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CAPACITY TESTS OF A REMOTE AIR-COOLED  
SIZE B, CLASS I REFRIGERANT CONDENSER

MANUFACTURED BY  
THERMO KING CORPORATION

by

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to

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1. Introduction

Capacity tests were made of a remote air-cooled refrigerant condenser, Size B, Class I, manufactured by the Thermo King Corporation of Minneapolis, Minnesota. This specimen was identified for testing purposes as NBS 178-58.

The tests were made with an apparatus conforming in most details to that described in the proposed ASRE Standard, PS 2.4, for remote air-cooled condensers. This apparatus provided a means for measuring the heat transfer capacity of this specimen by the psychrometric method and by the refrigerant flow method.

2. Test Procedure

Capacity tests were made at two values of saturation temperature of the refrigerant vapor entering the condenser, following the procedure and test conditions set forth in ASRE PS 2.4. At the higher saturation temperature of 130°F, tests were made at three air flow rates; namely, at the free discharge capacity of the fan, and at one lower and one higher value, ranging from 2950 cfm to 4100 cfm. In addition, one test was made at the high ambient temperature of 110°F, established as a standard for QMR&E application.

These tests are 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.

This condenser was tested with a Torrington propeller fan with air delivery capacity meeting the minimum requirement of the QMR&E Purchase Description dated March 22, 1957. However,



this condenser did not come equipped with a shroud or bellmouth orifice plate. To facilitate the tests, these parts were fabricated by the Sheet Metal Shop at NBS. A bellmouth radius of approximately  $3/8$ ", somewhat less than the QMR&E established minimum of  $1/2$ "; and an orifice diameter varying from the QMR&E specified value of  $24\ 1/2$ " by not more than  $\pm 1/8$ " were constructed for the tests.

### 3. Test Results

The results obtained and the dimensional data describing this condenser are attached. Fig. 1 indicates the shape and tube arrangement, and uses letter symbols to identify the dimensions of the specimen as summarized in Table 1. Table 1 describes the materials and construction of the condenser and lists significant dimensions of coil, fins, and complete unit.

Table 2 summarizes the test data and the heat rejection capacity ratings and heat transfer coefficients computed therefrom. Fig. 2 is a pressure-enthalpy diagram labeled with the symbols used in the proposed ASRE Standard, PS 2.4. This diagram indicates the changes in state conditions of the refrigerant occurring between the condenser inlet and outlet.

In order to provide a further means for comparing the performance of the various arrangements of tubes, tube arrangements, fins, etc., of the several condensers in this test program, two additional coefficients, which can be considered as Items 24 and 25 of Table 2, are as follows:

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

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



Addition to Table 2

<u>Item</u>	<u>ASRE High Sat'n. Temp.</u>			<u>ASRE Low Sat'n. Temp.</u>	<u>QMR&amp;E High Ambient Temp.</u>
	<u>High</u>	<u>Free Discharge</u>	<u>Low</u>		
24	7.77	7.18	6.74	5.81	7.30
25	.00207	.00207	.00250	.00175	.00230

It should be noted that the heat rejection capacity of this condenser at the QMR&E High Ambient Temperature conditions was 102.5 percent of the required value of 35,600 Btu per hour.





# CONDENSER SPECIMEN

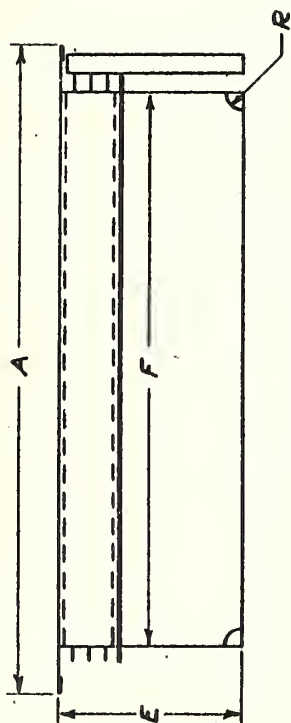
MFR. Thermo King Corp.

NBS NO. 178-58

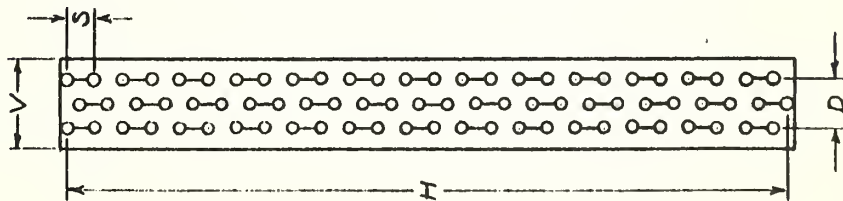
SIZE - B

CLASS - 1

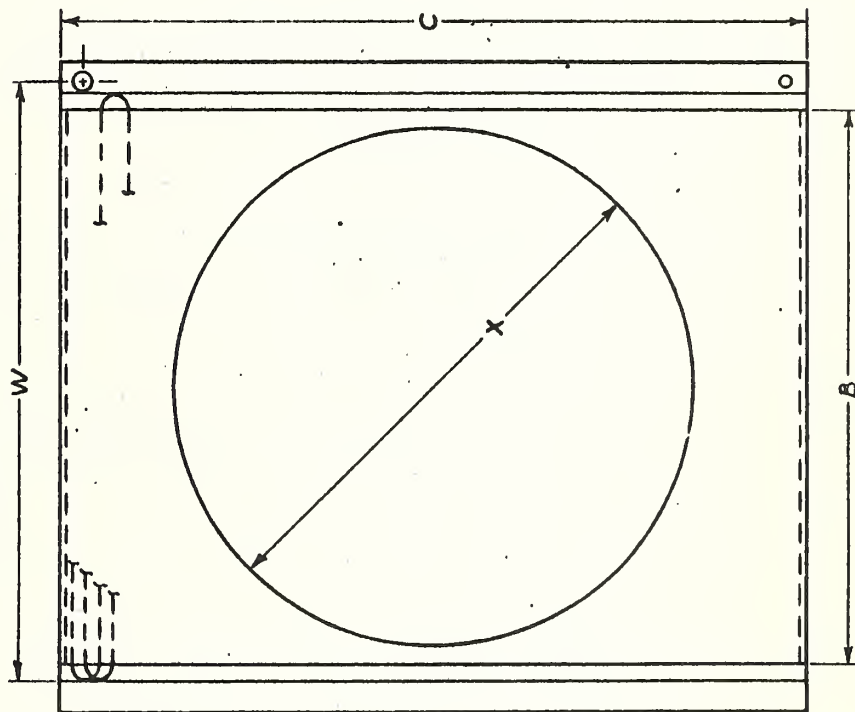
TOP VIEW



LEFT SIDE VIEW



REAR VIEW  
FACING AIR DISCHARGE



RIGHT SIDE VIEW

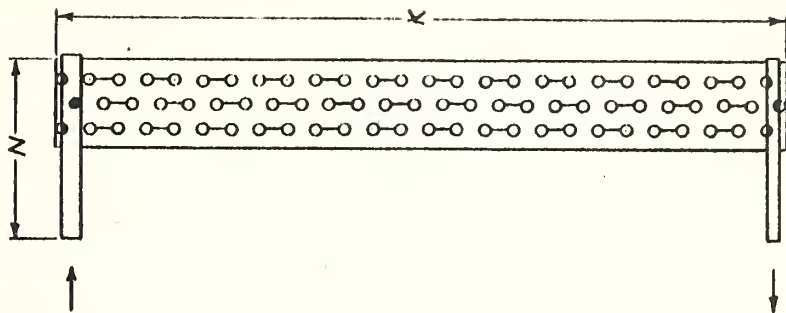
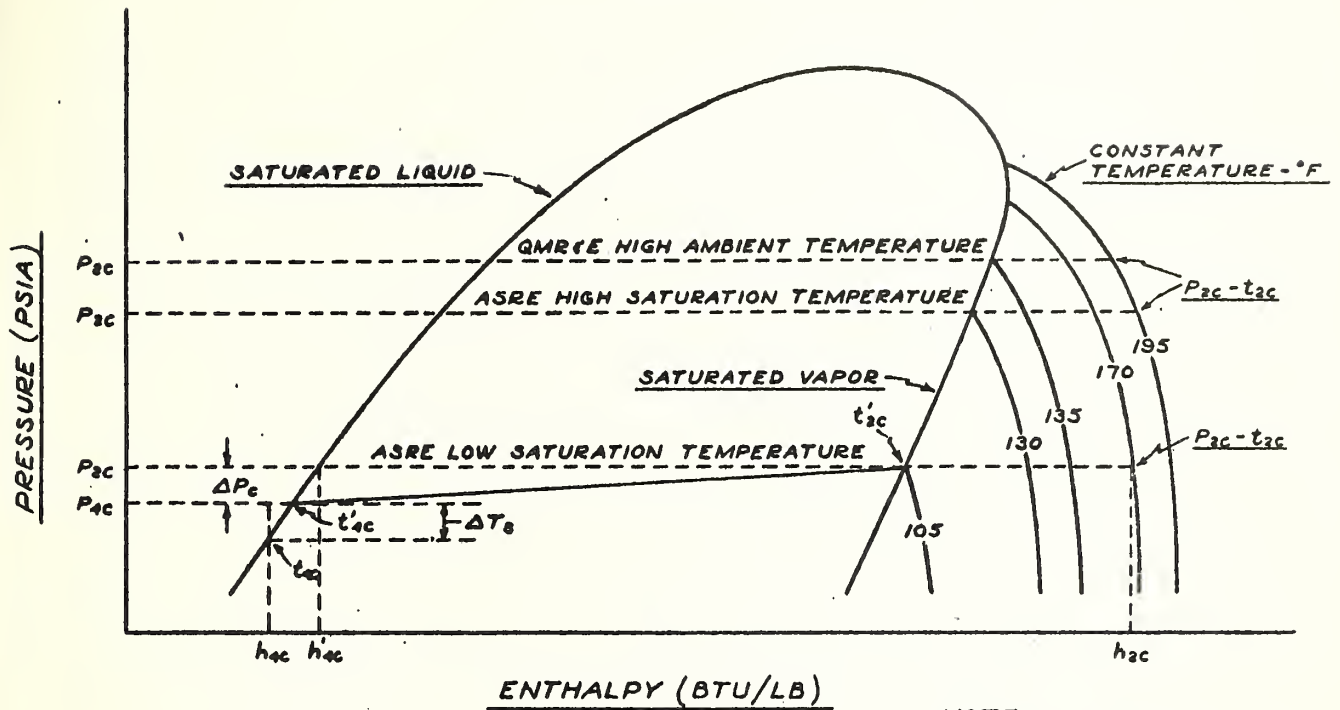


Fig 1



PRESSURE - ENTHALPY  
DIAGRAM  
NO SCALE



NOTE 1  
LABELED IN ACCORDANCE  
WITH ASRE PS 2.4

CONDENSER SPECIMEN  
DIAGRAM

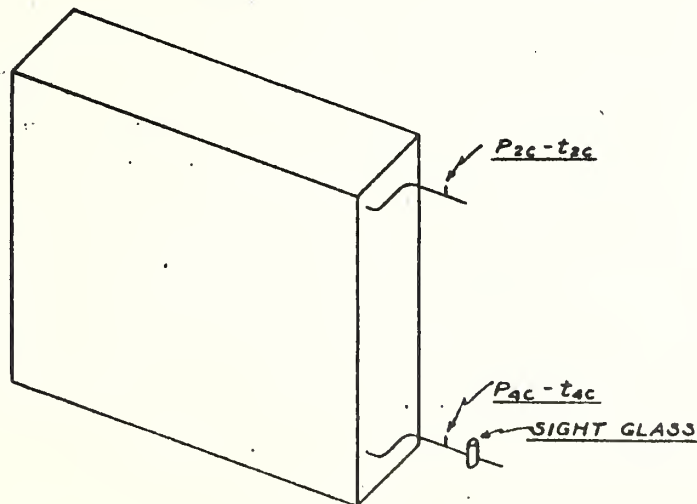


Fig 2



# CONDENSER SPECIMEN

MFR. Thermo King, Corp.		SIZE - B	
NBS NO. 178-58		CLASS - 1	
ITEM		PROPERTY	REMARKS
COIL TUBE CHARACTERISTICS			
1 MATERIAL		Copper	Type L
2 NUMBER OF ROWS DEEP		3	
3 NUMBER OF TUBES HIGH		26	
4 NUMBER OF CIRCUITS IN PARALLEL		3	
5 NUMBER OF TUBES PER CIRCUIT		26	
6 TUBE DIAMETER, O.D., IN.		1/2	
7 TUBE WALL THICKNESS, IN.		0.042	
8 TUBE RETURN BEND DIAMETER, O.D., IN.		1/2	
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	1.3	
12 PRIMARY SURFACE AREA, SQ. FT.		23.2	
COIL FIN CHARACTERISTICS			
1 MATERIAL		Aluminum	
2 TYPE OF FIN		Flat	Rolled Collar
3 FIN SPACING, PER INCH		8	191 Fins
4 FIN THICKNESS, IN.		0.015	
5 SECONDARY SURFACE AREA, SQ. FT.		238.3	
COIL DIMENSIONS			
1 FINNED HEIGHT, IN.	K	32.5	
2 FINNED WIDTH, IN.	F	27.0	
3 FINNED DEPTH, IN.	V	3.0	
4 COIL HEIGHT, IN.	H	31.9	
5 COIL WIDTH, IN.	W	29.5	
6 COIL DEPTH, IN.	D	2.0	
7 COIL DEPTH, OVERALL, IN.	N	10.8	
8 FACE AREA, SQ. FT.		6.2	
9 TOTAL SURFACE AREA, SQ. FT.		261.5	
OVERALL CONDENSER DIMENSIONS			
1 WIDTH, OVERALL, IN.	A	32.5	
2 WIDTH, SHROUD, IN.	B	27.5	Manufactured by NBS
3 HEIGHT, IN.	C	34.1	
4 DEPTH, IN.	E	11.0	
5 BELLMOUTH ORIFICE DIAMETER, IN.	X	24.5	Manufactured by NBS
6 BELLMOUTH RADIUS, IN.	R	3/8	Manufactured by NBS

Table 1





# CONDENSER SPECIMEN

MFR. Thermo King Corp.				NBS NO. 178-58				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				OBSERVED CONDITION				STANDARD CONDITION				OBSERVED CONDITION			
FAN SERIAL NO. E-2420-4				AIR FLOW RATE CFM				AIR FLOW RATE CFM				AIR FLOW RATE CFM			
FAN SPEED 1140				HIGH FREE DISCH. LOW				STANDARD CONDITION				FREE DISCHARGE			
MOTOR HP RATING 0.500				29.921 29.73 29.81 29.92				29.921 95 95 95				29.29 29.29 29.29 29.29			
REFRIGERANT Freon-12				75±5 75.0 75.2 77.0				75±5 95 95 95				75.2 75.2 75.2 75.2			
ITEM				95 95 95 95				130 130 130 130				105 105 105 105			
1. BAROMETRIC PRESSURE				194.7 194.6 195.2 195.2				170±10 170±10 170±10 170±10				172.0 172.0 172.0 172.0			
2. DRY BULB TEMPERATURE OF AIR ENTERING COIL				AIR FLOW METHOD				AIR FLOW METHOD				AIR FLOW METHOD			
3. WET BULB TEMPERATURE OF AIR ENTERING COIL				REFRIGERANT FLOW METHOD				REFRIGERANT FLOW METHOD				REFRIGERANT FLOW METHOD			
4. DRY BULB TEMPERATURE OF AMBIENT AIR				RATINGS				RATINGS				RATINGS			
5. SATURATION TEMPERATURE OF SATURATING REFRIGERANT VAPOR				14.47 12.95 11.73				3.12 2.45 2.44				3.29 0.55 1.0 1.0			
6. ENTERING REFRIGERANT VAPOR				56500 50050 45500				6.6 3.7 3.8				13300 13300 13300 13300			
7. NOZZLE AIR AND WATER VAPOR MIXTURE FLOW RATE				56100 50900 46300				14.47 12.95 11.73				13050 13050 13050 13050			
8. TOTAL HEAT REJECTION				54350 49950 45400				3.12 2.45 2.44				13000 13000 13000 13000			
9. CAPACITY				1750 950 900				6.6 3.7 3.8				50 50 50 50			
10. REFRIGERANT FLOW RATE				3750 3320 2700				56500 50050 45500				3320 3320 3320 3320			
11. CONDENSER COIL INTERNAL PRESSURE DROP				0.24 0.20 0.13				56500 50050 45500				0.20 0.20 0.20 0.20			
12. SUBCOOLING OF LEAVING REFRIGERANT LIQUID				450 520 600				56500 50050 45500				520 520 520 520			
13. TOTAL HEAT REJECTION				- - -				56500 50050 45500				- - -			
14. CONDENSING HEAT REJECTION				2418 2194 1996				56500 50050 45500				563 563 563 563			
15. SUBCOOLING HEAT REJECTION				235.4 213.6 194.3				56500 50050 45500				54.8 54.8 54.8 54.8			
16. AIR FLOW RATE				214.5 194.6 177.1				56500 50050 45500				49.9 49.9 49.9 49.9			
17. CONDENSER COIL EXTERNAL RESISTANCE				15.0 15.3 17.1				56500 50050 45500				3.9 3.9 3.9 3.9			
18. FAN MOTOR POWER				BTU/SF				56500 50050 45500				1573 1573 1573 1573			
19. FAN BRAKE HORSEPOWER				BTU/SF				56500 50050 45500				153.2 153.2 153.2 153.2			
20. HEAT REJECTION PER UNIT PRIMARY SURFACE AREA				BTU/SF				56500 50050 45500				139.6 139.6 139.6 139.6			
21. HEAT REJECTION PER UNIT SECONDARY SURFACE AREA				BTU/SF				56500 50050 45500				11.5 11.5 11.5 11.5			
22. HEAT REJECTION PER UNIT TOTAL SURFACE AREA				BTU/SF				56500 50050 45500				11.5 11.5 11.5 11.5			
23. HEAT REJECTION PER CFM				BTU				56500 50050 45500				11.5 11.5 11.5 11.5			

Table 2

