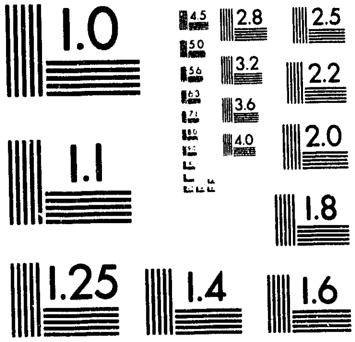
1.0
4.5
2.8
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1 of 1

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ADVANCED COOLING TECHNOLOGY, Inc.

FINAL TECHNICAL PROGRESS REPORT

August 12, 1993

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U. S. Department of Energy

Grant Project No. DE-FG01-91CE15525

Homer S. Myers

Homer S. Myers
Project Director

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P. O. Box 62
Oak Ridge, TN 37830

PROJECT DESCRIPTION

Advanced Cooling Technology (ACT), Inc., will perform the following tasks in order to develop an improved, more reliable and more marketable version of their ACT Evaporative Subcooling System.

1. Develop a more stable pump by reducing vibration levels.

2. Design and develop a drainage mechanism that will protect the coil.

3. Apply for Underwriters Laboratories approval and perform follow-up and coordination work to complete task to insure product is safe, within its intended applications.

4. Test invention's performance to demonstrate energy savings and long term resistance to scale and corrosion.

5. Contract with the American Refrigeration Institute to perform engineering tests under controlled laboratory conditions. Tests to incluse pressure and temperature data throughout the refrigeration cycle.

6. Organize data, and develop technical manual for helping purchasers determining energy savings and invention's merits.

7. Perform a field test in a cooperating supermarket, where utility usage can be measured on a before and after basis.

8. Submit progress and financial reports at the end of each calendar quarter. Submit a final report at the end of the grant period that summarizes the technical accomplishments and next steps to make this technology a commercially viable option. The final report will estimate the energy and other benefits of using this system.

Top priority in the conduct of this project was given to the improvements proposed in the mechanical design of the subcooler units. It was felt that this was necessary to provide fully engineered units for the subsequent tests which were to be run in the later parts of the project.

Second in importance was felt to be the completion of third party evaluation and performance testing of the units as support to negotiations for the installation of a complete system in a supermarket. This was based on concern which has been expressed by some market managers about the possible malfunction or lack of performance that might impact their operations.

Essentially all of the mechanical design improvements proposed for the Evaporative Subcooler were completed and the production of pilot quantities of the improved parts was done. An effort was made to have some of these installed in field units where difficulties have been observed in the past. Major attention was focussed on the performance of controlled third party tests of the effectiveness of the unit in improving energy efficiency.

In addition to the Grant project, a second or "Continuation Patent" which had been applied for in April, 1991, was granted by the U. S. Patent Office allowing much broader claims than was the case of the first patent which was granted in December, 1991.

Task No. 1
Pump Design

Meetings were held between staff members of ACT and their Consulting Engineer, Roy Abbott. The principal problem in allowing vibration to develop in the cone pump was identified as the fastening of the plastic cone to the fan motor shaft. Although the pumps could be aligned during assembly, a slight buildup of foreign material inside the cone could unbalance the pump and cause it to loosen the fastening to the shaft. Other pumps would occasionally become loosened after running for unknown reasons.

Two new types of fasteners were designed for consideration. One of these, the molding of a metal bushing containing a set screw into the plastic cone, was felt to be superior. Engineering drawings of these modifications to the pump mold were made and cost estimated for the mold modification and part cost in production were obtained. These figures were well within the budgeted cost

allowances and a purchase order for modifying the pump cone mold and the production of test parts was issued to Advantage Plastics & Engineering Co., of Louisville, KY. This was the same company who had made the original pump mold and parts.

The pump mold was redesigned and modified to incorporate the brass bushing containing a set screw for fastening the cone pump to the fan/pump motor shaft. A test run to make 100 parts was done. These parts were taken to our shop where six of them were heavily unbalanced to simulate a buildup of material during operation of the pump. This was accomplished by cementing a one ounce weight on one side of the bottom of the cone. The cones were then mounted on motors and installed in subcoolers. During operation, the vibration was extreme because of the severe unbalance. The six units were run in this condition for four days with no failures. A pump of our previous design would have failed in only a few minutes of operation under these conditions. At the completion of the run, the weights were removed and the alignment of the pumps checked. All were perfectly true, i. e., as good as at the beginning of the test.

A number of these improved units were sent to the field both on new subcooler units and also as replacement parts for old pumps which had failed in service because of vibration problems. No reports of difficulties with the new pumps have been received.

These highly successful results are believed to have solved the problems which have been encountered with thes pumps in the past. We consider this task of the project to be completed.

Task No. 2
Drainage Mechanism

As for planning improvements in the pump design, meetings were held between members of ACT and Roy Abbott. The problems were related to two effects, 1) corrosion or electrolysis of the aluminum coil in certain areas because of the immersion of the bottom of the coil in the water sump, and 2) drainage of water into the sump being prevented by an accumulation of the products of corrosion or electrolysis at the base of the coil.

Roy Abbott proposed a three part solution to these problems as follows:

1. Design plastic standoffs that can slide between the fins of the coil at three or four points to support the coil at a level about 1/8" above the sump water level, and,

2. Redesign the bottom of the housing which contains the sump so that it slopes down toward the center, thus lowering the sump water level by about 1 /4" so that even if the unit is not installed in a perfectly level manner, the coil bottom will not be immersed in the sump water, and,

3. Coat the coil with vinyl to a thickness of 0.00002" in the manner that aluminum air conditioner coils are treated at General Electric.

Drawings of these modifications were prepared by Roy Abbott and submitted to Louisville Pattern & Engineering Co., who had made the original molds and vacuum formed the parts made to date. These costs being within the projected values, a mold was ordered and made to produce stand-offs that could be inserted between the fins of the subcooler coil to raise it 1/8" above the level of the water in the pump sump. This will prevent the fins from resting in water and will reduce the possibility of corrosion or electrolysis. The mold was tested and 400 test parts were run.

In addition, the vacuum forming mold for the base of the subcoolers was modified by sloping the runoff from the coil to the pump sump by 1/4" thus giving further protection against the coil fins being immersed in water even if the unit were mounted somewhat off level.

The third step in reducing drainage problems was the coating of the coils with a very thin layer of plastic material. This has been a treatment used by General Electric for aluminum air conditioner coils and also by Signet Systems, a firm located in Harrodsburg, KY, who manufacture aluminum coils for automobile air conditioners. Signet Systems has coated two coils for us and will be coating 12 more for future tests. The first two coils were sent to a Florida west coast location for installation. Later an additional ten subcooler units with coated coils were also sent to a Florida area where the most severe corrosion problems have been encountered. Attempts will be made to follow the results of this treatment in affecting coil corrosion.

We believe that this completed the mechanical aspects of this task and that the only future work to be done would be to follow the results of the operations of the installed systems.

Task No. 3
Underwriters Laboratories Approval

A sample subcooler was sent to the Underwriters Laboratories at Triangle Research Park, North Carolina, for a preliminary evaluation and proposal for the continuation of tests leading to full scale Safety Evaluation and Certification.

This was initiated early in November and the first report received from them described the various tests that would need to be passed satisfactorily to obtain certification. Telephone conversations were held with them and it appeared that a number of these tests would cause no difficulty. Some, however, did pose difficult problems. One of these is their requirementthat, because this subcooler is a retrofit device, approval must be obtained from the manufacturers of the original equipment saying that the addition of this device will not jeopardize the safety of the original installation.

Following the discussions held with Underwriters Laboratories engineers, further attempts were made to determine if the requirement of approval of all major original equipment manufacturers was an absolute condition to the granting of their seal of approval. It appears that this is a necessary condition that would not be waived.

From discussions that had been held with some of these manufacturers in the past we have found none of them willing to jeapordize the validity of their own Underwriters Laboratories Approval on the basis of the performance of another manufacturers equipment. Such agreement would need to be reached with all of the major original equipment manufacturers who have secured Underwriters Laboratories Approval before they would proceed.

Another aspect of this problem is the fact that the original equipment manufacturers look upon manufacturers of retrofit equipment as competitors. The retrofitters, like ourselves, are usually trying to improve the performance of a cooling system. Frequently this retrofit improvement is an alternative to the purchase of upgraded replacement new equipment. Thus our success may be at the expense of a lost sale to the original equipment supplier.

As a consequence we do not believe that the Underwriters Laboratories requirements can be met and, therefore, there is not any purpose to be served by pursuing this task any further so it has been abandoned.

Task No. 5
ARI Engineering Performance Tests

At the beginning of this project, the American Refrigeration Institute, ARI, was contacted to determine the location of laboratories qualified and recommended to carry our laboratory engineering evaluation tests of refrigeration and air conditioning systems in accordance with their standards. Among these, the most widely recognized was ETL Testing Laboratories, Inc., in Cortland, New York. They were sent one of our evaporative subcoolers and were requested to quote prices for running tests of both refrigeration and air conditioning systems with and without the subcooler operating in the systems.

The prices quoted were within the budget provided for this task. We were to furnish the refrigeration system but they would work the test in with other tests being run for an air conditioner client so that no equipment of this type would need to be provided.

Authorization was given to them to proceed. A used refrigeration system was procured locally and was assembled and tested extensively in our shop. It was then shipped to their laboratories. Tests were scheduled to be performed during the middle of April and completed before the end of that month.

Successful completion of these tests would not only provide a report which would be very useful as a marketing aid but also would permit the mounting of an ETL Seal of Approval on each piece of equipment produced. We were advised by people in the trade that this recognition is accepted industry wide and is much more important than the Underwriters Laboratories Approval. The latter certifies only as to the safety while the former certifies as to the performance of the equipment.

Copies of the reports of the ARI tests performed by ETL Testing Laboratories are included herewith as Appendix A (Refrigeration) and Appendix B (Air Conditioning).

Refrigeration:

A Copeland 5 HP Refrigeration unit was rented and shipped to ETL Testing Laboratories for these tests and was returned to us at their completion. The results showed that at 95o F and at 41% Relative Humidity, the Evaporative Subcooler increased the capacity of the system by 7.86%. At 99.7o F and at 43% Relative Humidity, the increase was 12.48%.

Air Conditioning:

A Carrier Unitary 10 Ton Air Conditioner unit which was being tested for other characteristics at ETL Testing Laboratories was made available by the Carrier Corporation for use in our Evaporative Subcooler tests. The results showed that at 99.4o F and at 43% Relative Humidity, the Evaporative Subcooler improved the Energy Efficiency Ratio (EER) of the system by 8.31%.

Several considerations must be kept in mind in the interpretation of these results:

1. The ambient conditions under which the tests were carried out were rather normal summer temperatures and humidities. In many areas of the country, higher temperatures and lower humidities often prevail, both of which promote greater evaporative cooling.

2. The systems were both well "balanced", i.e., the capacities of the compressor and the condenser were well matched. The Copeland refrigeration components were selected by our engineer to achieve this balance. The Carrier air conditioner system is described as "unitary", with components selected and assembled by the manufacturer at the factory. These considerations along with the fact that the systems were properly charged with the correct amount of refrigerant by ETL Laboratories engineers before testing means that they were operating at top efficiency for the "base-line" tests before the Evaporative Subcoolers were installed. The conclusion that can be drawn from this is that the observed improvements are the minimum that can be expected for installation on systems operating under these ambient conditions.

3. In contrast, however, much larger improvements are frequently obtained in field installations. If, for example, a system is unbalanced because it has an undersized condenser, the addition of a subcooler, even without any evaporative cooling, will improve the performance of the system by increasing the condenser capacity bringing it nearer to balance with the compressor capacity. Add the effect of evaporative cooling and much more improvement is obtained. Similarly, if a system is not properly charged with refrigerant and, as a part of the subcooler installation, the refrigerant charge is brought to the proper level, additional improvement over that attributable to evaporative subcooling may be observed. While these are not true efficiency improvements achieved by evaporative subcooling, they are real energy efficiency gains resulting from the whole process of installing an evaporative subcooler.

Task Nos. 4, 6, 7 & 8

Work on these tasks was deferred due to inadequate financial resources of the Corporation. Negotiations were undertaken to attempt to secure additional capital through the sale of equity or the licensing of the patents covering the subcooler which are assigned to the Corporation. All inventory, tooling and improved parts produced as a part of the grant were kept in storage so that operations could be quickly reactivated if possible.

Unfortunately, these efforts were not successful. It was our feeling that it would not be appropriate to initiate activity on a task at a time when there were serious doubts that it could be completed. This, we felt, would have been an unjustifiied action that could lead to a waste of public funds.

APPENDIX A

REPORT
ETL TESTING LABORATORIES, INC.

INDUSTRIAL PARK CORTLAND, NEW YORK 13045

Order No. 64670-410 Date: May 4, 1992

REPORT NO. 517055
RENDERED TO
ADVANCED COOLING TECHNOLOGY INC.
PERFORMANCE TESTS OF A
"ACTEC" MODEL 10
EVAPORATIVE SUBCOOLER
(REFRIGERANT R-12)

General

This report gives the results of Performance Tests of an "ACTEC" Model 10 Evaporative Subcooler coupled to a "Copeland" Model CBAM-0500-TFC-001 condensing unit for refrigeration.

The samples were selected and submitted by the client and received at ETL on March 18, 1992. The work was authorized by client's letter dated February 26, 1992. Testing was coordinated through Mr. Ira Marsh representing the client.

Test Method

The test was performed in general accordance with the following standards published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

ASHRAE 41.9-88	A Standard Calorimeter Test Method for Flow Measurement of a Volatile Refrigerant
ASHRAE 20-70	Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers

Description of Test Setup

The evaporative subcooler and the refrigeration system condensing unit were installed in a temperature controlled environment. The refrigerant leaving the condensing unit was valved to go through or to bypass the "ACTEC 10" evaporative subcooler. The test system was coupled to a Secondary Refrigerant Calorimeter. Calibrated precision pressure gauges were used to determine refrigerant pressures throughout the system. Calibrated RTD's and thermocouples were used to measure refrigerant and ambient air temperatures. Refrigerant flow was determined by a turbine-type flow meter.

Calorimeter heat input was determined by a watthour transducer measuring the watt input to the evaporator heaters.

Refrigerant flowrate for the primary measurement was determined as the quotient of the heat input to the calorimeter and the enthalpy change of the refrigerant passing through it. The confirming method of the refrigerant flow was the turbine flow meter.

Checked by: MY

Description of Sample, Physical and Nameplate Data

1. General Description of Sample

The subcooler consisted of an aluminum finned copper heat exchanger coil, a down draft fan and a cone pump.

The refrigerant condensing system unit consisted of a compressor, condenser coil, fan and two receivers.

The refrigerant was R-12.

2. Nameplate Data

Subcooler

"Advanced Cooling Technology
ACTEC Evaporative Subcooler
Model No. 10 Serial 543
Voltage 230 Hz 60 0.4 Amps"

Condensing Unit

"Copeland
Model CBAM-0500-TFC-001
208/230 Volt 3 Ph 60 Hz"

Compressor

"Copeland
Model 9RA1-0500-TFC"

Description of Tests

Conditions

Ambient, °F	95	100
Saturation Suction, °F	-10	-10
Return Gas, °F	65	65

Test Runs 1 and 3 were with the refrigerant bypassing the evaporative subcooler.

Test Runs 2 and 4 were with the evaporative subcooler energized and supplied with city water.

Checked by: MY

Test Conditions	Test Run 1	Test Run 2
Saturated Suction, F	-10	-10
Return Gas, F	65	65
Ambient of Condenser, F	95	95
Results of Tests		
Condenser Ambient		
Air Inlet, F		
dry-bulb	95.2	95.0
wet-bulb	74.7	75.1
Barometer, in. Hg.	28.73	28.84
Calorimeter Side		
Electric Input to Heaters, Whrs	4,584	4,944
REFRIGERATING CAPACITY, BTUH	15,640	16,870
Calculated Refrigerant Flow, lbs/hr	283.9	283.9
Refrigerant Side		
Refrigerant Temperature, F		
Liquid at Condenser	107.5	107.0
Liquid Entering Subcooler	-	106.5
Liquid Leaving Subcooler	-	83.5
Liquid at Calorimeter	101.4	82.6
Suction at Calorimeter	61.6	61.4
Suction at Compressor	65.0	65.0
Refrigerant Pressures, PSIG		
Liquid at Condenser	173.5	173.0
Liquid at Calorimeter	172.0	171.5
Suction at Calorimeter	6.0	6.0
Suction at Compressor	4.5	4.5
Refrigerant Enthalpy, Btu/lb		
Entering Calorimeter	31.438	26.972
Leaving Calorimeter	86.512	86.407
Difference Across Calorimenter	55.072	59.435
Refrigerant Flow Rate, lbs/hr	278.6	277.7
Electrical Characteristics		
Voltage, volts		
Phase A-B	230	230
Phase B-C	230	230
Phase C-D	230	230
Current, amps		
Phase A	13.8	13.9
Phase B	15.2	15.1
Phase C	14.2	14.2
Total Power Input, watts	3,895	3,953

Checked by: My

Test Conditions	Test Run 3	Test Run 4
Saturated Suction, F	-10	-10
Return Gas, F	65	65
Ambient of Condenser, F	100	100
Results of Tests		
Condenser Ambient		
Air Inlet, F		
dry-bulb	99.9	99.5
wet-bulb	78.4	79.5
Barometer, in. Hg.	28.41	28.45
Calorimeter Side		
Electric Input to Heaters, Whrs	4,039	4,543
REFRIGERATING CAPACITY, BTUH	13,780	15,500
Calculated Refrigerant Flow, lbs/hr	258.8	262.3
Refrigerant Side		
Refrigerant Temperature, F		
Liquid at Condenser	115.9	115.6
Liquid Entering Subcooler	-	114.8
Liquid Leaving Subcooler	-	83.9
Liquid at Calorimeter	107.4	81.6
Suction at Calorimeter	59.5	60.3
Suction at Compressor	64.7	65.2
Refrigerant Pressures, PSIG		
Liquid at Condenser	198.5	196.0
Liquid at Calorimeter	197.5	195.0
Suction at Calorimeter	6.0	6.0
Suction at Compressor	4.5	4.5
Refrigerant Enthalpy, Btu/lb		
Entering Calorimeter	32.894	27.183
Leaving Calorimeter	86.139	86.255
Difference Across Calorimenter	53.245	59.072
Refrigerant Flow Rate, lbs/hr	254.6	254.8
Electrical Characteristics		
Voltage, volts		
Phase A-B	230	230
Phase B-C	230	230
Phase C-D	230	230
Current, amps		
Phase A	13.7	13.8
Phase B	14.9	14.7
Phase C	14.2	14.1
Total Power Input, watts	3,820	3,879

Checked by: [illegible]

Dates of Tests: April 22 - 24, 1992

Report Approved by:

Mark W. Paquette, Manager
Applied Products

Tests Supervised by:

Robert J. Hill
Project Engineer

Checked by: MM
Copy by:kn

Appendix B

REPORT
ETL TESTING LABORATORIES, INC.

INDUSTRIAL PARK CORTLAND, NEW YORK 13045

Order No. 64672-420 Date: June 11, 1992

REPORT NO. 518483

RENDERED TO

ADVANCED COOLING TECHNOLOGY, INCORPORATED

PERFORMANCE TESTS

OF A "CARRIER" UNITARY AIR CONDITIONER

MODEL 38AFC0085 CONDENSING UNIT

WITH MODEL 40RR008 BLOWER COIL

WITH AND WITHOUT AN "ACTEC" EVAPORATIVE SUBCOOLER

General

This report gives the results of Performance Tests of a "Carrier" Unitary Air Conditioner Model 38AFC0085 Condensing Unit With Model 40RR008 Blower Coil, with and without an "ACTEC" Evaporative Subcooler manufactured by Advanced Cooling Technology, Incorporated, Lexington, Kentucky 40503.

The sample used to test the evaporative subcooler was provided by Carrier Corporation.

Authorization for the tests was by client's letter dated February 26, 1992, signed by Mr. Homer S. Myers, President. The work was coordinated through Mr. Ira Marsh, Chief Engineer, representing the client.

The tests were conducted in accordance with ARI Standard 210/240-89, "Standard For Unitary Air-Conditioning And Air-Source Heat Pump Equipment," published by the Air-Conditioning and Refrigeration Institute, and ASHRAE Standard ANSI/ASHRAE 37-88, "Methods of Testing for Rating Unitary Air Conditioning and Heat Pump Equipment," published by the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.

Notes: (1) The results contained herein are for technical evaluation only and are applicable only to the specific test specimen referenced herein.

(2) The tests herein reported have not been performed at the request of the Air-Conditioning and Refrigeration Institute, and use of these findings by Advanced Cooling Technology, Inc. in any advertising or other literature shall state therein that the test is not part of the ARI Certification Program.

Description of Unit, Nameplate Data, etc.

1. General Description of Unit

The sample was a split-system air-cooled air conditioner. The condenser air w drawn through the condenser coil on three sides and discharged vertically by a f from the top of the section. The evaporator air was drawn through the front openin air filters and diagonal evaporator coil, and discharged vertically by a blower through two openings at the top of the section. The sections were connected by 25 f of 1-1/8-in. O.D. suction line (insulated) and 1/2-in. O.D. liquid line. The refrigerant control device contained in the unit was an expansion valve.

2. Nameplate Data

Condensing Unit

Model No. 38AFC008510 Serial No. 0792G78198

	Qty	Volts AC	Ph	Hz	RLA	LRA
Compressor	1	208/230	3	60	32.5	183
					FLA	HP
Fan	1	208/230	1	60	2.9	.50 NEC

Power Supply 208/230 V 3 Ph 60 Hz
R-22 Design Test Pressure High 477 Low 150
Permissible Voltage At Unit 253 Max. 187 Min.
Min. Circuit Amp 44.4 60 Fuse Only

Compressor

Copeland
Model No. BRE2-0750-TFC-214
Serial No. 92A 15605 00015
Customer No. GB30TN010A U019 Oil - 128
Volts 208/230 Ph 3 Hz 60 LRA 183
Volts 200/240 Hz 50 Pro T MO-C

Condenser Fan Motor

G.E. Model 5KCP39PGH806S
V 208/230 Hz 60 Ph 3 Amps 1.7
Cap 10.00/370 Rot. → RPM 1050
Mfg. No. HC44VL603A

Blower Coil Unit

Model No. 40RR-008-530 Serial No. 1292F91201
Design Test Pressure High 410 HP 1 Kw Out 0.75
Power Supply 208/230-460 Volts 3 Ph 60 Hz
I.D. Motor 230/460 Volts 3 Ph 60 Hz 3.8/1.9 FLA

Evaporator Blower Motor

Inaccessible

Description of Unit, Nameplate Data, etc. (cont'd)

3. Description of Coils	Evaporator	Condenser
Number of Coils	1	1
Fin Material	Aluminum	Aluminum
Tubing Material	Copper	Copper
Style	Staggered	Staggered
Type of Fins	Rippled	Rippled
Number of Fins per Inch	13	15
Diameter of Tubing (OD), in.	1/2	3/8
Number of Tubes per Row	20	32
Center-to-Center Distance Between Tubes, in.	1.25 x 1.25	1.0 x 0.866
Number of Rows Deep	3	2
Coil Height, in.	25.0	32.0
Coil Length, in.	42.0	77-1/2
Face Area (Total), sq. ft.	7.29	17.22

Results of Tests	W/Out Subcooler		W/ Subcooler	
	Test Run			
	1A*	A	1A*	A
Evaporator Side				
Air Temperature, F*				
Evaporator Inlet, dry-bulb	79.90	80.00	79.95	79.80
wet-bulb	67.10	67.30	67.25	67.20
Evaporator Outlet, dry-bulb	63.45	63.50	62.25	62.10
wet-bulb	59.60	59.80	58.85	58.70
Static Pressure at Unit Outlet, in. W.G.	0.31	0.31	0.30	0.30
Standard Air Flow, cfm	2985	2985	2985	2985
TOTAL COOLING EVAPORATOR SIDE, Btu/hr	74630	74930	83320	84160
Condenser Side				
Air Temperature, F*				
Condenser Inlet, dry-bulb	99.40	99.50	99.50	99.30
wet-bulb	78.80	78.90	79.50	79.50
Condenser Outlet, dry-bulb	-	127.30	-	127.90
Static Pressure at Unit Outlet, in. W.G.	-	-0.03	-	-0.04
Standard Air Flow, cfm	-	3555	-	3365
TOTAL COOLING CONDENSER SIDE, Btu/hr	-	74330	-	70200
Miscellaneous				
Electrical Characteristics of Motors				
Compressor, Condenser Fan & Evaporator Blower				
Voltage, volts				
Phase A-B	231	231	230	230
Phase B-C	229	229	230	229
Phase A-C	230	230	230	229
Current, amps				
Phase A	29.5	29.5	30.3	30.2
Phase B	31.4	31.5	32.5	32.4
Phase C	29.8	29.6	30.6	30.5
Power Input, watts				
Phase A-N/A	3330	3340	3500	3470
Phase B-N/B	3490	3500	3650	3640
Phase C-N/C	3210	3200	3300	3300
Total Power Input, watts	10030	10040	10450	10410
Energy Efficiency Ratio, EER	-	7.46	-	8.08
Refrigerant-Circuit Temperatures, F				
Discharge at Compressor	237.5	238.5	233.5	233.0
Liquid at Condenser	110.5	111.5	112.5	113.0
Liquid at Evaporator	109.0	110.0	95.5	95.0
Suction at Evaporator	58.5	59.0	55.5	55.5
Suction at Compressor	61.0	61.0	61.0	61.0
Liquid at Subcooler In	-	-	113.0	112.5
Liquid at Subcooler Out	-	-	96.0	96.0
Refrigerant-Circuit Pressures, psig				
Liquid at Condensing Unit	304.0	304.0	310.0	310.0
Suction at Condensing Unit	77.0	77.0	72.0	72.0

Note: Air temperatures are recorded to 0.05°F; this value is estimated and is valid only for obtaining temperature differentials as may be required to determine enthalpies.

*Preliminary Test Run - Condenser Side Free Air Discharge.

Remarks

In the absence of specified requirements, no conclusion has been drawn. The test results are furnished for the client's information and evaluation.

Dates of Tests: May 21-27, 1992

Report Approved by:

Reginaldo I. Romero
Program Administrator

Test Supervised by:

Byron F. Horak, Manager
Unitary Products

Copied by: mb

DATE
FILMED
10/20/93
END