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NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		**NBS REPORT**
1003-20-4891	May 27, 1959	6420

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

Manufactured by
McQuay, Incorporated
Minneapolis, Minnesota

by

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Air Conditioning, Heating, and Refrigeration Section
Building Technology Division

to

Mechanical Engineering Division
Headquarters,
Quartermaster Research and Engineering Command
Natick, Massachusetts

NBS

U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

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1. INTRODUCTION

A capacity test was made of a remote air-cooled refrigerant condenser, Size B, Class I, manufactured by McQuay, Inc., of Minneapolis, Minnesota. This specimen was identified for testing purposes as NBS 194-59.

This test was made with an apparatus conforming in most details to that described in the proposed ASRE Standard for remote air-cooled condensers, PS 2.4. 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

This capacity test was made at an ambient temperature of 110°F, established as a standard for QMR&E application.

This test is 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.

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 types of fins, tube arrangements, 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 $(ft^2)(°F)$
Item 25	Heat Rejection per Unit of Total Surface Area per Degree F Log Mean Temperature Difference per cfm of Standard Air, Btu/hr $(ft^2)(°F)(cfm)$

Addition to Table 2

Item	QMR&E High Ambient Temperature Free Discharge
24	7.08
25	0.00214

It should be noted that the heat rejection capacity of this condenser was 90 percent of the required value of 35,600 Btu per hour.

CONDENSER SPECIMEN

MFR. McQuay, Inc. NBS NO. 194-59 SIZE - B CLASS - 1

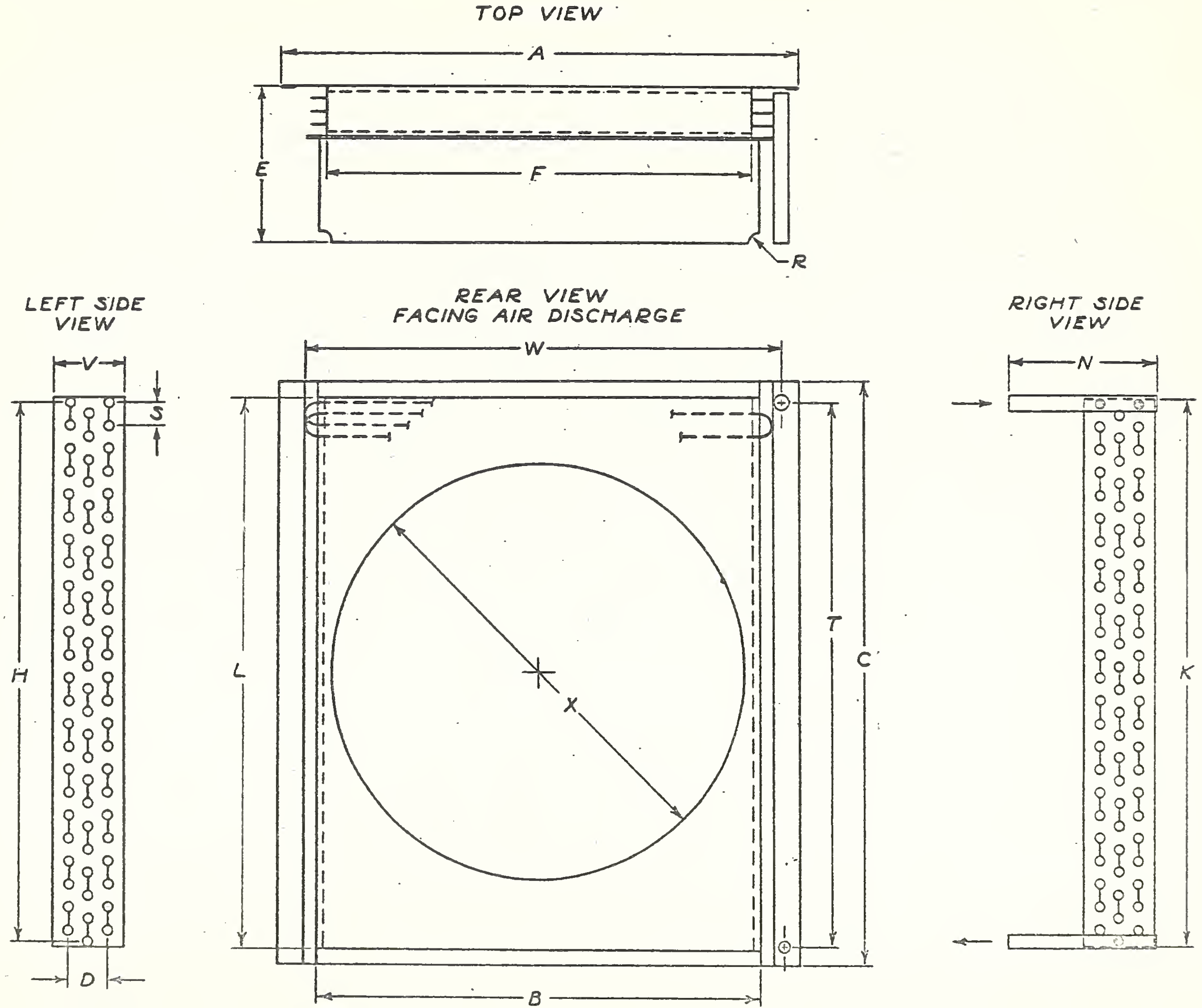
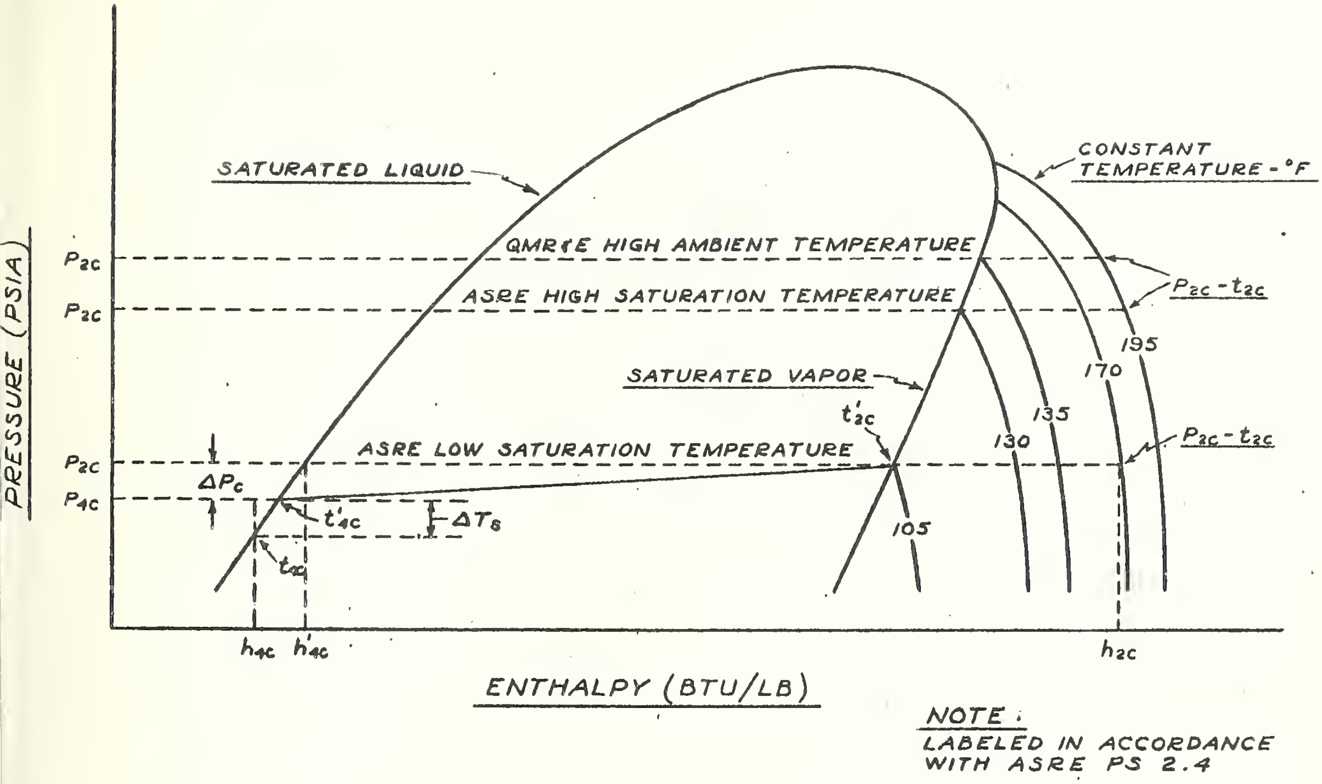


Figure 1

PRESSURE - ENTHALPY DIAGRAM

NO SCALE



CONDENSER SPECIMEN DIAGRAM

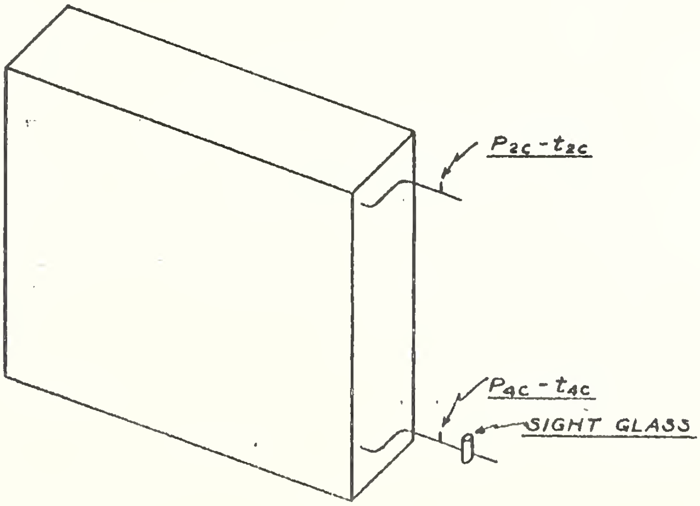


Figure 2

CONDENSER SPECIMEN

MFR. McQuay, Inc.		SIZE - B
NBS NO. 194-59		CLASS - 1

ITEM	PROPERTY	REMARKS
COIL TUBE CHARACTERISTICS		
1 MATERIAL	Copper	Type L
2 NUMBER OF ROWS DEEP	3	
3 NUMBER OF TUBES HIGH	24	
4 NUMBER OF CIRCUITS IN PARALLEL	3	
5 NUMBER OF TUBES PER CIRCUIT	24	
6 TUBE DIAMETER, O.D., IN.	1/2	
7 TUBE WALL THICKNESS, IN.	0.036	
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.	20.0	
COIL FIN CHARACTERISTICS		
1 MATERIAL	Aluminum	
2 TYPE OF FIN	Corrugated	Rolled Collar
3 FIN SPACING, PER INCH	7	164 Fins
4 FIN THICKNESS, IN.	0.011	
5 SECONDARY SURFACE AREA, SQ. FT.	197.4	
COIL DIMENSIONS		
1 FINNED HEIGHT, IN. K	30.0	
2 FINNED WIDTH, IN. F	25.3	
3 FINNED DEPTH, IN. V	3.1	
4 COIL HEIGHT, IN. H	29.4	
5 COIL WIDTH, IN. W	28.8	
6 COIL DEPTH, IN. D	2.1	
7 COIL DEPTH, OVERALL, IN. N	10.8	
8 FACE AREA, SQ. FT.	5.3	
9 TOTAL SURFACE AREA, SQ. FT.	217.5	
10 DISTANCE BETWEEN CONN., IN. T	29.4	
OVERALL CONDENSER DIMENSIONS		
1 WIDTH, OVERALL, IN. A	32.5	
2 WIDTH, SHROUD, IN. B	27.0	
3 HEIGHT, IN. C	34.1	
4 DEPTH, IN. E	11.0	
5 BELLMOUTH ORIFICE DIAMETER, IN. X	24 5/8	± 1/2 inch
6 BELLMOUTH RADIUS, IN. R	11/16	
7 HEIGHT, SHROUD, IN. L	30.0	

Table 1

CONDENSER SPECIMEN

MFR. McQuay, Inc.　NBS NO. 194-59　SIZE - B　CLASS - 1

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
ITEM				HIGH	FREE DISCH.	LOW		FREE DISCHARGE		FREE DISCHARGE
1. BAROMETRIC PRESSURE	P_{ab}	"Hg	29.921				29.921		29.921	29.70
2. DRY BULB TEMPERATURE OF AIR ENTERING COIL	t_{ae}	°F	95				95		110	110.1
3. WET BULB TEMPERATURE OF AIR ENTERING COIL	t'_{ae}	°F	75±5				75±5			75.8
4. DRY BULB TEMPERATURE OF AMBIENT AIR	t_{ae}	°F	95				95		110	110.1
5. SATURATION TEMPERATURE OF ENTERING REFRIGERANT VAPOR	t'_{2c}	°F	130				105		135	135.6
6. SUPERHEAT TEMPERATURE OF ENTERING REFRIGERANT VAPOR	t_{2c}	°F	195±10				170±10			197.0
			AIR FLOW METHOD				AIR FLOW METHOD			
7. NOZZLE AIR AND WATER VAPOR MIXTURE FLOW RATE	Q_{ad}	CFM								3680
8. TOTAL HEAT REJECTION CAPACITY	q_{tc}	BTUH								33050
			REFRIGERANT FLOW METHOD				REFRIGERANT FLOW METHOD			
9. REFRIGERANT FLOW RATE	W_r	lb/min								8.46
10. CONDENSER COIL INTERNAL PRESSURE DROP	ΔP_c	PSI								1.20
11. SUBCOOLING OF LEAVING REFRIGERANT LIQUID	ΔT_s	°F	10° MAX.				5° MAX.			3.0
12. TOTAL HEAT REJECTION CAPACITY	q_{tr}	BTUH								31800
			RATINGS				RATINGS			
13. TOTAL HEAT REJECTION	q_{tR}	BTUH							35600	31750
14. CONDENSING HEAT REJECTION	q_{cR}	BTUH								31300
15. SUBCOOLING HEAT REJECTION	q_{sR}	BTUH								450
16. AIR FLOW RATE	Q_R	CFM								3310
17. CONDENSER COIL EXTERNAL RESISTANCE	P_{as}	"H_2O								0.22
18. FAN MOTOR POWER	P_{fm}	WATTS								523
19. FAN BRAKE HORSEPOWER	P	BHP								-
20. HEAT REJECTION PER UNIT PRIMARY SURFACE AREA	BTUH/SF									1585
21. HEAT REJECTION PER UNIT SECONDARY SURFACE AREA	BTUH/SF									160.7
22. HEAT REJECTION PER UNIT TOTAL SURFACE AREA	BTUH/SF									145.9
23. HEAT REJECTION PER CFM	BTUH									9.6

Table 2