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CAPACITY TESTS OF TWO REMOTE AIR-COOLED SIZE B REFRIGERANT CONDENSERS

Manufactured by
Kramer Trenton Company
Trenton, New Jersey

by

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Air Conditioning, Heating, and Refrigeration Section
Building Technology Division

to
Mechanical Engineering Division
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1. INTRODUCTION

Capacity tests were made of two specimens of Size B remote air-cooled refrigerant condensers manufactured by the Kramer Trenton Company of Trenton, New Jersey. These specimens were of identical dimensions and were identified for testing purposes as NBS 147-58 and NBS 146-58. Specimen NBS 147-58 was a Class 1 condenser and consisted of a copper coil with aluminum fins. Specimen NBS 146-58 was a Class 2 condenser and consisted of a copper coil with copper fins.

The tests were made with an apparatus conforming in most details to that described in the proposed ASRE Standard for remote air-cooled condensers, PS2.4. This apparatus provided a means for measuring the heat transfer capacity of the specimens by the psychrometric method and by the refrigerant flow method.

2. TEST PROCEDURE

The capacity tests were made at an ambient temperature of 110°F, established as a standard for QMR&E application.

These tests were a part of a series of tests planned under the Condenser Standardization Project, QMREL-M P.O. 57-26, to determine the possibility of standardizing air-cooled condenser performance on the basis of maximum overall dimensions and minimum air flow rate.

These condensers were tested with a Torrington propeller fan with air delivery capacity meeting the minimum requirement of the QMR&E Purchase Description dated March 22, 1957.

3. TEST RESULTS

The results obtained and the dimensional data describing these condensers are attached. Figure 1 indicates the shape and tube arrangement of both specimens, and uses letter symbols to identify the dimensions of the specimens as summarized in Tables 1 and 2. Table 1 describes the materials and construction of the Class 1 condenser with aluminum fins and lists significant dimensions of coil, fins, and complete unit. Table 2 summarizes the corresponding information on the Class 2 condenser with copper fins.

Tables 3 and 4 summarize the test data, and the heat rejection capacity ratings and heat transfer coefficients computed therefrom. Figure 2 is a pressure-enthalpy diagram labeled with the symbols used in the proposed ASRE Standard, PS2.4. This diagram indicates the changes occurring in state conditions of the refrigerant between the condenser inlet and outlet.

Two Size B, Class 1 condensers, NBS 135-57 and NBS 147-58, both manufactured by the Kramer Trenton Company, were received under this standardization project. As indicated by letter symbol K of item 1, in the section on Coil Dimensions of Table 1, specimen NBS 147-58 consisted of a 2-section coil. The upper section had 215 fins and the lower section had 218 fins. Specimen NBS 135-57, examined for comparison purposes, consisted of a 3-section coil with fins 16 in. high on the top section, 8 in. high on the middle section, and 10 in. high on the bottom section. The top section had 219 fins, the middle section had 216 fins, and the bottom section had 214 fins.

In order to provide a further means for comparing the performance of the various types of fins, tube arrangements, etc., of the several condensers in this test program, two additional coefficients were evaluated, which can be considered as Items 24 and 25 of Tables 3 and 4 as follows:

Item 24 Heat Rejection per Unit of Total Surface Area per Degree F Log Mean Temperature Difference, $\text{Btu/hr(ft}^2\text{)}(^{\circ}\text{F})$

Item 25 Heat Rejection per Unit of Total Surface Area per Degree F Log Mean Temperature Difference per cfm of Standard Air, $\text{Btu/hr(ft}^2\text{)}(^{\circ}\text{F})(\text{cfm})$

Addition to Table 2

<u>Item</u>	<u>QMR&E High Ambient Temperature</u> <u>Free Discharge</u>	
Specimen No.	NBS 147-58	NBS 146-58
Fin Material	Aluminum	Copper
24.	5.32	5.55
25.	0.00166	0.00174

In comparing the results on the two condensers, it will be noted that the Class 1 specimen with aluminum fins had about 2% more total surface area than the Class 2 specimen with copper fins, but the heat transfer coefficients shown as items 24 and 25 above were about 4% higher on the specimen having the copper fins. The rating of the specimen with aluminum fins was about 92% and that of the specimen with copper fins about 93% of the required value of 35,600 Btu/hr.

CONDENSER SPÉCIMEN

MFR. Kramer Trenton Co.

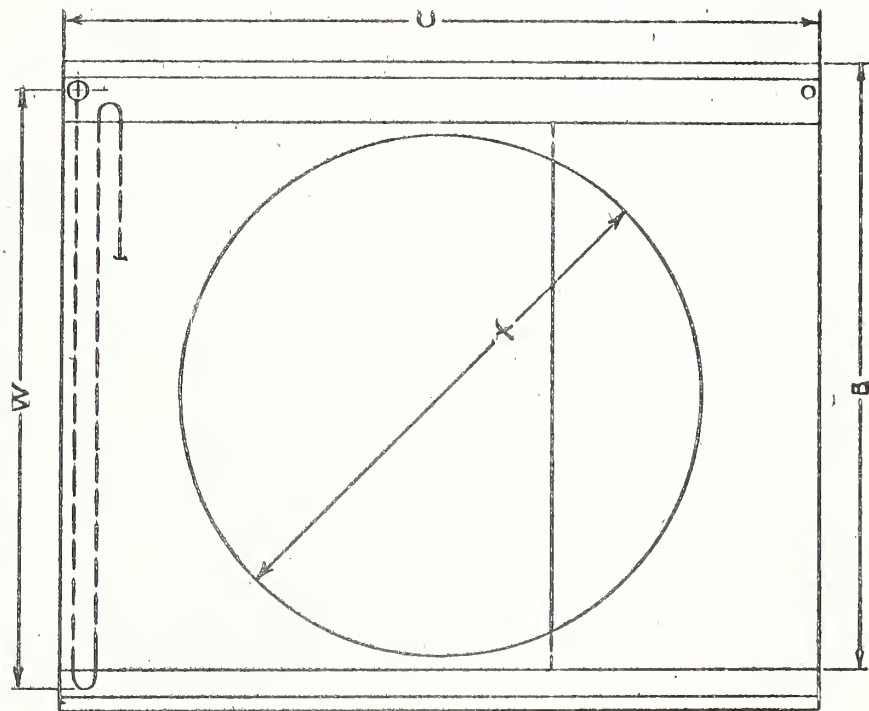
NBS NO. 147-58 146-58 SIZE - B

CLASS - 1 and 2

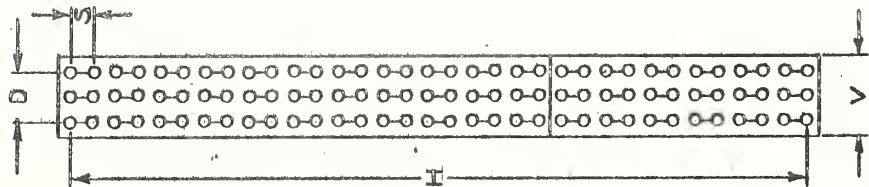
TOP VIEW



REAR VIEW
FACING AIR DISCHARGE



LEFT SIDE VIEW



RIGHT SIDE VIEW

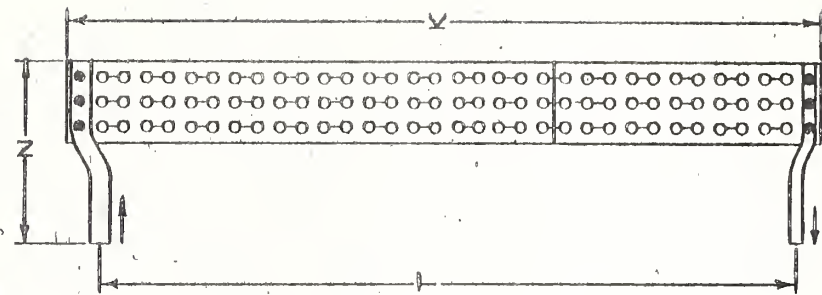
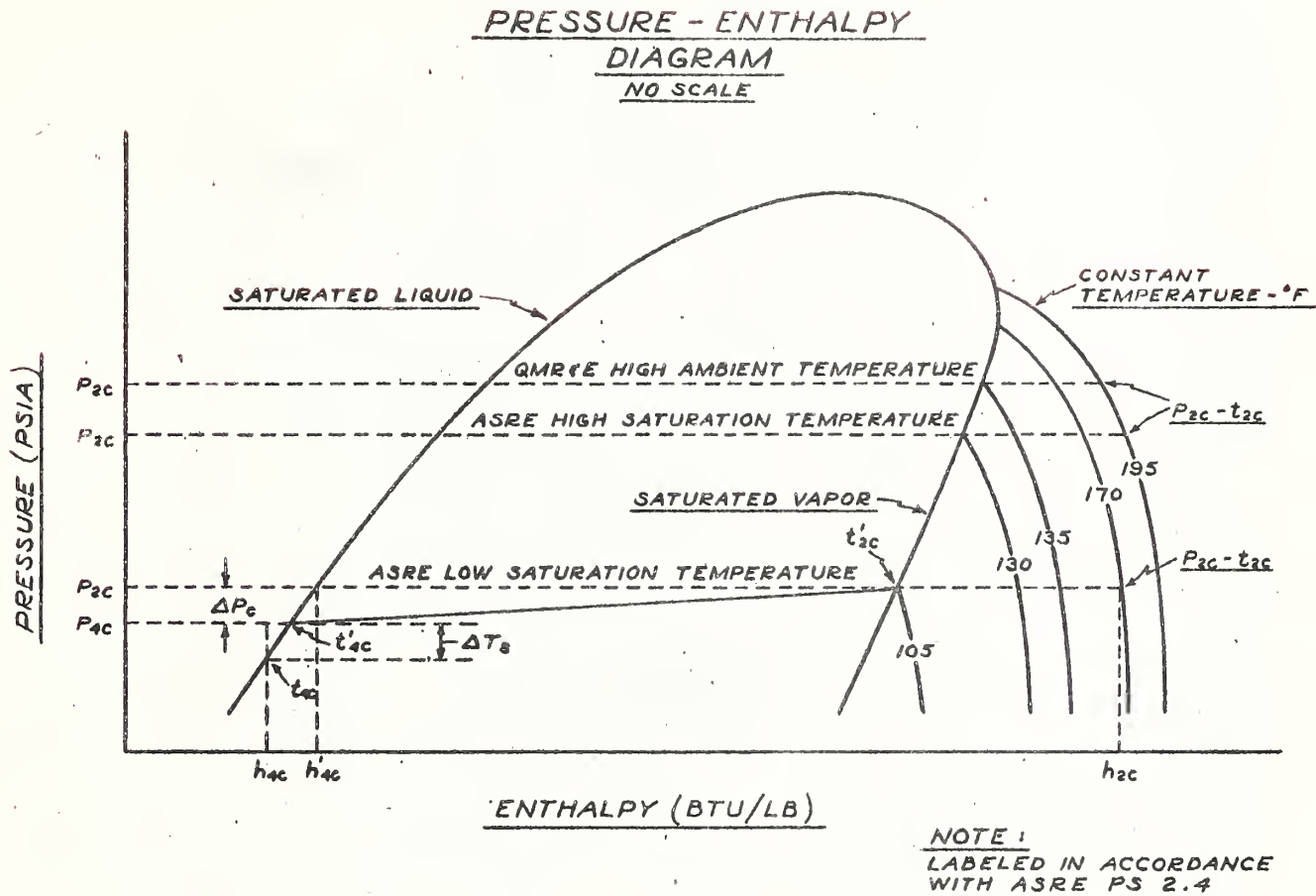


Figure 1



CONDENSER SPECIMEN
DIAGRAM

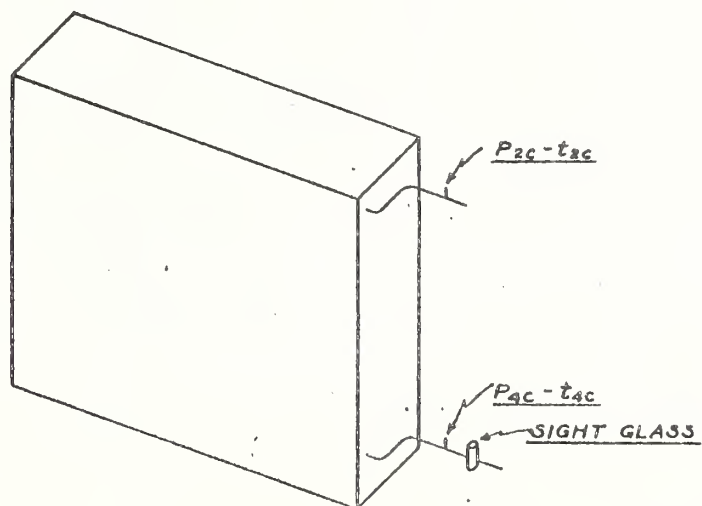


Figure 2

CONDENSER SPECIMEN

MFR. Kramer Trenton Company		SIZE - B	
NBS NO. 147-58		CLASS - 1	
ITEM		PROPERTY	REMARKS
COIL TUBE CHARACTERISTICS			
1 MATERIAL		Copper	Type L
2 NUMBER OF ROWS DEEP		3	
3 NUMBER OF TUBES HIGH		34	
4 NUMBER OF CIRCUITS IN PARALLEL		3	
5 NUMBER OF TUBES PER CIRCUIT		34	
6 TUBE DIAMETER, O.D., IN.		3/8	
7 TUBE WALL THICKNESS, IN.		0.030	
8 TUBE RETURN BEND DIAMETER, O.D., IN.		3/8	
9 GAS INLET CONNECTION DIAM., O.D., IN.		7/8	
10 LIQUID OUTLET CONN. DIAMETER, O.D., IN.		5/8	
11 VERTICAL TUBE SPACING, IN.	S	1.0	
12 PRIMARY SURFACE AREA, SQ. FT.		22.6	
COIL FIN CHARACTERISTICS			
1 MATERIAL		Aluminum	
2 TYPE OF FIN		Embossed	Rolled collar
3 FIN SPACING, PER INCH		8	215 fins on upper sec.
4 FIN THICKNESS, IN.		0.009	218 fins on lower sec.
5 SECONDARY SURFACE AREA, SQ. FT.		283.2	
COIL DIMENSIONS			
1 FINNED HEIGHT, IN.	K	34.0	fins in 2 sec. vertically
2 FINNED WIDTH, IN.	F	27.1	upper sec. 22 in. high
3 FINNED DEPTH, IN.	V	3.0	lower sec. 12 in. high
4 COIL HEIGHT, IN.	H	33.0	
5 COIL WIDTH, IN.	W	29.5	
6 COIL DEPTH, IN.	D	2.0	
7 COIL DEPTH, OVERALL, IN.	N	10.6	
8 FACE AREA, SQ. FT.		6.4	
9 TOTAL SURFACE AREA, SQ. FT.		305.8	
10 DISTANCE BETWEEN CONNECTIONS	T	31.0	
OVERALL CONDENSER DIMENSIONS			
1 WIDTH, OVERALL, IN.	A	32.5	
2 WIDTH, SHROUD, IN.	B	27.4	
3 HEIGHT, IN.	C	34.1	
4 DEPTH, IN.	E	11.0	
5 BELLMOUTH ORIFICE DIAMETER, IN.	X	24 5/8	
6 BELLMOUTH RADIUS, IN.	R	5/8	

Table 1

CONDENSER SPECIMEN

MFR. Kramer Trenton Company		SIZE - B	
NBS NO. 146-58		CLASS - 2	
ITEM		PROPERTY	REMARKS
COIL TUBE CHARACTERISTICS			
1 MATERIAL		Copper	Type L
2 NUMBER OF ROWS DEEP		3	
3 NUMBER OF TUBES HIGH		34	
4 NUMBER OF CIRCUITS IN PARALLEL		3	
5 NUMBER OF TUBES PER CIRCUIT		34	
6 TUBE DIAMETER, O.D., IN.		3/8	
7 TUBE WALL THICKNESS, IN.		0.030	
8 TUBE RETURN BEND DIAMETER, O.D., IN.		3/8	
9 GAS INLET CONNECTION DIAM., O.D., IN.		7/8	
10 LIQUID OUTLET CONN. DIAMETER, O.D., IN.		5/8	
11 VERTICAL TUBE SPACING, IN.	S	1.0	
12 PRIMARY SURFACE AREA, SQ. FT.		22.6	
COIL FIN CHARACTERISTICS			
1 MATERIAL		Copper	
2 TYPE OF FIN		Embossed	Rolled collar
3 FIN SPACING, PER INCH		8	211 fins on upper sec.
4 FIN THICKNESS, IN.		0.009	212 fins on lower sec.
5 SECONDARY SURFACE AREA, SQ. FT.		277.0	
COIL DIMENSIONS			
1 FINNED HEIGHT, IN.	K	34.0	fins in 2 sec. vertically
2 FINNED WIDTH, IN.	F	27.1	upper sec. 22 in. high
3 FINNED DEPTH, IN.	V	3.0	lower sec. 12 in. high
4 COIL HEIGHT, IN.	H	33.0	
5 COIL WIDTH, IN.	W	29.5	
6 COIL DEPTH, IN.	D	2.0	
7 COIL DEPTH, OVERALL, IN.	N	10.6	
8 FACE AREA, SQ. FT.		6.4	
9 TOTAL SURFACE AREA, SQ. FT.		299.7	
10 DISTANCE BETWEEN CONNECTIONS	T	31.0	
OVERALL CONDENSER DIMENSIONS			
1 WIDTH, OVERALL, IN.	A	32.5	
2 WIDTH, SHROUD, IN.	B	27.4	
3 HEIGHT, IN.	C	34.1	
4 DEPTH, IN.	E	11.0	
5 BELLMOUTH ORIFICE DIAMETER, IN.	X	24.6	
6 BELLMOUTH RADIUS, IN.	R	5/8	

Table 2

CONDENSER SPECIMEN

MFR. Kramer Trenton Co.			NBS NO. 146-58			SIZE - B			CLASS - 2		
AIR CIRCULATING EQUIPMENT AND REFRIGERANT USED			ASRE HIGH SATURATION TEMPERATURE			ASRE LOW SATURATION TEMPERATURE			QMR & E HIGH AMBIENT TEMPERATURE		
FAN MFR. — Torrington FAN SERIAL NO. — E-2420-4 FAN SPEED — 1140 rpm MOTOR HP RATING — 0.500 REFRIGERANT — Freon-12			STANDARD CONDITION		OBSERVED CONDITION	STANDARD CONDITION		OBSERVED CONDITION	STANDARD CONDITION		OBSERVED CONDITION
			AIR FLOW RATE CFM		AIR FLOW RATE CFM	AIR FLOW RATE CFM		AIR FLOW RATE CFM	AIR FLOW RATE CFM		AIR FLOW RATE CFM
			HIGH	FREE DISCH.	LOW	FREE DISCHARGE		FREE DISCHARGE			
ITEM			29.921	95		29.921	95		29.921	110	29.42
1. BAROMETRIC PRESSURE			P _{ab}	"Hg							
2. DRY BULB TEMPERATURE OF AIR ENTERING COIL			t _{ae}	°F							110.0
3. WET BULB TEMPERATURE OF AIR ENTERING COIL			t _{we}	°F	75±5		75±5				75.0
4. DRY BULB TEMPERATURE OF AMBIENT AIR			t _{ae}	°F	95		95		110		110.0
5. SATURATION TEMPERATURE OF ENTERING REFRIGERANT VAPOR			t _{sc}	°F	130		105		135		135.1
6. SUPERHEAT TEMPERATURE OF ENTERING REFRIGERANT VAPOR			t _{sc}	°F	195±10		170±10				197.4
			AIR FLOW METHOD			AIR FLOW METHOD					
7. NOZZLE AIR AND WATER VAPOR MIXTURE FLOW RATE			Q _{ad}	CFM							3580
8. TOTAL HEAT REJECTION CAPACITY			q _{tc}	BTUH							33250
			REFRIGERANT FLOW METHOD			REFRIGERANT FLOW METHOD					
9. REFRIGERANT FLOW RATE			W _r	lb/min							8.62
10. CONDENSER COIL INTERNAL PRESSURE DROP			ΔP _c	PSI							8.25
11. SUBCOOLING OF LEAVING REFRIGERANT LIQUID			ΔT _s	°F	10° MAX.		5° MAX.				7.9
12. TOTAL HEAT REJECTION CAPACITY			q _{tr}	BTUH							33550
			RATINGS			RATINGS					
13. TOTAL HEAT REJECTION			q _{tr}	BTUH							33200
14. CONDENSING HEAT REJECTION			q _{cr}	BTUH							31750
15. SUBCOOLING HEAT REJECTION			q _{sr}	BTUH							1450
16. AIR FLOW RATE			Q _r	CFM							3190
17. CONDENSER COIL EXTERNAL RESISTANCE			P _{as}	"H ₂ O							0.16
18. FAN MOTOR POWER			P _{tm}	WATTS							503
19. FAN BRAKE HORSEPOWER			P	BHP							
20. HEAT REJECTION PER UNIT PRIMARY SURFACE AREA			BTUH/SF								1467
21. HEAT REJECTION PER UNIT SECONDARY SURFACE AREA			BTUH/SF								119.9
22. HEAT REJECTION PER UNIT TOTAL SURFACE AREA			BTUH/SF								110.8
23. HEAT REJECTION PER CFM			BTUH								10.4

Table 3

CONDENSER SPECIMEN

MFR. Kramer Trenton Co.			NBS NO. 147-58			SIZE - B			CLASS - 1		
AIR CIRCULATING EQUIPMENT AND REFRIGERANT USED			ASRE HIGH SATURATION TEMPERATURE			ASRE LOW SATURATION TEMPERATURE			QMR & HIGH AMBIENT TEMPERATURE		
FAN MFR. Torrington FAN SERIAL NO. E-2420-4 FAN SPEED 1140 rpm MOTOR HP RATING 0.500 REFRIGERANT Freon-12			STANDARD CONDITION	OBSERVED CONDITION		STANDARD CONDITION	OBSERVED CONDITION		STANDARD CONDITION	OBSERVED CONDITION	
				AIR FLOW RATE CFM			AIR FLOW RATE CFM			AIR FLOW RATE CFM	
				HIGH	FREE DISCH.		LOW	FREE DISCH.		FREE DISCHARGE	
ITEM			AIR FLOW METHOD			AIR FLOW METHOD			REFRIGERANT FLOW METHOD		
1. BAROMETRIC PRESSURE			P _{ab}	"Hg	29.921			29.921			29.60
2. DRY BULB TEMPERATURE OF AIR ENTERING COIL			t _{ae}	°F	95			95			110.1
3. WET BULB TEMPERATURE OF AIR ENTERING COIL			t _{we}	°F	75 ± 5			75 ± 5			76.2
4. DRY BULB TEMPERATURE OF AMBIENT AIR			t _{ae}	°F	95			95			110.1
5. SATURATION TEMPERATURE OF ENTERING REFRIGERANT VAPOR			t _{sc}	°F	130			105			135.3
6. SUPERHEAT TEMPERATURE OF ENTERING REFRIGERANT VAPOR			t _{sc}	°F	195 ± 10			170 ± 10			195.4
7. NOZZLE AIR AND WATER VAPOR MIXTURE FLOW RATE			Q _{ad}	CFM							3570
8. CAPACITY			q _{tc}	BTUH							32650
9. REFRIGERANT FLOW RATE			W _r	lb/min							8.57
10. CONDENSER COIL INTERNAL PRESSURE DROP			ΔP _c	PSI							6.45
11. SUBCOOLING OF LEAVING REFRIGERANT LIQUID			ΔT _s	°F	10° MAX.			5° MAX.			9.7
12. CAPACITY			q _{tr}	BTUH							33300
			RATINGS			RATINGS			RATINGS		
13. TOTAL HEAT REJECTION			q _{tr}	BTUH							32750
14. CONDENSING HEAT REJECTION			q _{cr}	BTUH							31150
15. SUBCOOLING HEAT REJECTION			q _{sr}	BTUH							1650
16. AIR FLOW RATE			Q _r	CFM							3200
17. CONDENSER COIL EXTERNAL RESISTANCE			P _{es}	"H ₂ O							0.17
18. FAN MOTOR POWER			P _{fm}	WATTS							503
19. FAN BRAKE HORSEPOWER			P	BHP							-
20. HEAT REJECTION PER UNIT PRIMARY SURFACE AREA			BTUH/SF								1446
21. HEAT REJECTION PER UNIT SECONDARY SURFACE AREA			BTUH/SF								115.6
22. HEAT REJECTION PER UNIT TOTAL SURFACE AREA			BTUH/SF								107.0
23. HEAT REJECTION PER CFM			BTUH								10.2

Table 4



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