in control changes.

The ECSMCs control the equipment divert valve through a signal interface unit (SIU) in the P210 right power management power. The SIU monitors for these conditions:

- Circuit malfunctions
- Open circuit breakers
- Failed relays
- Valid current.

If the SIU finds no malfunctions and gets an open command, it energizes a relay in the power management panel to open the valve.

The valve has a motor and limit switches (not shown). The limit switches remove power from the motor when the valve gets to the commanded position. The switches also give valve position feedback directly to right ECSMC. The right card supplies valve position data to the left card on the ARINC 629 buses.

Forward Cargo A/C Control Set to AUTO

On the ground with the forward cargo A/C control set to AUTO, the usual position of the equipment divert valve is open. The valve can close if there is an inhibit, or if the vent valve fails closed.

In the air with the forward cargo A/C control set to AUTO, the usual position of the equipment divert valve is close.

Forward Cargo A/C Control Set to OFF

On the ground or in the air with the forward cargo A/C set to OFF, the usual position of the equipment divert valve is open. The valve can close if there is an inhibit, or if all of these conditions occur:

- The vent valve fails closed
- The forward cargo heat valve fail closed.

Inhibits

If any of these conditions occur, the equipment divert valve is set to closed:

- Smoke is detected by the E/E cooling smoke detector
- The forward cargo fire switch is set to ARMED
- The equipment cooling switch is set to OVRD.

Fail Safe Control

The relay that supplies power to the valve is set so that it always supplies power to close the valve. This makes sure the valve closes if the right and left ECSMCs have malfunctions.

Indication

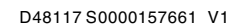
A status message shows when the valve has a malfunction, or the circuit that controls the valve has a malfunction.

The ECSMCs monitor information from the ELMS. This information helps the ECSMCs isolate malfunctions with the valve.

Training Information Point

You can use the MAT to do a ground test of the valve.

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - EQUIPMENT DIVERT VALVE

**A/C - EQUIPMENT COOLING - FWD CGO HT & VENT VLVS - FUNCTIONAL DESCRIPTION****General**

The forward cargo heat valve and vent valve are usually in opposite positions. If the forward cargo heat valve closes, vent valve opens.

The right ECSMC gives primary control of the valves when the airplane gets power, the left card gives backup control. When the airplane changes from air to ground, the card in control changes.

The ECSMCs control the valves through the signal interface units (SIUs) in the P110 left power management power. The SIUs monitor for circuit malfunctions, open circuit breakers, failed relays, and valid current. If an SIU finds no malfunctions and gets an open command, it energizes the appropriate relay in the power management panel to open the related valve.

Limit switches (not shown) in the valves remove power from the valve's motor when the valve gets to the commanded position. Limit switches in the valves give feedback directly to the appropriate ECSMC. The cards supply valve position data to each other on the ARINC 629 buses.

Normal Control - Forward Cargo Heat Valve

On the ground with the forward cargo A/C control set to OFF, the valve usually moves between open and closed as ambient temperature changes. The forward cargo heat valve closes when the temperature at the TAT probe is more than 55F (13C), it opens when the temperature is less than 50F (10C). In the air with the forward cargo A/C control set to OFF, the valve usually stays open. On the ground or in the air with the forward cargo A/C control set to AUTO, the valve stays closed.

On the ground, the forward cargo heat valve will be open unless one of these conditions occurs:

- Smoke is detected by the E/E cooling smoke detector
- Forward cargo fire switch is set to ARMED
- Equipment cooling switch is set to OVRD
- Ambient temperature (TAT) is more than 55F (13C)
- Forward cargo air conditioning control is set to AUTO
- Ground test commands the valve to close.

In the air, the forward cargo heat valve is open unless one of these conditions occurs:

- Forward cargo air conditioning control is set to AUTO
- Smoke is detected by the E/E cooling smoke detector
- Forward cargo fire switch is set to ARMED
- Equipment cooling switch is set to OVRD.

Normal Control - Vent Valve

The usual position of the vent valve changes so that its position is the opposite of the position of the heat valve. For example, when the heat valve is open the vent valve is closed.

The vent valve and the cargo heat valve can both be close if the forward cargo fire switch is set to ARMED.

Both valves can also be close if the forward cargo A/C is set to OFF and any one of these conditions occur:

- Smoke is detected by the E/E cooling smoke detector
- Equipment cooling switch is set to OVRD.

Fail Safe Control

The relays that supply power to the valves are set so that they always supply power to close the valves. This makes sure both valves close if the right and left ECSMCs have malfunctions.

Indication

Status messages show when a valve has a malfunction or the circuit that controls the valves has a malfunction.

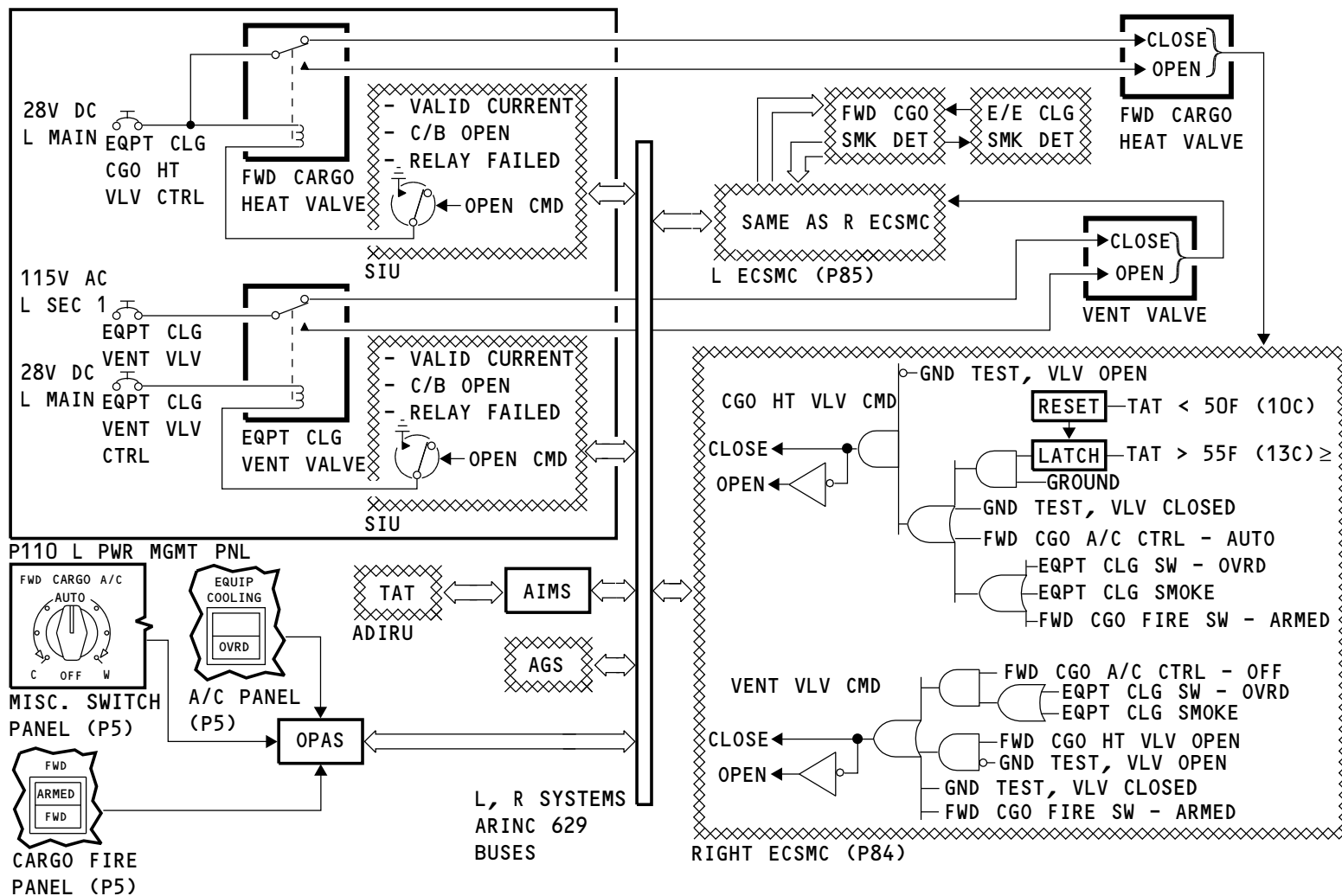
The ECSMCs monitor information from the ELMS. This information helps the ECSMCs isolate malfunctions with the valves.

21-27-00

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D48079 S0000157665_V1

A/C - EQUIPMENT COOLING - FWD CGO HT & VENT VLVS - FUNCTIONAL DESCRIPTION

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**A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE SELECTION LOGIC****General**

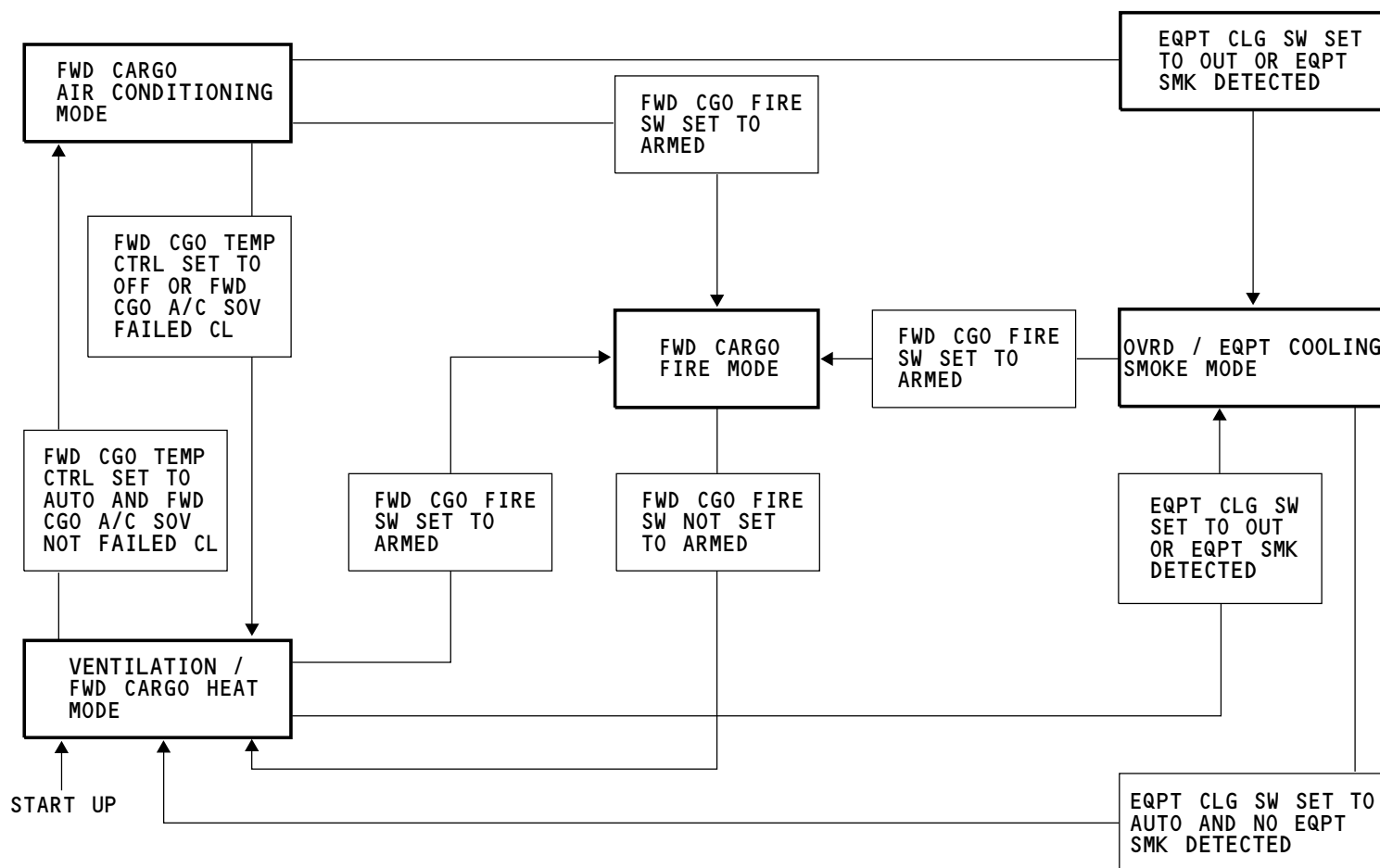
The exhaust part of the forward equipment cooling system can operate in one of these four vent modes:

- Forward cargo air conditioning
- Ventilation/forward cargo heat
- Forward cargo fire
- Override/equipment cooling smoke.

Each mode has different sub-states that allow for changes in airplane conditions.

The diagram shows the conditions used by the ECSMCs to select one of the four vent modes. When the ECSMCs first get power, the usual vent mode is the ventilation/forward cargo heat mode.

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ECSMC, FORWARD EQUIPMENT COOLING VENT MODE SELECTION LOGIC

M35733 S000612360_V2

A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE SELECTION LOGIC

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE - FWD CARGO AIR CONDITIONING

General

The forward cargo air conditioning vent mode is enabled if the forward cargo temperature control is set to AUTO and the forward cargo A/C shutoff valve is not failed closed.

This ventilation mode has these sub-states:

- Forward cargo exhaust/vent overboard
- Forward cargo exhaust/vent inboard
- No forward cargo exhaust/vent inboard
- Forward cargo exhaust/no vent
- No forward cargo exhaust/no vent.

The diagram shows the two usual sub-states:

- Forward cargo exhaust/vent overboard
- Forward cargo exhaust/vent inboard.

The table shows all of the possible sub-states of the forward cargo air conditioning vent mode. The table also shows the fan and the valve conditions that can occur.

Sub-State (Selection Logic)	Vent Fan	Exh Fan	Vent valve	Cargo Heat Valve	Divert Valve	Inbd Valve	A/C SOV
Fwd Cargo Exhaust Vent Overboard (Gnd and Divert Valve Not Failed Closed)	on	on	open	close	open	close	open
Fwd Cargo Exhaust Vent Inboard (Air or Divert Valve Failed Closed)	on	on	open	close	close	open	open

Sub-State (Selection Logic)	Vent Fan	Exh Fan	Vent valve	Cargo Heat Valve	Divert Valve	Inbd Valve	A/C SOV
No Fwd Cargo Exhaust Vent Inboard (not shown) (Vent Valve Failed Closed)	on	off	close	close	close	open	open
Fwd Cargo Exhaust No Vent (not shown) (Vent Valve and Inbd Valve Failed Closed)	off	on	close	close	open	close	open
No Fwd Cargo Exhaust No Vent (not shown) (Air and Inbd Valve Failed Closed or Divert Valve Failed Closed))	off	off	open	close	close	*[1]	open

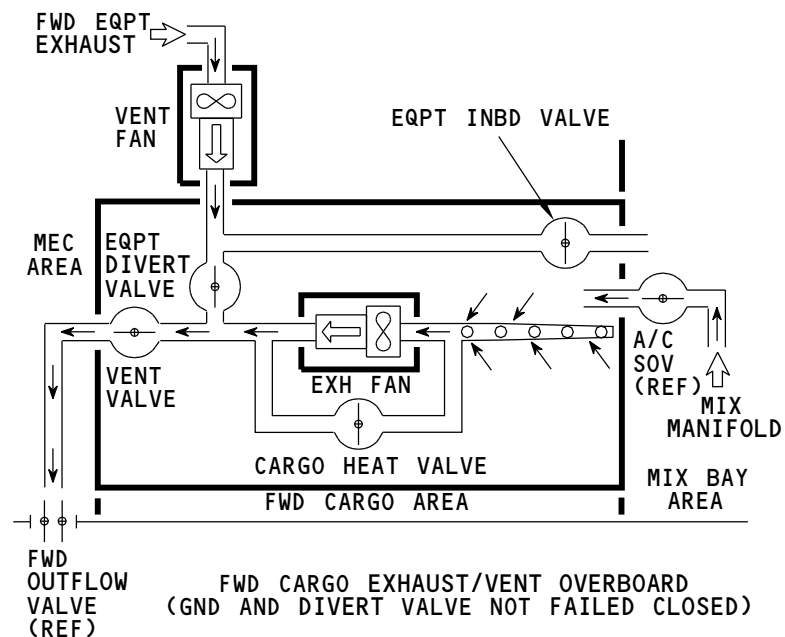
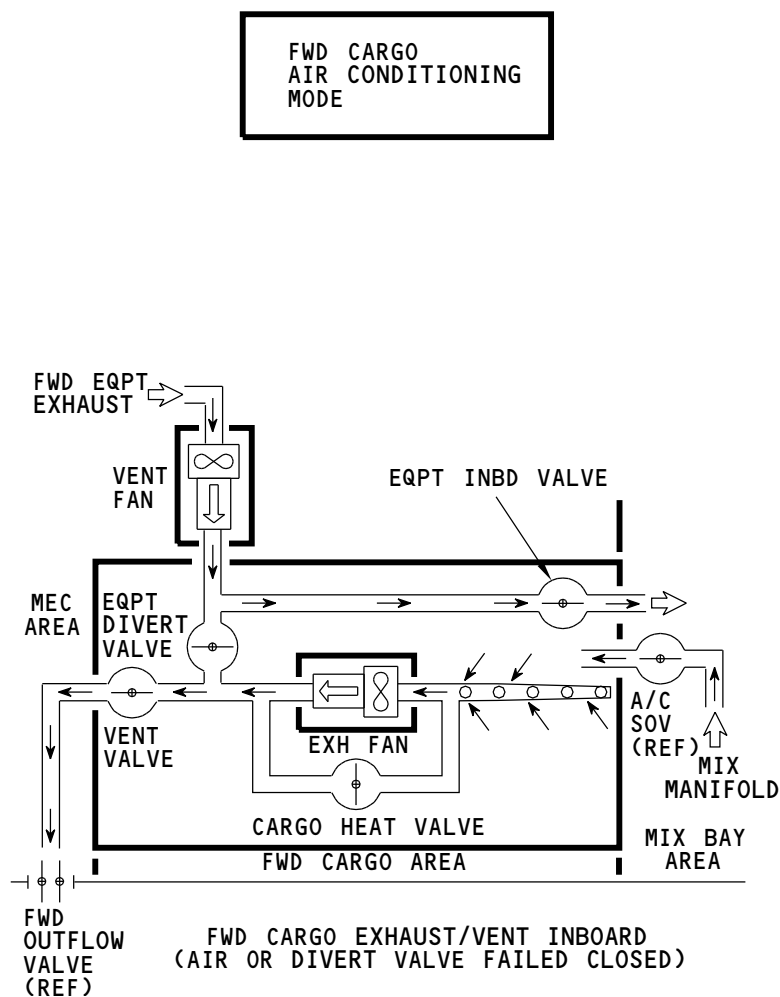
*[1] Open if not failed closed

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M35734 S000612361_V1

A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE - FWD CARGO AIR CONDITIONING

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE - VENT / FWD CARGO HEAT

General

The vent/forward cargo heat vent mode is enabled if any of these conditions occur:

- The forward cargo temperature control is set to OFF
- The forward cargo air conditioning shutoff valve fails in the closed position.

This vent mode has these sub-states:

- Vent overboard
- Forward cargo heat
- Vent inboard
- No vent.

The diagram shows the two usual sub-states:

- Vent overboard
- Forward cargo heat.

The table below shows all of the possible sub-states of the vent/forward cargo heat vent mode. The table also shows the fan and the valve conditions that can occur.

Sub-State (Selection Logic)	Vent Fan	Exh Fan	Vent Valve	Cargo Heat Valve	Divert Valve	Inbd Valve	A/C SOV
Vent Overboard ((Gnd & TAT >55F) Or Fwd Cargo Heat Valve Failed Closed) And Vent Valve Not Failed Closed	on	off	open	close	open	close	close

Sub-State (Selection Logic)	Vent Fan	Exh Fan	Vent Valve	Cargo Heat Valve	Divert Valve	Inbd Valve	A/C SOV
Cargo Heat ((Air Or (Gnd & TAT <50F)) And Fwd Cargo Heat Valve Not Failed Closed) Or Vent Valve Failed Closed	on	off	close	open	open	close	close
Vent Inboard (Not Shown) Divert Valve Failed Closed Or (Vent Valve Failed Closed And Fwd Cargo Heat Valve Failed Closed)	on	off	close	*[1]	close	open	close
No Vent (Not Shown) (Divert Valve Failed Closed Or (Vent Valve Failed Closed And Fwd Cargo Heat Valve Failed Closed)) And Inbd Valve Failed Closed	off	off	close	*[1]	*[1]	close	close

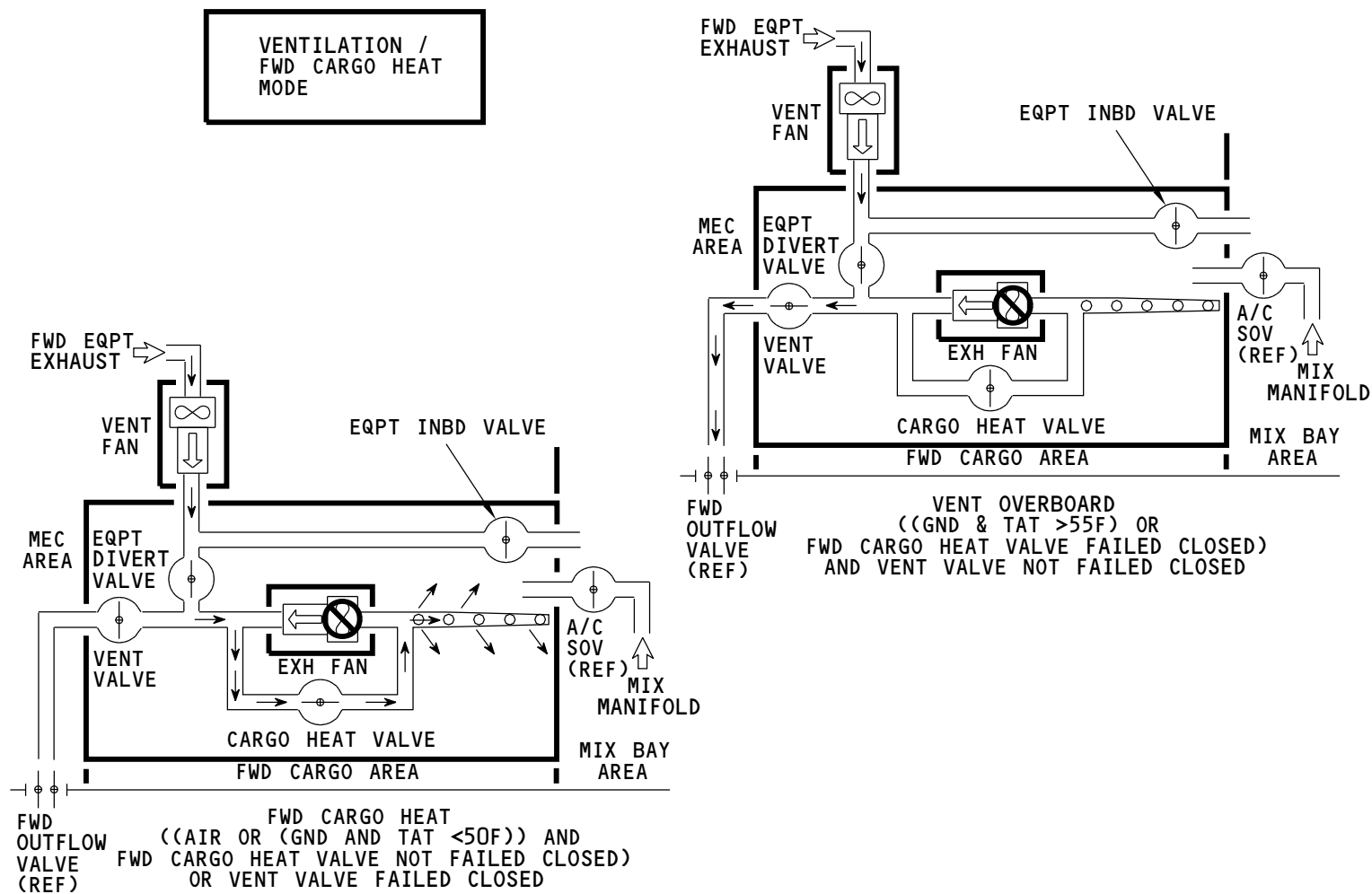
*[1] Open if not failed closed

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M35735 S000612362_V3

A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE - VENT / FWD CARGO HEAT

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE - OVRD / EQPT COOLING SMOKE

General

The override / equipment cooling smoke vent mode is enabled if any of these conditions occur:

- The equipment cooling override switch is set to the out position
- Smoke is detected by the forward equipment cooling smoke detector.

This vent mode has these sub-states:

- Forward cargo air conditioning (FCAC) disabled
- Forward cargo air conditioning (FCAC) enabled
- Forward cargo air conditioning (FCAC) enabled and vent valve failed closed.

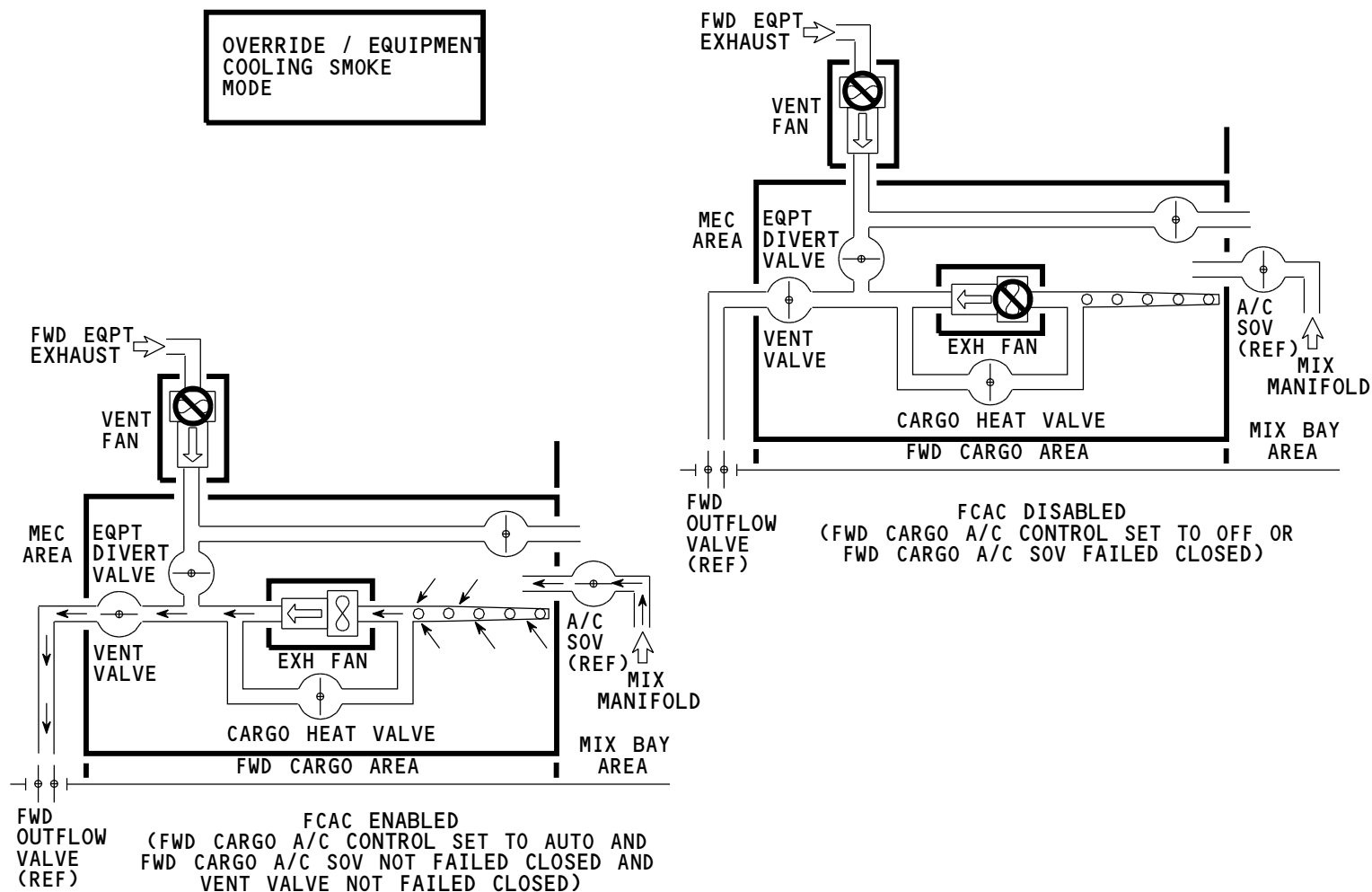
The diagram shows the two usual sub-states:

- FCAC disabled
- FCAC enabled.

The table below shows all of the possible sub-states of the override / equipment cooling smoke vent mode. The table also shows the fan and the valve conditions that can occur.

Sub-State (Selection Logic)	Vent Fan	Exh Fan	Vent Valve	Cargo Heat Valve	Divert Valve	Inbd Valve	A/C SOV
Fcac Disabled (Fwd Cargo A/C Control Set To Off Or Fwd Cargo A/C SOV Failed Closed)	off	off	close	close	close	close	close

Sub-State (Selection Logic)	Vent Fan	Exh Fan	Vent Valve	Cargo Heat Valve	Divert Valve	Inbd Valve	A/C SOV
Fcac Enabled (Fwd Cargo A/C Control Set To Auto And Fwd Cargo A/C SOV Not Failed Closed And Vent Valve Not Failed Closed)	off	on	open	close	close	close	open
Fcac Enabled And Vent Valve Failed Closed (Not Shown) (Fwd Cargo A/C Control Set To Auto And Fwd Cargo A/C SOV Not Failed Closed And Vent Valve Failed Closed)	off	off	close	close	close	close	open



M35736 S000612363_V1

A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE - OVRD / EQPT COOLING SMOKE

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A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE - FWD CARGO FIRE

General

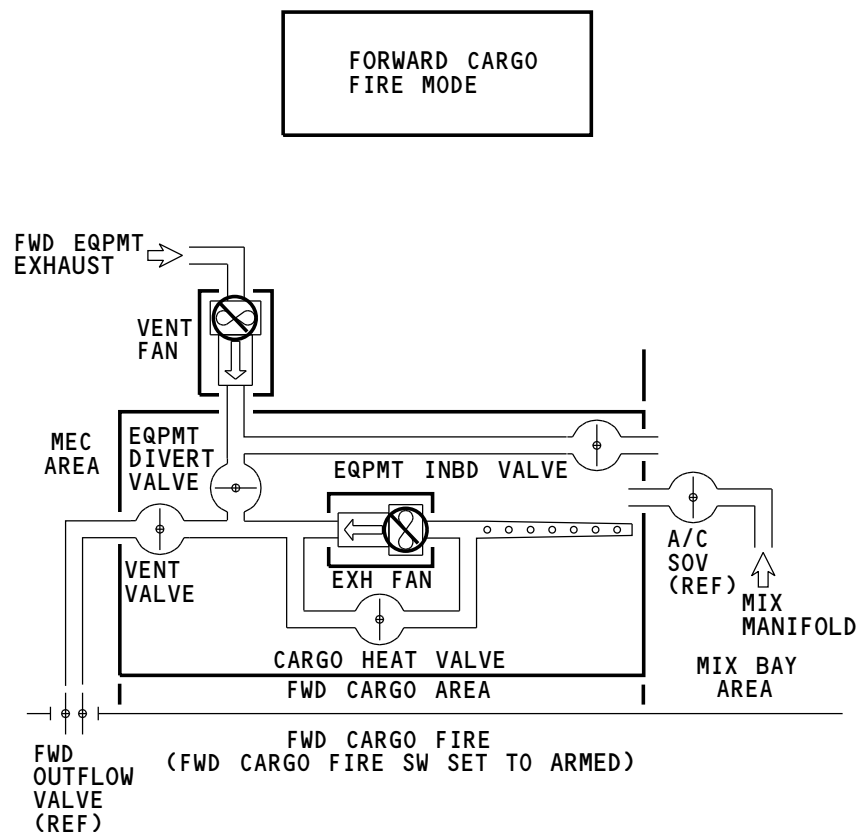
The forward cargo fire vent mode is enabled when the forward cargo fire switch is set to the ARMED position.

This mode has one sub-state, fwd cargo fire. The diagram shows the fwd cargo fire sub-state.

The table below shows the fan and the valve conditions that can occur.

Sub-State (Selection Logic)	Vent Fan	Exh Fan	Vent Valve	Cargo Heat Valve	Divert Valve	Inbd Valve	A/C SOV	IFE Cooling Fan
Fwd Cargo Fire (Fwd Cargo Fire Switch Set To Armed)	off	off	close	close	close	close	close	off

ARO ALL	EFFECTIVITY



M35737 S000612364_V2

A/C - EQUIPMENT COOLING - FUNCTIONAL DESCRIPTION - VENT MODE - FWD CARGO FIRE

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**A/C - EQUIPMENT COOLING - IFE - INTRODUCTION****Purpose**

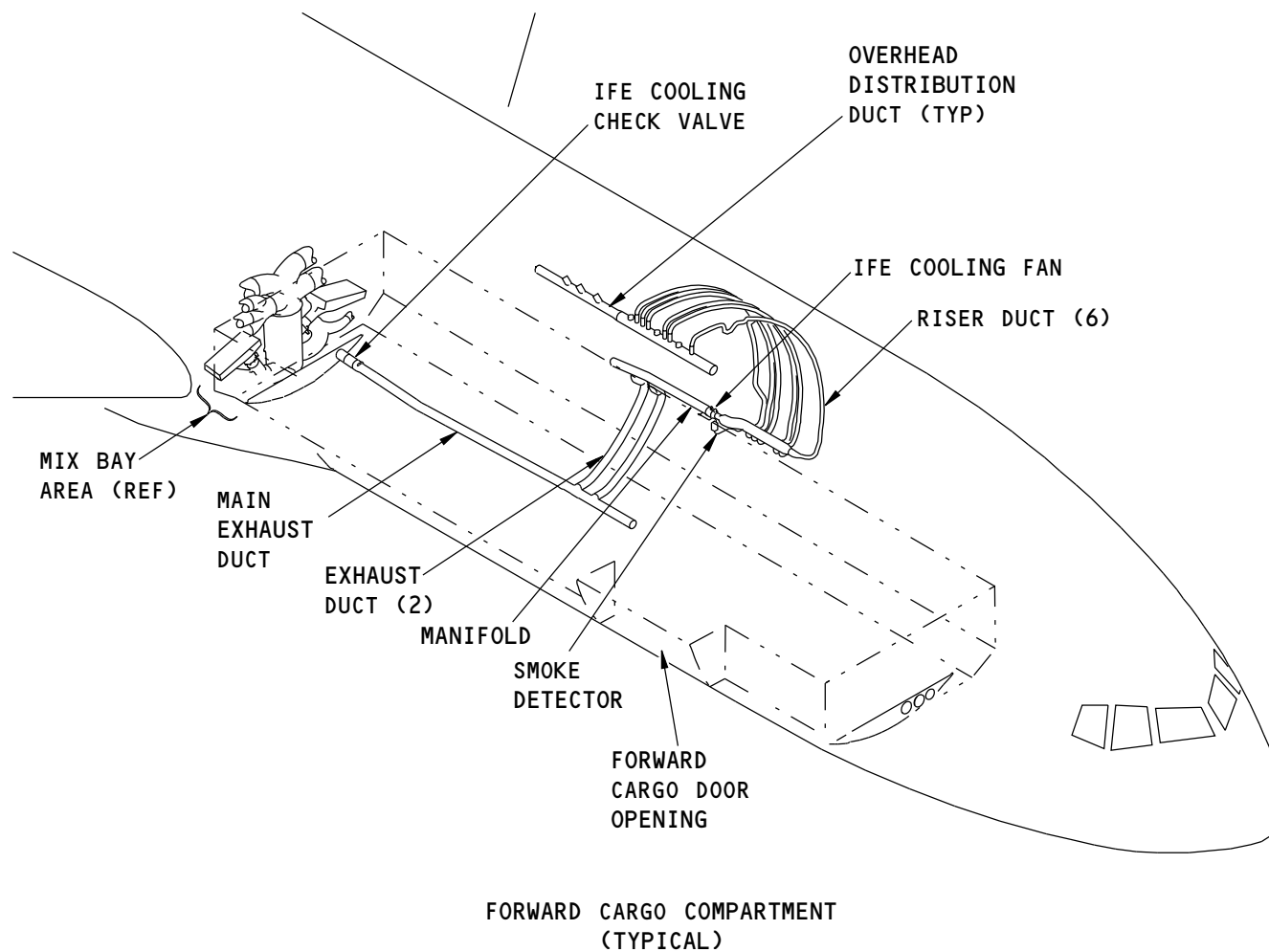
The IFE cooling fan and related ducts pull cooling air through the in-flight entertainment (IFE) components in the passenger cabin. An IFE cooling smoke detector monitors for smoke in the air from the IFE components. Typical locations for the IFE components include the Purser Work Station, the Video Control Center (VCC) and the Cabin Equipment Center (CEC).

Location

The IFE cooling fan is in a manifold outboard of the forward cargo compartment sidewall on the left side. The IFE cooling smoke detector is adjacent to the fan at the same location.

Six small riser ducts connect the manifold to an overhead distribution duct. The overhead duct is above the passenger cabin ceiling. The overhead duct has many connections. Some connections connect to IFE equipment and some are not used. The connections that are not used are for future use if necessary. The length of the overhead duct can be short if the IFE equipment is near the door 2 area or the duct can be long if the IFE equipment is away from the door 2 area.

Two large exhaust ducts aft of the fan connect the sidewall manifold to the main exhaust duct under the cargo floor. The main exhaust duct goes aft to the mix bay area.



484462 S0000144044_V1

A/C - EQUIPMENT COOLING - IFE - INTRODUCTION

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A/C - EQUIPMENT COOLING - IFE - GENERAL DESCRIPTION

Power

The left main bus provides 115v ac and 28v dc to ELMS for the operation of the IFE cooling system.

General

The IFE cooling fan pulls cooling air through IFE components in the passenger cabin. The IFE cooling fan moves the warm exhaust air to the mix bay area for recirculation.

ARO 001-016 POST SB 777-21-0189

A vibration monitor unit is installed on the fan.

ARO ALL

There is an IFE/PASS SEATS switch on the electrical systems control panel in the P5 overhead panel. The IFE/PASS SEATS switch must be in the ON position to enable operation of the IFE cooling fan.

ARO 001-017

There is an IFE LOSS OF COOLING indicator light in the Video Control Center (VCC). The light will come on when the cooling system is not available.

ARO ALL

The ECS miscellaneous cards (ECSMC) give data to ELMS for operation of the fan. Fan overheat indications go directly to the ECSMCs. The ECSMCs get these other inputs for control logic:

- OPAS, forward cargo air conditioning on
- OPAS, forward cargo fire switch arm
- AIMS, engine off or engine starting
- ELMS, IFE cooling smoke alarm
- AGS, airplane on ground.

The ECSMC in control tells ELMS to set the IFE cooling fan to on for most airplane conditions. The card tells ELMS to turn off the fan if any of these conditions occur:

- IFE/PASS SEATS switch is put to the OFF position
- IFE cooling fan overheat (latched)

ARO 001-016 POST SB 777-21-0189

- IFE cooling fan vibration monitor unit fails or simulates an open overheat switch.

ARO ALL

- Forward cargo fire switch is set to ARMED
- Forward cargo smoke detected
- IFE cooling smoke detector detects smoke (latches)
- IFE cooling smoke detector fails
- The Power On Test or the IFE Equipment Cooling Test is initiated.

An IFE cooling smoke detector monitors the cooling air at the fan. The smoke detector gives a smoke alarm signal to ELMS if it finds smoke in the air. ELMS gives the smoke alarm signal to the ECSMCs. The cards latch the condition and the card in control tells ELMS to do these things:

- Turn off the IFE cooling fan

ARO 001-017

If ELMS detects a non-normal condition and shuts off the IFE Cooling Fan, then the LOSS OF COOLING light will illuminate.

ARO ALL

No EICAS or CSCP/CACP indications show for IFE cooling air smoke.

Training Information Point

When the IFE cooling system is off, ELMS will automatically remove power from the in-flight entertainment equipment.

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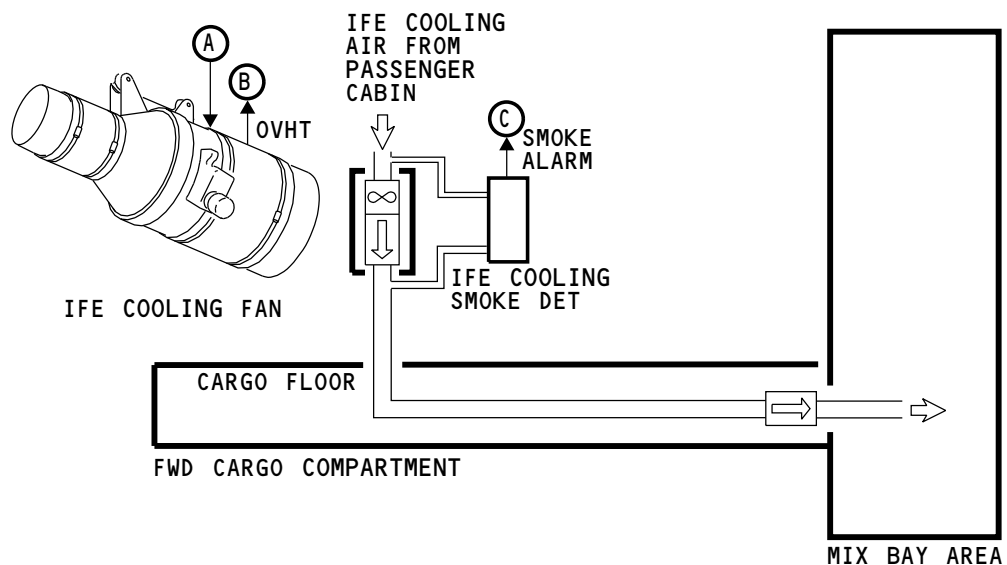
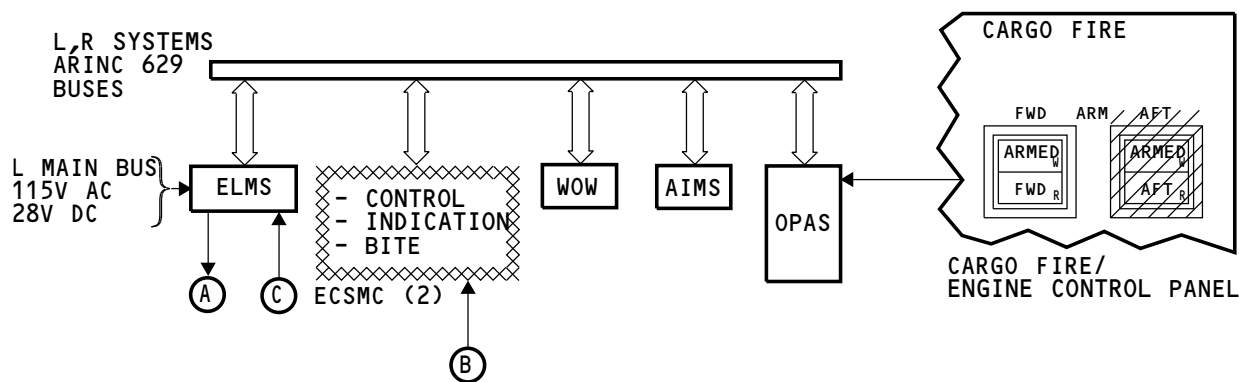
A/C - EQUIPMENT COOLING - IFE - GENERAL DESCRIPTION

| ARO 001-017

All equipment located in the VCC will shut off when the IFE cooling system does not operate. The LOSS OF COOLING light is provided to give the cabin crew an indication when an automatic shutdown of the IFE Cooling System occurs. If the IFE Cooling System shuts down during flight, it cannot be reset until the airplane has landed.

| ARO ALL

ARO ALL	EFFECTIVITY



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A/C - EQUIPMENT COOLING - IFE - GENERAL DESCRIPTION

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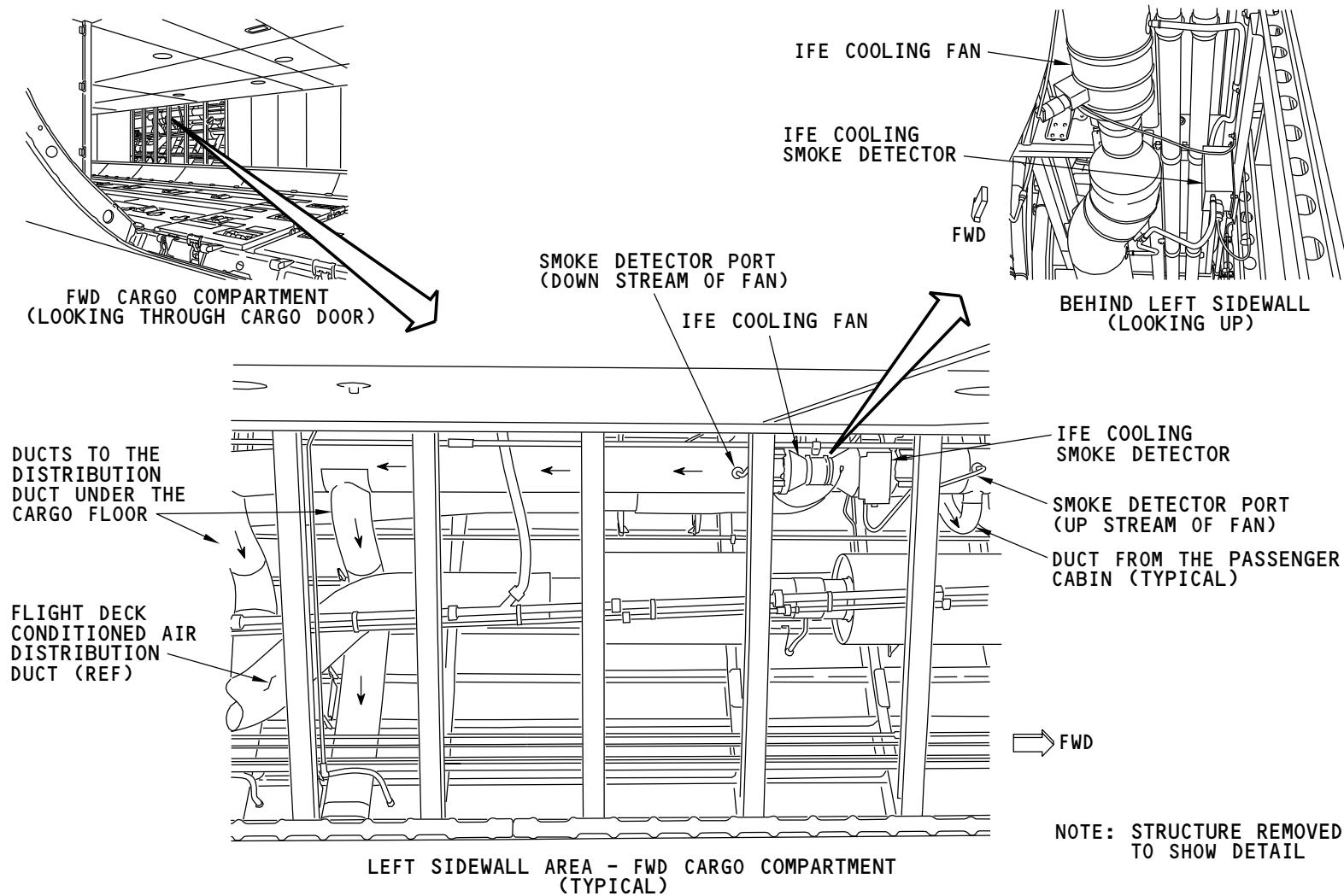
**A/C - EQUIPMENT COOLING - IFE - COOLING FAN AND SMOKE DETECTOR****General**

The IFE cooling fan and IFE cooling smoke detector are behind the left side wall in the forward cargo compartment. The smoke detector attaches to structure that holds the side wall panel on.

Cooling air from the IFE components in the passenger cabin comes through six small ducts forward of the fan. The smoke detector has ports that connect forward and aft of the fan.

Air that comes from the fan goes through two ducts that connect to a distribution duct under the cargo floor.

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A/C - EQUIPMENT COOLING - IFE - COOLING FAN AND SMOKE DETECTOR

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**A/C - EQUIPMENT COOLING - IFE - CHECK VALVE****Purpose**

The IFE equipment cooling check valve prevents halon from leaking out of the forward cargo compartment in the event of a cargo compartment fire and failure of the fire hardened duct.

Physical Description

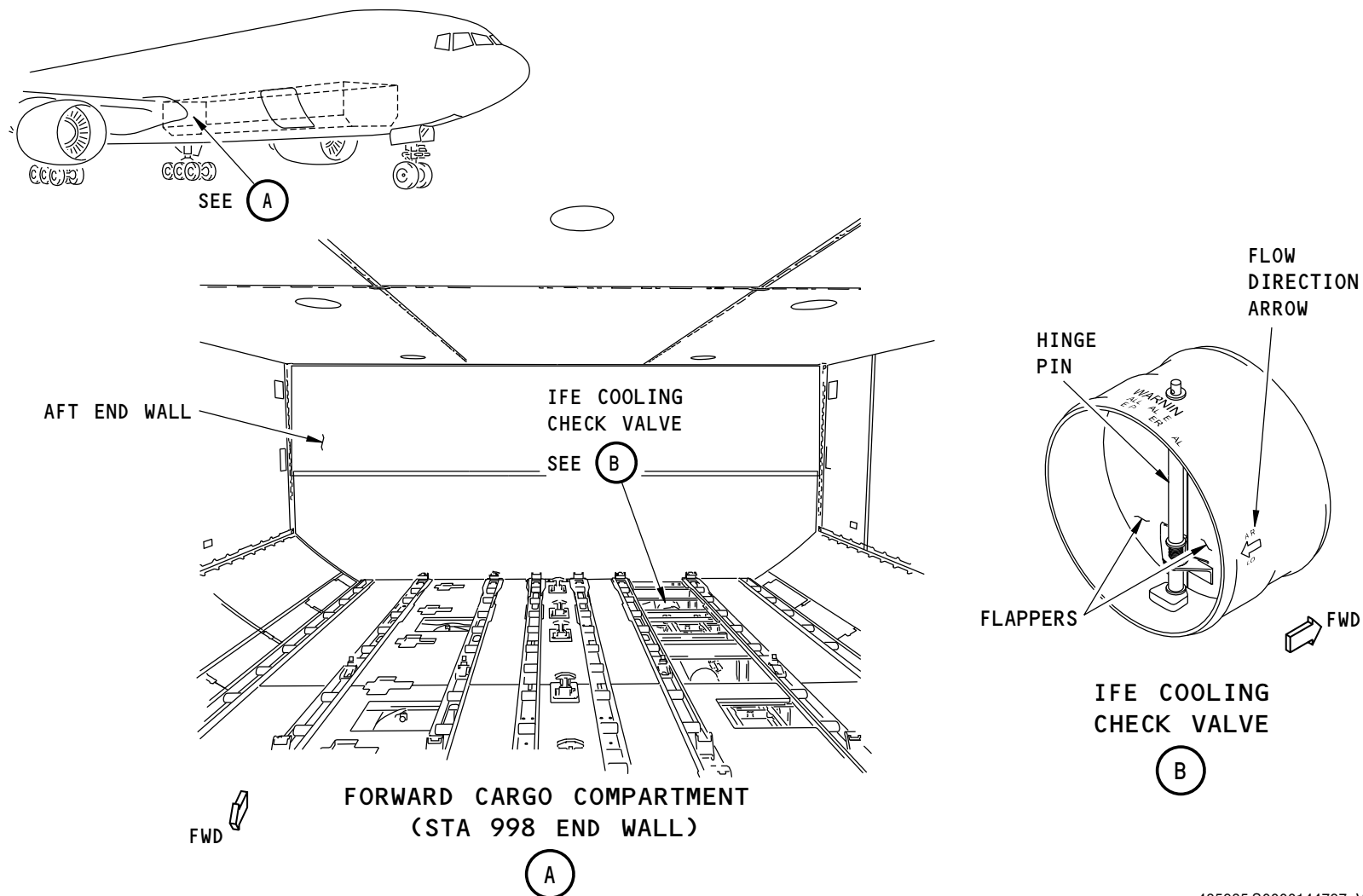
The check valve is a flapper-type valve. The valve is spring-loaded to the closed position.

Location

The check valve is on the left side of the forward cargo compartment forward of the mix bay. The valve is in the IFE cooling system exhaust duct.

Training Information Point

The check valve has an air flow direction arrow on the valve to help you install the valve correctly.



485985 S0000144797_V1

A/C - EQUIPMENT COOLING - IFE - CHECK VALVE

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**A/C - EQUIPMENT COOLING - IFE - VIBRATION MONITOR UNIT****Purpose**

A vibration monitor unit provides early detection of fan mechanical failure and contains diagnostic capability to monitor malfunction via a status LED. There is no change to the airplane systems behaviour due to the presence of the vibration monitor unit.

Physical Description

The IFE Cooling fan is monitored by a vibration monitor unit. The vibration monitor unit is electronically installed between the fan and power source. It is equipped with a test button and a status LED to monitor the fan and vibration monitor unit condition.

Location

The vibration monitor unit is installed on the IFE Cooling fan.

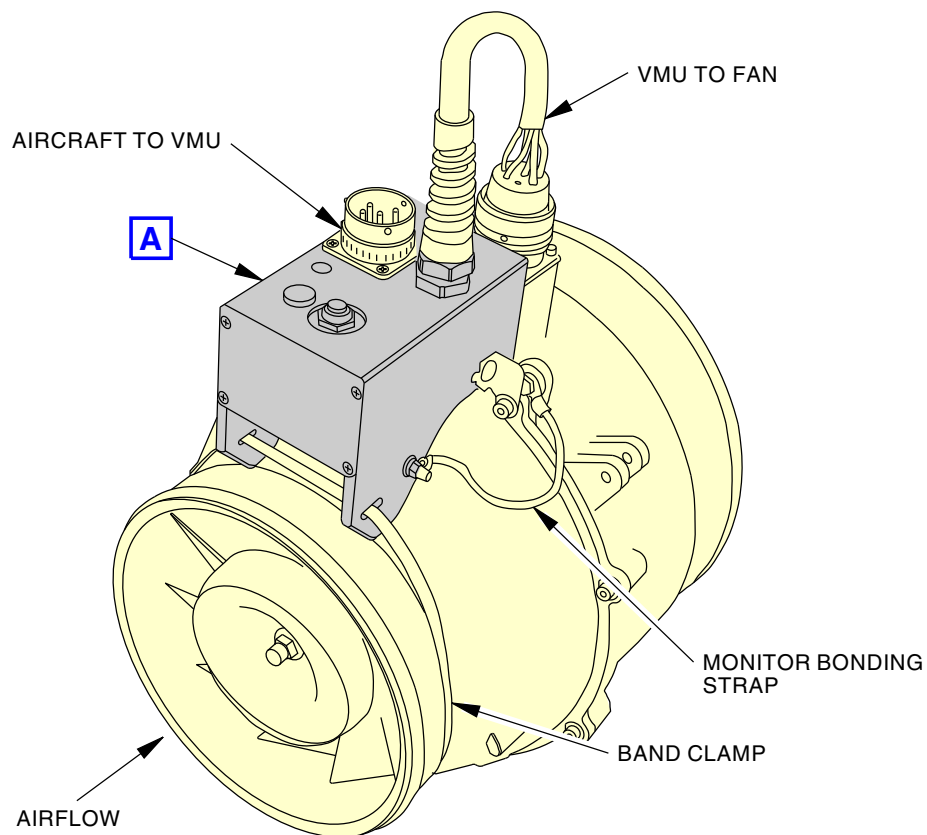
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ARO 001-016 POST SB 777-21-0189

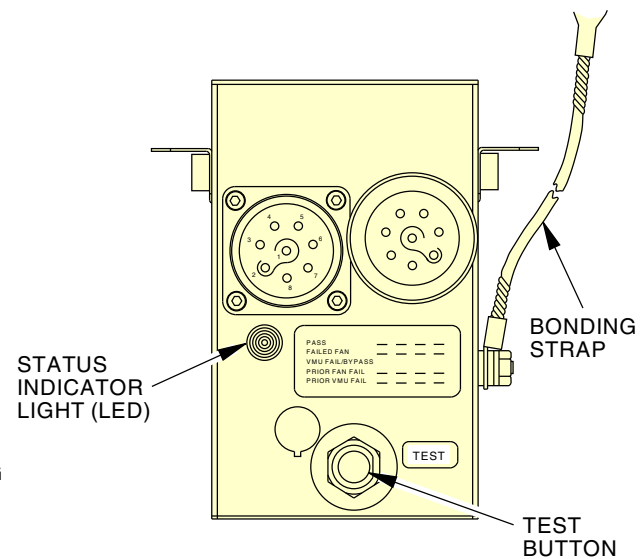
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Page 98.10
Sep 05/2018



**FAN/MONITOR MOUNTING
(EXAMPLE)**



VIBRATION MONITOR UNIT

A/C - EQUIPMENT COOLING - VIBRATION MONITOR UNIT

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Page 98.12
Sep 05/2018

A/C - EQUIPMENT COOLING - IFE - FUNCTIONAL DESCRIPTION

General

ARO 017-999; ARO 001-016 PRE SB 777-21-0189

The 115v ac left main section 2 bus supplies power to the IFE cooling fan. The ECSMC in control sends data to ELMS to turn on the fan. Each ECSMC has logic to control the fan. The fan sends an overheat indication to the left ECSMC. The EICAS status message IFE COOLING FAN shows for an overheat condition of the fan.

ARO 001-016 POST SB 777-21-0189

The 115v ac left main section 2 bus supplies power to the IFE cooling fan. The fan vibration monitor unit is physically and electronically installed between the fan power source and the fan itself. The power supplied passes through the vibration monitor unit unaltered. There is no change to the airplane systems behaviour due to the presence of the vibration monitor units. The ECSMC in control sends data to ELMS to turn on the fan. Each ECSMC has logic to control the fan. The fan or the vibration monitor sends an overheat indication to the left ECSMC. The EICAS status message IFE COOLING FAN shows for an overheat condition of the fan.

ARO ALL

There is an IFE/PASS SEATS switch on the electrical systems control panel in the P5 overhead panel. The IFE/PASS SEATS switch must be in the ON position to enable operation of the IFE cooling fan.

The 28v dc left main bus supplies power to the IFE smoke detector. The smoke detector monitors the opacity of the IFE cooling air that goes through it. It gives an alarm to ELMS if smoke is in the air. ELMS supplies a smoke alarm signal to the ECSMCs. The cards latch the smoke alarm as an IFE CLG SMOKE condition and the card in control tells ELMS to turn off the fan. The maintenance message IFE COOL SMOKE DETECTED is generated when the IFE cooling smoke detector finds smoke in the air.

No EICAS or CSCP/CACP indications show for IFE cooling air smoke.

The ECSMC in control tells ELMS to set the IFE cooling fan to on for most airplane conditions. The card tells ELMS to turn off the fan if any of these conditions occur:

- IFE/PASS SEATS switch is put to the OFF position
- IFE cooling fan overheat (latched)

ARO 001-016 POST SB 777-21-0189

- IFE cooling fan vibration monitor fails or simulates an open overheat switch

ARO ALL

- Forward cargo fire switch is set to ARMED
- Forward cargo smoke detected
- IFE cooling smoke detector detects smoke (latches)
- IFE cooling smoke detector fails
- IFE cooling system test.

ARO 001-017

If ELMS detects a non-normal condition and shuts off the IFE Cooling Fan, then the LOSS OF COOLING light will illuminate.

ARO ALL

Test

The ECSMC in control does a power-up test of the IFE cooling system. This test does a check to find if the control logic can operate the fan. This test also does a check of the operation of the smoke detector. You can do these ground tests of the IFE cooling system from the maintenance access terminal:

- 21 ENVIRONMENTAL CONTROL SYSTEM
- SYSTEM TEST
- IFE COOLING SYSTEM.

The power-up test and the ground test reset latched faults when they start.

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**A/C - EQUIPMENT COOLING - IFE - FUNCTIONAL DESCRIPTION**

The EICAS status message, DETECTOR IFES SMOKE shows if the power-up or ground test finds a smoke detector test failure. No EICAS messages show if the power-up or ground test finds a fan or valve malfunction.

Training Information Point

When the IFE cooling system is off, ELMS will automatically remove power from the in-flight entertainment equipment.

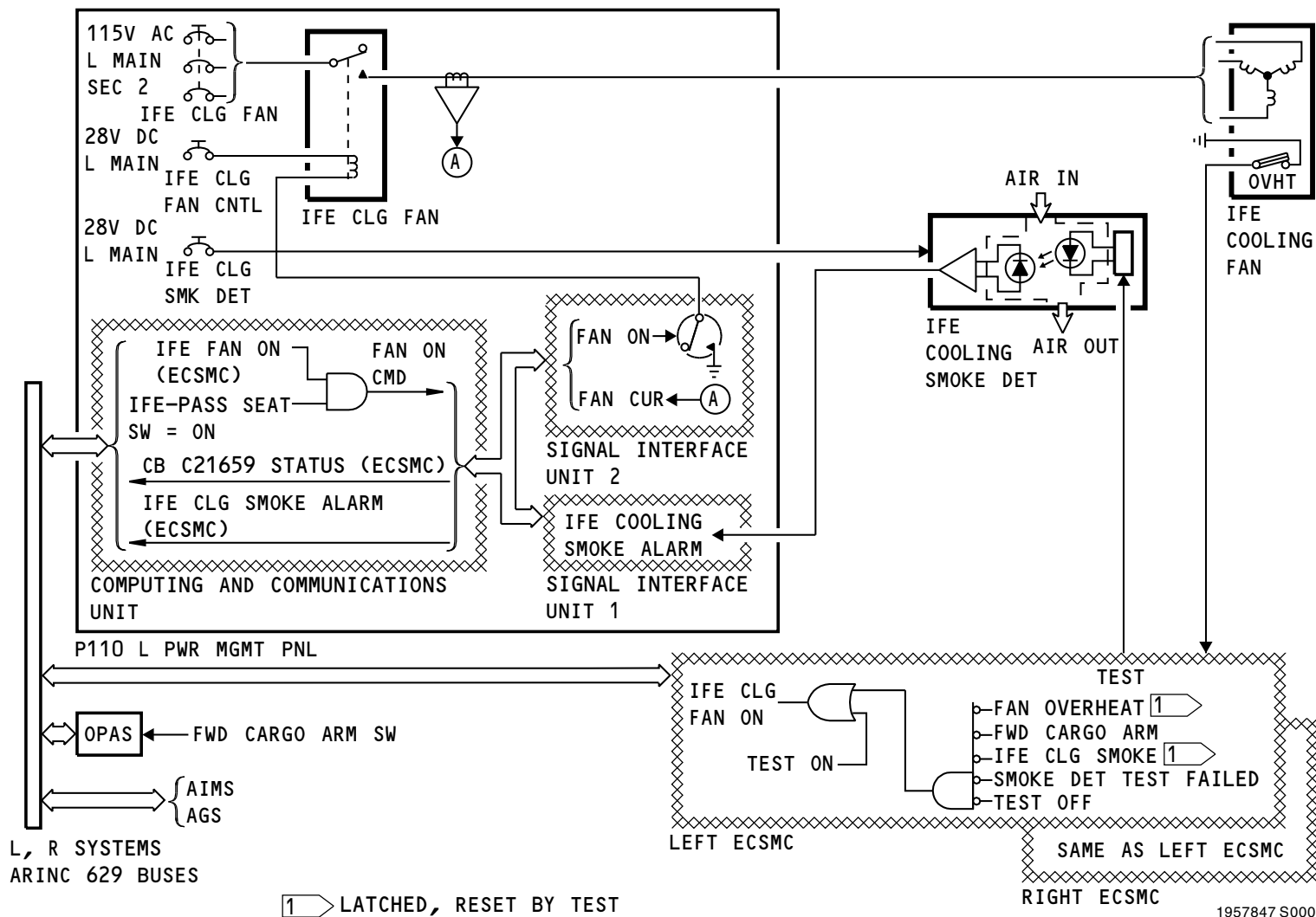
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The LOSS OF COOLING light is provided to give the cabin crew an indication when an automatic shutdown of the IFE Cooling System occurs. If the IFE Cooling System shuts down during flight, it cannot be reset until the airplane has landed.

| ARO ALL**21-27-00****ARO ALL** EFFECTIVITY

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A/C - EQUIPMENT COOLING - IFE - FUNCTIONAL DESCRIPTION

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**A/C - EQUIPMENT COOLING - GROUND TESTS****General**

You select the equipment cooling ground tests from ATA 21 Environmental Control System.

Equipment Cooling

This test makes sure that these equipment cooling LRU installations are correct:

- Sensors
- Valves
- Fans.

The test takes 2 to 5 minutes.

This test shows for these ground test types:

- System test
- LRU replacement test.

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GROUND TESTS

SELECT ATA SYSTEM (48)

21 ENVIRONMENTAL CONTROL SYSTEM
21 CABIN PRESSURE CONTROL SYSTEM
21 CABIN TEMPERATURE CONTROL SYSTEM
22 AUTOPILOT FLIGHT DIRECTOR SYSTEM
22 AIMS - AUTOTHROTTLE
23 HF COMMUNICATION SYSTEM
23 VHF COMMUNICATION SYSTEM
23 SATELLITE COMMUNICATIONS (SATCOM) SYSTEM
23 AIMS - DATA COMMUNICATION MANAGEMENT

SELECT TEST TYPE

☒ SYSTEM TEST
☐ LRU REPLACEMENT TEST

SELECT SYSTEM TEST (6)

AFT CARGO HEAT
BULK CARGO HEAT
CHILLER BOOST FAN
DOOR AREA HEATER
EQUIPMENT COOLING
LAVATORY/GALLEY VENTILATION FAN

CONTINUE HELP GO BACK

SELECT SYSTEM TEST

(6)

AFT CARGO HEAT
BULK CARGO HEAT
CHILLER BOOST FAN
DOOR AREA HEATER
EQUIPMENT COOLING
LAVATORY/GALLEY VENTILATION FAN

NOTE: SYSTEM TESTS SHOW.
LRU REPLACEMENT TESTS ARE THE SAME.

1 THIS IS THE AIR CONDITIONING -
EQUIPMENT COOLING TEST.

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A/C - EQUIPMENT COOLING - GROUND TESTS

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Page 98.17
Sep 05/2018



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**AIR CONDITIONING - FWD CARGO COMPARTMENT CONDITIONED AIR DISTRIBUTION - GENERAL DESCRIPTION****Purpose**

The forward cargo compartment conditioned air distribution system moves conditioned air from the mix manifold into the forward cargo compartment.

General Description

The system has these parts:

- Air conditioning shutoff valve (A/C SOV)
- Supply duct
- Branch ducts
- Air outlets.

The AUTO position of the forward cargo air conditioning control enables the operation of the A/C SOV. The ECSMCs control the position of the valve, fully open or closed. The right card monitors valve position directly.

The valve opens if all of these conditions occur:

- The forward cargo air conditioning control is in the AUTO position
- L or R air conditioning pack is on
- The forward cargo fire switch is not in the ARMED position.

When the shutoff valve is open, air moves through the valve from the mix manifold into the supply duct. Air in the supply duct moves into the cargo compartment through the branch ducts and air outlets. The air outlets make the air move up and around the cargo in the compartment. Air moves out of the compartment through the cargo heat duct. See the ventilation section for more information about the forward cargo ventilation (exhaust) system (SECTION 21-26).

Interfaces

The system has a mechanical interface with the upper part of the mix manifold and with the trim air system. See the main air distribution section for more information about the mix manifold (SECTION 21-21). See the zone temperature control and indication section for more information about the trim air system (SECTION 21-61).

The system has an interface with these systems:

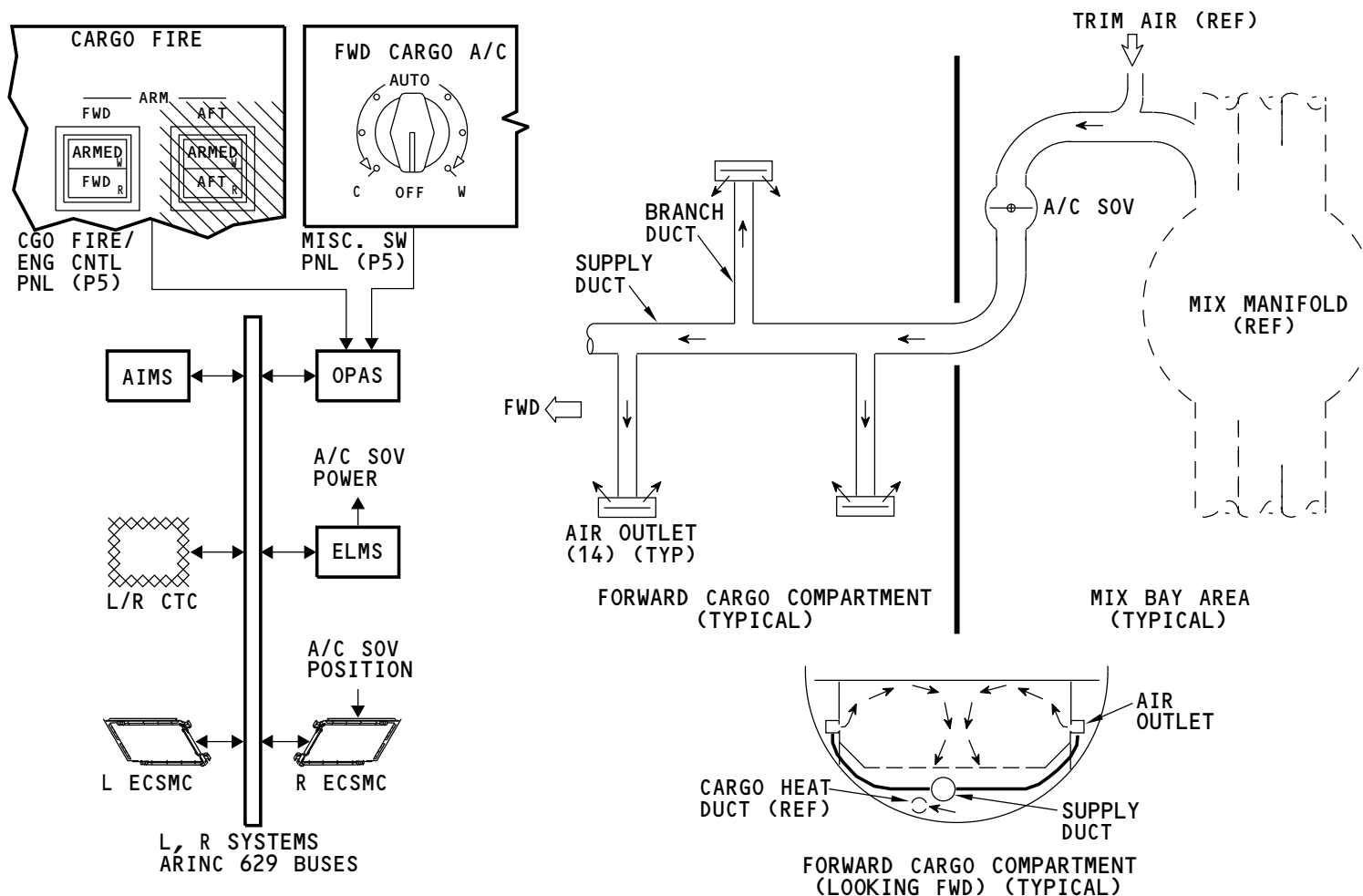
- AIMS for messages and ground test
- OPAS for forward cargo fire switch position and forward cargo air conditioning control position
- CTCs get A/C SOV position information
- ELMS controls the power to the valve.

The CTCs use valve fully open position information to enable an increase in pack air flow and to enable cargo zone temperature control. See the pack flow control section for more information about the pack flow control (SECTION 21-51). See the zone temperature control and indication section for more information about the trim air system (SECTION 21-61).

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AIR CONDITIONING - FWD CARGO COMPARTMENT CONDITIONED AIR DISTRIBUTION - GENERAL DESCRIPTION

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**AIR CONDITIONING - FWD CARGO COMPARTMENT CONDITIONED AIR DISTRIBUTION - A/C SHUTOFF VALVE****Purpose**

The forward cargo air conditioning shutoff valve (A/C SOV) controls the movement of conditioned air from the mix manifold into the forward cargo conditioned air supply duct.

Location

The A/C SOV is aft of the forward cargo compartment in the right side of the mix bay area. The valve is below the right recirculation filters.

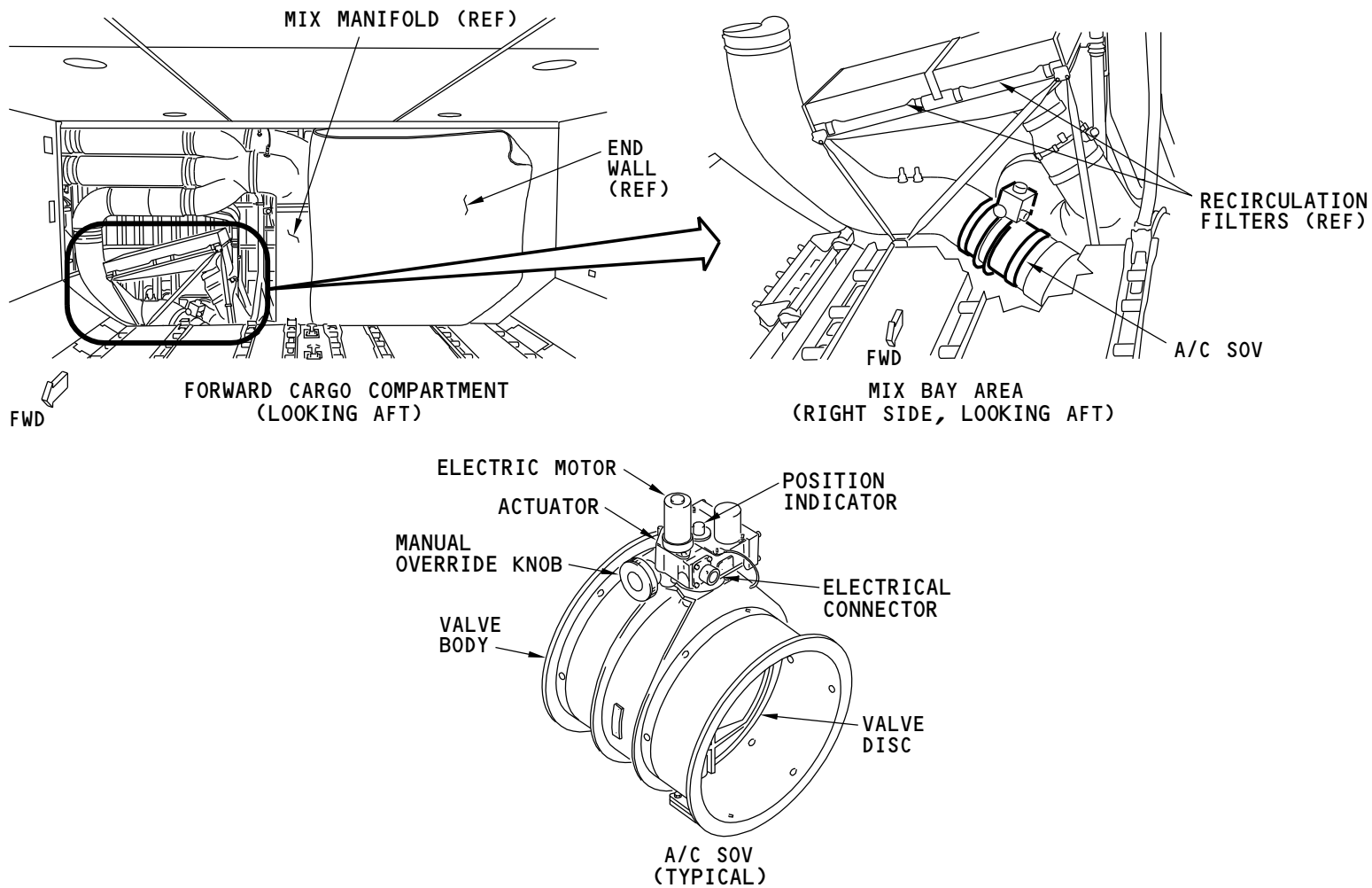
Physical Description

The valve has these components:

- Valve body
- Actuator.

The diameter of the valve body is nine inches (23 cm). The body has an internal valve disc. The actuator has these components:

- Manual override knob
- Electric motor
- Position indicator
- Electrical connector.



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AIR CONDITIONING - FWD CARGO COMPARTMENT CONDITIONED AIR DISTRIBUTION - A/C SHUTOFF VALVE

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**AIR CONDITIONING - FWD CARGO COMPARTMENT CONDITIONED AIR DISTRIBUTION - DUCTING AND AIR OUTLETS****Purpose**

The forward cargo compartment conditioned air distribution has ducts and air outlets. They control the movement of conditioned air in the forward cargo compartment.

Location

The ducts are in these locations:

- Right side of the mix bay area
- Under the forward cargo compartment floor
- Outboard of the forward cargo compartment sidewalls.

Air outlets are part of the forward cargo compartment sidewalls. Eight are on the left side and six on the right side.

Physical Description

The supply duct is a rigid type. It starts at the air conditioning shutoff valve (A/C SOV) as a 9 inch diameter (23 cm) duct. The duct ends in the forward part of the compartment in the left sidewall. The duct size decreases to 2.5 inch (6.4 cm) in the left sidewall area.

Branch ducts connect the supply duct to the air outlets. The branch ducts are a rigid type that have a diameter of 2.5 inches (6.4 cm).

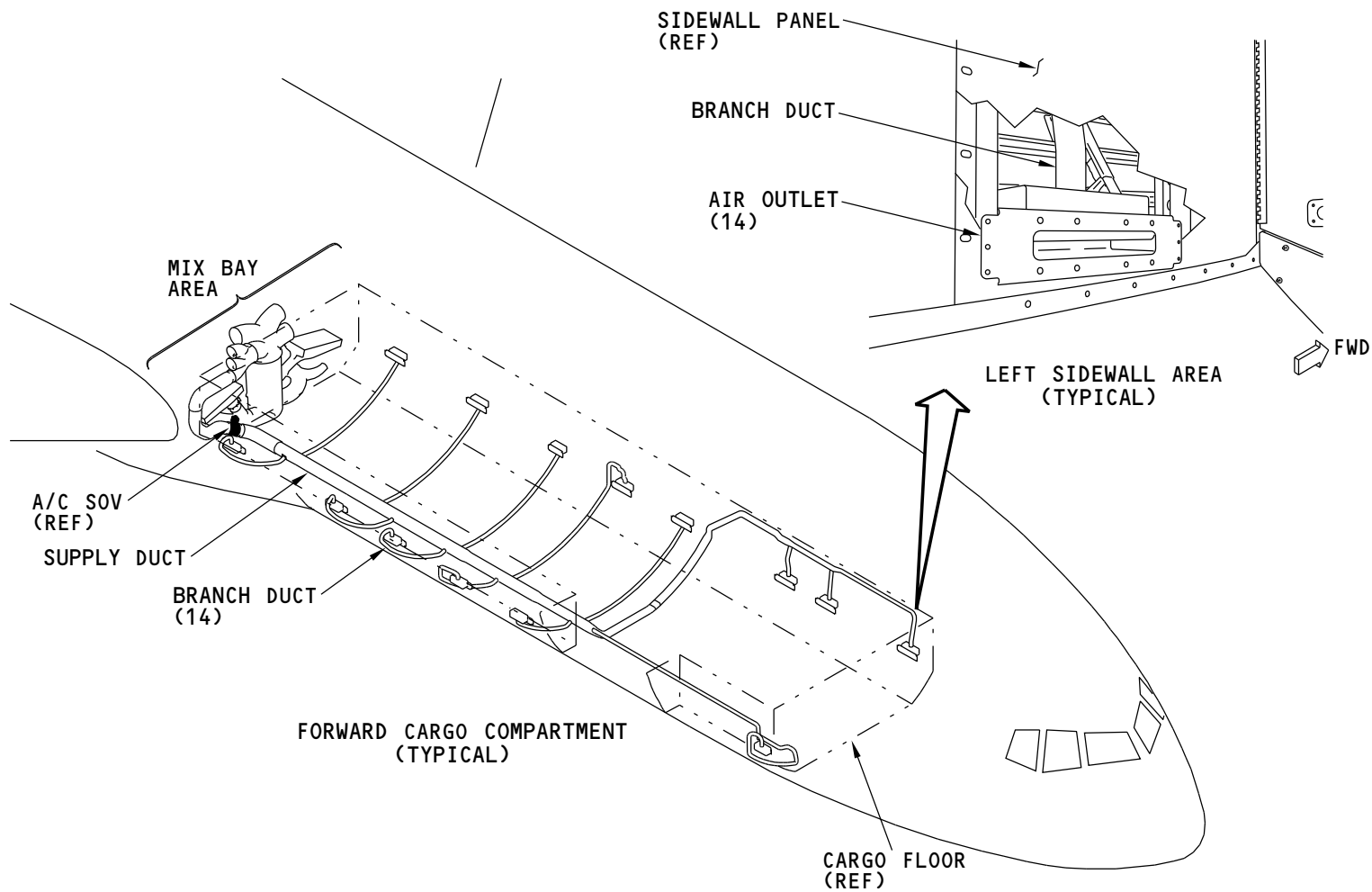
The air outlets have a shape that makes the conditioned air move up as it flows into the cargo compartment. Each outlet has a branch duct connection. The left sidewall air outlets are not interchangeable with the right sidewall air outlets.

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AIR CONDITIONING - FWD CARGO COMPARTMENT CONDITIONED AIR DISTRIBUTION - DUCTING AND AIR OUTLETS

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**AIR CONDITIONING - FWD CARGO COMPARTMENT CONDITIONED AIR DISTRIBUTION - FUNCTIONAL DESCRIPTION****General**

The ECSMCs give control for the forward cargo air conditioning shutoff valve (A/C SOV).

The right ECSMC gives primary control of the valve when the airplane gets power and the left card gives backup control. When the airplane changes from air to ground, the card in control changes.

The ECSMC monitor airplane conditions and fully opens the A/C SOV when all of these conditions occur:

- Forward cargo air conditioning control is in the AUTO position
- The left or right air conditioning pack is on
- Forward cargo fire switch is not in the ARMED position
- The ground test to close the valve is not enabled.

Fail Safe Control

The relay that supplies power to the valve is set so that it always supplies power to close the valve. This makes sure the valve closes if the right and left ECSMCs have malfunctions.

Indication

Status messages show when a valve has a malfunction or the circuit that controls the valves has a malfunction.

The ECSMCs monitor information from the ELMS. This information helps the ECSMCs isolate malfunctions with the valve.

Cabin Temperature Control (CTC) Interface

The left and right CTCs monitor the position of the A/C SOV. The CTCs increase the air conditioning pack flow when all of these conditions occur:

- The A/C SOV is fully open
- The pack flow is set to flow schedule 1.

See the pack flow control section for more information about the pack flow control as it relates to the A/C SOV (SECTION 21-51).

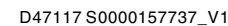
The right CTC controls the forward cargo compartment temperature to the selected target value when the A/C SOV is open. See the zone temperature control and indication section for more information about the temperature control for the forward cargo compartment (SECTION 21-61).

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AIR CONDITIONING - FWD CARGO COMPARTMENT CONDITIONED AIR DISTRIBUTION - FUNCTIONAL DESCRIPTION

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AIR CONDITIONING - PRESSURIZATION - INTRODUCTION

Purpose

The cabin pressurization system controls cabin altitude and protects the fuselage structure against internal and external overpressurization.

Abbreviations and Acronyms

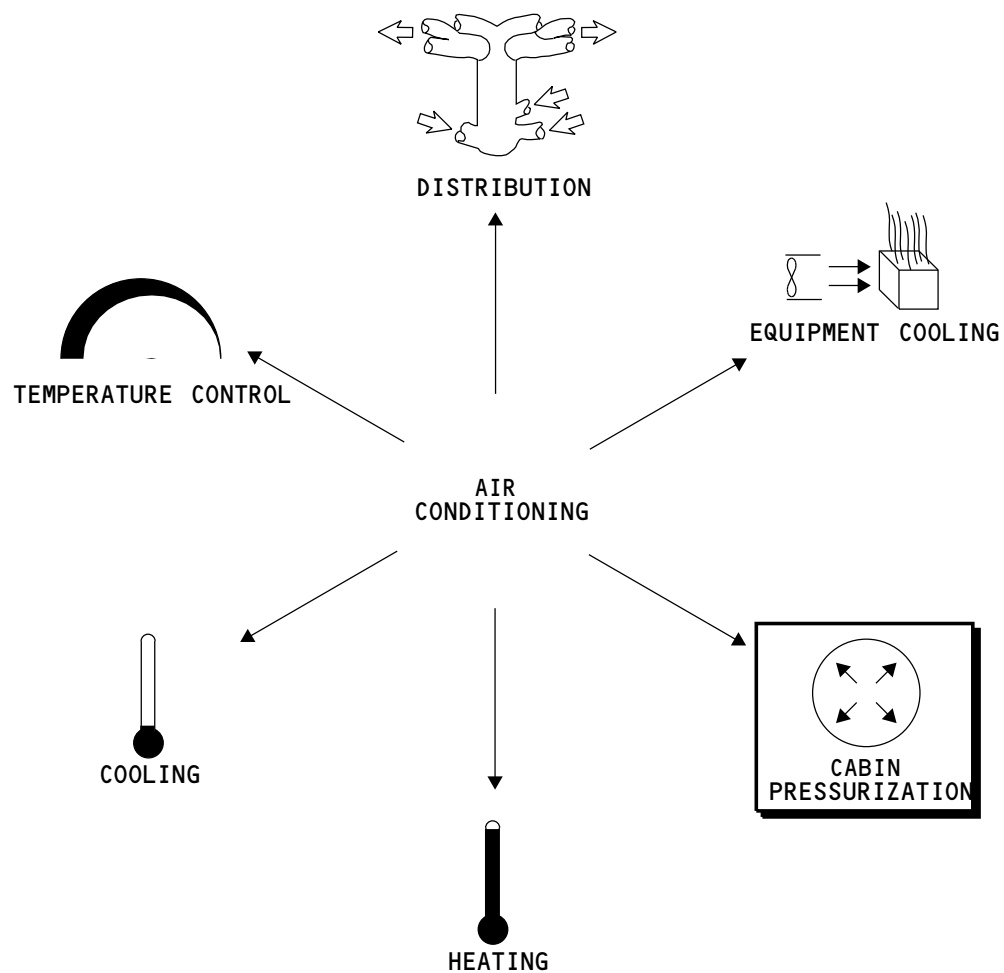
- actr - actuator
- ADIRS - air data inertial reference system
- ADIRU - air data inertial reference unit
- AFDS - autopilot flight director system
- AGS - air/ground system
- AIMS - airplane information management system
- alt - altitude
- ARINC - Aeronautical Radio, Inc.
- ASCPC - air supply cabin pressure controller
- auto - automatic
- brk - brake
- capt - captain
- CMCF - central maintenance computing function
- CPCS - cabin pressure control system
- CPOV - cabin pressure outflow valve
- decr - decrease
- ECS - environmental control system
- ECU - electronic control unit
- EEC - electronic engine control
- EFIS - electronic flight instrument system
- elcx - electronics
- ELMS - electrical load management system
- FCAC - forward cargo air conditioning
- F/O - first officer
- flt - flight
- FMCF - flight management computing function
- fwd - forward
- incr - increase
- ldg - landing
- man - manual
- max - maximum
- mgmt - management
- MFD - multi-function display
- ofv - outflow
- OPAS - overhead panel ARINC 629 system
- PDF - primary display function
- pnl - panel
- pos - position
- press - pressure
- PSI - pounds per square inch
- pwr - power
- RSU - remote sensor unit
- RVDT - rotary variable differential transformer
- slfpm - sea level feet per minute
- snsr - sensor
- sol - solenoid
- stby - standby
- VCA - valve controller assembly
- VCU - valve control unit
- vlv - valve
- WOW - weight-on-wheels

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AIR CONDITIONING - PRESSURIZATION - INTRODUCTION

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AIR CONDITIONING - PRESSURIZATION - GENERAL DESCRIPTION

General

These are the two parts of the pressurization system:

- cabin pressure control
- cabin pressure relief.

The cabin pressure control system controls the amount of air that flows out of the airplane. This keeps the cabin air pressure in limits at altitude.

The cabin pressure relief system keeps the internal pressure of the airplane to a limit.

The pneumatic system usually supplies more than a sufficient quantity of air through the air conditioning packs to pressurize the airplane. Outflow valves in the forward and aft areas of the airplane control the amount of air that goes out of the airplane. This keeps the cabin air pressure within limits.

Outflow Valves

You can set the outflow valve control to automatic or manual mode from the flight deck. The forward and aft outflow valves can each be set to automatic or manual mode independent of the mode set for the other valve. When you set the two outflow valves to the automatic mode with the forward cargo air conditioning set to off, the usual position of the valves is so that 20 percent of the total air outflow goes out through the forward outflow valve and 80 percent goes out through the aft outflow valve. When you set the two outflow valves to the automatic mode with the forward cargo air conditioning set to on, the usual position of the valves is so that 50 percent of the total air outflow goes out through the forward outflow valve and 50 percent goes out through the aft outflow valve.

In the manual mode, you control the position of one or both of the valves.

Pressure Relief

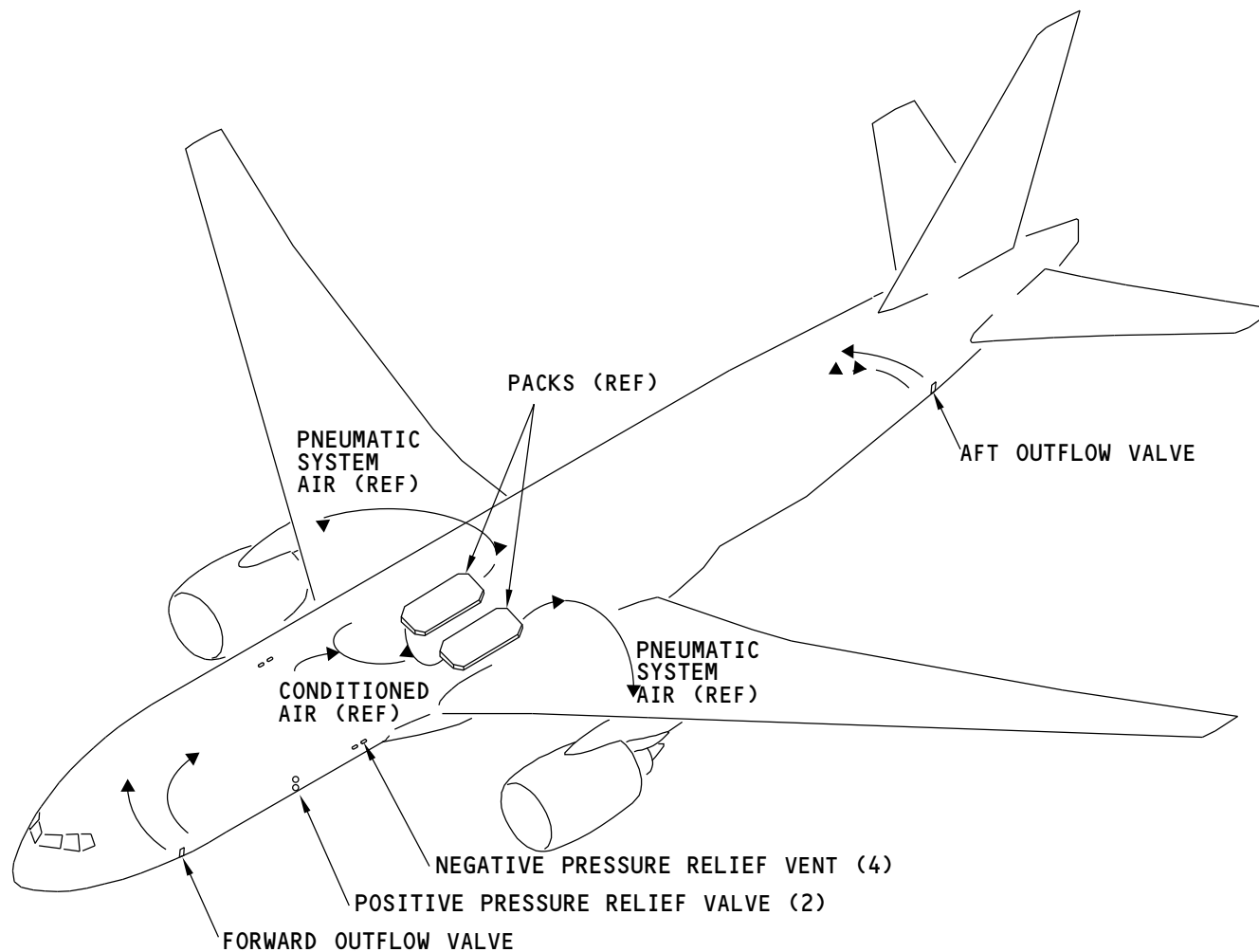
Positive pressure relief valves and negative pressure relief vents, in the forward part of the airplane keep the difference between cabin pressure and ambient pressure in limits.

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AIR CONDITIONING - PRESSURIZATION - GENERAL DESCRIPTION

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AIR CONDITIONING - PRESSURIZATION - INDICATIONS - EICAS DISPLAY

ECS Data Block

This pressurization information shows in the ECS (environmental control system) data block on the EICAS display:

- Duct pressure
- Cabin altitude (CAB ALT)
- Rate in feet per minute
- Forward and aft outflow valve position
- Landing altitude (LDG ALT)
- Indication of landing altitude from AIMS (AUTO) or from bleed air/pressurization panel (MAN).
- Cabin differential pressure (~P)

The ECS data block shows for these conditions:

- Duct pressure less than 11 psi with the related engine running
- Cabin altitude exceedance
- Selection of manual outflow valve operation
- Manual input of landing altitude
- Differential pressure exceedance
- Display of a related alert message
- Selection of the air synoptic display.

The ECS data block goes away after the condition which caused it goes away.

Duct pressure shows these colors for these conditions:

- White when duct pressure is 11 psi or more
- Amber if duct pressure is less than 11 psi.

Cabin altitude shows these colors for these conditions:

- White for a cabin altitude of 8500 feet or lower
- Amber if cabin altitude is higher than 8500 feet
- Red if the cabin altitude warning message shows.

Differential pressure shows these colors for these conditions:

- White if the ~P is less than 8.8 psid.
- Amber if the ~P is more than, or equal to, 8.8 psid.
- Red if the ~P is more than, or equal to, 9.1 psid.

Cabin Altitude Warning Message

A warning message shows if cabin altitude is higher than a safe limit. The cabin altitude at which the warning message shows is related to the selected landing altitude:

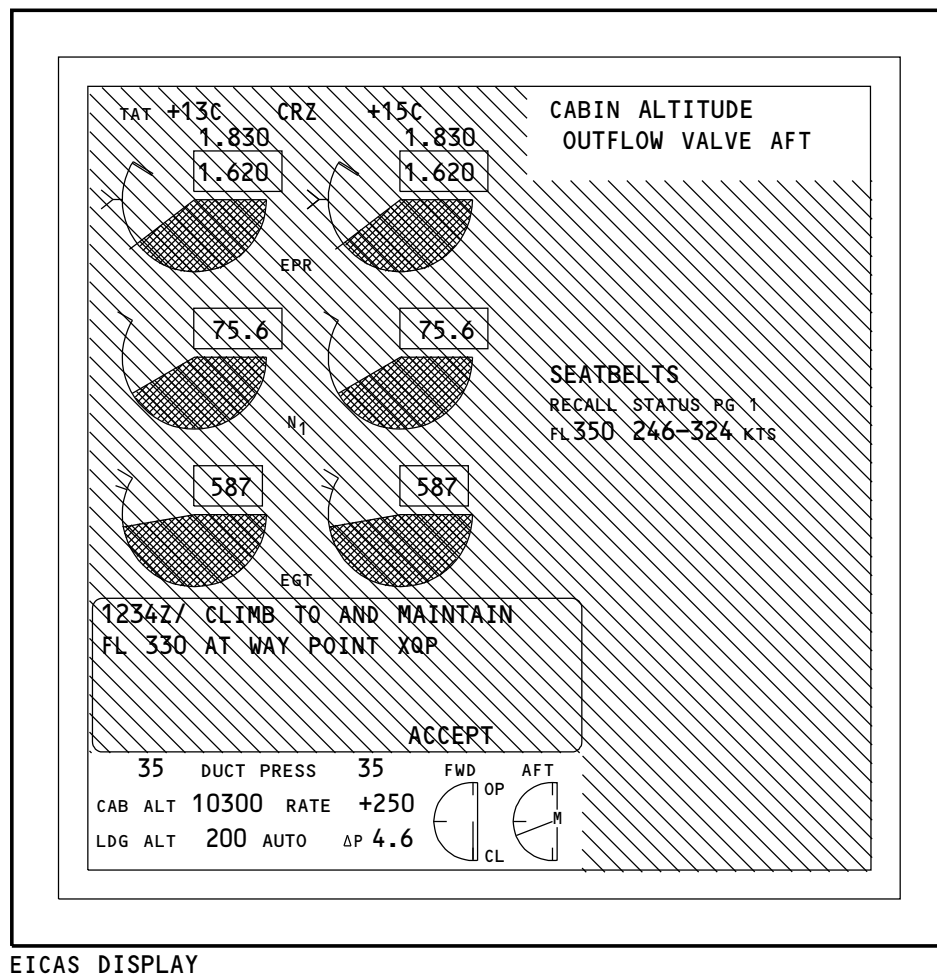
- If the landing altitude is 9,650 feet or lower, then the warning message shows at 10,000 feet
- If the landing altitude is higher than 9,650 feet, then the warning message shows at 14,200 feet
- If the landing altitude data is not valid, then the warning message shows at 15,000 feet.

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AIR CONDITIONING - PRESSURIZATION - INDICATIONS - EICAS DISPLAY

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AIR CONDITIONING - PRESSURIZATION - INDICATIONS - AIR SUPPLY MAINTENANCE PAGE FORMAT

Air Supply Maintenance Page

The air supply maintenance page shows this cabin pressure system information:

- Cabin altitude (CAB ALT)
- Rate in feet per minute
- Landing altitude (LDG ALT)
- Indication of landing altitude from AIMS (AUTO) or from bleed air/pressurization panel (MAN)
- Differential pressure (~P)
- Indication of left (L) or right (R) air supply/cabin pressure controller (ASCPC) in control (message goes away if none are in control).

The air supply maintenance page shows this outflow valve information:

- Forward and aft outflow valve position (0.00 closed, 1.00 fully open)
- Indication of manual (MAN) control of each outflow valve (no indication shows for automatic control).

ARO ALL	EFFECTIVITY

AIR SUPPLY			
	L	R	
HIGH PRESS S/O VLV	OPEN	OPEN	
PRESS REG S/O VLV	OPEN	OPEN	
FAN AIR VLV	CLOSED	CLOSED	
STARTER VLV	CLOSED	CLOSED	
ENG HIGH STAGE PRESS	120	120	
INTERIM DUCT PRESS	38	38	
MANIFOLD DUCT PRESS	38	38	
PRECOOLER OUT TEMP	400	400	
BLEED FLOW RATE	120	120	
ENG N1 FAN SPEED	90	90	
LEFT ISO VLV		OPEN	
CENTER ISO VLV		CLOSED	
RIGHT ISO VLV		OPEN	
APU ISO VLV		CLOSED	
FLIGHT PHASE		CRUISE	

CABIN PRESSURE SYSTEM:				OUTFLOW VALVES	
				FWD	AFT
CAB ALT	5000	RATE	+125		
LDG ALT	3000	AUTO	ΔP 7.0	0.45	0.45
ASCPC IN CONTROL	L			MAN	

AC TEMP ZONE	DATE 17 JAN 91	UTC 18:44:33

AIR SUPPLY MAINTENANCE PAGE

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AIR CONDITIONING - PRESSURIZATION - INDICATIONS - AIR SUPPLY MAINTENANCE PAGE FORMAT

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Page 9
May 05/2015

AIR CONDITIONING - PRESSURIZATION - SYSTEM TESTS**General**

These are the pressurization system tests that show when you select ATA 21 Cabin Pressure Control System:

- Left cabin pressure control system
- Right cabin pressure control system.

Left and Right Cabin Pressure Control System

These tests make sure that these LRUs operate correctly:

- Cabin pressure control function of the related ASCPC
- Forward outflow valve
- Aft outflow valve.

During the test, the outflow valves move. The tests take approximately 1-2 minutes each.

**WARNING**

MAKE SURE THAT PERSONS ARE CLEAR OF THE FORWARD AND THE AFT OUTFLOW VALVE ASSEMBLIES BEFORE YOU DO THIS TEST. INJURY TO PERSONS CAN OCCUR.

GROUND TESTS

SELECT ATA SYSTEM (55)

- 21 ENVIRONMENTAL CONTROL SYSTEM
- 21 CABIN PRESSURE CONTROL SYSTEM
- 21 CABIN TEMPERATURE CONTROL SYSTEM
- 22 AUTOPILOT FLIGHT DIRECTOR SYSTEM
- 22 AIMS - AUTO THROTTLE
- 23 HF COMMUNICATION SYSTEM
- 23 VHF COMMUNICATION SYSTEM
- 23 SATELLITE COMMUNICATIONS (SATCOM) SYSTEM
- 23 AIMS - DATA COMMUNICATION MANAGEMENT

SELECT TEST TYPE

☒ SYSTEM TEST

☐ OPERATIONAL TEST

☐ DEPLOYMENT TEST

SELECT SYSTEM TEST (2)

LEFT CABIN PRESSURE CONTROL SYSTEM

RIGHT CABIN PRESSURE CONTROL SYSTEM

CONTINUE

HELP

GO BACK

SELECT SYSTEM TEST (2)

LEFT CABIN PRESSURE CONTROL SYSTEM
RIGHT CABIN PRESSURE CONTROL SYSTEM

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AIR CONDITIONING - PRESSURIZATION - SYSTEM TESTS

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21-30-00-006

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - INTRODUCTION

Purpose

The cabin pressure control system (CPCS) controls the amount of air that flows out of the airplane. This keeps the cabin air pressure within acceptable limits at all airplane operating altitudes (-2,000 through 43,100 feet, -610 through 13,146 meters).

Physical Description

The cabin pressure control system has these components:

- One remote cabin pressure sensor
- Flight deck controls
- Two outflow valves.

There are two outflow valve part numbers, 2214420 is referred to as the OFV (outflow valve) and 2119160 is referred to as the CPOV (cabin pressure outflow valve). These LRUs can be installed in multiple configurations. The CPCS control mode is dependent on the installed configuration. The default control mode is referred to as the fixed rate control mode. The CPCS operates in the minimum rate control mode if an OFV is installed in the aft position or the CPOV in the aft position is disabled by opening the applicable circuit breakers.

For more information on the CPCS control modes see: 21-31-00-006 and 21-31-00-012

Interfaces - Minimum Rate Control Mode

The air supply cabin pressure controllers (ASCPCs) provide control, indications, and bit for the CPCS in the minimum rate control mode. The controllers also have an internal sensor that they use to monitor cabin pressure. The internal sensor is used for control and to give an output on the ARINC 629 buses. The ASCPCs are part of the engine air supply system. See the engine air supply section for more information about the ASCPC interfaces related to cabin pressure control (SECTION 36-11).

The remote cabin pressure sensor sends data to the AIMS, the ASCPCs, and ELMS. AIMS uses the remote sensor data as an alternative to the ASCPC cabin pressure data.

The ASCPCs use the remote cabin pressure sensor to cross check data from their internal cabin pressure sensor.

ELMS sends the remote cabin pressure sensor data on the ARINC system buses. ELMS also uses the remote cabin pressure sensor data as an alternative to the ASCPC cabin pressure data.

Interfaces - Fixed Rate Control Mode

The air supply cabin pressure controllers (ASCPCs) provide communications, indications, and bit for the CPCS. The aft CPOV provides control in the fixed rate control mode. The ASCPCs are part of the engine air supply system. See the engine air supply section for more information about the ASCPC interfaces related to cabin pressure control (SECTION 36-11).

The ASCPCs can provide backup control for this system if there is a failure of the aft cabin pressure outflow valve (CPOV). Control of the CPCS by the ASCPCs provides dispatch relief for airplanes with the aft CPOV failed. To operate the CPCS with the ASCPCs in control the applicable circuit breakers for the aft CPOV must be opened. When the ASCPCs provide control the CPCS operates in the minimum rate control mode.

The ASCPCs have an internal sensor that they use to monitor cabin pressure. When the ASCPCs are in control of the cabin pressure the internal sensor is used for control and to give an output on the ARINC 629 buses.

The CPOVs have an internal sensor that they use to monitor cabin pressure. When the CPOVs are in control of the cabin pressure the internal sensor is used for control and to give an output on the ARINC 629 buses.

The remote cabin pressure sensor sends data to the AIMS, the ASCPCs, and ELMS. AIMS uses the remote sensor data as an alternative to the CPOV cabin pressure data.

The ASCPCs use the remote cabin pressure sensor to cross check data from the CPOVs internal cabin pressure sensor.

ELMS sends the remote cabin pressure sensor data on the ARINC system buses. ELMS also uses the remote cabin pressure sensor data as an alternative to the CPOV cabin pressure data.

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**AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - INTRODUCTION****Interfaces - Fixed Rate or Minimum Rate Control Mode**

See these sections for more information about the ELMS interfaces related to cabin pressure:

- Passenger compartment illumination (SECTION 33-21)
- Information signs (SECTION 33-22)
- Passenger Oxygen System (SECTION 35-21).

The ASCPCs usually get landing altitude from the flight management computing function (FMC) of the AIMS. As an alternative to the FMC, the flight crew can manually set landing altitude from the bleed air/pressurization panel.

The cabin pressure control system also interfaces with these systems/LRUs:

- ADIRS
- AFDS
- CMCF
- ECSMC
- EEC
- EFIS
- FMC
- OPAS
- PDF
- Left (right) WOW card.

See the engine air supply section for more information about the interfaces related to the ASCPCs and cabin pressure control (SECTION 36-11).

General Description

The flight crew sets automatic or manual control of the outflow valves from the flight deck.

Each valve is controlled independently. You can set auto for one and manual for the other.

Auto Control

In the automatic mode, the left ASCPC usually controls the position of the valves. The right ASCPC gives backup control.

In the automatic mode, the left channel of the aft CPOV usually controls the position of the valves. The right channel of the aft CPOV gives backup control.

Automatic control supplies these functions, most important first:

- Controls the cabin-to-ambient differential pressure to a maximum of 8.6 $\pm$.05 psid
- Limits the cabin pressure rate-of-change
- Controls the cabin altitude to no more than 8000 feet (2440 meters)
- Limits takeoff and landing pressure bump
- Controls the ratio of air outflow between the forward and aft outflow valves.

Manual Control

For manual control the flight crew controls cabin rate-of-change and cabin altitude by manually controlling the position of the outflow valves. The flight crew use the outflow valve switches on the P5 panel to enable manual control.

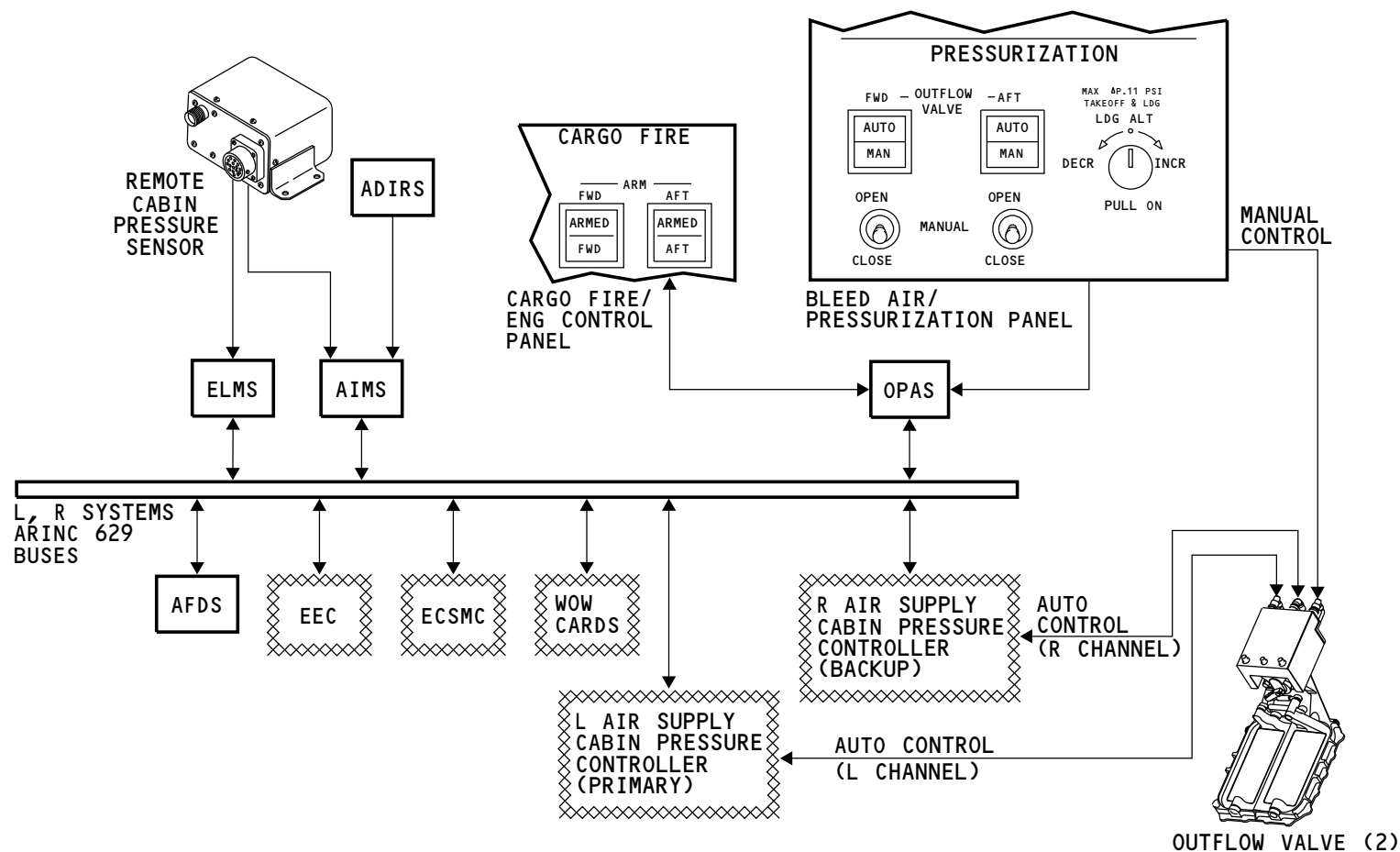
Once manual control is selected, the flight crew uses the outflow valve manual switches to control the position of the outflow valves.

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - INTRODUCTION

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**AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - AIR SUPPLY CABIN PRESSURE CONTROLLER****General**

The air supply cabin pressure controllers (ASCPCs) control the pneumatic system. The ASCPCs can also control the cabin pressure control system (CPCS). Control of the CPCS by the ASCPCs is dependent on the installed configuration. For more information on the possible installed configurations and the CPCS control modes see: (21-31-00-001).

Location

The left and right ASCPCs are in the MEC on the E1 and E2 racks.

Physical Description

The ASCPCs have test and cabin pressure sense ports on the front. The test port is for in-shop service. The cabin pressure sense port lets the controllers monitor cabin pressure.

The ASCPCs use operational program software (OPS) that you can load.

Training Information Point

The ASCPCs are LRUs. The circuit cards inside the ASCPC are not LRUs.

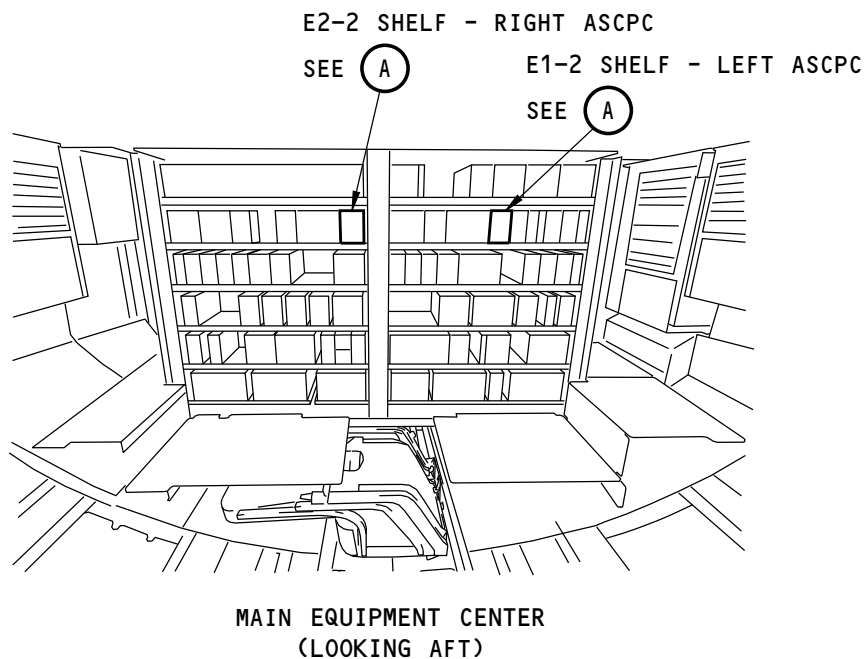
The left and right ASCPCs are interchangeable.

See the engine air supply section for more information about the ASCPCs (SECTION 36-11).

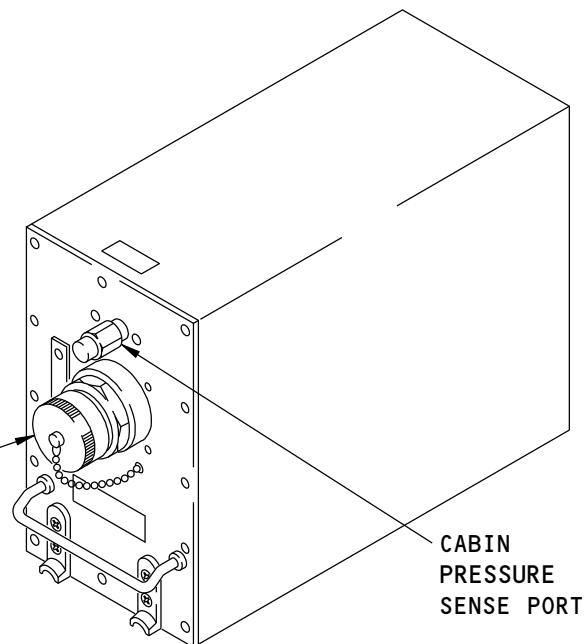
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TEST
CONNECTOR



AIR SUPPLY CABIN PRESSURE CONTROLLER
(TYPICAL)

(A)

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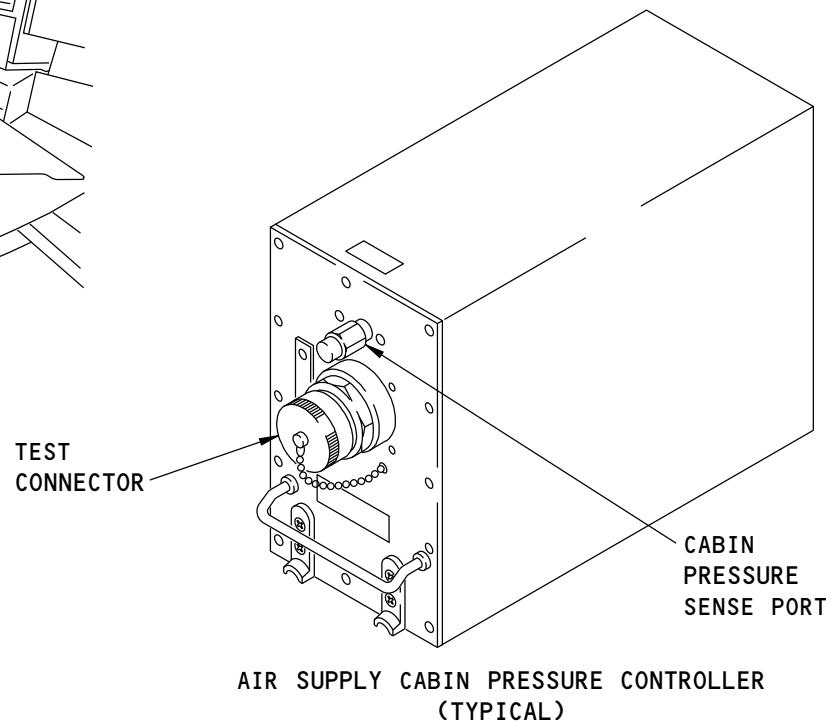
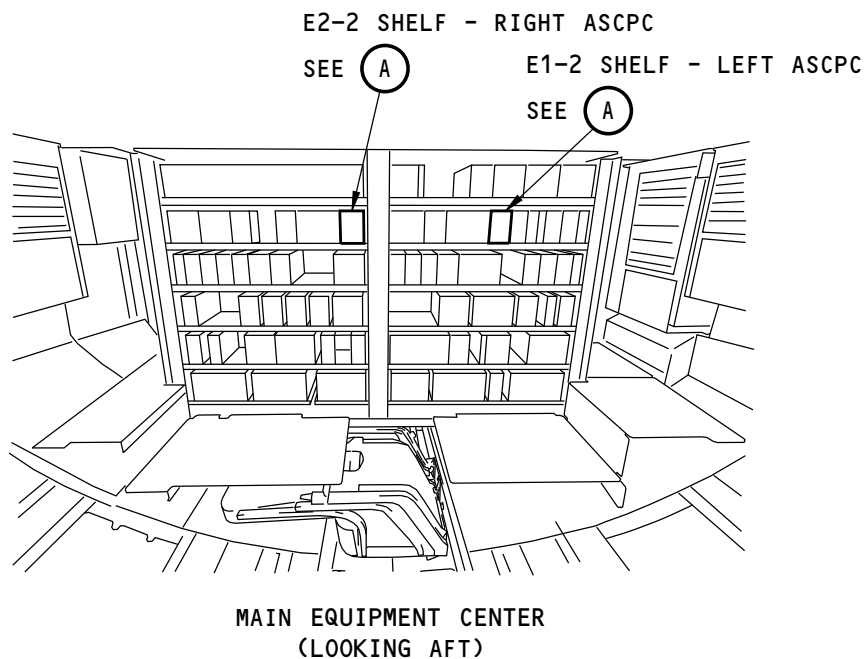
AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - AIR SUPPLY CABIN PRESSURE CONTROLLER

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ARO ALL; AIRPLANES WITH ASCPC P/N 1152972

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - AIR SUPPLY CABIN PRESSURE CONTROLLER

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - OUTFLOW VALVE - INTRODUCTION**Purpose**

Forward and aft outflow valves allow the flow of pressurized cabin air out of the airplane.

Location**ARO ALL**

The aft outflow valve is adjacent to the aft waste tank. Access is through the aft waste tank enclosure panel at the rear of the bulk cargo compartment.

ARO ALL; AIRPLANES WITH OUTFLOW VALVE P/N 2214420

The forward outflow valve is below the P110 left power management panel in the main equipment center.

Physical Description

The outflow valve can be installed in the forward or aft location. The valve weighs approximately 30.25 lbs (13.72 kg). Each valve has these assemblies:

- Actuator assembly
- Frame assembly
- Gearbox assembly.

The actuator assembly has these line replaceable components:

- Outflow valve control unit
- Left outflow valve motor
- Right outflow valve motor
- Outflow valve gearbox assembly.

The frame assembly has these parts:

- Door (2)
- Nut plate (18)
- Push rod (2).

The valve control unit is a two channel controller. The unit has these parts:

- Airplane electrical connectors (3)
- RVDT electrical connector (1)
- Motor electrical connector (2).

The gearbox assembly has reduction gears, two internal RVDTs and an actuator crank.

Training Information Point

You can remove the forward outflow valve only from inside the airplane. You can remove the aft outflow valve from outside the airplane or from inside the airplane.

ARO ALL

To prepare for pressurized flight with an outflow valve that does not operate, set the position of the valve to a specified position, then open the applicable circuit breakers.

ARO ALL; AIRPLANES WITH OUTFLOW VALVE P/N 2214420

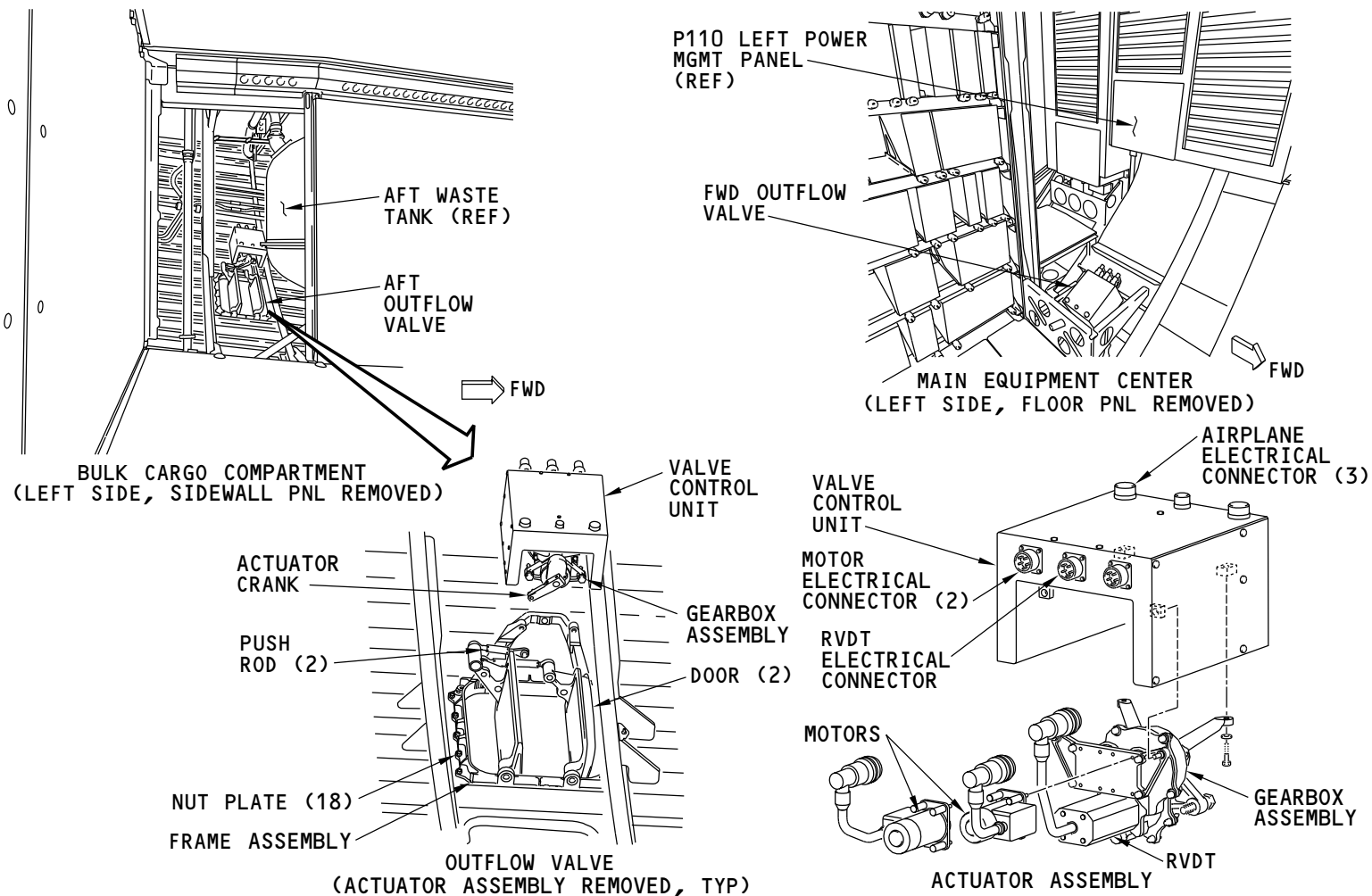
To prepare the airplane for unpressurized flight with outflow valves that do not operate, lock the valves open.

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EFFECTIVITY
ARO ALL; AIRPLANES WITH OUTFLOW VALVE P/N 2214420

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M35759 S000612394_V2

AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - OUTFLOW VALVE - INTRODUCTION

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - OUTFLOW VALVE - FUNCTIONAL DESCRIPTION**General**

The outflow valve control unit (VCU) has two channels. The left channel controls the left outflow valve motor, and the right channel controls the right outflow valve motor. Each channel has a separate power supply.

In the minimum rate control mode, the left channel has an interface with the left ASCPC and the right channel has an interface with the right ASCPC. The channels have interfaces with the ASCPC on an ARINC 429 bus.

An outflow valve in the forward position can be operated in the fixed rate control mode. In the fixed rate control mode the left channel has an interface with the left channel of the aft CPOV. The right channel has an interface with the right channel of the aft CPOV. The channels have interfaces with the ECUs and ASCPCs on an ARINC 429 bus. For the CPCS fixed rate control mode configuration requirements see: 21-31-00-001.

The CPCS will always operate in the minimum rate control mode if an outflow valve (OFV) is installed in the aft position.

For manual control of the outflow valve, both channels have an interface with the bleed air/pressurization panel.

Outflow Valve Control Unit

The valve control unit has these functions:

- Controls motor speed and position
- Monitors valve position (RVDTs)
- Supplies BITE.

The forward and aft outflow valves operated in the minimum rate control mode receive motor control inputs from the ASCPCs. In the automatic mode, the motor control logic uses information from the related ASCPC to set motor speed and the position of the outflow valve. The valve can open or close completely in less than 10 seconds for the automatic mode. ASCPC information usually causes the VCU to change motor speed for smooth changes in cabin pressure.

A forward outflow valve that is operated in the fixed rate control mode receives inputs from the ECUs on the aft cabin pressure outflow valve. In the automatic mode, the motor control logic uses information from the related ECU to set motor speed and the position of the outflow valve. The valve can open or close completely in less than 10 seconds for the automatic mode. ECU information usually causes the VCU to change motor speed for smooth changes in cabin pressure.

In the manual mode, the motor control logic uses the signal from the outflow valve manual switches on the bleed air/pressurization panel to open or close the outflow valve. The valve can open or close completely in approximately 27 seconds for the manual mode.

Two RVDTs that are part of the gearbox send valve position information back to the VCU and ASCPCs in automatic and manual modes.

Outflow Valve Motors

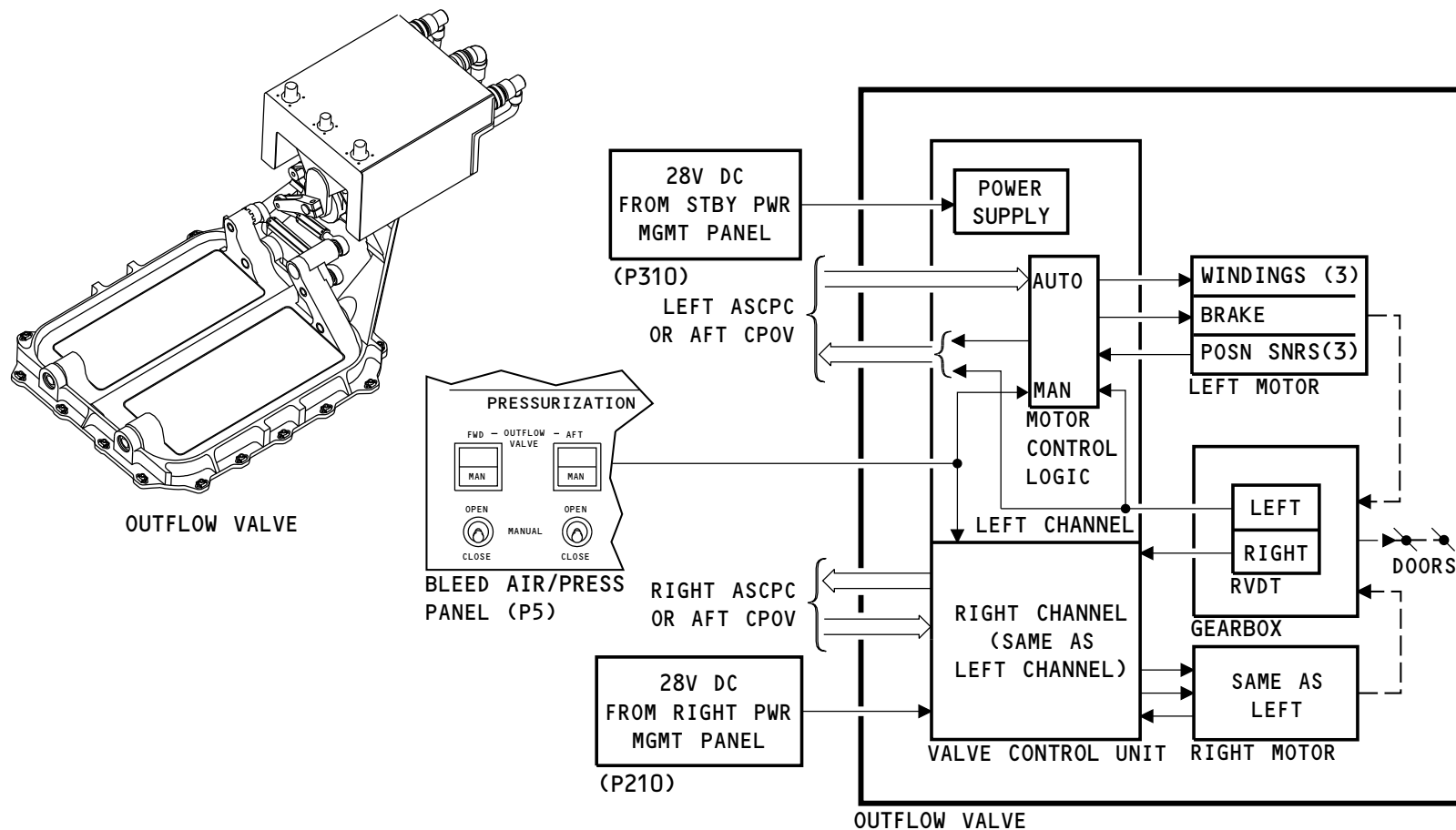
A brake solenoid in the motor stops movement when the motor does not have a command to turn. Sensors in the motor give rotor position information to the VCU. The VCU uses rotor position to monitor motor speed. Both motors mechanically connect to the gearbox.

Gearbox

The gearbox changes the motor inputs to door and RVDT positions.

BITE

The VCU continuously monitors for outflow valve faults. If the VCU finds a fault, the VCU supplies the fault data to the ASCPCs for indication and to keep in memory.



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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - OUTFLOW VALVE - FUNCTIONAL DESCRIPTION

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**AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - CABIN PRESSURE OUTFLOW VALVE - INTRODUCTION****Purpose**

Forward and aft cabin pressure outflow valves control the flow rate of pressurized cabin air out of the airplane.

Location**ARO ALL**

The aft cabin pressure outflow valve is adjacent to the aft waste tank. Access is through the aft waste tank enclosure panel at the rear of the bulk cargo compartment.

ARO ALL; AIRPLANES WITH OUTFLOW VALVE P/N 2119160

The forward cabin pressure outflow valve is below the P110 left power management panel in the main equipment center.

Physical Description

Both forward and aft cabin pressure outflow valves are the same. The valve weighs approximately 34.0 lbs (15.45 kg). Each valve has these assemblies:

- Valve controller assembly
- Frame assembly
- Gearbox assembly

The valve controller assembly has these line replaceable units:

- Left electronic control unit
- Right electronic control unit
- Left DC auto motor
- Right DC auto motor
- Wiring harness.

The frame assembly has these parts:

- Door (2)
- Nut plate (18)

- Push rod (2).

The gearbox assembly has compound planetary gears and an actuator crank. A manual control module which includes a series wound brush DC motor is attached to the gearbox assembly. The gearbox assembly and the manual control module are not line replaceable units.

Training Information Point

You can remove the forward cabin pressure outflow valve only from inside the airplane. You can remove the aft cabin pressure outflow valve from outside the airplane or from inside the airplane.

To prepare for pressurized flight with a cabin pressure outflow valve that does not operate, set the position of the valve to a specified position, then open the applicable circuit breakers.

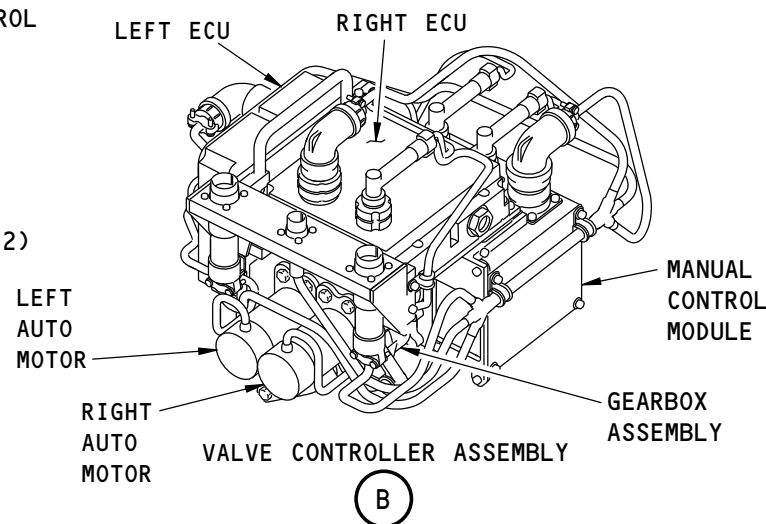
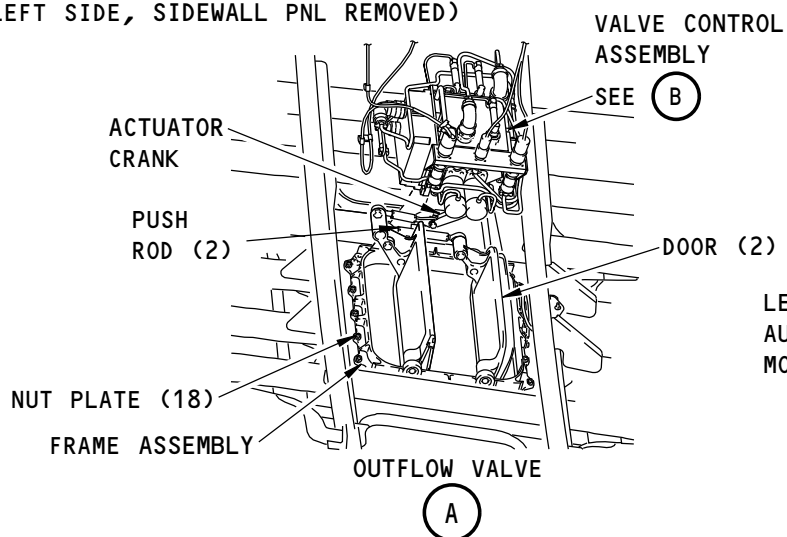
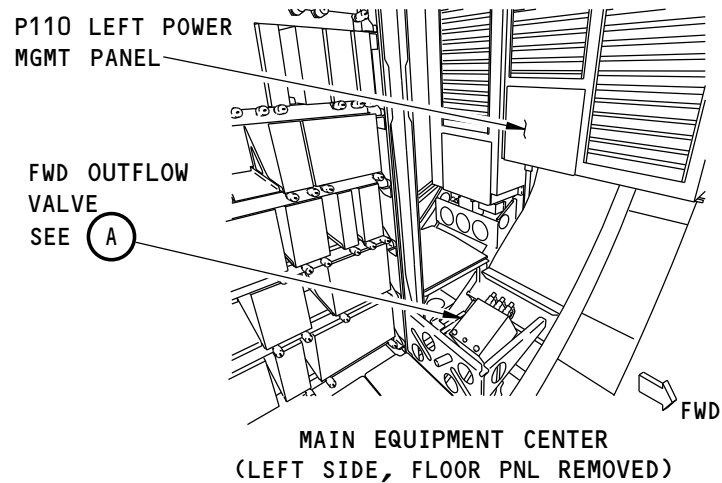
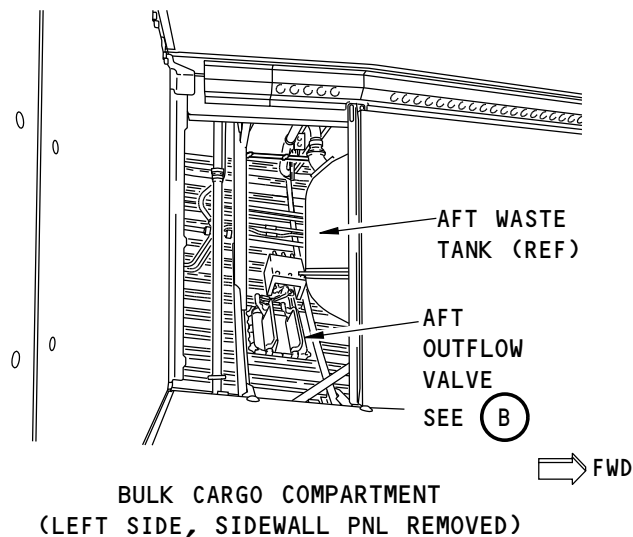
To prepare the airplane for unpressurized flight with cabin pressure outflow valves that do not operate, lock the valves open.

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - CABIN PRESSURE OUTFLOW VALVE - INTRODUCTION

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**AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - CABIN PRESSURE OUTFLOW VALVE - FUNCTIONAL DESCRIPTION****General**

Two electronic control units (ECU) are a part of the CPOV controller assembly. Each ECU controls one auto motor. The left ECU controls the left auto motor on the left channel. The right ECU controls the right auto motor on the right channel. Each ECU has a separate power supply.

The left channel has an interface with the left ASCPC and the right channel has an interface with the right ASCPC. These interfaces allow the ASCPC to control the auto motor when there is a fault in the ECU that controls the CPOV. The channels have interfaces with the ASCPC on an ARINC 429 bus.

There is a third motor for manual control of the CPOV. Selection of manual control electrically disconnects the two auto motors. For manual mode operation, both channels have an interface with the bleed air/pressurization panel.

Outflow Valve Electronic Control Unit

The electronic control units have these functions:

- Controls motor speed and position
- Monitors valve position
- Supplies BITE.

In the automatic mode, the motor control logic uses information from the related ECU to set motor speed and the position of the outflow valve. The valve can open or close completely in less than 10 seconds for the automatic mode.

In the manual mode discrete signals from the manual switches on the bleed air/pressurization panel open or close the outflow valve. The valve can open or close completely in approximately 15 seconds for the manual mode.

Outflow Valve Motors

A brake solenoid in the motor stops movement when the motor does not have a command to turn. Sensors in the motor give rotor position information to the ECU. The ECU uses rotor position to monitor motor speed. All three motors mechanically connect to the gearbox.

Gearbox

The gearbox changes the motor inputs to door positions. Three potentiometers send valve position information back to the ECUs and ASCPCs in automatic and manual modes.

BITE

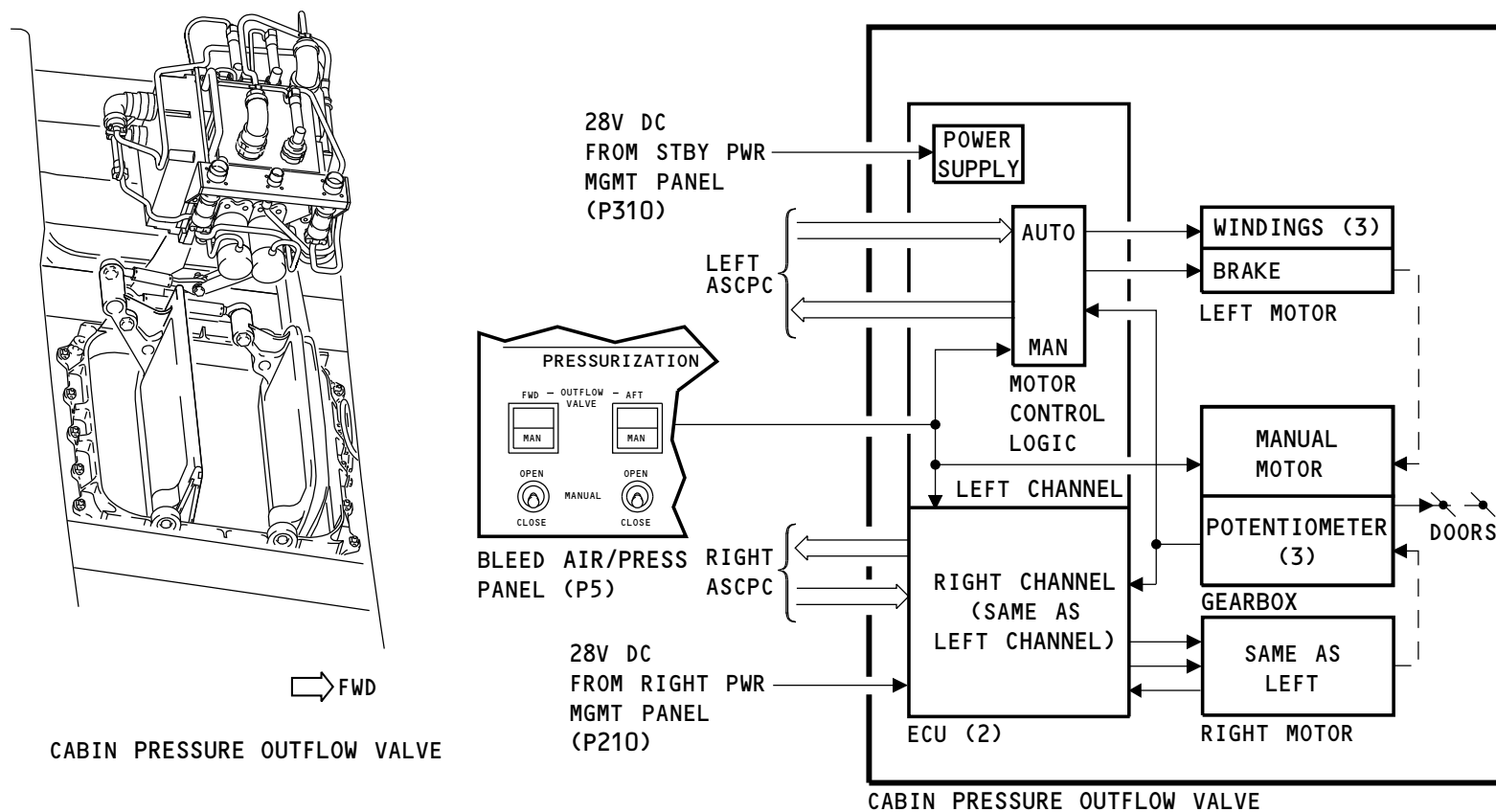
The ECU continuously monitors for outflow valve faults. If the ECU finds a fault, the ECU supplies the fault data to the ASCPCs for indication and to keep in memory.

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - CABIN PRESSURE OUTFLOW VALVE - FUNCTIONAL DESCRIPTION

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**AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - REMOTE CABIN PRESSURE SENSOR****Purpose**

The remote cabin pressure sensor measures cabin air pressure independently of the ASCPCs.

Physical Description

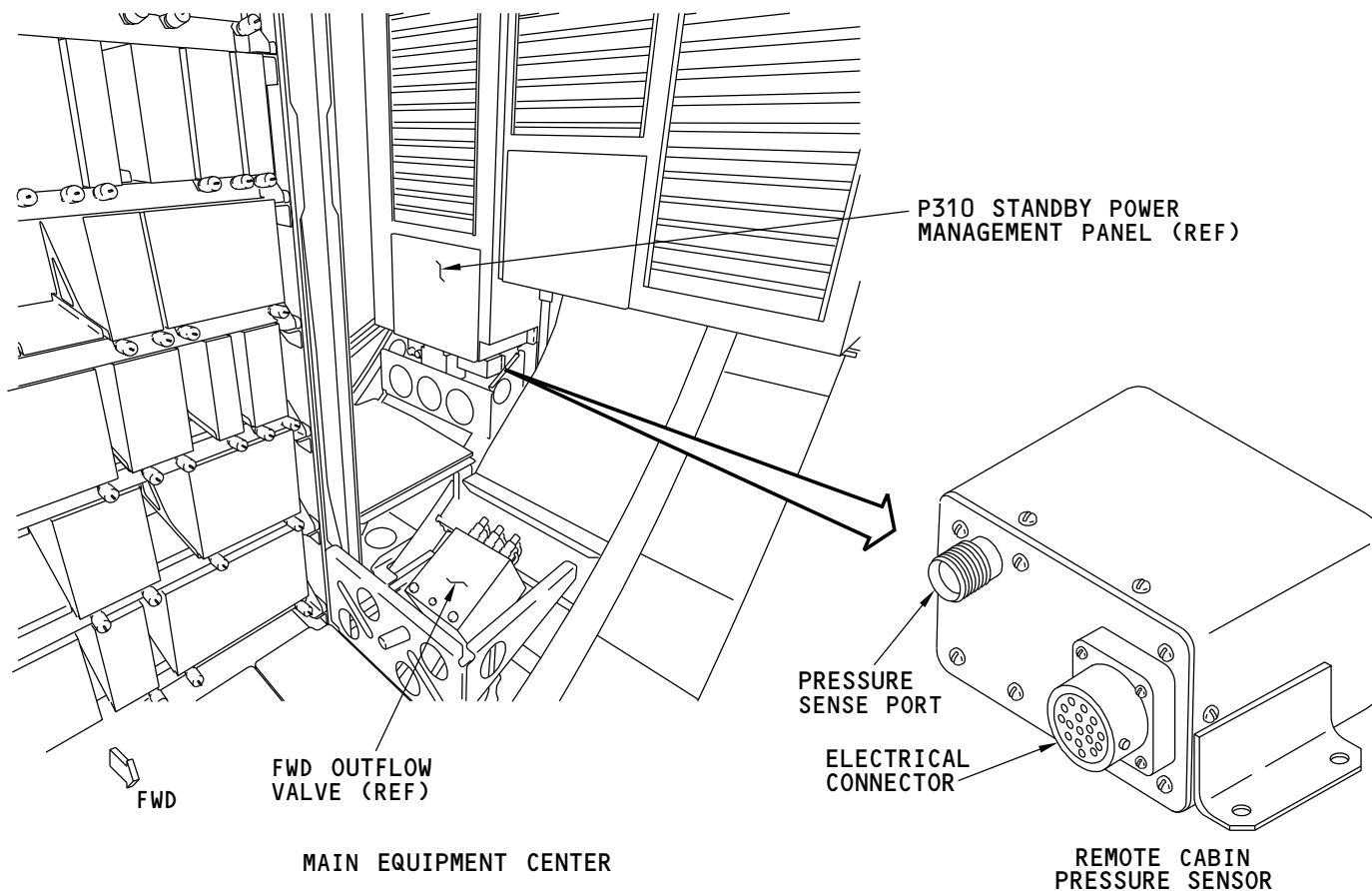
The sensor is an electronic device. It has an internal pressure sensor

Location

The remote cabin pressure sensor is in the main equipment center below the P310 standby power management panel.

The remote cabin pressure sensor mounts with the pressure sense port down. This keeps air velocity effects to a minimum.

The central maintenance computing system (CMCS) does not test the remote cabin pressure sensor.



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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - REMOTE CABIN PRESSURE SENSOR

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**AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - BLEED AIR/PRESSURIZATION PANEL****Bleed Air/Pressurization Panel**

These controls are on the bleed air/pressurization panel:

- Forward and aft outflow valve switches
- Forward and aft outflow valve manual switches
- Landing altitude selector.

Outflow Valve Switches

The forward and aft outflow valve switches set the outflow valves to automatic or manual operation. The switches are alternate-action switches. The AUTO indication on the switch shows the valves in automatic operation. When the MAN indication shows, the valves are in manual operation. In the MAN position, the ECS (environmental control system) data block shows on the EICAS display. The selection of the MAN position causes these indications:

- The related advisory message, OUTFLOW VALVE FWD (AFT) shows on the EICAS display
- The caution message, CABIN ALTITUDE AUTO shows on the EICAS display if both valves are set to MAN
- An M shows on the related valve position indicator in the ECS data block
- MAN shows below the valve position data on the air supply maintenance page (not shown).

Outflow Valve Manual Switches

The forward and aft outflow valve manual switches set the position of the outflow valves. The switches are toggle type switches with a spring-loaded center off position. These switches only function when the outflow valve switches are in the MAN position. Valve position shows in the ECS data block.

Landing Altitude Control

When the knob on the landing altitude selector is in, the ASCPC uses landing altitude data from the flight management computing function (FMC) of AIMS.

When the landing altitude selector is out, the ECS data block shows and MAN shows next to the landing altitude data. MAN also shows on the air supply maintenance page (not shown) next to the landing altitude data. The landing altitude selector sets the landing altitude value. The ASCPC uses this value for landing altitude.

The flight crew moves the landing altitude control to the right to increase or to the left to decrease the landing altitude. The control is spring-loaded to the center position. The landing altitude limits are 1,000 feet below sea level to 14,000 feet above sea level.

Training Information Point

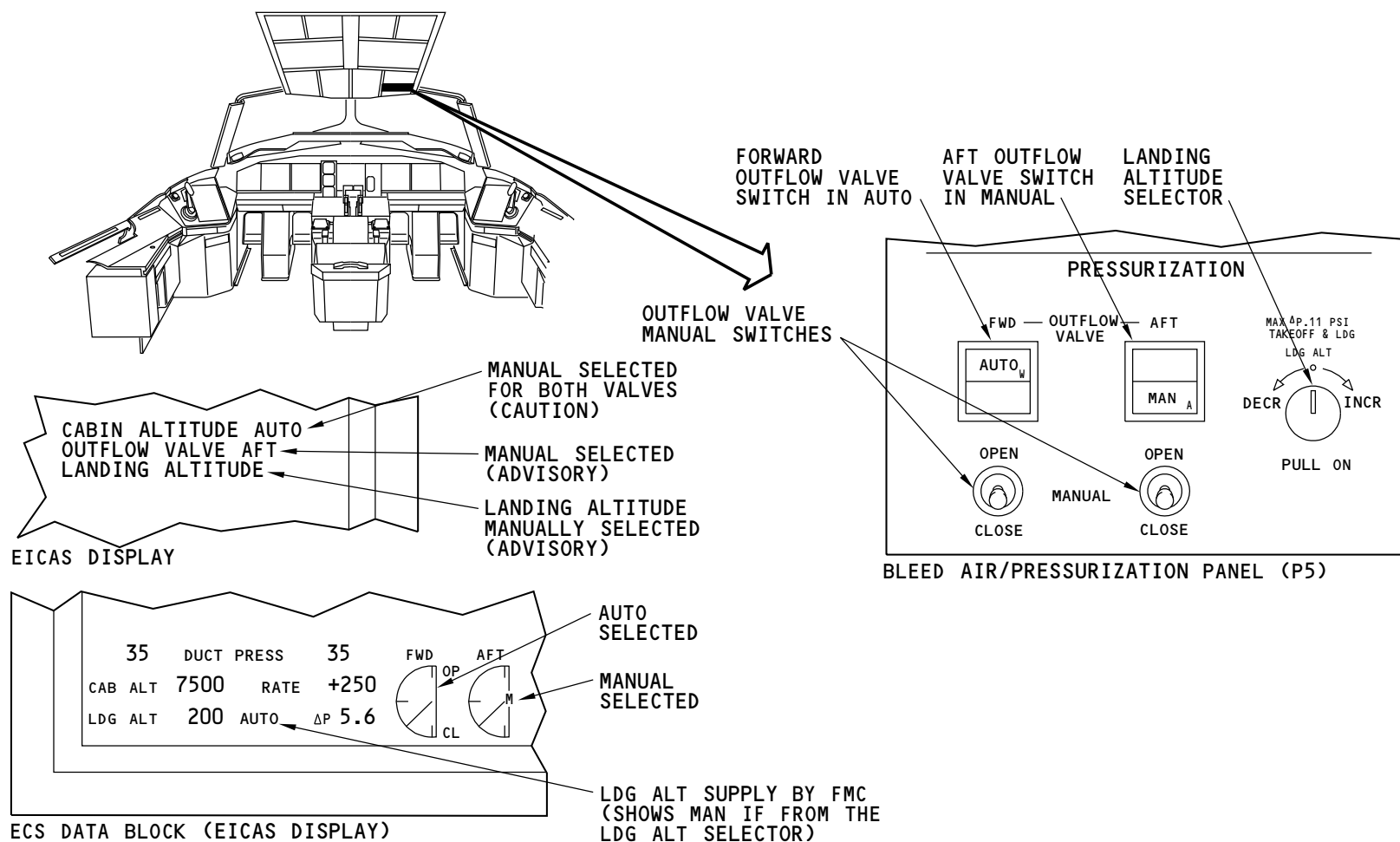
One outflow valve can operate in automatic mode and the other can operate in manual mode at the same time.

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - BLEED AIR/PRESSURIZATION PANEL

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**AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - MINIMUM RATE CONTROL MODE****General**

In the minimum rate control mode, the air supply cabin pressure controllers (ASCPCs) supply control, indications, and BIT for the cabin pressure control system. ARINC 429 buses connect the ASCPCs to the related channels of the VCU (outflow valves) or ECU (cabin pressure outflow valves). The left and right channels get power from a different bus. The outflow valve switches on the bleed air/pressurization panel set automatic or manual mode.

The ASCPCs have these modes of operation:

- Initialization (power up)
- Preflight BIT
- Automatic.

Initialization

The initialization mode runs when the ASCPCs first get power or when you install new software.

When the initialization mode is on, the ASCPCs do a check of these components and functions:

- Memory functions
- Checks if ground test is selected
- Software compatibility (left ASCPC to right ASCPC).

Preflight BIT

The ASCPCs do a preflight BIT when the airplane is on the ground and one or the two outflow valve switches are in AUTO.

When the preflight BIT mode is on, the ASCPCs do internal checks and an operational check of the outflow valves. During these checks, the outflow valves move. If there are faults, flight deck indications show.

Automatic Mode

When the outflow valve switches are in AUTO, the OPAS sends a signal to the ASCPCs. This sets the outflow valves for automatic operation.

Usually, the left ASCPC controls the left motor in each outflow valve through the left channels of the VCU (outflow valves) or ECU (cabin pressure outflow valves). If, because of system failures, the left ASCPC cannot control both valves, the control configuration changes. This is the control sequence:

- L ASCPC is in control if it can control both valves
- R ASCPC is in control if it can control both valves
- L ASCPC is in control if it can control the aft valve
- R ASCPC is in control if it can control the aft valve
- L ASCPC is in control if it can control the forward valve
- R ASCPC is in control if it can control the forward valve.

Usually the ASCPC commands the positions of the valves so that 20 percent of the outflow is through the forward valve and 80 percent is through the aft valve. This changes if one of the ASCPCs cannot control both valves. In that condition, each valve permits 50 percent of the outflow. This helps prevent loss of cabin pressure control if one valve fails so that it can not be controlled by the left or right ASCPC.

The same change occurs if any of these conditions occur:

- Forward or aft cargo fire switches set to ARMED
- Forward cargo air conditioning system enabled.

This keeps smoke or odors from the cargo compartment out of the cabin area. It also keeps a sufficient concentration of extinguishing agent in the cargo compartment.

The ASCPCs use the VCUs (outflow valves) or ECUs (cabin pressure outflow valves) to control cabin pressure and cabin pressure rate of the change. The VCUs (outflow valves) or ECUs (cabin pressure outflow valves) get speed commands from the ASCPC. The speed commands can move the outflow valve slowly or fast. The valve can move fully open or closed in less than 10 seconds.

The ASCPCs use this data to control cabin pressure:

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - MINIMUM RATE CONTROL MODE

SIGNAL	PRI SOURCE	BU SOURCE
Cabin Pressure	Active ASCPC	Other ASCPC
Ambient pressure	ADIRU	EEC
Ground speed	ADIRU	
Landing altitude	AIMS (FMCF)	Ldg Alt Selector
Differential press	AIMS (FMCF)	
Cruise altitude	AIMS (FMCF)	
Time for climb	AIMS (FMCF)	
Time for descent	AIMS (FMCF)	
ETA top of descent	AIMS (FMCF)	
Barometric correction	AIMS (PDF)	
Vertical nav on/off	AFDC	
Fwd cargo A/C enabled	Primary ECSMC	Other ECSMC
Air or ground mode	WOW	

Cabin pressure

The ASCPCs monitor cabin pressure from an internal sensor. The sensors also give an output on the ARINC 629 buses.

The remote cabin pressure sensor sends an analog pressure signal to the electrical load management system (ELMS). The ELMS puts this signal on the ARINC 629 buses. The ASCPCs use this data to do a BITE check of the internal cabin pressure sensors.

The remote sensor also gives an analog pressure output to the AIMS. The AIMS uses this signal if the cabin pressure data is not available from the ASCPCs or from ELMS.

Ambient Pressure

The ASCPCs usually get ambient pressure data from the ADIRU. If that data is not available or is not valid, the ASCPCs use ambient pressure data from the electronic engine control (EEC).

Landing Altitude

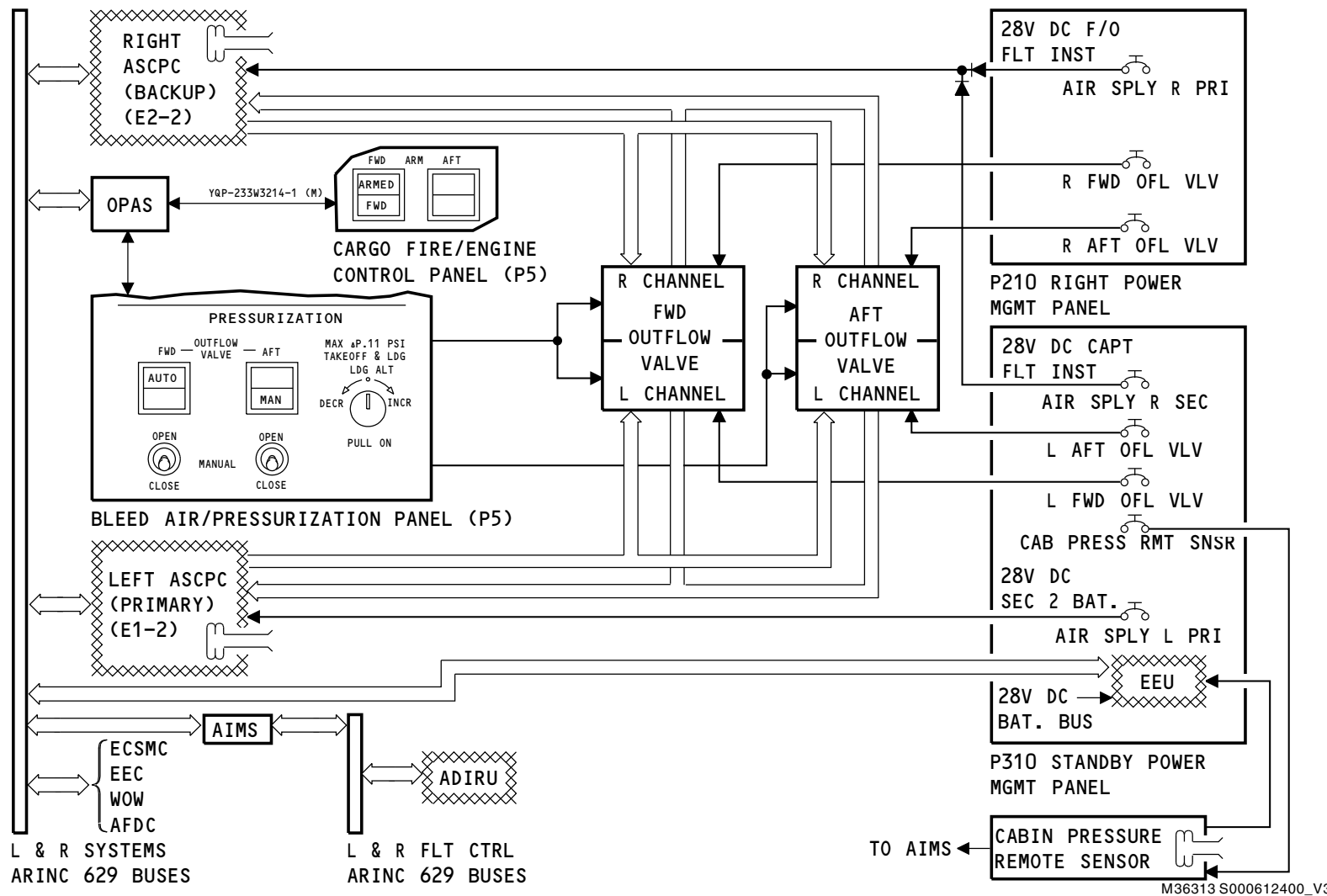
In usual operation, the flight management computing function (FMCF) of the AIMS sends landing altitude data to the ASCPCs. Alternatively, the flight crew manually sets the data with the landing altitude selector on the bleed air/pressurization panel.

Manual Mode

When an outflow valve switch is in the MAN position, the ASCPC releases control of that outflow valve. The outflow valve manual switch sends open or close signals to the left and right channels of the VCU (outflow valves) or manual motor (cabin pressure outflow valves). In the manual mode the outflow valve opens or closes at a fixed speed. In the manual mode the valve can open or close fully in approximately 27 seconds.

Training Information Point

You can use the MAT to do a ground test of the cabin pressure control system. The ground test is the same as the preflight BIT.



AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - MINIMUM RATE CONTROL MODE

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Page 24
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**AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - FIXED RATE CONTROL MODE****General**

The information that follows is applicable when the CPCS operates in the fixed rate control mode. For information on the minimum rate control mode see: 21-31-00-006

In the fixed rate control mode, the aft cabin pressure outflow valve (CPOV) supplies control, indications, and BIT for the cabin pressure control system. ARINC 429 buses connect the CPOV channels to their related ASCPCs. The left and right CPOV channels get power from a different bus. The switches on the bleed air/pressurization panel set automatic or manual mode.

An outflow valve (OFV) installed in the forward position can operate in the fixed rate control mode if a CPOV is installed in the aft position. When an outflow valve is installed in the forward position the ARINC 429 buses connect the aft CPOV channels to the VCU on the forward outflow valve.

The CPOVs have these modes of operation:

- Initialization (power up)
- Ground (preflight BIT)
- Automatic.

Initialization Mode

The initialization mode runs when the ASCPCs first get power or when you install new software.

When the initialization mode is on, the ASCPCs do a check of these components and functions:

- Memory functions
- Checks if ground test is selected
- Software compatibility (left ASCPC to right ASCPC).
- Establish communication with CPOVs.
- Determine CPCS control mode (fixed rate or minimum rate).

Ground Mode (Preflight BIT)

The ASCPCs do a preflight BIT when the airplane is on the ground and one or the two outflow valve switches are in AUTO.

When the preflight BIT mode is on, the CPOVs do internal checks and an operational check. During these checks, the outflow valve doors move. If there are faults the CPOVs annunciate the faults found to the ASCPCs. If no faults are found the ASCPCs return cabin pressure control to the aft CPOV.

Automatic Mode

When the outflow valve switches are in AUTO, the OPAS sends a signal to the ASCPCs. This sets the outflow valves for automatic operation.

Usually, the left ECU on the aft CPOV controls the left motor in each outflow valve through the left ECU channels. If, because of system failures, the left ECU cannot control both valves, the control configuration changes. This is the control sequence:

- L ECU (aft CPOV) is in control if it can control both valves
- R ECU (aft CPOV) is in control if it can control both valves

Usually the left ECU on the aft CPOV sets the position of each valve so that 20 percent of the outflow is through the forward valve and 80 percent is through the aft valve. This changes if the left ECU cannot control both valves. In that condition, each valve permits 50 percent of the outflow. This helps prevent loss of cabin pressure control if one valve fails so that it can not be controlled by the left or right ECU.

The same change occurs if any of these conditions occur:

- Forward or aft cargo fire switches set to ARMED
- Forward cargo air conditioning system enabled.

This keeps smoke or odors from the cargo compartment out of the cabin area. It also keeps a sufficient concentration of extinguishing agent in the cargo compartment.

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**AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - FIXED RATE CONTROL MODE**

The ECUs control cabin pressure and cabin pressure rate of the change. The ECUs give speed commands to the auto motors. The speed commands can move the outflow valve doors slowly or fast. The valve can move fully open or closed in less than 10 seconds.

The ECUs use this data to control cabin pressure:

SIGNAL	PRI SOURCE	BU SOURCE
Cabin Pressure	Active aft CPOV ECU	Other aft CPOV ECU
Ambient pressure	ADIRU	EEC
Ground speed	ADIRU	
Landing altitude	AIMS (FMCF)	Ldg Alt Selector
Differential press	AIMS (FMCF)	
Cruise altitude	AIMS (FMCF)	
Barometric correction	AIMS (PDF)	
Vertical nav on/off	AFDC	
Air or ground mode	WOW	
Fwd cargo A/C enabled	Primary ECSMC	Other ECSMC

Manual Mode

When an outflow valve switch is in the MAN position, the aft CPOV releases control. The outflow valve manual switch sends discrete inputs to the manual motor on the outflow valve. The manual motor opens or closes the outflow valve at a fixed speed. In the manual mode the valve can open or close fully in approximately 15 seconds.

Cabin pressure

The ECUs monitor cabin pressure from an internal sensor. The sensors also give an output on the ARINC 629 buses.

The remote cabin pressure sensor sends an analog pressure signal to the electrical load management system (ELMS). The ELMS puts this signal on the ARINC 629 buses. The ECUs use this data to do a BITE check of the internal cabin pressure sensors.

The remote sensor also gives an analog pressure output to the AIMS. The AIMS uses this signal if the cabin pressure data is not available from the ECUs or from ELMS.

Ambient Pressure

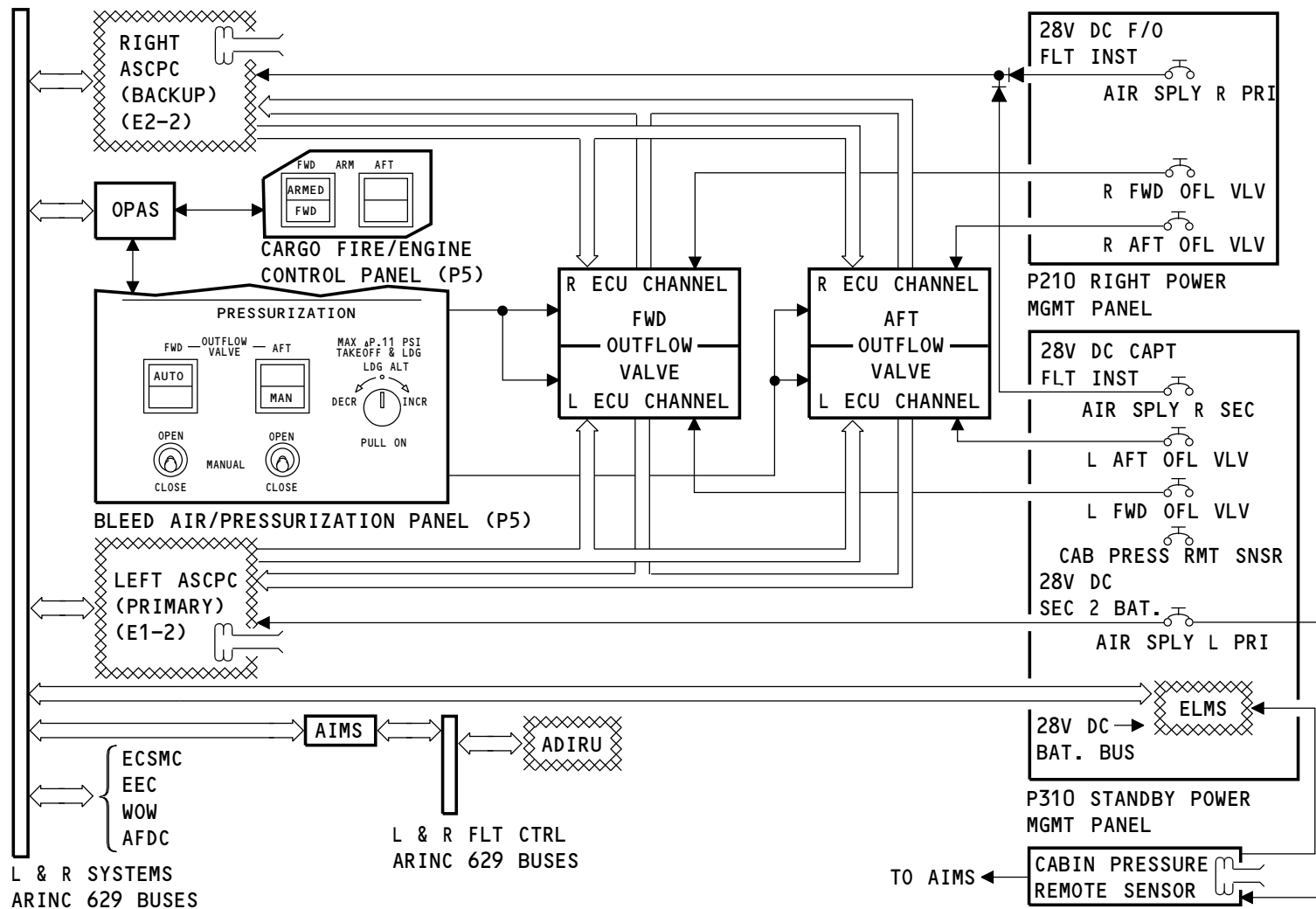
The ECUs usually get ambient pressure data from the ADIRU. If that data is not available or is not valid, the ECUs use ambient pressure data from the electronic engine control (EEC).

Landing Altitude

In usual operation, the flight management computing function (FMCF) of the AIMS sends landing altitude data to the ECUs. Alternatively, the flight crew manually sets the data with the landing altitude selector on the bleed air/pressurization panel.

Training Information Point

You can use the MAT to do a ground test of the cabin pressure control system. The ground test is the same as the preflight BIT.



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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FUNCTIONAL DESCRIPTION - FIXED RATE CONTROL MODE

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILE - MINIMUM RATE CONTROL MODE**General**

The air supply and cabin pressure controllers (ASCPCs) use data from the flight management computing function (FMC) of AIMS to control cabin pressure. These are the FMC modes that the ASCPCs use:

- Ground mode/takeoff
- Climb
- Cruise
- Descent
- Landing/ground mode.

Ground Mode/Takeoff

When the ground mode is on, the ASCPC sets the outflow valves to full open. This makes sure that the airplane does not pressurize on the ground.

When the ground mode is on more than one minute, both ASCPCs do a preflight BIT. This test does a test of the operation of the ASCPCs and the outflow valve.

When the engine N1 speed is more than 60%, and the airplane speed is above 25 knots and increasing, the ASCPC moves the outflow valves to a more closed position. This pre-pressurizes the airplane to 0.1 psi above takeoff field pressure, approximately 189 feet (58 meters) below the takeoff field. The valves continue to close as the airplane speed increases. This keeps cabin pressure surges due to the force of ram air at a minimum as the airplane rotates.

Climb

The ASCPC enables the climb mode when any of these conditions occur:

- The takeoff mode is enabled and the airplane goes from the ground to the air
- The airplane climbs more than 1000 feet (305 meters)
- The FMC shows a climb mode.

During climb, the ASCPC has these functions:

- Calculates and sets the target value for cabin altitude at cruise
- Calculates and sets the cabin rate of climb to a value less than or equal to 500 feet/minute (153 meters/minute)
- Limits the cabin to ambient pressure differential to 8.6 psi
- Limits cabin altitude to 8000 feet (2440 meters) or less
- Adjusts the outflow valves to give a smooth change in cabin pressure.

The climb mode has two ways that it can operate:

- FMC climb mode
- Internal climb mode.

The FMC climb mode is enabled if all of these conditions occur:

- FMC data is correct
- Autopilot is on
- Vertical navigation is on.

When the FMC climb mode is enabled, the ASCPC calculates and sets the target value for cabin altitude based on these inputs:

- The FMC airplane cruise altitude data
- The FMC landing field elevation data
- The cabin limits.

The target value is set to 0.1593 psi more than the set landing field pressure if these conditions occur:

- The cabin differential pressure does not go above its limit
- The cabin altitude does not go above its limit.

The 0.1593 psi value makes the cabin altitude approximately 300 feet (92 meters) below the landing field elevation. This helps to prevent cabin pressure surges when the airplane lands.

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILE - MINIMUM RATE CONTROL MODE

If the landing field is more than 8000 feet (2440 meters), the target value for cabin altitude is set to 7950 feet (2425 meters). This only occurs if the calculated cabin altitude target value is less than 8.6 psid.

The cabin altitude target value is set to a value that gives a differential pressure of 8.6 psi if the calculated target is more than 8.6 psid.

The internal climb mode is enabled when the FMC climb mode is not enabled. The internal climb mode causes these conditions to occur:

- The cruise altitude is set to 43,100 feet (13,146 meters)
- The target cabin altitude is set to 7950 feet (2425 meters).

If the FMC climb mode is enabled, the ASCPC uses cruise altitude data and the time to the cruise altitude from the FMCF to calculate the necessary climb schedule. The schedule makes sure the cabin reaches the target cabin altitude at the same time the airplane gets to the cruise altitude. The usual climb schedule sets the cabin rate of change to less than 0.266 psi/minute, approximately 500 ft./min (53 m/min).

Cruise

The ASCPC enables the cruise mode if the airplane altitude does not change more than 100 feet (31 meters) for more than three minutes. The ASCPC also enables the cruise mode if the FMCF mode is cruise.

At cruise altitude the ASCPC adjusts the outflow valves to keep the cabin pressure constant at the value calculated for the cabin altitude target.

Descent

The ASCPC enables the descent mode if the airplane descends more than 1000 feet (305 meters) or if the FMCF mode is descent.

During descent, the ASCPC adjusts the outflow valves to give a smooth change in cabin pressure. The descent mode sets the target cabin altitude to a cabin pressure value of 0.1593 psi more than landing field pressure.

For descent, the landing altitude can be equal to the airport that the airplane departed from. It can also be equal to the destination airport. The ASCPC uses the destination airport if any of these conditions occur:

- More than 400 nautical miles from departure airport
- More than halfway to the destination airport
- Two minutes or less before start of FMC planned descent.

The descent mode has two ways that it can operate:

- FMC descent mode
- Internal descent mode.

When the FMC descent mode is enabled, the ASCPC uses landing altitude data from the FMCF to calculate the necessary descent schedule. The descent schedule makes sure the cabin pressure gets to the target for the cabin altitude when the airplane gets to the landing altitude. The usual schedule for the FMC descent mode sets the cabin rate of change to 0.159 psi/minute, approximately 300 ft./min (92 m/min) or less.

If the internal descent mode is enabled, the cabin pressure changes at a maximum rate until one of these conditions occurs:

- The target cabin altitude is reached
- The 8.6 psi cabin differential pressure limit controls cabin pressure.

If the landing field elevation is above the cabin altitude, the cabin rate of changes is 0.266 psi/minute, approximately 500 ft./min (153 m/min). If the landing field elevation is below the cabin altitude, the cabin rate of change is 0.239 psi/minute, approximately 451 ft./min (138 m/min).

If the landing altitude is more than 8000 feet (2440 meters), the descent schedule lets the cabin altitude go above the usual limit of 8000 feet (2440 meters).

If landing altitude data from the FMCF is incorrect, the flight crew manually sets the landing altitude. If there is no landing altitude data given, 1000 feet (305 meters) is the default value.

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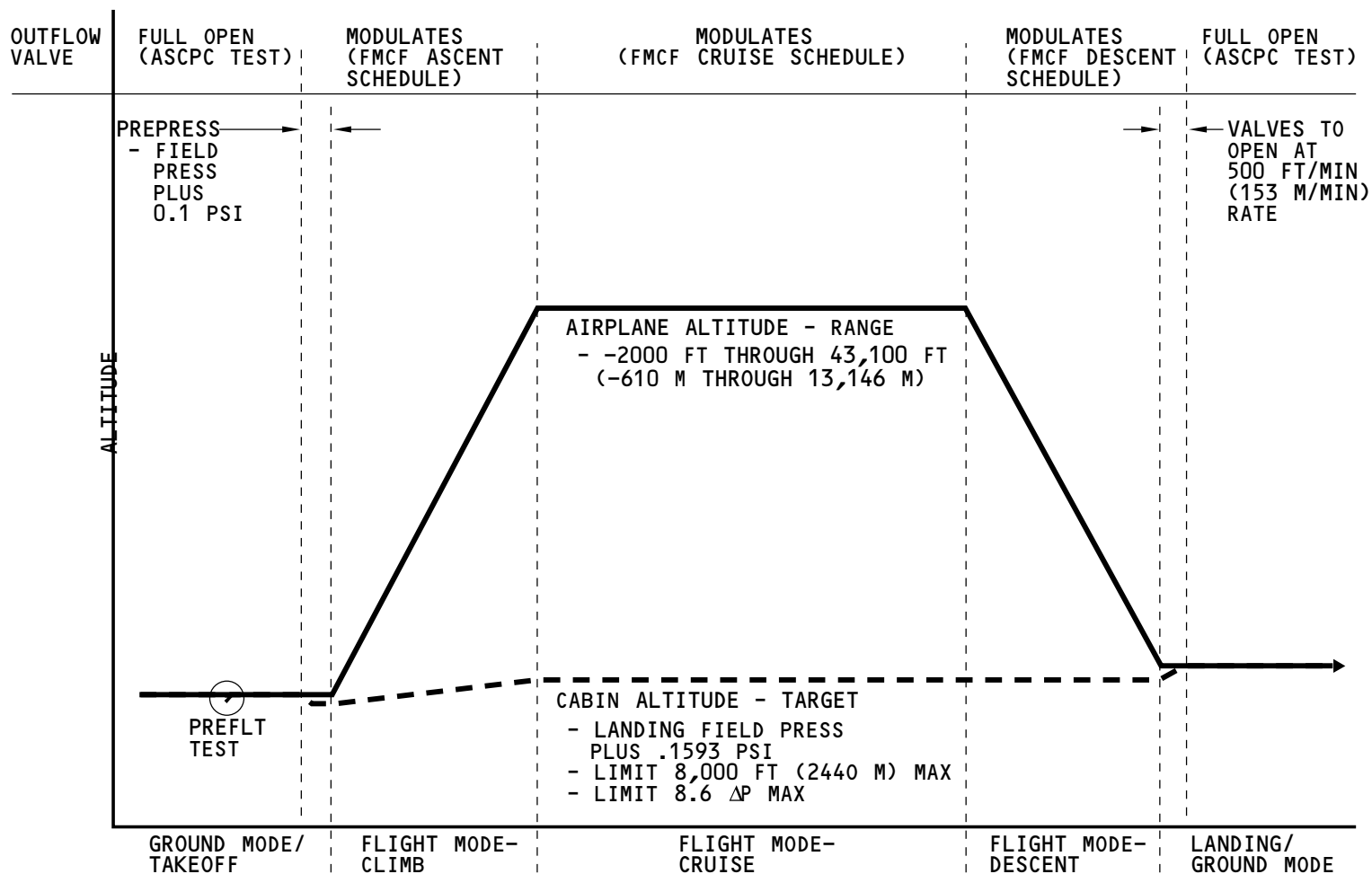


AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILE - MINIMUM RATE CONTROL MODE

Landing/Ground Mode

When the airplane lands, the ASCPC in control puts the outflow valves in the full open position. The valves move at a rate that makes the cabin pressure change 0.2655 psi/minute, approximately 500 ft./min (153 m/min). If the valves are not full open after 45 seconds, the rate changes to 2000 feet/minute (610 m/min.). One minute after landing, the ASCPCs do a preflight BIT.

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILE - MINIMUM RATE CONTROL MODE

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Page 32
Sep 05/2016



AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILE - FIXED RATE CONTROL MODE

General

The aft cabin pressure outflow valve (CPOV) controls the cabin pressure when operation is in the fixed rate control mode. The aft CPOV uses these modes of operation to control cabin pressure:

- Takeoff
- Climb (cruise clamp)
- Flight Abort
- Descent
- Landing.

Ground Mode (Preflight BIT)

The ASCPCs do a preflight BIT when the airplane is on the ground for more than one minute and one or the two outflow valve switches are in AUTO.

When the preflight BIT mode is on, the CPOVs do internal checks and an operational check. During these checks, the outflow valves move. If there are faults, the CPOVs annunciate the faults found to the ASCPCs. If no faults are found the ASCPCs return cabin pressure control to the aft CPOV.

The aft CPOV sets the outflow valves to full open. This makes sure that the airplane does not pressurize on the ground.

Takeoff Mode

The CPOV changes to the Takeoff Mode when the airplane is on the ground and takeoff roll is sensed to be 25 knots and increasing. The function of the Takeoff Mode is to pre-pressurize the airplane to decrease the cabin pressure transient experienced as the airplane rotates.

The aft CPOV pre-pressurizes the airplane to 0.159 psi above ambient pressure, at a rate of -300 slfpm.

Climb Mode (Cruise Clamp)

The CPOV changes to the Climb Mode when the airplane is sensed to be airborne (WOW = false). The function of the Climb Mode is to control the cabin pressure during the airplane climb. The aft CPOV uses ambient altitude, cruise altitude, landing altitude and barometric correction data to calculate the cabin cruise pressure and the landing altitude pressure.

For takeoffs below 8000 feet, the target cabin pressure is set at the lower value of the cruise ambient pressure +8.6 psi or 14.7 psi (sea level). The cabin rate command is limited to 500 slfpm for decreases in cabin pressure. The cabin rate command is limited to -300 slfpm for increases in the cabin pressure.

For takeoffs above 8000 feet, the target cabin pressure will be the takeoff altitude as long as the airplane stays below the abort envelope and cruise is not detected. After pre-pressurization the cabin climbs up to the takeoff altitude at 500 slfpm until the airplane altitude exceeds the abort envelope. After the airplane leaves the abort envelope, the target cabin pressure is set at the lower value of the cruise ambient pressure +8.6 psi or 14.7 psi (sea level).

If there is no valid cruise altitude input from the FMC the CPOV will use a default value of 2.85 psia (approximately 39,000 feet). This results in a cabin pressure cruise target of $2.85 + 8.6 = 11.45$ psia (approximately 6750 feet).

Manual changes to the landing altitude during the Climb Mode will cause the system to recalculate the cabin cruise altitude. If the manually selected landing altitude is higher than the cabin altitude cruise target, the new cabin cruise target will be the selected landing altitude.

The Cruise Clamp sets when there is a less than 500 slfpm rate increase in altitude. The set time for Cruise Clamp varies between 1 minute and 10 minutes depending on the airplane altitude. When the Cruise Clamp is set the target cabin pressure is set at the lower value of the ambient pressure 8.6 psi or 14.7 psi (sea level). The Cruise Clamp will reset if the cabin altitude changes by an increase or decrease of more than 500 feet from the Cruise Clamp altitude.

**AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILE - FIXED RATE CONTROL MODE****Flight Abort Mode**

The CPOV changes to Flight Abort Mode from Climb Mode only. The change to Flight Abort Mode occurs when the airplane descends more than 500 feet from the maximum altitude achieved while in climb mode and the airplane stays in the flight abort envelope. The function of Flight Abort Mode is to control the cabin pressure during airplane descent due to an aborted climb. In the Flight Abort Mode the CPOV sets the cabin pressure target to match the takeoff pressure. The pressure rate change while in Flight Abort Mode is limited to 500 slfpm for depressurization and -600 slfpm for pressurization. From the Flight Abort Mode the CPOV can change to either Landing Mode or Climb Mode.

Descent Mode

The CPOV changes to Descent Mode from Climb Mode (Cruise Clamp) only. The change to Descent Mode occurs when the airplane is sensed to have descended 1000 feet from its maximum altitude. The function of Descent Mode is to control the cabin pressure during airplane descent. The CPOV sets a target pressure equal to the lower of the landing pressure or the airplane ambient pressure plus 8.6 psid. From the Descent Mode the CPOV can change to Landing Mode or Climb Mode.

Landing Mode

The CPOV changes to Landing Mode when the airplane is sensed to be on the ground. The function of Landing Mode is to change the cabin pressure to be the same as the ambient pressure at a controlled rate. The ambient pressure is to prepare for opening the cabin doors.

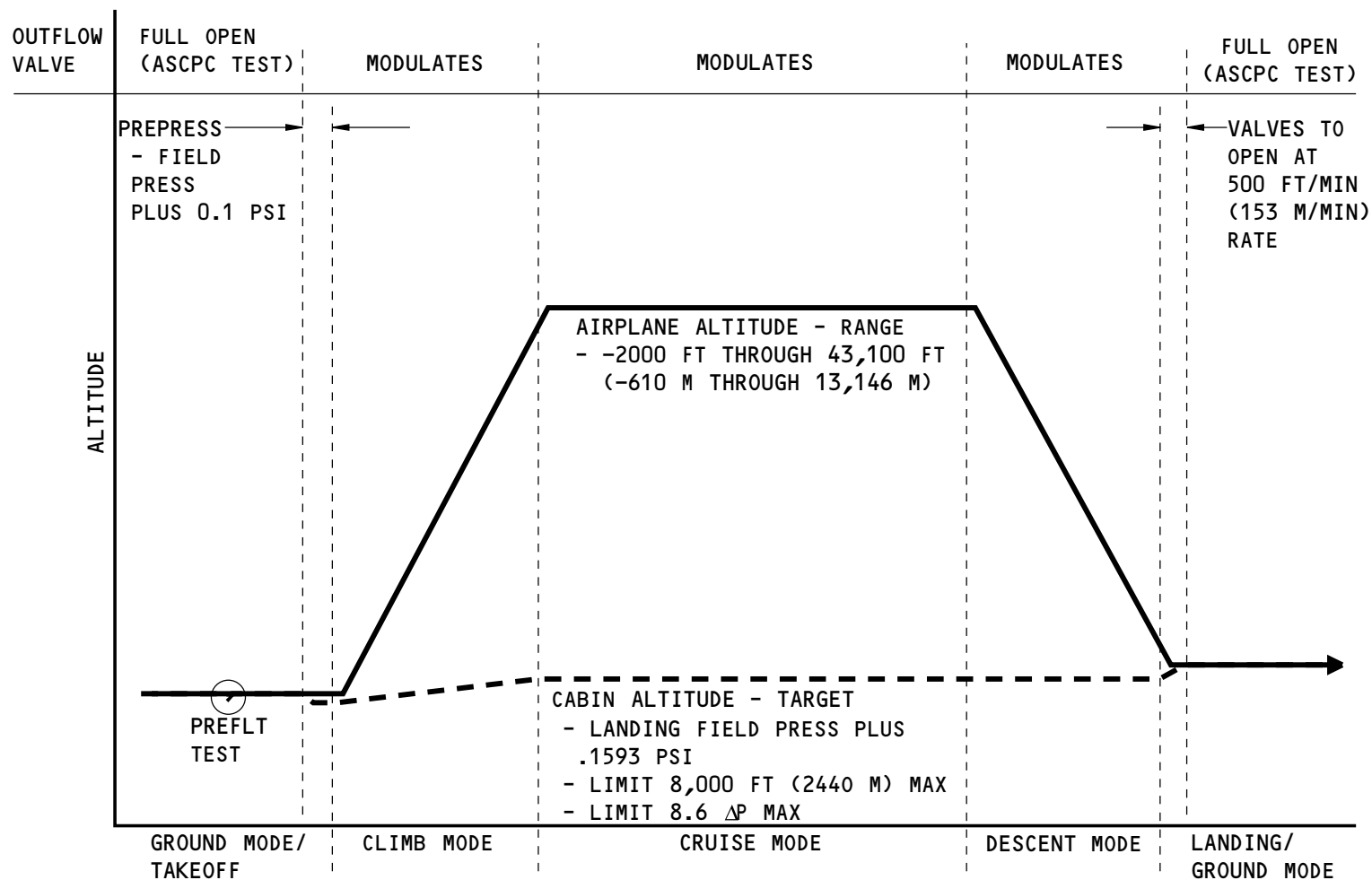
From the Landing Mode the CPOV can change to Climb Mode if the airplane is sensed to be airborne again such as during a touch and go. The CPOV can change the Landing Mode to the Ground Mode when the CPOVs are sensed to be fully open and the airplane is on the ground.

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILE - FIXED RATE CONTROL MODE

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILES - MINIMUM RATE CONTROL MODE

General

These flight profiles give examples of the relation between airplane altitude and cabin altitude from takeoff to landing. They are based on these FMC modes: climb, cruise, and descent. The modes are active if all of these conditions occur:

- FMCF supplies correct data
- Autopilot is on
- Vertical navigation is on.

New York (USA) to Quito (Ecuador)

This shows a flight profile where the landing field elevation is above the 8,000 feet (2440 meters) cabin altitude limit. The ASCPC sets the target for cabin altitude to 7,950 feet (2425 meters).

The ASCPC makes sure the cabin altitude gets to the target altitude when the airplane gets to cruise altitude. Scheduled step climbs are included in the calculation of the cabin rate of climb.

The ASCPC holds the cabin altitude at the target value when the airplane is in the cruise mode. When the airplane descends more than 1000 feet (305 meters), the ASCPC changes the target value for the cabin pressure. The ASCPC sets the cabin pressure value to 0.1593 psi more than the landing field pressure. The cabin altitude climbs at a rate that lets the cabin get to its target altitude at the same time the airplane lands.

Seattle (USA) to Denver (USA)

This shows a flight profile from a low altitude airport to a high altitude airport. In this example, the target for the cabin altitude can not be set to the landing field elevation. If the landing field elevation were selected, cabin differential pressure would go above the 8.6 psid limit. Therefore, the ASCPC sets the target for the cabin altitude to the pressure limit of 8.6 psid.

The ASCPC makes sure the cabin altitude gets to the target altitude when the airplane gets to cruise altitude. Scheduled step climbs are included in the calculation of the cabin rate of climb. Unscheduled step climbs cause the ASCPC to hold the cabin altitude at the value it is at when the airplane stops its climb. When the airplane starts to climb, the ASCPC returns to the calculated rate of climb for the cabin.

The ASCPC holds the cabin altitude at the target value when the airplane is in the cruise mode. When the airplane descends more than 1000 feet (305 meters), the ASCPC sets the target cabin altitude to 0.1593 psi more than the landing field pressure. The cabin altitude descends at a rate that lets the cabin get to its target altitude at the same time the airplane lands. The ASCPC makes sure the differential pressure limit does not go above the 8.6 psi limit.

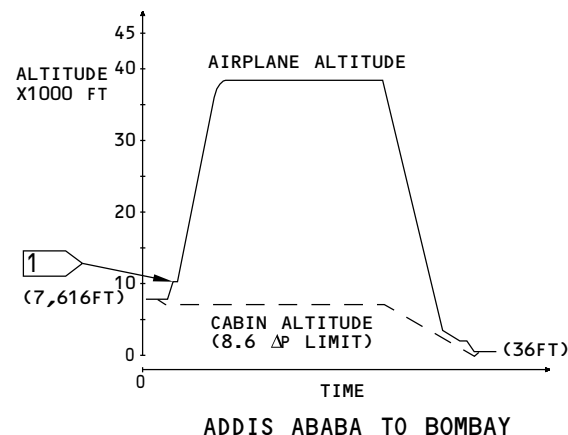
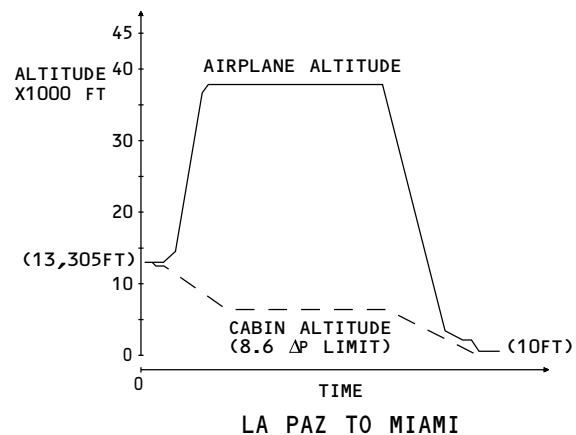
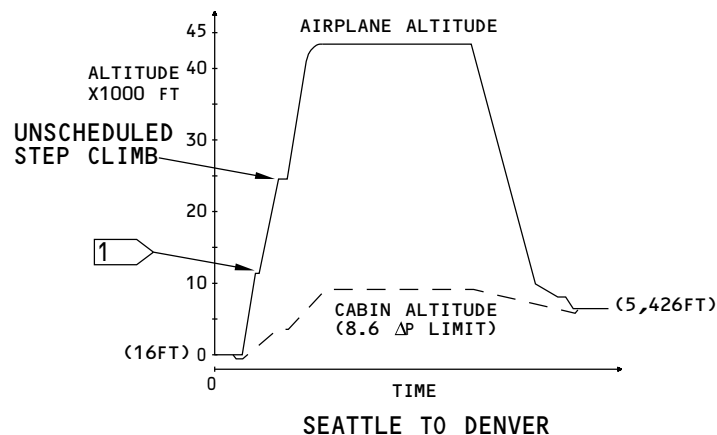
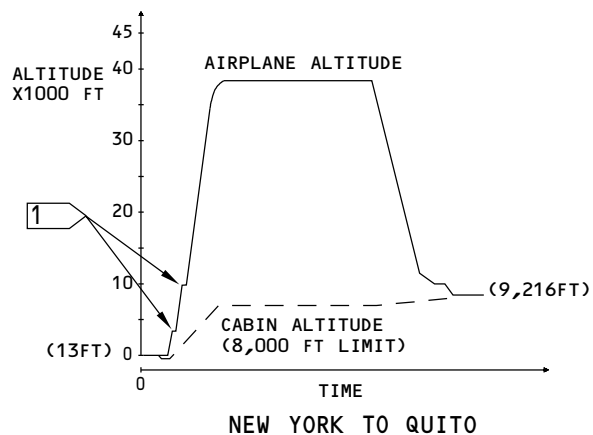
La Paz (Bolivia) to Miami (USA)

This shows a flight profile that starts at an airport above the 8,000 feet (2440 meters) cabin altitude limit. The ASCPC sets the target for the cabin altitude the same as it did in the example for the flight from Seattle to Denver.

Addis Ababa (Ethiopia) to Bombay (India)

This shows a flight profile that starts near the 8,000 feet (2440 meters) cabin altitude limit and ends near sea level. The ASCPC sets the target for the cabin altitude the same as it did in the example for the flight from Seattle to Denver.

EFFECTIVITY	
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1 SCHEDULED STEP CLIMB

M36316 S000612403_V2

AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILES - MINIMUM RATE CONTROL MODE

21-31-00

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**AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILES - FIXED RATE CONTROL MODE****General**

The flight profile examples are for cabin pressure control system operation in the fixed rate control mode. For operation in the minimum rate control mode see: 21-31-00-009. These flight profiles give examples of the relation between airplane altitude and cabin altitude from takeoff to landing. They are based on the CPOV control modes: climb, cruise clamp, and descent. The modes are active if all of these conditions occur:

- FMCF supplies correct data
- Autopilot is on
- Vertical navigation is on.

New York (USA) to Quito (Ecuador)

This shows a flight profile where the landing field elevation is above the 8,000 feet (2440 meters) cabin altitude limit. The CPOV sets the target for cabin altitude to 7,950 feet (2425 meters).

The CPOV makes sure the cabin altitude gets to the target altitude when the airplane gets to cruise altitude. Scheduled step climbs are included in the calculation of the cabin rate of climb.

The CPOV holds the cabin altitude at the target value when the airplane reaches the cruise altitude. When the airplane descends more than 1000 feet (305 meters), the CPOV changes the target value for the cabin pressure. The CPOV sets the cabin pressure value to 0.1593 psi more than the landing field pressure. The cabin altitude climbs at a rate that lets the cabin get to its target altitude at the same time the airplane lands.

Seattle (USA) to Denver (USA)

This shows a flight profile from a low altitude airport to a high altitude airport. In this example, the target for the cabin altitude can not be set to the landing field elevation. If the landing field elevation were selected, cabin differential pressure would go above the 8.6 psid limit. Therefore, the CPOV sets the target for the cabin altitude to the pressure limit of 8.6 psid.

The CPOV makes sure the cabin altitude gets to the target altitude when the airplane gets to cruise altitude. Scheduled step climbs are included in the calculation of the cabin rate of climb. Unscheduled step climbs cause the CPOV to hold the cabin altitude at the value it is at when the airplane stops its climb. When the airplane starts to climb, the CPOV returns to the calculated rate of climb for the cabin.

The CPOV holds the cabin altitude at the target value when the airplane reaches the cruise altitude. When the airplane descends more than 1000 feet (305 meters), the CPOV sets the target cabin altitude to 0.1593 psi more than the landing field pressure. The cabin altitude descends at a rate that lets the cabin get to its target altitude at the same time the airplane lands. The CPOV makes sure the differential pressure limit does not go above the 8.6 psi limit.

La Paz (Bolivia) to Miami (USA)

This shows a flight profile that starts at an airport above the 8,000 feet (2440 meters) cabin altitude limit. The CPOV sets the target for the cabin altitude the same as it did in the example for the flight from Seattle to Denver.

Addis Ababa (Ethiopia) to Bombay (India)

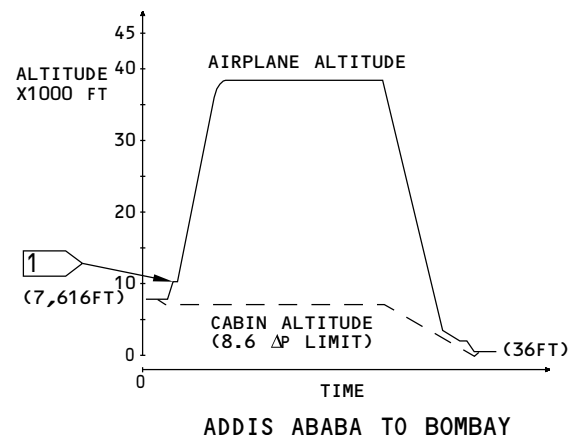
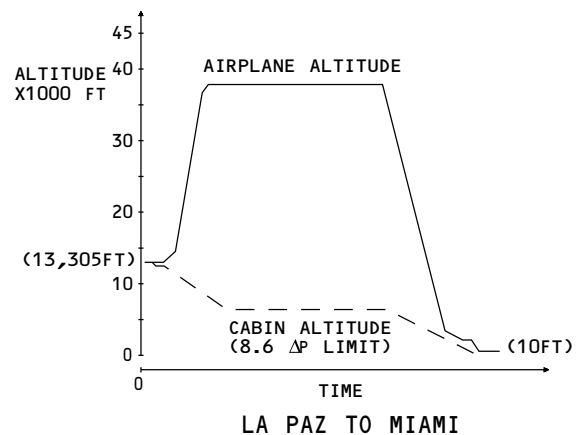
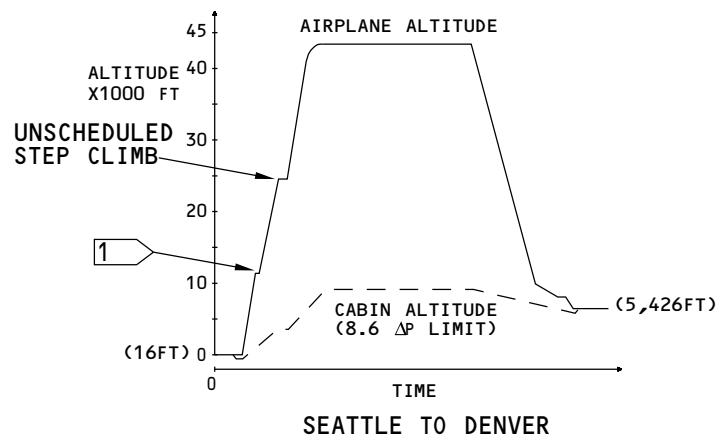
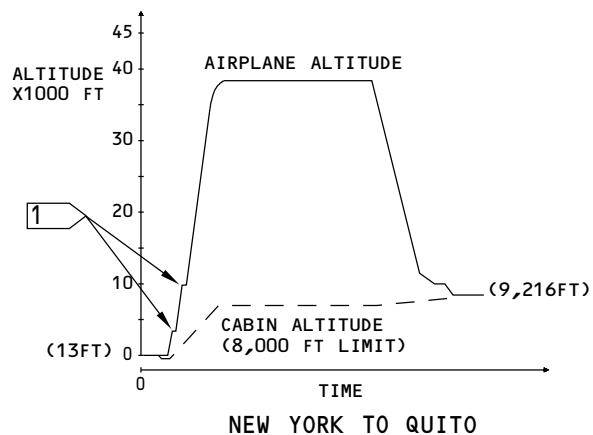
This shows a flight profile that starts near the 8,000 feet (2440 meters) cabin altitude limit and ends near sea level. The CPOV sets the target for the cabin altitude the same as it did in the example for the flight from Seattle to Denver.

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1 SCHEDULED STEP CLIMB

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AIR CONDITIONING - CABIN PRESSURE CONTROL SYSTEM - FLIGHT PROFILES - FIXED RATE CONTROL MODE

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**AIR CONDITIONING - CABIN PRESSURE RELIEF SYSTEM - INTRODUCTION****Purpose**

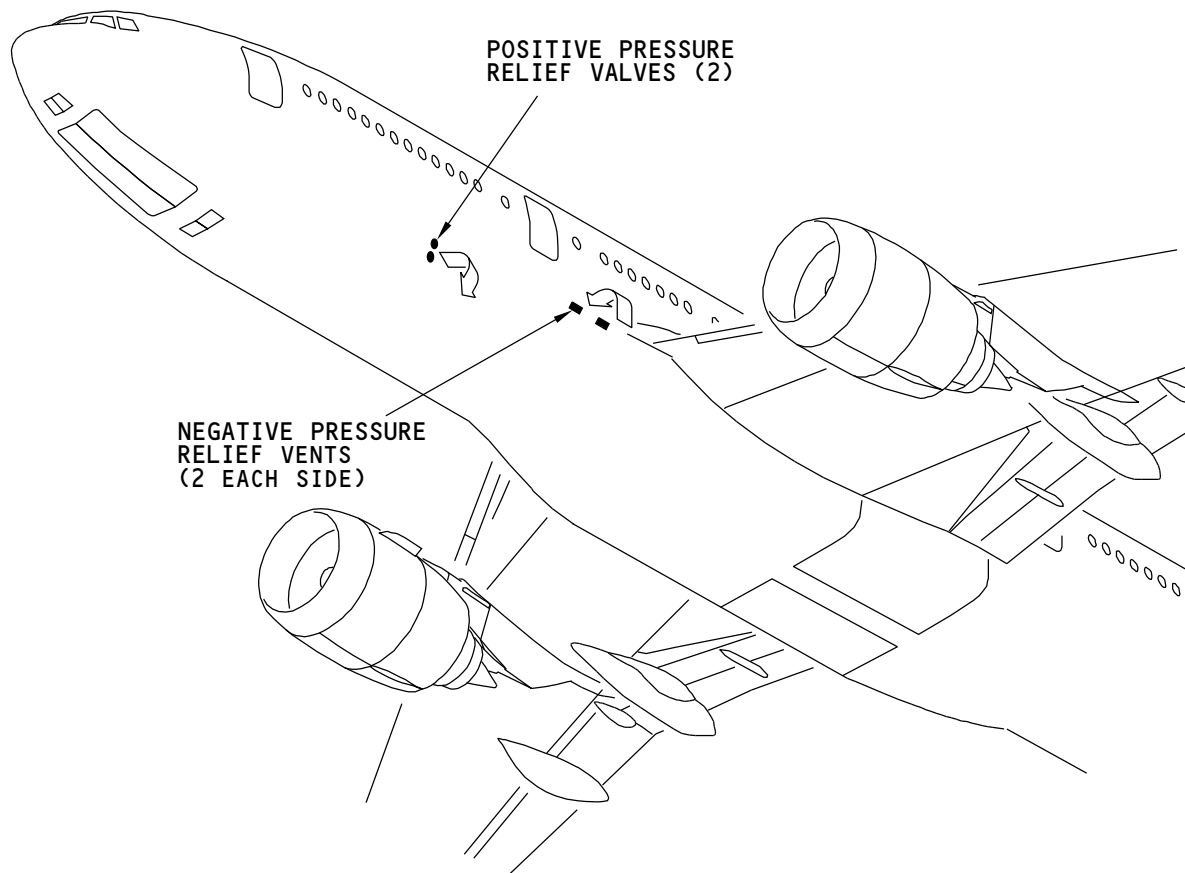
The cabin pressure relief system limits the internal pressure of the airplane.

General Description

Two positive pressure relief valves bleed air overboard if the internal pressure increases above a safe limit. This limit is above the normal pressure in the airplane.

Four negative pressure relief vents bleed air into the airplane if ambient pressure is higher than the pressure in the airplane. This can occur during rapid airplane descent.

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M35762 S000612404_V2

AIR CONDITIONING - CABIN PRESSURE RELIEF SYSTEM - INTRODUCTION

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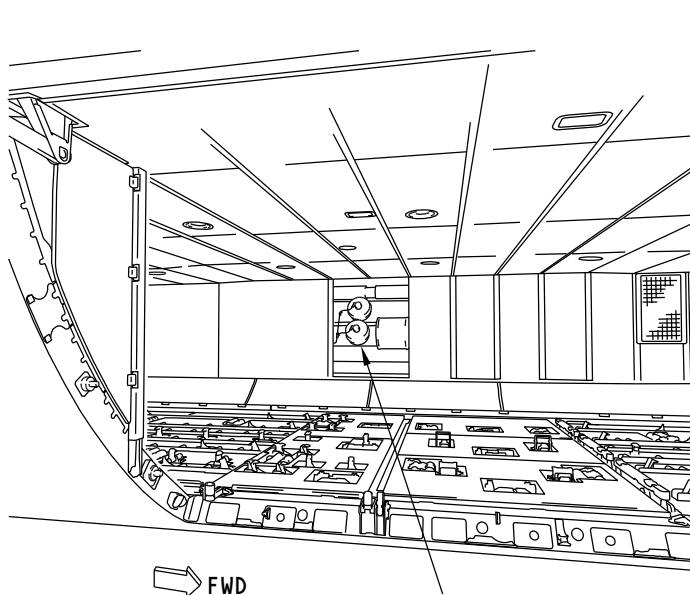
AIR CONDITIONING - CABIN PRESSURE RELIEF SYSTEM - COMPONENT LOCATIONS

Component Locations

The positive pressure relief valves are adjacent to each other and behind the left sidewall lining of the forward cargo compartment. The valves are opposite the forward cargo door at station 603.

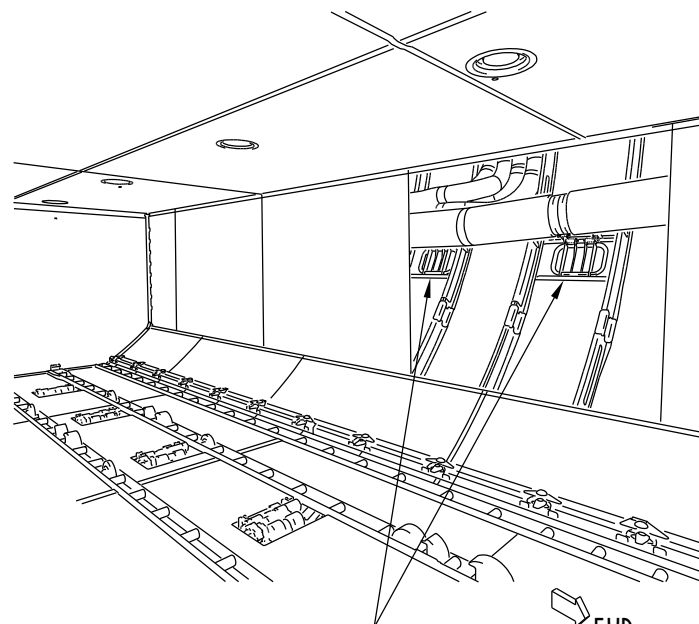
Two negative pressure relief vents are on each side of the airplane. These vents are at stations 815 and 857, behind the sidewall lining of the forward cargo compartment.

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FWD

POSITIVE PRESSURE
RELIEF VALVE (2)

FORWARD CARGO COMPARTMENT
(LOOKING THROUGH FWD CARGO DOOR)


FWD

NEGATIVE PRESSURE
RELIEF VENTS (4)
(LEFT SIDE SHOWN,
RIGHT SIDE OPPOSITE)

FORWARD CARGO COMPARTMENT
(LEFT SIDE LOOKING AFT)

M35763 S000612405_V2

AIR CONDITIONING - CABIN PRESSURE RELIEF SYSTEM - COMPONENT LOCATIONS

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**AIR CONDITIONING - CABIN PRESSURE RELIEF SYSTEM - POSITIVE PRESS RELIEF VALVE AND FILTER****Purpose**

The positive pressure relief valve opens when cabin air pressure is higher than ambient pressure by a set value. This permits air to go out of the airplane to keep differential pressure below a safe limit.

Physical Description

The positive pressure relief valve is a mechanical device. It has an air filter and two ambient pressure sense connections. The air filter supplies cabin pressure to the valve. The ambient pressure connections supply ambient pressure to the valve.

An integral ambient sense port (not shown) is in the base of the valve. A remote ambient sense port is in the side of fuselage aft of the pressure relief valves. Tubing connects the sense ports to the valve.

Functional Description

When cabin pressure differential at the remote ambient pressure sense port increases to 8.95 psi, the relief valve opens. This permits air to go out of the airplane. If the remote pressure sense port does not function, the relief valve opens when cabin pressure differential at the integral ambient sense port increases to 9.42 psi.

When cabin pressure differential goes below the limit, the positive pressure relief valve closes.

If the positive pressure relief valve opens, small doors open on the outer surface of the valve. This shows a brightly colored edge on the valve doors. These doors stay open when the valve closes. The maintenance technician must close these doors manually.

Training Information Point

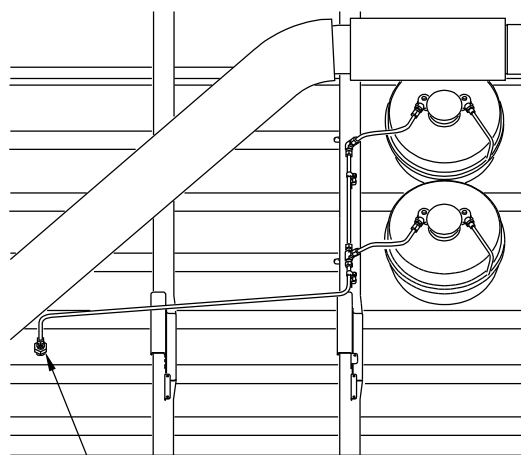
You can replace the air filter.

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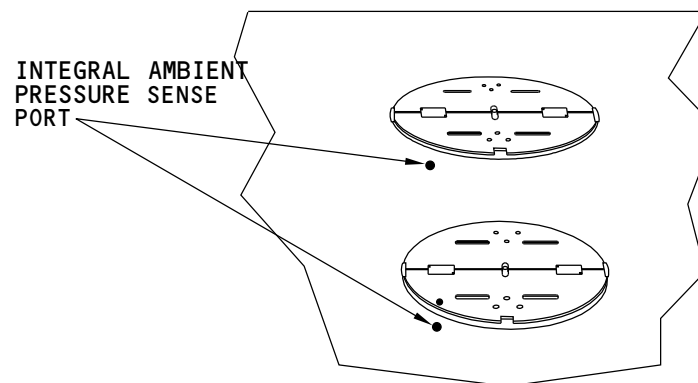
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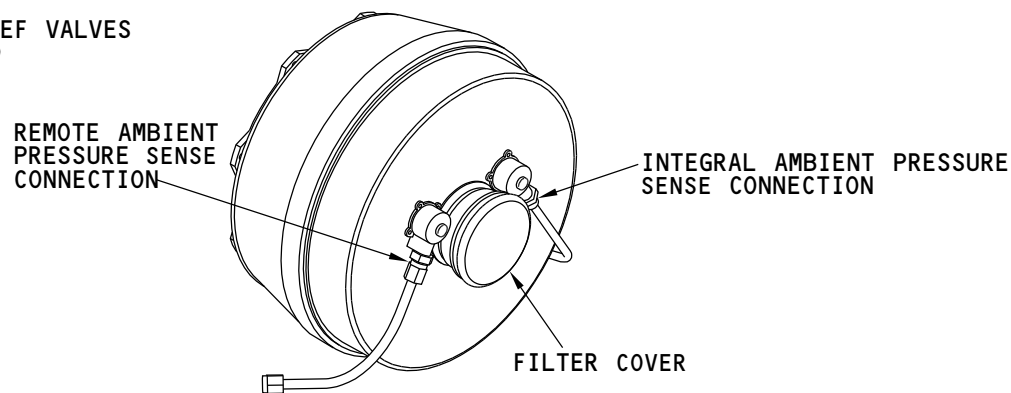
REMOTE AMBIENT PRESSURE
PRESSURE SENSE PORT

POSITIVE PRESSURE RELIEF VALVES
(INTERNAL VIEW)



INTEGRAL AMBIENT
PRESSURE SENSE
PORT

POSITIVE PRESSURE RELIEF VALVES
TRIPPED OPEN
(EXTERNAL VIEW LOOKING UP)



REMOTE AMBIENT
PRESSURE SENSE
CONNECTION

INTEGRAL AMBIENT PRESSURE
SENSE CONNECTION

FILTER COVER

POSITIVE PRESSURE RELIEF VALVE

M35764 S000612406_V1

AIR CONDITIONING - CABIN PRESSURE RELIEF SYSTEM - POSITIVE PRESS RELIEF VALVE AND FILTER

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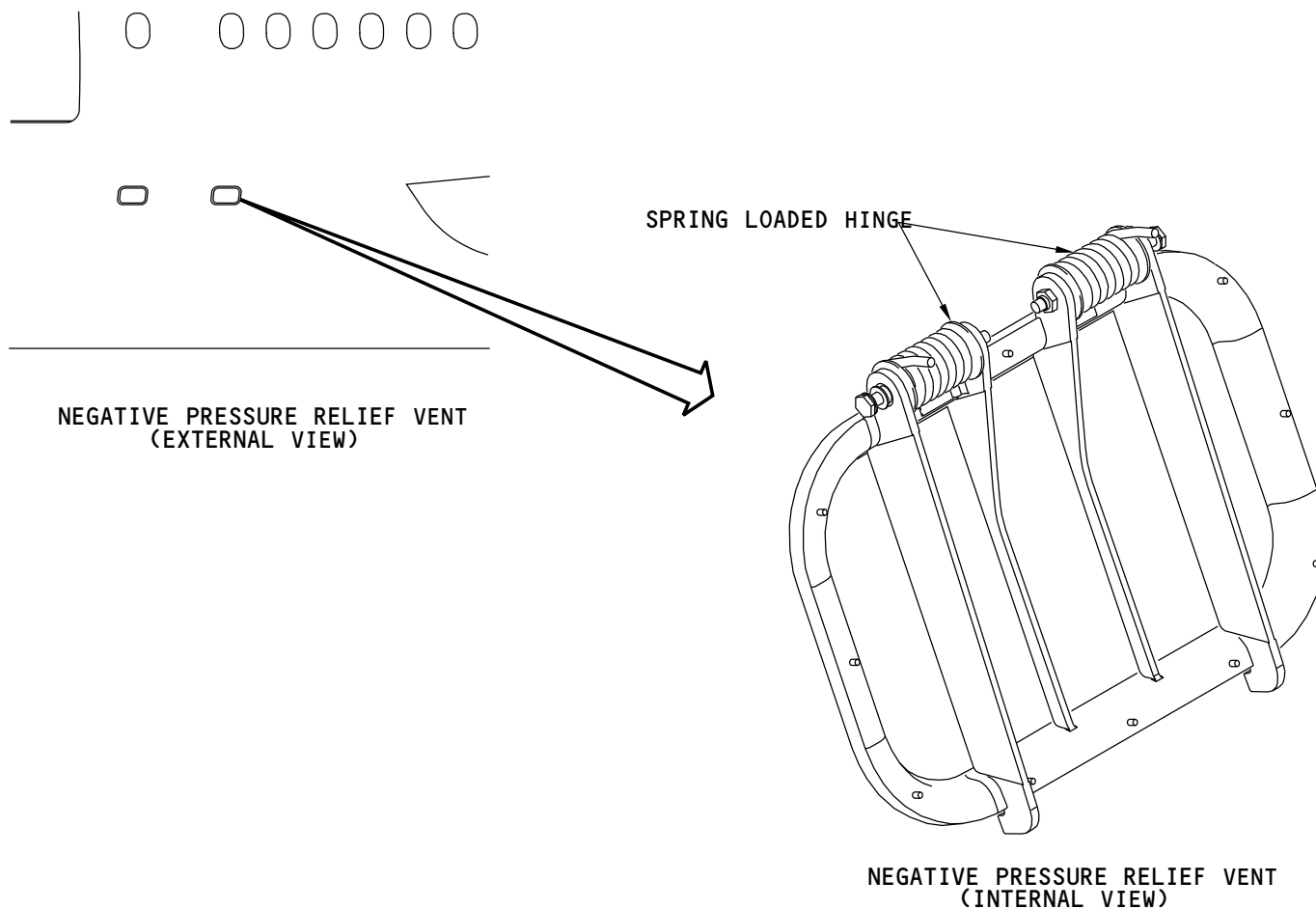
**AIR CONDITIONING - CABIN PRESSURE RELIEF SYSTEM - NEGATIVE PRESS RELIEF VENT****Purpose**

The negative pressure relief vent opens when cabin pressure is less than ambient pressure. This prevents negative cabin pressure. Too much negative cabin pressure could damage the fuselage structure.

Physical Description

The negative pressure relief vent is a spring-loaded door. The door starts to open at a differential pressure of 0.2 psi. It is full open at a differential pressure of 0.5 psi.

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AIR CONDITIONING - CABIN PRESSURE RELIEF SYSTEM - NEGATIVE PRESS RELIEF VENT

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**AIR CONDITIONING - HEATING - INTRODUCTION****Purpose**

Heat sources add heat to cabin areas and cargo compartments to keep temperatures at necessary levels.

Crew Rest Area Heating

In-line electric heaters keep the crew rest area warm. See the crew rest area heating system section for more information about the crew rest area heating (SECTION 21-41).

Forward Cargo Heating

The forward cargo compartment uses warm air from the equipment cooling system to keep temperature in limits. See the forward cargo compartment heating section for more information about the forward cargo compartment heating (SECTION 21-43).

Aft and Bulk Cargo Heating

The aft and bulk cargo compartments use air from the pneumatic system to keep temperature in limits. See the aft and bulk cargo compartment heating section for more information about the aft and bulk cargo compartment heating (SECTION 21-44).

Supplemental Heating

These areas use electric heaters to keep temperature in limits.

- Flight deck foot and shoulder heaters
- Door heaters
- Galley heaters.

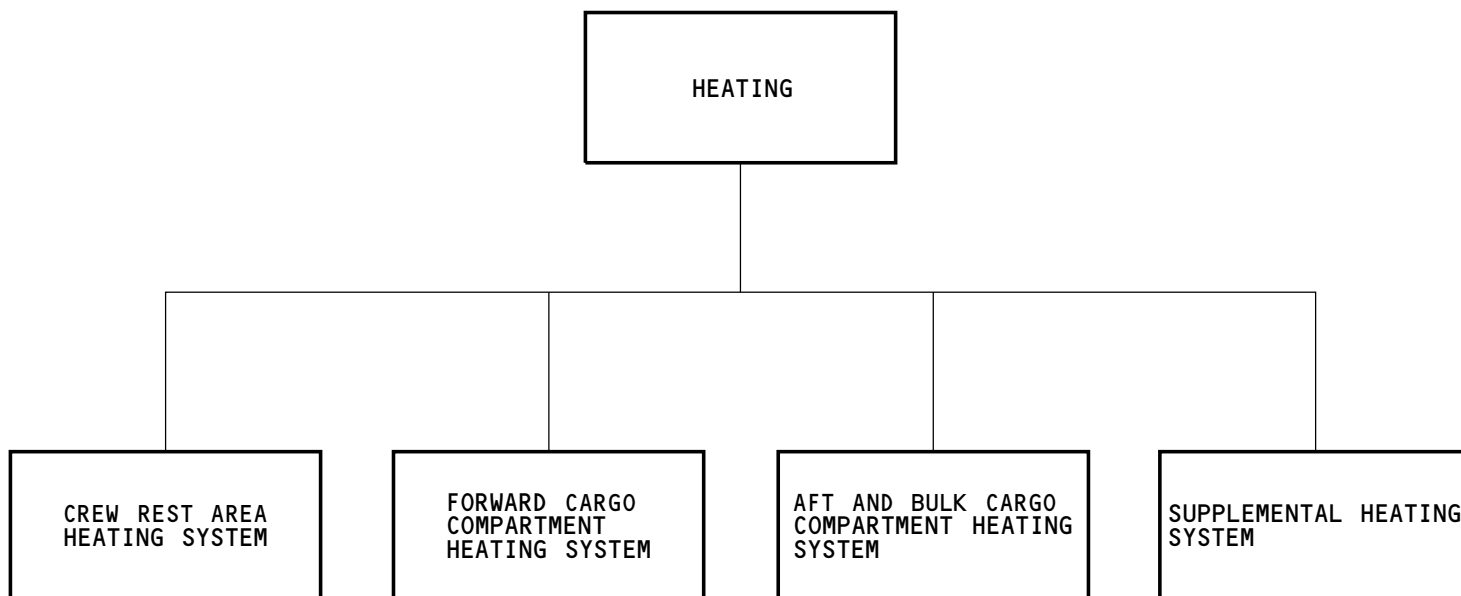
See the supplemental heating section for more information about the supplemental heating system (SECTION 21-45).

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AIR CONDITIONING - HEATING - INTRODUCTION

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AIR CONDITIONING - HEATING - AIR SYNOPTIC DISPLAY AND MAINTENANCE PAGE

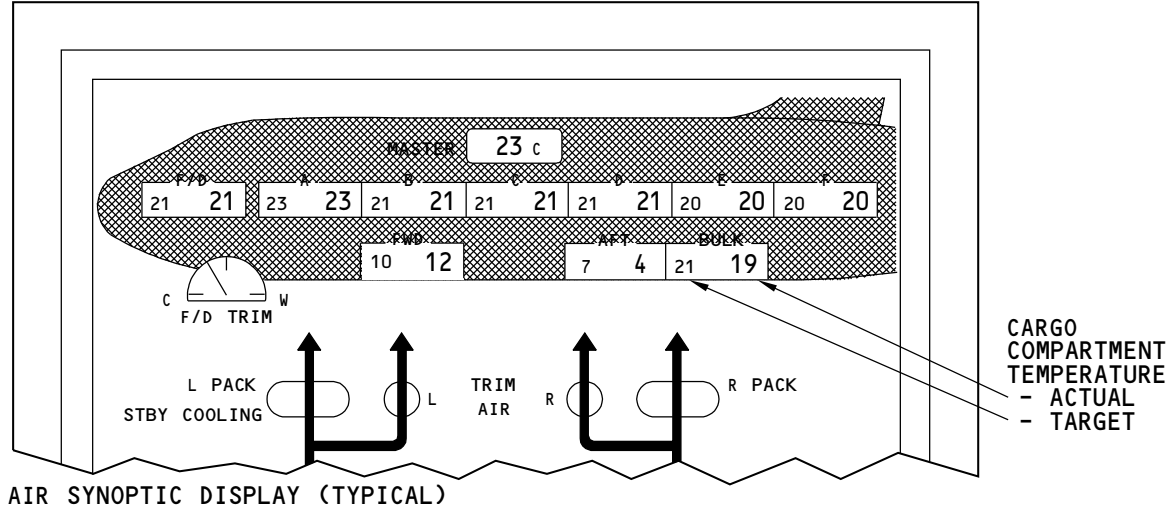
General

The air synoptic display and the maintenance page show this cargo compartment temperature data:

- Target temperature, set on the flight deck
- Actual compartment temperature.

The maintenance page also shows duct temperature for the forward cargo air distribution duct. See the zone temperature control and indication section for more information about the forward cargo air conditioning system (SECTION 21-61).

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AIR CONDITIONING

	MASTER TEMP 25							SEATS 289		
	F/D	A	B	C	D	E	F	FWD	AFT	BULK
ZONE TEMP	21	25	25	24	24	22	25	12	5	20
TRGT TEMP	21	25	25	24	24	22	25	10	7	21
DUCT TEMP	22	27	26	27	26	28	29	8	--	--
TRIM VLV	0.27	0.45	0.46	0.44	0.48	0.35	0.24	0.00	--	--
CTRL CH	1	1	2	1	2	1	2	2	--	--

AIR CONDITIONING - HEATING - AIR SYNOPTIC DISPLAY AND MAINTENANCE PAGE

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AIR CONDITIONING - HEATING - GROUND TESTS**General**

These are the heating ground tests that show when you select ATA 21 Environmental Control System:

- Aft cargo heat
- Bulk cargo heat
- Door area heater.

Aft Cargo Heat

This test makes sure that these LRU installations are correct:

- Aft cargo heat shutoff valve
- Aft cargo heat temperature control valve
- Aft cargo compartment temperature sensor.

You must pressurize the pneumatic system for this test. During this test, hot air comes out of the aft cargo heat duct. This test takes approximately 2-5 minutes.

This test shows for these ground test types:

- System test
- LRU replacement test.

Bulk Cargo Heat

This test makes sure that these LRU installations are correct:

- Bulk cargo heat shutoff valve
- Bulk cargo heat temperature control valve
- Bulk cargo ventilation fan
- Bulk cargo compartment temperature sensor.

You must pressurize the pneumatic system for this test. During this test, hot air comes out of the bulk cargo heat duct. This test takes approximately 2-5 minutes.

This test shows for these ground test types:

- System test
- LRU replacement test.

Door Area Heater

This test makes sure that all passenger door area heater installations are correct.

This test takes 2 to 5 minutes.

This test shows for these ground test types:

- System test
- LRU replacement test.

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GROUND TESTS

SELECT ATA SYSTEM (48)

- 21 ENVIRONMENTAL CONTROL SYSTEM
- 21 CABIN PRESSURE CONTROL SYSTEM
- 21 CABIN TEMPERATURE CONTROL SYSTEM
- 22 AUTOPILOT FLIGHT DIRECTOR SYSTEM
- 22 AIMS - AUTOTHROTTLE
- 23 HF COMMUNICATION SYSTEM
- 23 VHF COMMUNICATION SYSTEM
- 23 SATELLITE COMMUNICATIONS (SATCOM) SYSTEM
- 23 AIMS - DATA COMMUNICATION MANAGEMENT

SELECT TEST TYPE

◆

SYSTEM TEST

◇

LRU REPLACEMENT TEST

SELECT SYSTEM TEST (6)

- AFT CARGO HEAT
- BULK CARGO HEAT
- CHILLER BOOST FAN
- DOOR AREA HEATER
- EQUIPMENT COOLING
- LAVATORY/GALLEY VENTILATION FAN

CONTINUE

HELP

GO BACK

SELECT SYSTEM TEST (6)

- 1 AFT CARGO HEAT
- 1 BULK CARGO HEAT
- CHILLER BOOST FAN
- DOOR AREA HEATER
- EQUIPMENT COOLING
- LAVATORY/GALLEY VENTILATION FAN

NOTE: SYSTEM TESTS SHOW.
LRU REPLACEMENT TESTS ARE THE SAME.

1 THESE ARE THE AIR CONDITIONING -
HEATING TESTS.

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AIR CONDITIONING - HEATING - GROUND TESTS

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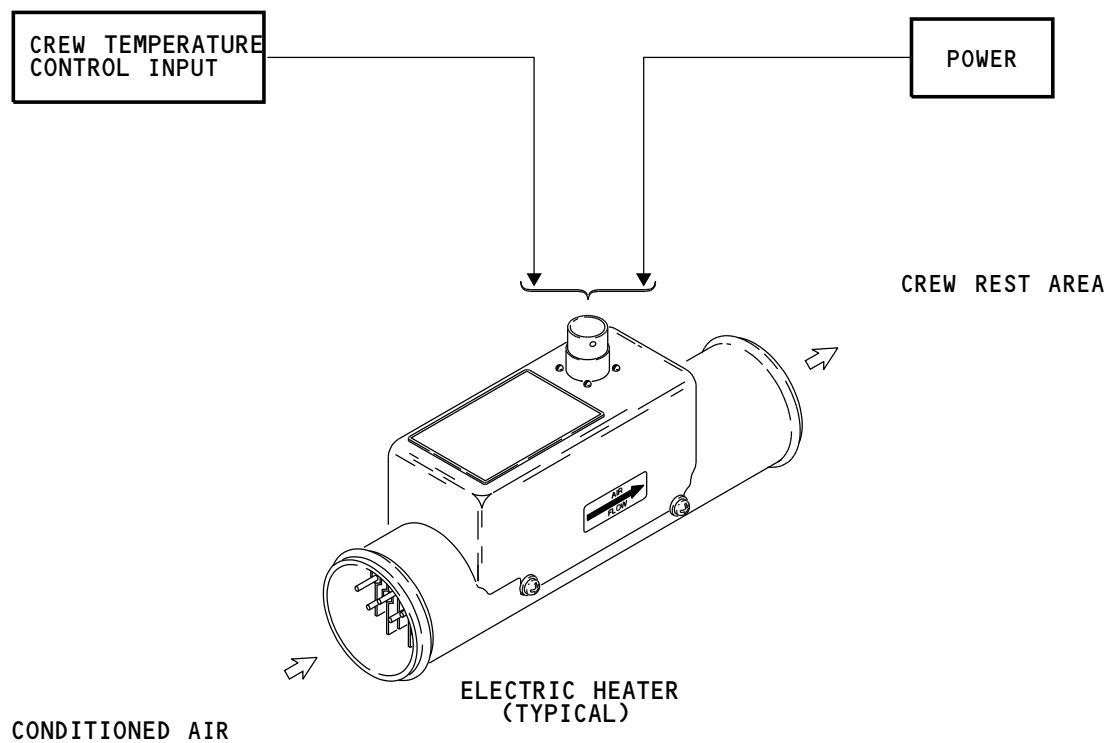
**AIR CONDITIONING - CREW REST AREA HEATING - INTRODUCTION****Purpose**

The purpose of crew rest area heating system is to let the crew select a comfortable temperature for the rest module.

General

Crew rest areas get fresh air from the left pack. Rest areas are heated by inline electric heaters. Elms provides power for heater operations. Manual controls inside the rest modules provide a way to adjust the temperature of the air supplied to the rest area.

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AIR CONDITIONING - CREW REST AREA HEATING - INTRODUCTION

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**AIR CONDITIONING - CREW REST AREA HEATING - FLIGHT CREW REST - INTRODUCTION****Purpose**

The purpose of flight crew rest heating system is to let the crew select a comfortable temperature for the rest module.

General

The flight deck conditioned air distribution duct gives conditioned air to the crew rest air distribution duct. The crew rest air distribution duct supplies conditioned air to the flight crew rest (FCR). Adjustment of the flight deck temperature control sets the air temperature in the duct. An in-line electric heater increases the temperature in the FCR if necessary. A temperature control on the FCR attendant switch panel controls the heater.

See the flight deck conditioned air distribution section for more information about flight deck air distribution (SECTION 21-22).

See the zone temperature control and indication section for more information about flight deck temperature control (SECTION 21-61).

Training Information Point

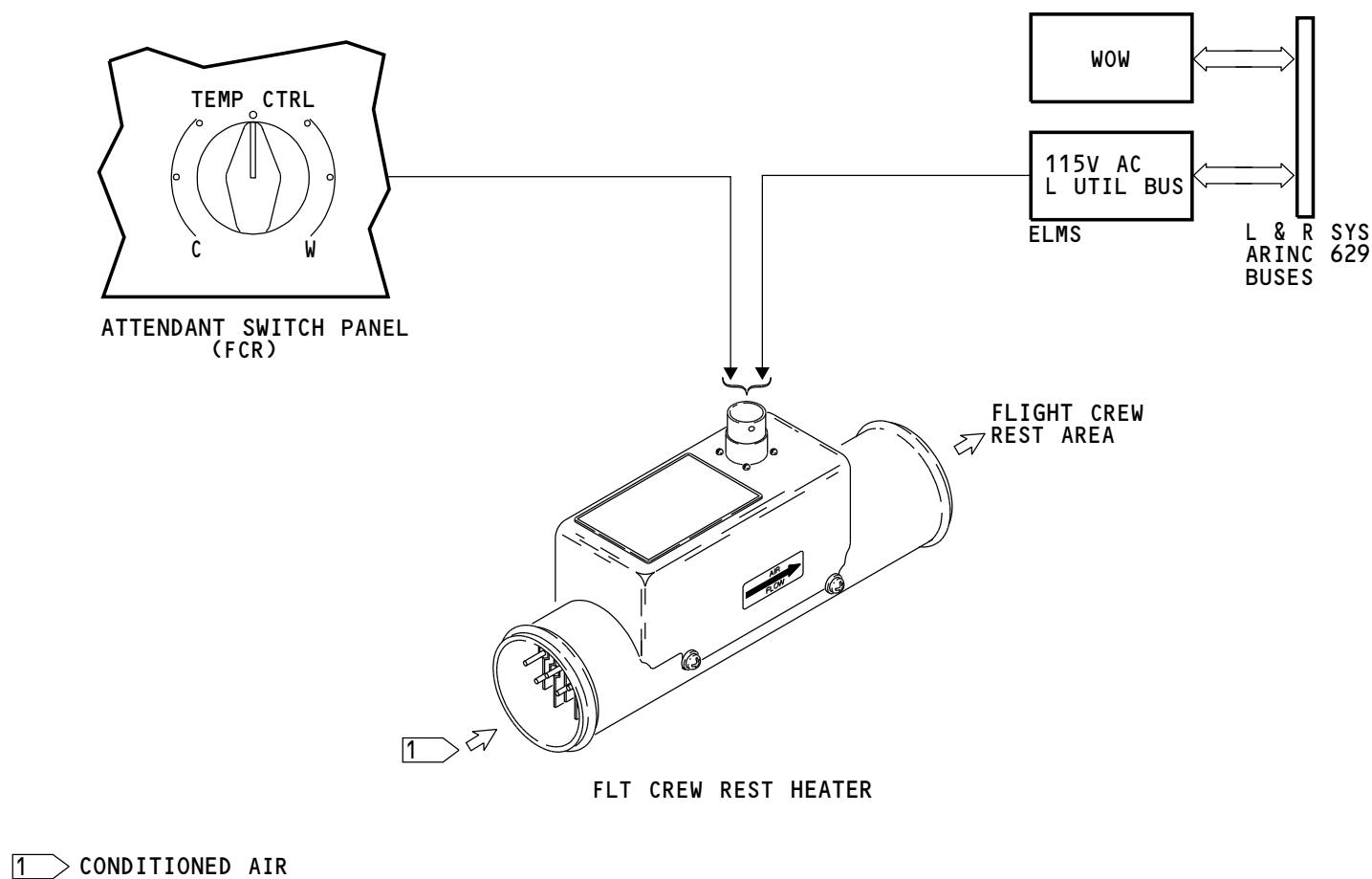
AIMS does not monitor the heater circuits. The crew reports inoperative heaters.

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AIR CONDITIONING - CREW REST AREA HEATING - FLIGHT CREW REST - INTRODUCTION

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**AIR CONDITIONING - CREW REST AREA HEATING - FLIGHT CREW REST - COMPONENT LOCATIONS****Component Locations**

The heater is above the ceiling of the flight crew rest area. The heater control is on the attendant switch panel in the FCR module.

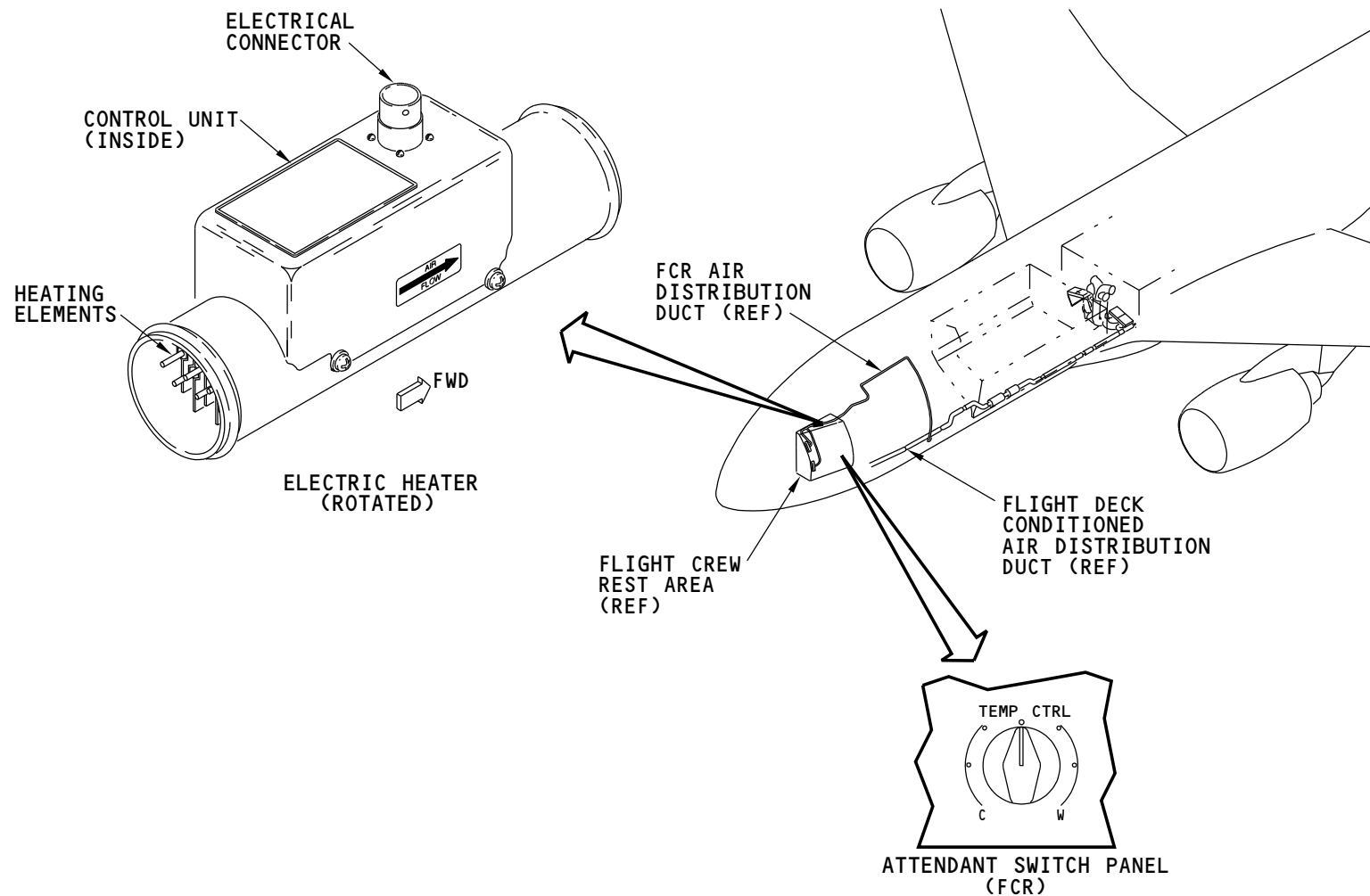
Physical Description

The heater is a 750-watt electric resistance in-line air heater for a three inch diameter duct. An electronic control unit controls the temperature. Internal overheat protection keeps surface temperature and outlet air temperature to a limit.

Training Information Point

The crew rest area heater is interchangeable with the flight deck shoulder heaters.

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AIR CONDITIONING - CREW REST AREA HEATING - FLIGHT CREW REST - COMPONENT LOCATIONS

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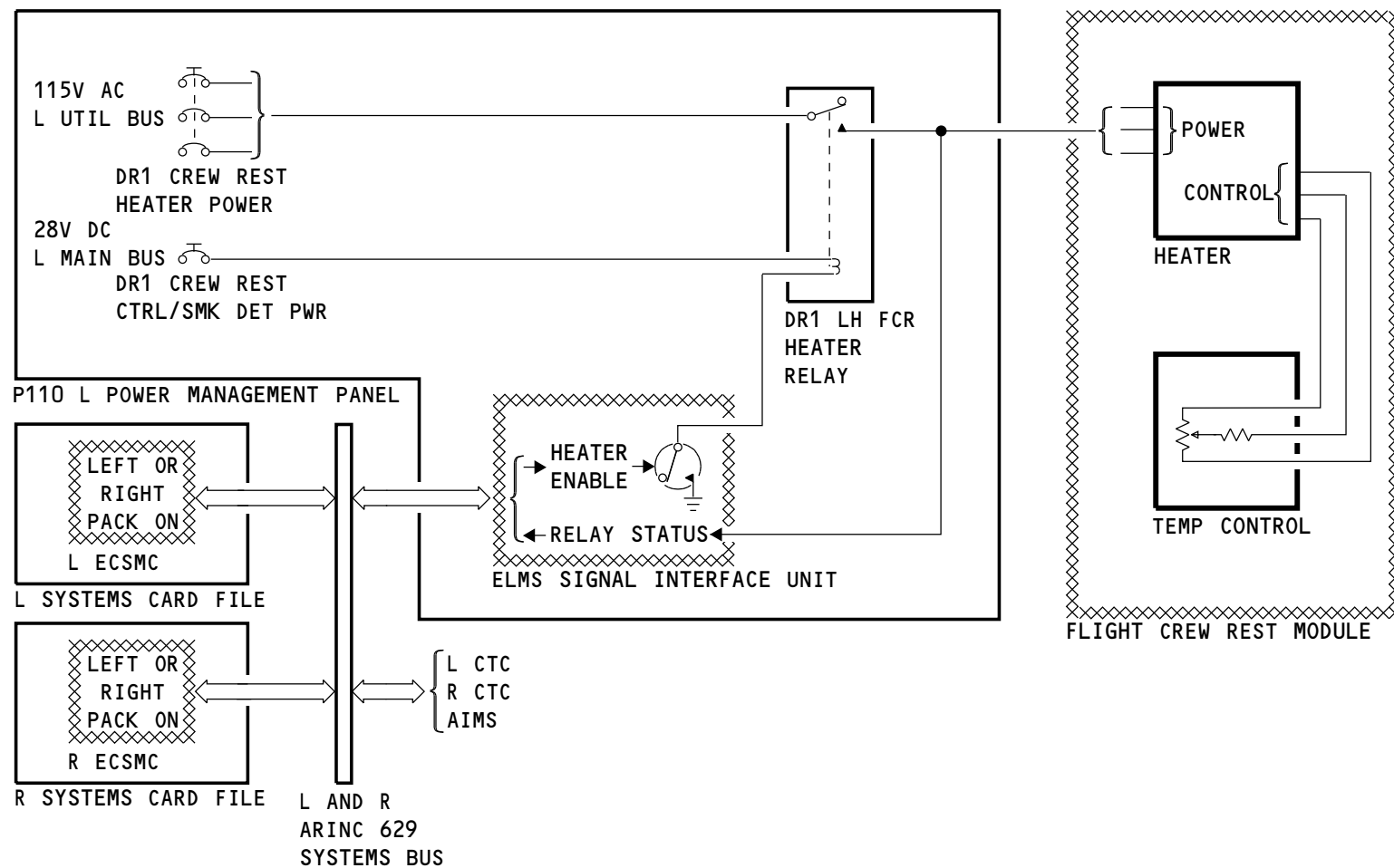
**AIR CONDITIONING - CREW REST AREA HEATING - FLIGHT CREW REST - FUNCTIONAL DESCRIPTION****Functional Description**

The left utility bus supplies 115v ac three-phase power to the heater. A relay in the left power management panel lets power go to the heaters. The relay energizes when at least one air conditioning pack is on.

The CTCs tell the ECSMCs when a pack is on. The ECSMC that is in control sends a signal to the ELMS signal interface unit (SIU) to energize the heater relay. If the status of the relay is not correct, the SIU sends this information to the AIMS. The central maintenance computing function causes a maintenance message.

When the heaters have power, an input from the temperature control in the crew rest module sets the temperature.

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AIR CONDITIONING - CREW REST AREA HEATING - FLIGHT CREW REST - FUNCTIONAL DESCRIPTION

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Page 9
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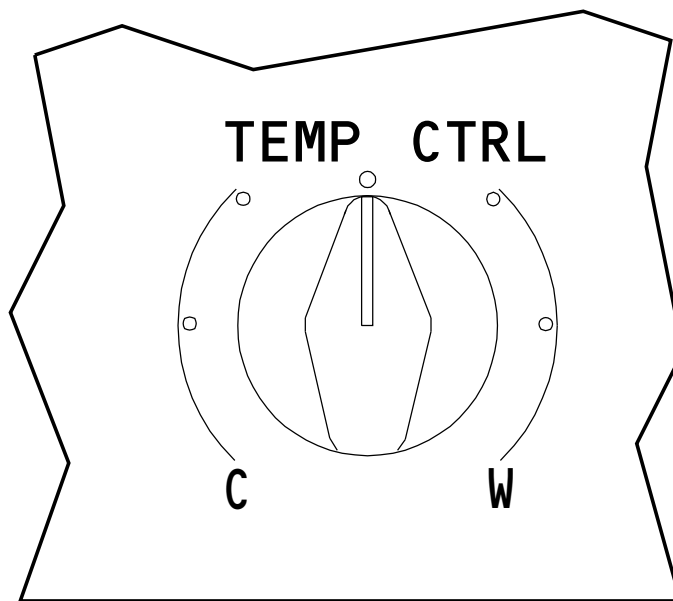
AIR CONDITIONING - CREW REST AREA HEATING - FLIGHT CREW REST - OPERATION

General

The heater controller for the flight crew rest has one temperature selector that rotates to cold or warm settings. The selector is on the FCR attendant switch panel.

The heater warms the conditioned air that goes to the crew rest area. The temperature selector lets you control the temperature of the air by control of the power going to the heater elements.

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ATTENDANT SWITCH PANEL
(FCR)

AIR CONDITIONING - CREW REST AREA HEATING - FLIGHT CREW REST - OPERATION

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AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - INTRODUCTION

Purpose

The forward cargo compartment heating system keeps the compartment temperature above freezing.

General Description

The forward cargo heating system interfaces with the forward equipment cooling system. These systems include the components and the necessary logic to give cargo heating.

The forward cargo heating system has these components:

- Temperature sensor
- Heater
- Ducts.

The temperature sensor gives compartment temperature data for control and indication.

The heater keeps the compartment temperature above 40F (4.4C).

The duct moves air from the forward equipment cooling exhaust duct into the compartment.

The equipment cooling system uses these valves to control the movement of exhaust air:

- Equipment divert valve
- Equipment inboard valve
- Equipment vent valve
- Forward cargo heat valve.

The equipment inboard valve and the equipment divert valve control exhaust air movement into the mix bay area or into the vent duct. See the equipment cooling section for more information about the inboard and divert valves (SECTION 21-27).

The equipment vent valve and the forward cargo heat valve control the movement of exhaust air into the forward cargo heat duct or into the vent duct. The cargo heat duct supplies air equally into the compartment. The overboard exhaust duct controls the movement of exhaust air to the area near the forward pressurization outflow valve.

The forward cargo heating system comes on when the forward cargo air conditioning control is in the OFF position. The zone temperature control system controls the compartment temperature when the control is in the AUTO position. See the zone temperature control and indication section for more information about the control and operation of the forward cargo zone temperature control (SECTION 21-61).

On the ground, the forward cargo heat valve normally moves between the open and the closed position as ambient temperature changes. The valve closes when the temperature at the TAT probe is more than 55F (13C). It opens when the temperature is less than 50F (10C).

The forward cargo heat valve is open in the air.

When cargo heating is enabled, the position of the heat valve changes so that its position is opposite the position of the vent valve. For example, when the vent valve is open the heat valve is closed.

The forward cargo heater is enabled when the forward cargo heat valve is open. The heater turns on/off at these compartment temperatures:

- ON when less than 40F (4.4C)
- Off when more than 50F (10C).

The heater will not operate if the equipment cooling vent fan is off or when the forward cargo heat valve is closed.

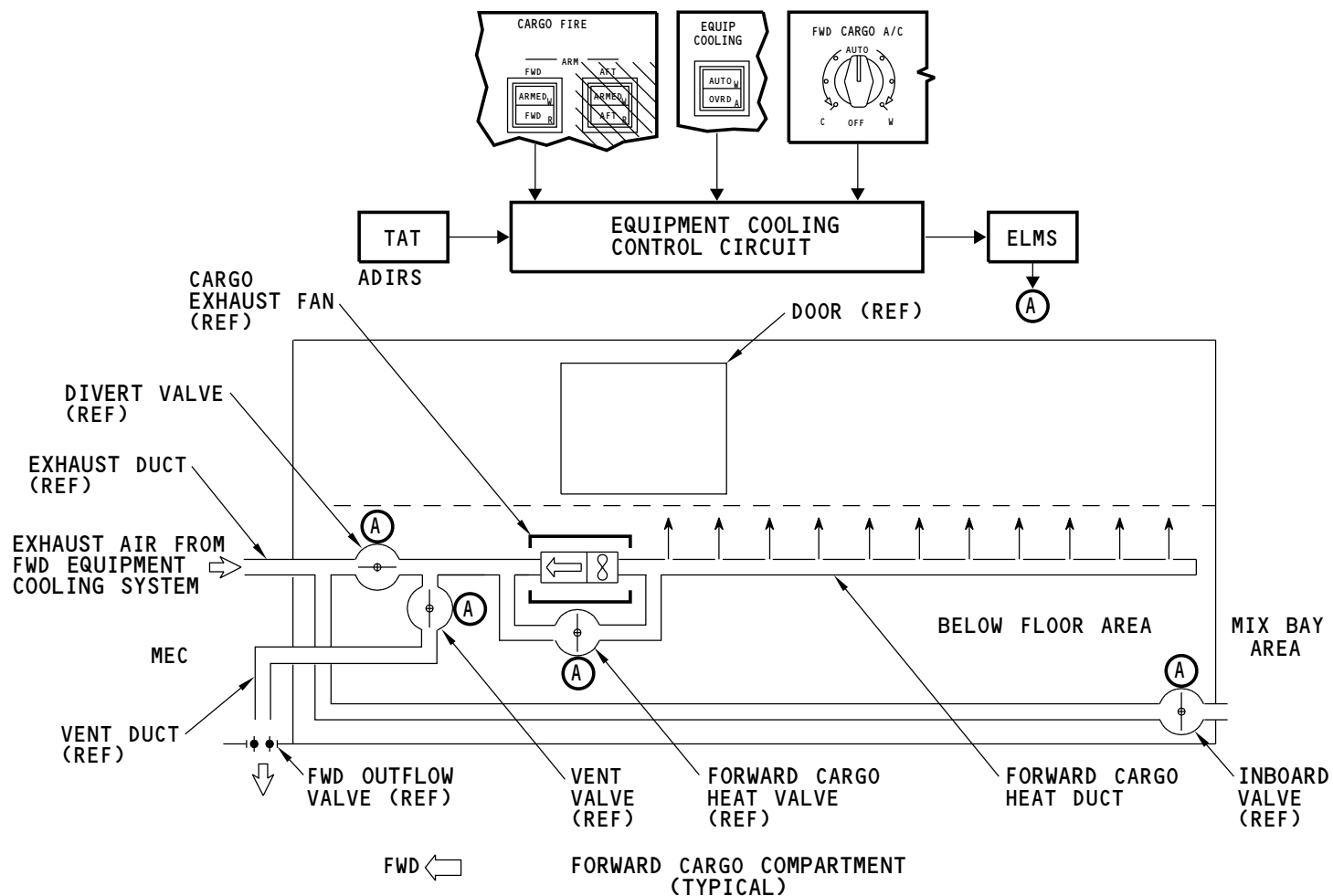
See the equipment cooling section for more information about the control and operation of the equipment cooling vent and forward cargo heating (SECTION 21-27).

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AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - INTRODUCTION

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**AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - HEAT DUCT****Purpose**

The forward cargo heat duct supplies equipment exhaust air into the forward cargo compartment.

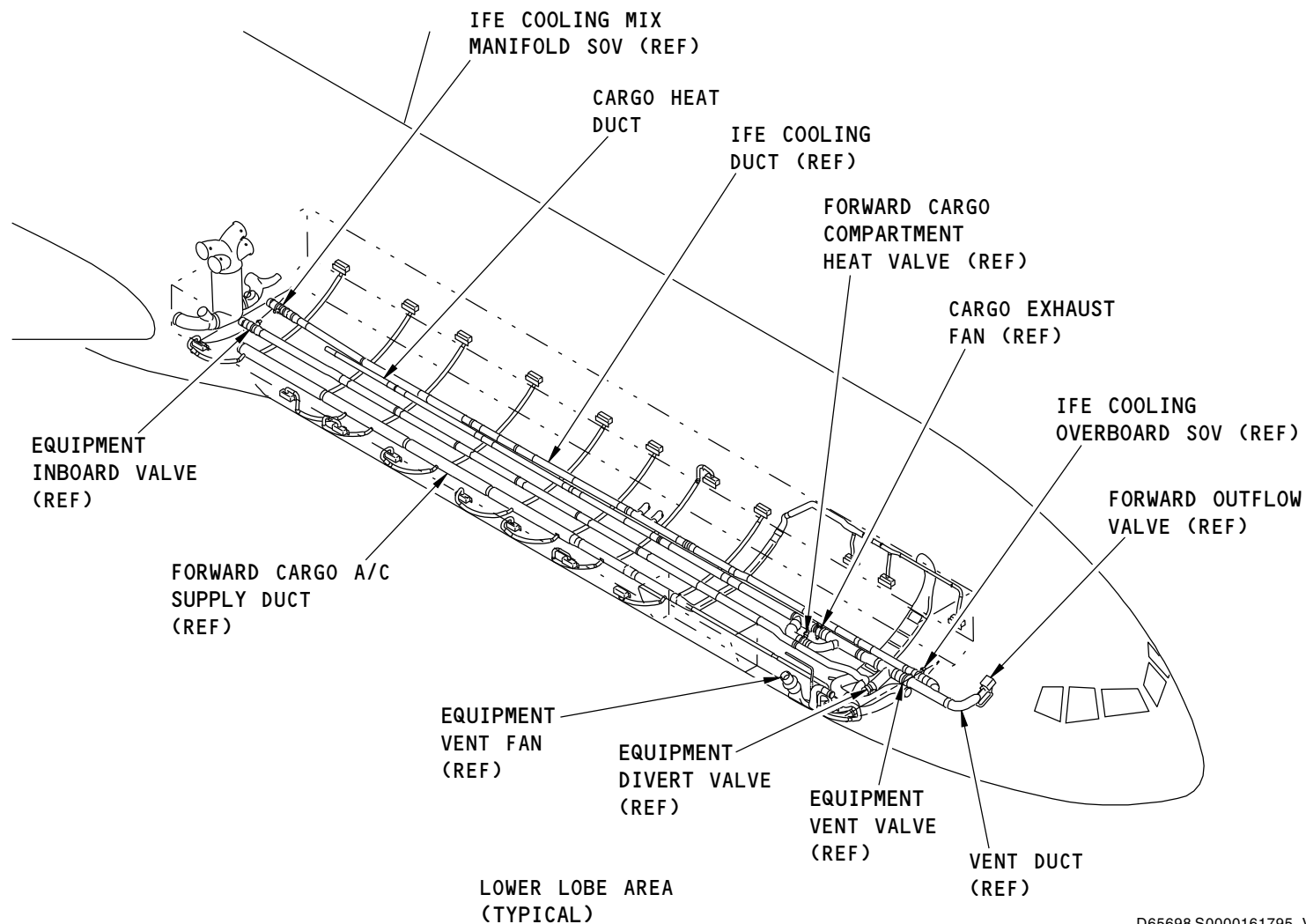
Location

The forward cargo heat duct is below the floor of the forward cargo compartment, on the left side.

Physical Description

The rigid type duct connects to the forward cargo exhaust fan and to the forward cargo compartment heat valve. The diameter of the duct decreases aft of the fan. Near the fan, the diameter is approximately nine inches (23 cm). At the end of the duct, the diameter is approximately four inches (10 cm). The duct has holes on the inboard and outboard sides. There are more holes on the inboard side than on the outboard side. The holes supply air into the forward cargo compartment.

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AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - HEAT DUCT

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AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - HEATER**Purpose**

The forward cargo heater keeps the temperature of the forward cargo compartment more than 40F (4.4C).

Location

The forward cargo heater is in-line with the cargo heat duct. The heater connects to a section of the duct that is below the left forward ball panel.

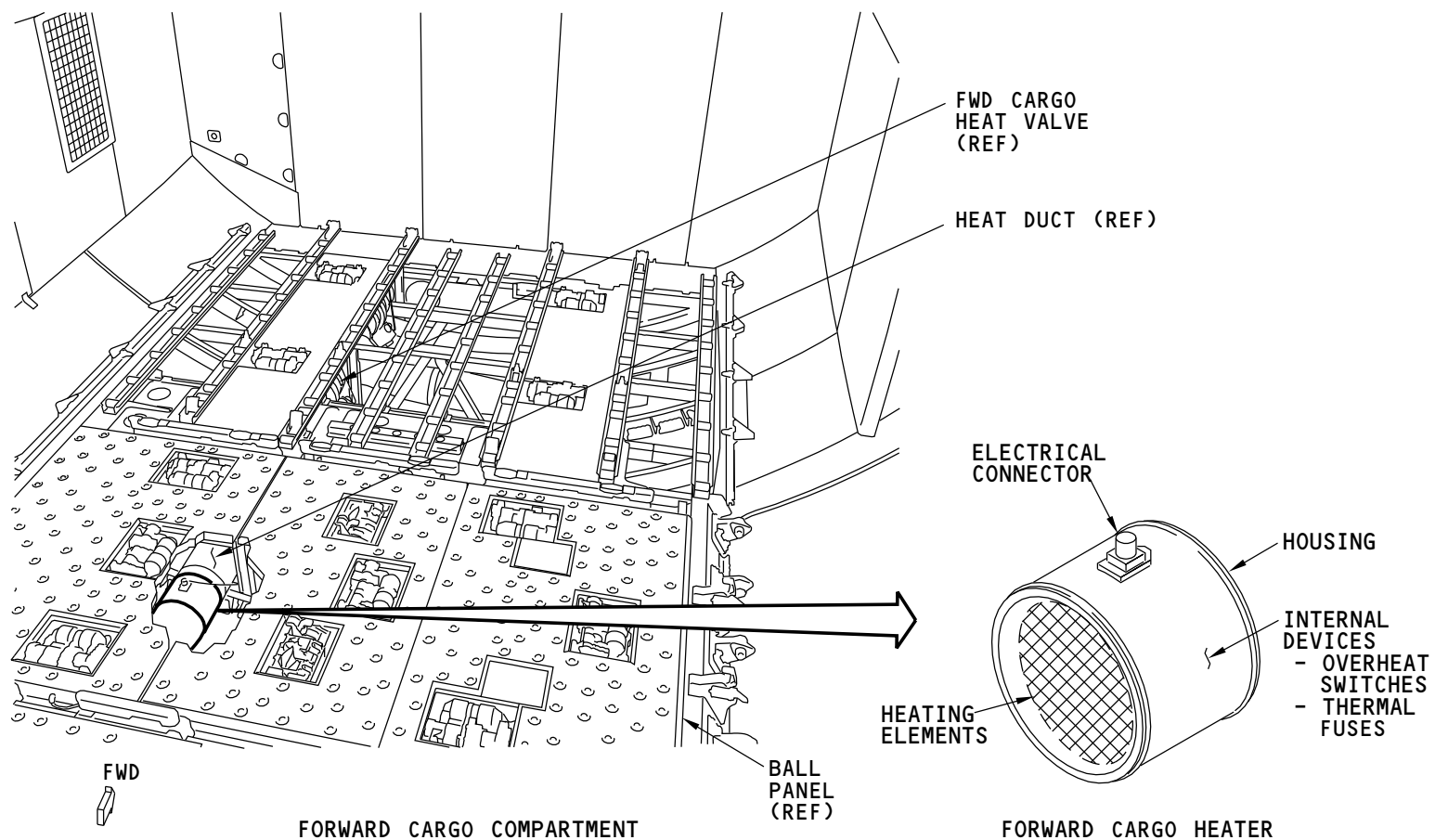
Physical Description

The forward cargo heater is a 5000 watt unit that supplies heat to the equipment exhaust air before it flows into the forward cargo compartment. The heater has these parts:

- Housing
- Electrical connector
- Heating element (3)
- Overheat switch (3)
- Thermal fuse (3).

The overheat switches give duct air over-temperature protection (150F, 65.6C). These switches reset when the heater cools off. The thermal fuses give surface over-temperature protection for the housing (300F, 149C) and the heating elements (450F, 232C). The fuses do not reset.

The heater operates with airflow in either direction. The heater uses 115V AC three phase power.



AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - HEATER

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**AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - TEMPERATURE SENSOR****Purpose**

The right ECSMC uses the forward cargo temperature sensor to monitor the forward cargo compartment temperature.

Physical Description

The sensor is a single element thermistor. The sensor has a threaded housing with an electrical connection.

Location

The sensor is in an air inlet plenum that connects to the lavatory/galley ventilation system. The plenum is in the left sidewall of the forward cargo compartment, near the aft set of ball panels (STA 652).

Training Information Point

The forward cargo temperature sensor is interchangeable with these sensors:

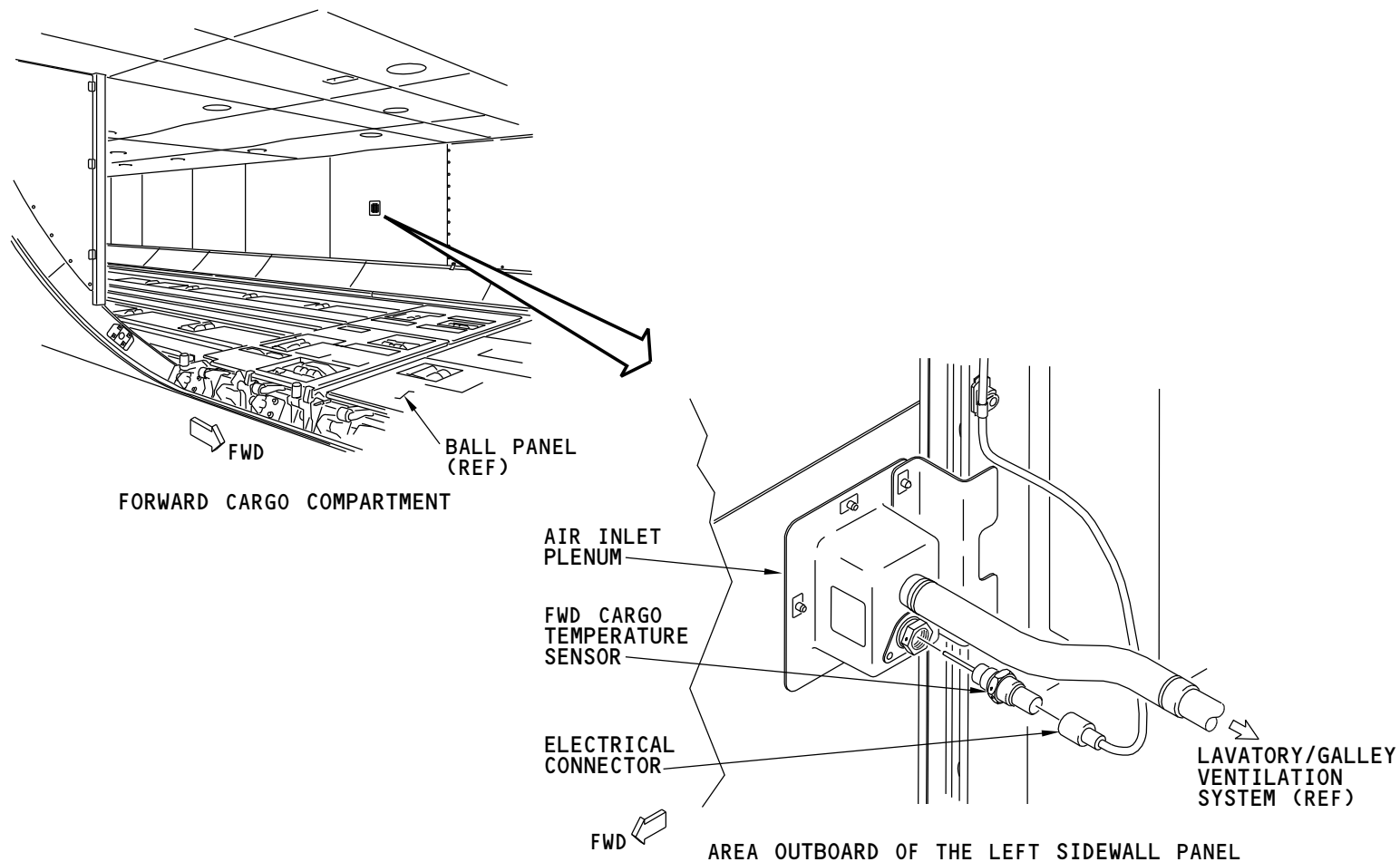
- Mix manifold temperature sensors
- Passenger cabin zone duct temperature sensors
- Flight deck zone duct temperature sensors.

You remove the applicable sidewall panel to get access the forward cargo temperature sensor.

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AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - TEMPERATURE SENSOR

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**AIR CONDITIONING - FORWARD CARGO COMPARTMENT HEATING - FUNCTIONAL DESCRIPTION****Functional Description**

The right ECSMC controls the heater through a signal interface unit (SIU in the P210 right power management power. If the SIU gets a heater on command, it energizes a relay in the power management panel to supply power to the heater.

The right ECSMC gives a heater on command if all of these conditions occur:

- Compartment temperature is less than 40F (4.4C)
- Forward cargo heat valve is open
- Equipment cooling vent fan is on
- Forward cargo temperature sensor has no faults.

Overheat switches and thermal fuses in the heater remove power from the heater if the heater has an overheat. The switches give duct air over-temperature protection (150F, 65.6C). The switches reset when the air cools. The fuses give surface over-temperature protection for the housing (300F, 149C) and the heating elements (450F, 232C). The fuses do not reset.

The right ECSMC removes the heater on command if any of these conditions occur:

- Compartment temperature is more than 50F (10C)
- Forward cargo heat valve is closed
- Equipment cooling vent fan is off
- Forward cargo temperature sensor has a fault.

Indication

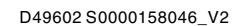
The right ECSMC monitors circuit information from the ELMS. This information helps the ECSMC isolate faults with the heater and the sensor.

Maintenance messages show when the heater or the sensor fails.

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**AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - INTRODUCTION****Purpose**

Aft and bulk cargo compartment heating controls the amount of pneumatic system air supplied to heat these cargo compartments.

General Description

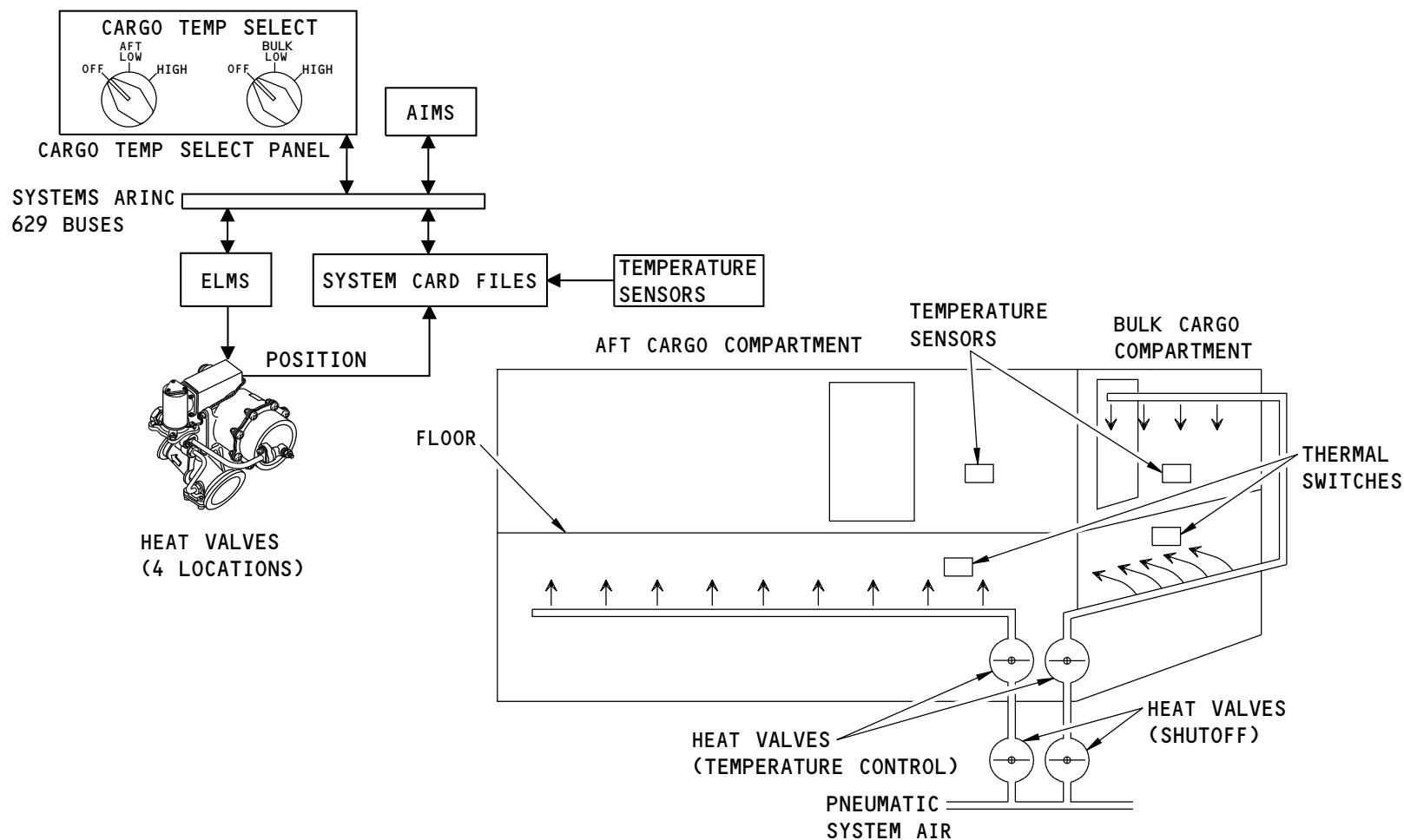
The aft and bulk cargo compartments receive warm air from the pneumatic system. The aft and bulk cargo compartments each have two heat valves. One functions as a shutoff valve. The other functions as a temperature control valve. These valves open or close to supply more or less warm air to keep compartment temperatures within limits.

The cargo temperature select panel on the flight deck gives manual control of the temperature for the aft and bulk cargo compartments. Operation of the valves is from environmental control system miscellaneous cards (ECSMCs) in the system card files.

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AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - INTRODUCTION

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**AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - HEAT VALVES****Purpose**

The aft and bulk cargo heat valves control the amount of air added from the pneumatic system to heat these compartments. The aft and bulk cargo compartments have four heat valves that do these functions:

- Two for system Shutoff
- Two for temperature control.

Physical Description

The aft and bulk cargo heat valves have these parts:

- Relief valve
- Flow assembly
- Electrical solenoid valve
- Optical switch assembly
- Actuator assembly.

Location

The bulk cargo heat valves are in the left side wall where the aft and bulk cargo compartments come together. The aft cargo heat valves are in the left side wall of the aft cargo compartment.

Functional Description

With no power to the solenoid valve, the butterfly valve (not shown) in the flow assembly is closed. When the solenoid gets power and pneumatic air is available to the valve, the butterfly valve will fully open.

The optical switch assembly tells the ECSMC when the valve is completely open or closed.

Training Information Point

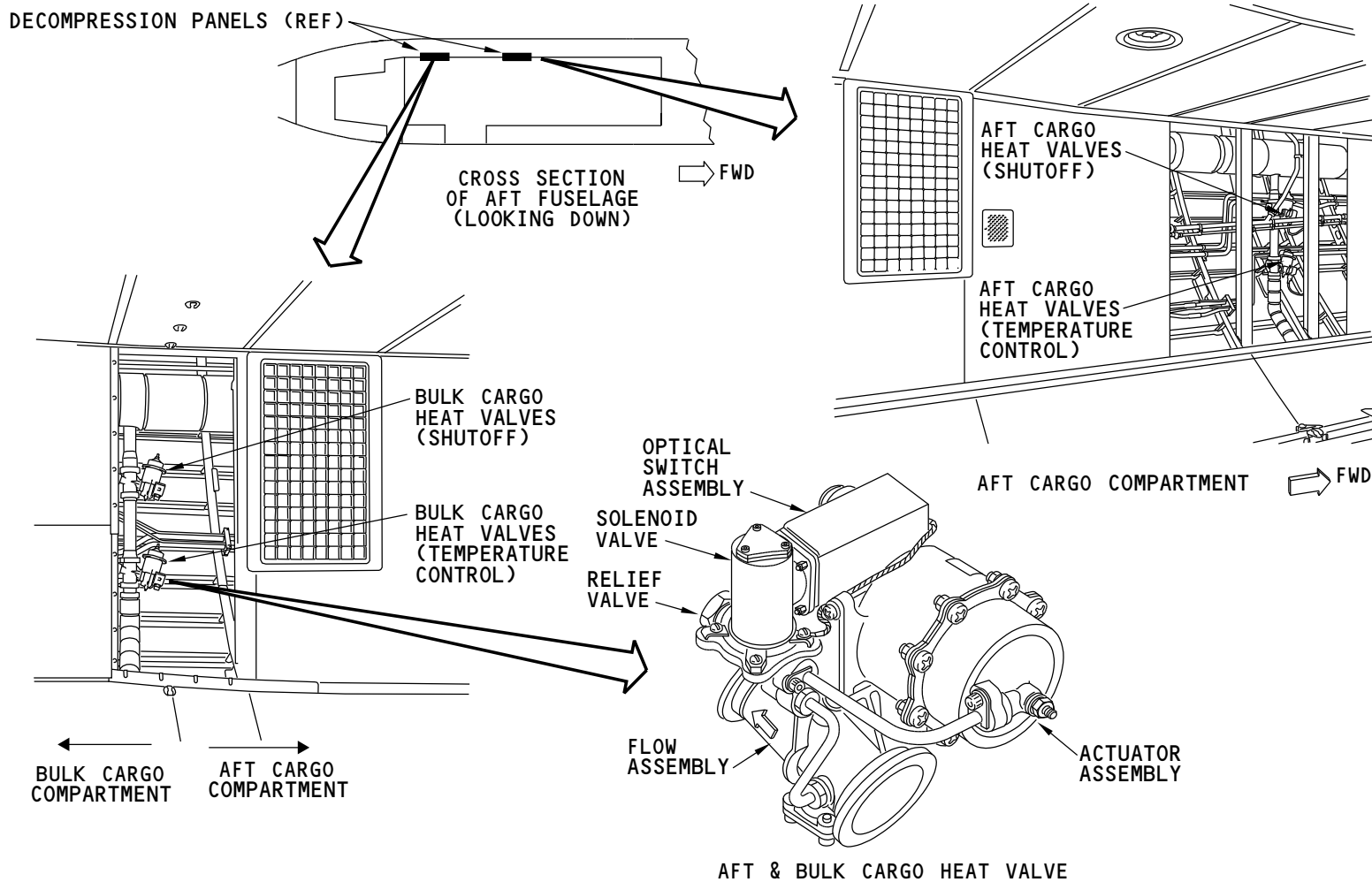
The aft and bulk cargo heat valves are all the same.

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AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - HEAT VALVES

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**AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - TEMPERATURE SENSORS****Purpose**

The aft and bulk cargo compartment temperature sensors monitor the temperature in the related compartment. The ECS miscellaneous cards (ECSCMs) use these temperatures to control the amount of heat added to the cargo compartments.

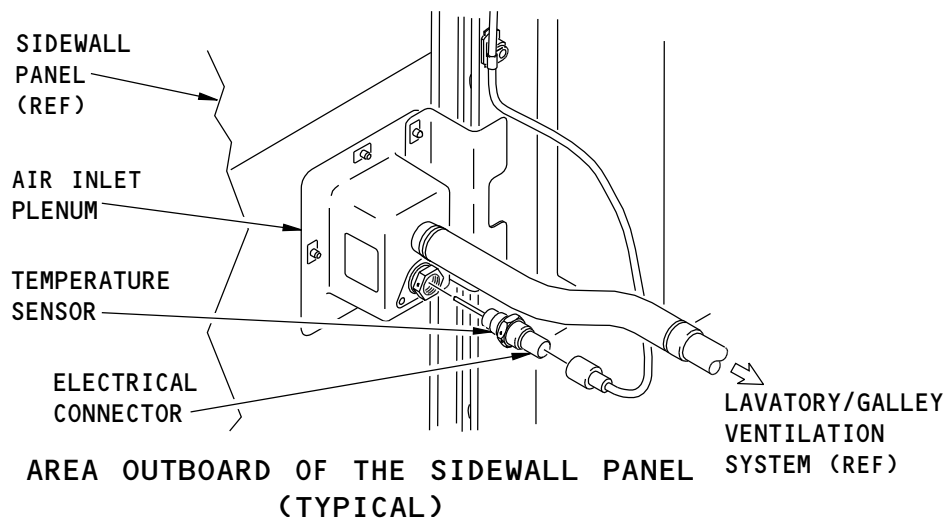
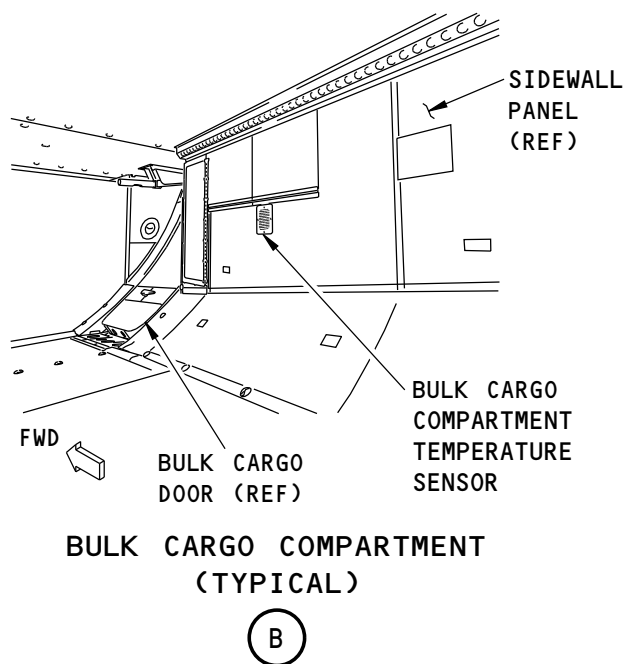
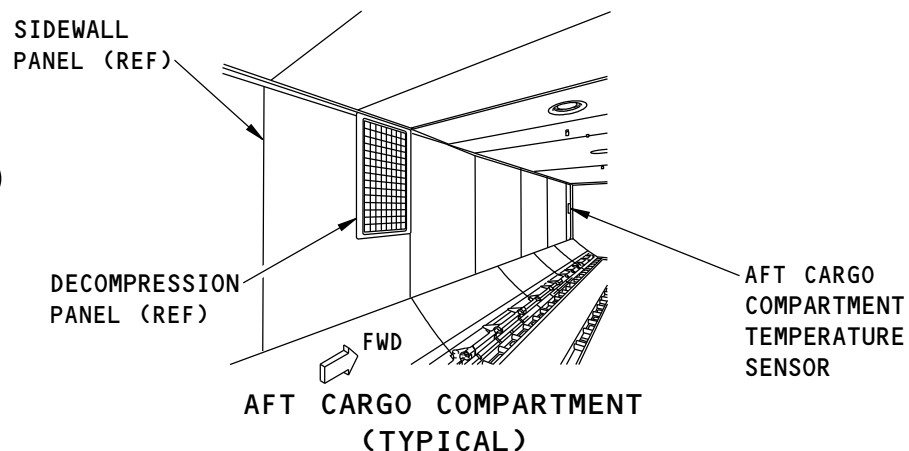
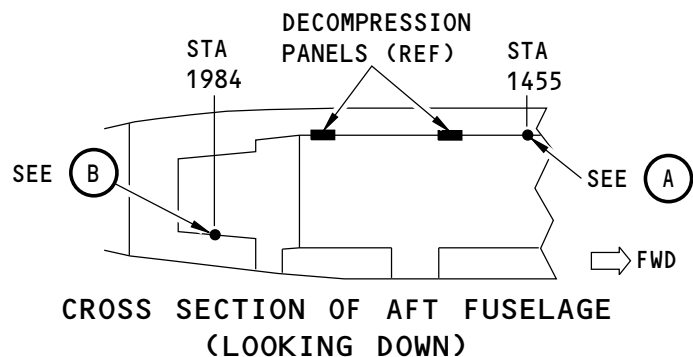
Physical Description

These sensors are a single element thermistor type of sensor. These sensors have a threaded housing with an electrical connection.

Location

The aft cargo compartment temperature sensor is on the left side wall of the aft cargo compartment (STA 1455). The bulk cargo compartment temperature sensor is on the right side wall of the bulk cargo compartment (STA 1984).

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AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - TEMPERATURE SENSORS

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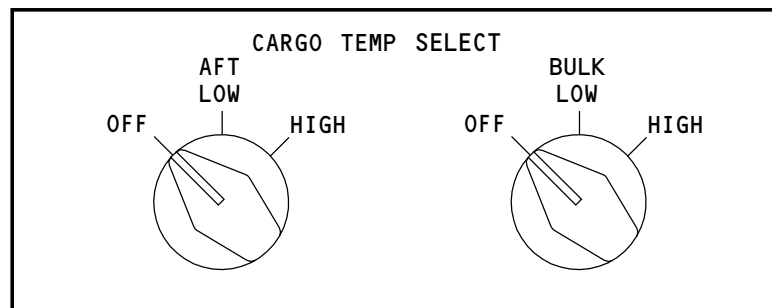
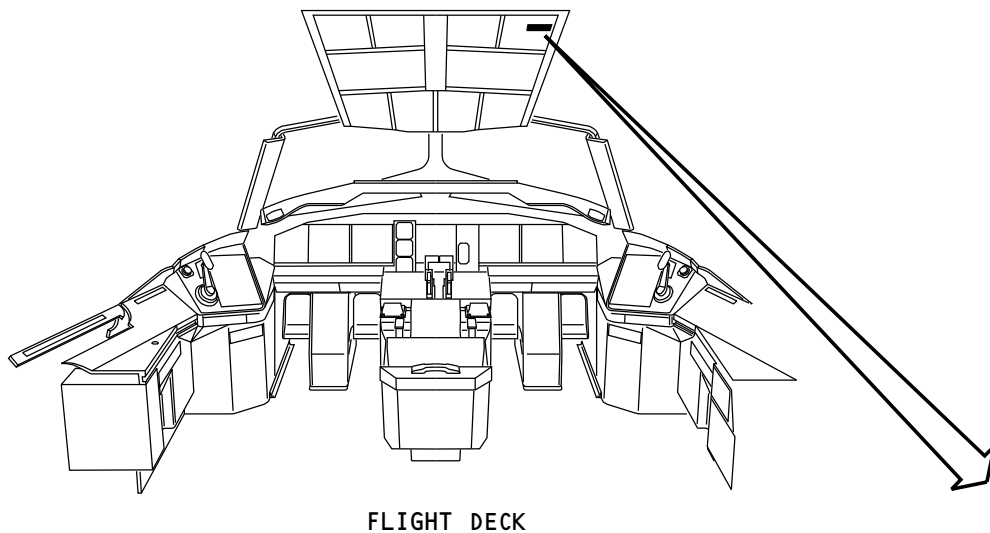
**AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - TEMPERATURE SELECTORS****Purpose**

The cargo temperature selectors give manual control of the aft and bulk cargo compartment temperatures. Each cargo compartment has a selector on the cargo temperature select panel.

Location

The aft and bulk cargo temperature selectors are on the P61 overhead maintenance panel.

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CARGO TEMPERATURE SELECT PANEL (P61)

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AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - TEMPERATURE SELECTORS

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AIR CONDITIONING - AFT AND BULK CARGO COMPARTMENT HEATING - FUNCTIONAL DESCRIPTION

General

The aft and bulk cargo temperature selectors set the temperature range for these compartments.

Each cargo compartment has two heat valves that do these functions:

- Shutoff
- Temperature control.

Valve Open

The open signal for the aft cargo heat valves comes from the left environmental control system miscellaneous card (ECSMC) in the left system card file. The open signal for the bulk cargo heat valves comes from the right ECSMC in the right system card file.

An open signal for the aft cargo heat valves goes to the left power management panel. An open signal for the bulk cargo heat valves goes to the right power management panel. Switches in the electrical load management system (ELMS) signal interface unit (SIU) supply a ground to energize the related cargo heat shutoff valve relay and cargo heat temperature control relay. These relays apply power to the open solenoid on the related valve.

When the heat valves are enabled, the shutoff valve is open. The temperature control valve cycles open and closed to keep the temperature in the cargo compartment to within 5F (3C) of the selected temperature.

Overheat Protection

Overheat switches for the SOV and the TCV will override the open signal and close the valves at underfloor compartment temperatures more than 125°F (52°C).

Indication

An optical sensor monitors valve position. An open and closed discrete from each valve goes to the related ECSMC for control.

A sensor in each compartment supplies temperature data to the related ECSMC.

Operation

Cargo temperature selectors for aft and bulk cargo compartments set cargo compartment temperatures for HIGH, LOW, or OFF. The HIGH selection sets the compartments to 70 ±5°F (21 ±3°C). The LOW selection sets the compartments to 45 ±5°F (7 ±3°C).

Inhibits

The operation of the valves is not enabled if any of these conditions occur:

- The temperature in the aft cargo compartment is more than 90F (32C) and the shutoff or temperature control valve is closed
- The airplane is on the ground with a cargo door open
- The cargo heat selector is set to off
- The aft cargo fire system is armed
- The two lavatory/galley ventilation fans are failed off
- TAT is more than the selected temperature
- The cargo temperature sensor is failed
- Limitations on the use of bleed air.

If the cargo compartment temperature is more than 90F (32C) and the SOV and the TCV are not closed, the system latches the two valves closed. To reset the latch, do a ground test on the MAT.

Limitations on the Use of Bleed Air

The cargo heat valves are commanded closed for certain airplane conditions to minimize the use of bleed air. These are the conditions:

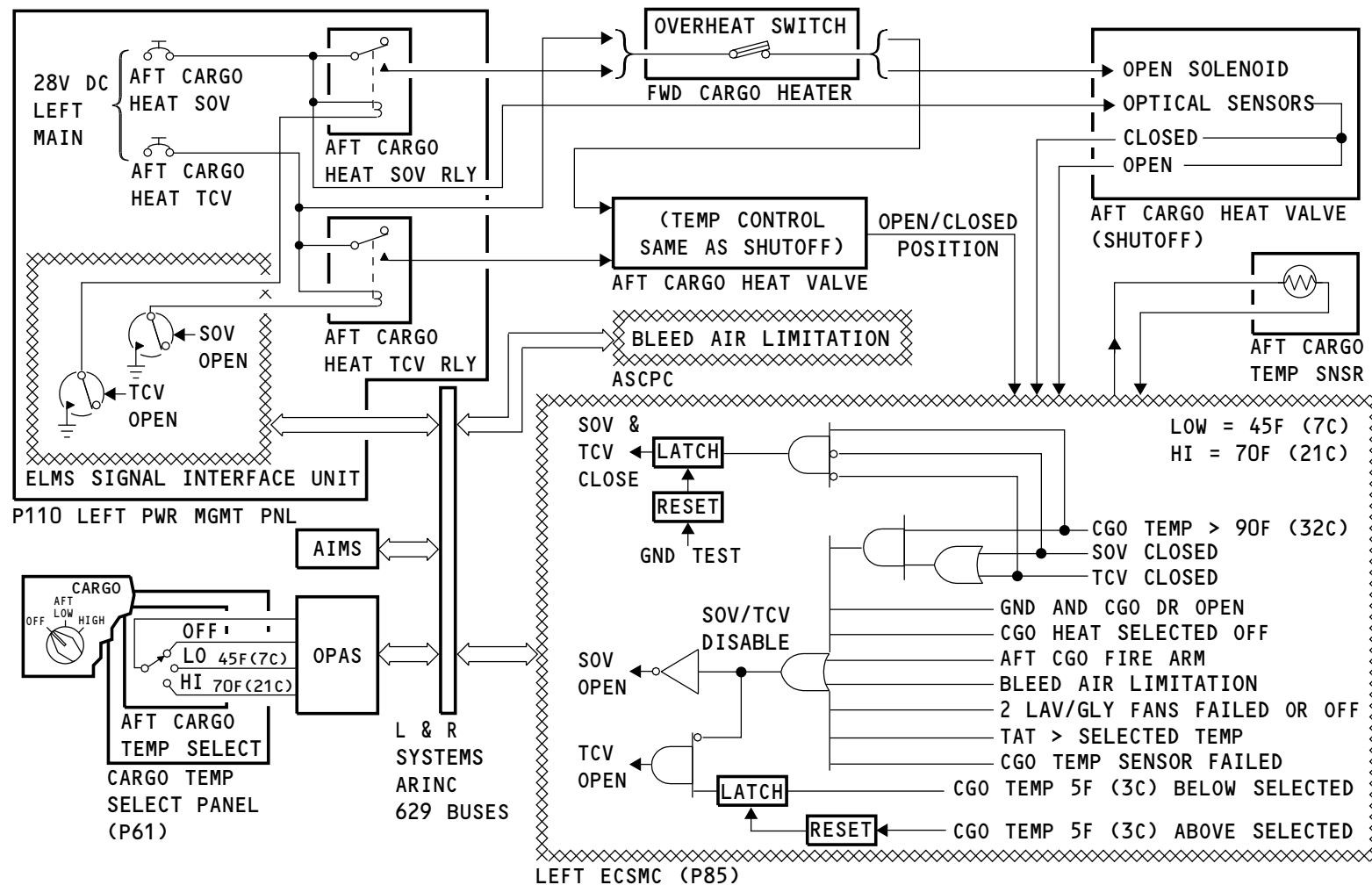
- Engine start
- Takeoff
- Autoslat extension
- Only one engine is running and one or more wing anti-ice valve is open.

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**AIR CONDITIONING - SUPPLEMENTAL HEATING - INTRODUCTION****General**

In locations where the heat from trim air is not sufficient, supplemental heaters add more heat. Heaters supply heat to these areas.

- Flight crew feet (rubber pedal area)
- Flight crew shoulders (number 2 window area)
- Passenger doors (floor area)
- Some galleys (floor area).

These galley complexes can have supplemental heaters:

- Forward
- Mid
- Aft.

The environmental control system miscellaneous cards (ECSCMs) supply control logic for all supplemental heaters. The cards enable heater operation based on airplane conditions. ELMS gives power for heater operation. Some heaters have manual controls that you adjust the temperature they supply.

These heaters for the flight compartment area have manual control:

- Foot heaters
- Shoulder heaters.

The door heaters have no manual control.

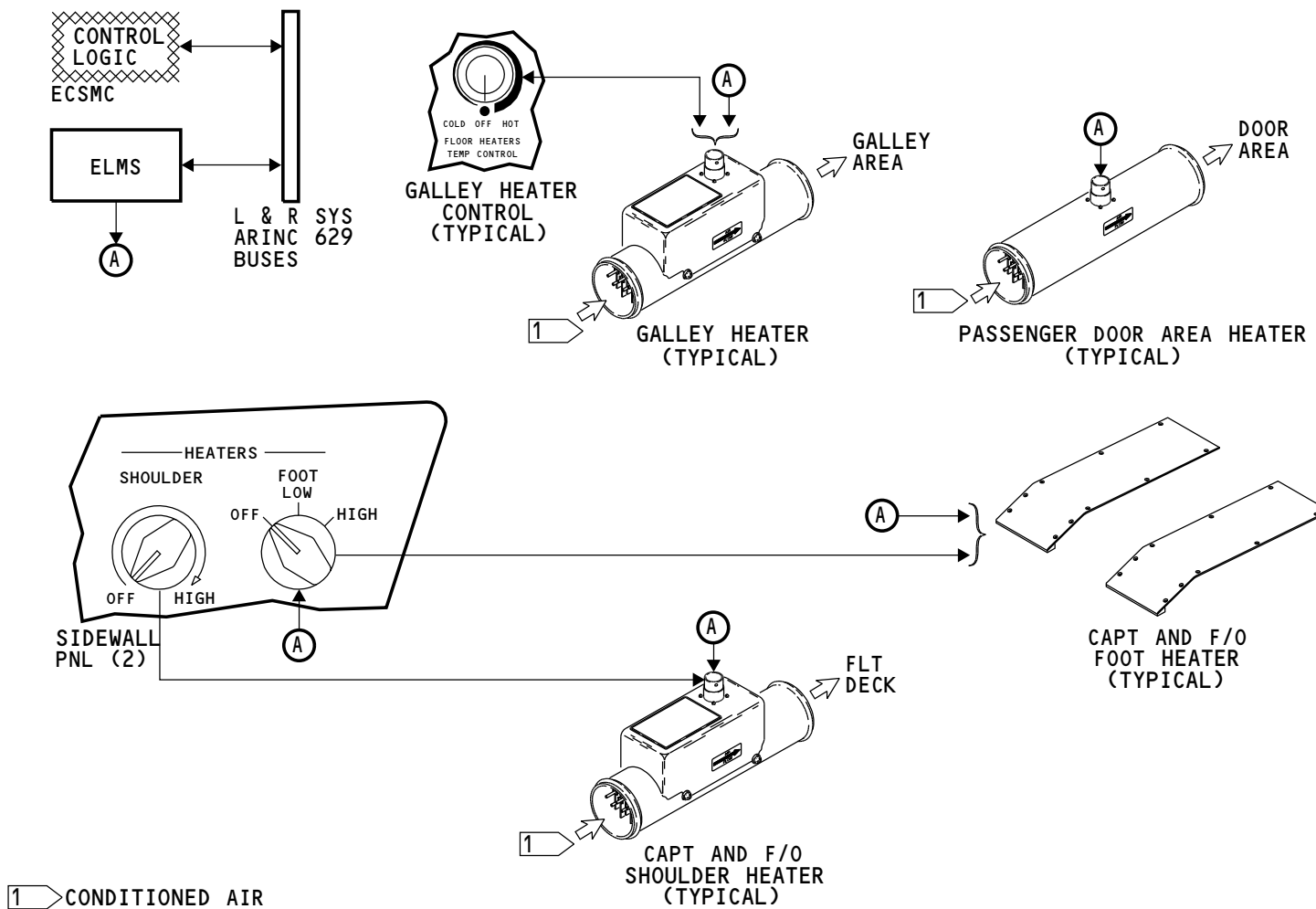
The galley complexes that have a supplemental heater have a manual control.

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AIR CONDITIONING - SUPPLEMENTAL HEATING - INTRODUCTION

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**AIR CONDITIONING - SUPPLEMENTAL HEATING - FLIGHT DECK FOOT HEATERS****Purpose**

Flight deck foot heaters add heat to the foot areas of the flight crew.

Physical Description

These are electrical heaters.

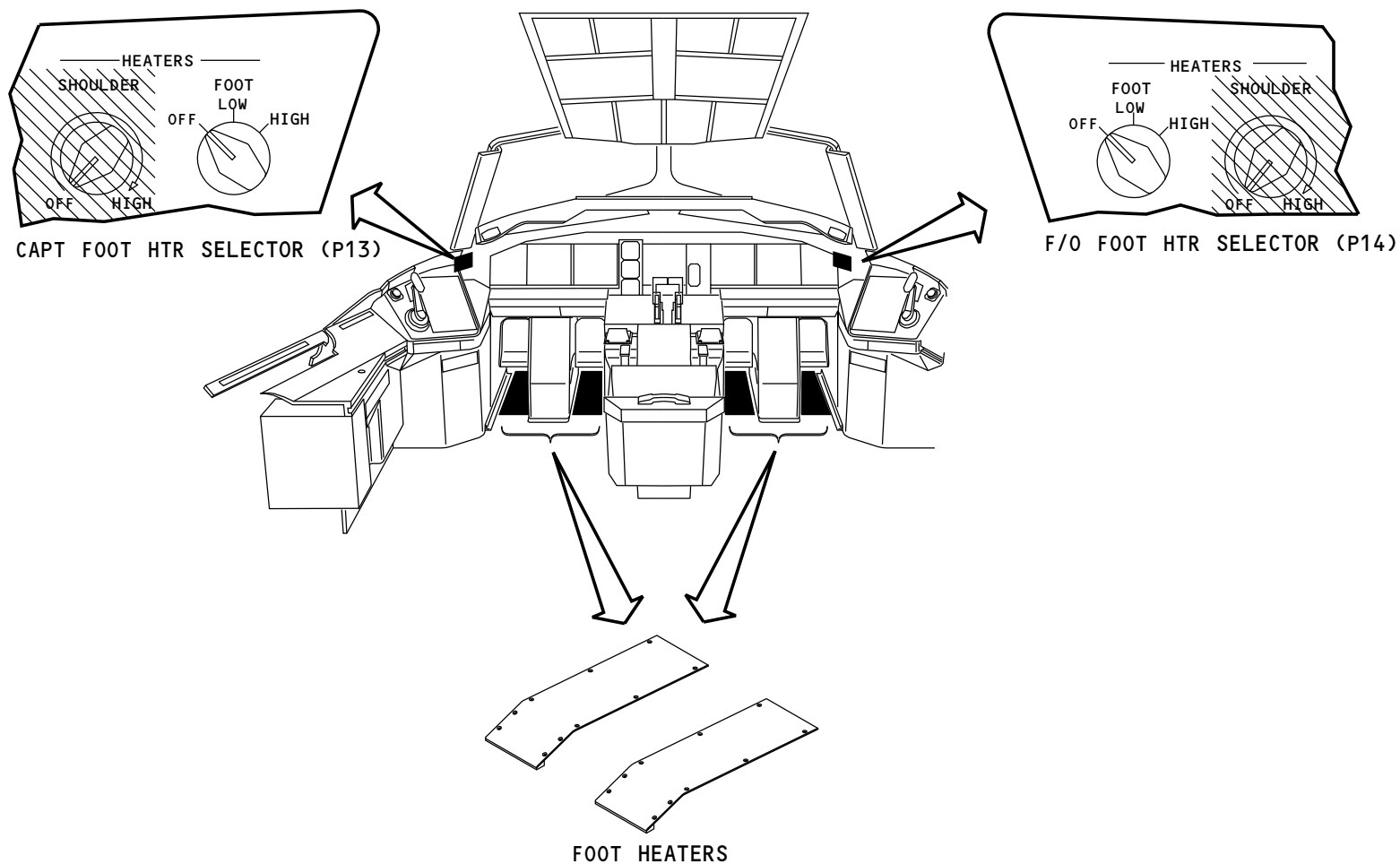
Location

One set of foot heaters is on the floor under each set of rudder pedals.

The captain foot heater selector is on the P13 sidewall panel - captain. The first officer foot heater selector is on the P14 sidewall panel - first officer.

Operation

The foot heater selectors permit selection of a high or low heat.



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AIR CONDITIONING - SUPPLEMENTAL HEATING - FLIGHT DECK FOOT HEATERS

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**AIR CONDITIONING - SUPPLEMENTAL HEATING - FLIGHT DECK SHOULDER HEATERS****Purpose**

Flight deck shoulder heaters add heat to the air supplied to the shoulder areas of the flight crew.

Physical Description

These are electrical heaters.

Location

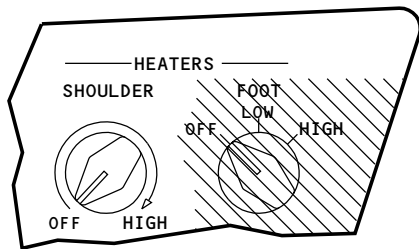
One heater is on each side of the nose wheel well in the main equipment center.

The captain shoulder heater control is on the P13 sidewall panel - captain.
The first officer shoulder heater control is on the P14 sidewall panel - first officer.

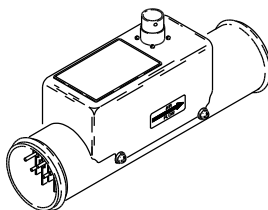
Operation

The shoulder heater controls set the level of heat from the shoulder heaters.

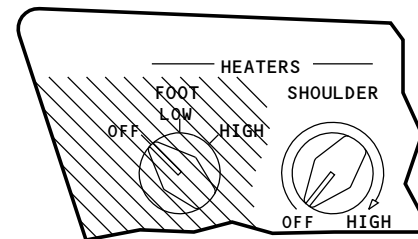
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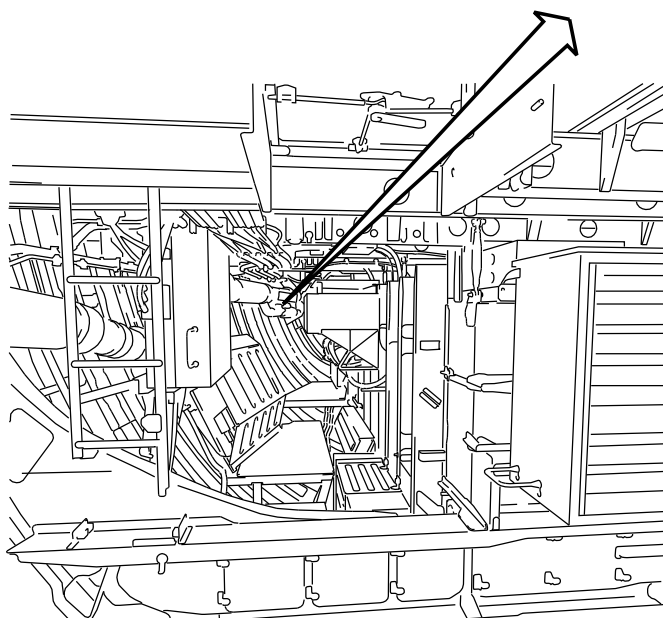
CAPTAIN SHOULDER HTR CTRL (P13)



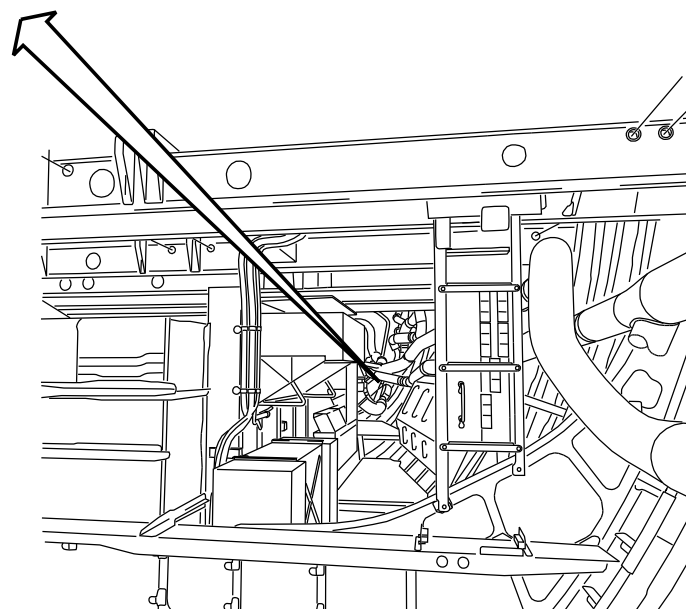
SHOULDER HEATER



F/O SHOULDER HTR CTRL (P14)



MAIN EQUIPMENT CENTER
(LEFT SIDE, LOOKING FORWARD)



MAIN EQUIPMENT CENTER
(RIGHT SIDE, LOOKING FORWARD)

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AIR CONDITIONING - SUPPLEMENTAL HEATING - FLIGHT DECK SHOULDER HEATERS

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**AIR CONDITIONING - SUPPLEMENTAL HEATING - DOOR AREA HEATERS****Purpose**

Door area heaters add heat around the sides of each passenger door.

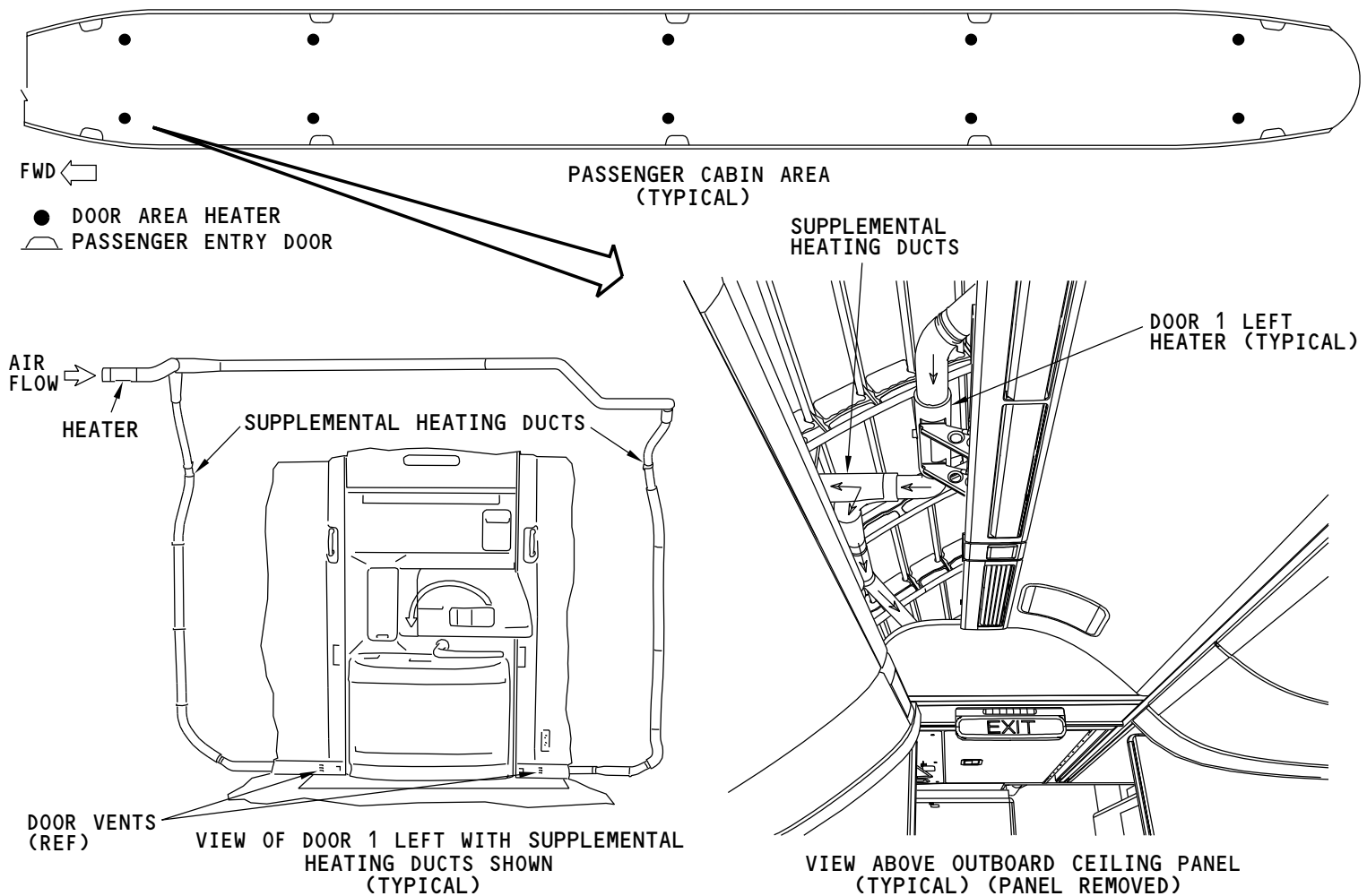
General Description

One electric heater is above the ceiling near each of these doors.

- Door 1 heaters are aft of the doors, above the first outboard ceiling panel
- Door 2, 3 and 4 heaters are above the outboard ceiling panel that is next to the related door
- Door 5 heaters are forward of the doors, above the last outboard ceiling panel.

Door 2 heaters get air from the ducts that carry air from the forward recirculation fan. Doors 3 and 4 heaters get air from the ducts that carry air from the aft recirculation fan. Doors 1 and 5 heaters get air from the ducts that carry conditioned air.

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AIR CONDITIONING - SUPPLEMENTAL HEATING - DOOR AREA HEATERS

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**AIR CONDITIONING - SUPPLEMENTAL HEATING - GALLEY HEATERS****Purpose**

Galley heaters add heat to the conditioned air that goes to these galleys:

- Forward galley area
- Mid galley area
- Aft galley area.

Location

Galley heaters are in-line with conditioned air ducts that give air to the galleys. The heaters are at these locations:

- Forward galley area, one heater above the overdoor panel at door 1 right
- Mid galley area, one heater above the ceiling on the right side of the airplane (RBL 32), near the mid galley (station 1450)
- Aft galley area, two heaters above the ceiling of the aft galley.

The galleys that have a heater also have a heater control. The control lets the cabin attendants set the quantity of heat from the heater.

Physical Description

The galley heater is an electrical unit that uses 3 phase, 115vac. The heater has these parts:

- Body (tube assembly)
- Printed circuit card (PCC)
- Cover
- Electrical connector.

The body has a heater core and temperature sensors.

The printed circuit card attaches to the body under the cover. The card gives automatic control of the heater. The card controls the quantity of heat provided based on inputs from a control in the galley and the temperature sensors in the body of the heater. The card is sensitive to damage by electrostatic discharge (ESDS).

The heater has no LRUs.

Training Information Point

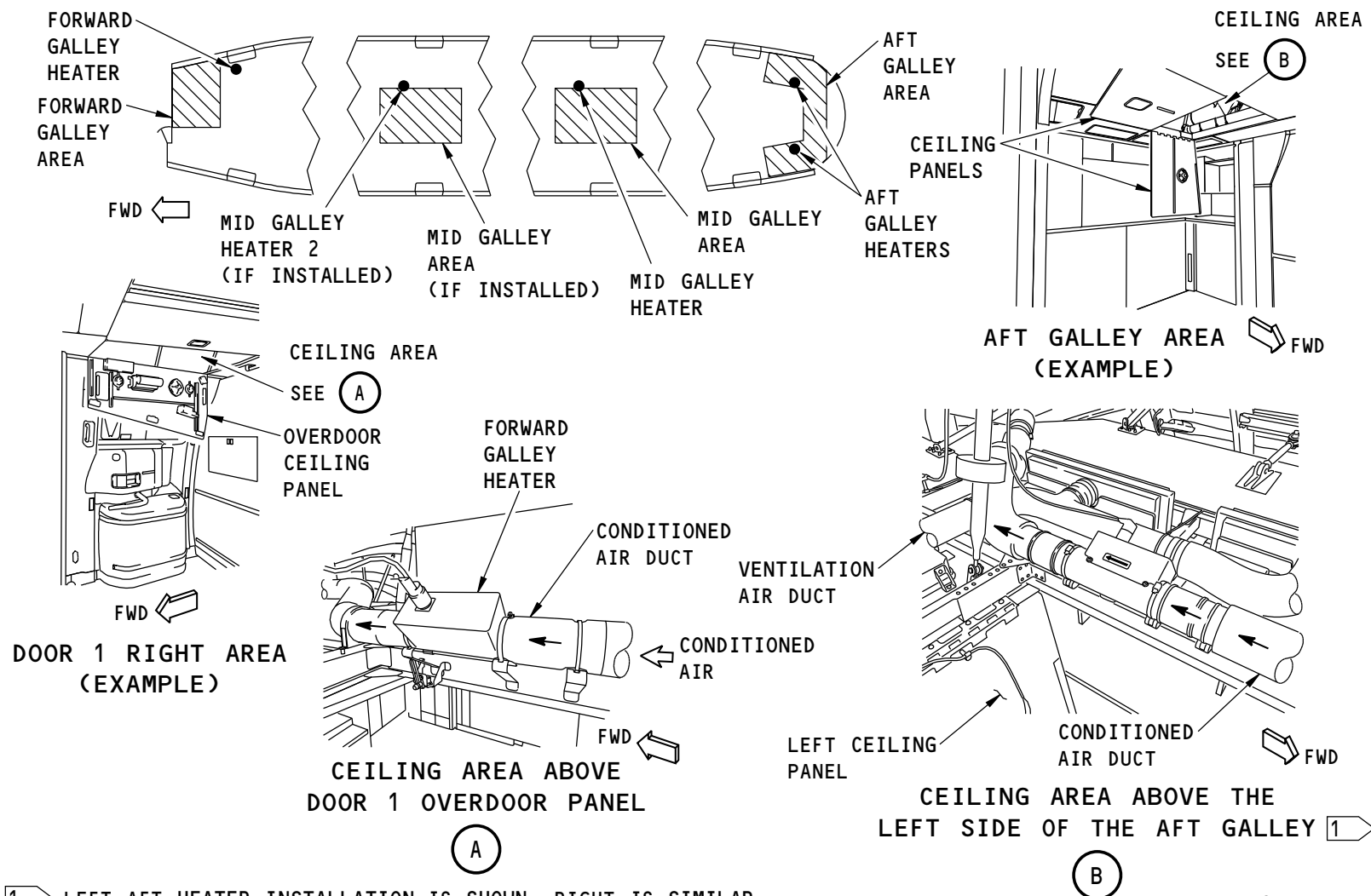
The heater cover has a placard that shows the correct direction of airflow. Make sure you install the heater correctly for the direction of airflow. If you install the heater incorrectly, the heater will overheat and fail.

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1 LEFT AFT HEATER INSTALLATION IS SHOWN, RIGHT IS SIMILAR.

AIR CONDITIONING - SUPPLEMENTAL HEATING - GALLEY HEATERS

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A/C - SUPPLEMENTAL HEATING - DOOR AREA HEATERS - FUNCTIONAL DESCRIPTION**General**

The enable signals for the door area heaters come from the ECSMCs in the system card files. At card file power up, the right ECSMC gives primary control and the left gives backup control. The primary and backup control changes cards at each air/ground transition.

See the air conditioning section for more information about the ECSMC (SECTION 21-00).

The ELMS has four circuits that the ECSMC use to enable the eight passenger door area heaters. Each ELMS circuit enables two heaters. These heaters are enabled together:

- Doors 1 and 2 left
- Doors 1 and 2 right
- Doors 3, 4 and 5 left
- Doors 3, 4 and 5 right.
- Door 1 left
- Door 1 right.

The enable signal for the heaters goes to the left power management panel. A switch in the ELMS signal interface unit (SIU) supplies a ground to energize the related heater relay. Each relay supplies power to the related heater.

Control

Door area heaters receive power when these conditions are true:

- Sufficient air flow exists in the air conditioning distribution ducts
- The airplane is in the air.

During single pack operation, there is sufficient air flow when the pack is in schedule 1 or 2 and all recirculation fans are on. During 2 pack operation, there is sufficient air flow when the packs are in schedule 1 or 2 and two or more recirculation fans are on.

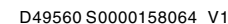
Current sensors monitor the heater current during operation.

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**A/C - SUPPLEMENTAL HEATING - GALLEY AND FLIGHT DECK HEATERS - FUNCTIONAL DESCRIPTION****General**

The enable signals for the galley heaters and the foot and shoulder heaters for the captain and first officer come from the ECSMCs in the system card files. At card file power up, the right ECSMC gives primary control and the left gives backup control. The primary and backup controls change cards at each air-ground transition.

See the air conditioning section for more information about the ECSMC (SECTION 21-00).

The ELMS has circuits that the ECSMCs use to enable the forward and aft galley and flight deck heaters. The enable signal for the heaters shown goes to the left power management panel. A switch in the ELMS signal interface unit (SIU) supplies a ground to energize the related heater relay. Each relay supplies power to the related heater.

Galley Heaters

The galley heaters get power if the left or right pack is on.

Each galley complex contains a heater control. This control sets the level of heat for the heater. In the OFF position, the switch disconnects the control input to the heater. This stops the heater.

Flight Deck Heaters

The captain and first officer both have a heater control for the related foot and shoulder heaters. These heaters get power when the airplane is in the air.

The foot heater selector sets the voltage for high or low power operation. The foot heaters have overtemperature protection. A control thermostat in each foot heater closes the circuit at approximately 70F (21C) and opens the circuit at approximately 80F (27C).

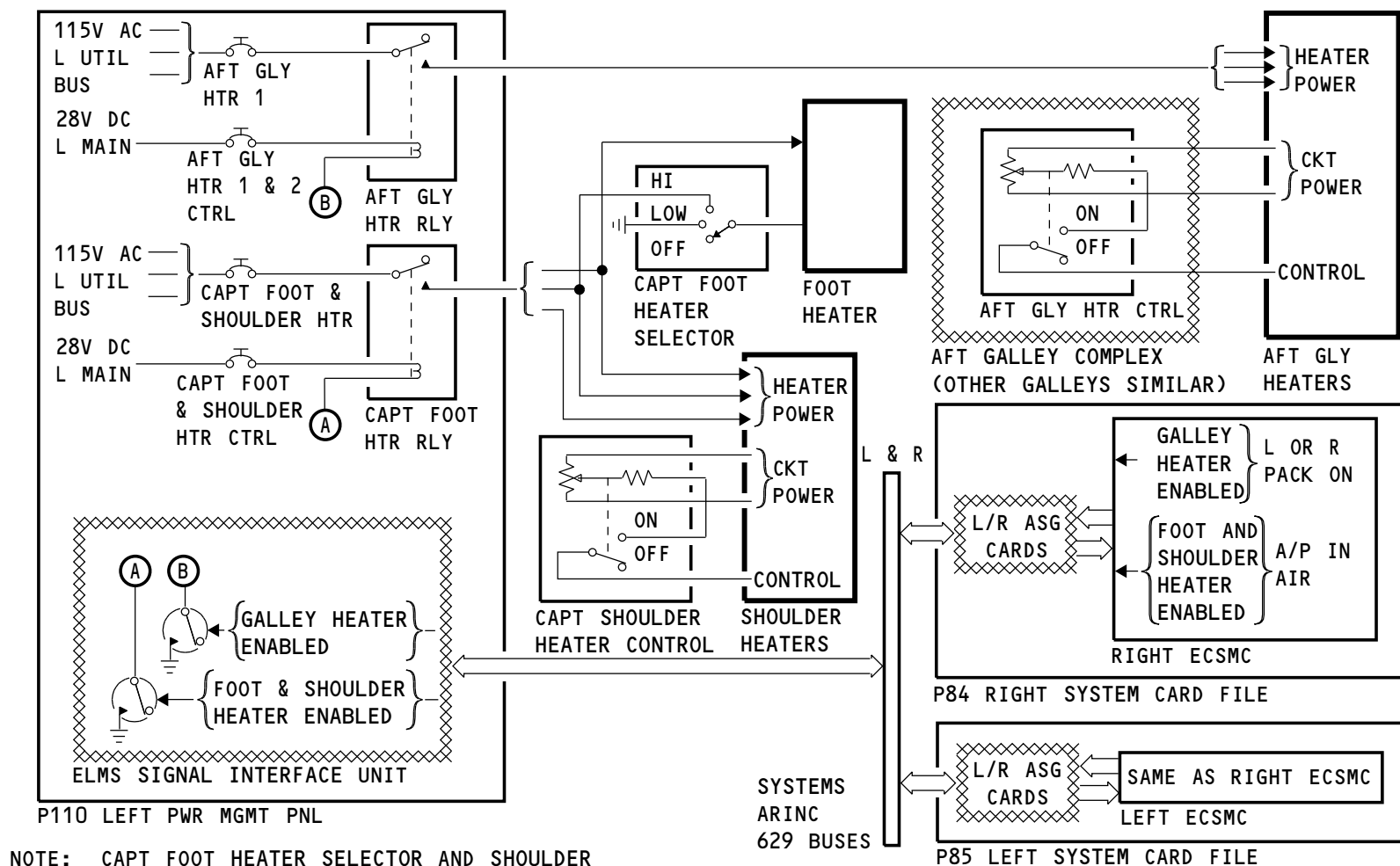
The shoulder heater control sets the level of heat. In the OFF position, the switch disconnects the control input to the heater. This stops the heater.

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**AIR CONDITIONING - COOLING - INTRODUCTION****General**

The cooling system includes these two subsystems:

- Pack flow control
- Pack cooling and mix manifold temperature control.

Pack Flow Control

These are the functions of the pack flow control system:

- Pack air on/off control
- Ozone control bypass
- Pack air flow regulation.

The pack air on/off control function controls the rate that the pack starts and stops. The ozone control bypass function controls when the ozone removal system operates. The pack air flow regulation function controls the quantity of air that goes into the airplane. See the pack flow control section for more information about the pack flow control system (SECTION 21-51).

Pack Cooling And Mix Manifold Temperature Control

Two air conditioning packs decrease the temperature of air from the pneumatic system.

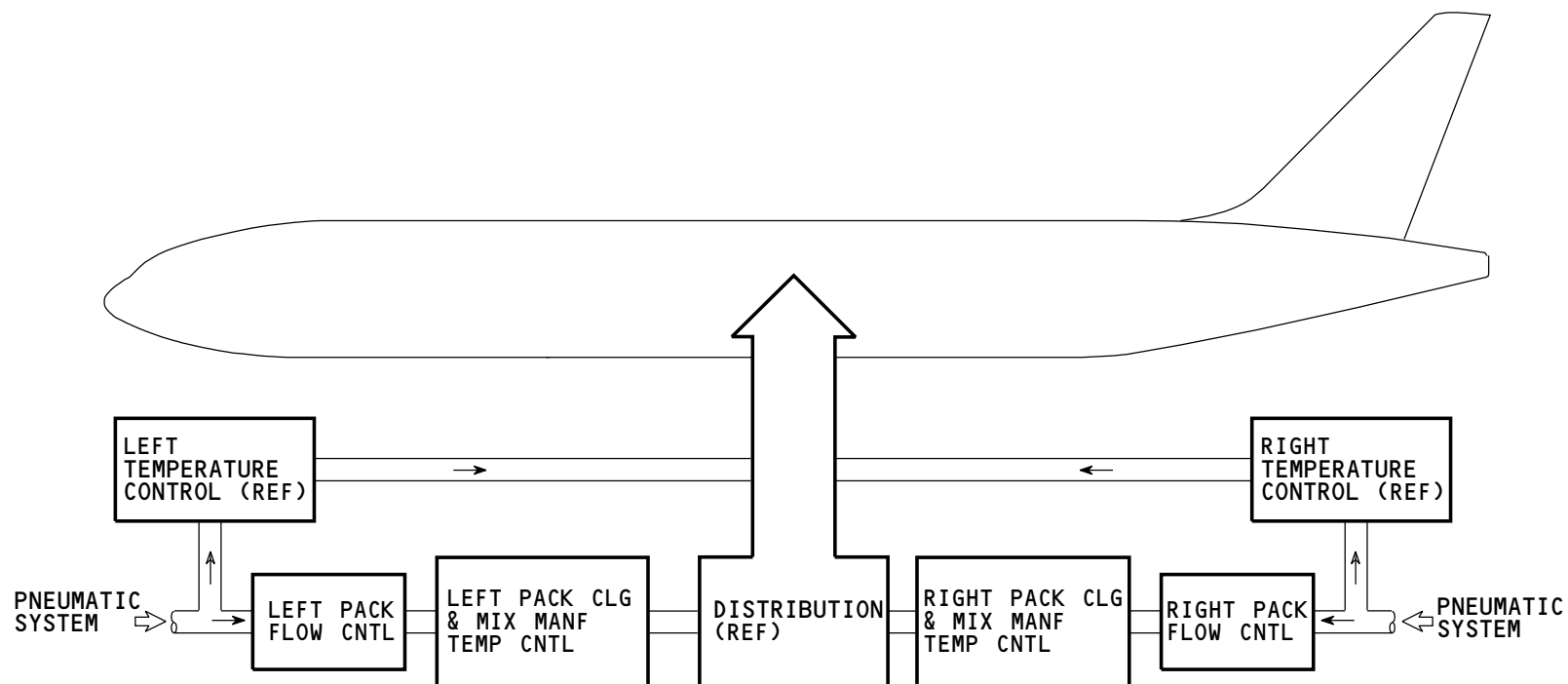
The mix manifold temperature control function adjusts the pack outlet air temperature. This function keeps the distribution air temperature equal to a reference temperature set by the zone temperature control system. See the pack cooling and mix manifold temperature control section for more information about the pack (SECTION 21-52). See the zone temperature control and indication section for more information about temperature control for the mix manifold (SECTION 21-61).

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AIR CONDITIONING - COOLING - INTRODUCTION

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**AIR CONDITIONING - COOLING - GENERAL DESCRIPTION - CONTROL****CTC Functions**

The CTCs control air flow into the air conditioning packs and control the mix manifold temperature. Two identical control channels in each CTC give redundancy.

With the APU off and the pack switches in AUTO, the CTCs use flow schedule data from the ASCPCs to control pack air flow. If the APU supplies air to the packs, the CTCs tell the APUC the amount of air necessary. Then, the CTCs do not use the flow schedule from the ASCPCs.

For some conditions when pack air flow is too low, the CTCs send bleed bias signals to the ASCPCs.

ASCPC Functions

The ASCPCs set the flow schedule for the CTCs, give backup pack flow control, and control the engine bleed air system.

The ASCPCs get information about bleed air users and about airplane operating conditions from the left and right system ARINC 629 buses. The ASCPCs use the information to set the pack air flow schedule and send the flow schedule data to the CTCs. The left ASCPC is primary for this function and the right ASCPC is the backup.

The ASCPCs cause the pack flow control valves to close for some conditions. The ASCPC is redundant with the CTC for these conditions.

The ASCPCs are also able to keep the pack outlet temperature in limits by controlling the pack air flow. This is called backup pack flow control. Backup pack flow control is a degraded mode of operation that maintains cabin pressurization but does not give accurate temperature control. The packs operate in this mode if the CTCs do not have electrical power.

If an ASCPC gets a bleed bias signal from the CTC, the ASCPC adjusts the engine bleed air system. This decreases the engine bleed air temperature or increases the HPSOV regulation set point.

See the pack flow control section for more information about the ASCPC functions that have a relation to the air conditioning pack flow control (SECTION 21-51).

Electrical Power

The CTCs get electrical power from the 28v dc main buses and the 115v ac transfer buses. The ASCPC digital circuits get 28v dc power from the section 2 battery bus, the captain's flight instrument bus and the first officer's flight instrument bus. The left ASCPC can operate on battery power. The right ASCPC can operate on standby power from the captain's and first officer's flight instrument buses. The CTCs can not operate with only battery or standby power.

Economy Cooling Mode

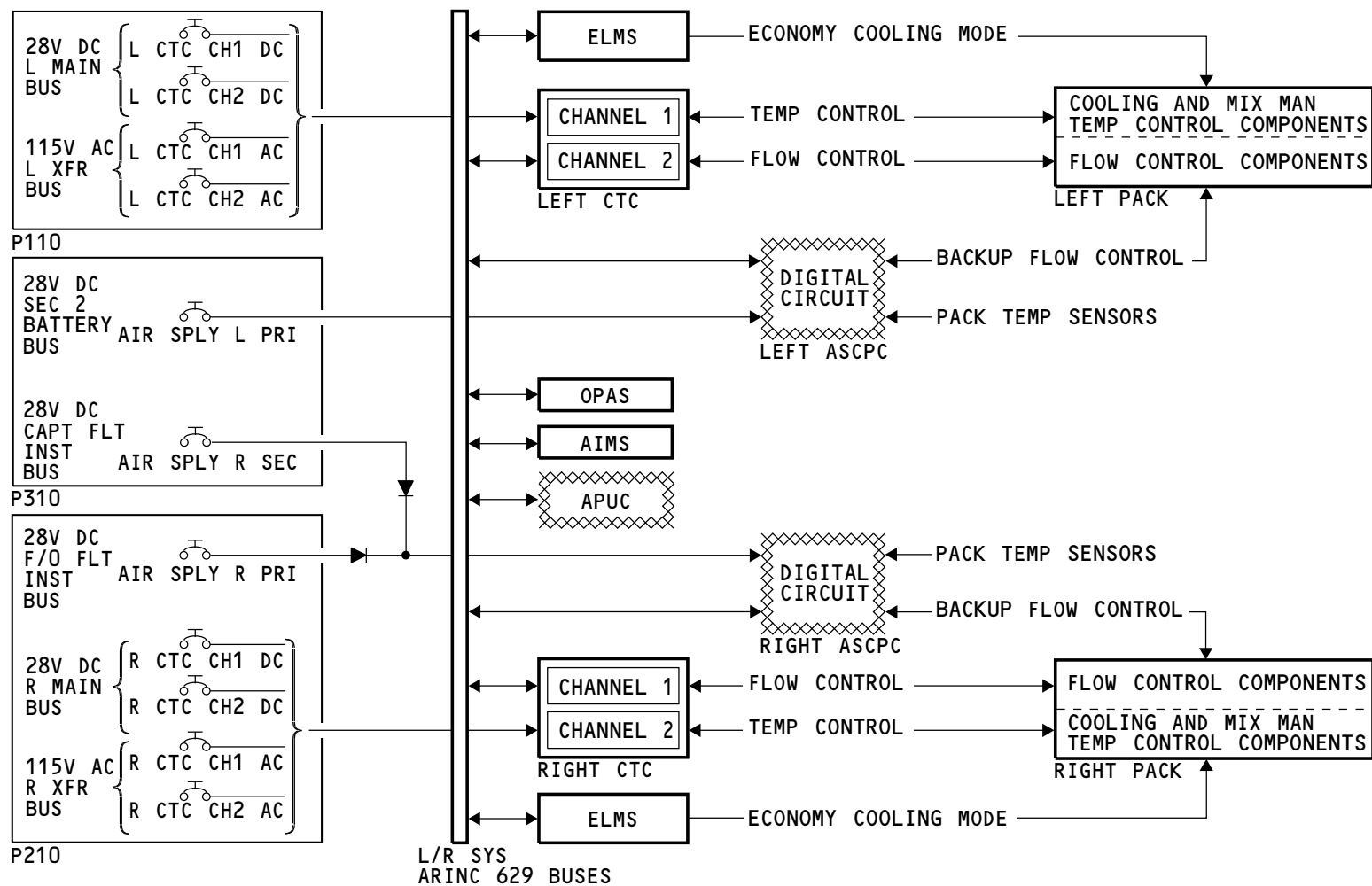
For some conditions when pack air flow is too low, the CTC adjusts the pack temperature control components to help increase flow. An ARINC 629 signal from the CTC to ELMS puts the pack into the economy cooling mode.

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AIR CONDITIONING - COOLING - GENERAL DESCRIPTION - CONTROL

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AIR CONDITIONING - COOLING - INTERFACES

Interfaces

These systems have an interface with the CTC on the Systems ARINC 629 buses:

- Overhead panel ARINC 629 system (OPAS): air conditioning panel pack controls and indications and the forward cargo air conditioning control, AUTO/OFF
- Power panels: control of the economy cooling valve
- Proximity sensor electronics unit (PSEU): air ground
- Environmental control system miscellaneous cards (ECSCMs): recirculation fan overheat switches and forward cargo A/C shutoff valve, open/closed
- Air supply cabin pressure controller (ASCPC): flow schedules, stall recovery
- Auxiliary power unit controller (APUC): APU status, pack demand
- Airplane information management system (AIMS) cabinet: primary display system (PDS), central maintenance computing system (CMCS)
- Air Data Inertial Reference Unit (ADIRU): Airplane Altitude.

The CTC supplies analog control signals to these components:

- Flow control and shutoff valves
- Ram air inlet door actuator
- Ram air exhaust door actuator
- Low limit valve
- Second stage turbine bypass valve.

These components supply analog data to the CTC:

- Pack flow sensor
- Flow control valve proximity switches
- Primary heat exchanger inlet temperature sensor
- Ram air inlet RVDT
- Ram air exhaust RVDT
- Low limit valve RVDT

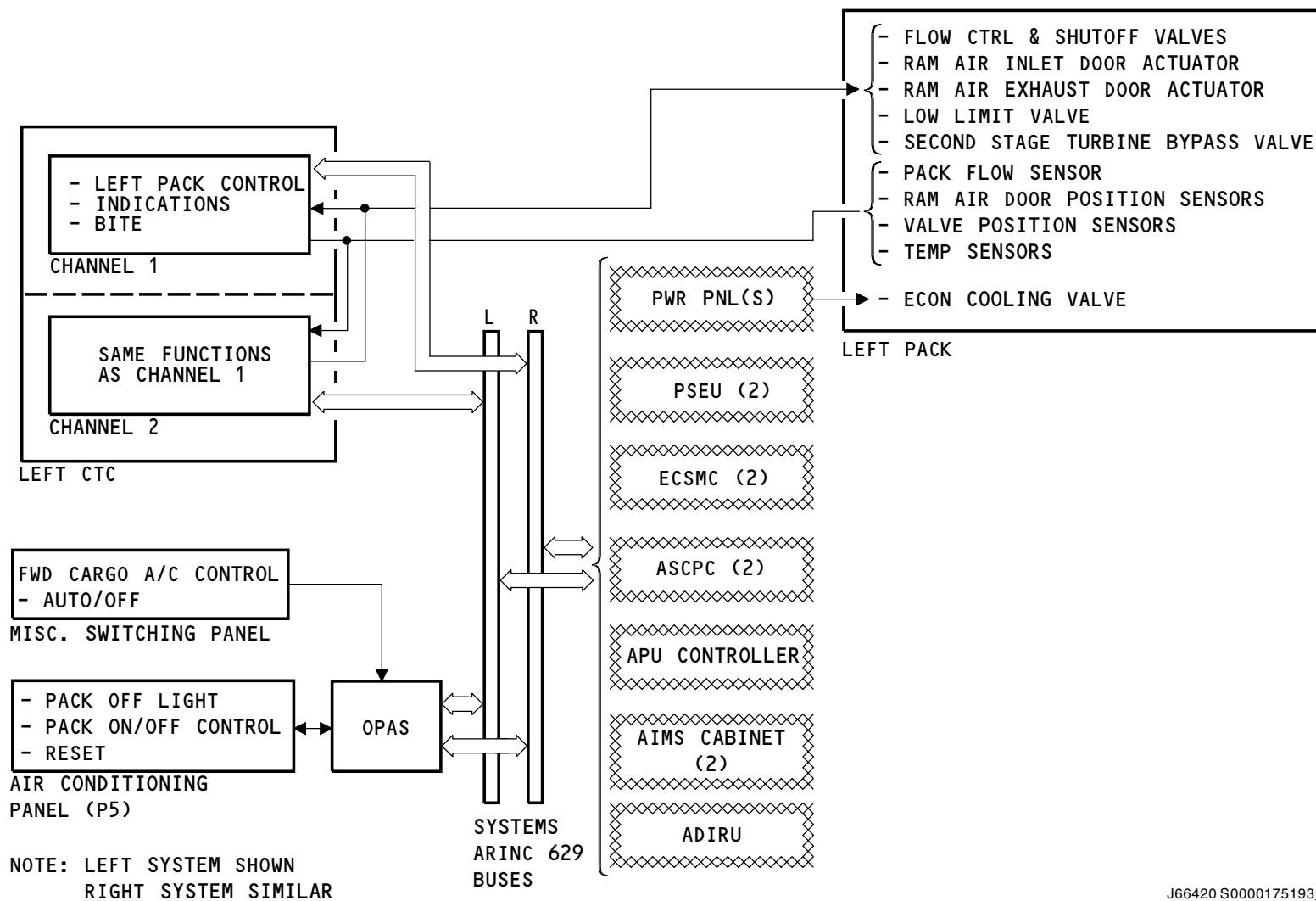
- Second stage turbine bypass valve RVDT
- Primary heat exchanger outlet temperature sensor
- Compressor discharge temperature sensors 1 and 2
- Secondary heat exchanger outlet temperature sensor
- Turbine inlet temperature sensor
- Condenser inlet temperature sensors 1 and 2
- Pack discharge temperature sensor
- Mix manifold temperature sensors 1 and 2.

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AIR CONDITIONING - COOLING - INTERFACES

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**AIR CONDITIONING - COOLING - OPERATION****General**

The air conditioning panel has these controls for pack operation:

- Left and right pack switches
- Air conditioning reset switch.

Location

The air conditioning panel is on the P5 overhead panel in the flight deck.

Pack Control

The L PACK and R PACK switches are alternate-action switches. AUTO shows when you push the switch in for selection of automatic pack operation.

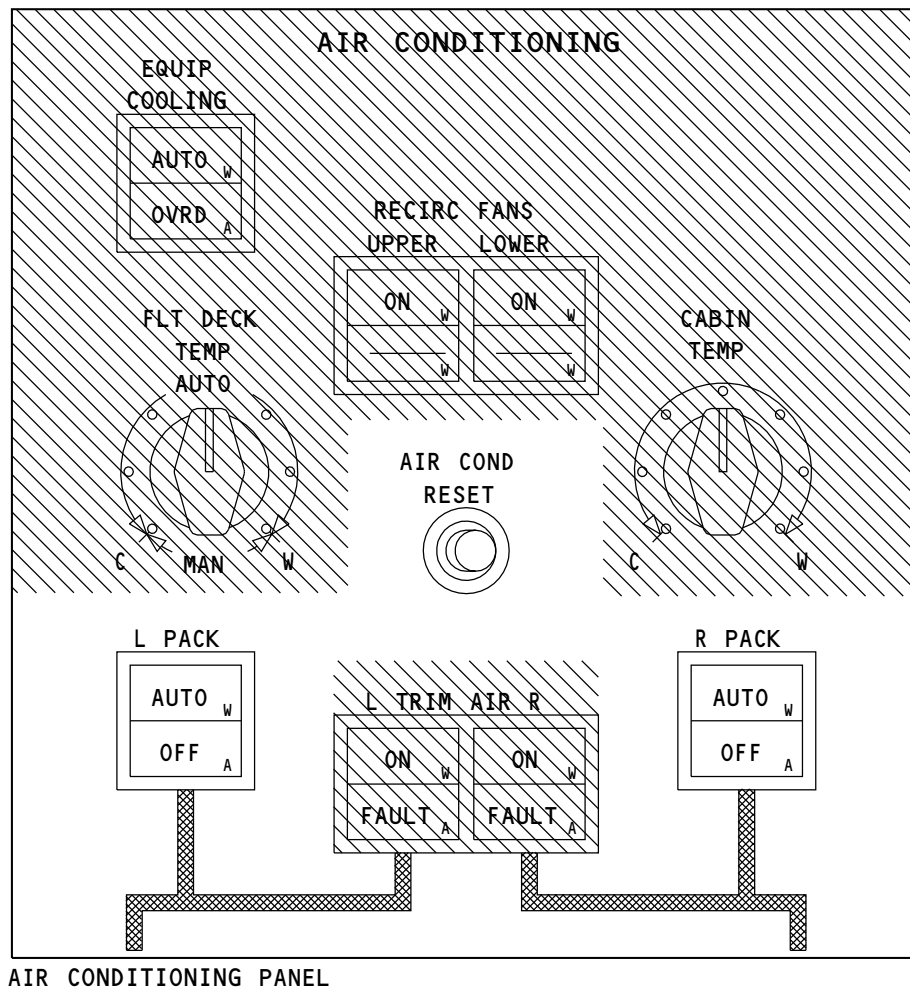
The OFF indication is not a function of switch position. It shows when the flow control and shutoff valves are closed.

Air Conditioning Reset Control

The AIR COND RESET switch is a momentary-action switch. This switch starts the system after a failure.

Training Information Point

The left and right main buses supply power for the OFF indications on the pack switches. If these buses have no power, the OFF indication does not show.



AIR CONDITIONING - COOLING - OPERATION

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AIR CONDITIONING - COOLING - AIR SYNOPTIC DISPLAY AND AIR CONDITIONING MAINTENANCE PAGE

Air Synoptic Display

The top part of the air synoptic display shows information about the air conditioning system.

Green flow bars show air flow through the left and right packs. These symbols show the status of the packs:

- Pack on - green oval
- Pack off or pack status data invalid - white oval
- Pack failed - amber oval with amber X.

The STBY COOLING message and an advisory message PACK MODE L (R) show when a pack is on and has any of these faults:

- Air cycle machine (ACM) failed
- Both condenser inlet temperature sensors failed
- Economy cooling valve failed open.

If the pack stops, the STBY COOLING message shows.

Air Conditioning Maintenance Page

All the temperatures on the air conditioning maintenance page are in degrees C.

The air conditioning maintenance page has this information:

- MIX MANIFOLD TEMP - Temperature in the mix manifold
- FLOW SCHEDULE - Right air conditioning pack flow schedule: 0,1,2,3, or 4. Usual left pack flow schedule is the same as the right
- PACK FLOW-VOLUME - Pack flow rate in cubic meters per minute
- PACK FLOW-MASS - Pack flow rate in kilograms per minute
- PACK OUT TEMP - Temperature at the outlet of the packs
- PRI HX IN TEMP - Temperature at the inlet of the primary heat exchangers
- PRI HX OUT TEMP - Temperature at the outlet of the primary heat exchangers

- CPRSR OUT TEMP - Temperature at the outlet of the air cycle machine compressors
- SEC HX OUT TEMP - Temperature at outlet of the secondary heat exchangers
- CONDENSER IN TEMP - Temperature at the inlet of the condensers
- STG 2 TURB IN TEMP - Temperature at the inlet of turbine 2 in the air cycle machines
- TRIM AIR PRESS - The difference, in psid, between cabin pressure and trim air pressure
- PACK CTRL CH - Shows the channel in control for the left and right cabin temperature controllers
- PACK IN PRESS - Pressure, in psia, at the inlet to the air conditioning packs
- LOW LIM VLV POS - Position of the low limit valve (0.00 is closed, 1.00 is open)
- TURB BYP VLV - Position of the turbine bypass valve in percent heat (0.00 is closed, 1.00 is open)
- RAM AIR INLET - Position of the ram air inlet in percent heat (0.00 is open, 1.00 is closed)
- RAM AIR EXIT - Position of the ram air exit in percent heat (0.00 is open, 1.00 is closed)
- ECON COOL VLV - Open or closed position of the economy cooling valve
- LOWER FLOW CTRL VLV - Open or closed position of the lower flow control valve
- UPPER FLOW CTRL VLV - Open or closed position of the upper flow control valve.

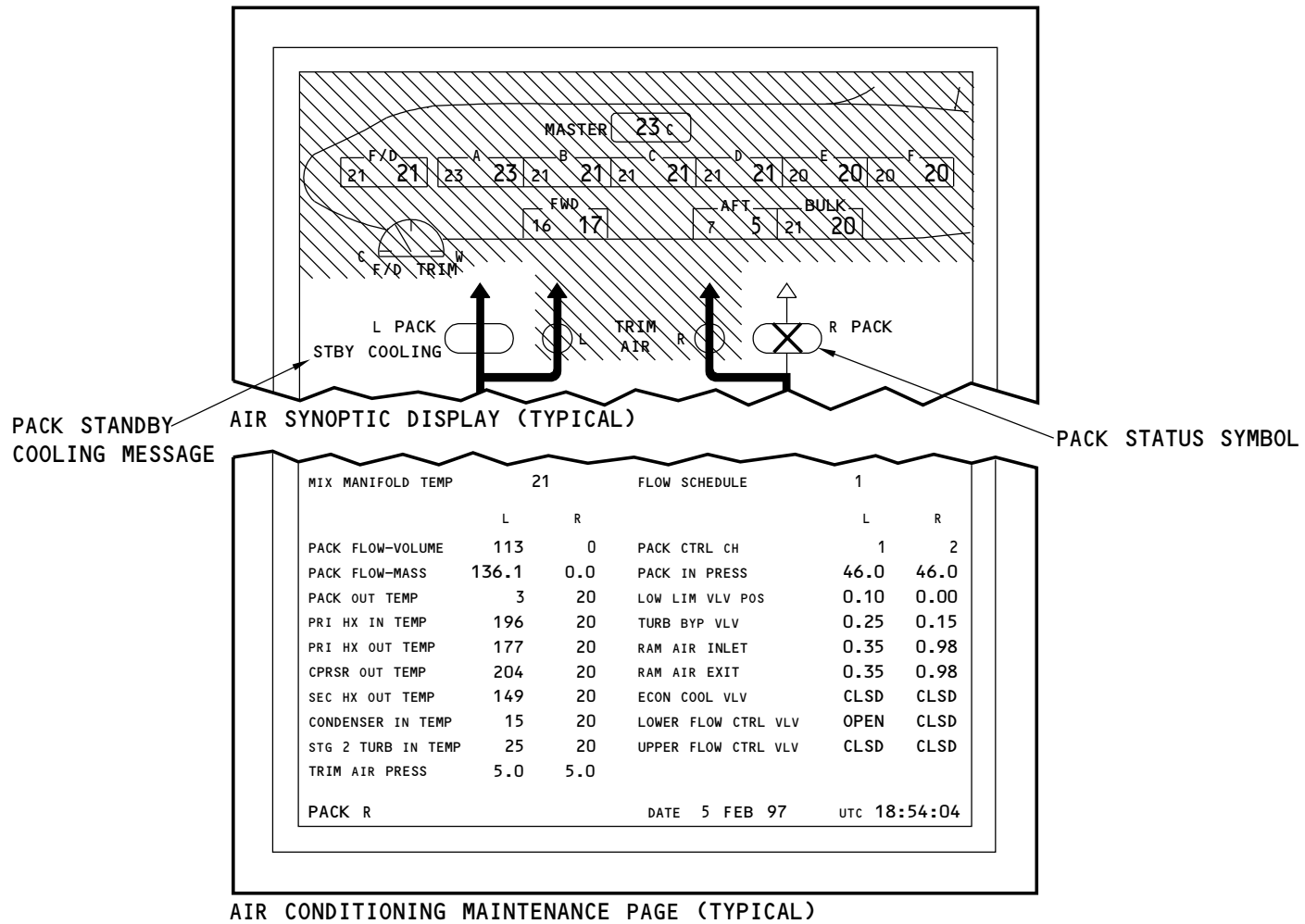
See the primary display system for more information about the air conditioning maintenance page (SECTION 31-61).

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AIR CONDITIONING - COOLING - AIR SYNOPSIS DISPLAY AND AIR CONDITIONING

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AIR CONDITIONING - COOLING - GROUND TESTS**General**

These are the cooling ground tests that show when you select ATA 21 Cabin Temperature Control System:

- Left pack actuators
- Left system air on
- Left system air off
- Right pack actuators
- Right system air on
- Right system air off.

Left and Right Pack Actuators

This test makes sure that the related cabin temperature controller can control these air conditioning pack LRUs:

- Ram air inlet door
- Turbine bypass valve
- Low limit valve.

During this test, the related pack operation stops, and the ram air doors move. The test takes approximately 3-5 minutes.

This test shows for these ground test types:

- System test
- Operational test
- LRU replacement test.

Left and Right System Air On

This test makes sure that the related cabin temperature controller can control these air conditioning pack and trim air LRUs:

- Upper flow control valve
- Lower flow control valve
- Economy cooling valve

- Air cycle machine
- Trim air pressure regulation and shutoff valve.

During this test, the related pack operation stops, and the ram air doors move. The test takes approximately 5-10 minutes.

This test shows for these ground test types:

- System test
- Operational test
- LRU replacement test.

Left and Right System Air Off

This test makes sure that the related cabin temperature controller can control these air conditioning pack LRUs:

- Ram air inlet door
- Turbine bypass valve
- Low limit valve.

This test also makes sure that the related cabin temperature controller can control the trim air system on that side.

During this test, the related pack and trim air operation stops, and the ram air doors move. The test takes approximately 2-3 minutes.

This test shows for these ground test types:

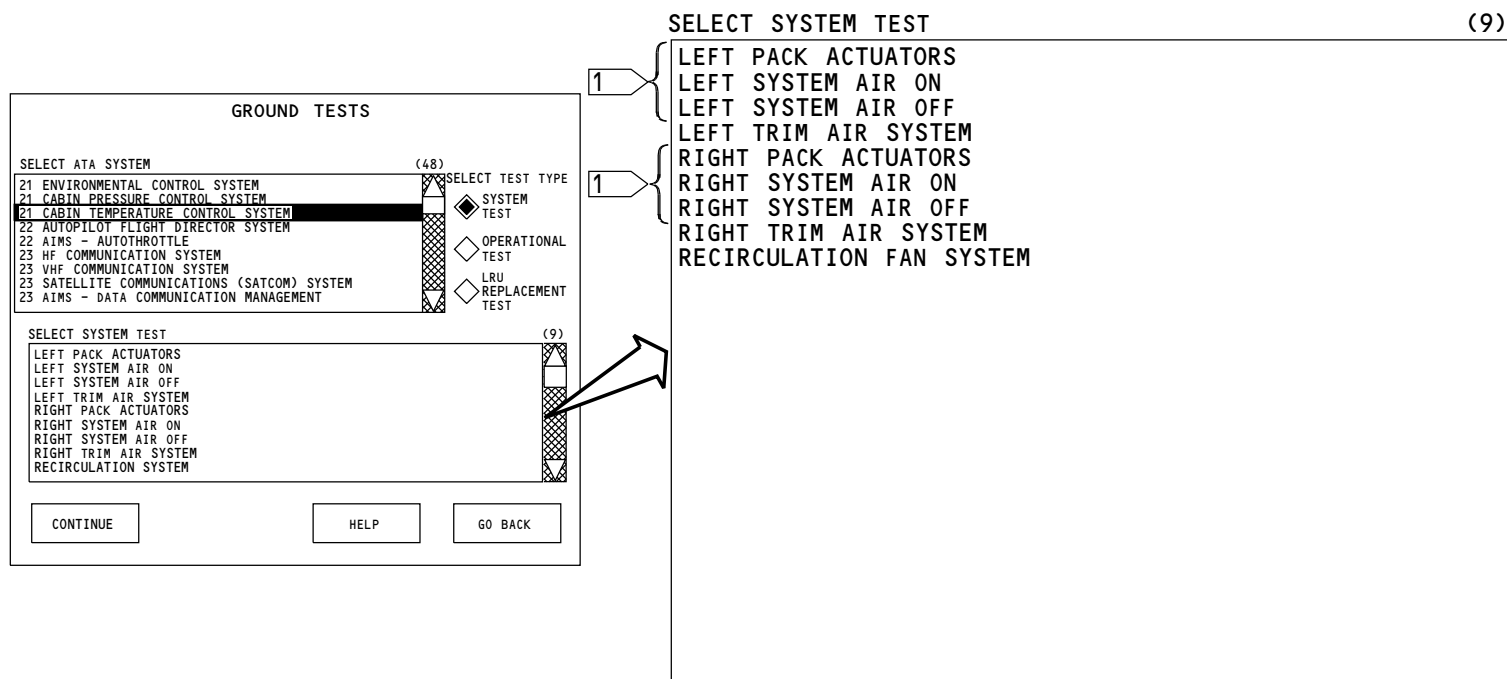
- System test
- Operational test
- LRU replacement test.

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NOTE: SYSTEM TESTS SHOW.
OPERATIONAL AND LRU REPLACEMENT TESTS ARE SIMILAR.

1 THESE ARE THE AIR CONDITIONING -
COOLING TESTS.

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AIR CONDITIONING - COOLING - GROUND TESTS

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**AIR CONDITIONING - PACK FLOW CONTROL - INTRODUCTION****Purpose**

The flow control system controls the quantity of air that goes from the pneumatic system into the air conditioning packs. These are the functions of the pack flow control system:

- Pack air on/off control
- Pack air flow regulation
- Ozone converter bypass
- Backup pack flow control
- Engine air supply system bias.

The CTCs and the ASCPCs have logic that control the pack air flow. The ASCPCs have the backup pack flow control.

Components

The pack flow control system has these components:

- Pack flow sensor
- Upper flow control and shutoff valve
- Lower flow control and shutoff valve
- Primary heat exchanger inlet temp sensor.

The systems for the left and right packs are the same.

Pack Air On/Off Control

With the air conditioning pack switch off, the two flow control and shutoff valves close. With the pack switch in AUTO, the flow control valves control pack air flow. The valves close if the pack fails, has an overheat condition, or if a higher priority bleed user is on.

Pack Air Flow Regulation

The flow control system makes decisions about the amount of air the packs can have. These decisions take into account the needs of other bleed air users and airplane operating conditions.

Ozone Converter Bypass

The ozone converter decreases the amount of atmospheric ozone that goes into the cabin. Ozone is in the atmosphere at high altitudes. The ozone converter is serviceable for a longer time if it operates only at high altitudes. At low altitudes the lower flow control valve closes and the upper valve controls flow. At high altitude the upper valve closes and the lower valve controls flow.

Backup Pack Flow Control

If only battery or standby power are available, the packs operate in a backup mode. The flow control system adjusts the pack air flow to keep the pack outlet temperature in limits.

Engine Bleed System Bias

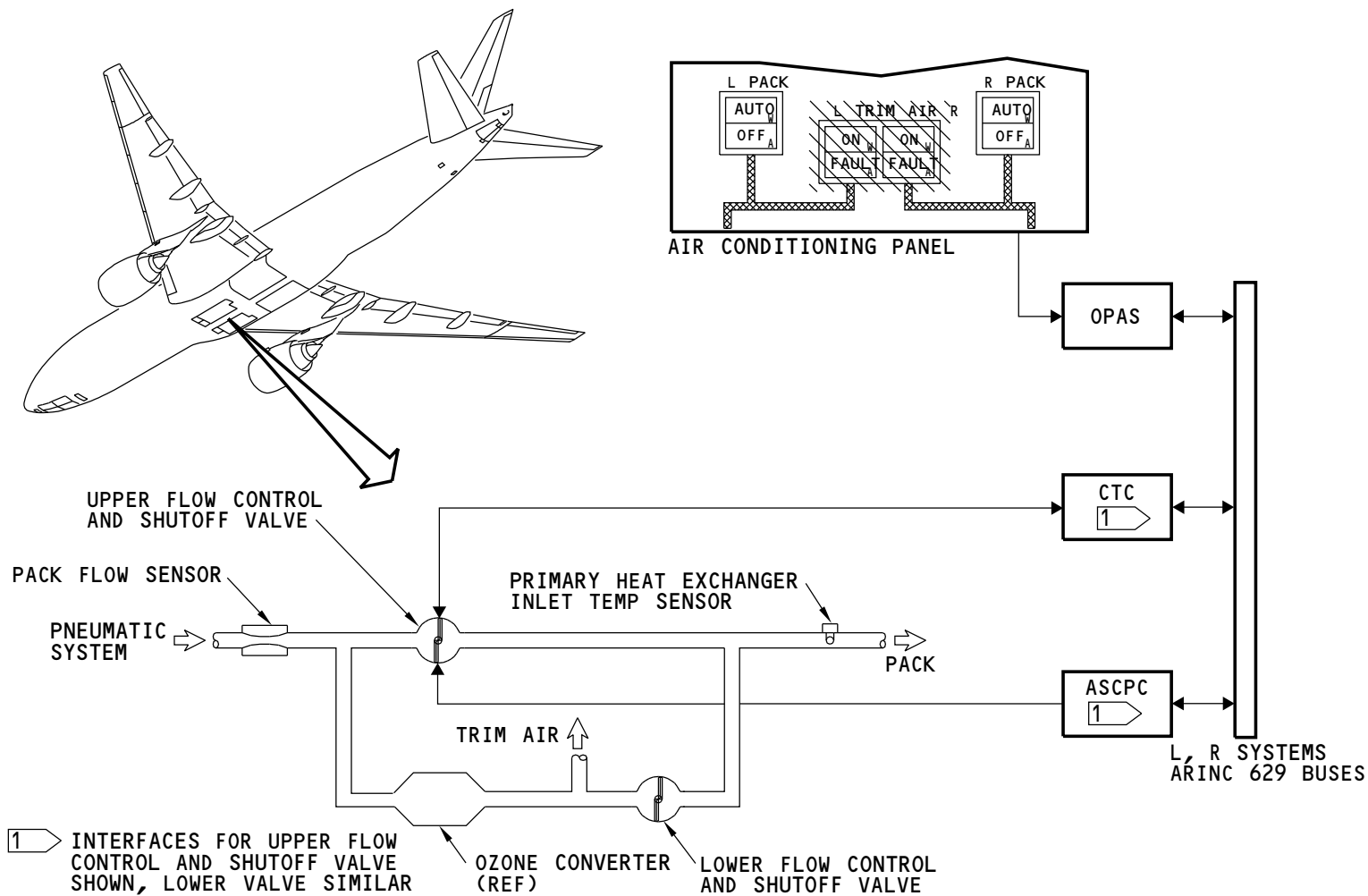
For some low flow conditions, the flow control system sends signals to the pneumatic system. These signals adjust the engine bleed air temperature or HPSOV set-point. Lower bleed air temperature lets the pack operate with less restriction to air flow. A higher HPSOV set point lets the pneumatic system supply more air at low engine power settings.

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AIR CONDITIONING - PACK FLOW CONTROL - INTRODUCTION

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AIR CONDITIONING - PACK FLOW CONTROL - GENERAL DESCRIPTION**General**

The CTC and ASCPC have interfaces with the flow control components and with some of the pack temperature sensors. The CTC and ASCPC measure the pack air flow, control the flow control and shutoff valves, and monitor pack temperatures.

CTC Functions

If the APU is on, the CTC closes the lower valve and opens the upper valve. The APU controller controls air flow to the packs. If the APU is not on, the CTC adjusts the valves to control pack air flow.

The upper valve controls flow at low altitudes. The lower valve controls air flow at high altitudes. If the upper or lower valve fails, the other valve controls flow at all altitudes.

The CTC uses data from the pack flow sensor to measure the volume of air going into the pack. With data from the primary heat exchanger inlet temperature sensor, the CTC calculates the mass air flow to the pack. The CTC uses air flow data to control and monitor the operation of the valves.

The CTC closes the upper and lower valves if any of these conditions occur:

- Pack switch OFF
- Flow schedule 0
- Compressor discharge overheat
- Pack outlet overheat
- Pack failure.

ASCPC Functions

The ASCPC closes the upper and lower valves if any of these conditions occur:

- Pack switch OFF
- Stall warning
- Compressor discharge overheat.

For these conditions, the valve close signals are redundant with the CTC valve close signals.

If the CTC fails or loses power, the ASCPC gives backup flow control. The upper valve closes and the lower valve controls. For backup up flow control, it is necessary to have valid data from the pack outlet and compressor discharge temperature sensors inside the pack. An overheat condition at either temperature sensor closes the valves.

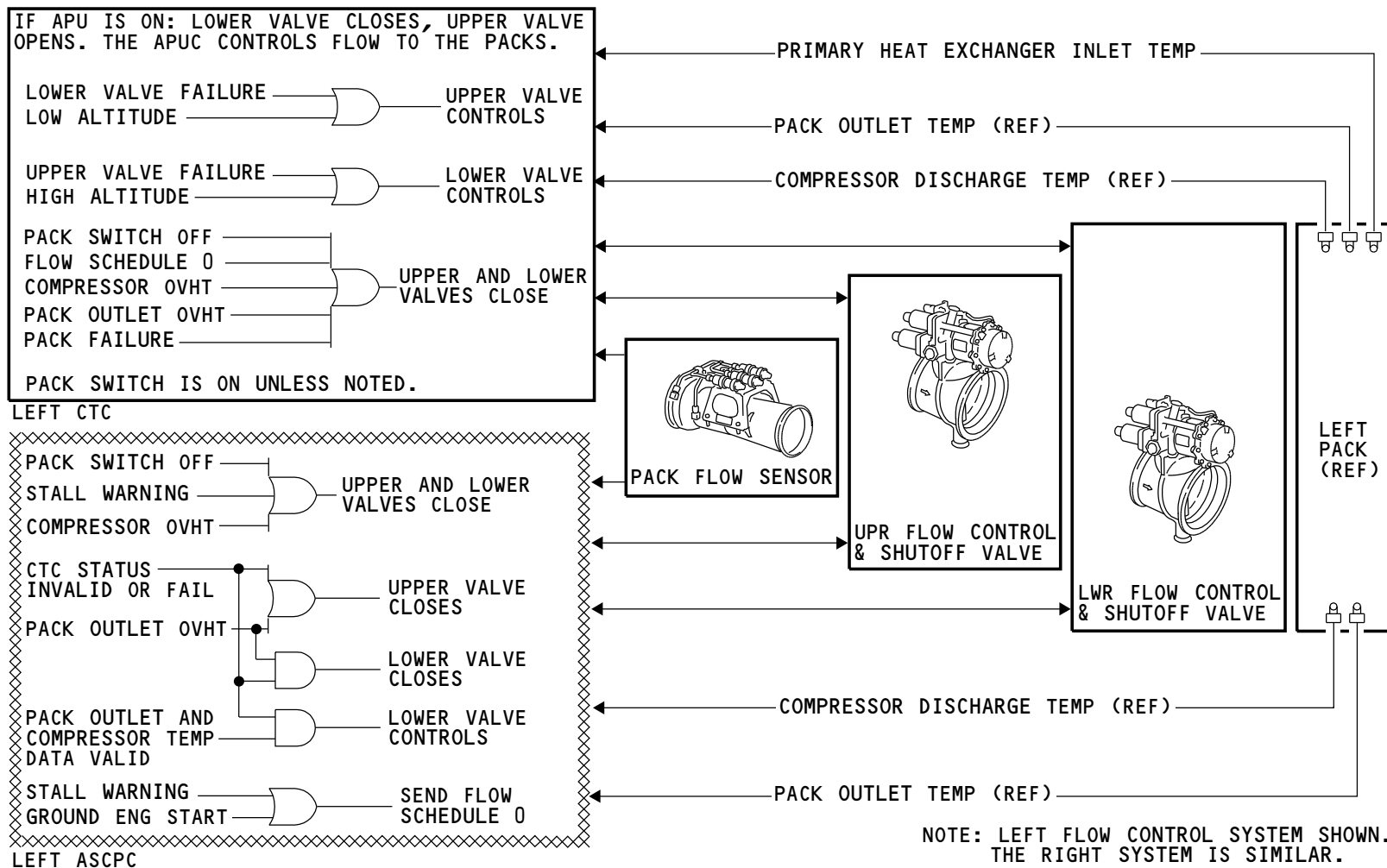
The ASCPC sends one of five flow schedules to the CTC. The CTC uses the flow schedule data to make decisions about the amount of air to send to the packs. A stall warning or ground engine start condition causes the ASCPC to send flow schedule 0. The CTC closes the flow control and shutoff valves for flow schedule 0.

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AIR CONDITIONING - PACK FLOW CONTROL - GENERAL DESCRIPTION

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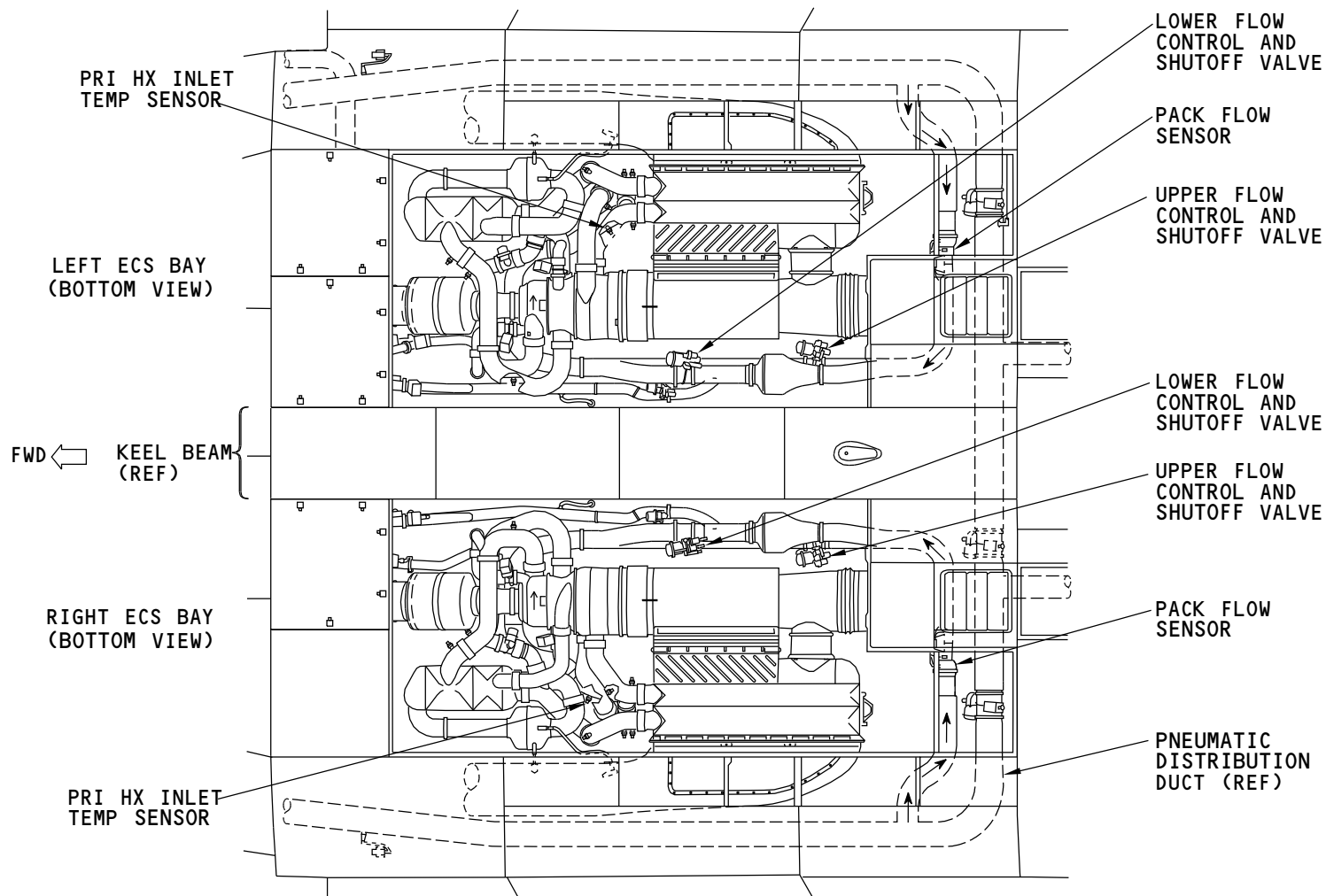
**AIR CONDITIONING - PACK FLOW CONTROL - COMPONENT LOCATIONS****Component Locations**

Each pack has these flow control components in the ECS bay:

- Primary heat exchanger inlet temperature sensor
- Lower flow control and shutoff valve
- Pack flow sensor
- Upper flow control and shutoff valve.

The components are interchangeable between packs.

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AIR CONDITIONING - PACK FLOW CONTROL - COMPONENT LOCATIONS

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**AIR CONDITIONING - PACK FLOW CONTROL - FLOW CONTROL AND SHUTOFF VALVES****Purpose**

The flow control and shutoff valves control the air flow to the packs.

Physical Description

The upper and lower flow control and shutoff valves are interchangeable. These are the parts of the valve:

- A proximity switch
- A locking plug
- A locking crank/position indicator
- A pneumatic actuator
- A disc
- Two torque motors.

Functional Description

The flow control and shutoff valves operate by a pneumatic actuator which moves the disc in the valve. If there is no air pressure from the pneumatic system, a spring in the actuator closes the valve.

With no power to the torque motors, the connections to ambient air pressure close. Supply pressure pushes the valve open against the force of the spring in the actuator.

With power applied, the torque motors bleed air from one side of the pneumatic actuator. This permits the spring to move the valve disc to decrease the flow rate.

One torque motor connects to the CTC. The other torque motor connects to the ASCPC. Each torque motor can independently control the actuator. The CTC gives normal control of the valve. The ASCPC gives backup pack flow control if the CTC can not operate.

A proximity switch sends a signal to the CTC when the valve is closed.

Training Information Point

You use the locking plug and locking crank to lock the valve closed.

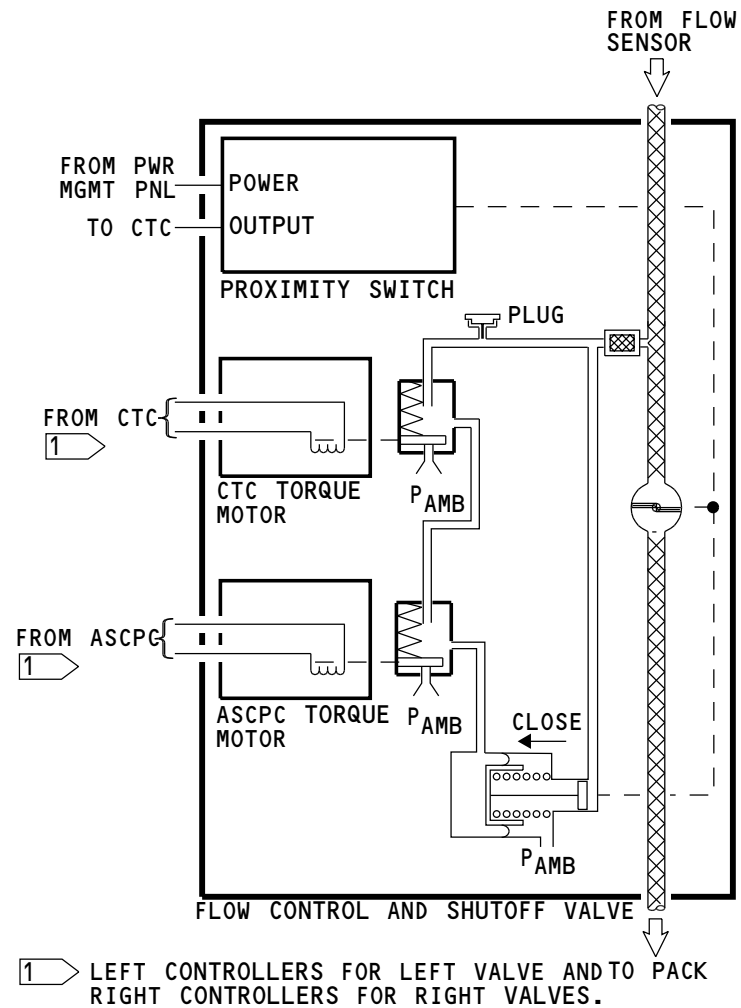
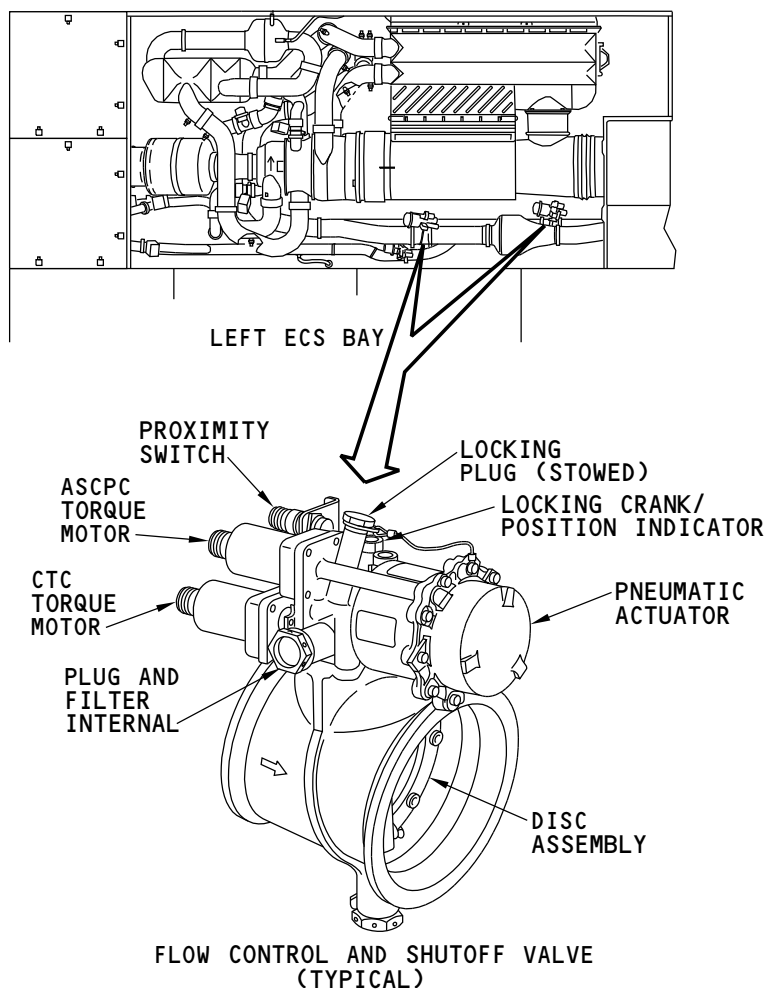
The filter is an LRU.

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AIR CONDITIONING - PACK FLOW CONTROL - FLOW CONTROL AND SHUTOFF VALVES

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**AIR CONDITIONING - PACK FLOW CONTROL - FLOW SENSOR****Purpose**

The pack flow sensor supplies two types of air pressure information, pack inlet and pack inlet differential to the related CTC and ASCPC. The controllers use the pressure information to help calculate the rate of air flow from the pneumatic system into the airplane.

Physical Description

There are two pack flow sensors, one for each air conditioning pack/trim air system. Each sensor has these parts:

- High pressure (inlet) line (2)
- Inlet pressure sensor
- Differential pressure sensor (2)
- Electrical connector (3)
- Bracket (pressure sensor attachment)
- Titanium body
- Low pressure (venturi) line (2).

The titanium body is in the shape of a venturi. The pressure sensors attach to a bracket that attaches to the body. The pressure sensors use lines to connect to the body.

Location

The pack flow sensors are in the aft part of the left and right ECS bays. You get access through these blowout doors:

- 195QL left pack flow sensor
- 196QR right pack flow sensor.

Functional Description

The CTC differential pressure sensor gives an output in proportion to the pressure difference across the venturi part of the pack flow sensors body. The inlet pressure sensor gives an output in proportion to the pack inlet air pressure. These outputs go to the CTC.

Power for the CTC differential pressure sensor and inlet pressure sensor comes from the power management panel that supplies the pack.

The ASCPC differential pressure sensor is the same as the CTC differential pressure sensor. The ASCPC gets differential pressure information and gives power to its differential pressure sensor.

Training Information Point

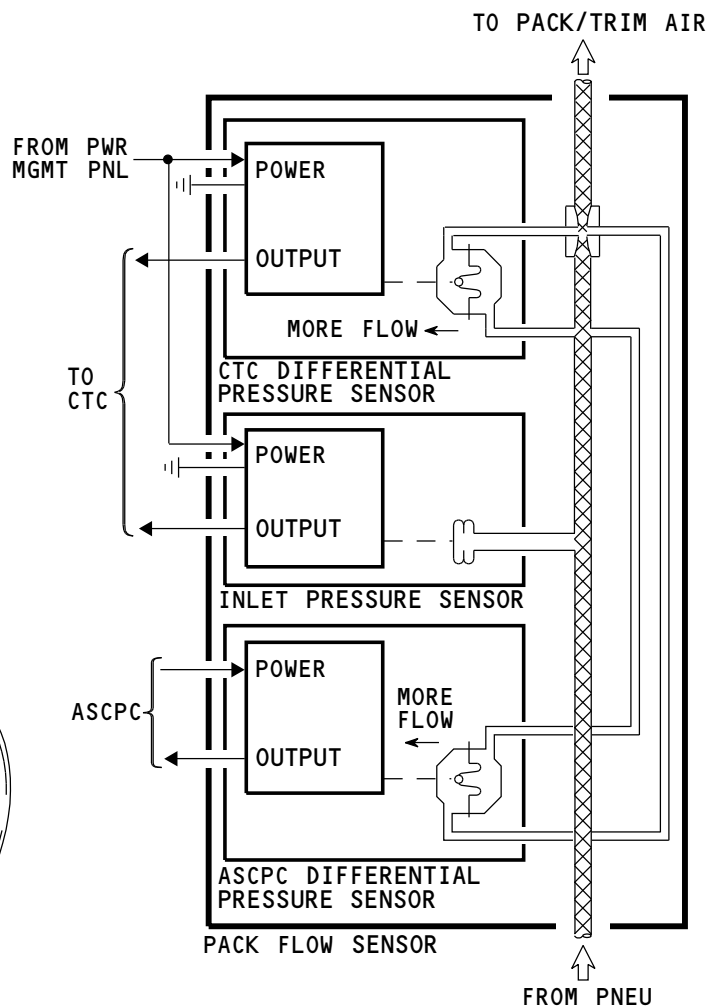
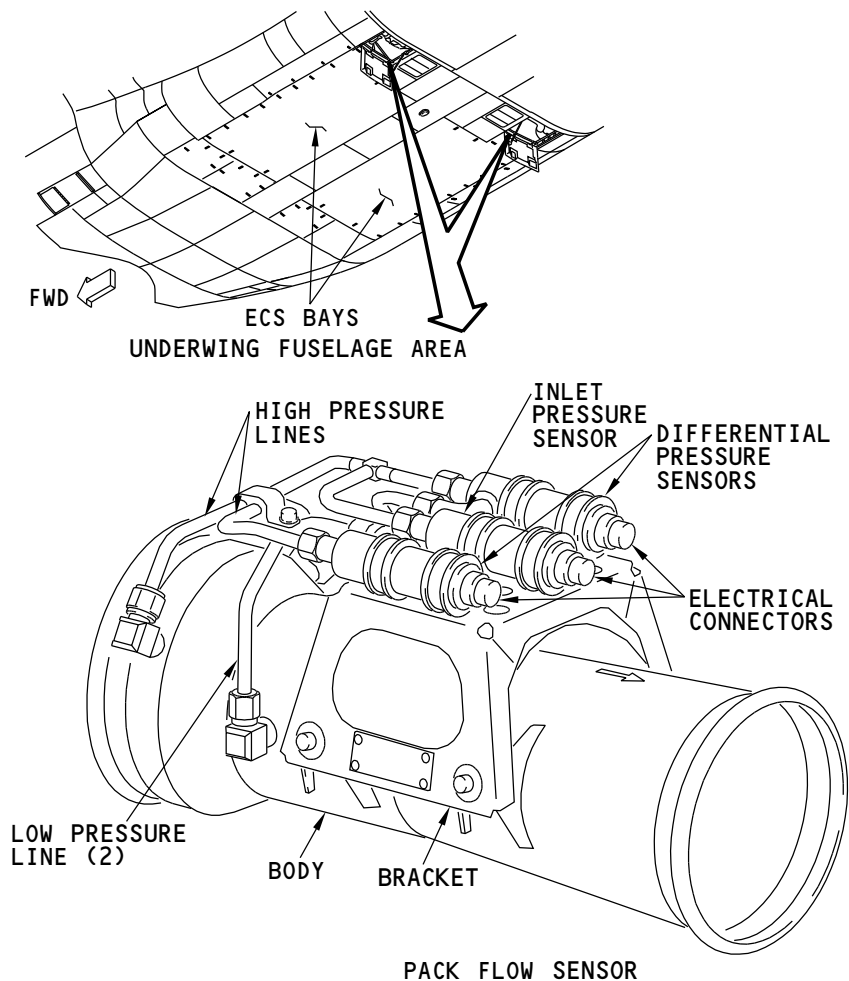
The pack flow sensor is an LRU. The individual inlet and differential pressure sensors are not LRUs.

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AIR CONDITIONING - PACK FLOW CONTROL - FLOW SENSOR

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**AIR CONDITIONING - PACK FLOW CONTROL - PRIMARY HEAT EXCHANGER INLET TEMPERATURE SENSOR****General**

The primary heat exchanger (PRI HX) inlet temperature sensor monitors the PRI HX inlet temperature.

Temperature data goes to the cabin temperature controller (CTC). It uses the data with data from the flow sensor to calculate pack mass air flow.

See the zone temperature control and indication section for more information about the CTC (SECTION 21-61).

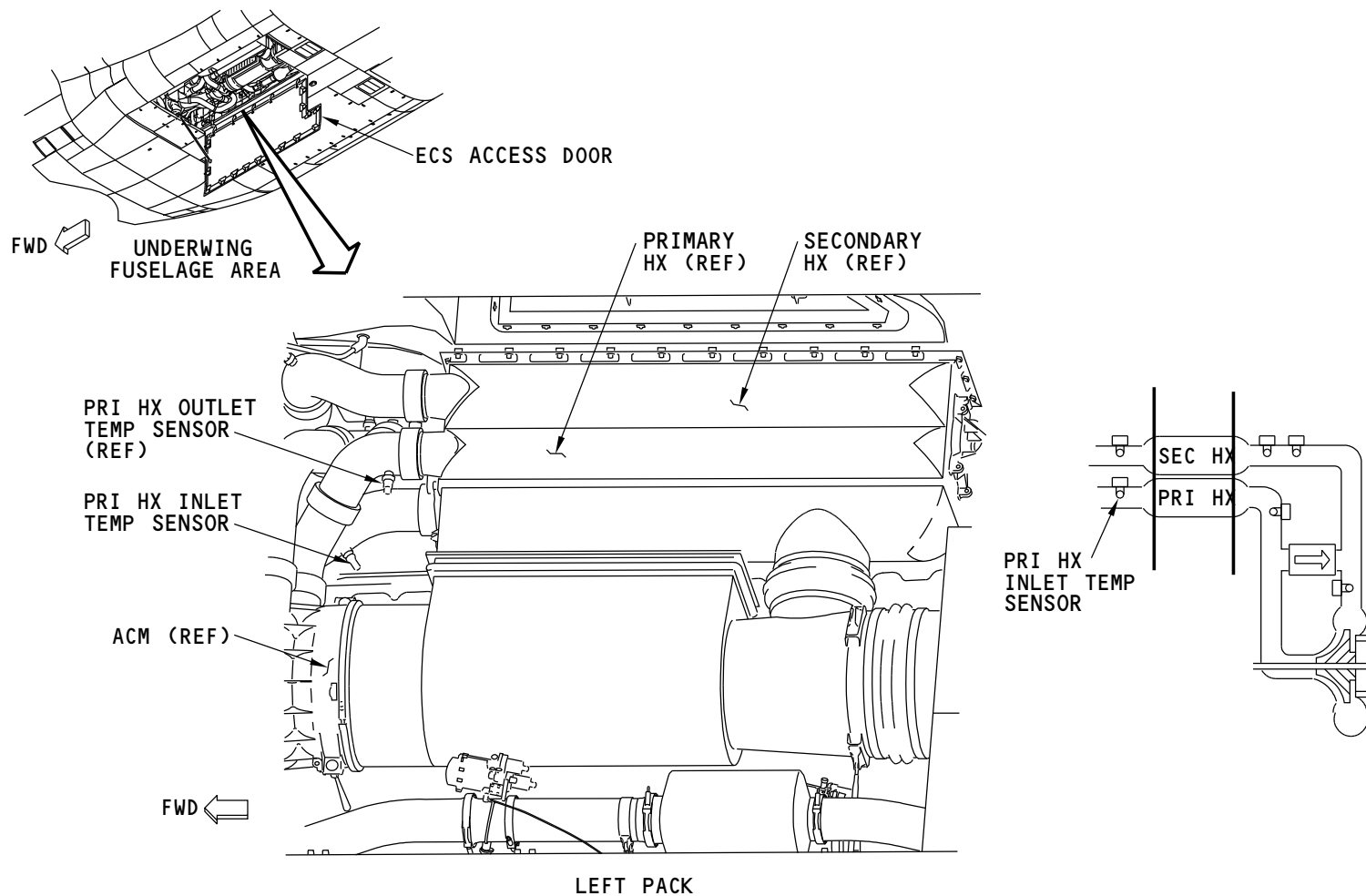
Physical Description

The sensor is a single element resistance temperature device (RTD). Threads on the sensor connect it to the boss in the duct. The sensor electrical connector is also threaded.

Training Information Point

This sensor is interchangeable with the other high temperature sensors in the pack.

See the pack cooling and mix manifold temperature control section for more information about sensors on the pack (SECTION 21-52).



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AIR CONDITIONING - PACK FLOW CONTROL - PRIMARY HEAT EXCHANGER INLET TEMPERATURE SENSOR

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**AIR CONDITIONING - PACK FLOW CONTROL - FUNCTIONAL DESCRIPTION - ASCPC FLOW SCHEDULES****General**

The ASCPC sets the flow schedules for the left and right CTCs. The left ASCPC is primary for this function, and the right ASCPC is the backup. The CTCs use the flow schedule data to calculate the amount of air to send to the packs.

The ASCPC has an ARINC 629 interface with other systems and LRUs. These interfaces give the ASCPC data about airplane operating conditions and about other bleed air users. The ASCPC uses these inputs to set the pack air flow schedules.

The ASCPC sends the selected flow schedules to the CTCs through the left and right ARINC 629 systems buses (not shown).

Flow Schedules

Flow schedule 1 gives the greatest airflow to the air conditioning packs and is the usual flow schedule.

Schedules 2, 3, and 4 give less and less air to the packs. In general, these schedules are in effect for one or more of these conditions:

NOTE: Schedule 4 is used for the first two minutes from takeoff roll.

- The amount of bleed air available is less than usual
- More than the usual number of bleed air user systems are on
- Takeoff or single engine operation.

Schedule 0 stops the air flow into the packs. During an engine start on the ground, the packs shut off to make air available to the starter. The packs stay off for 2 minutes to allow time to start the two engines. For a stall warning, schedule 0 makes sure the air driven hydraulic pumps get enough air for auto-slat deployment.

Training Information Point

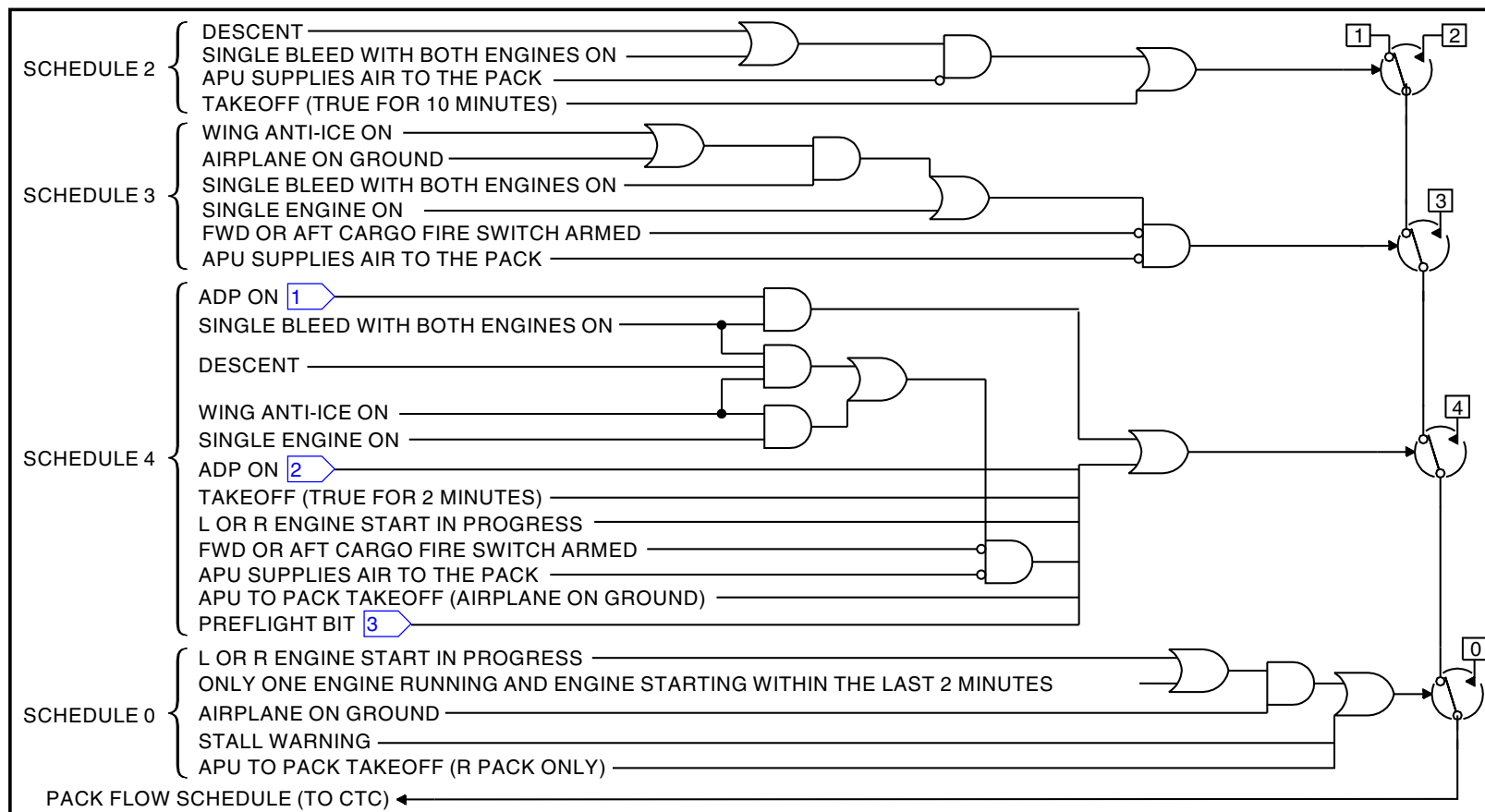
If you start just one engine, the pack does not operate until two minutes after the start. The pack OFF light stays on during the two minutes.

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ASCPC

1

C2 ADP FOR LEFT PACK FLOW SCHEDULE
C1 ADP FOR RIGHT PACK FLOW SCHEDULE

2

C1 ADP FOR LEFT PACK FLOW SCHEDULE
C2 ADP FOR RIGHT PACK FLOW SCHEDULE

3

APPLICABLE TO 777 AIRPLANES WITH PW ENGINES, 777-300ER AIRPLANES OR 777-200LR AIRPLANES
FOR LEFT PACK: BETWEEN 13 AND 45 SECONDS AFTER START OF PREFLIGHT BIT.
FOR RIGHT PACK: GREATER THAN 13 SECONDS AFTER START OF PREFLIGHT BIT.

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AIR CONDITIONING - PACK FLOW CONTROL - FUNCTIONAL DESCRIPTION - ASCPC FLOW SCHEDULES

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**AIR CONDITIONING - PACK FLOW CONTROL - FUNCTIONAL DESCRIPTION - CTC FLOW CONTROL****Upper/Lower Valve Selection**

If the airplane altitude is low, the cabin temperature controllers (CTCs) use the upper flow control and shutoff valves to control air flow into the packs. These are the altitudes:

- Below 26,000 feet (7930 meters) on climb
- Below 24,000 feet (7315 meters) on descent.

If the airplane altitude is high, the CTC use the lower flow control and shutoff valves to control air flow into the packs. These are the altitudes:

- 26,000 feet (7930 meters) or above on climb
- 24,000 feet (7315 meters) or above on descent.

If one of the valves fails, the CTC controls the other valve at all altitudes.

Flow Regulation

The CTC calculates four flow rates. The flow schedule from the ASCPC tells the CTC which flow rate to use. The usual air flow rate for the left and right packs is the same. The flow rate of one pack can be 10 percent more or 10 percent less than the other pack.

If the right CTC decreases its pack flow rate to keep pack operation in limits, the right CTC sends a signal to the left CTC. The left CTC adds this R CTC flow bias signal to the flow rate for the left pack. The total is the flow command. A single pack has a flow command limit of 81% of the total flow into the airplane. See the pack cooling and mix manifold temperature control section for more information about the functional description of the packs (SECTION 21-52).

The CTC compares the flow command with the measured pack flow. The difference makes a drive signal for the flow control and shutoff valve. The valve moves until the measured pack flow equals the flow command.

Flow Rate Adjustments

If any recirculation fans are inoperative when the CTC uses schedule 1, the CTC increases the flow rate. The total flow into the airplane increases 67 lbs/min for each fan that is off, 33.5 lbs/min per pack. This keeps the total airplane ventilation rate constant.

If the forward cargo air conditioning system is on, the total flow into the airplane increases 50 lbs/min, 25 lbs/min per pack. This keeps the total airplane ventilation rate constant.

If the forward or aft cargo fire switch is armed, the CTC sets the schedule 2 flow rate (except when schedule 0 is active). The ASCPC does not send schedules 3 or 4 if a cargo fire switch is armed. Schedule 2 supplies sufficient fresh air for the airplane occupants and keeps smoke out of the passenger compartment and flight deck.

The CTC closes the flow control and shutoff valve for these conditions:

- Flow schedule 0 from the ASCPC
- Pack outlet overheat
- Compressor discharge overheat
- Pack failure.

Other Flow Control Functions

At times, the air flow into the pack is not enough even with a flow control and shutoff valve full open. For some low flow conditions, the pack operates in economy cooling mode to help increase the air flow. An ARINC 629 input signal to the ELMS puts the pack into the economy cooling mode. See the pack cooling and mix manifold temperature control section for more information about the economy cooling mode (SECTION 21-52).

The CTC can also tell the ASCPC to adjust the engine bleed air supply system to help increase pack air flow. ARINC 629 signals tell the ASCPC to reduce the engine bleed air temperature or increase the HPSOV set point. See the engine air supply section for more information about the engine bleed bias (SECTION 21-52).

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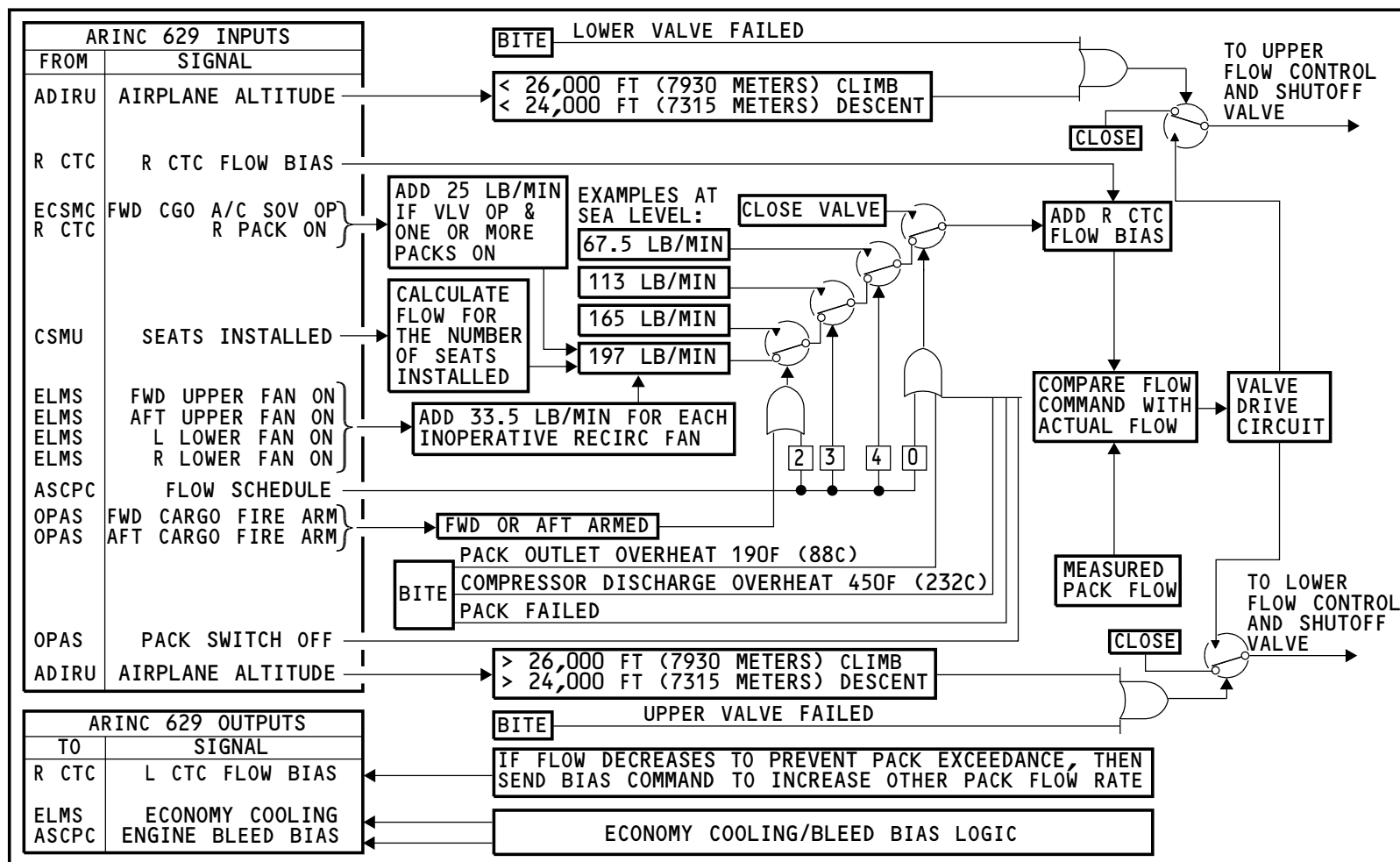


AIR CONDITIONING - PACK FLOW CONTROL - FUNCTIONAL DESCRIPTION - CTC FLOW CONTROL

APU Demand

When the APU supplies the air for pack operation, the CTCs do not use the flow schedules from the ASCPCs. The CTCs set the flow control valve to fully open. The CTCs send an APU DEMAND signal to the APU controller (APUC) to tell it the amount of air necessary for the ventilation and the heating or the cooling of the airplane. See the zone temperature control and indication section for more information on APU DEMAND (SECTION 21-61).

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LEFT CTC

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AIR CONDITIONING - PACK FLOW CONTROL - FUNCTIONAL DESCRIPTION - CTC FLOW CONTROL

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**AIR CONDITIONING - PACK FLOW CONTROL - FUNCTIONAL DESCRIPTION - START-UP AND SHUTDOWN****General**

The flow control and shutoff valves open and close at specified rates. The rates are different for different conditions. When one valve starts to open, the OFF light in the pack switch goes out. When the two valves close, the OFF light comes on.

Pack Start-up

When you put the pack switch to AUTO, the flow control and shutoff valve opens. The valve opens at a rate that gives efficient air cycle machine acceleration. The air flow increases to 60 lb/min in 5 seconds, then increases to the schedule rate in 55 more seconds.

NOTE: Full pack flow varies based on many conditions such as APU or engines supplying bleed air, trim air off or on, recirc fans off or on, ambient outside temperature, etc.

Normal Pack Shutdown On The Ground

When you put the pack switch to OFF, the flow control and shutoff valve closes. The valve closes at a rate that permits condensed water to evaporate from the pack.

The air flow decreases to 60 lb/min in 15 seconds, stays at 60 lb/min for 15 seconds, then goes to 0 in 5 seconds. This sequence lets the pack temperature increase. Water condensation stops, and any water left in the pack evaporates.

Pack Shutdown In Flight Or Protective Pack Shutdown

If you put the pack switch OFF in flight, the flow control and shutoff valve closes slowly. The pack air flow decreases by 25 lb/min per second as the valve closes. The valve closes at this same rate for a protective pack shutdown from an overheat condition or a pack failure.

Stall Warning

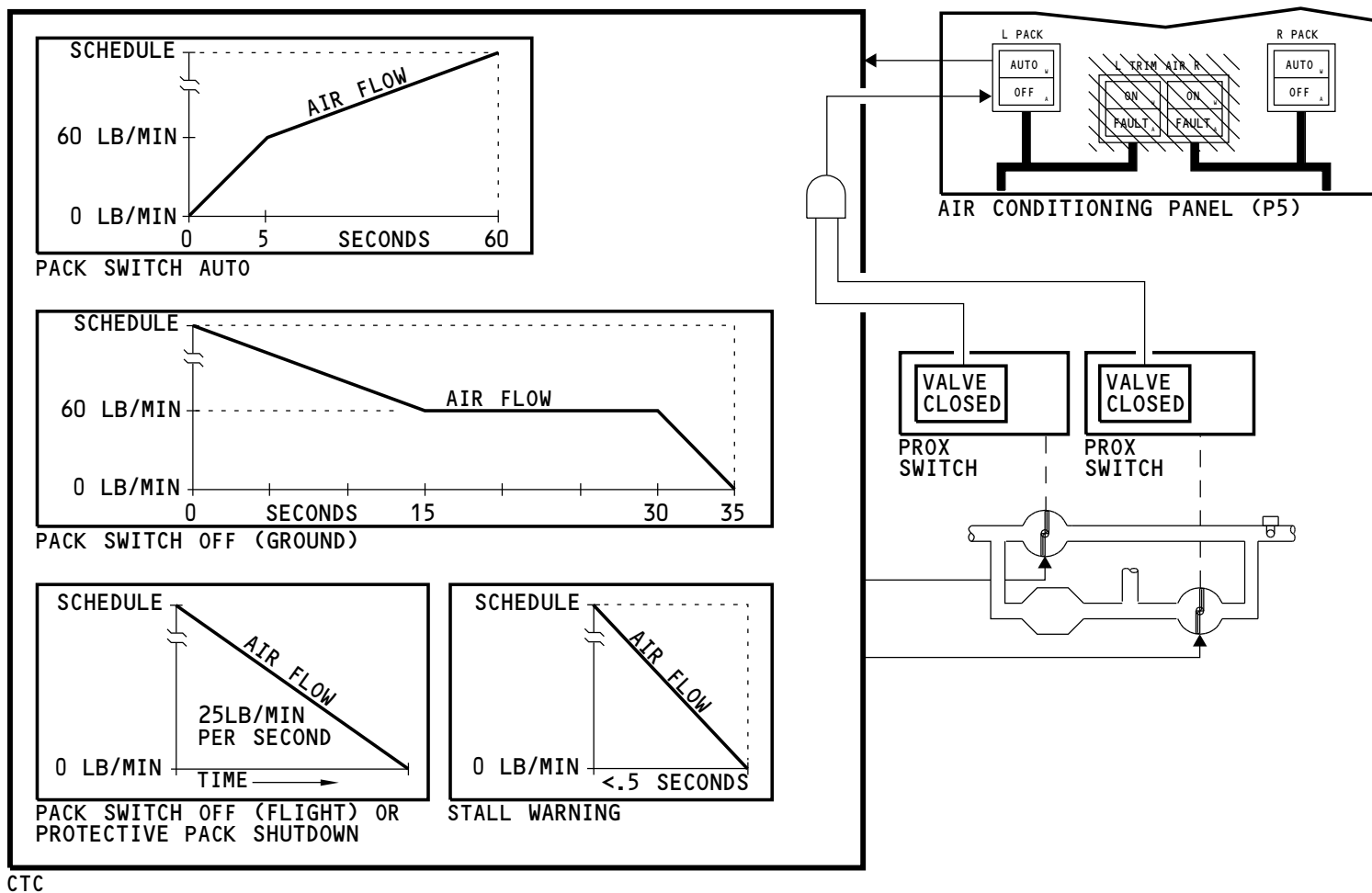
The valve closes quickly for a stall warning condition. Air flow goes to 0 in less than 1/2 second

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CTC

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AIR CONDITIONING - PACK FLOW CONTROL - FUNCTIONAL DESCRIPTION - START-UP AND SHUTDOWN

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AIR CONDITIONING - PACK FLOW CONTROL - FUNCTIONAL DESCRIPTION - ASCPC FLOW CONTROL

General

The ASCPC is a backup to the CTC for these functions:

- Trim air system shutdown
- Backup pack flow control
- Pack shutdown.

The left ASCPC gives the above functions for the left CTC and the right ASCPC gives the above functions for the right CTC.

See the section on trim air pressure regulation and shutoff control for more information about the trim air system shutdown function provided by the ASCPC (SECTION 21-62).

Backup Pack Flow Control

The CTC gives a CTC status signal to the ASCPC. If the CTC fails or has no electrical power, the status signal is not valid. The ASCPC gives backup flow control if it has valid data from the pack outlet temperature sensor and the compressor discharge temperature sensor. If the temperature data is not valid, the ASCPC will not give backup pack flow control. The upper flow control valve closes and the lower valve goes full open, this is the default position for the valve when air is available in the pneumatic system.

If the sensors give valid data the ASCPC gives backup flow control. The upper flow control valve closes and the lower valve controls air flow into the pack.

The ASCPC keeps the flow rate at 67 pounds per minute if the conditions for flow schedule 4 are active. See the page Pack Flow Control - Functional Description - ASCPC Flow Schedules in this section for more information about the conditions that make flow schedule 4 active.

If flow schedule 4 is not active, the ASCPC keeps pack outlet temperature between 40F (4C) and 110F (43C). To do this it keeps the pack flow between 150 pounds per minute and 250 pounds per minute. The ASCPC keeps the pack flow at 150 pounds per minute as long as the pack outlet temperature is more than 40F (4C) and less than 110F (43C). If the pack outlet temperature is low, the ASCPC increases the flow to 200 pounds per minute. After 30 seconds, if the temperature is still low, the ASCPC increases the flow to 250 pounds per minute.

If the pack outlet temperature becomes more than 110F (43C), the ASCPC decreases the flow rate in the same way. The minimum flow rate is 150 pounds per minute when schedule 4 is not active.

Pack Shutdown

The ASCPC closes both flow control and shutoff valves for any of these conditions:

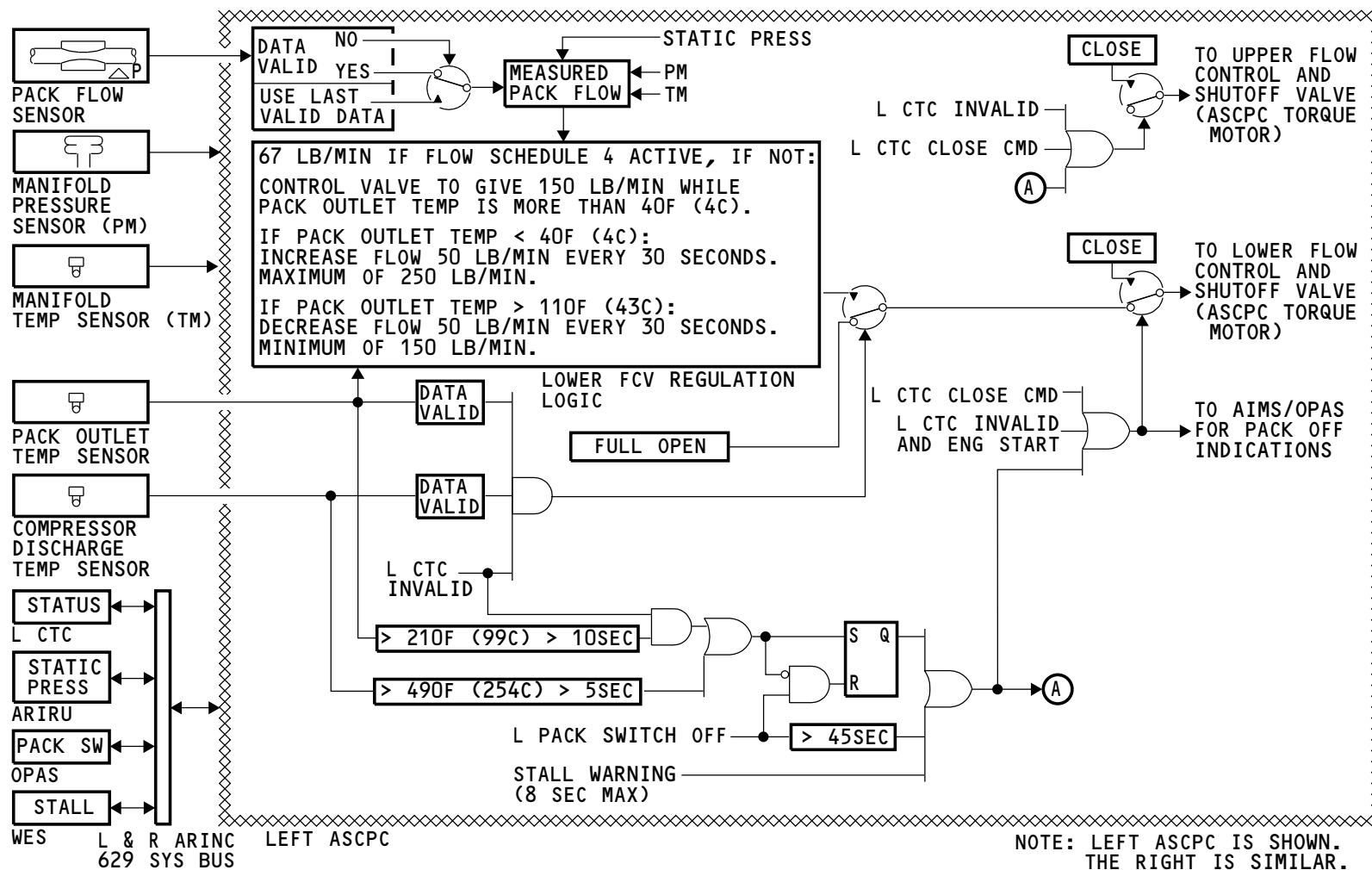
- Pack outlet overheat with CTC status invalid
- Compressor discharge overheat
- Pack switch OFF
- Stall warning.

For all conditions except the first, the ASCPC pack shutdown function is a backup to the CTC shutdown function.

The overheat shutdown function resets when you put the pack switch OFF then ON if the overheat condition no longer exists.

When the ASCPC commands the upper and lower flow control valves to close, it also give a signal to AIMS and to OPAS for these pack off indications:

- OFF light in the left pack switch
- PACK L advisory message.



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AIR CONDITIONING - PACK FLOW CONTROL - FUNCTIONAL DESCRIPTION - ASCPC FLOW CONTROL

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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - INTRODUCTION****Purpose**

Pack cooling and mix manifold temperature control operates the pack to control pack discharge air temperature to a value that supplies sufficient cooling air to the flight deck and the mix manifold.

See the functional description page on pack cooling and mix manifold temperature control in this section for more information about pack operation (SECTION 21-52).

General Description

The air conditioning (A/C) pack has components that give these functions:

- Ram air and heat exchanger cooling
- Air cycle machine cooling
- Water removal.

Air from the flow control system usually flows through the pack in this sequence:

- Primary heat exchanger (PRI HX)
- Air cycle machine (ACM) compressor
- Secondary heat exchanger (SEC HX)
- Over the reheater and condenser cores
- Water collector
- Reheater
- ACM turbine 1
- Condenser
- ACM turbine 2
- Conditioned air check valve
- Mix manifold.

Air from the pack mixes with recirculated air in the mix manifold. This air moves through the distribution system to the forward cargo compartment zone and the passenger cabin zones. The flight deck gets air directly from the left pack.

The ram air part of the pack keeps the compressor outlet temperature in limits. It also gives pack outlet temperature control.

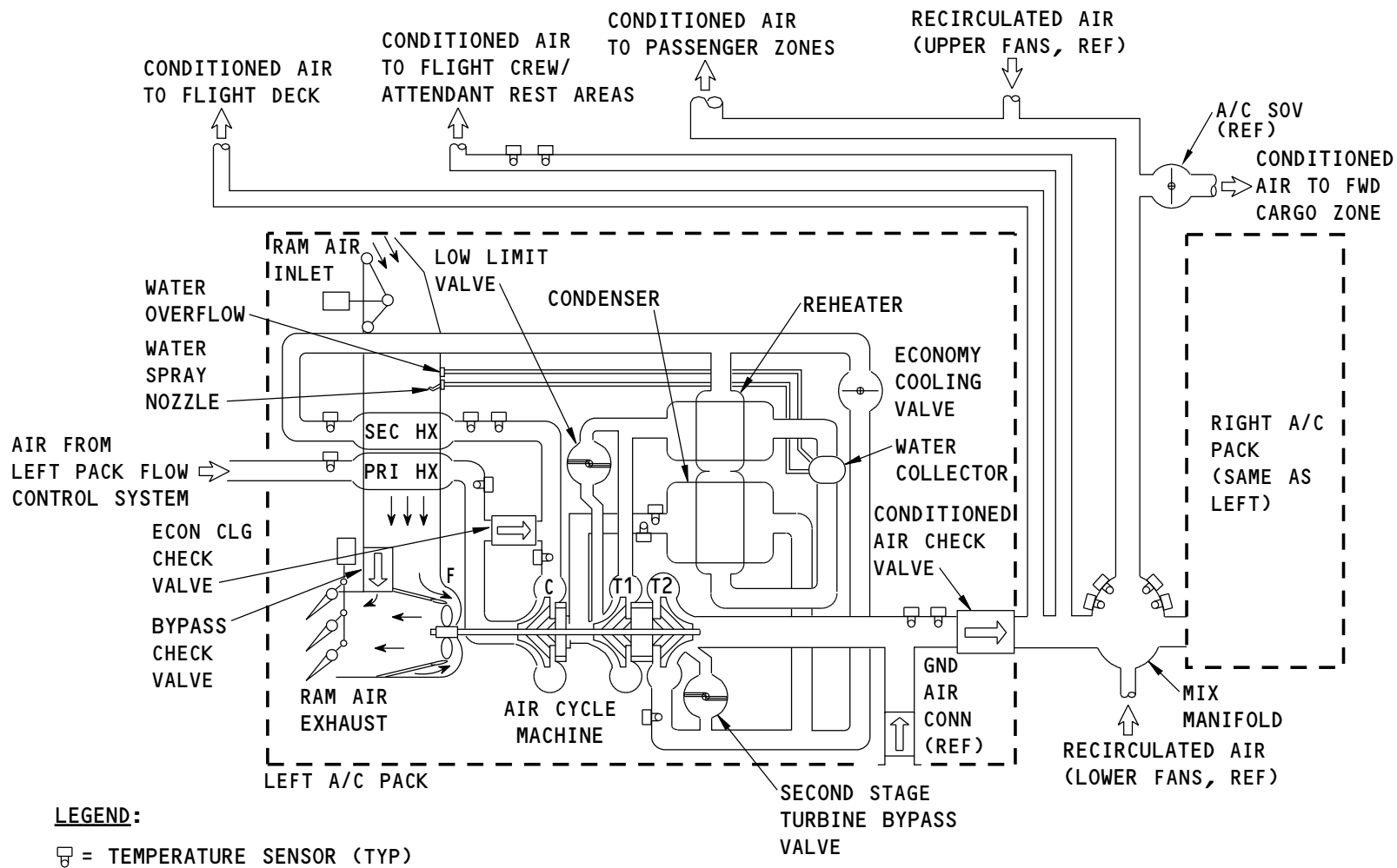
The right pack operates the same as the left pack.

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AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CONTROL - INTRODUCTION

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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - COMPONENT LOCATIONS****Component Locations**

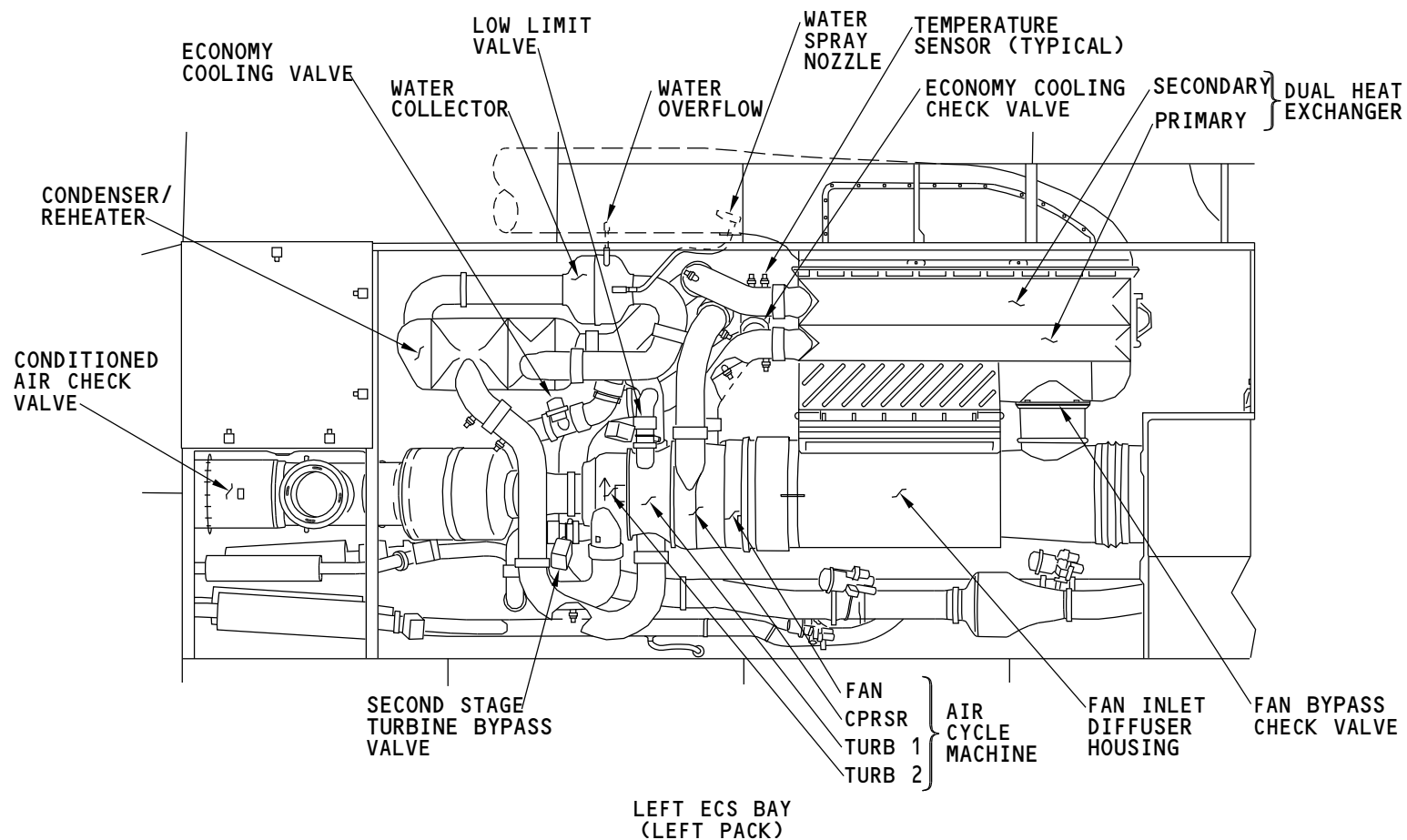
Most of the pack cooling and mix manifold temperature control components are in the ECS bay. Four mix manifold temperature sensors are in the aft part of the forward cargo compartment (not shown). The left and right ECS bays have a pack, a conditioned air check valve, and ram air system components (not shown).

The ram air system component locations are described in another part of this section.

Each pack has these components:

- Economy cooling valve
- Water collector
- Low limit valve
- Water overflow
- Water spray nozzle
- Temperature sensors (10 places)
- Economy cooling check valve
- Dual heat exchanger
- Fan bypass check valve
- Fan inlet and diffuser housing
- Air cycle machine (ACM)
- Second stage turbine bypass valve
- Condenser/reheater.

All of the components in the left and right packs are the same except for five of the ducts that connect the pack components together. The orientation of the components in one pack is a mirror image of the other. The airflow is also a mirror image. The difference in the ducts lets the inlets to the dual heat exchangers always be on the top and the outlets on the bottom.



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AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - COMPONENT LOCATIONS

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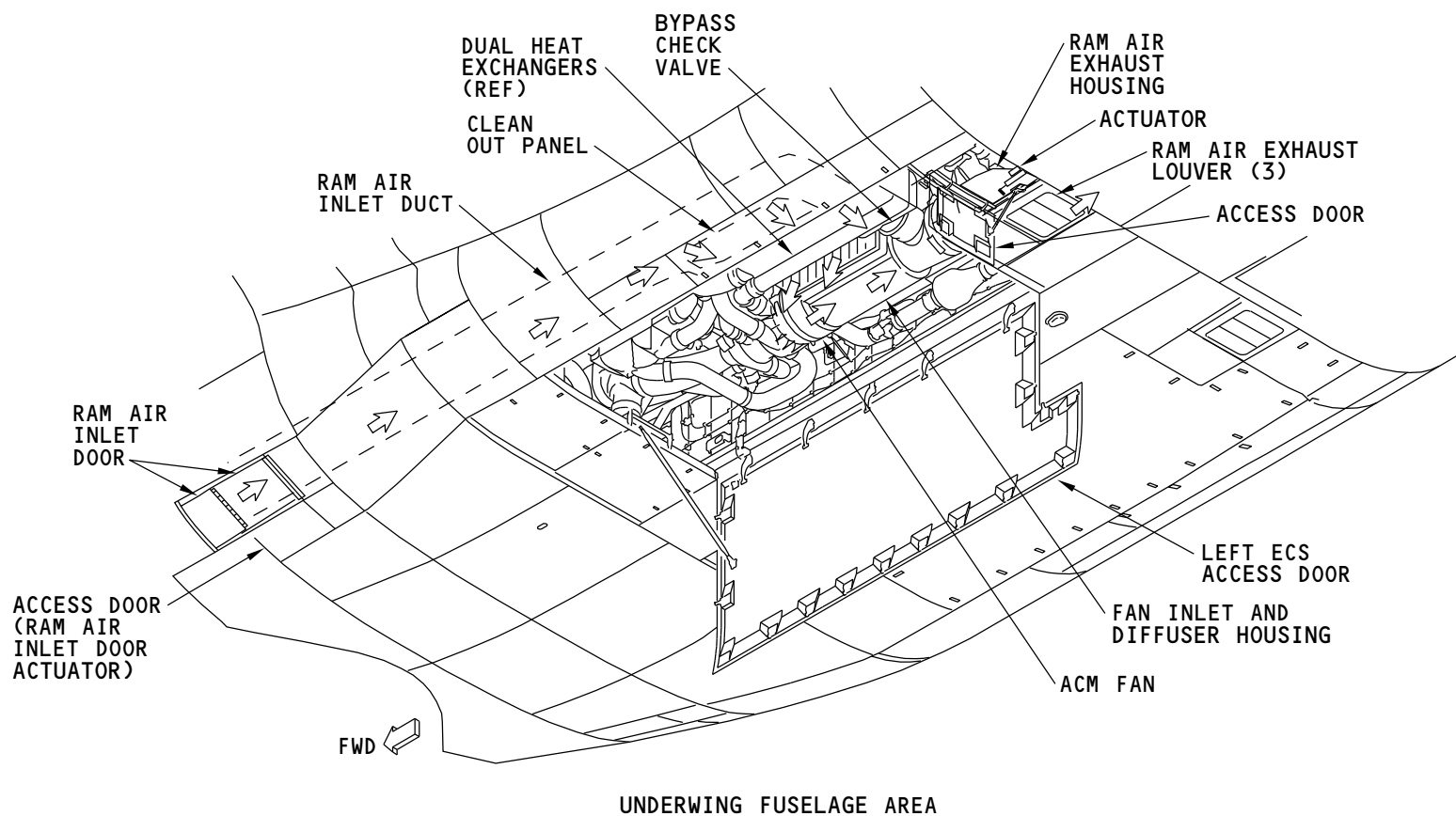
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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - RAM AIR - COMPONENT LOCATIONS****Component Locations**

All of the ram air components of the left and right air conditioning packs are in the underwing fuselage area. Each pack has these ram air components:

- Ram air inlet door (two sections)
- Ram air inlet door actuator (not shown)
- Ram air inlet duct
- Ram air inlet duct clean out panel
- Fan bypass check valve
- Fan inlet and diffuser housing
- Fan section of the ACM
- Ram air exhaust housing
- Ram air exhaust actuator
- Ram air exhaust louvers.

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NOTE: LEFT RAM AIR SYSTEM
SHOWN, RIGHT SIMILAR

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AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - RAM AIR - COMPONENT LOCATIONS

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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - DUAL HEAT EXCHANGER****Purpose**

The dual heat exchanger removes heat from pneumatic system air and from air compressed by the air cycle machine.

Physical Description

The dual heat exchanger has a primary and secondary heat exchanger core. There are inlets and outlets for the pneumatic system air and the ram air.

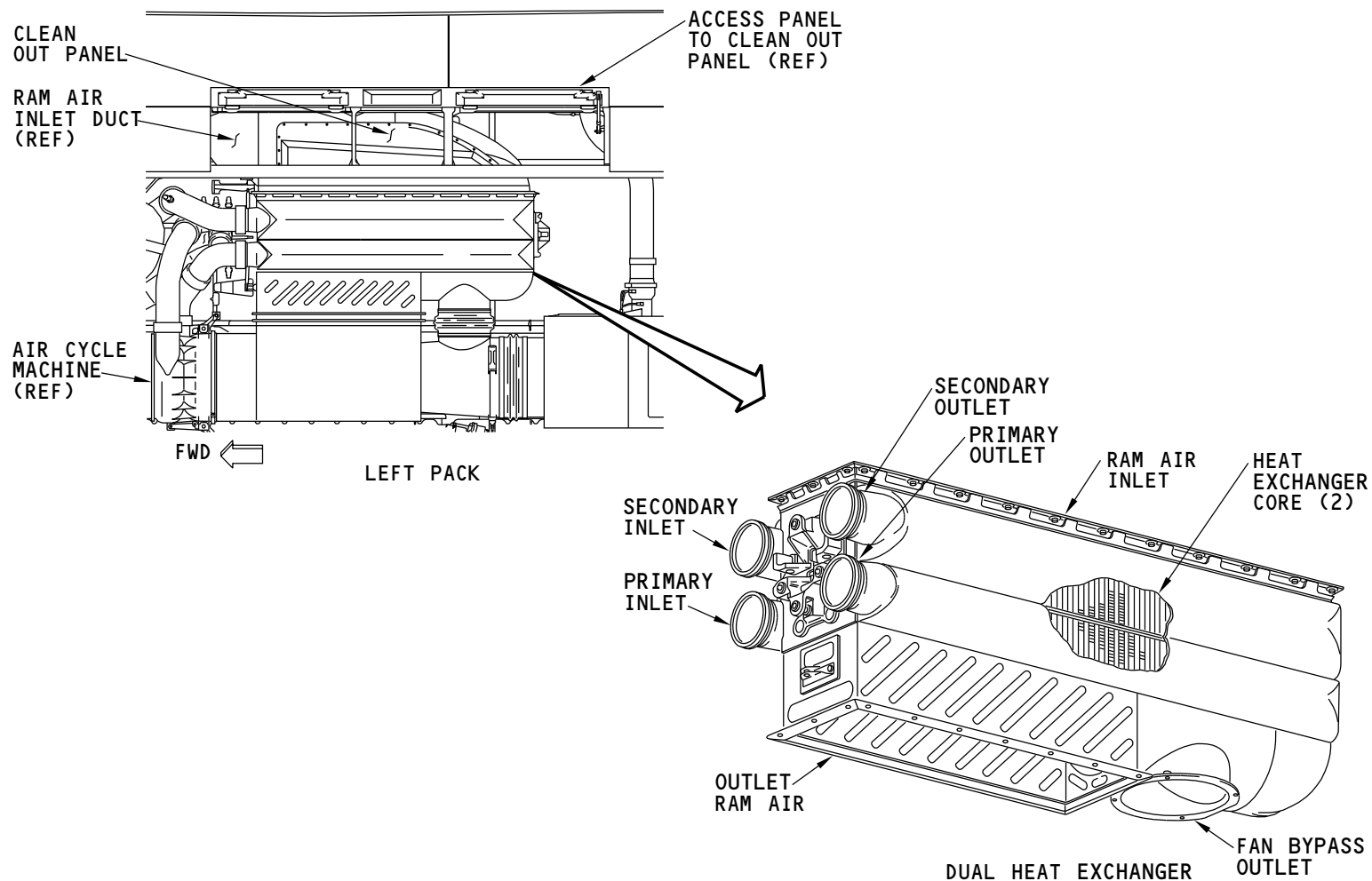
You remove and install the dual heat exchanger as a single unit. It weights 194 Lb (88 Kg).

The heat exchanger for the left pack and the right pack are identical. The orientation of the heat exchanger in one pack is a mirror image of the other. The airflow is also a mirror image. The pneumatic system air inlets are always on the top and the outlets are on the bottom. The ram air always flows from outboard to inboard.

Training Information Point

A panel outboard of each ECS access door gives access to the heat exchanger cleanout panels. Use high pressure water or air to loosen dirt.

ARO ALL	EFFECTIVITY



M35837 S000612519_V1

AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - DUAL HEAT EXCHANGER

21-52-00

21-52-00-003

ARO ALL	EFFECTIVITY
	D633W101-ARO

**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - ECONOMY COOLING CHECK VALVE****Purpose**

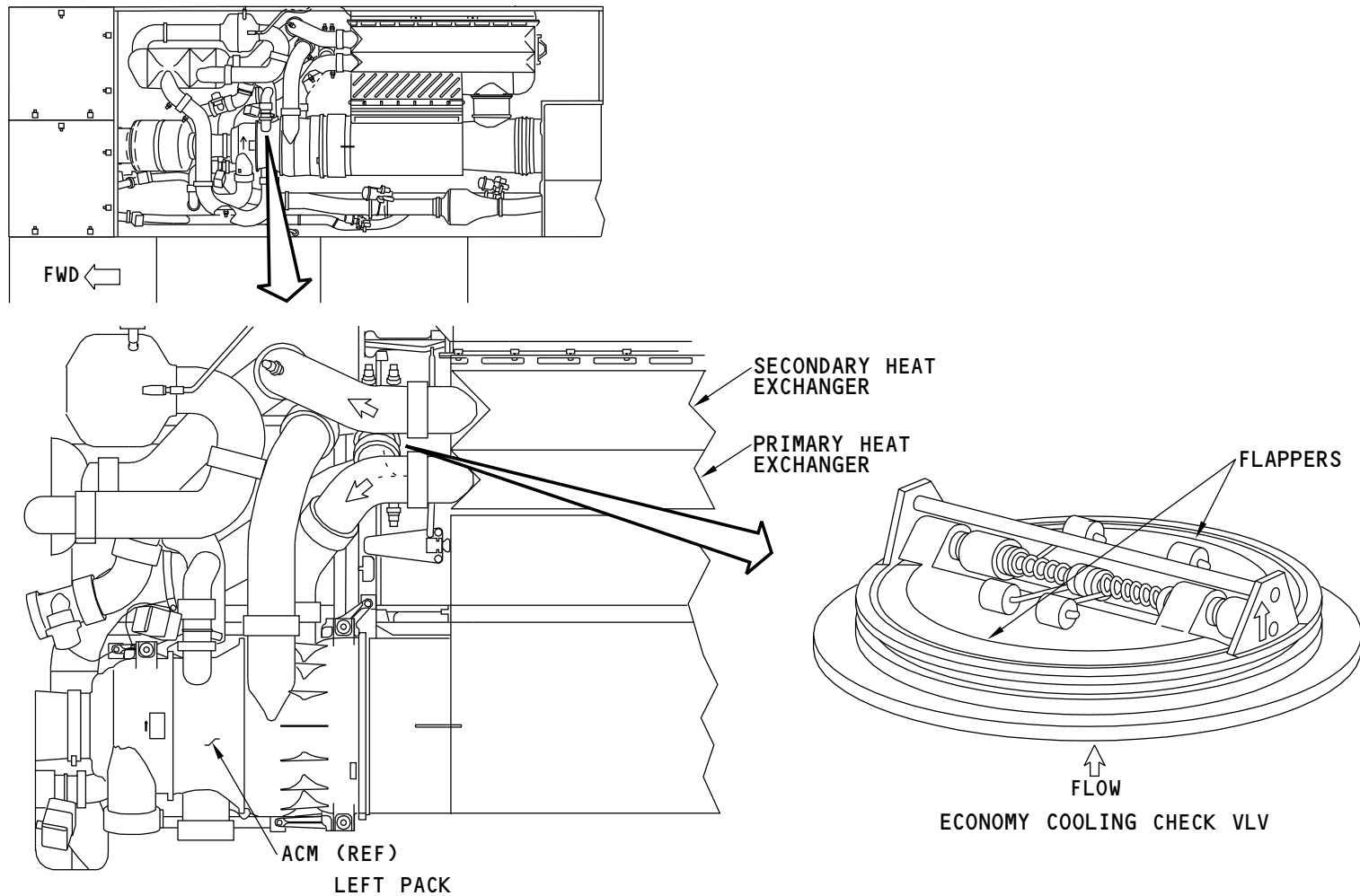
The economy cooling check valve permits air flow around the ACM compressor when the pack starts to operate or when the pack has an ACM failure.

When the economy cooling check valve is open, the air flows directly from the primary heat exchanger outlet to the secondary heat exchanger inlet.

Physical Description

The economy cooling check valve has two spring-loaded flappers.

ARO ALL	EFFECTIVITY
	D633W101-ARO



M35838 S000612520_V1

AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - ECONOMY COOLING CHECK VALVE

21-52-00-004

ARO ALL	EFFECTIVITY

D633W101-ARO

21-52-00

**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - AIR CYCLE MACHINE****Purpose**

The air cycle machine (ACM) compresses air in the compressor stage and expands air in the two turbine stages.

Physical Description

The air cycle machine has one compressor stage and two isolated turbine stages. These stages turn on the same shaft. A fan in the ram air flow also connects to this shaft.

Air bearings hold the shaft of the air cycle machine in position when the shaft turns.

Functional Description

The compressor compresses the air from the primary heat exchanger. The compressed air flows out to other pack components.

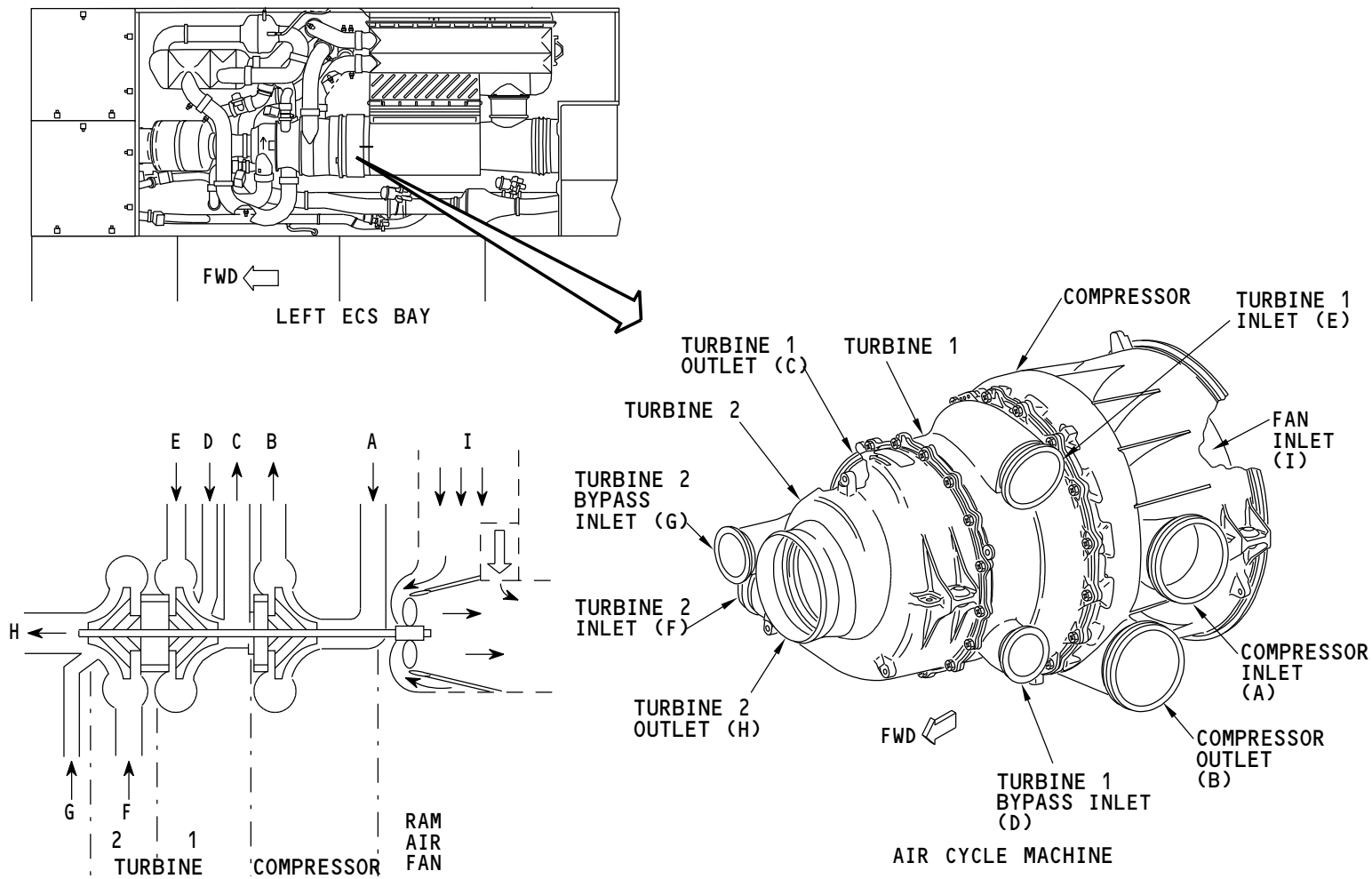
Each turbine receives air from different points in the pack. The air expands and decreases in temperature as it goes through the turbine. The energy released in the turbines turns the shaft of the air cycle machine.

The ram air fan moves ambient air through the ram air ducts when the airplane is on the ground.

Training Information Point

There is a direction arrow near a placard on the ACM that shows the direction to rotate the ACM before you do a torque check. Damage can occur if you manually turn the ACM in the incorrect direction. The placard has the maximum allowable torque.

ARO ALL	EFFECTIVITY



M35839 S000612521_V1

AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - AIR CYCLE MACHINE

21-52-00

21-52-00-005

ARO ALL	EFFECTIVITY
	D633W101-ARO

**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - CONDENSER/REHEATER****Purpose**

The condenser/reheater has two functions. It cools the air in the pack before it goes through the water collector. This lets the moisture in the air collect in the water collector. The condenser/reheater heats pack air to add energy to the air. The heated air helps operate the turbine in the air cycle machine.

Physical Description

The condenser/reheater has condenser and reheater heat exchanger cores. These cores are within a container through which pack air flows. The condenser/reheater weighs approximately 70 lb (32kg).

Functional Description

Air comes into the condenser/reheater from the secondary heat exchanger at A. This air flows over both heat exchanger cores. The heat exchangers absorb heat from this air. The decrease in air temperature condenses water so that the water collector can remove it from the air. The air flows out of the condenser/reheater at B.

The air from the water collector goes into the reheater at C. This air absorbs heat from the air that flows over the reheater core. The air flows out of the reheater at D.

The air from turbine 1 goes into the condenser at E. This air absorbs heat from the air that flows over the condenser core. The air flows out of the condenser at F.

Training Information Point

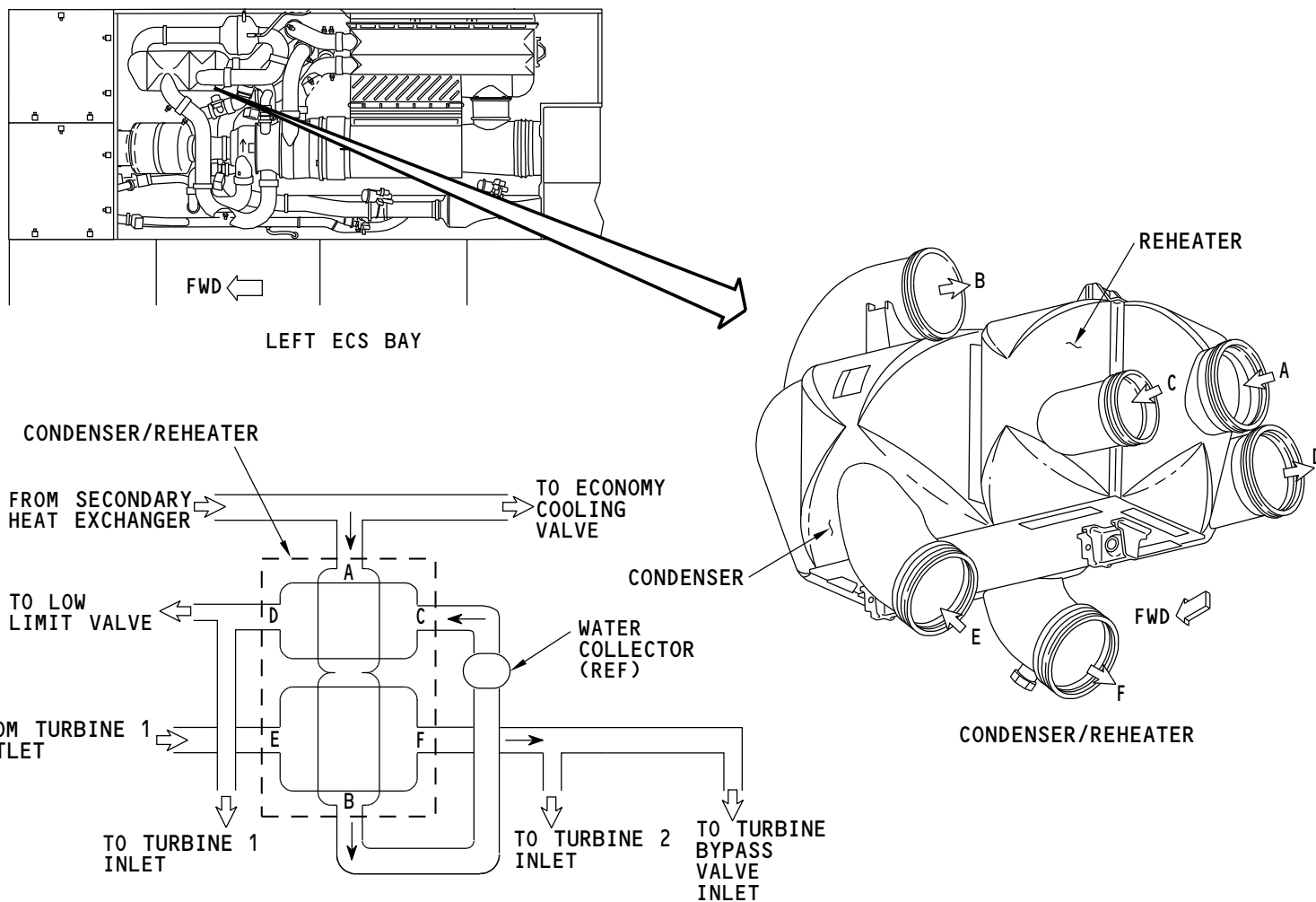
Remove and install the condenser/reheater with the water collector as an assembly. This balances the condenser/reheater weight on the hoist adapter.

21-52-00

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M35840 S000612522_V1

AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - CONDENSER/REHEATER

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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - WATER COLLECTOR AND SPRAY NOZZLE****Purpose**

The water collector removes water from pack air. The spray nozzle sprays the water into the air in the ram air inlet duct. The overflow lets water dump directly into the ram air inlet duct if the water collector has too much water in it.

Physical Description

The water collector is a device with no movable parts. Internal vanes are set to push air into a circular flow.

The spray nozzle has no moving parts. The nozzle has these parts:

- Pintle
- Nozzle
- Housing
- Water drain line connector.

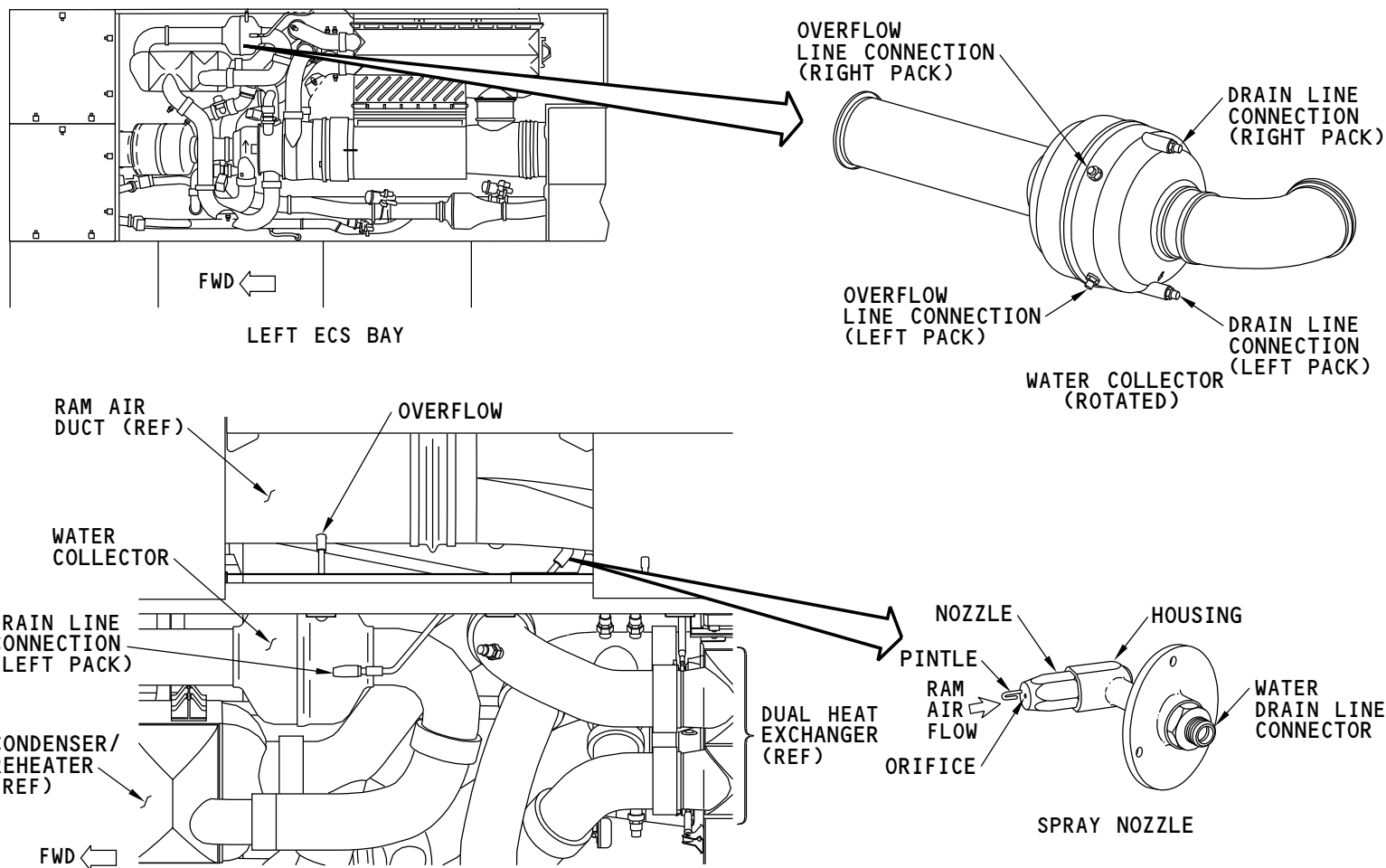
Location

A water collector and spray nozzle are outboard of the condenser/reheater in each ECS bay.

Functional Description

Air in the water collector turns in a circular flow. This pushes condensed water out of the air. A collector removes the water. Air pressure sends the water to the spray nozzle. The nozzle sprays the water in the incoming ram air near the secondary heat exchanger. The water added to the ram air inlet duct increases the heat removal by the secondary heat exchanger.

ARO ALL	EFFECTIVITY



M35841 S000612523_V1

AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - WATER COLLECTOR AND SPRAY NOZZLE

21-52-00-007

ARO ALL	EFFECTIVITY
	D633W101-ARO

21-52-00

**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - LOW LIMIT AND TURBINE BYPASS VLVS****Purpose**

The low limit valve controls the amount of reheater air that goes around the first stage turbine of the ACM. The CTC uses this valve to limit the output air temperature of the first stage turbine above 34F (1C) so water in the air does not freeze.

The second stage turbine bypass valve controls the amount of condenser air that goes around the second stage turbine of the ACM. The CTC uses turbine bypass valve to control pack outlet temperature.

These valves function together with the ram air doors to control the output temperature of the pack.

Physical Description

The valve has these parts:

- Position indicator
- Disc
- Valve body
- Manual open/close knob
- Electrical actuator
- Electrical connector (not shown).

The low limit valve and the second stage turbine bypass valve are the same. Each uses a disc which rotates to adjust air flow. The disc is driven by a motor that can be turned in both directions. The motor uses 115v ac to operate the valve.

An RVDT gives an electrical indication of the disc position. An indicator on top of the electrical actuator gives a visual indication of disc position.

Functional Description

The CTC controls the operation of the low limit valve and the second stage turbine bypass valve. Both valves operate the same. A close or open signal from the CTC turns the motor in the necessary direction.

The RVDT in each valve sends the position of the valve to the CTC. The CTC use the position information for control and valve position indication.

Training Information Point

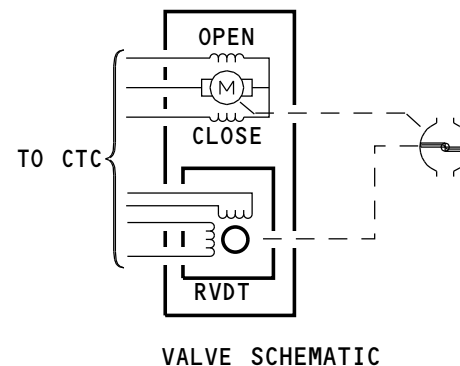
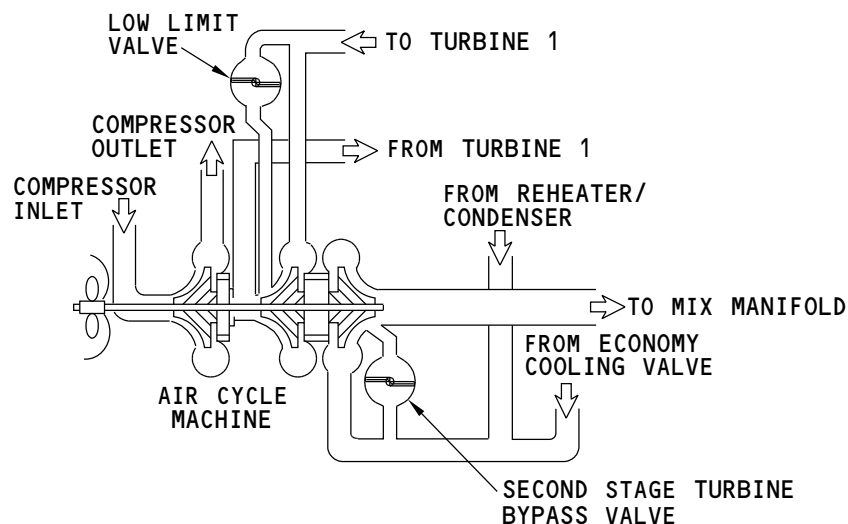
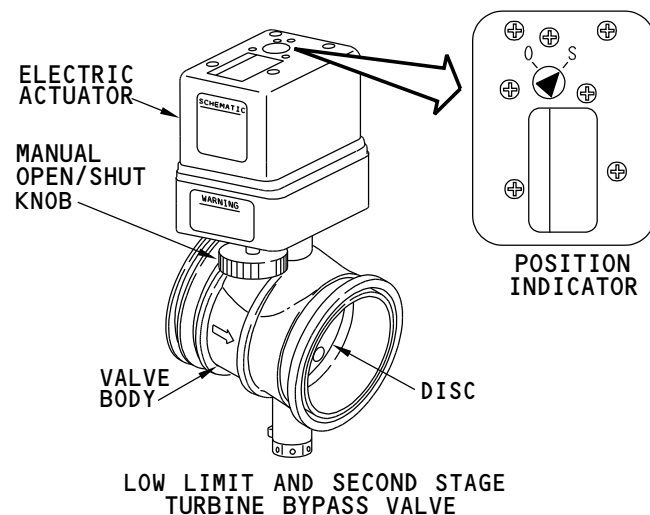
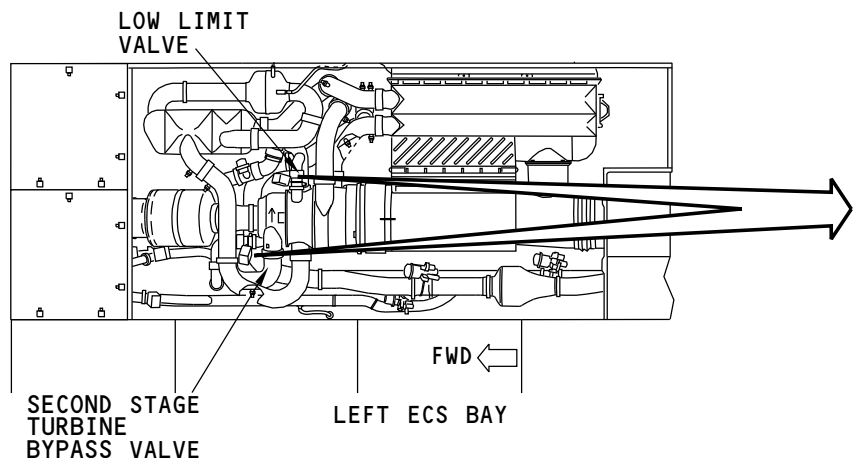
Manually open or shut the valve with the manual open/shut knob. You must disconnect the electrical connector first. The valve will move to the commanded position when the valve gets power if you do not remove the electrical connector.

21-52-00

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M35842 S000612524_V1

AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - LOW LIMIT AND TURBINE BYPASS VLVs

21-52-00

21-52-00-008

ARO ALL	EFFECTIVITY
	D633W101-ARO

**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - ECONOMY COOLING VALVE****General**

The economy cooling valve opens to let air go around the air cycle machine turbine 1 and the water separation parts of the pack. The valve opens when the pack functions in the economy cooling mode or the standby cooling mode. See the functional description of the packs in this section for more information about these modes.

Physical Description

The economy cooling valve has these parts:

- Locking crank/position indicator
- Pneumatic actuator
- Locking plug
- Plug and filter
- Solenoid
- Electrical connector
- Valve body
- Disc.

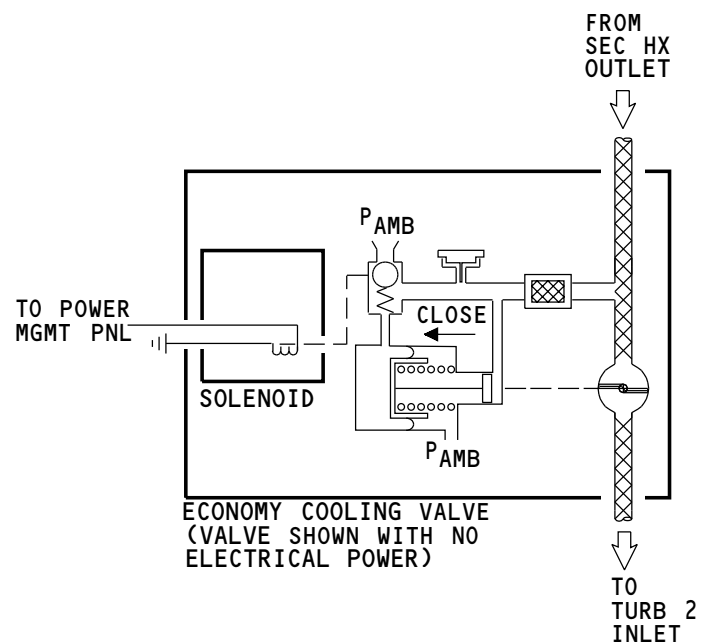
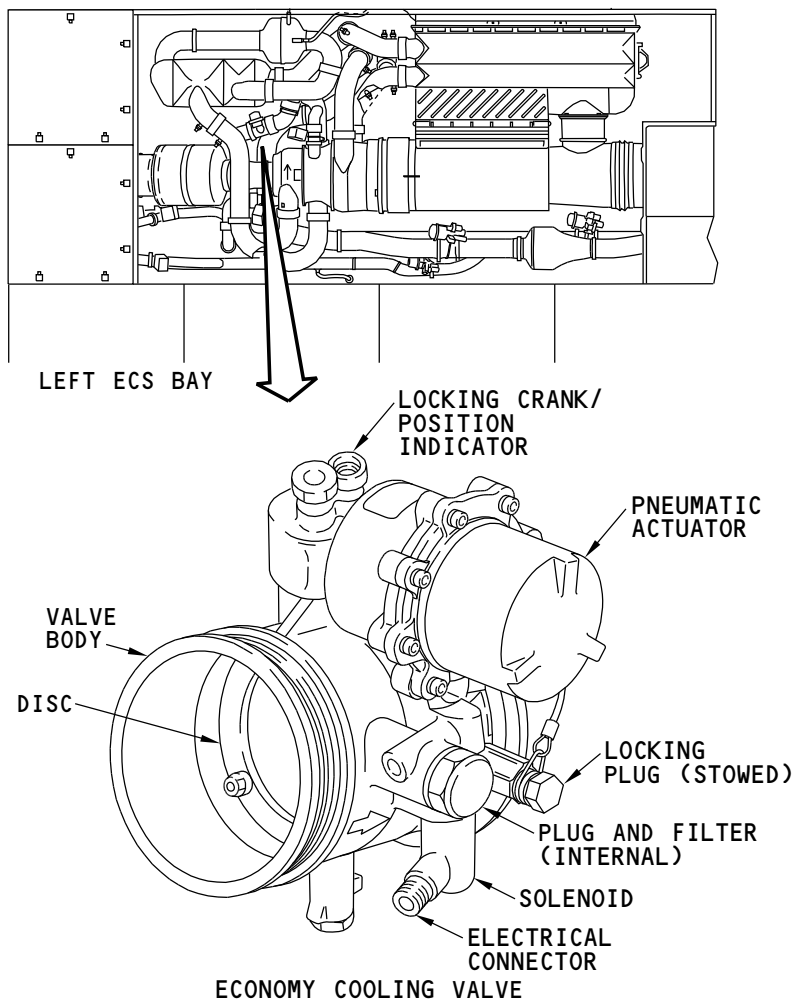
A pneumatic actuator moves the disc to open or close the valve.

Functional Description

The economy cooling valve is electrically controlled and pneumatically actuated. The valve is spring-loaded closed. With no power to the solenoid, control pressure in the actuator opens the valve. When the solenoid energizes, control pressure bleeds from the actuator and the valve closes.

Training Information Point

Use the locking plug to manually lock the valve to the closed position.



M35843 S000612525_V1

AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - ECONOMY COOLING VALVE

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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - CONDITIONED AIR CHECK VALVE****Purpose**

The conditioned air check valve prevents a decrease of cabin pressure if an air conditioning duct failure occurs in the ECS bay.

Physical Description

The conditioned air check valve is a single flapper-type valve.

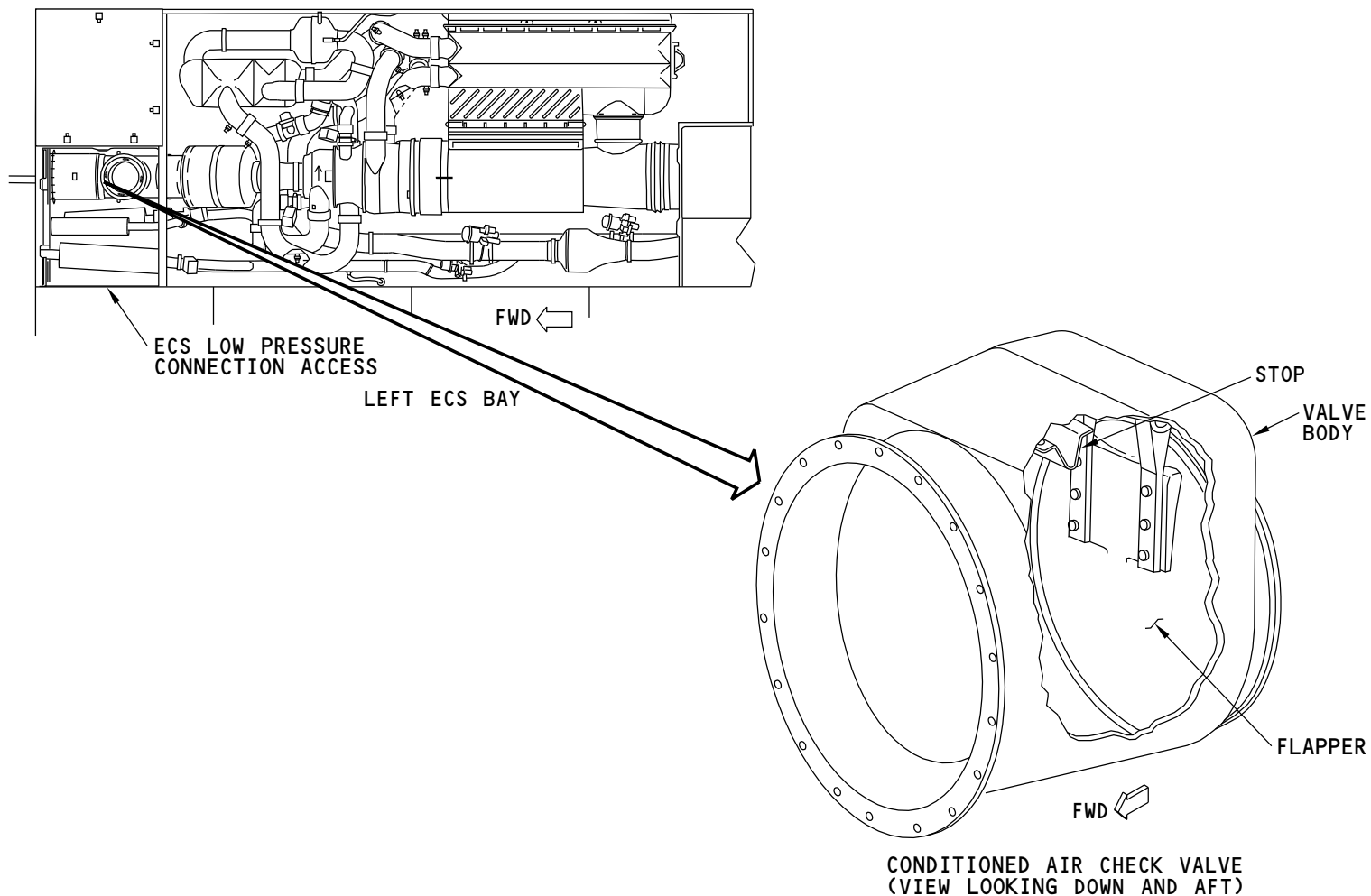
Location

The valves are at the forward end of the ECS bays. They attach to the forward cargo compartment pressure bulkhead. Access is through the ECS low pressure connection doors.

Physical Description

The conditioned air check valve is a single flapper-type valve.

ARO ALL	EFFECTIVITY
	D633W101-ARO



M35844 S000612526_V1

AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - CONDITIONED AIR CHECK VALVE

21-52-00

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AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - PACK COOLING TEMP SENSORS

Purpose

The pack cooling temperature sensors monitor the air temperatures at eight different locations in the pack.

These are the pack cooling temperature sensors:

- Primary heat exchanger outlet temperature sensor
- Compressor discharge temperature sensors 1 and 2 (CTC)
- Secondary heat exchanger outlet temperature sensor
- Compressor discharge temperature sensor (ASCPC)
- Condenser inlet temperature sensors 1 and 2
- Pack discharge temperature sensor (CTC)
- Pack discharge temperature sensor (ASCPC)
- Secondary turbine inlet temperature sensor.

The primary heat exchanger inlet temperature sensor supplies data for flow control. See the pack flow control section for more information about flow control (SECTION 21-51).

The cabin temperature controller (CTC) uses the pack cooling temperature data for control, BIT, and indications. See the zone temperature control and indication section for more information about the CTC (SECTION 21-61).

Physical Description

The sensors have an electrical connection and a threaded housing. The sensors install into a threaded boss on the air conditioning duct. There are single element resistance/temperature sensors and single element thermistor sensors.

These sensors are single element resistance/temperature sensors:

- Primary heat exchanger outlet temperature sensor
- Compressor discharge temperature sensors 1 and 2 (CTC)
- Compressor discharge temperature sensor (ASCPC)
- Secondary heat exchanger outlet temperature sensor.

These sensors are single element thermistor sensors:

- Condenser inlet temperature sensors 1 and 2
- Secondary turbine inlet temperature sensor
- Pack discharge temperature sensor (CTC)
- Pack discharge temperature sensor (ASCPC).

Location

The sensors are in air ducts in the ECS bay.

Training Information Point

These sensors are interchangeable:

- Primary heat exchanger outlet temperature sensor
- Compressor discharge temperature sensor (2) (CTC)
- Compressor discharge temperature sensor (ASCPC)
- Secondary heat exchanger outlet temperature sensor.

The primary heat exchanger inlet temperature sensor is also interchangeable with the above sensors.

These sensors are interchangeable:

- Condenser inlet temperature sensor (2)
- Secondary turbine inlet temperature sensor.

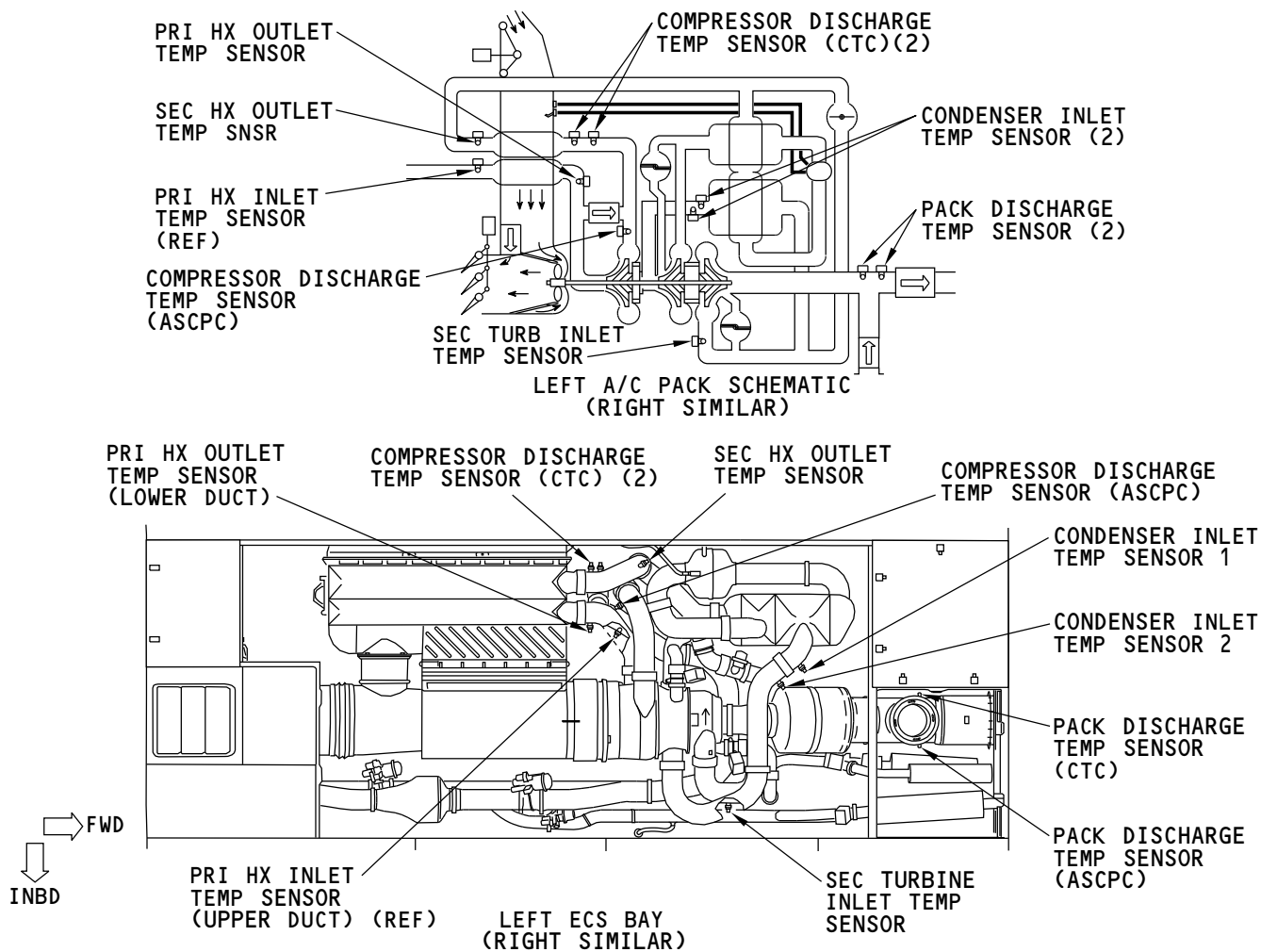
The ASCPC and CTC pack discharge temperature sensors are interchangeable.

21-52-00

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M35846 S000612528_V1

AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CONTROL - PACK COOLING TEMP SENSORS

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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - MANIFOLD TEMP SENSORS****Purpose**

The mix manifold temperature sensors monitor air temperatures at the mix manifold. There are four mix manifold outlet temperature sensors.

Physical Description

The sensors are single element thermistor devices. The sensor housing has an external hex wrench fitting and threads for installation in the mix manifold.

Location

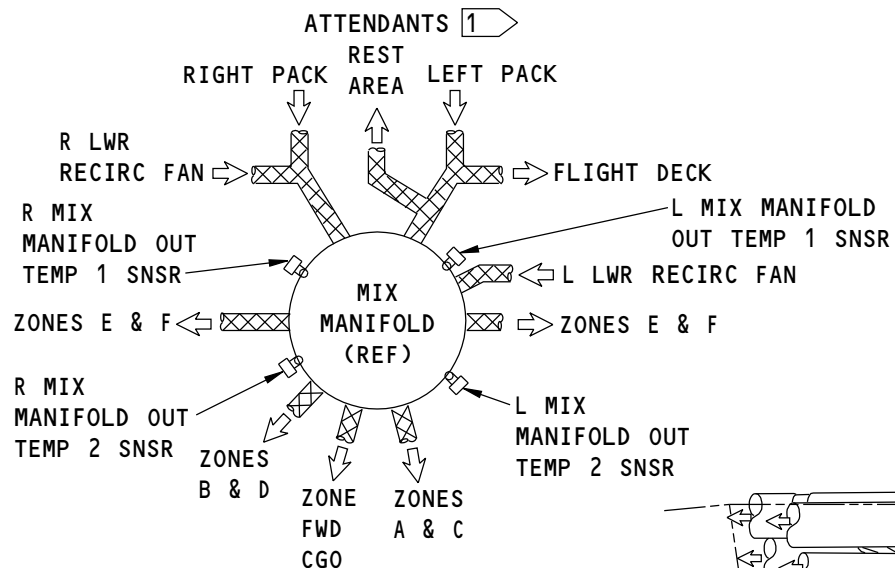
The sensors are in the top of the mix manifold. Open the flexible neoprene liner at the aft end of the forward cargo compartment to get access to the mix manifold area.

Training Information Point

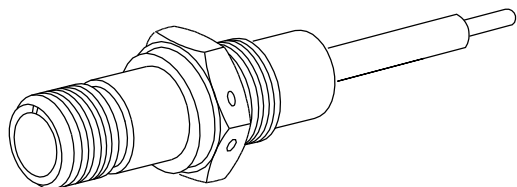
The mix manifold temperature sensors are interchangeable. They are also interchangeable with these sensors:

- Cabin zone duct temperature sensors
- Forward cargo conditioned air duct temperature sensors
- Forward cargo compartment temperature sensors.

ARO ALL	EFFECTIVITY



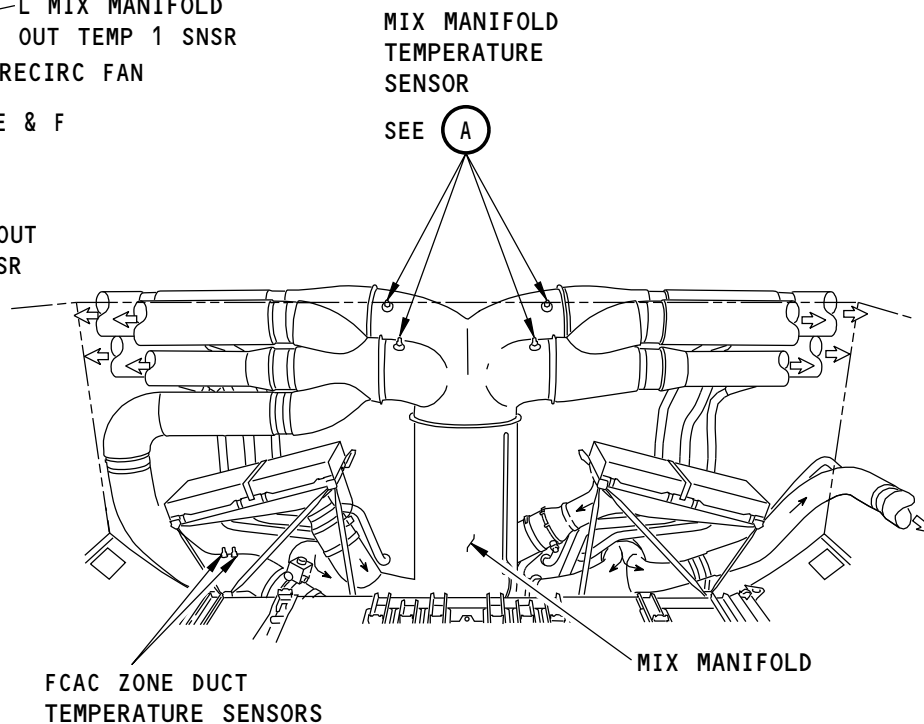
MIX MANIFOLD SCHEMATIC



**MIX MANIFOLD TEMPERATURE SENSOR
(EXAMPLE)**



1 IF INSTALLED



**MIX BAY AREA
(FORWARD CARGO COMPARTMENT)
(VIEW IN THE AFT DIRECTION)**

2182334 S0000482499_V1

AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - MANIFOLD TEMP SENSORS

21-52-00

21-52-00-013

ARO ALL

EFFECTIVITY

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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - RAM AIR INLET DOOR AND ACTUATOR****Purpose**

The ram air inlet door controls the flow of ram air supplied to the dual heat exchanger. This is to control the amount of air used to cool the dual heat exchanger. This functions with other components to control air temperature from the pack.

Physical Description

The ram air inlet door is a two part assembly. The forward part has a hinge attached at a permanent position at the ram air inlet.

The aft part has a free hinge attached on the aft side of the forward part. The aft side of the aft part mounts on swing links.

The actuator turns a torque tube that attaches to the aft part of the door behind the hinge.

Location

The ram air inlet doors are on the bottom of the airplane forward of the ECS bay doors.

Functional Description

A close or open signal from the CTC operates the actuator motor in the necessary direction.

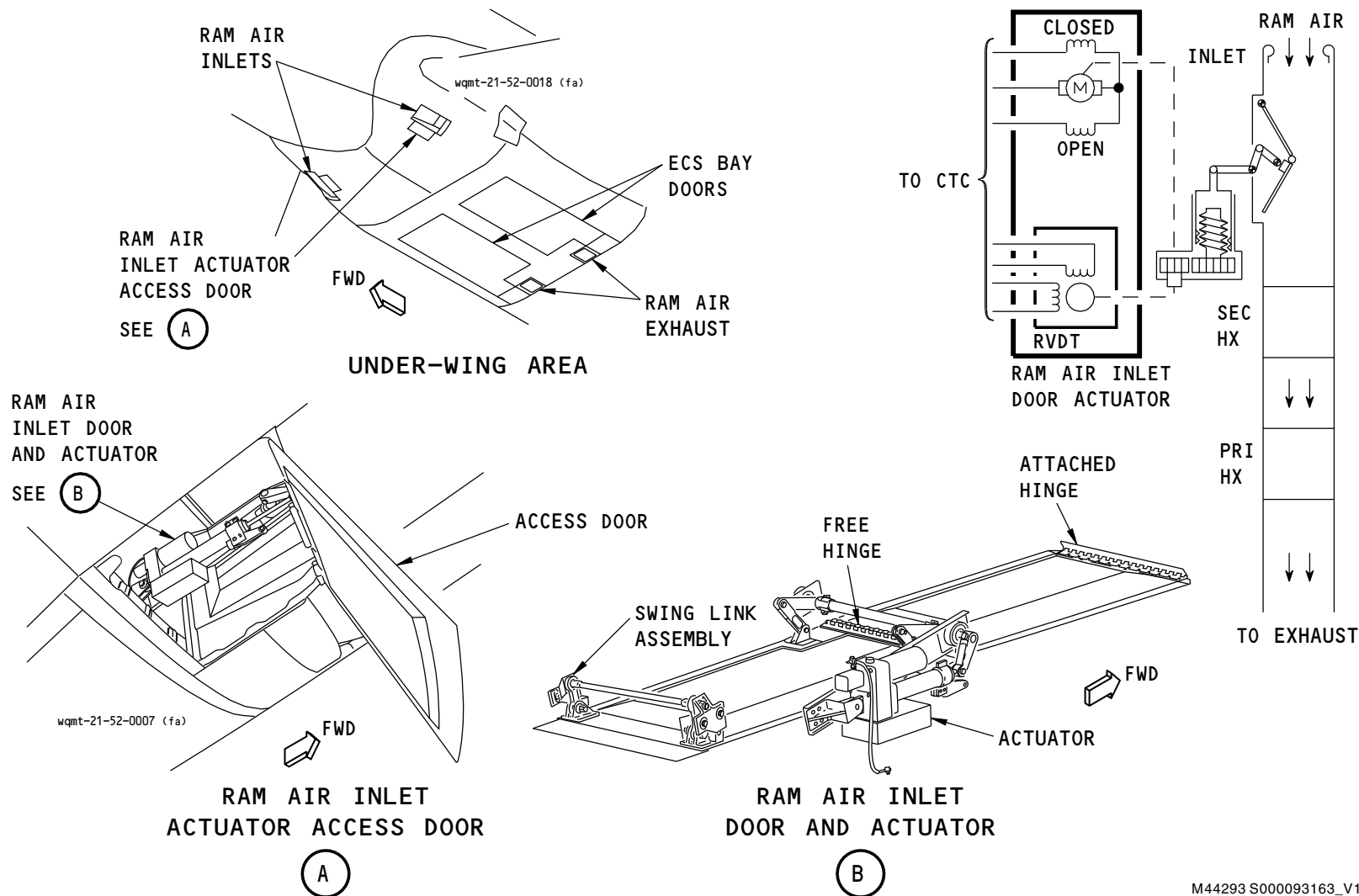
A rotary variable differential transformer (RVDT) in the actuator sends the position of the door to the CTC.

Training Information Point

When you change a component of the ram air inlet system, measure the closed position of the door. If it is necessary, adjust the actuator to get the correct measurement.

The ram air inlet doors are normally open with the airplane on the ground. You use a MAT special function to close the ram air door if necessary.

ARO ALL	EFFECTIVITY



M44293 S000093163_V1

AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - RAM AIR INLET DOOR AND ACTUATOR

21-52-00

21-52-00-014

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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - RAM AIR EXHAUST HOUSING ASSEMBLY AND ACTUATOR****Purpose**

The ram air exhaust door controls the flow of ram air that flows from the dual heat exchanger. This is to control the amount of air that cools the dual heat exchanger. This functions, with other components, to control air temperature from the pack.

See part II of the airplane maintenance manual for more information on the MAT special function.

Physical Description

The ram air exhaust door has louvers. Control linkage attaches the louvers together and to the actuator.

Location

The ram air exhaust doors are on the bottom of the airplane at the aft end of the ECS bay doors.

Functional Description

A close or open signal from the CTC operates the actuator motor in the necessary direction.

A rotary variable differential transformer (RVDT) in the actuator sends the position of the door to the CTC.

Training Information Point

When you change a component of the ram air exhaust system, measure the closed position of the exhaust louvers. If it is necessary, adjust the actuator to get the correct measurement.



MAKE SURE THAT PERSONNEL ARE CLEAR OF THE RAM AIR INLET DOORS, RAM AIR EXHAUST LOUVERS, LINKAGES, AND ACTUATORS. THESE COMPONENTS CAN MOVE DURING THE PROCEDURE. POSSIBLE INJURY TO PERSONNEL CAN OCCUR.

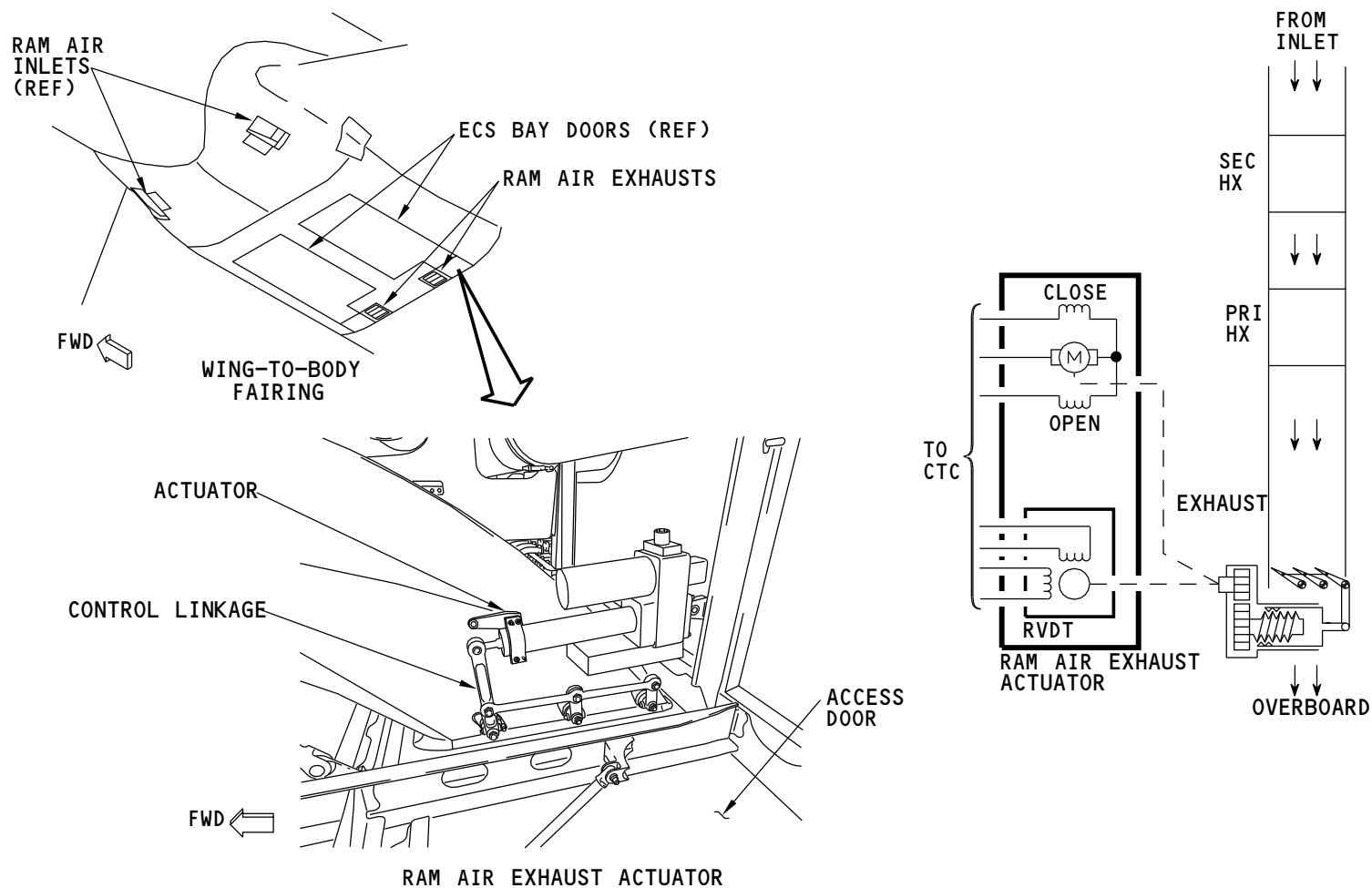
The ram air exhaust louvers are normally open with the airplane on the ground. You use a MAT special function to close the exhaust louvers if necessary.

21-52-00

EFFECTIVITY	
ARO ALL	

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M35854 S000612537_V1

AIR COND - PACK CLG AND MIX MANIFOLD TEMP CTRL - RAM AIR EXHAUST HOUSING ASSEMBLY AND ACTUATOR

21-52-00

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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FAN INLET DIFFUSER HOUSING AND CK VLV****Purpose**

The fan inlet diffuser housing connects the dual heat exchanger to the ACM fan and ram air exhaust duct.

The fan bypass check valve permits air to go around the ACM fan at higher ram air flow.

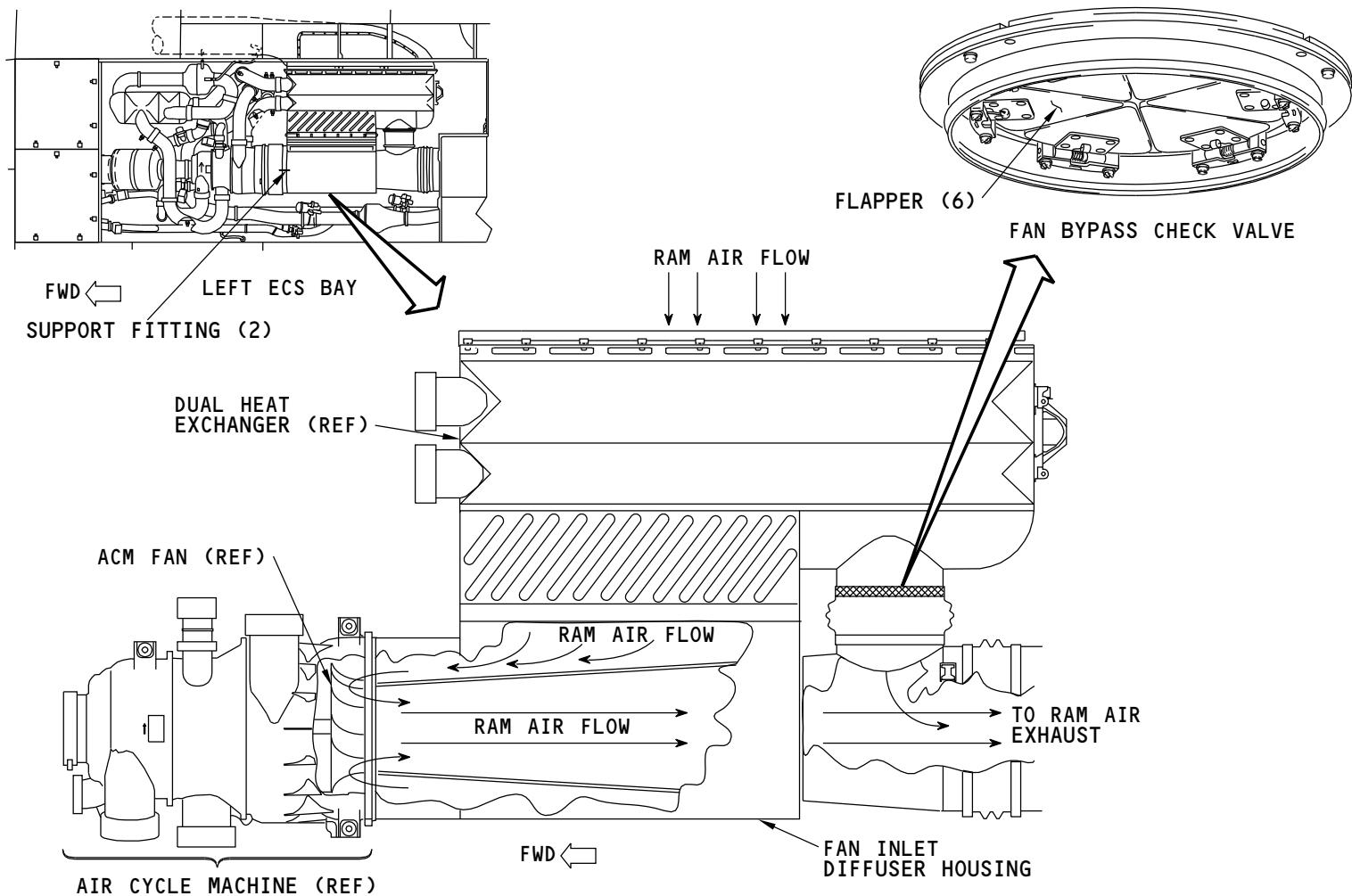
Physical Description

The fan inlet diffuser housing is a metal container with flexible connections at the ram air inlet and fan bypass. An inner assembly separates the air flow that goes to and from the ACM fan.

The fan bypass check valve is a flapper-type valve.

Training Information Point

The fan inlet diffuser housing has a strap that attaches to the upper support fitting and to airplane structure (not shown). The strap supports the housing when the ACM or dual heat exchanger is removed. Make sure you install this strap when you install the fan inlet diffuser housing.



M35547 S000612539_V1

AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FAN INLET DIFFUSER HOUSING AND CK VLV

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ARO ALL	EFFECTIVITY
	D633W101-ARO

AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FUNCTIONAL DESCRIPTION - CONTROL

General

The CTCs control the related air conditioning pack. The CTCs usually set the packs to keep the temperature in the mix manifold to a calculated value and to keep pack outlet temperatures within 10F (5.5C) of each other.

The calculated temperature value for the mix manifold is called integrated mix manifold temperature error (IMMTE) reference. The IMMTE reference is based on cooling and heating requirements of the zones that usually get conditioned air from the mix manifold. The right CTC usually calculates this reference. The left CTC follows the right CTC. The left can make the calculation if the right CTC fails. See the zone temperature control and indication section for more information about the calculation of the IMMTE reference (SECTION 21-61).

The left and right CTCs can control the related pack outlet temperature to different values. This occurs when the flight deck needs more cooling than the request by the IMMTE reference. If the flight deck needs more cooling, the left CTC controls the left pack outlet temperature to satisfy the flight deck requirements. The right CTC controls the right pack outlet to satisfy the IMMTE reference.

The left and right CTCs control the temperature of air from the related pack by direct adjustment of these components:

- Second stage turbine bypass valves (TBV)
- Low limit valves (LLV)
- Ram air door actuators.

The CTCs use the economy cooling valve (ECV) to bypass the water removal part of the pack. The CTC opens the ECV when water removal is not necessary or when the CTC must increase airflow into the airplane. The CTC controls the economy cooling valve through the ELMS computing and communications unit (CCU).

For usual control, the CTCs set the speed and direction of valve/actuator movement based on the difference between actual (RVDT) and desired position. Desired position is a CTC calculated position for valve/actuator based on these conditions:

- Pack on or off, pre-positioning for off

- Pack control, usual or backup.

When a pack is on, the desired position for a valve or an actuator is usually set to a preset schedule for each valve/actuator. The schedules for the ram air door actuators, TBV, and LLV do these functions:

- Keeps the use of ram air to a minimum
- Adjust ram air flow to keep ACM fan surge margins
- Keeps the compressor outlet temperatures within limits.

The position schedules for the ram air door actuators and the TBV and LLV automatically adjusts for low (less than .5 MACH) and high (more than or equal to .5 MACH) airspeeds. The schedule for the ram air door actuators also adjusts for the economy cooling mode.

Ram Air Doors Actuators

Both inlet and exhaust door actuators operate the same way. CTC control of the ram air inlet and exhaust actuators has these functions:

- Limit closed position if LLV or TBV fail (ACM surge protection)
- Keep ram air inlet position less than or equal to ram air exhaust (protects ram air ducts from too much pressure)
- Limit compressor outlet temperature (prevents compressor overheat)
- Keep the mix manifold temperature more than or equal to 35F (2C) if TBV full open (prevents water freezing in mix manifold)
- Control pack outlet temperature to satisfy the IMMTE reference (valve/actuator preset schedules).

A rotary variable differential transformer (RVDT) in each actuator sends the door position to the CTC.

Second Stage Turbine Bypass Valve

CTC control of the second stage turbine bypass valve has these functions:

- Limit open position if ram air door actuator fails (ACM surge protection)
- TBV full open if ACM fails (standby cooling, lets the pack continue to operate)

21-52-00

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AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FUNCTIONAL DESCRIPTION - CONTROL

- Change position to control pack flow if flow control valve is full open and pack in economy cooling mode (lets pack satisfy pack flow schedule)
- Keep the mix manifold temperature more than or equal to 35F (2C) (prevents water freezing in mix manifold)
- Control pack outlet temperature to the IMMTE reference (valve/actuator preset schedules).

An RVDT in the valve sends the valve position to the related CTC.

Low Limit Valve

CTC control of the low limit valve has these functions:

- Keep condenser inlet temperature more than or equal to 34F (1C) (prevents water freezing in the hot side of the condenser)
- Control pack outlet temperature if TBV is full open and the mix manifold temperature less than the IMMTE reference or less than 35F (2C).

Economy Cooling Valve

The CTC tells the electrical load management system (ELMS) CCU to open or close the economy cooling valve (ECV). The ELMS CCU uses the economy cooling valve relay to set the position of the ECV. To open the valve, ELMS removes electrical power from the relay. This causes air pressure in the pack to open the valve. To close the valve, ELMS energizes the relay which gives 28v dc to a solenoid in the ECV. This causes air pressure in the pack to close the valve.

Sensors - Temperature and RVDT

The CTCs monitor pack temperature sensors and valve/actuator RVDTs. The CTCs use this information for control, BIT and indications for the related air conditioning pack.

See the zone temperature control and indication section for more information about the pack temperature sensors (SECTION 21-61).

Indication - Standby Cooling

When the related CTC sets the related pack to operate in the standby cooling mode, the AIMS shows these two indications:

- EICAS advisory message PACK MODE L (R)
- STBY COOLING message on the air synoptic display.

The STBY COOLING message shows next to the related pack symbol.

See the cooling section for more information about the pack indications (SECTION 21-50).

Pack Off Positioning

The CTC sets the positions of the ram air door actuators, LLV, TBV and ECV when a pack is off. These are the related positions for a pack when the airplane is in the air:

- Ram air inlet and exhaust are at 0.98 percent of heating (98 percent closed)
- LLV is at 0.00 percent of heating (full closed)
- TBV is at 0.15 percent of heating (part open)
- ECV is closed.

These are the related positions for a pack when the airplane is on the ground:

- Ram air inlet and exhausts are at 0.00 percent of heating (full open)
- LLV is at 0.00 percent of heating (full closed)
- TBV is at 0.00 percent of heating (full closed)
- ECV is closed.

ASCPC Interface

The ASCPCs monitor the compressor and pack discharge temperatures. The ASCPCs have their own temperature sensors, they do not use the same sensors as the CTCs.

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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FUNCTIONAL DESCRIPTION - CONTROL**

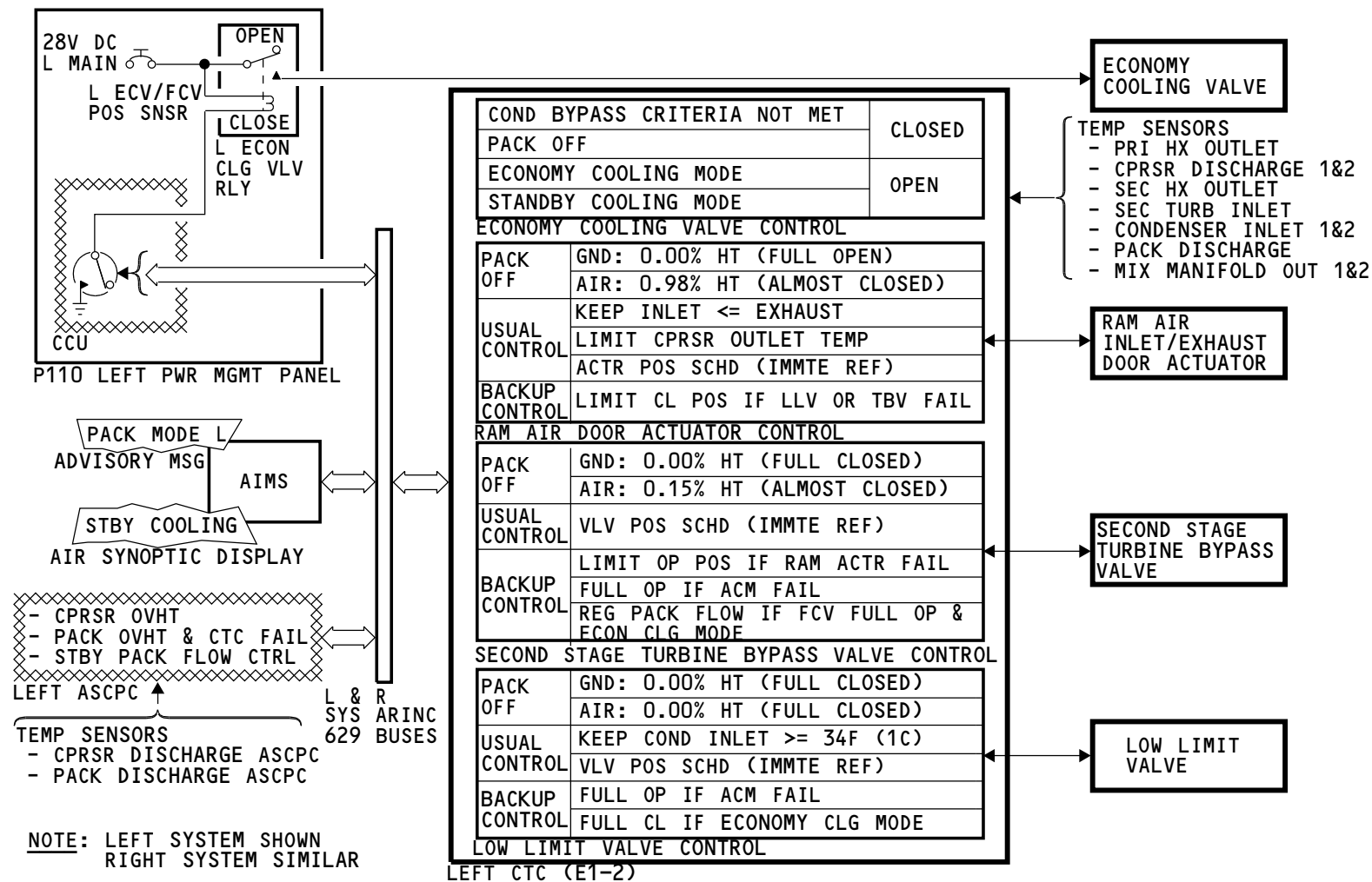
The related ASCPC uses the compressor and pack discharge temperature information to set the related pack to off if any of these conditions occur:

- Compressor overheat more than 490F (254C) for 5 seconds
- Pack overheat, 210F (99C) for 10 seconds and the related CTC has failed.

The related ASCPC also uses the temperature information to keep discharge temperatures in limits when it gives backup pack flow control.

See the pack flow control section for more information about backup pack flow control (SECTION 21-51).

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AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FUNCTIONAL DESCRIPTION - CONTROL

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AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FUNCTIONAL DESCRIPTION - PACKS

General

The left CTC controls the left pack, and the right CTC controls the right pack.

In full air cycle machine (ACM) operation, the CTC controls the pack internal air temperatures and the pack output air temperature by adjustment of these components:

- Second stage turbine bypass valve (TBV)
- Low limit valve (LLV)
- Ram air door actuators.

These components operate in sequence to keep the necessary air temperature from the pack. This temperature is called the integrated mix manifold temperature error (IMMTE) reference. The CTC uses the TBV for primary control of pack output air temperature. The LLV and the ram air door actuator operate if the TBV is full open and the CTC still must increase pack outlet temperature. This keeps the necessary ram air flow to a minimum.

The right CTC is the primary controller of the mix manifold temperature. The left CTC usually follows the right in this condition. This type of operation makes the left and right pack outlet temperatures stay within 10F (5.5C) of each other. If the right pack is off or is in an overtemperature condition, the left CTC takes control of the mix manifold temperature.

The left and right CTCs can also control pack outlet temperatures to different values if it is necessary for the flight deck to have more cooling than the mix manifold.

The CTC usually uses the economy cooling valve (ECV) to help keep the scheduled air flow through the pack when the airplane is at high altitudes and low pneumatic duct pressure (economy cooling mode). The valve can be used to bypass the ACM if the ACM fails (STBY COOLING mode).

Compressor Outlet Temperatures Control

The CTC usually uses the ram air part of the system to control air temperature at the compressor outlet. The CTC can adjust pack air flow to limit compressor outlet temperature or stop pack operation to give protection. The CTC controls compressor out temperature in these limits:

COMPRESSOR OUT TEMP F (C)		CTC RESPONSE
< 25,000FT	> 25,000FT	
< 340 (171)	< 400 (204)	MODULATE RAM AIR DOORS FOR PACK OUT TEMP CTRL
≥ 340 (171)	≥ 400 (204)	RAM AIR DOORS FULL OPEN
≥ 355 (179) ^{*[1]}	≥ 415 (213) ^{*[1]}	REQUEST LOWER PRECOOLER OUT TEMP FROM ASCPC (250F, 121C)
≥ 355 (179)	≥ 415 (213)	DECREASE PACK FLOW (LOWEST VALUE ≥ SCHEDULE 4)
≥ 450(232) > 10 SEC	≥ 450(232) > 10 SEC	CLOSE FCV & LATCH PACK OFF ^{*[2]}

*[1] SINGLE PACK OPERATION OR PACK FAILURE OR ACM FAILED.

*[2] RESET WITH PACK SW OR AIR COND RESET SW

See the pack flow control section for more information about the pack flow schedules and control (SECTION 21-51).

See the air conditioning section for more information about the air conditioning reset switch (SECTION 21-00).

Condenser Inlet Temperatures Control

The CTC usually uses the LLV to prevent the formation of ice in the condenser. The CTC can adjust pack air flow to keep the condenser from freezing. The CTC always controls the condenser inlet temperature so that it does not go to a value less than 34F (1C).

21-52-00

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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FUNCTIONAL DESCRIPTION - PACKS****Pack Outlet Temperatures Control**

The CTC usually uses the TBV, ECV, and the ram air part of the system to control the pack outlet air temperature. The CTC can adjust pack air flow to limit pack outlet temperature or stop pack operation to give protection. The CTC controls pack outlet temperature within these limits:

PACK OUTLET TEMP F (C)	CTC RESPONSE
< 160 (71)	MODULATE TBV & RAM AIR DOORS FOR PACK OUT TEMP CTRL
≥ 160 (71) < 180 (82)	MODULATE PACK TO FULL COLD: * AIR DOORS TOWARDS FULL OPEN * TBV TOWARDS FULL CLOSED
≥ 180 (82) ^{*[1]}	REQUEST LOWER PRECOOLER OUT TEMP FROM ASCPC (250F, 121C)
≥ 180 (82)	DECREASE PACK FLOW (LOWEST VALUE ≥ SCHEDULE 4)
≥ 190 (88) > 10 SEC	CLOSE FCV & LATCH PACK OFF ^{*[2]}

^{*[1]} SINGLE PACK OPERATION OR PACK FAILURE OR ACM FAILED

^{*[2]} RESET WITH PACK SW OR AIR COND RESET SW

To prevent ice in the mix manifold, the CTC controls the pack valves and ram air doors to keep the mix manifold outlet temperature to a value more than 35F (2C). If the temperature at the mix manifold outlet decreases to a value less than this level, the CTC increases pack outlet temperature.

See the pack flow control section for more information about the pack flow schedules and control (SECTION 21-51).

See the air conditioning section for more information about the air conditioning reset switch (SECTION 21-00).

Economy Cooling Mode

The CTC selects the economy cooling mode if the all of these conditions occur:

- ACM operates

- One or both condenser inlet temperature sensors operate
- ECV operates
- Pack flow is less than the scheduled value or ambient temperature is less than 20F (-7C)
- Conditions for ACM not failed - condenser bypass are true.

The conditions for ACM not failed - condenser bypass change with altitude. The chart shows five examples.

ACM NOT FAILED - CONDITIONS FOR CONDENSER BYPASS	
ALTITUDE	AMBIENT TEMP F (C) ^{*[1]}
≤ 0	≤ 14 (-10)
10,000	≤ -9 (-23)
20,000	≤ -18 (-28)
≥ 30,000	≤ -24 (-31)

^{*[1]} IF AMBIENT TEMP ≤ INDICATED VALUE, THEN CONDENSER BYPASS CAN OCCUR.

In the economy cooling mode, air goes directly from the secondary heat exchanger to turbine two of the ACM. The CTC sets the second stage turbine bypass valve to control pack output temperature and the low limit valve to keep the condenser inlet above 34F (1C).

The CTC keeps a pack in the economy cooling mode until any one of these conditions is true:

- Conditions for condenser bypass are not true
- TBV full closed, ram air doors more than 80 percent open and pack outlet temperature 5F (2.7C) more than IMMTE
- Pack flow schedule 4 is active
- Actual pack flow less than 100 ppm or more than two times the value of pack flow schedule 2.

There are no flight deck effect when the pack operates in the economy cooling mode.

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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FUNCTIONAL DESCRIPTION - PACKS****Non-Normal Operations**

In addition to compressor and pack outlet overheat conditions, these cause non-normal operations:

- ACM failure
- Pack temperature sensor failures
- Economy cooling value failure
- Low limit valve failure
- Turbine bypass valve failure
- Ram air door failures
- Single pack operation.

Standby Cooling Mode

These faults cause the related pack to operate in the standby cooling mode:

- ACM failure
- Condenser inlet temperature sensors 1 and 2 fail
- Economy cooling valve failed open.

There are two ways the pack can operate when in the standby cooling mode: heat exchanger cooling or condenser bypass. The related CTC sets how the pack operates in the standby cooling mode based on which of these components have failed:

- Heat exchanger cooling occurs if the ACM fails
- Condenser bypass occurs if both condenser sensors, 1 and 2 fail or if the economy cooling valve fails in the open position.

These indications show when a pack operates in the standby cooling mode: the advisory message PACK MODE L (R) shows and the message STBY COOLING shows next to the related pack symbol on the air synoptic display.

See the air conditioning section for more information about the air synoptic display (SECTION 21-00).

ACM Failure (Heat Exchanger - STBY COOLING mode)

If an ACM failure occurs, the pack continues to operate in the STBY COOLING mode only if the ACM failed - condenser bypass criteria is met or when the other pack cannot meet the minimum flow necessary for schedule 4. If not, the pack stops. The pack can start again if the above conditions make it necessary.

The conditions for ACM failed - condenser bypass change with altitude. The chart shows five examples.

ACM FAILED - CONDITIONS FOR CONDENSER BYPASS	
ALTITUDE	AMBIENT TEMP F (C) ^{*[1]}
≤ 0	≤ 35 (2)
10,000	≤ 25 (-4)
20,000	≤ 18 (-8)
≥ 30,000	≤ 12 (-11)

^{*[1]} IF AMBIENT TEMP ≤ INDICATED VALUE, THEN CONDENSER BYPASS CAN OCCUR.

When the pack operates in the heat exchanger - STBY COOLING mode, the related CTC sets these valves fully open:

- Economy cooling valve
- Low limit valve
- Turbine bypass valve.

In this mode, the CTC adjusts the position of the ram air doors to control the pack outlet air temperature, heat exchanger cooling only. If the pack can not hold the necessary temperature (pack out temperature 5F (2.7C) greater than IMMTE) and the TBV is not full open, the CTC sends a signal to the ASCPC for a lower precooler outlet temperature, (250F, 121C).

See the engine air supply section for more information about the precooler out temperature control and bleed air control (SECTION 36-11).

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AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FUNCTIONAL DESCRIPTION - PACKS

Condenser Sensor/Economy Cooling Valve Failure (Condenser Bypass - STBY COOLING mode)

If both condenser inlet temperature sensors 1 and 2 fail or if the economy cooling valve fails open, the pack continues to operate in the STBY COOLING mode only if the ACM not failed - condenser bypass criteria is met. If not, the pack stops. The pack can start again if the condenser bypass criteria is met. When the pack operates in the condenser bypass - STBY COOLING mode, the related CTC controls the pack outlet temperature with these pack components:

- Economy cooling valve, set to full open
- Low limit valve, set to full close
- Second stage turbine bypass valve, modulating
- Ram air doors, modulating.

Pack Sensor Failures

These sensors have an effect on pack operation if they fail:

- Pack inlet differential pressure sensor, part of the pack flow sensor (not shown)
- Compressor out temperature sensors 1 and 2
- Condenser inlet temperature sensors 1 and 2.

The CTC has these two sources for pack inlet differential pressure: the pack flow sensor and the related ASCPC. If both sources fail, the pack stops.

See the pack flow control section for more information about the pack flow sensor (SECTION 21-51).

The CTC has three sources for compressor out temperature: compressor out temperature sensors 1 and 2 and the related ASCPC. If all sources fail, the pack stops.

The CTC has two sources for condenser inlet temperature, condenser inlet temperature sensors 1 and 2. If both fail, the pack operates in the standby cooling mode or stops.

See the zone temperature control and indication section for more information about the effects of other failed sensors on the air conditioning system (SECTION 21-61).

Ram Air Door Failures

If a door failure occurs, a limit on the movement of the serviceable door makes sure that the exhaust area is not less than the area at the inlet door. If temperature cannot stay within limits when there is a ram air door failure, the CTC decreases pack flow. The amount of decrease in flow is related to the temperature limits. The minimum flow is schedule 4. The serviceable pack increases flow to keep total fresh air ventilation constant.

If the inlet or exhaust door RVDT fails, the CTC moves the related actuator to the full open position. The CTC times the movement of the door to set the door to full open. After this, the CTC identifies the condition as an actuator failure.

Low Limit and Second Stage Turbine Bypass Valve Failures

If a low limit valve failure occurs, the CTC adjusts pack flow to keep condenser inlet temperature at or above 34F (1C). If a second stage turbine bypass valve failure occurs, the CTC sets the position of the ram air doors to control the pack outlet temperature. If the pack can not hold the necessary temperature, the CTC adjusts pack flow to control air temperature to the mix manifold.

If the low limit or second stage turbine bypass valve RVDT fails, the CTC moves the related valve to the 60 percent open position. The CTC times the movement of the valve to set it at 60 percent open. After this the CTC identifies the condition as a valve failure.

Single Pack Operation

In single pack operation, the CTC controls the TBV, LLV, ECV, and ram air doors actuators as usual to keep the necessary temperature in the mix manifold (IMMTE reference). The CTC also increases pack air flow to keep it close to the usual amount when two packs are on. The maximum flow has a limit so it is not more than the value set for flow schedule 2.

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**AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FUNCTIONAL DESCRIPTION - PACKS**

If the CTC can not keep pack flow or temperature (pack out temperature 5F (2.7C) more than IMMTE reference) at the necessary value, it can select one or all of these conditions to increase pack flow and to help control the pack out temperature:

- Operate the pack in the economy cooling mode if the conditions for this mode permit it
- Tell the ASCPC to supply a lower precooler outlet temperature (250F, 121C) if the turbine bypass valve is not full open
- Adjust the position of the second stage turbine bypass valve to control flow and temperature
- If the second stage turbine bypass valve is fully open, or a lower precooler out temperature is not available (wing anti-ice if on) or does not let the pack operate to the necessary temperature, the CTC tells the ASCPC to supply a higher pneumatic pressure (6 psi bias for HPSOV control).

When the CTC must choose to control pack flow or pack out temperature, pack flow is usually first in the order of control. Pack overheat protection control, always overrides pack flow control.

See the pack flow control section for more information about the pack flow schedules (SECTION 21-51).

Single pack operation can cause the related lower recirculation fan (not shown) to stop if these conditions occur:

- Airplane on the ground
- Pack at maximum cooling
- Mix manifold temperature 12F (6.7C) > IMMTE reference.

When a fan is set to off, this helps the related pack meet the necessary IMMTE reference by reducing the amount of cabin air put in to the mix manifold.

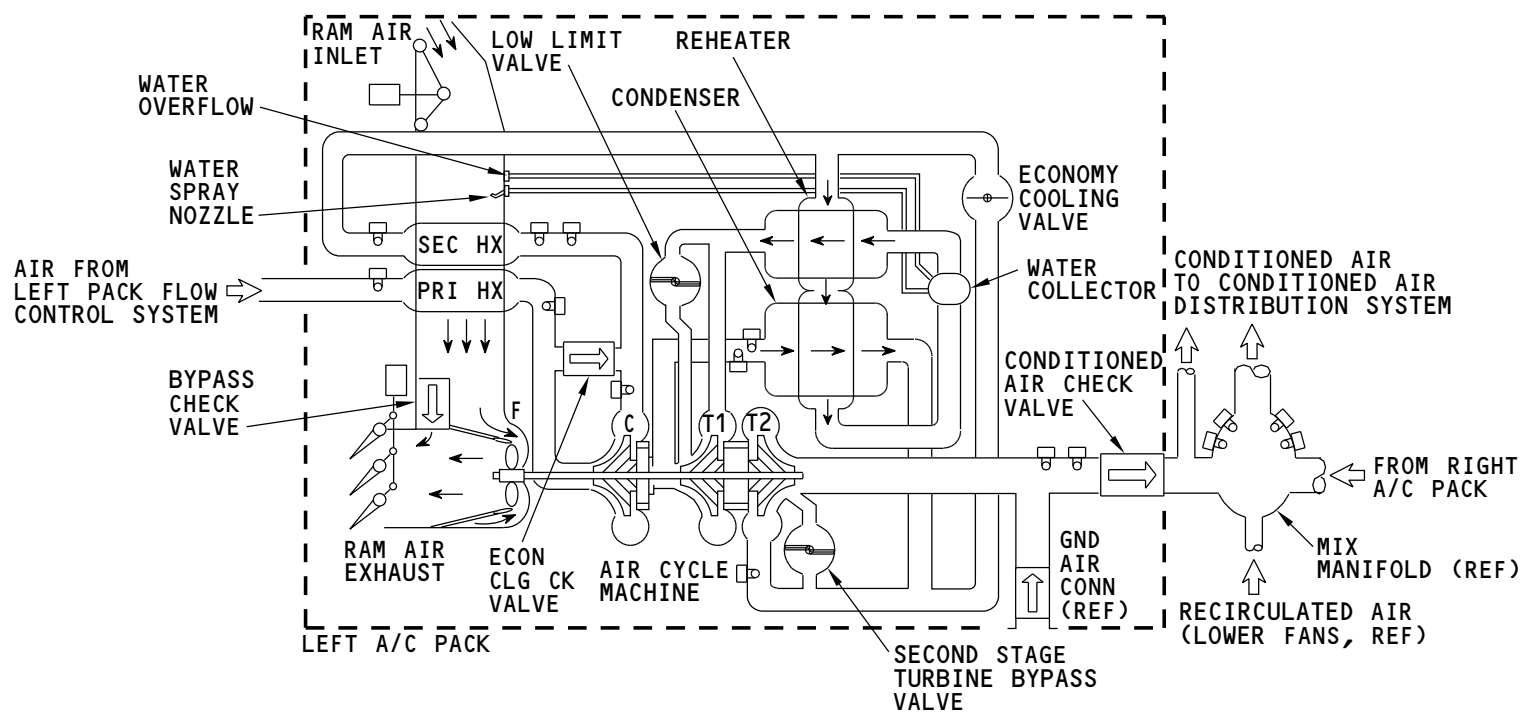
See the recirculation system section for more information about the recirculation fan control (SECTION 21-25).

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☐ = TEMP SENSOR (TYP)

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AIR CONDITIONING - PACK CLG AND MIX MANIFOLD TEMP CTRL - FUNCTIONAL DESCRIPTION - PACKS

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**AIR CONDITIONING - TEMPERATURE CONTROL - INTRODUCTION****Purpose**

The temperature control system controls the temperature in these locations:

- Forward cargo compartment
- Flight deck
- Passenger cabin.

The system sets the target temperature for the air conditioning packs. The system also sets the amount of air necessary from the APU when the APU supplies air to the packs.

The system has these parts:

- Zone temperature control and indication
- Trim air pressure regulation and shutoff control.

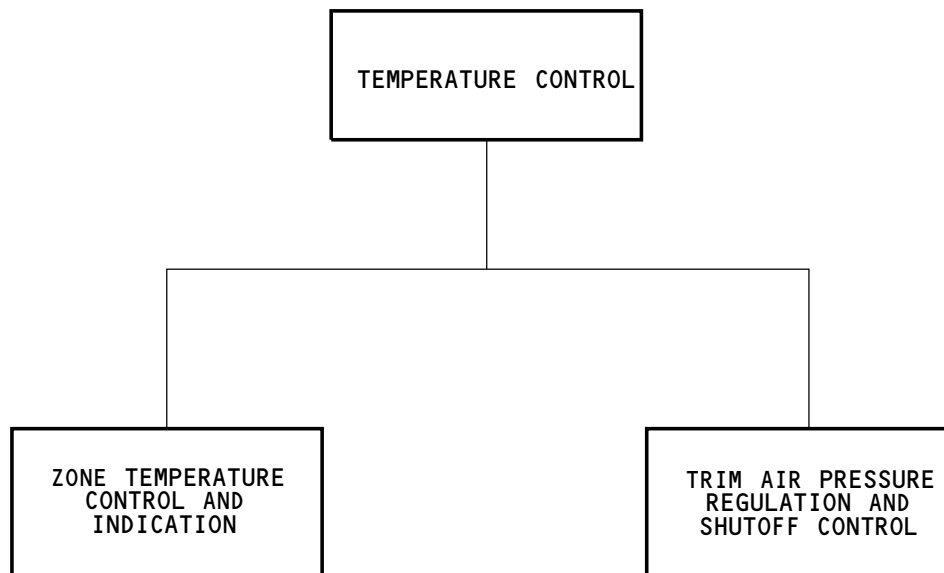
Zone Temperature Control and Indication

The zone temperature control and indication system adjusts flight deck, passenger cabin, and forward cargo compartment zone temperatures to set values.

Trim Air Pressure Regulation and Shutoff Control

The trim air pressure regulation and shutoff control adjusts, monitors, and distributes trim air supply pressure to the trim air modulating valves.

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AIR CONDITIONING - TEMPERATURE CONTROL - INTRODUCTION

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AIR CONDITIONING - TEMPERATURE CONTROL - GENERAL DESCRIPTION - CONTROL**General**

The cabin temperature controllers (CTCs) adjust the trim air temperature components. The CTCs control these components to get the necessary air pressure and temperatures in the these areas:

- Flight deck
- Passenger cabin
- Forward cargo zones.

The controls are on these panels:

- Air conditioning panel on the P5 overhead panel in the flight deck
- Miscellaneous switching panel on the P5 overhead panel in the flight deck
- Cabin system control panel (CSCP) in the passenger cabin
- Cabin area control panels (CACP) in the passenger cabin.

The system has an interface with the ECSMCs. The cards give information about the condition of the lavatory/galley vent fans. If both fans are off, the CTCs do not use the sensors in the zones to control zone temperatures. See the zone temperature control and indication section for more information about the control of zone temperatures with failed sensors (SECTION 21-61).

Trim Air Pressure Regulation and Shutoff Control

The trim air pressure regulation and shutoff valve controls trim air supply pressure to a set value. The trim air pressure sensor gives trim air duct pressure information to the CTC. The CTC uses it for control and indication. The air supply cabin pressure controller (ASCPC) supplies alternative control of the trim air pressure regulation and shutoff valve.

Zone Temperature Control

The trim air modulating valves adjust the flow of warm air added to the cold air that goes to the temperature control zones.

The FLT DECK TEMP control let the flight crew set the target temperatures for the flight deck zone. The CABIN TEMP control let the flight crew set the master temperature for all of the passenger zones. The minimum selectable temperature is 65F (18C) and the maximum is 85F (29C).

The CSCP and the CACP let the attendants adjust the target temperature for the cabin by area. The area temperature can be set 10F (6C) more or less than the master. The temperatures can not be set less than 65F (18C) or more than 85F (29C).

The FWD CARGO A/C control lets the flight crew set the target temperature for the forward cargo zone. The minimum selectable temperature is 40F (4C) and the maximum is 80F (27C).

Zone air temperature sensors and zone duct temperature sensors give temperature information to the CTC. The CTC use the information for control and indication.

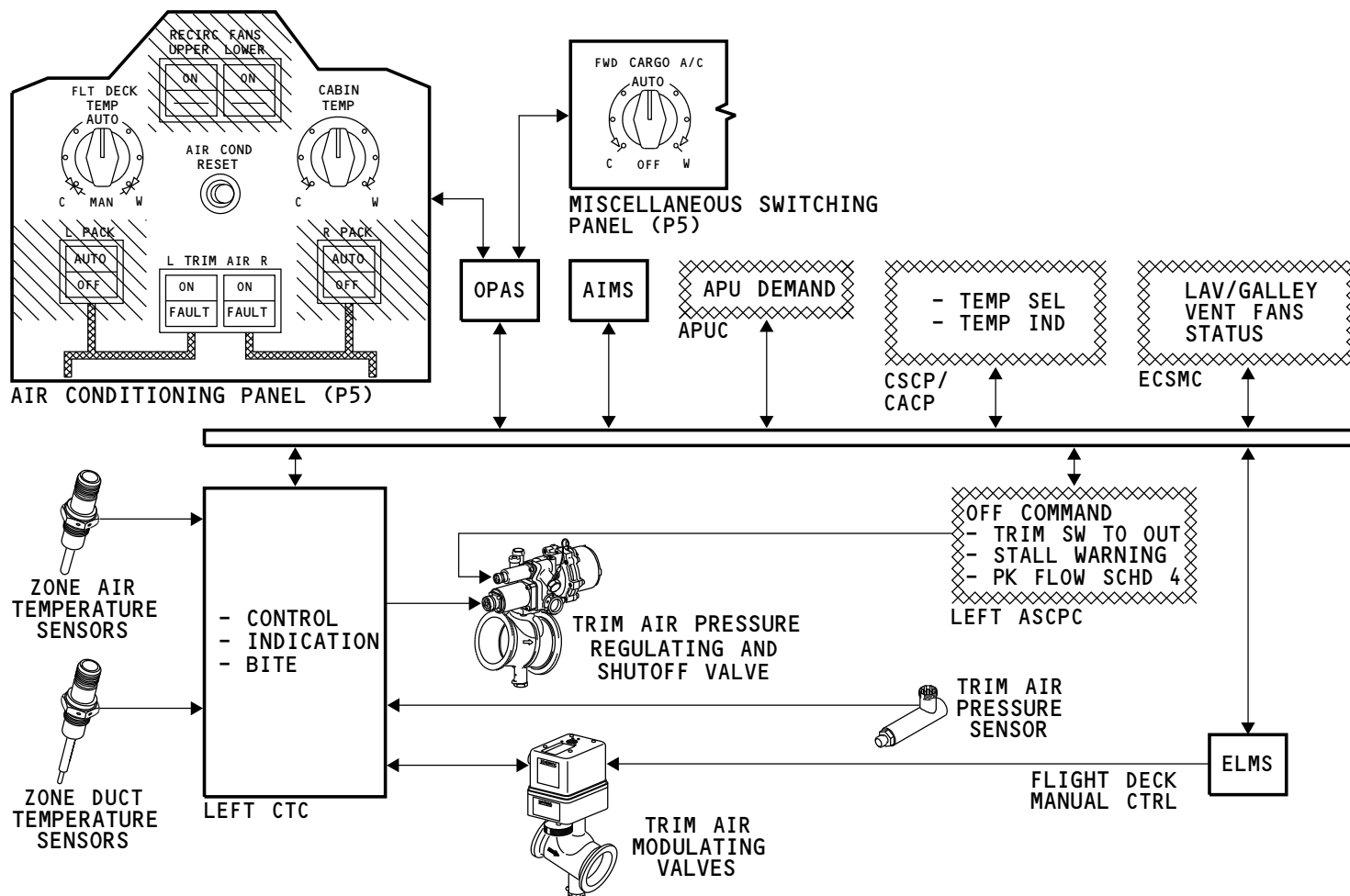
The CTC has an interface with the APU controller (APUC). When the APU supplies air for pack operation and temperature control, the CTC tells the APUC the amount of air to supply. The CTC uses the APU DEMAND signal to tell the APUC the amount of air that is needed. See the zone temperature control and indication section for more information about the APU DEMAND signal (SECTION 21-61).

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NOTE: LEFT SYSTEM SHOWN, RIGHT SIMILAR

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AIR CONDITIONING - TEMPERATURE CONTROL - GENERAL DESCRIPTION - CONTROL

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**AIR CONDITIONING - TEMPERATURE CONTROL - GENERAL DESCRIPTION - MECHANICAL****Trim Air Pressure Regulation and Shutoff Control**

A left side and a right side trim air pressure regulating and shutoff valves make sure the trim air supply is between 2 and 8.5 psi above cabin pressure. The usual pressure is 5 psi above cabin pressure. This allows sufficient flow and keeps pneumatic system noise to a minimum. The trim air pressure sensors give trim air pressure information to the cabin temperature controllers (not shown) for control and indication.

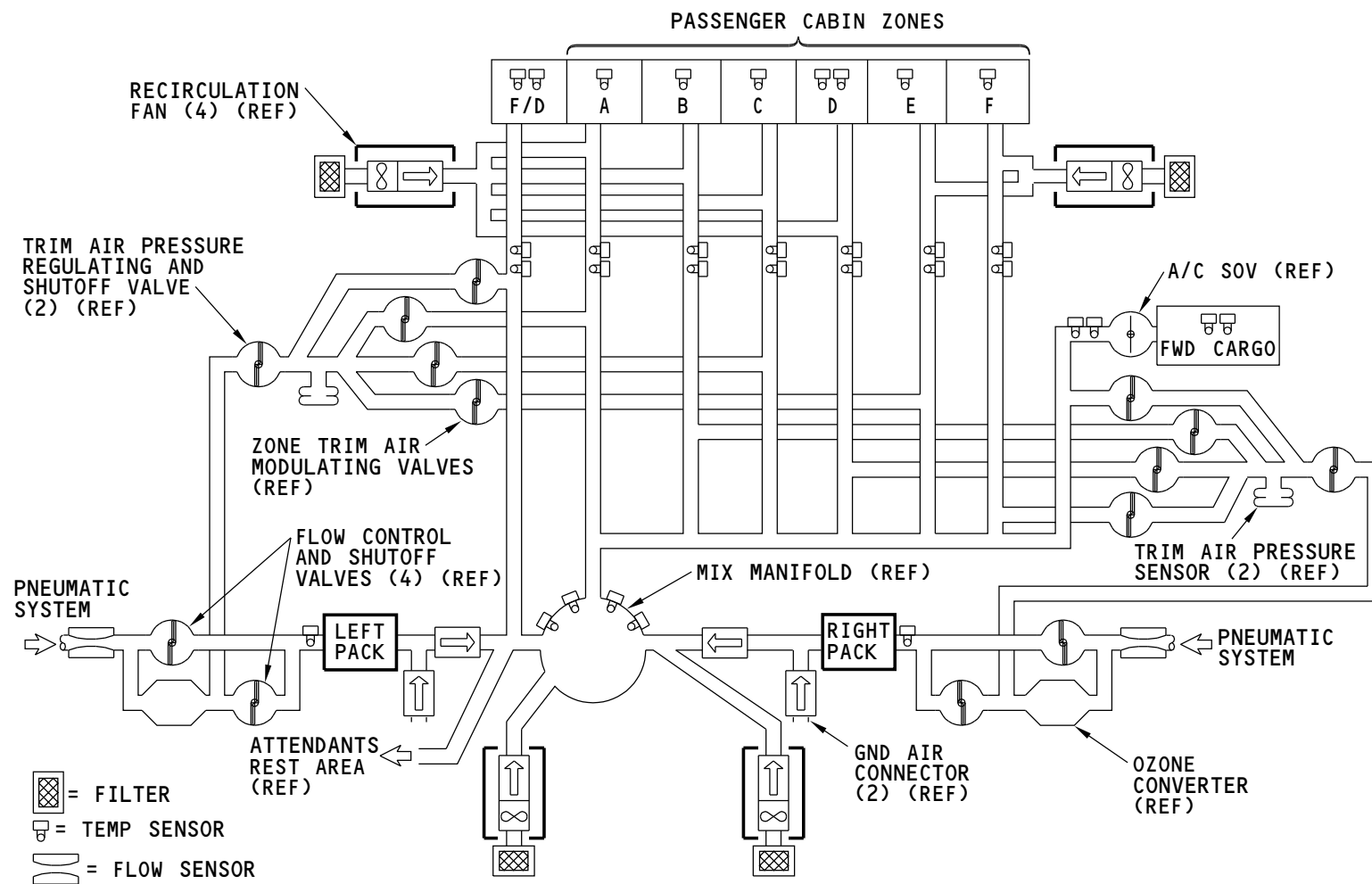
Zone Temperature Control

The cabin temperature controllers use the packs to control cooling for the flight deck and the mix manifold.

The trim air modulating valves control the quantity of trim air supplied to each zone. Trim air for the passenger and forward cargo zones mixes with the air from the mix manifold. Trim air for the flight deck mixes with the air from the left pack.

Each trim air modulating valve adjusts the amount of trim air to control the zone temperature. Zones that need a higher temperature get more trim air. Zones that need a lower temperature get less trim air.

The zone air temperature sensors and zone duct temperature sensors give air temperature information to the cabin temperature controllers (not shown) for control and indication.



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AIR CONDITIONING - TEMPERATURE CONTROL - GENERAL DESCRIPTION - MECHANICAL

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AIR CONDITIONING - TEMPERATURE CONTROL - INTERFACES**Interfaces**

These systems have an interface with the CTC on the systems ARINC 629 buses:

- Airplane information management system (AIMS): ground test, indication and fault monitoring
- Air ground system (AGS): air/ground information
- Cabin services system (CSS): cabin selected temperatures
- APU controller (APUC): quantity of air necessary for zone temperature control and ventilation (APU demand signal)
- Environmental control system miscellaneous cards (ECSMCs): lavatory/galley ventilation fan status (on/off), forward cargo air conditioning system status (enabled/not enabled)
- Air supply cabin pressure controller (ASCPC): flow schedules, stall condition, altitude
- Overhead panel ARINC 629 system (OPAS): forward cargo temperature control, flight deck temperature control, passenger cabin temperature control, trim air control, trim air fault indications, air conditioning reset.

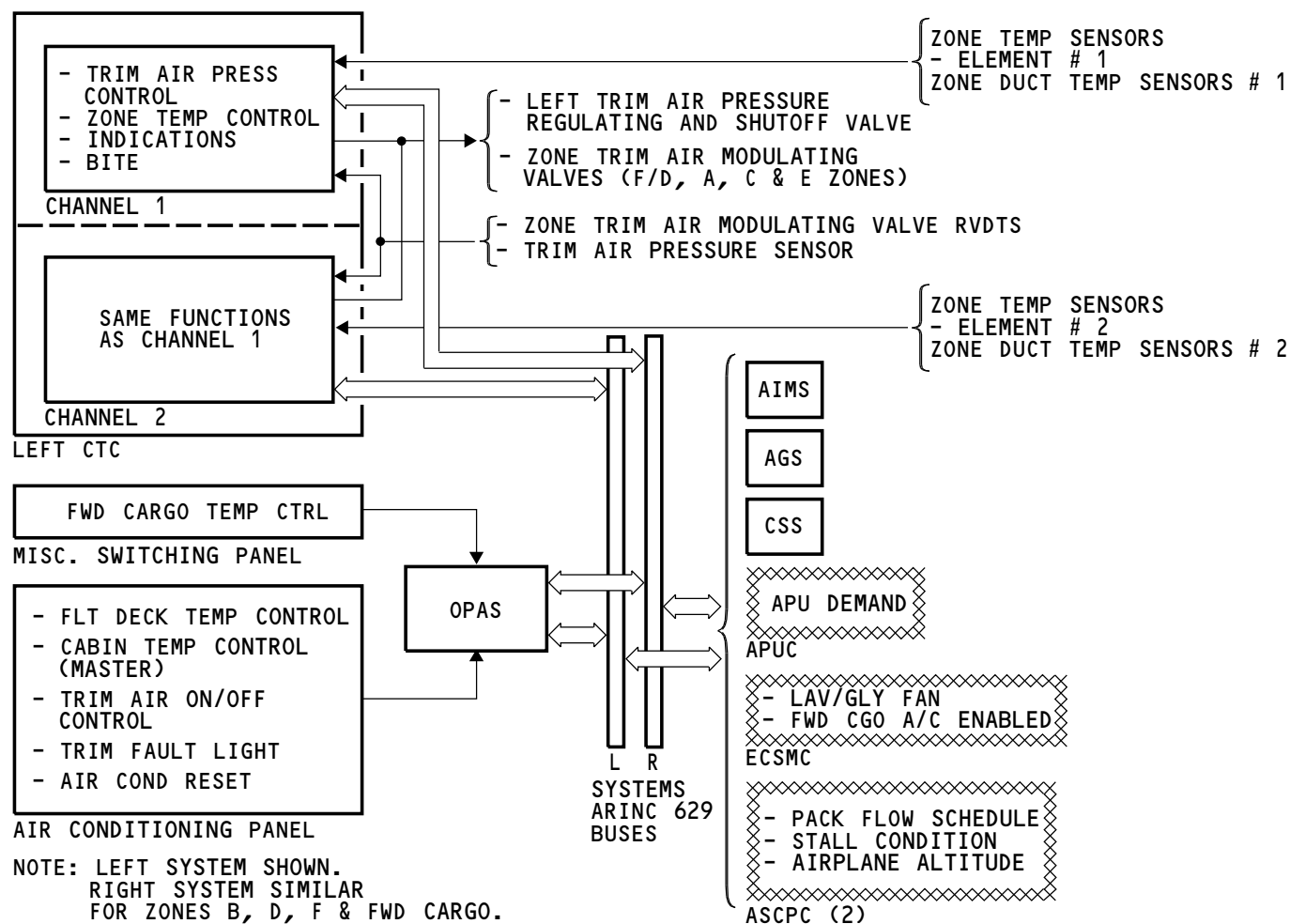
The CTC supplies analog control signals to these components:

- Trim air pressure regulating and shutoff valves
- Zone trim air modulating valves.

These components supply analog data to the CTC:

- Zone trim air modulating valve RVDTs
- Zone temperature sensors
- Zone duct temperature sensors
- Trim air pressure sensor.

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AIR CONDITIONING - TEMPERATURE CONTROL - INTERFACES

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AIR CONDITIONING - TEMPERATURE CONTROL - FUNCTIONAL DESCRIPTION

General

Warm trim air from the pneumatic system mixes with cold air from the mix manifold to keep each zone temperature at its target value. The cabin temperature controllers (CTCs) use the trim air pressure regulating and shutoff valves (PRSOVs) to keep the trim air pressure between 2 and 8.5 psi above cabin pressure. The CTCs control the trim air modulating valves to add the necessary quantity of warm air for zone temperature control.

The CTCs use sensors in the ducts and at zone locations to monitor air temperature for control.

The CTCs sets the packs to supply the coldest air necessary for the zone that needs the lowest mix manifold temperature. Zones that need higher temperatures get pack air mixed with trim air. The CTCs set each trim air modulating valve to keep the related zone at its target temperature.

Normal Function

The flight crew sets the master temperature for the passenger compartment and target temperatures for the flight deck and forward cargo compartment.

The minimum selectable temperature for the flight deck and passenger cabin is 65F (18C) and the maximum is 85F (29C). The cabin crew can adjust the target temperature for each zone in the passenger cabin. This temperature can be 10F (6C) higher or lower than the master temperature set by the flight crew. The minimum selectable temperature for the cargo compartment is 40F (4C) and the maximum is 80F (27C).

Immediately after an engine start, the ASCPCs send flow schedule 1 to the CTC. The CTC sets the trim air pressure regulating and shutoff valves to the open position while the ASCPC tests its control over these valves. When the ASCPC completes this test, the CTC sets the valves to the correct position, and the ASCPC releases control. The usual pressure for the trim air PRSOVs is 5 psi above cabin pressure.

The CTC closes the trim air pressure regulating and shutoff valves for these conditions:

- CTC channel 1 and 2 failed
- Pack flow at flow schedule 4

- Stall recovery
- Trim air pressure sensor failed
- Trim air switch set to OFF
- Duct temperature greater than 190F (88C).

Both trim air pressure regulating and shutoff valves function if at least one pack operates.

When the APU supplies air for pack operation and airplane ventilation, the CTCs tell the APUC the quantity of air to supply with the APU DEMAND signal. See the zone temperature control and indication section for more information about the APU DEMAND signal (SECTION 21-61).

Non-Normal Function

These conditions cause non-normal operations:

- Loss of left side trim
- Loss of right side trim
- Overheat conditions (190F, 88C)
- Single trim modulating valve failure.

Loss of Left Side Trim

If there is a failure of the left side trim system, the left CTC sets the left pack to hold the flight deck target temperature. The right CTC sets the right pack to hold the necessary mix manifold temperature.

The left CTC decreases or increases the flight deck target temperature up to a maximum of 5F (3C) for any of these conditions:

- Average cabin zone temperature is 2F (1C) above or below the average target temperature
- Single cabin zone temperature is 5F (3C) above or below its target temperature.

This type of control lets the cabin area have priority over the flight deck. It does this when the right pack and right trim system does not keep the cabin areas at the necessary temperatures.

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**AIR CONDITIONING - TEMPERATURE CONTROL - FUNCTIONAL DESCRIPTION****Loss of Right Side Trim**

If there is a failure of the right side trim system, The right CTC sets the right pack to hold the necessary mix manifold temperature. The left pack follows the right pack until flight deck trim modulating valve is closed. The left CTC then controls the left pack to keep the flight deck at the target temperature down to a minimum of 65F (18C).

The left CTC does not keep the flight deck at its target temperature if the right pack operates at full heat and any of these conditions occur:

- Average cabin zone temperature is 5F (3C) below the average reference temperature
- Single cabin zone temperature is 5F (3C) below its target temperature.

When the right pack does not keep the cabin area at the necessary temperature, the left CTC increases the flight deck target temperature up to a maximum of 5F (3C).

Overheat Conditions

The applicable CTC starts to close the trim air modulating valve if the related zone duct air temperature increases to 160F (71C). The related trim air pressure regulating and shutoff valve latches closed if duct temperature increases to 190F (88C) for 10 seconds.

Single Trim Modulating Valve Failure

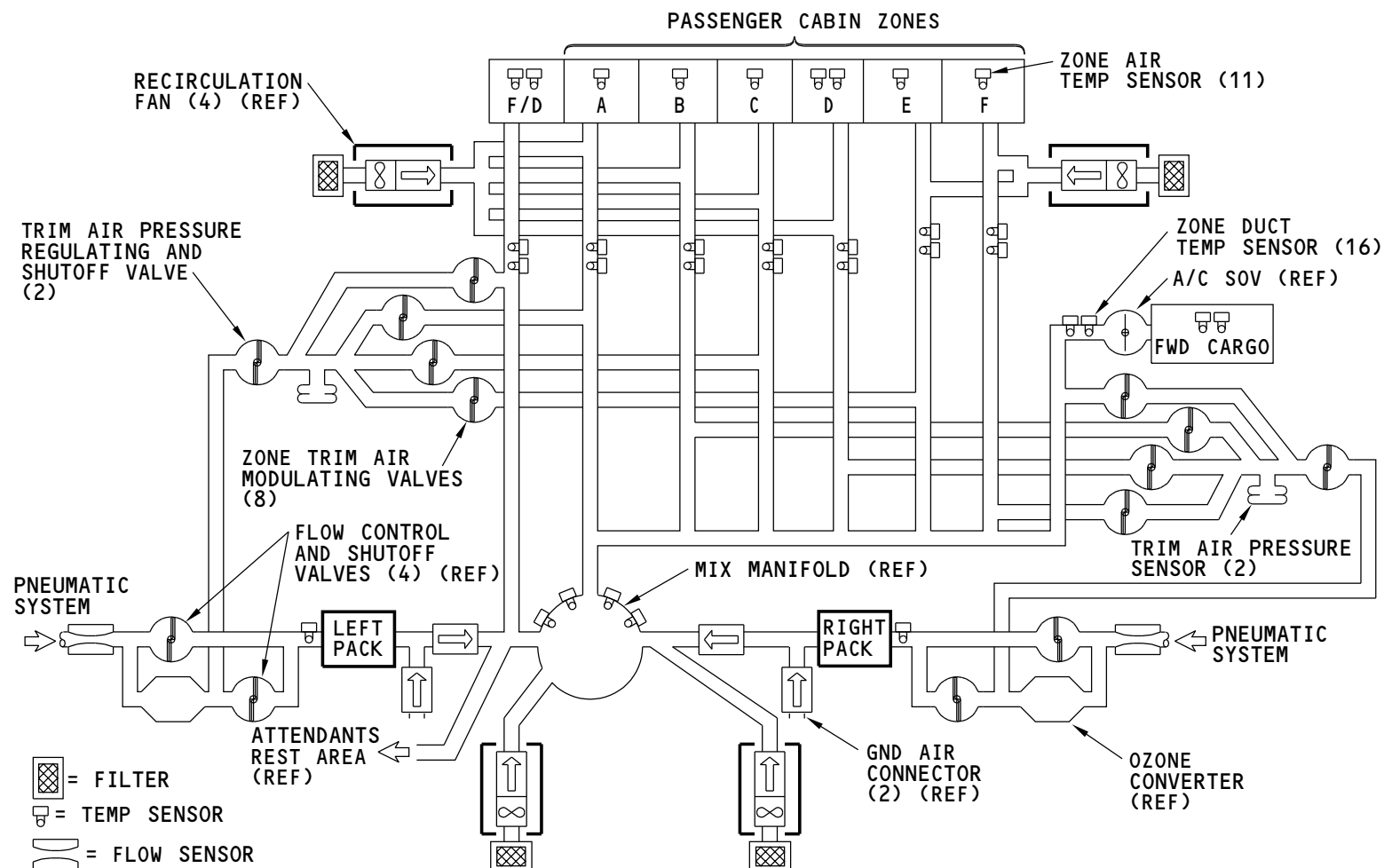
If a trim air modulating valve is not fully closed and has a failure, the applicable CTC controls the pressure reference for the related trim air pressure regulating and shutoff valve to keep zone duct temperature to a limit (zone duct temperature backup control mode). The applicable CTC does not use this mode if the valve is less than 10 degrees open (1 percent heating) and has a failure.

If the RVDT in a valve has a failure, The applicable CTC operates the valve with no position feedback. This type of control is called open loop control. The applicable CTC looks at temperature change downstream of a valve to monitor movement.

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AIR CONDITIONING - TEMPERATURE CONTROL - FUNCTIONAL DESCRIPTION

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Page 14
May 05/2015

**AIR CONDITIONING - TEMPERATURE CONTROL - OPERATION - FLIGHT DECK****General**

The miscellaneous switching panel has the forward cargo air conditioning control for temperature control operation.

The air conditioning panel has these controls for temperature control operation:

- Left and right trim air switches
- Flight deck temperature control
- Cabin temperature control
- Air conditioning reset switch.

Location

The miscellaneous switching panel and air conditioning panel are on the P5 overhead panel in the flight deck.

Forward Cargo Air Conditioning Control

The FWD CARGO A/C control lets the flight crew set the temperature for the forward cargo compartment. The control can be set to OFF or to AUTO. The OFF position enables the forward cargo heating system. See the forward cargo heating section for more information about the forward cargo heating system (SECTION 21-43).

The AUTO position lets the right CTC control the temperature to a target value. The minimum selectable target temperature is 40F (4C) and the maximum is 80F (27C).

Trim Air Control

L and R TRIM AIR switches are alternate-action switches. ON shows when you push the switch in for automatic operation of the trim system.

The applicable FAULT light and the applicable advisory message TRIM AIR L (R) (not shown) are not a function of switch position. They show when any of these conditions occur:

- The related trim air switch is set to the out position
- The related trim air PRSOV is latched closed.

The left trim air PRSOV is latched closed if any of these conditions occur:

- Flight deck zone duct overheating (190F, 88C)
- Passenger cabin zone A duct overheating (190F, 88C)
- Passenger cabin zone C duct overheating (190F, 88C)
- Passenger cabin zone E duct overheating (190F, 88C)
- Left trim air PRSOV fault
- Left CTC fault (both channels)
- Left trim air pressure sensor fault.

The right trim air PRSOV is latched closed if any of these conditions occur:

- Forward cargo compartment zone duct overheating (190F, 88C)
- Passenger cabin zone B duct overheating (190F, 88C)
- Passenger cabin zone D duct overheating (190F, 88C)
- Passenger cabin zone F duct overheating (190F, 88C)
- Right trim air PRSOV fault
- Right CTC fault (both channels)
- Right trim air pressure sensor fault.

Air Conditioning Reset Control

The AIR COND RESET switch is a momentary-action switch. This switch starts the system after a failure.

Flight Deck Temperature Control

The FLT DECK TEMP control lets the flight crew set the temperature for the flight deck. The control can be set to MAN or to AUTO. The MAN position lets the flight crew manually adjust the temperature to any value. The AUTO position lets the left CTC control the temperature to a target value. The minimum selectable target temperature is 65F (18C) and the maximum is 85F (29C).

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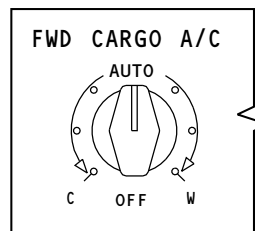
AIR CONDITIONING - TEMPERATURE CONTROL - OPERATION - FLIGHT DECK

Cabin Temperature Control

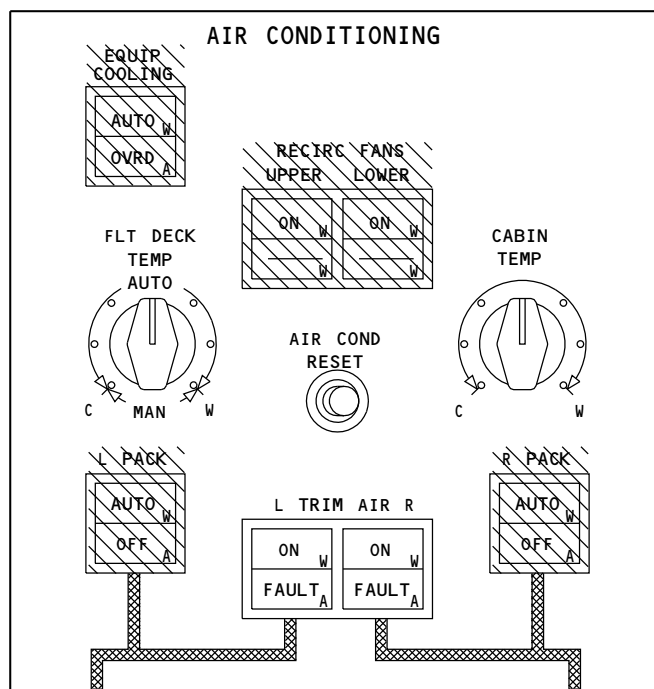
The CABIN TEMP control lets the flight crew set the master target temperature for the passenger compartment. The minimum selectable target temperature is 65F (18C) and the maximum is 85F (29C).

The left and right main buses power the FAULT indications on the trim air switches. If these buses have no power, the FAULT indication does not show.

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MISCELLANEOUS SWITCHING PANEL (P5)



AIR CONDITIONING PANEL (P5)

AIR CONDITIONING - TEMPERATURE CONTROL - OPERATION - FLIGHT DECK

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**AIR CONDITIONING - TEMPERATURE CONTROL - OPERATION - CABIN CONTROLS****Cabin Controls**

The flight attendants use the cabin system control panel (CSCP) or the cabin area control panel (CACP) to set temperatures for each passenger zone. The cabin temperature selection on the cabin controls main menu selects the cabin temperature screen.

Operation

The left and right arrows on the screen select a zone. The temperature of that zone in degrees C and degrees F is at the lower left area of the screen. The up and down arrows in the lower right area of the screen select the target temperature for that zone.

ECS Inactive

The ECS NO COMMUNICATION pop-up window shows when all of these conditions occur:

- Cabin temperature screen shows
- CTCs do not give temperature data for more than 5 seconds.

The pop-up window goes away when the cabin temperature window does not show or when the CTCs send temperature data.

Invalid Temperature Information from ECS

The INVALID DATA message shows in the actual temperature boxes or in the target temperature box when any of these conditions occur:

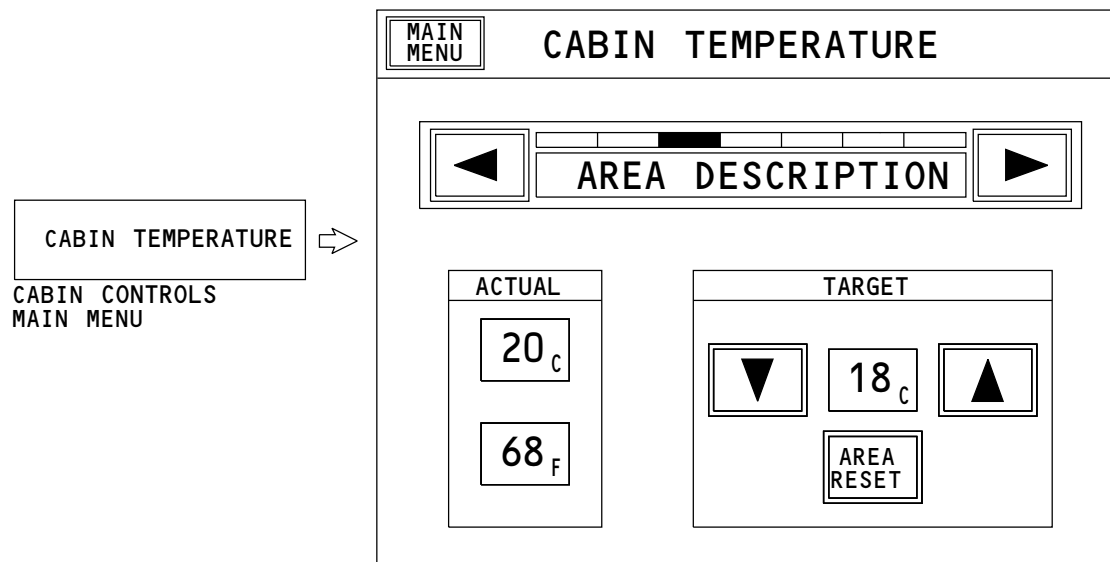
- Applicable data is not supplied
- Applicable data is not in limits.

The message goes away when the temperature data is supplied and is in limits.

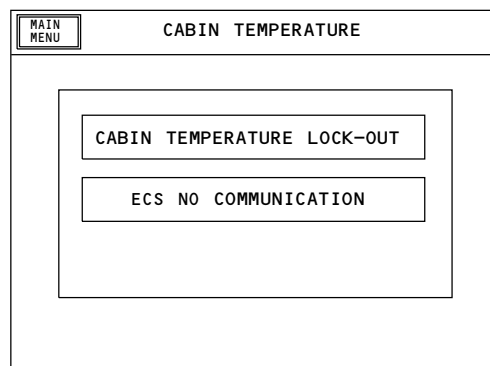
Training Information Point

The CSS configuration database sets the text for the AREA DESCRIPTION and sets the number of areas. The text has a limit of 40 characters. The number of areas has a limit of 15. The usual number of areas is 3. See the cabin services system section for more information about the configuration database (SECTION 23-39).

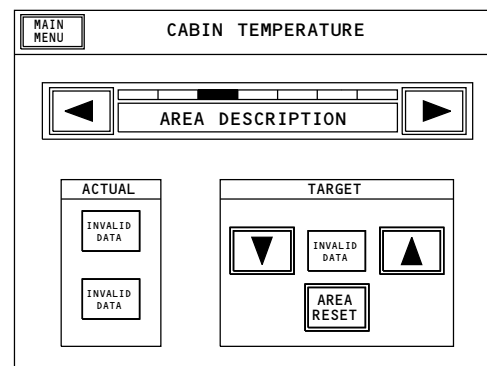
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CSCP/CACP SCREEN (TYPICAL)



ECS NO COMMUNICATION POP-UP WINDOW (TYPICAL)



INVALID DATA (TYPICAL)

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AIR CONDITIONING - TEMPERATURE CONTROL - OPERATION - CABIN CONTROLS

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**AIR CONDITIONING - TEMPERATURE CONTROL - AIR SYNOPTIC DISPLAY AND AIR CONDITIONING MAINT PAGE****General**

All temperatures on the air synoptic display and the air conditioning maintenance page are in degrees C.

Air Synoptic Display

The top part of the MFD air synoptic display shows these cabin temperature indications:

- The MASTER box shows the cabin temperature set by the flight crew.
- The number at the left in the F/D box is the flight deck target temperature set by the flight crew. The number at the right is the actual flight deck temperature.
- The number at the left in the zone boxes A-F is the target zone temperature set by the cabin crew. The number at the right in each box is the actual zone temperature.

The flight deck trim air modulating valve position shows on the indication on the left of the display.

Normal flow of left and right trim air shows as open valve symbols and flow arrows.

Air Conditioning Maintenance Page

The top part of the air conditioning maintenance page shows these cabin temperature indications:

- MASTER TEMP - Temperature selected on the cabin temperature control on the P5 panel
- ZONE TEMP - Actual temperature in each zone
- TRGT TEMP - Target (selected) temperature for each zone
- DUCT TEMP - Temperature measured in each zone distribution duct
- TRIM VLV - Position of each trim air modulating valve in percent heat (0.00 is closed, 1.00 is open)
- CTRL CH - Shows which CTC channel is in control. Left CTC controls zones F/D, A, C, & E. Right CTC controls zones B, D, F, & FWD cargo

- TRIM AIR PRESS - The difference, in psid, between cabin pressure and trim air pressure.

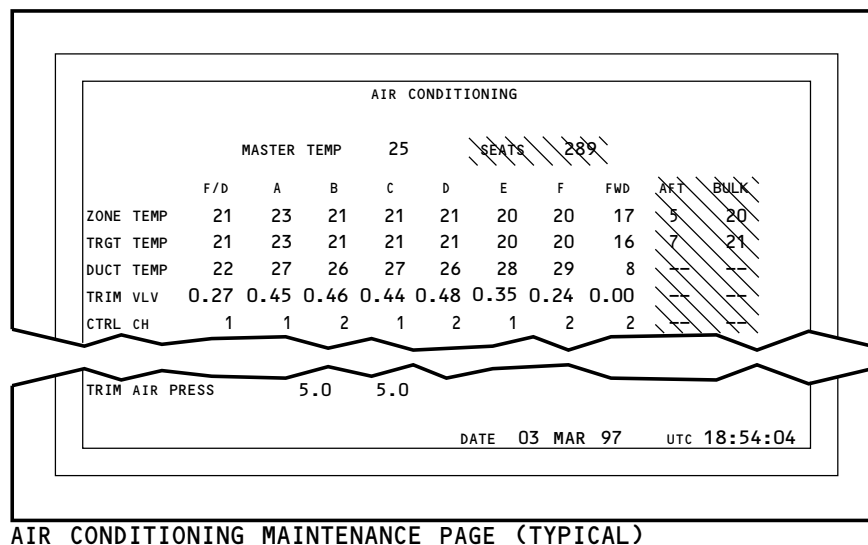
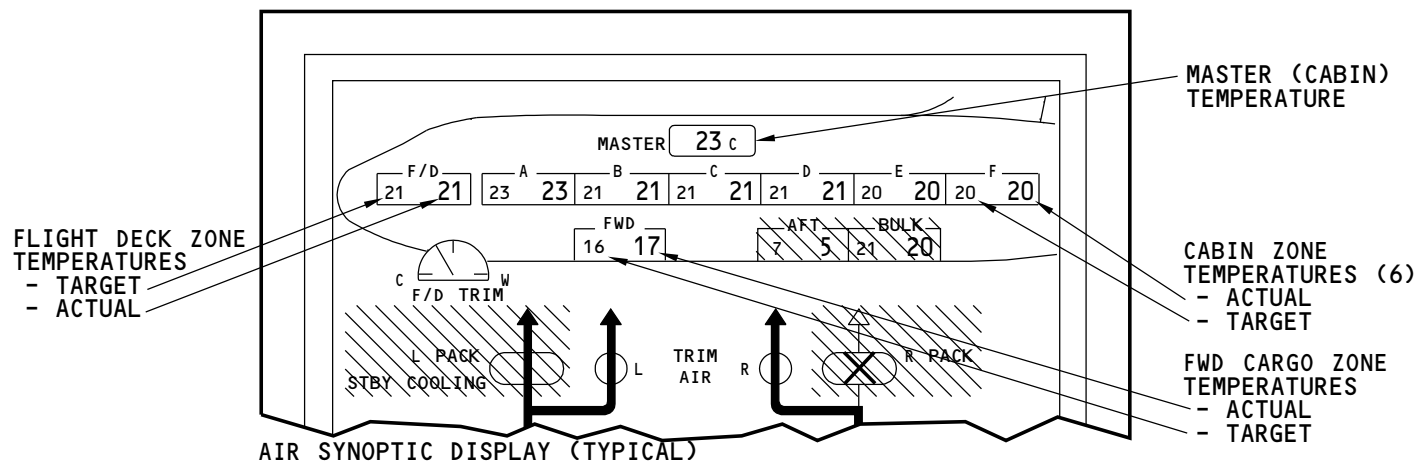
See the primary display system section for more information about the air synoptic display and the air conditioning maintenance page (SECTION 31-61).

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AIR CONDITIONING - TEMPERATURE CONTROL - AIR SYNOPTIC DISPLAY AND AIR CONDITIONING MAINT PAGE

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AIR CONDITIONING - TEMPERATURE CONTROL - GROUND TESTS

General

These are the temperature control ground tests that show when you select ATA 21 Cabin Temperature Control System:

- Left cabin temperature controller
- Right cabin temperature controller
- Left trim air system
- Right trim air system.

Left and Right Cabin Temperature Controller

These tests make sure that the related cabin temperature controller can change control between channels 1 and 2. This test also does a continuous built-in-test.

The test takes approximately 1-2 minutes.

This test shows for these ground test types:

- Operational test
- LRU replacement test.

Left and Right Trim Air System

This test makes sure that the related cabin temperature controller can control the trim air modulating valves of the trim air system on that side.

You must pressurize the pneumatic system for this test. During this test, the related trim air modulating valves open one at a time. The test takes approximately 2-3 minutes.

This test shows for these ground test types:

- System test
- Operational test
- LRU replacement test.

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GROUND TESTS

SELECT ATA SYSTEM

21 ENVIRONMENTAL CONTROL SYSTEM
21 CABIN PRESSURE CONTROL SYSTEM
21 CABIN TEMPERATURE CONTROL SYSTEM
22 AUTOPILOT FLIGHT DIRECTOR SYSTEM
22 AIMS - AUTOTHROTTLE
23 HF COMMUNICATION SYSTEM
23 VHF COMMUNICATION SYSTEM
23 SATELLITE COMMUNICATIONS (SATCOM) SYSTEM
23 AIMS - DATA COMMUNICATION MANAGEMENT

(48) SELECT TEST TYPE

☐ SYSTEM TEST
☒ OPERATIONAL TEST
☐ LRU REPLACEMENT TEST

SELECT OPERATIONAL TEST

LEFT CABIN TEMPERATURE CONTROLLER
LEFT PACK ACTUATORS
LEFT SYSTEM AIR ON
LEFT SYSTEM AIR OFF
LEFT TRIM AIR SYSTEM
RIGHT CABIN TEMPERATURE CONTROLLER
RIGHT PACK ACTUATORS
RIGHT SYSTEM AIR ON
RIGHT SYSTEM AIR OFF
RIGHT TRIM AIR SYSTEM
RECIRCULATION FAN SYSTEM

CONTINUE

HELP

GO BACK

(11)

SELECT OPERATIONAL TEST

1

1

1

1

NOTE: OPERATIONAL TESTS SHOW.
LRU REPLACEMENT TESTS ARE THE SAME.
SYSTEM TESTS DO NOT INCLUDE LEFT AND
RIGHT CABIN TEMPERATURE CONTROLLER.

1 THESE ARE THE AIR CONDITIONING -
TEMPERATURE CONTROL TESTS.

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AIR CONDITIONING - TEMPERATURE CONTROL - GROUND TESTS

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AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - INTRODUCTION

Purpose

The zone temperature control and indication system adjusts flight deck, passenger cabin and the forward cargo compartment zone temperatures to set values.

General Description

The left and right cabin temperature controllers (CTCs) monitor and give temperature control for all zones. The left controller monitors and controls these zones:

- Flight deck (F/D)
- Passenger zone A
- Passenger zone C
- Passenger zone E.

The right controller monitors and controls these zones:

- Forward cargo zone
- Passenger zone B
- Passenger zone D
- Passenger zone F.

The CTCs use the air conditioning packs for cooling and the trim air modulating valves to adjust the temperature in zones that need more heat. See the air conditioning chapter for more information about the pack cooling and mix manifold temperature control system (SECTION 21-52).

You use the flight deck temperature control on the air conditioning panel to control the flight deck temperature. AUTO lets you set the target temperature between 65F (18C) and 85F (29C). MAN selection lets you manually adjust the temperature in the flight deck.

You use the cabin temperature control on the air conditioning panel to select the (master) target temperature for all zones in the passenger cabin area. You use the cabin temperature screen on the cabin area control panels or cabin system control panel to bias the target temperature for passenger cabin areas. You can adjust the temperature 10F (6C) above or below the master target value. The bias does not let you select a temperature below 65F (18C) or above 85F (29C).

You use the forward cargo air conditioning control on the miscellaneous switching panel to control the forward cargo temperature. The AUTO range lets the right CTC control the temperature in the forward cargo compartment when the airplane is in the air. AUTO lets you set the target temperature between 40F (4C) and 80F (27C). The OFF position lets the usual cargo heating system operate if it is selected on. See the air conditioning chapter for more information about the forward cargo heating system (SECTION 21-43).

Interfaces

The CTCs use sensors in the zones and in the air conditioning distribution ducts to monitor air temperature in these areas. The temperature data is used for control and indication.

The CTCs use RVDTs in the modulating valves to monitor valve position. Valve position data is used for control and indication.

The CTCs get air ground information from the air ground system. The CTCs use this information for control of the forward cargo air conditioning system. The CTCs also use the information to calculate the APU DEMAND signal.

AIMS give these functions for the zone temperature control system:

- Indication
- Airplane at cruise, FMC data
- Ground test.

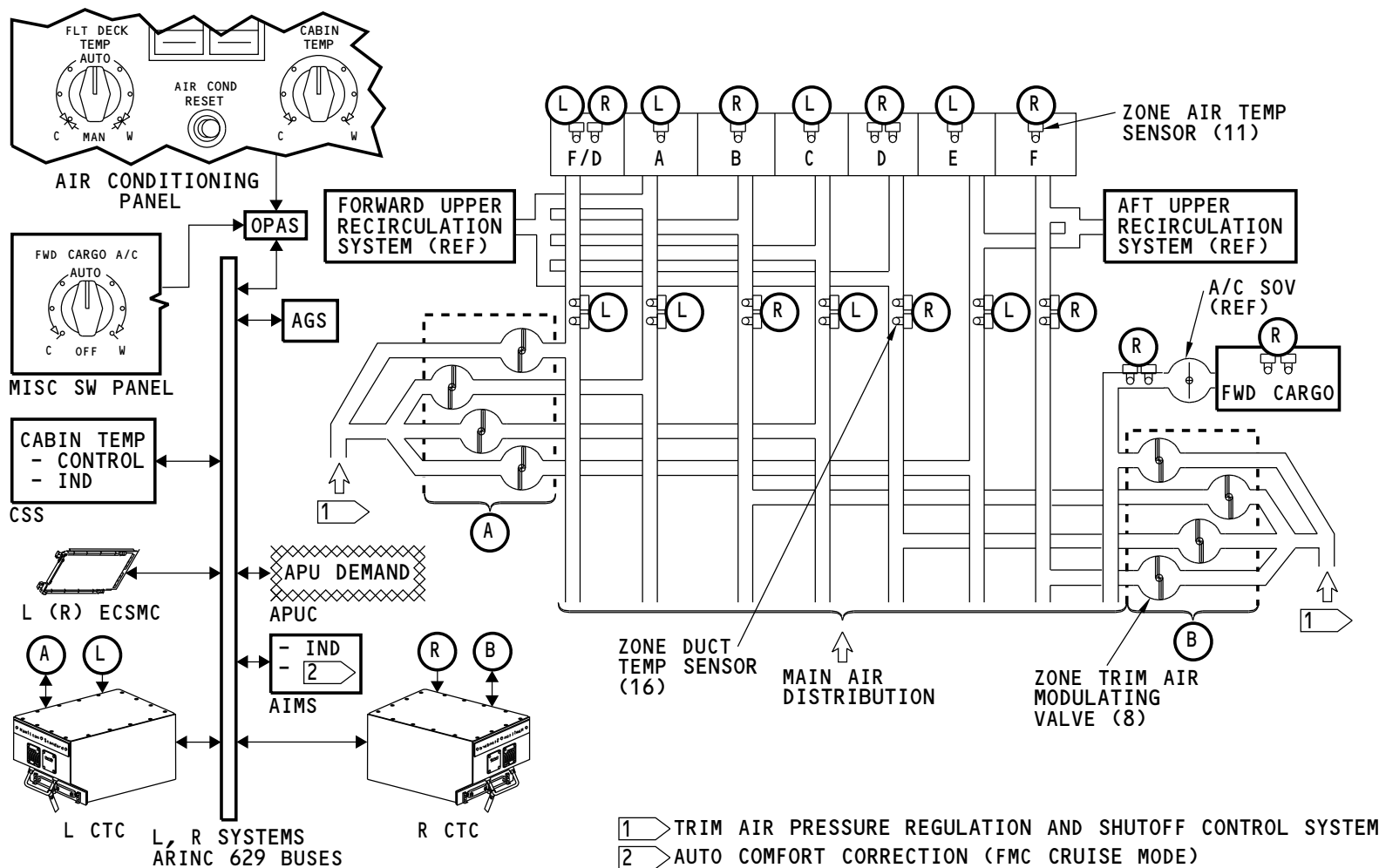
A status message shows if a CTC fails. AIMS also gives maintenance messages that relate to sensor and valve faults.

**AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - INTRODUCTION**

The CTCs get data from the left and right ECSMCs about the position of the air conditioning shutoff valve (A/C SOV). Zone temperature control for the forward cargo compartment is inhibited if the air conditioning shutoff valve is closed. See the air conditioning chapter for more information about the ventilation system (SECTION 21-26).

The CTCs give the APU controller (APUC) an APU DEMAND signal when the APU supplies air for pack operation on the ground. The signal is used to control the quantity of air necessary for ventilation and heating or cooling in the airplane.

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AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - INTRODUCTION

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**AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CTC - PHYSICAL DESCRIPTION****Location**

The left and right cabin temperature controllers (CTC) are in the main equipment center on the E1 and E2 racks.

Physical Description

The CTCs weigh 25 lbs (11.5 kg) each. The controllers have two test connectors on the front. The connectors are for shop service.

The CTCs use operational program software (OPS) that you can load.

Training Information Point

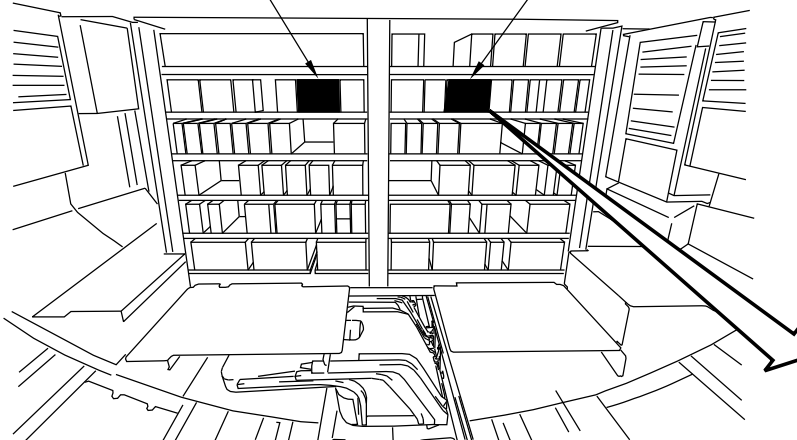
The CTCs are LRUs. The circuit cards in the CTCs are not LRUs.

The Left and right CTCs are interchangeable.

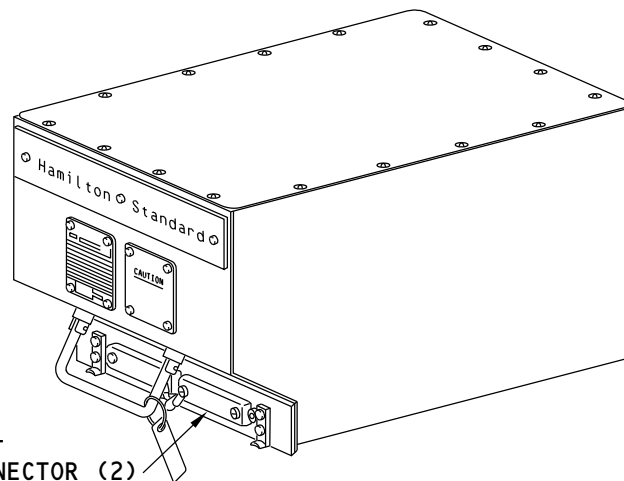
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E2-2 SHELF
- RIGHT CABIN TEMPERATURE
CONTROLLER (CTC)

E1-2 SHELF
- LEFT CABIN TEMPERATURE
CONTROLLER (CTC)



MAIN EQUIPMENT CENTER
(LOOKING AFT)



TEST
CONNECTOR (2)

CABIN TEMPERATURE CONTROLLER
(TYPICAL)

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AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CTC - PHYSICAL DESCRIPTION

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AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CTC - INTERFACES 1

Purpose

The left and right cabin temperature controllers (CTC) give control, indications, and BIT for these systems:

- Cooling
- Temperature control
- Recirculation.

Control Channels

The CTCs have two control channels that are the same, 1 and 2. One channel is in control (primary) and the other is tracking (backup). The channel in control changes if any of these conditions occur:

- Channel in control has a fault (processor, RVDT or sensor interface, motor or torque motor driver)
- Ground test
- Air to ground change and both related flow control valves closed.

The left and right CTCs change control channels independently of each other. You can see which CTC control channel is in control on the air conditioning maintenance page. A status message shows on the status display if both channels in one CTC fail. See the air conditioning section for more information about the air conditioning maintenance page (SECTION 21-00).

The CTCs control these subsystems:

SYSTEM	SUB-SYSTEM	CTC	CONTROL
COOLING	L PACK FLOW CONTROL	L	PRI, *[1]
	R PACK FLOW CONTROL	R	PRI, *[2]
	L PACK CONTROL	L	PRI
	R PACK CONTROL	R	PRI
	MIX MANIFOLD TEMPERATURE CONTROL	L	BU
	MIX MANIFOLD TEMPERATURE CONTROL	R	PRI
TEMP CONTROL	ZONE TEMP CTRL - FLT DK AND ZONES A, C, E	L	PRI, *[3]
	ZONE TEMP CTRL - ZONES B, D, F, & FWD CGO	R	PRI
	L TRIM AIR PRESS REG & SHUTOFF CTRL	L	PRI
	R TRIM AIR PRESS REG & SHUTOFF CTRL	R	PRI
RECIRCULATION	UPPER & LOWER FAN CONTROL	L	BU
	UPPER & LOWER FAN CONTROL	R	PRI

*[1] L ASCPC GIVES LIMITED BACKUP IF L CTC FAILS

*[2] R ASCPC GIVES LIMITED BACKUP IF R CTC FAILS

*[3] R CTC GIVES COOLING FOR F/D IF L PACK OFF

Power - Interfaces

Each channel in the left and right CTCs use power from two isolated sources. Channels 1 and 2 in the left CTC use 115v ac from the left transfer bus and 28v dc from the left main bus. Channels 1 and 2 in the right CTC use 115v ac from the right transfer bus and 28v dc from the right main bus.



AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CTC - INTERFACES 1

ARINC - Interfaces

The CTCs receive and send information on the left and right systems 629 ARINC buses (not shown). These are the systems from which the CTCs receive information:

- AIMS: ground test, altitude, cabin pressure, TAT, air speed
- APUC: APU on/off, ECS pneumatic mode
- ASCPCs: left and right pack flow schedules (L ASCPC usual source), pack discharge temperature, compressor out temperature, manifold air temperature, duct pressure, left and right pack calculated mass air flow, left and right pack inlet differential pressure
- CSS: request for bias of cabin zone target temperature ([10F, 5.5C), number of passenger seats
- CTC: mix manifold temperature, intergraded mix manifold temperature error (IMMTE) reference (R CTC usual source), pack flow mass air flow, CTC status, pack on/off
- ECSMC: upper or lower recirculation fan overheat, lavatory/galley ventilation fans on/off, A/C SOV position open/closed
- ELMS: status for the upper and lower recirculation fans and the economy cooling valve (ECV) circuits
- OPAS: switch/control position for: L PACK and R PACK, UPPER RECIRC FANS and LOWER RECIRC FANS, AIR COND RESET, FLT DECK TEMP and CABIN TEMP, FWD CARGO FIRE and AFT CARGO FIRE
- WES: stall warning
- WOW: air/ground.

These are the systems that get information from the CTCs:

- AIMS: indications, ground test
- APUC: APU demand control (air flow request)
- ASCPCs: CTC status, pack inlet pressure, low bleed air temperature request (250F, 121C), increase bleed air pressure (6 psi bias)
- CSS: actual zone temperature, cabin target temperature (master plus CSS bias)

- CTC: mix manifold temperature, mix manifold temperature reference (R CTC usual source), pack flow mass air flow, CTC status, pack on/off
- ELMS: ECV open/close request, upper and lower recirculation fans on/off requests
- OPAS: OFF lights for the left and right packs and FAULT lights for left and right trim air.

Control - Interfaces

The CTCs directly control these related valves and actuators:

- Upper and lower flow control valves (FCV)
- Trim air pressure regulating and shutoff valve (TRIM PRSOV)
- Turbine bypass valve (TBV)
- Low limit valve (LLV)
- Zone trim air modulating valves (L CTC: F/D, zones A, C, E) (R CTC: zones B, D, F, & fwd cargo).

The CTCs usually use position loop control to set the valves and actuators that directly connect to them. It is necessary to use RVDTs for this type of control.

The CTCs can use a type of control that does not require RVDTs, open loop control. The CTCs look at temperature or pressure change downstream of a valve to monitor valve movement. The CTCs use open loop control for valves that do not have RVDTs or for valve and actuators that have failed RVDTs.

The CTCs indirectly control the related economy cooling valve (ECV) and the upper and lower recirculation (RECIRC) fans.

See the pack cooling and mix manifold temperature control section for more information about the control and operation of the ECV (SECTION 21-52). See the recirculation section for more information about the control and operation of the recirculation fans (SECTION 21-25).

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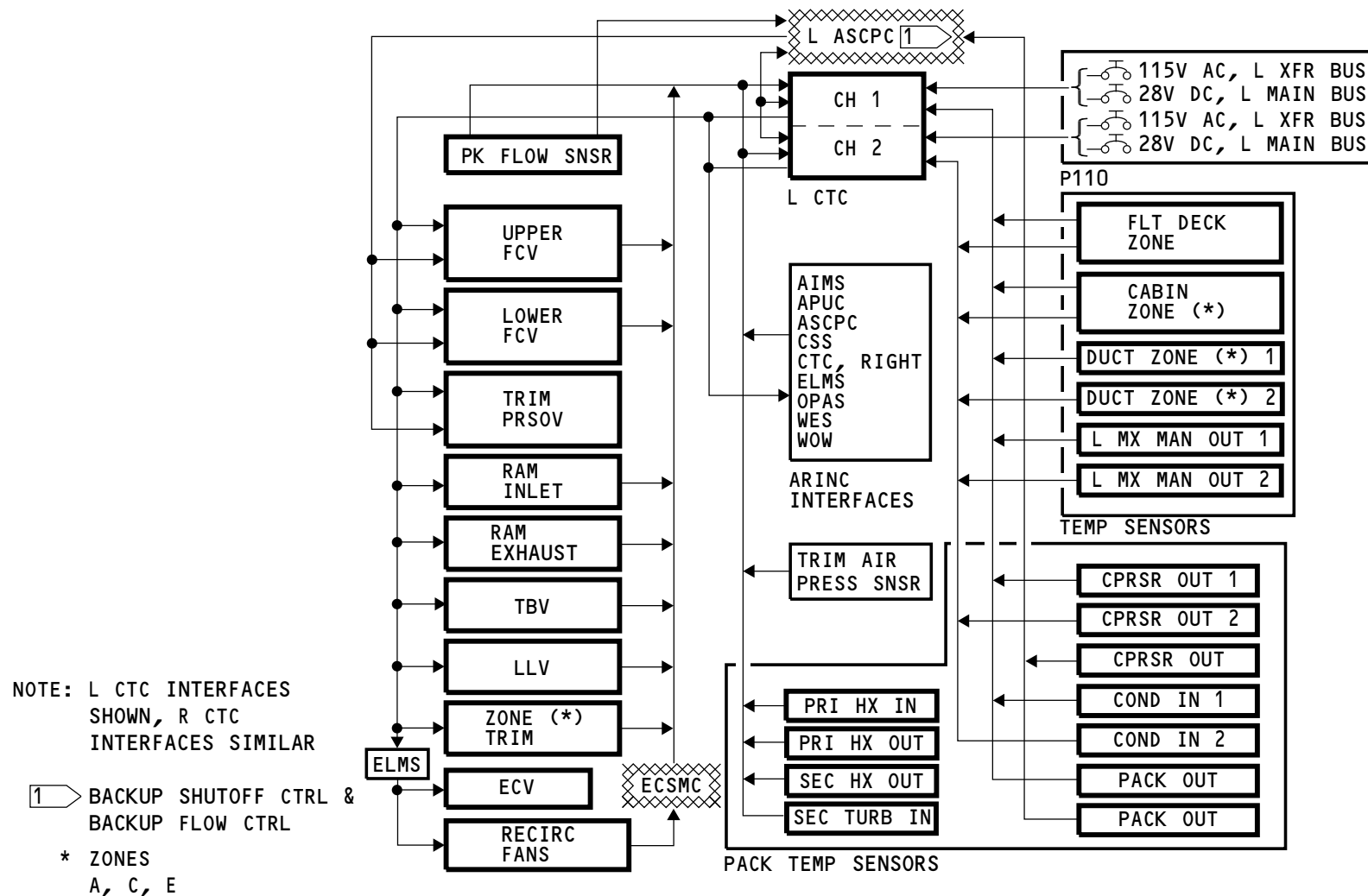


AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CTC - INTERFACES 1

Training Information Point

The ASCPCs work with the CTCs to give backup shutoff control for the FCVs and trim PRSOV if the related CTCs fail or lose control of the valves. The ASCPCs also use the FCVs to give backup control of pack flow if the related CTC fails. See the pack flow control section for more information about the control and operation of the pack flow (SECTION 21-51).

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AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CTC - INTERFACES 1

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AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CTC - INTERFACES 2

General

The left and right cabin temperature controllers (CTCs) monitor these types of sensors:

- Pressure
- Temperature
- RVDT.

Pressure and Temperature Sensors - Analog Interfaces

Each CTC monitors its own set of sensors to get pressure and temperature information for control, BIT, and indication. All sensors supply indication data. The CTC sensor interface table shows the primary functions and the effect on the CTCs if there is a loss of sensor input or total loss of data.

RVDT - Analog Interfaces

The CTCs monitor RVDTs in valves and actuators to get position information for control, BIT and indication. The CTC valve/actuator interface table shows the primary functions and the effect on the CTCs if there is a loss of RVDT input or total loss of data. See these sections for more information about the temperature sensors monitored by the CTCs:

- Pack flow control (SECTION 21-51)
- Pack cooling and mix manifold temperature control (SECTION 21-52)
- Trim air pressure regulation and shutoff control (SECTION 21-62).

SENSOR	FUNCTION	LOSS OF INPUT	LOSS OF DATA
PACK FLOW SENSOR, INLET & DIFF PRESS	- PACK FLOW CALC - PACK FLOW CTRL	USE ASCPC DATA	USE 28 PSI IF LOSS OF INLET PRESS, SHUT DOWN PACK FOR LOSS OF DIFF PRESS
PRI HX INLET TEMP	PACK FLOW CALC	USE ASCPC DATA	USE 380F (193C)
PRI HX OUT TEMP	PRI HX OUTL TEMP IND	NO BACKUP	NO EFFECT ON PACK OPN
CPRSR OUT TEMP 1	CPRSR OUT TEMP CTRL	USE OTHER CHAN DATA OR ASCPC DATA	SHUT DOWN PACK
CPRSR OUT TEMP 2	CPRSR OUT TEMP CTRL	USE OTHER CHAN DATA OR ASCPC DATA	
SEC HX OUT TEMP	BIT	NO BACKUP	USE OTHER PACK SENSORS FOR BIT
CONDENSER IN TEMP 1	LLV CTRL	USE OTHER CHAN DATA	CLOSE LLV & SET PACK TO STBY COOLING MODE OR SHUT DOWN PACK
CONDENSER IN TEMP 2	LLV CTRL	USE OTHER CHAN DATA	
SEC TURB IN TEMP	BIT	NO BACKUP	USE PACK DISCH TEMP FOR BIT
PACK DISCH TEMP	PACK OUT TEMP CTRL	USE ASCPC DATA	USE SEC TURB IN TEMP

CTC SENSOR INTERFACES

SENSOR	FUNCTION	LOSS OF INPUT	LOSS OF DATA
MIX MAN OUT TEMP 1	MIX MAN TEMP CTRL	USE OTHER CHAN DATA	USE LAST VALUE
MIX MAN OUT TEMP 2	MIX MAN TEMP CTRL	USE OTHER CHAN DATA	
ZONE DUCT TEMP 1	DUCT TEMP CTRL	USE OTHER CHAN DATA	SHUT TRIM MOD VALVE
ZONE DUCT TEMP 2	DUCT TEMP CTRL	USE OTHER CHAN DATA	
ZONE TEMP 1	ZONE TEMP CTRL	USE OTHER CHAN DATA	USE DUCT TEMP FOR REFERENCE CTRL (ALT MODE)
ZONE TEMP 2	ZONE TEMP CTRL	USE OTHER CHAN DATA	
TRIM AIR PRESS	TRIM AIR PRESS CTRL	NO BACKUP	SHUT TRIM PRSOV

CTC SENSOR INTERFACES (CONTINUED)

VLV/ACTR	FUNCTION	LOSS OF INPUT	LOSS OF DATA
RAM AIR INLET DR	PACK TEMP CTRL	NO BACKUP	SET DR TO 0% OF HEAT
RAM AIR EXHAUST DR	PACK TEMP CTRL	NO BACKUP	SET DR TO 0% OF HEAT
LOW LIMIT	PACK TEMP CTRL	NO BACKUP	SET VLV TO 60% OF HEAT
TURB BYPASS	PACK TEMP CTRL	NO BACKUP	SET VLV TO 60% OF HEAT
TRIM AIR MOD	ZONE TRIM AIR CTRL	NO BACKUP	USE OPEN LOOP CTRL OF VLV

CTC VALVE/ACTUATOR INTERFACES

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AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CTC - INTERFACES 2

21-61-00

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**AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - ZONE TRIM AIR MODULATING VALVES AND MUFFLERS****Purpose**

The zone trim air modulating valves control the flow of air from the pneumatic system to each zone. The mufflers reduce the noise in the flight deck and passenger cabin caused by the flow of trim air.

Location

The valves and the mufflers are in the forward part of the left and right ECS bays. There is one valve and one muffler for each temperature control zone.

You get access to the mufflers and the valves through the left and right ground conditioned air panels and the ECS bay doors.

Physical Description

Each valve has these parts:

- Electrical actuator
- Valve body
- Manual open/shut knob
- Electrical connector.

All of the trim air modulating valves are the same. Each has an internal disc in the valve body. The electrical actuator has these internal parts:

- Motor
- RVDT and position indicator
- Gears.

The motor controls disc position. The RVDT gives an electrical indication of the disc position and a visual indication of disc position.

Functional Description

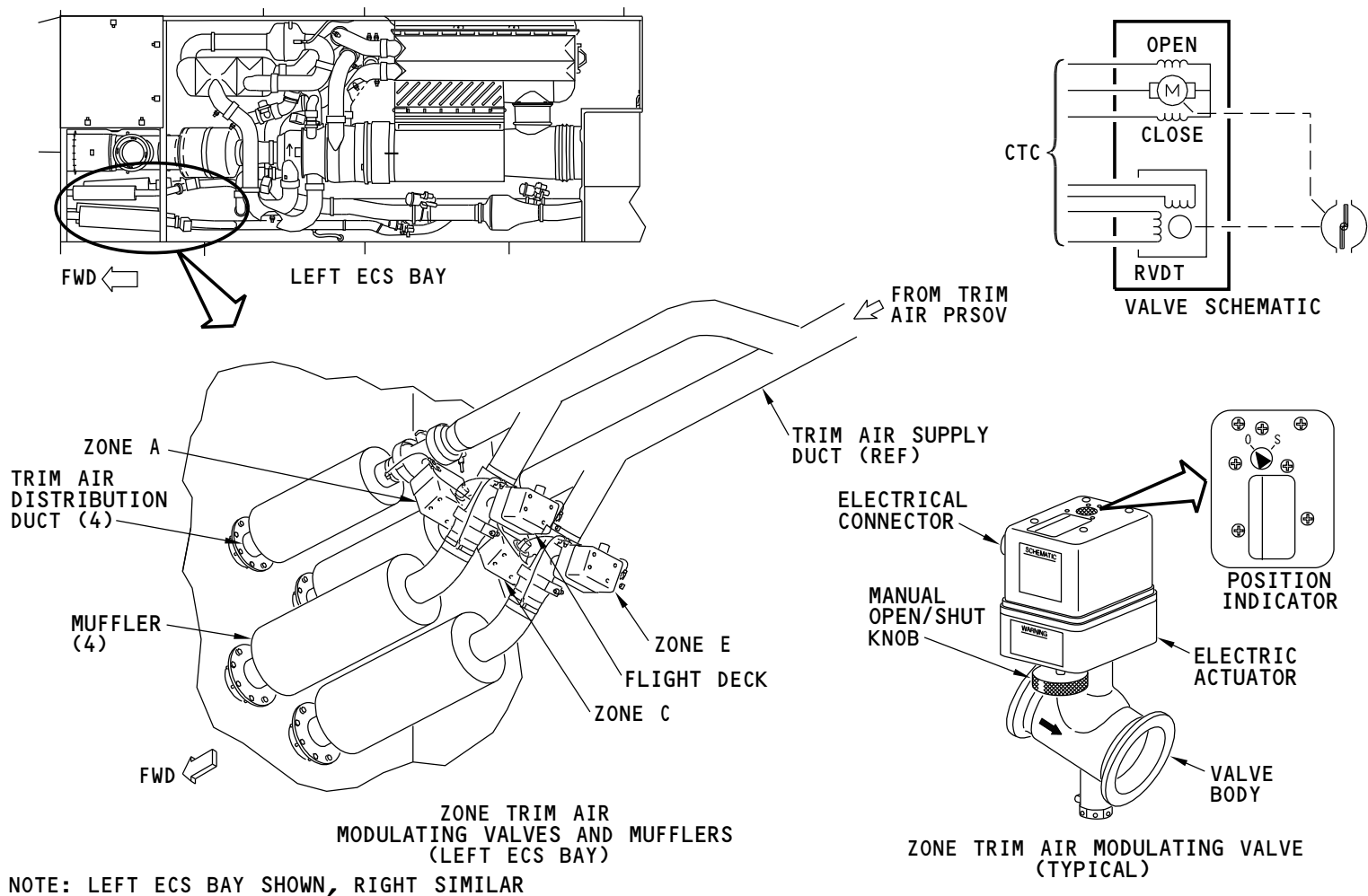
A close or open signal from the CTC operates the actuator motor in the necessary direction.

The RVDT gives valve position to the CTC.

Training Information Point

Manually open or shut the valve with the manual open/shut knob. You must disconnect the electrical connector first. If you do not remove the electrical connector the valve will move to the commanded position when the valve gets power.

EFFECTIVITY	
ARO ALL	



M35890 S000612598_V1

AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - ZONE TRIM AIR MODULATING VALVES AND MUFFLERS

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AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FLIGHT DECK ZONE DUCT TEMP SENSORS

Purpose

The flight deck zone duct temperature sensors monitor air temperature within the air distribution duct.

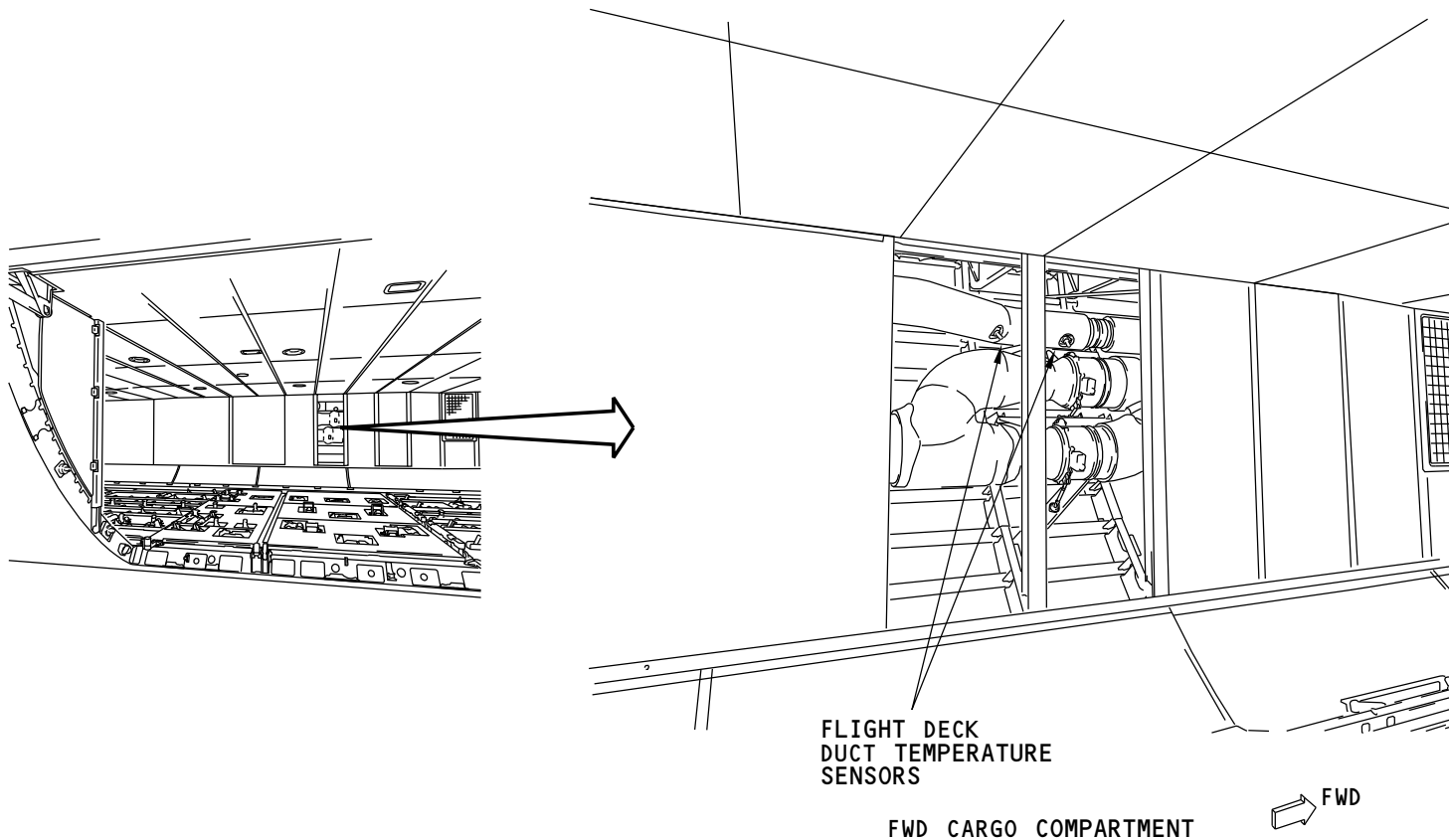
Physical Description

The sensors are solid state electronic devices.

Location

The flight deck zone duct temperature sensor is along the duct that supplies conditioned air to the flight deck.

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M35891 S000612599_V1

AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FLIGHT DECK ZONE DUCT TEMP SENSORS

21-61-00

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**AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CABIN ZONE DUCT TEMP SENSORS****Purpose**

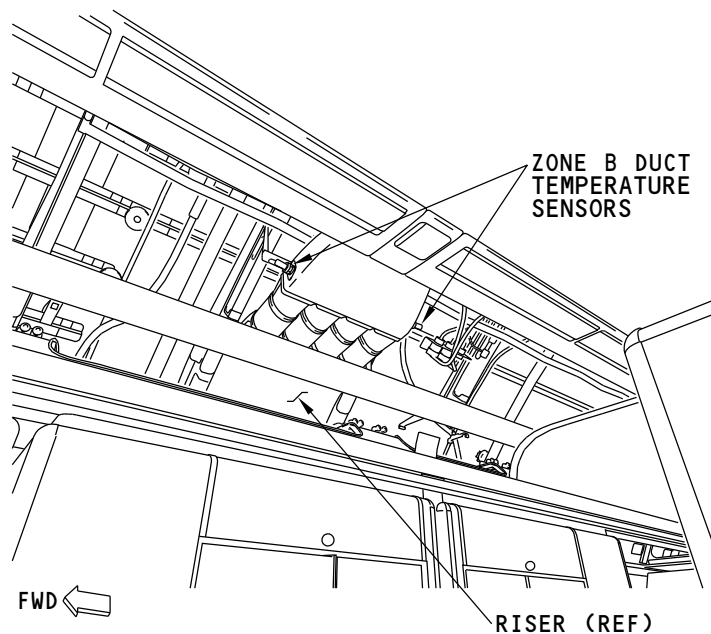
The cabin zone duct temperature sensors monitor air temperature within the air distribution ducts.

Physical Description

The sensors are solid state electronic devices.

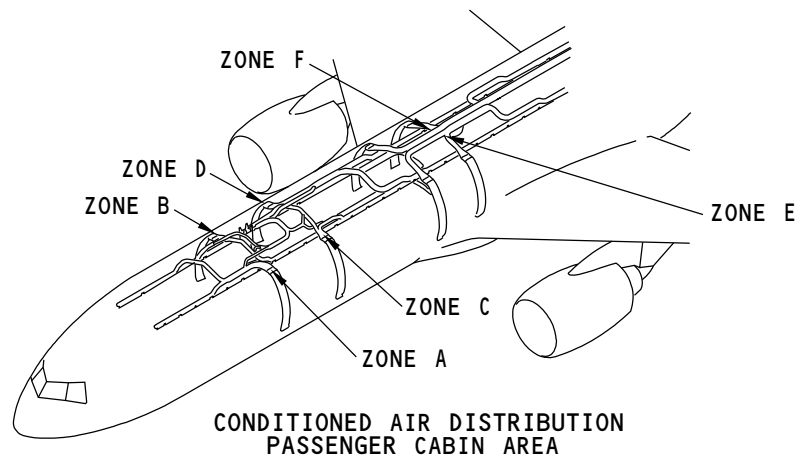
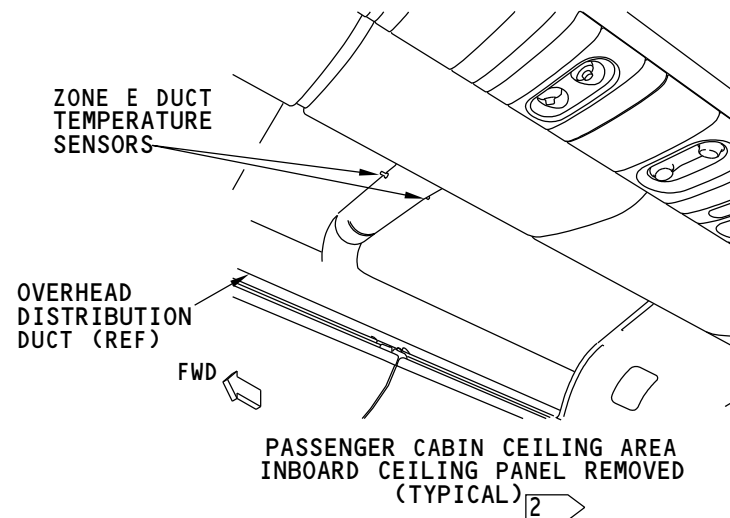
Location

The cabin zone duct temperature sensors are in the ducts that supply conditioned air to the cabin zones. The sensors for zones A, B, C, and D are at the top of the related risers. The sensors for zones E and F are at the top of the distribution duct.



PASSENGER CABIN CEILING AREA
OUTBOARD CEILING PANEL REMOVED
(TYPICAL) 1

- 1 ZONE B SHOWN, ZONES A, C AND D SIMILAR
2 ZONE E SHOWN, ZONE F OPPOSITE



M35893 S000612601_V1

AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CABIN ZONE DUCT TEMP SENSORS

21-61-00

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**AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FORWARD CARGO ZONE DUCT TEMP SENSORS****Purpose**

The right cabin temperature controller (CTC) uses the forward cargo zone duct temperature sensors to monitor the air temperature inside of the forward cargo conditioned air supply duct.

Location

The sensors are in the mix bay area of the forward cargo compartment. The sensors are in the supply duct near the A/C SOV.

Physical Description

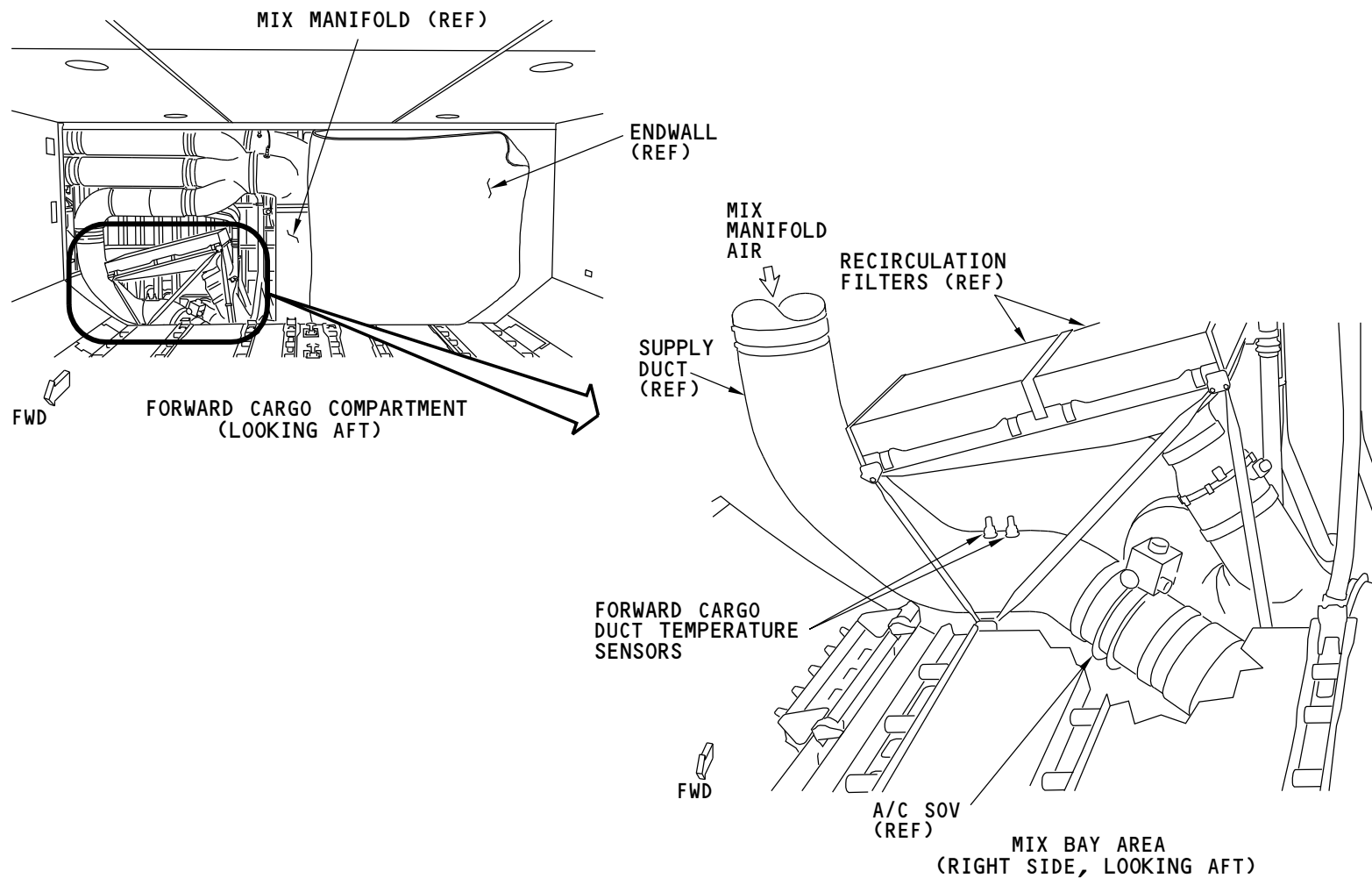
The sensors are single element thermistors. Each sensor has a threaded housing with an electrical connection.

Training Information Point

The forward cargo zone duct temperature sensors are interchangeable with these sensors:

- Forward cargo zone air temperature sensors
- Passenger cabin zone duct temperature sensors
- Flight deck zone duct temperature sensors.

You remove the right part of the aft end wall panel to get access the forward cargo zone duct temperature sensors.



M36363 S000612614_V1

AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FORWARD CARGO ZONE DUCT TEMP SENSORS

21-61-00

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**AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FLIGHT DECK ZONE AIR TEMP SENSORS****Purpose**

The cabin temperature controllers (CTCs) use the flight deck zone temperature sensors to monitor the flight deck temperature.

Physical Description

The sensors are dual element thermistors. Each sensor has a threaded housing with an electrical connection.

The sensors are interchangeable with the ones in passenger cabin zones.

Location

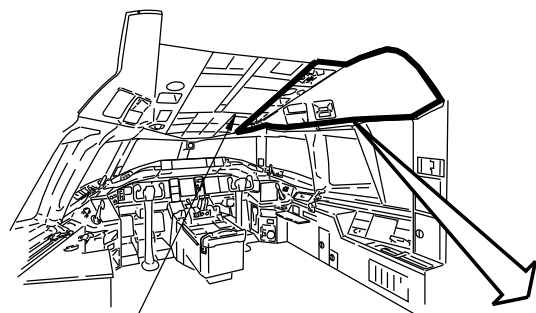
The sensors are in an air inlet plenum that connects to the lavatory/galley ventilation system. This inlet is in the flight deck ceiling, to the right of the P11 circuit breaker panel.

Training Information Point

One sensor supplies temperature information to the left CTC for usual flight deck temperature control. The other supplies temperature information to the right CTC. The right CTC can control the mix manifold temperature to supply cooling air for the flight deck when the left pack is off.

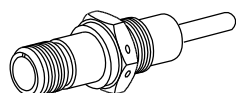
The sensors have dual elements so that one element supplies data to channel 1 of the related CTC and the other supplies data to channel 2.

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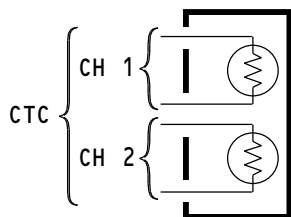


P11 CIRCUIT
BREAKER PANEL
(REF)

FLIGHT DECK

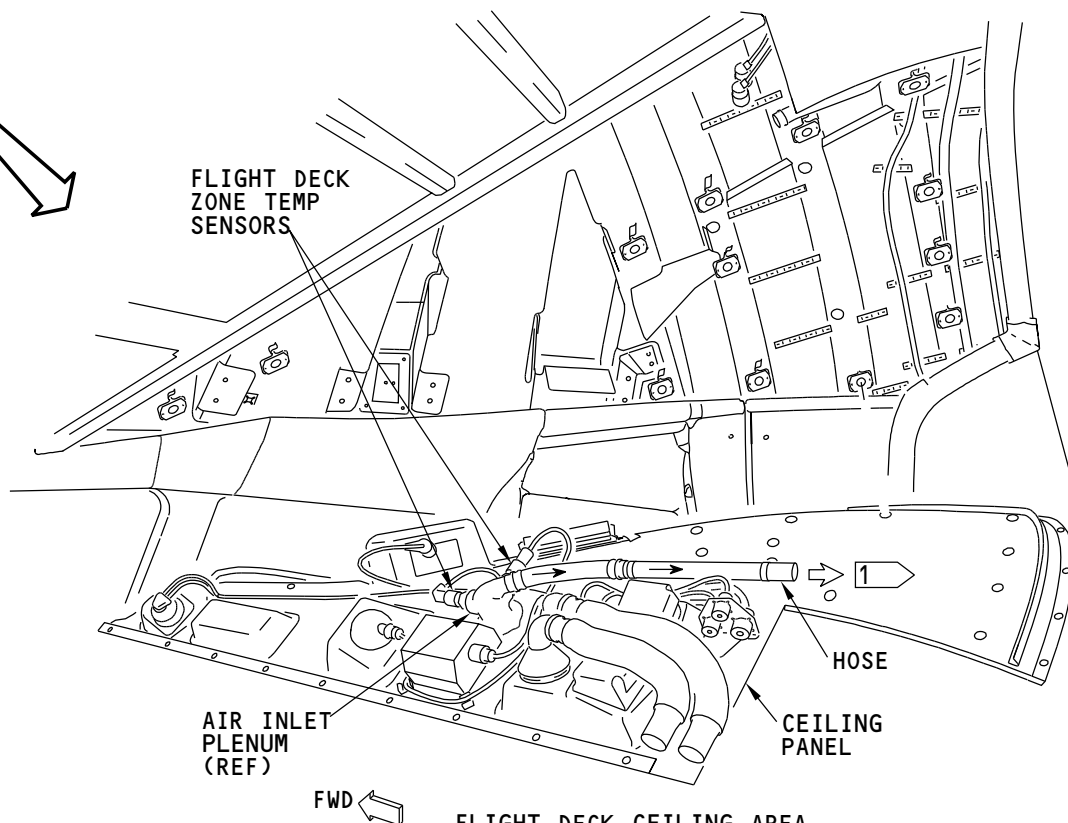


TEMPERATURE SENSOR
(TYPICAL)



TEMPERATURE SENSOR CIRCUIT
(TYPICAL)

1 TO LAVATORY/GALLEY VENTILATION SYSTEM



FLIGHT DECK
ZONE TEMP
SENSORS

AIR INLET
PLENUM
(REF)

HOSE

CEILING
PANEL

FWD

FLIGHT DECK CEILING AREA
(RIGHT SIDE)

M35894 S000612602_V1

AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FLIGHT DECK ZONE AIR TEMP SENSORS

21-61-00

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AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CABIN ZONE AIR TEMP SENSORS

Purpose

The cabin temperature controllers (CTC) use the cabin zone temperature sensors to monitor the temperature of air pulled from the zones by the ventilation system.

Physical Description

The sensors are thermistors with two elements. Each sensor has a threaded housing with an electrical connection.

The sensors are interchangeable with the ones in the flight compartment.

Location

The sensors are in the same area as the left outboard passenger service units (PSUs). Each sensor is in a plenum that attaches to a zone air temperature sensor panel. The plenum has an air inlet grille on the lower side of the panel. The plenum has a hose that connects it to the lavatory/galley ventilation system on the upper side of the panel. The sensors are at these station locations:

- Zone A: station 464
- Zone B: station 629
- Zone B: station 676 (wiring provisions only)
- Zone C: station 825 (wiring provisions only)
- Zone C: station 825+76
- Zone D (forward): station 938
- Zone D (aft): station 1080
- Zone E: station 1364
- Zone F: station 1796.

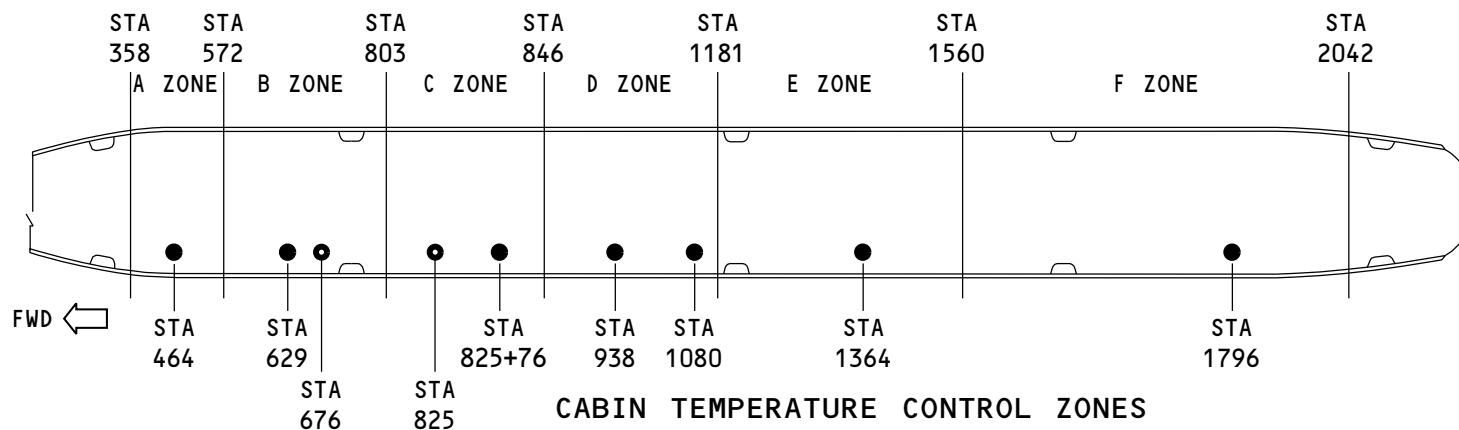
Training Information Point

Cabin temperature control zones can have one or two temperature sensors. A second sensor permits different interior configurations. Galleys, lavatories, closets, and partitions can prevent one sensor from accurately measuring the temperature in a zone. When there are two sensors in one zone, the cabin temperature controllers use an average of the temperature information from the sensors.

Any zone can have two sensors. Zone D always has two sensors. Zones B and C have wiring for a second sensor. If you install a second sensor, you must also load a new operational program configuration (OPC) software in the CTCs.

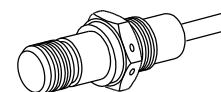
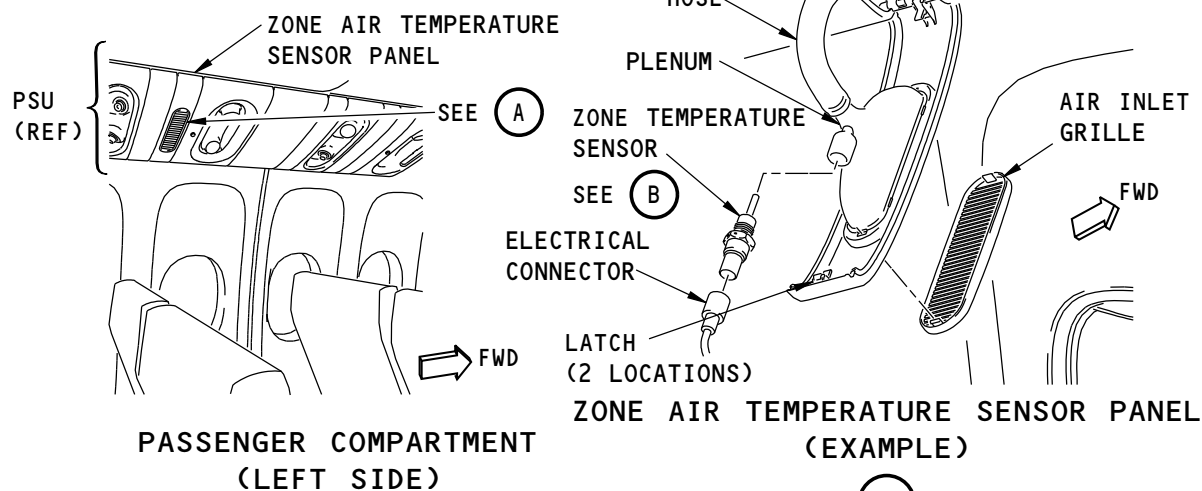
Sensors in these zones connect to the left CTC: A, C and E. Sensors in these zones connect to the right CTC: B, D and F.

The sensors have two elements so that one element supplies data to channel 1 of the related CTC and the other element supplies data to channel 2.

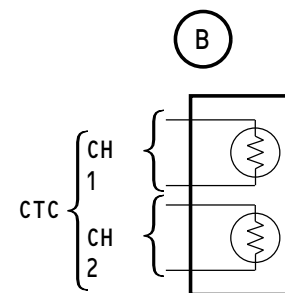


● CABIN ZONE TEMP SENSOR

● PROVISIONS (WIRES) FOR CABIN ZONE TEMPERATURE SENSOR



ZONE TEMPERATURE SENSOR (EXAMPLE)



488728 S0000145909_V1

AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CABIN ZONE AIR TEMP SENSORS

21-61-00

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**AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FORWARD CARGO ZONE AIR TEMP SENSORS****Purpose**

The right cabin temperature controller (CTC) uses the forward cargo zone air temperature sensors to monitor the forward cargo compartment temperature.

Physical Description

The sensors are single element thermistors. Each sensor has a threaded housing with an electrical connection.

Location

The sensors are in the air inlet plenums that connect to the lavatory/galley ventilation system. The inlet plenums are in the left sidewall of the forward cargo compartment. One plenum is near the MEC access door (STA 450). The other plenum is near the aft endwall (STA 900).

Training Information Point

The forward cargo zone air temperature sensors are interchangeable with these sensors:

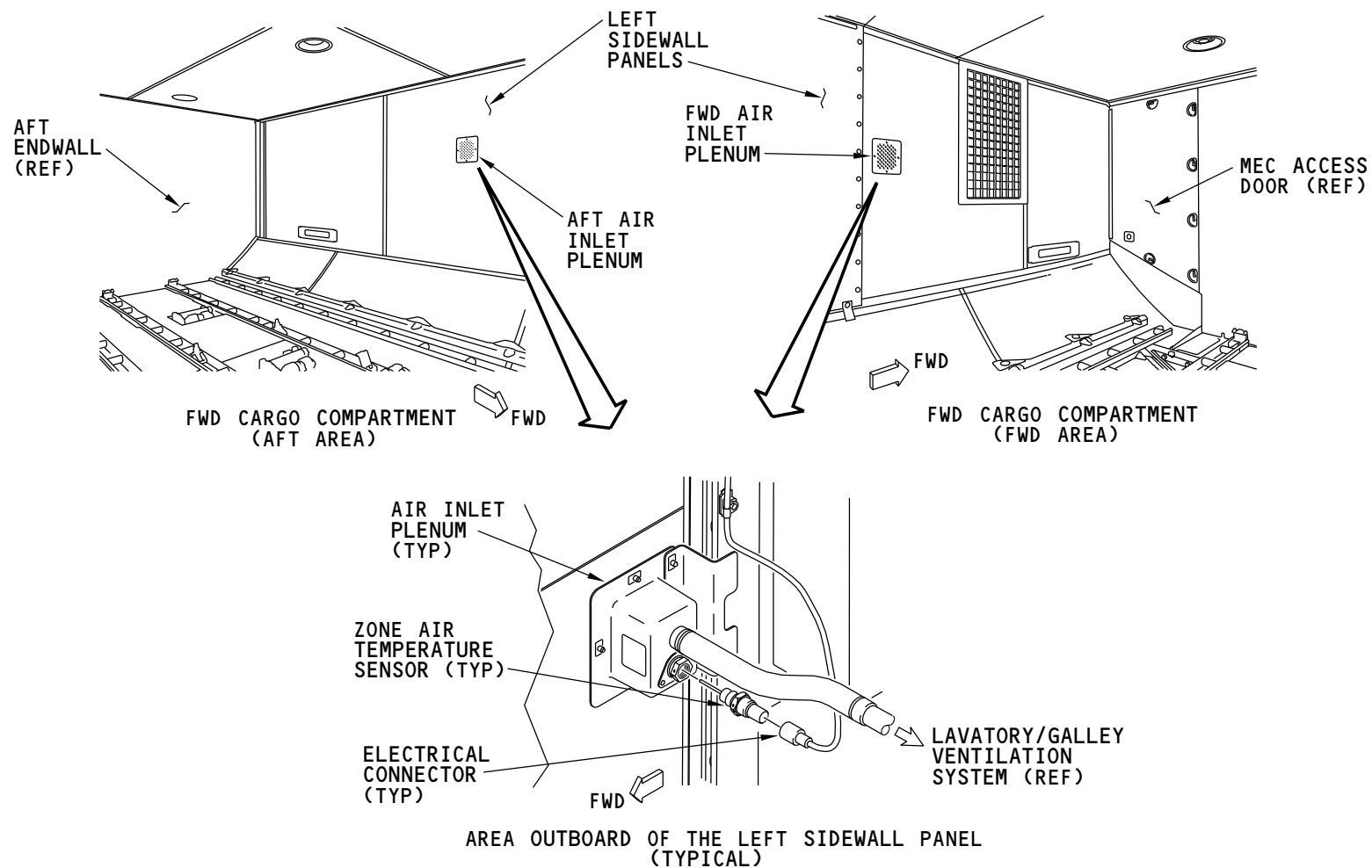
- Forward cargo zone duct temperature sensors
- Passenger cabin zone duct temperature sensors
- Flight deck zone duct temperature sensors.

Your remove the applicable sidewall panel to get access the forward cargo zone air temperature sensors.

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AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FORWARD CARGO ZONE AIR TEMP SENSORS

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**AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FLIGHT DECK FUNCTIONAL DESCRIPTION****General**

The flight crew uses the flight deck temperature control on the P5 overhead panel to set the target temperature for the flight deck. The low temperature value (C on the control) is 65 F (18 C). The high temperature value (W on the control) is 85 F (29 C).

The manual area on the flight deck temperature control is spring-loaded to MAN. In the W or C positions the flight deck temperature control sets the position of the flight deck trim air modulating valve.

Automatic Mode

The left CTC controls the flight deck trim air modulating valve to keep the zone temperature at the target value. The valve open and close commands go from the left CTC through the contacts of the auto/manual control flight deck trim air relay. The RVDT of the flight deck trim air modulating valve gives valve position to the left CTC. Flight deck sensors send actual temperature data to both CTCs.

Manual Mode

With the flight deck temperature control in MAN the electrical load management system (ELMS) computing and communications unit (CCU) removes control of the flight deck trim air modulating valve from the CTC.

In the W position the ELMS CCU supplies power to the open coil of the flight deck trim air modulating valve.

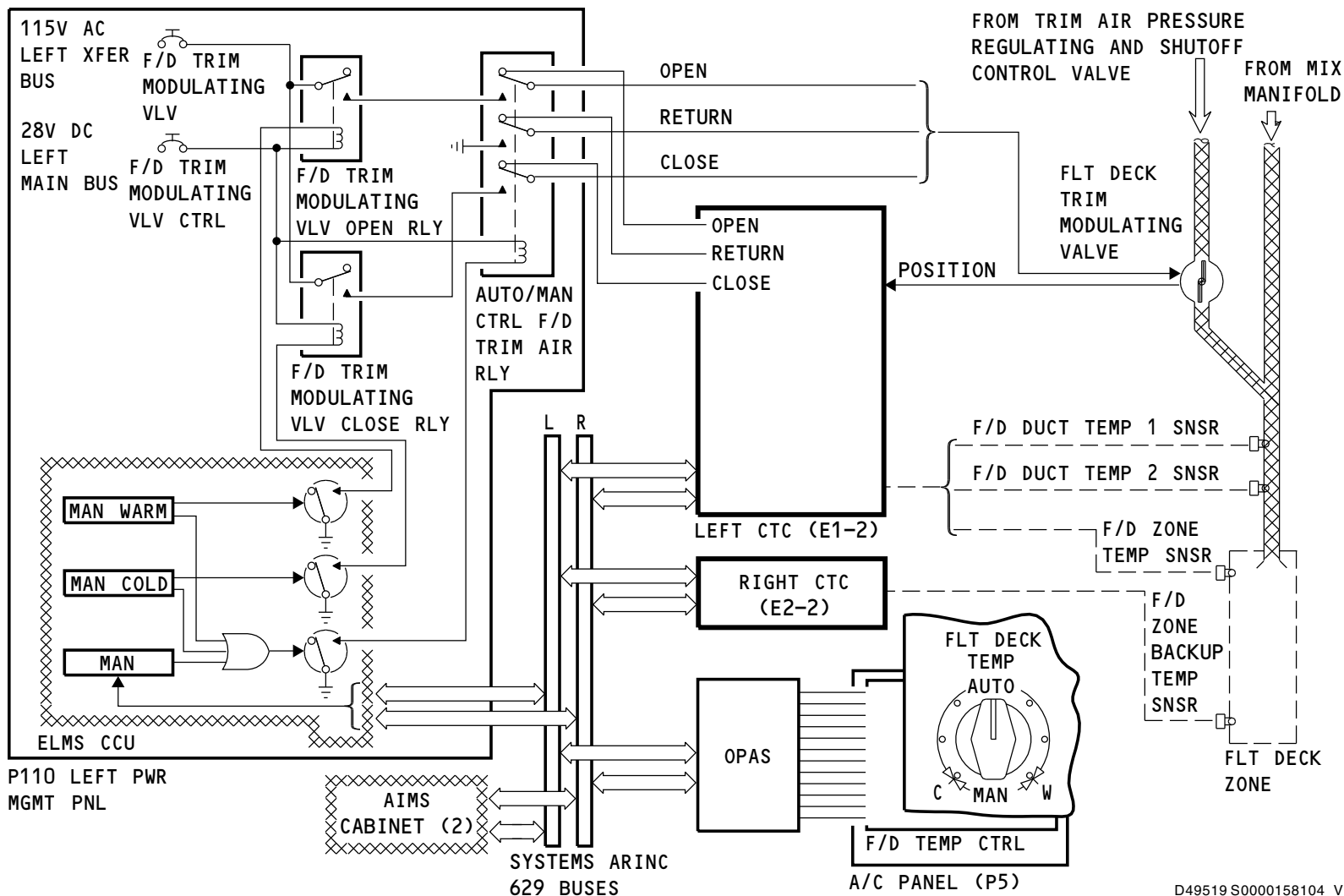
In the C position the ELMS CCU supplies power to the close coil of the flight deck trim air modulating valve.

When released, the flight deck temperature control moves back to the MAN position. In this position no power is at the contacts of the auto/manual control flight deck trim air relay. This keeps the trim air modulating valve in the set position.

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AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FLIGHT DECK FUNCTIONAL DESCRIPTION



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AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CABIN ZONE FUNCTIONAL DESCRIPTION

General

The cabin temperature control on the air conditioning panel sets the master temperature value for all cabin areas. The low temperature value (C on the control) is 65F (18C). The high temperature value (W on the control) is 85F (29C).

The number of cabin areas will not always be the same as the number of temperature control zones. Each cabin area may have one or more temperature control zones. The number of cabin areas is set by the CSS configuration database. See the cabin services system section for more information about the configuration database (SECTION 23-39).

The cabin temperature screen on the cabin system control panel (CSCP) or on the cabin area control panels (CACP) lets you adjust the temperature in each cabin area. You can set the temperature in each area plus or minus 10F (6C) from the master temperature value set on the air conditioning panel. You cannot set the temperature in the cabin areas below 65F (18C) or above 85F (29C).

Cabin Zone Temperature Control

The CTCs calculate a zone target temperature for each temperature control zone. The zone target temperature is used in other calculations for the control of these components:

- Zone trim air modulating valves
- Zone trim air PRSOV (backup control if the modulating valve fails open)
- Second stage turbine bypass valve (A/C pack component)
- Low limit valve (A/C pack component)
- Ram air actuator (A/C pack component).

The CTCs use these inputs to calculate the zone target temperatures:

- Selected master temperature from the CABIN TEMP control
- Bias to the master temperature (10F, 6C) from the CABIN TEMPERATURE screen.

The zone target temperatures shows on these screens:

- Cabin temperature screen, CSCP/CACP
- Air synoptic display
- Air conditioning maintenance page.

Zone air temperature sensors send the CTCs actual compartment temperature data. The CTCs set the actual compartment temperatures equal to the average of elements 1 and 2. If there are two sensors in a temperature control zone, the appropriate CTC averages the data from both sensors.

The CTC adjusts the position of the cabin zone trim air modulating valve to make the actual zone temperature match the target temperature.

If both elements of the zone air temperature sensor fail, the CTCs use the duct temperature sensors in an alternate control mode. The alternate mode does not provide closed loop control. The cabin area temperature may need adjustment to keep the temperature at a comfortable level.

Cabin Zone Alternate Control Mode

If the lavatory/galley ventilation fans are off, then there is no air flow past the zone temperature sensors and the actual zone temperature is not available.

If the zone temperature sensors fail, then the actual cargo compartment temperature is not available.

When the actual cargo compartment temperature is not available, the CTC uses an alternate control mode to calculate a duct target temperature. The alternate control mode uses duct temperature data instead of the cabin temperature data from the zone air temperature sensors.

The initial duct target temperature is set to the value of the actual duct temperature at the time that the cabin zone temperature data becomes unavailable. The cabin zone temperature control system still responds to the temperature selector switch in the alternate control mode, but it does not respond to changes in the cabin zone temperature. The selector switch changes the duct target temperature directly when the alternate control mode is active.

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**AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CABIN ZONE FUNCTIONAL DESCRIPTION**

The CTC adjusts the position of the cabin zone trim air modulating valve to make the actual duct temperature match the target duct temperature.

In the alternate control mode, there is no crew awareness of the actual cabin zone temperature, nor will the system compensate for changes in heat load or ambient temperatures during flight.

Zone Duct Temperature Control

The CTCs calculate a zone duct target temperature for each temperature control zone. The target temperature has a high and a low limit. The high limit is 160F (71C) and the low limit changes with altitude. These are the low limits:

- 35F (1.7C) when the airplane is less than 29,000 feet (8845 meters)
- Decreases to 29F (-1.7C) when the airplane is at 31,000 feet (9455 meters)
- Decreases to 21F (-6C) when the airplane is at 35,000 feet (10,675 meters) or above.

The CTCs use zone duct temperature data to control the position of the trim air modulating valves. See the zone temperature control and indication - zone temperature calculation page in this section for more information about the calculation of the trim air modulating valve position and the calculation of the necessary A/C pack outlet temperature. The CTCs also use the data to control one or both of the trim air PRSOVs when a trim air modulating valve fails open. See the trim air pressure regulation and shutoff control section for more information about the control of the trim air PRSOV (SECTION 21-62).

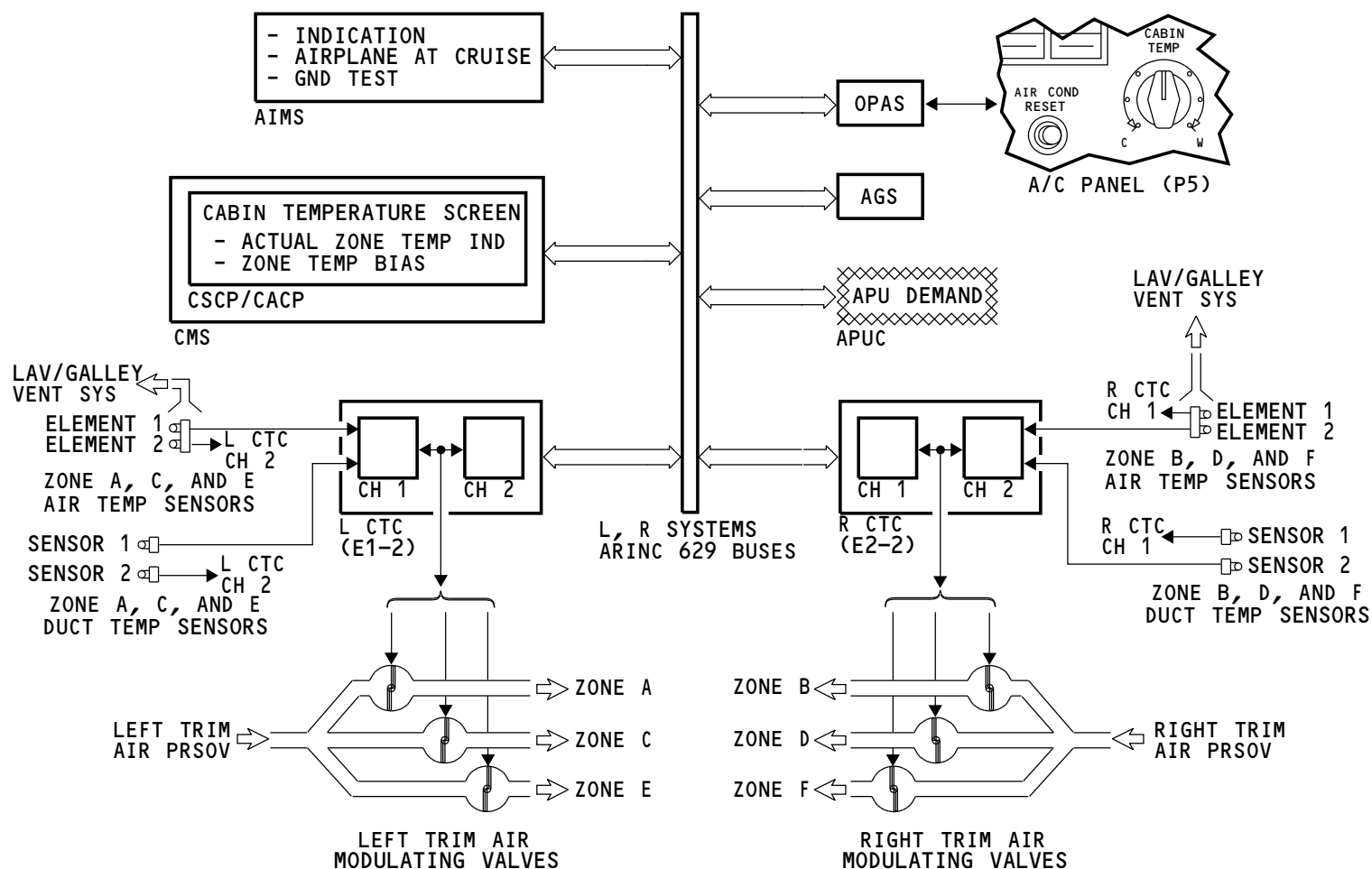
Zone duct temperature sensors send the CTCs duct temperature data. The CTCs set the duct temperature equal to the average of sensors 1 and 2. The CTCs make a zone duct temperature error signal for each temperature control zone. The CTCs move the trim air modulation valves to supply the quantity of trim air to keep the duct temperature at the target value.

APU DEMAND

When the APU gives air for pack operation on the ground, the right CTC calculates the quantity of air necessary for ventilation and for heating or cooling. The CTC compares these inputs to calculate the APU demand signal:

- Zone duct temperature error signal for the most cooling
- Zone duct temperature error signal for the most heating
- Passenger seat count
- A preset minimum limit.

The CTC calculates the APU demand signal and sends it to the APUC. The APUC controls the quantity of air to the packs and the trim air system.



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AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - CABIN ZONE FUNCTIONAL DESCRIPTION

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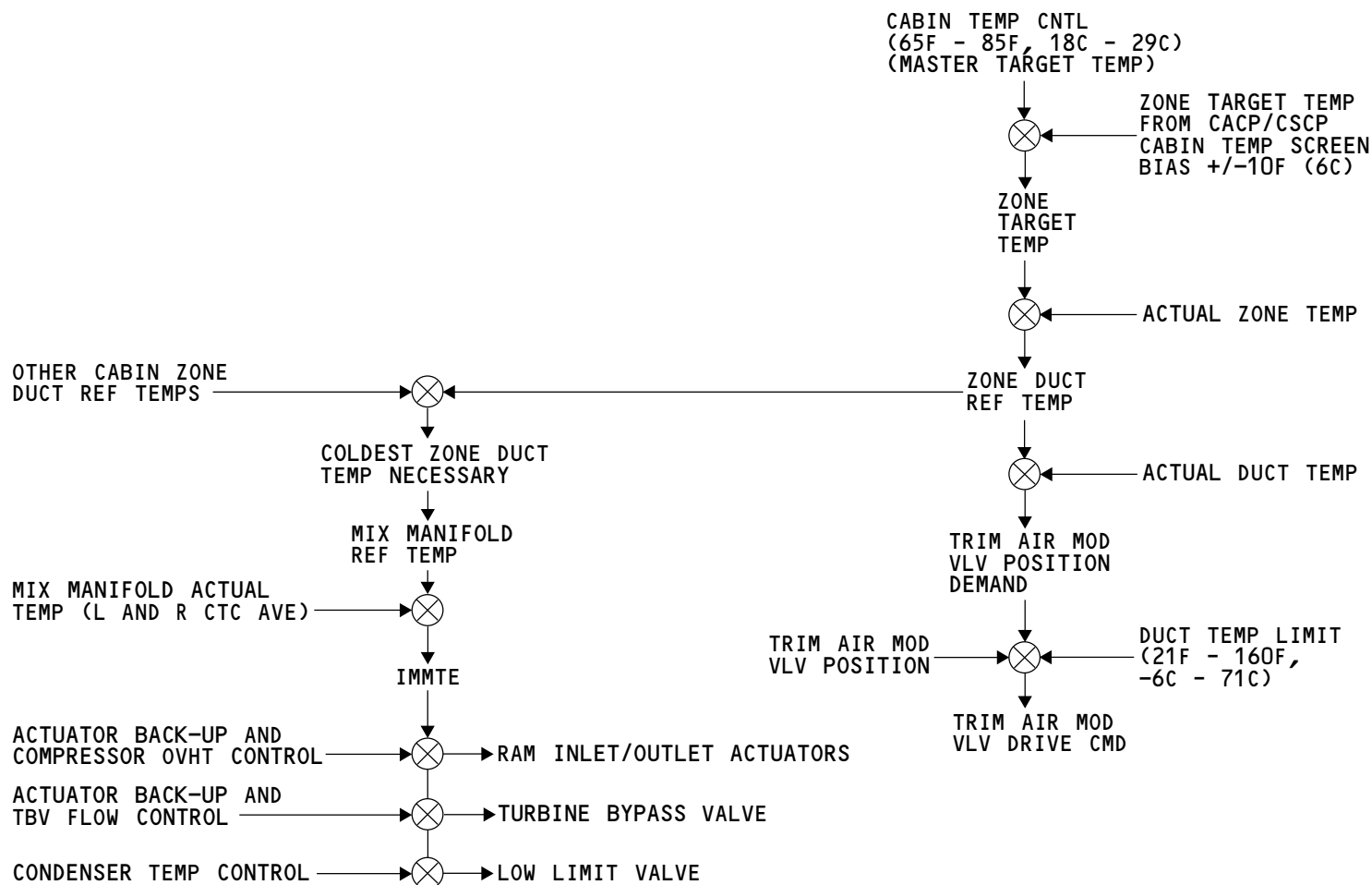


AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - ZONE TEMPERATURE CALCULATION

General

This graphic shows the control inputs and CTC logic for the trim air modulating valve and pack components.

ARO ALL	EFFECTIVITY



M35902 S000612616_V2

AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - ZONE TEMPERATURE CALCULATION

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Page 34
May 05/2015

AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FORWARD CARGO ZONE FUNCTIONAL DESCRIPTION

General

The AUTO position of the FWD CARGO A/C control enables the forward cargo zone temperature control system and sets the target temperature. The low temperature value (C on the control) is 40F (4C). The high temperature value (W on the control) is 80F (27C). The auto position also enables the forward cargo ventilation system. See the ventilation section for more information about the forward cargo ventilation system (SECTION 21-26).

The AIR COND RESET switch lets you restart the forward cargo air conditioning system if it stops. The switch supplies a reset signal to the CTCs.

The left and right ECSMCs give data to the right CTC about these components:

- Lavatory/galley ventilation fans on/off status
- Forward cargo A/C SOV open/close position.

AIMS gives indications and the ground test functions.

Forward Cargo Zone Temperature Control

Forward cargo zone temperature control is enabled when the Forward Cargo A/C SOV is open.

The right CTC gets target temperature data from the FWD CARGO A/C control.

Two zone air temperature sensors send compartment temperature data to the right CTC. The CTC sets the actual compartment temperature equal to the average of the forward and aft sensors.

The CTC adjusts the position of the Forward Cargo A/C trim air modulating valve to make the actual compartment temperature match the target temperature.

The target and actual temperatures show on these screens:

- Air synoptic display
- Air conditioning maintenance page.

If the two zone air temperature sensors fail, or if the lavatory/galley fans are off, then the CTCs use the duct temperature sensors in an alternate control mode.

Forward Cargo Zone Alternate Control Mode

If the lavatory/galley ventilation fans are off, then there is no air flow past the forward cargo zone temperature sensors and the actual cargo compartment temperature is not available.

If the forward and aft cargo zone temperature sensors fail, then the actual cargo compartment temperature is not available.

When the actual cargo compartment temperature is not available, the CTC uses an alternate control mode to calculate a duct target temperature. The alternate control mode uses duct temperature data instead of the forward cargo compartment temperature data from the zone air temperature sensors.

The initial duct target temperature is set to the value of the duct temperature at the time that the cargo compartment temperature data becomes unavailable. The forward cargo temperature control system still responds to the temperature selector switch in the alternate control mode, but it does not respond to changes in the forward cargo compartment temperature. The selector switch changes the duct target temperature directly when the alternate control mode is active.

The CTC adjusts the position of the Forward Cargo A/C trim air modulating valve to make the actual duct temperature match the target duct temperature.

In the alternate control mode, there is no crew awareness of the actual forward cargo compartment temperature, nor will the system compensate for changes in heat load or ambient temperatures during flight.

Zone Duct Temperature Control

Two zone duct temperature sensors send duct temperature data to the right CTC. The CTC sets the actual duct temperature equal to the average of duct temperature sensors 1 and 2.

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**AIR CONDITIONING - ZONE TEMP CTRL AND INDICATION - FORWARD CARGO ZONE FUNCTIONAL DESCRIPTION**

The right CTC calculates a zone duct target temperature signal for the forward cargo zone. The signal is used to control the temperature in the forward cargo conditioned air supply duct. The duct target temperature has a high and a low limit. The high limit is 160F (71C) and the low limit changes with altitude. These are the low limits:

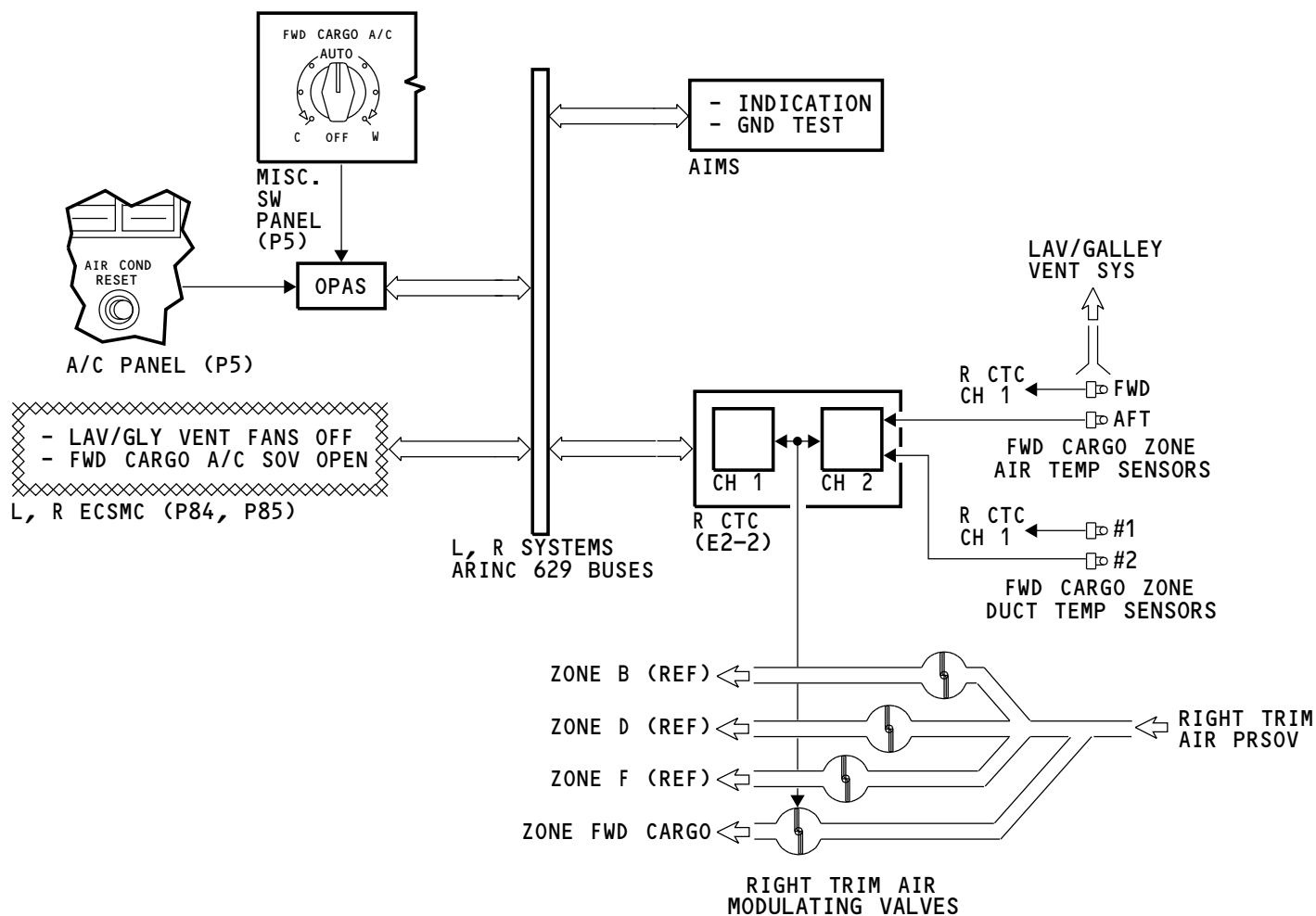
- 35F (1.7C) when the airplane is less than 29,000 feet (8845 meters)
- Decreases to 29F (-1.7C) when the airplane is at 31,000 feet (9455 meters)
- Decreases to 21F (-6C) when the airplane is at 35,000 feet (10,675 meters) or above.

To calculate the zone duct target temperature signal, the right CTC compares the actual compartment temperature to the zone target temperature.

The zone duct target temperature is used to calculate the zone duct temperature error signal. The error signal is used to control the position of the trim air modulating valve, and in the calculation of the target temperature for the mix manifold.

When the forward cargo conditioned air supply duct is at its target temperature, the cargo compartment temperature stays at its target value. See the pack cooling and mix manifold temperature control section for more information about the pack functions and the control of the mix manifold temperature (SECTION 21-52).

EFFECTIVITY	
ARO ALL	



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AIR CONDITIONING - ZONE TEMP CTRL AND IND - FORWARD CARGO ZONE FUNCTIONAL DESCRIPTION

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**AIR CONDITIONING - TRIM AIR PRESS REGULATION AND SHUTOFF CTRL - INTRODUCTION****General**

Trim air pressure regulation and shutoff control system adjusts, monitors and distributes trim air supply pressure to the trim air modulating valves.

The related CTC controls and monitors the operation of this part of the air conditioning system. The CTCs use the trim air PRSOV to keep the trim air supply pressure between 2 and 8.5 psi above cabin pressure. The usual pressure is 5 psi above cabin pressure.

The related ASCPC gives backup off control for the trim air PRSOV. The ASCPCs are the usual sources for cabin pressure data.

The remote cabin pressure sensor is a backup source for cabin pressure data.

The trim air switches enable trim air operation when they are set to ON. The switches turn off the trim system when they are in the out position. The FAULT light turns on and the advisory message TRIM AIR L (R) shows when any of these conditions occur:

- Related zone duct overheat
- Related trim air switch set to out
- Related trim air system has a fault (trim air PRSOV, controller, pressure sensor).

See the zone temperature control and indication section for more information about the zone temperature control system (SECTION 21-61).

Location of Components

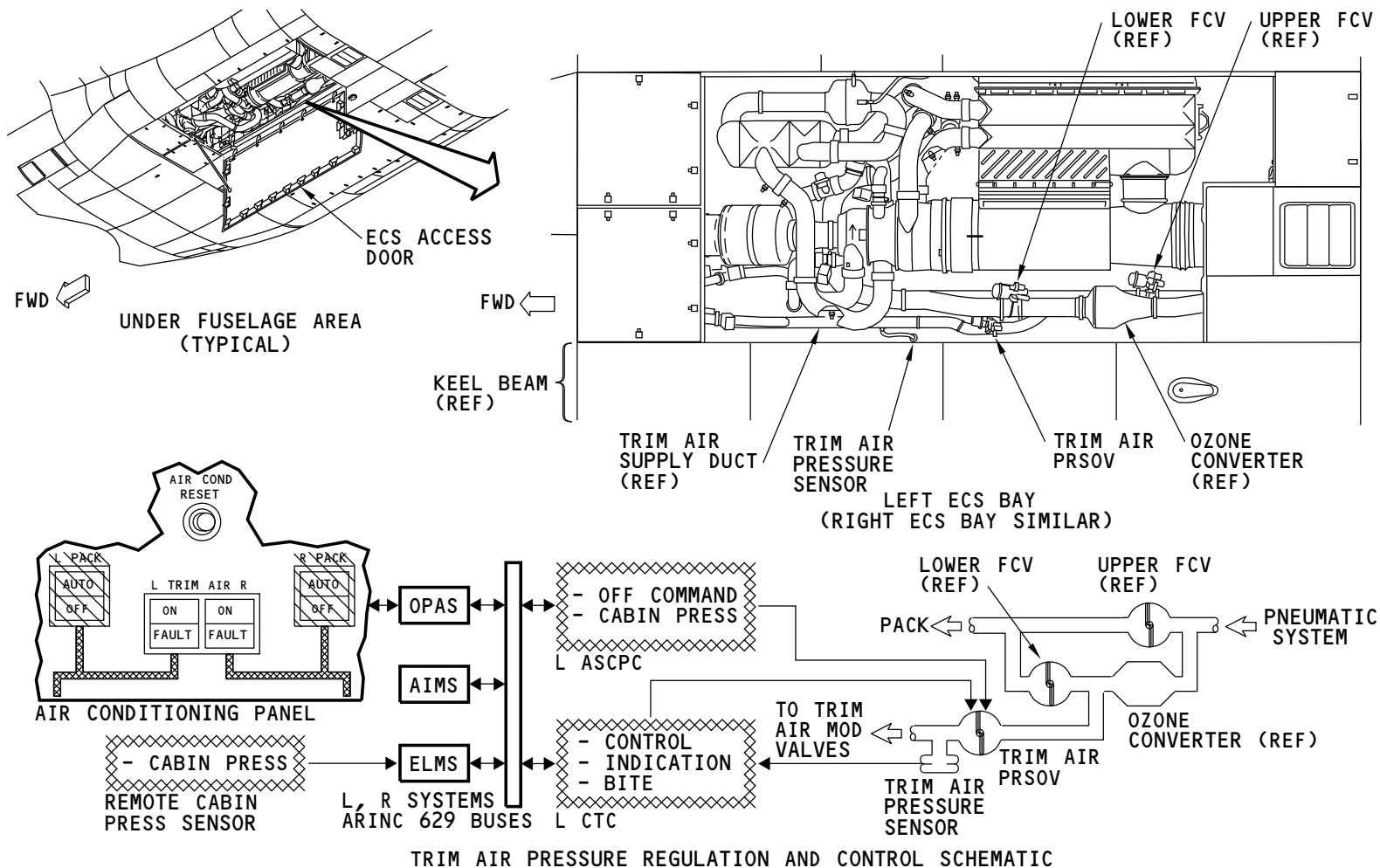
These components are in each ECS bay:

- Trim air pressure regulating and shutoff valve (PRSOV)
- Trim air pressure sensor (on the keel beam, forward of the trim air pressure regulating and shutoff valve).

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AIR CONDITIONING - TRIM AIR PRESS REGULATION AND SHUTOFF CTRL - INTRODUCTION

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AIR CONDITIONING - TRIM AIR PRESS REGULATION AND SHUTOFF CTRL - TRIM AIR PRSOV

General

The CTC uses the trim air pressure regulating and shutoff valve (PRSOV) to give shutoff control and to control the pressure of the air that goes to the trim air modulating valves. The CTC can also use the valve to give backup zone temperature regulation. See the zone temperature control and indication section for more information about the zone temperature control system (SECTION 21-61).

Location

The left and right trim air PRSOVs are in the related ECS bays next to the keel beam. You open the related ECS access door to get access to the valves.

Physical Description

These are the parts of the valve:

- Pneumatic actuator
- Locking crank/position indicator
- Shutoff solenoid
- Torque motor
- Valve disc
- Valve body
- Plug and filter (internal)
- Locking plug.

The valve is electrically controlled and pneumatically operated. This valve is not spring-loaded open or closed. The valve is fail safe off, if no power goes to the torque motor.

Functional Description

Control air pressure pushes on the open side of the pneumatic actuator to move the valve to open. Supply air pressure pushes on the close side of the pneumatic actuator to move the valve towards close. A change in the amount of the control air pressure makes the valve control trim air pressure downstream of the valve. The CTC uses the torque motor to set the amount of control air that goes to the pneumatic actuator.

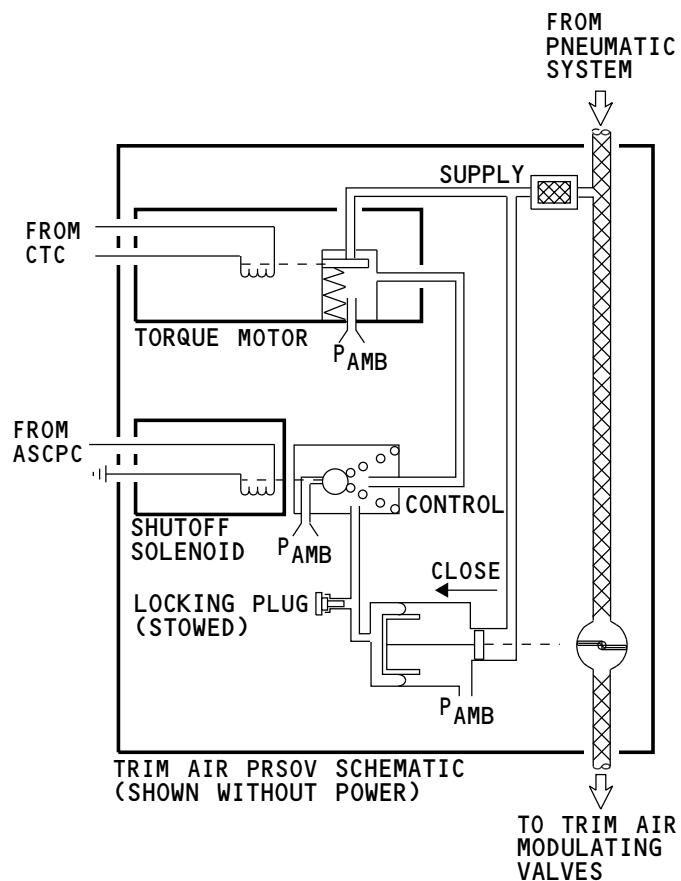
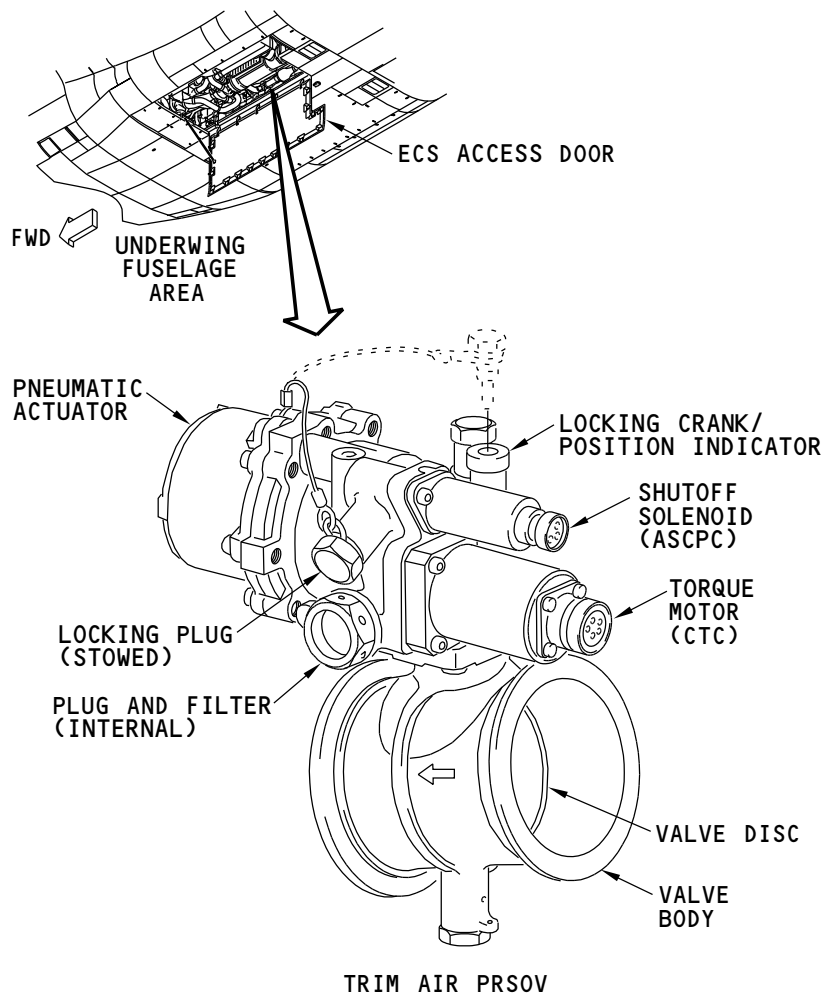
The torque motor operates like a spring-loaded-closed modulating valve. With no current to the torque motor, it is spring-loaded to stop control air and vents control pressure from the open side of the pneumatic actuator. This lets supply pressure move the actuator to close the trim air PRSOV (fail safe off). The amount of current that goes to the torque motor is directly related to the value to which the trim air PRSOV controls trim air pressure to. When the CTC increases current to the torque motor, control pressure to the pneumatic actuator increases, the valve disc opens more and downstream pressure increases.

The ASCPC uses the solenoid to give backup shutoff control for the trim air PRSOV. With no voltage to the solenoid, it is spring-loaded to let control pressure go from the torque motor to the open side of the pneumatic actuator. With 28v dc to the solenoid, it stops control air and vents control pressure from the open side of the pneumatic actuator.

See the page on the functional description of the trim air pressure regulation and shutoff control section for more information on trim air pressure control.

Training Information Point

You can use the locking plug and locking crank/position indicator to lock the trim air PRSOV closed. When you remove the locking plug from its stowed position, control pressure is vented.



AIR CONDITIONING - TRIM AIR PRESS REGULATION AND SHUTOFF CTRL - TRIM AIR PRSOV

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**AIR CONDITIONING - TRIM AIR PRESS REGULATION AND SHUTOFF CTRL - TRIM AIR PRESSURE SENSOR****Purpose**

The trim air pressure sensor monitors air pressure at the outlet of the trim air pressure regulating and shutoff valve.

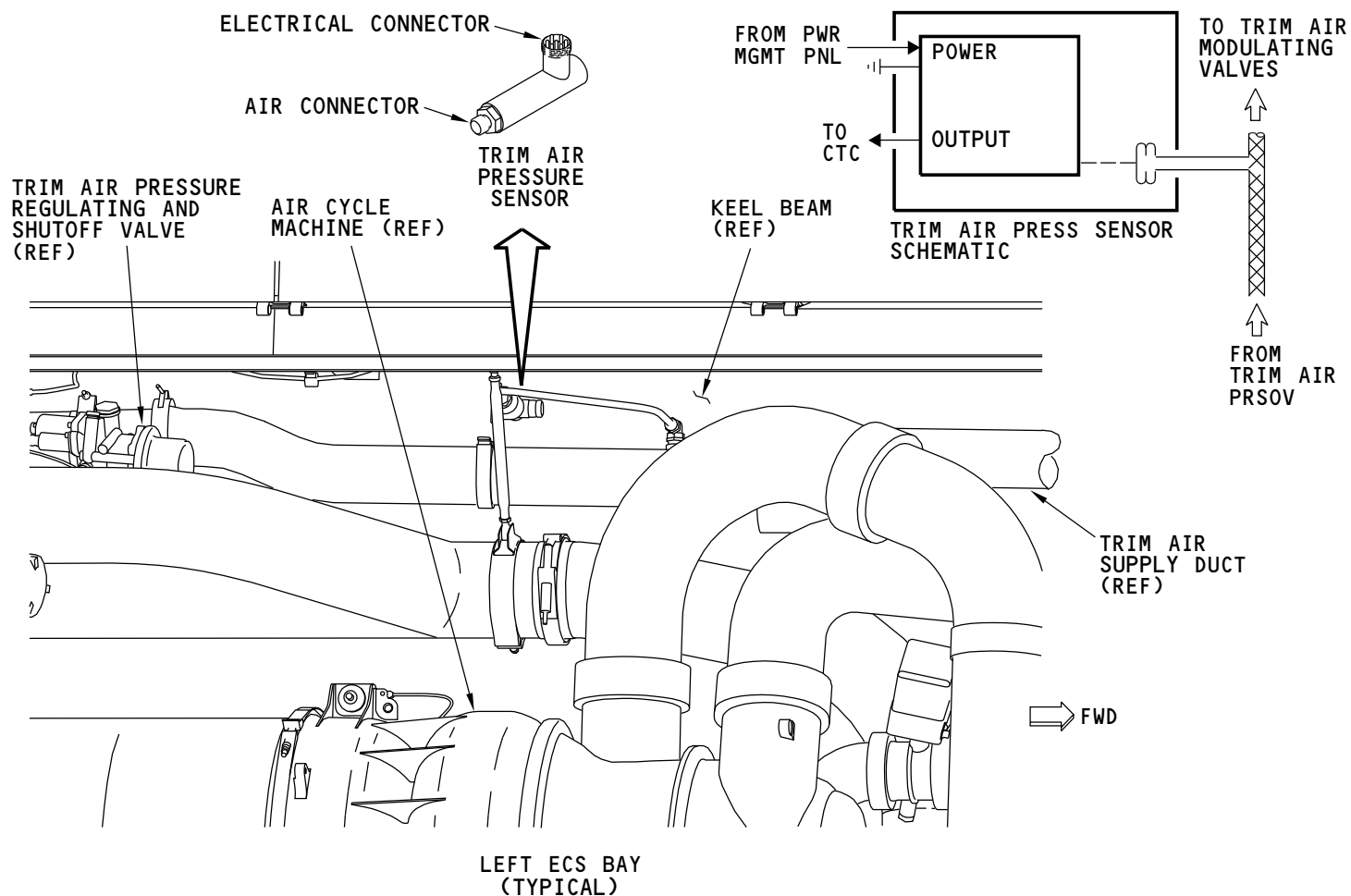
Physical Description

The sensor is an electronic device. It connects to the air duct through a small pressure line.

Location

The sensor mounts on the keel beam adjacent to the trim air pressure regulating and shutoff valve.

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AIR CONDITIONING - TRIM AIR PRESS REGULATION AND SHUTOFF CTRL - TRIM AIR PRESSURE SENSOR

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AIR CONDITIONING - TRIM AIR PRESS REGULATION AND SHUTOFF CTRL - FUNCTIONAL DESCRIPTION

CTC Control

The left cabin temperature controller (CTC) gives usual control of the trim air pressure regulating and shutoff valve (PRSOV). The left CTC uses information about airplane conditions to calculate the position of the trim air PRSOV. These components and systems give information to the left CTC:

- AIR COND RESET switch, resets latched conditions in the CTCs
- L TRIM AIR switch, in or out position
- Remote cabin pressure sensor, backup source for cabin pressure
- AGS, airplane on the ground condition used during the ASCPC preflight test
- AIMS, ground test conditions and indications
- WES, stall condition
- Left trim air pressure sensor, trim air supply duct pressure
- ASCPCs, primary source for cabin pressure and alternative close control for the trim air PRSOV.

The left trim air PRSOV opens only if all of these conditions occur:

- One or both air conditioning packs are on
- Pack flow schedule 4 is not selected
- Airplane is not in a stall condition
- Left trim air switch is set to the ON position
- Left trim air pressure sensor is not failed
- One of both channels of the left CTC operates
- No duct overheating condition in zones B, C, E, or F/D.

The usual pressure regulation value for the trim air PRSOV is 5 psi above cabin pressure.

The CTC can adjust the regulation value between 2 - 8.5 psi above cabin pressure. The CTC can adjust the regulation value as necessary to control zone temperature. The CTC does this only when a trim air modulating valve fails more than 10 percent open. See the zone temperature control and indication section for more information about the control of the trim air modulating valves (SECTION 21-61).

Duct Overheat

A duct overheat (190F, 88C) for zones that get conditioned air from the mix manifold causes the related trim air PRSOV to latch closed. A duct overheat (190F, 88C) for the flight deck zone can operate one of these two ways:

- If the left pack outlet temperature is less than 160F (71C), then the trim air PRSOV is latched closed
- If the left pack outlet temperature is equal to or more than 160F (71C), then the trim air PRSOV closes but does not latch.

This type of control makes sure the left trim system does not latch off when the left pack gives air to the flight deck at a high temperature. See the pack cooling and mix manifold temperature control section for more information about the temperature control function of the air conditioning pack (SECTION 21-52).

ASCPC Control

The air supply cabin pressure controller (ASCPC) can close the trim air pressure regulating and shutoff valve to decrease the load on the pneumatic system. The ASCPC closes the valve if any of these conditions occur:

- Airplane is in a stall condition
- Left trim air switch is set to the out position.

For the trim air system, the stall condition has a maximum time limit of 8 seconds. After 8 second the trim system returns to normal operation.

ASCPC Preflight Test

Immediately after an engine start, the ASCPCs send flow schedule 1 to the CTCs. The CTCs set the trim air pressure regulating and shutoff valves to the open position while the ASCPC does a test of its control over these valves. When the ASCPC completes this test (15 sec), the CTC sets the valves to the correct position, and the ASCPC releases control.

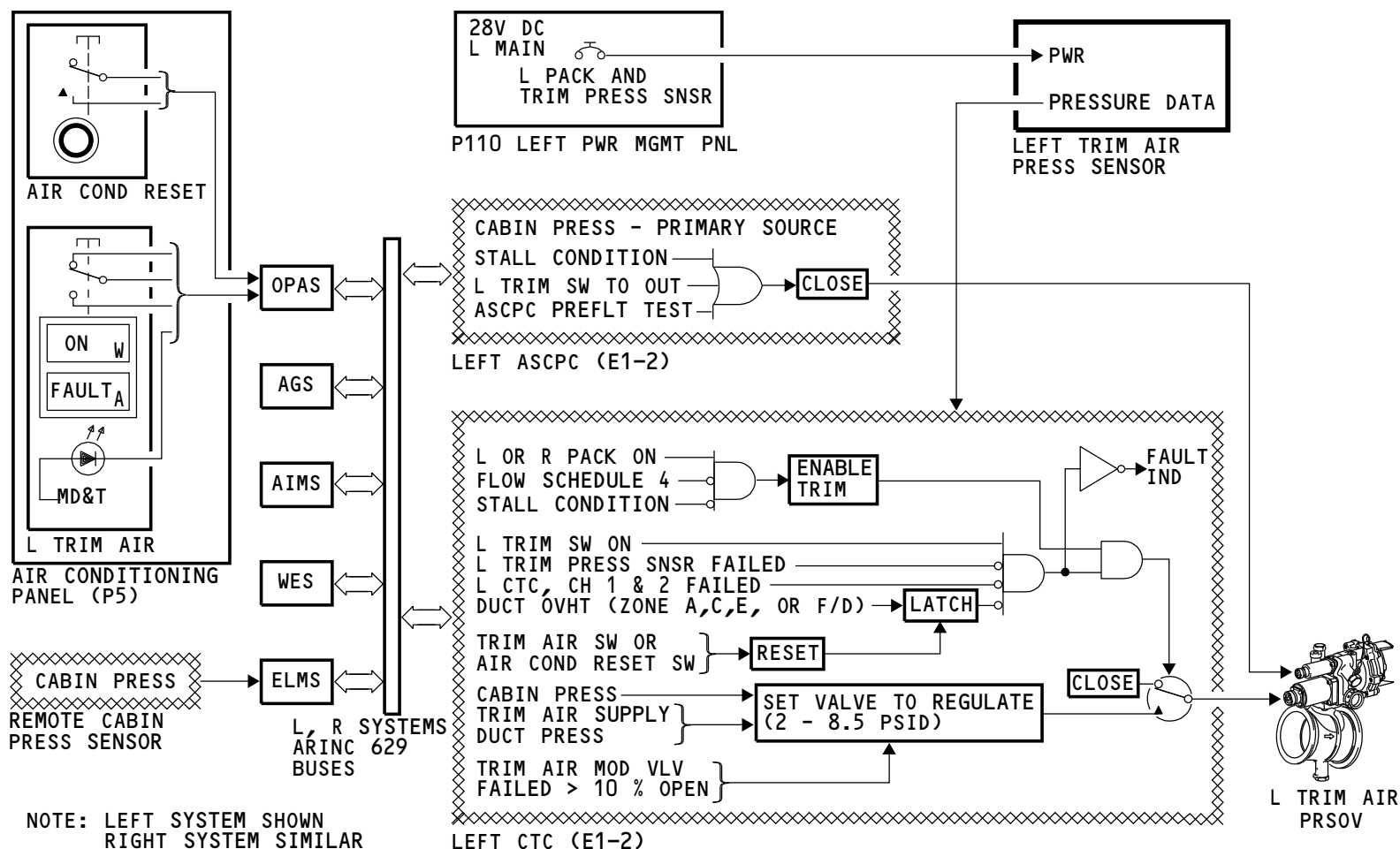
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AIR CONDITIONING - TRIM AIR PRESS REGULATION AND SHUTOFF CTRL - FUNCTIONAL DESCRIPTION

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**AIR CONDITIONING - OZONE CONTROL****Purpose**

Ozone control keeps ozone concentrations in the air flow to a satisfactory limit when the airplane is at high altitudes.

Physical Description

The ozone converter has no moving parts. It contains a catalytic material through which the air flows.

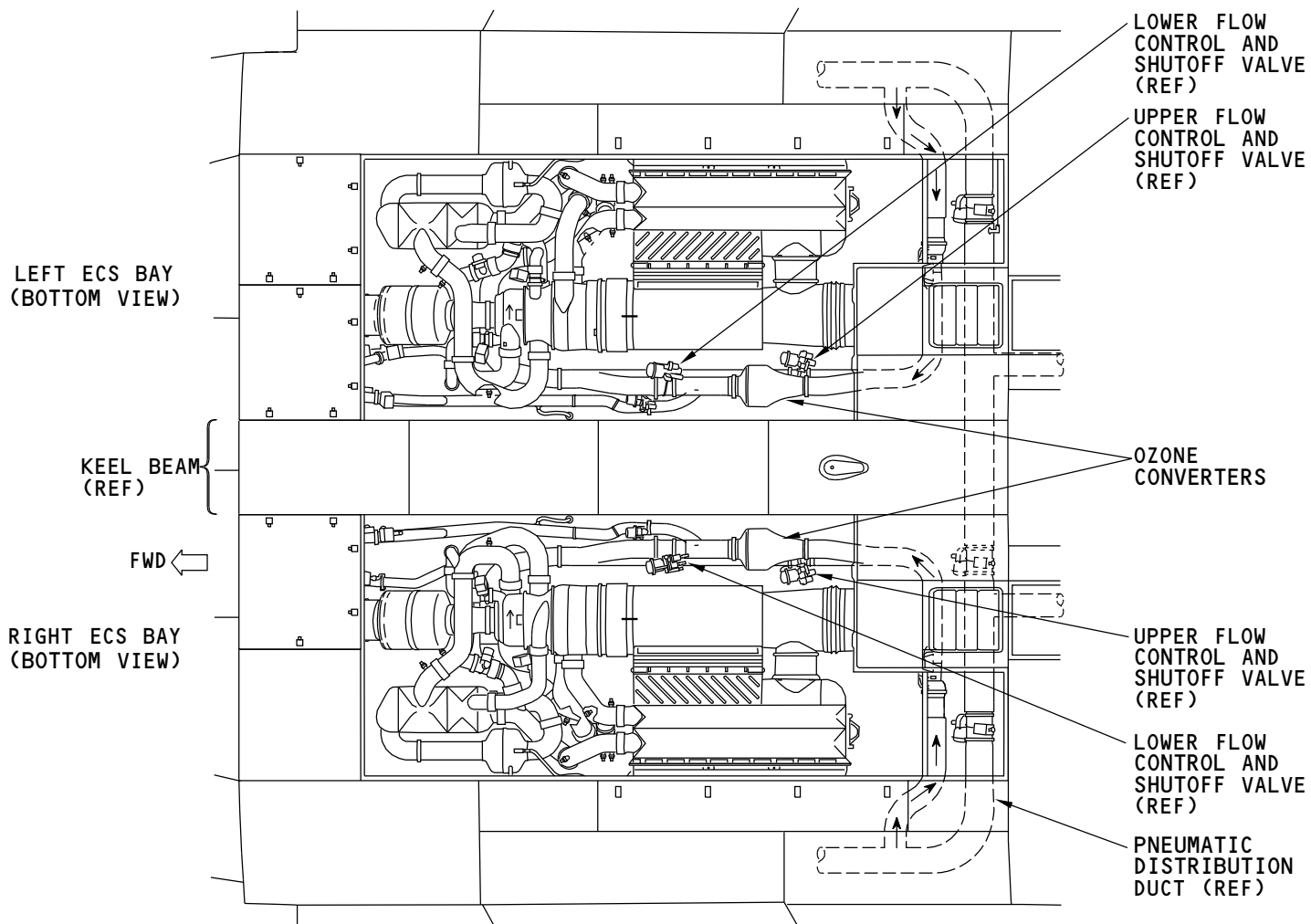
Location

An ozone converter is part of each pack in the ECS bay. It attaches to the lower air ducts that supply each pack. The converter is aft of the lower flow control valve and below the upper flow control valve.

Functional Description

The ozone converter is a catalytic device that removes ozone concentrations. Air goes through the converter before it flows into the pack. A chemical reaction in the converter changes ozone molecules to oxygen molecules.

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AIR CONDITIONING - OZONE CONTROL

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