NATIONAL BUREAU OF STANDARDS REPORT

2072

Model NM2B Electric Drinking Water Cooler

manufactured by

Sunroc Refrigeration Company

by

Henry Karger
C. W. Phillips
P. R. Achenbach

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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Heating and Air Conditioning Section
Building Technology Division

to

Headquarters, United States Marine Corps
Department of the Navy
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NBS

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ABSTRACT

Two specimens of a preproduction Model NM2B electric drinking water cooler, manufactured by the Sunroc Refrigeration Company, were tested to determine compliance with Federal Specification OO-C-566b, as modified by Invitation to Bid #2053, issued by Headquarters, United States Marine Corps on June 13, 1951. One or the other of the two specimens were found to be in compliance with most requirements of the specifications as modified. The major points of non-compliance for both specimens were:

(1) The coolers did not meet the performance requirements regarding refrigeration control.

(2) The coolers did not meet the requirements that internal water lines should be rigidly anchored.

Since some deficiencies were noted on the second specimen that were not observed on the first specimen, and vice-versa, it was apparent that better quality control and more careful inspection was needed to assure consistent quality in production.

INTRODUCTION

In accordance with requests from the Headquarters, United States Marine Corps, in letters dated October 18, 1951, and February 4, 1952, tests and inspections of Model NM2B electric drinking water cooler manufactured by Sunroc Refrigeration Company, Glenn Riddle, Pennsylvania, were made to determine compliance with Federal Specification OO-C-566b, as modified in the U. S. Marine Corps Invitation for Bids #2053, dated June 13, 1951. Two specimens of this model water cooler were utilized in the tests.

The performance of the specimens was determined by direct tests as required in the Federal Specification. Special tests described herein were made to determine the performance of certain components. Conclusions about compliance of the specimens with regard to materials, construction, and durability were drawn from the results of inspections, plating tests, and other physical and chemical determinations with respect to the same Federal Specification. The tests required such detailed dismantling and sampling of construction materials of both specimen coolers that it was impractical to attempt reassembly.

DESCRIPTION OF TEST SPECIMENS

The two water cooler specimens submitted for test were identified as follows:

NBS Test Specimen 69-51, Specification Type I, Size 10
Sunroc Company Model NM2B
Serial Number 211 944
Code Number 1-10AH1
Identified in this report as specimen S-1

NBS Test Specimen 78-52, Specification Type I, Size 10
Sunroc Company Model NM2B
Serial Number 214 732
Identified in this report as specimen S-2

Specimen S-2 was submitted after tests showed that specimen S-1 did not comply with certain of the requirements of the specification as modified, hence the tests on specimen S-2 were in general confined to the points of noncompliance of specimen S-1. The outside appearance of both specimen coolers was identical. They were housed

in formed, one-piece steel enclosures which constituted the back and sides of the coolers. This housing enclosed the condensing unit compartment and evaporator section and provided structural support for the unit. The solid front panel could be removed, after loosening a screw at the bottom of the panel, by pulling the panel away from the cooler at the bottom and down from the recess formed by the top of the cooler. All of the controls and electric connections were accessible from the front side after the front panel was removed.

A front view of specimen S-1 is shown in Fig. 1. Fig. 2 shows a rear view of the cooler, and the machine compartment is shown in Fig. 3 after removal of the front panel. Fig. 4 shows the refrigeration unit after removal from the cooler housing. A front view of cooler specimen S-2 is shown in Fig. 5.

The dimensions and weight of the coolers were as follows:

Height, in.	44
Width of cabinet, in.	14-1/2
Depth of cabinet, in.	15
Width and depth of basin top, in.	15-3/4
Weight, including wood shipping base, lb.	145-1/2

The weight of the wooden base was approximately 10 lb.

TEST PROCEDURE

The laboratory investigation of the specimens made to determine compliance with Federal Specification OO-C-566b was divided into two main parts. First, tests were made to determine compliance with the performance requirements of the following paragraphs of the specification some of which were modified in the Invitation to Bid:

(1)	D-1, E-1, F-3a	Capacity Test
(2)	D-1a, F-3d	Peak Draw Test
(3)	D-1b, F-3b	Maximum Operating Test
(4)	D-6a	Jet of Water
(5)	D-6d	Water Regulator and Valve Test
(6)	D-10d	Refrigeration Control Test
(7)	D-10d(1)	Freezing Test
(8)	D-11b	Motor Overload Protection Test
(9)	D-13a	Operation at Varying Water Pressure
(10)	D-13b	Drain Capacity
(11)	F-3c, D-11a	Overload Test

Secondly, tests and/or inspections were made to determine compliance with other applicable paragraphs relative to materials of construction, composition of materials, arrangement of components, etc.

All performance tests listed above were conducted in a temperature-controlled room under the general conditions set forth in paragraph F-3a of the Federal Specification, except where the paragraph applicable for a specific test called for a different set of conditions. Temperatures were measured by means of calibrated thermocouples using an electronic, constant-balance type of potentiometer. Accuracy of this instrument was checked at intervals during the tests by means of ice-bath references. Inlet and outlet drinking water temperatures were measured by thermocouples in thin-walled stainless steel wells four inches long, mounted so that the thermocouple junctions were approximately in the plane of the exterior surface of the cooler cabinet. Water-flow rates were determined in a manner that did not interfere with the flow of cooled water wasted through the pre-cooler. Supply water temperatures and pressures were controlled by close-differential mechanical devices.

Additional information on the test procedure for particular tests is included with the report of the test results to further clarify how the results were obtained in cases where the specification did not provide adequate details.

PERFORMANCE TEST RESULTS

The following paragraphs show the results obtained on specimens S-1 and S-2 during the performance tests listed under the section on Test Procedure.

(1) Capacity Test (Paragraphs D-1, E-1, F-3a)

Table 1, which follows, summarizes the results obtained during the capacity test on specimen S-1 and compares the observed performance with the specification requirements. The entry entitled "Drinking Water Flow Rate at 30°F Temperature Difference, Gallons per Hour", gives the calculated water flow rate for a 30°F difference between supply and drinking water temperature when the actual difference during the test was not exactly 30°F.

Table 1 shows that the observed capacity of specimen S-1 exceeded the required capacity for Type I, Size 10 coolers.

TABLE 1. CAPACITY TEST OF SPECIMEN S-1

Performance Characteristics	Required Performance	Observed Performance
Ambient Temperature, °F	90	90.2
Electric Power input, watts	-	278
Terminal Voltage	110	110
Total Current Input, amps	-	3.6
Drinking Water, Inlet Temp., °F	80	79.4
Drinking Water, Outlet Temp., °F	50	50.3
Drinking Water, Temp. Diff., °F	30	29.1
Spill through precooler, %	60	60.7
Drinking Water flow rate, observed, gph	-	11.3
Drinking Water flow rate, corrected for a 30°F temp. difference, gph	9.0 (minimum)	10.9

(2) <u>Peak Draw Test</u> (Paragraphs D-1a, F-3d modified)

The specification as modified in the Invitation to Bid specified that 37-1/2 percent of the required hourly capacity shall be drawn off in 15 minutes. The water temperature at the beginning of the 15-minute period must be not lower than 45°F or higher than 50°F and shall not rise more than 10 degrees at any time during the 15-minute period. The water must be drawn off, beginning immediately after the compressor-motor cuts off in a normal cycle, in not less than three or more than six equal intervals per gallon of required draw-off capacity. The water must be drawn off at a rate of not less than 1/2 gallon per minute per bubbler. It was assumed that in accord with general requirements of paragraph F-3a, 60% of the cooled water should be allowed to flow through the precooler as water was being drawn.

For this test, the specimen coolers were equipped with self-closing hand-operated valves adjusted to permit water to flow at a rate of 1/2 gallon per minute when opened. Water was drawn from both specimens in 54 equal samples, each consisting of a 40% portion, drawn first, and a 60% portion, drawn second. The 40% portion was poured into a container for subsequent weighing. It simulated water consumed and did not pass through the precooler. The 60% portion was poured into a vessel of low thermal mass immediately prior to each subsequent draw. This vessel allowed the 60% portion to flow through the precooler during the time required for the entire subsequent draw.

Specimen S-1, as submitted, did not meet the peak draw requirements, primarily because of the inability of the compressor motor to start on thermostat demand in time to prevent delivery of outlet drinking water in excess of 60°F soon after the start of the peak draw test. Installation of a motor-starting capacitor by representatives of the Sunroc Company permitted prompt starting on thermostat demand and overcame this difficulty.

Because the original thermostat in Specimen S-1 failed to meet the requirements of the refrigeration control test, three additional thermostats were installed in this water cooler during the course of the tests. Since compliance with the peak draw requirements depends on the thermostat performance additional peak draw tests were made with the other thermostats in an effort to find one that would permit the cooler to meet the requirements of both the peak draw test and the refrigeration control test.

Three peak draw tests were made using thermostat No. 2 in specimen S-1 with initial outlet drinking water temperatures of 48.7°F, 46.5°F, and 49.4°F and temperature rises of 9.5°F, 11.2°F, and 10.7°F, respectively. Since outlet drinking water temperatures in excess of 57°F were observed in all peak draw tests made, it was evident that peak draw requirements could not be met unless the initial outlet water temperature was above 47°F. Compliance with the peak draw requirements was indicated in one of the three tests described above, but even with an initial water temperature above 47°F there was an element of chance in the matter of compliance as evidenced by the third test which showed a temperature rise of 10.7°F with an initial water temperature of 49.4°F.

A peak draw test was not made with thermostat #3. However, the time response of thermostat #3 in starting the compressor-motor under peak drawn test conditions was identical to that for thermostat #2, which permitted the cooler specimen S-1 to meet one peak draw test. It was assumed, therefore, that thermostat #3 would have been equally satisfactory for the peak draw requirements.

Compliance with peak draw requirements was not observed when using thermostat #4 in Specimen S-1. This was the only thermostat which met the requirements of the refrigeration control test, as outlined under Section 6 of the Test Results. Thermostat #4 caused the cooler to fail the peak draw test because the time response was not prompt enough in demanding compressor operation.

A peak draw test was made with cooler specimen S-2. With an initial water temperature of 49.2°F, the rise of outlet drinking water during the peak draw test was observed to be 7.8°F, hence this cooler was in compliance with peak draw requirements. It will be noted that neither water cooler specimen met the requirements of both the peak draw test and the refrigeration control test with a given thermostat.

(3) Maximum Operating Test (Paragraphs D-1b, F-3b)

The specification required that the cooler should start and operate satisfactorily, and should be operated continuously for at least 8 hours under conditions of 110°F ambient temperature, 100°F inlet water temperature, 50°F outlet drinking water temperature, and, it was assumed in accord with paragraph F-3a, with 60% spill through the precooler.

Specimen cooler S-1 was operated for eight hours under the above conditions. At the conclusion of the test, the cooler was turned off and left idle for a period of five minutes and then restarted to determine whether or not it would start satisfactorily without causing the motor overload mechanism to operate. The cooler started and operated satisfactorily during this test.

Table 2, which follows, shows the average conditions maintained during the maximum operating test.

TABLE 2. MAXIMUM OPERATING TEST OF SPECIMEN S-1

Performance Characteristics	Required Performance	Observed Performance
Electric Power input, watts	-	292
Terminal Voltage	110	110
Total Current input, amps	-	3.7
Ambient Temperature, °F	110	109.9
Drinking Water, Inlet temp., °F	100	100.2
Drinking Water, Outlet temp., °F	50	49.9
Drinking Water, temp. diff., °F	50	50.3
Spill through precooler, %	60	60.3
Drinking Water flow rate, observed, gph	-	3.87
Drinking Water flow rate, corrected for a 50°F temp. difference, gph	-	3.89

(4) Jet of Water (Paragraph D-6a)

The position of the jet of water relative to the orifice, guard, and cooler basin was observed and was found to be in compliance with the specification requirements for specimen S-1.

(5) Water Regulator and Valve Test (Paragraph D-6d)

Both specimen coolers were equipped with an adjustable automatic water-pressure regulating valve and a hand-operated, push-button type, self-closing stop valve. These two valves together with the bubbler and bubbler guard formed an integral mechanism. The adjustment for the pressure-regulating valve was accessible by removing the hexagonal nut holding the push-button on the bubbler assembly. Adjustments could then be made with a screw driver. The bubbler assembly could be removed from the cooler by hand without breaking the cooling unit insulation.

Observations were made of the stream height, throw distance, and rate of water discharge on cooler specimen S-1 for inlet water pressures of approximately 20 psig and 75 psig. The results are summarized in Table 3, which follows.

Water did not spurt from the bubbler of the specimen cooler when the stop valve was opened except when purging air during the initial filling of the cooler. No objectionable splashing of the drinking water on the cooler top was observed.

TABLE 3. WATER PRESSURE REGULATOR PERFORMANCE-SPECIMEN S-1

Supply Water Pressure, psig	20	75
Stream Height above nozzle, in.	3-1/8	3-3/8
Stream Height above guard, in.	1-3/8	1-5/8
Throw distance from nozzle, in.	6	6-1/2
Rate of Water Flow, gal/hr	19.5	20.6

(6) Refrigeration Control Test (Paragraph D-10d modified)

The specimen coolers were equipped with thermostats, actuated by refrigerant and incoming water temperatures, which controlled the operation of the compressor motor. The thermostats were readily accessible for adjustment and servicing when the front panels of the coolers were removed, and could be replaced without breaking the main insulation of the cooling unit housing.

The requirements of paragraph D-10d, as modified in the invitation to bid, were interpreted by the United States Marine Corps in a letter to the Sunroc Company dated December 12, 1951, as follows:

> "Refrigeration control shall be by means of an adjustable thermostat having a single, external controlling device (knob). The thermostat shall be capable of causing delivery of outlet drinking water in a range of from 45 degrees to 55 degrees fahrenheit, or higher, at any one rate of outlet drinking water withdrawal. A differential, not to exceed plus or minus 5 degrees fahrenheit at any control point, shall be permitted. The control point of the outlet drinking water shall be defined as the average temperature reading of outlet drinking water taken at equal intervals in time, or at the time of every thermostat operation. The differential shall be defined as the maximum permissible exclusion (excursion) from the control point. It shall not be possible, by means of the single, external thermostat adjusting knob, to cause delivery of outlet drinking water having a temperature of less than 40 degrees fahrenheit, under any condition of flow."

Adjustment of the thermostat on both specimen coolers could be effected by turning a knob, which had a dial divided into seven positions, numbered from 1 to 7. An arrow on the dial indicated the thermostat would cause the cooler to deliver colder water when the knob was turned to the higher numbers on the dial, i.e. position number 1 would be the warmest position and position number 7 would be the coldest position.

The requirement outlined above was interpreted by this Bureau to mean that the cooler should be capable of delivering drinking water at any one rate of water withdrawal at a temperature of 45°F or lower for the coldest setting of the thermostat adjusting knob (position #7), and at a temperature of 55°F or higher for the warmest setting of the thermostat adjusting knob (position #1). For the purpose of this test it was assumed by this Bureau that compliance at one of the following two rates of water withdrawal would be sufficient to show compliance with the range and differential requirements and at both rates to show compliance with the minimum delivered water temperature requirement. The first of these was a nominal no-load draw-off rate, during which approximately 1/24th of the required hourly capacity was withdrawn intermittently through the

bubbler per hour. The second was a half-load draw-off rate, during which approximately 1/2 of the required hourly capacity was withdrawn intermittently through the bubbler per hour.

For the no-load test, two 6-ounce samples of water were withdrawn every 15 minutes, and the temperature of the second sample was recorded. For the half-load test, two 6-ounce samples were withdrawn every minute and fifteen seconds, and the temperature of the second sample was recorded. The tests were conducted in an ambient temperature of 90°F, and the inlet water temperature was maintained at a temperature of 80°F.

Four thermostats were installed successively on Specimen S-1 by representatives of the Sunroc Company in connection with this requirement and the peak draw requirement. Only thermostat #4 met the requirements of paragraph D-10d, as interpreted by the United States Marine Corps. However, the cooler did not meet peak draw requirements using thermostat #4. It was the understanding of this Bureau that the performance of the cooler, specimen S-1, was to be judged with respect to its ability to control outlet drinking water temperature on the basis of operation with thermostat #3, indicated by the Sunroc Company as their standard thermostat. Thermostat #3 had insufficient range adjustment to comply with the above quoted requirement. During the half-load test, the lowest outlet drinking water temperature observed at the lowest setting of the thermostat (position #7) was 41.9°F and the highest temperature observed at the highest setting (position #1) was 49.4°F. During the no-load test, the lowest outlet drinking water temperature at the lowest setting of the thermostat (position #7) was 49.9°F, and the highest temperature observed at the highest settling (position #1) was 57.8°F. Hence the requirement that the temperature control be adjustable in a range of from 45°F to 55°F was not met for either of the two chosen test conditions.

Additional thermostat tests were made with specimen cooler S-2. Again, it was found that the thermostat had insufficient adjustment range to comply with the requirements. For this specimen cooler, during the half-load test, the lowest outlet drinking water temperature observed at the lowest setting of the thermostat (position #7) was 40.9°F, and the highest temperature observed for the highest setting (position #1) was 49.9°F. During the no-load test, the lowest temperature observed at the lowest setting was 51.1°F and the highest temperature observed at the highest setting was 61.2°F.

(7) Freezing Test (Paragraph D-10d(1) Modified)

Each water cooler specimen had an additional thermostat, non-adjustable external to the thermostat housing, to serve as a protective device against freezing. The freezing test was made with specimen cooler S-1. The primary drinking water thermostat was shunted, and the cooler was operated for 16 hours in an ambient of 33°F. At the conclusion of the test, drinking water could be drawn from the bubbler, indicating that the additional thermostat had controlled the compressor motor operation to prevent freezing of water in the cooler.

(8) <u>Motor Overload Protection Test</u> (Paragraph D-11b)

Paragraph D-11b states in part "Motors shall be protected in case of failure of the starting mechanism or excessive overload by a thermal protective device of proper current rating, which shall open the circuit before the motor windings reach a temperature that will injure the motor."

Both specimen coolers were equipped with such a device. Tests were made with specimen S-1. To determine the protection afforded, two tests were made, both in a 90°F ambient temperature, with supply water flowing steadily through the cooler at a rate slightly in excess of 30 gallons per hour. <u>First</u>, the power lead to the starting winding of the motor was disconnected. The cooler was then energized electrically, and measurements were made of the motor running winding resistance immediately following each cutout of the overload protector. The overload protector was allowed to function until successive temperatures at the time of cutout were no longer increasing and the temperature rise of the winding was computed on the basis of the highest resistance observed. The highest motor winding temperature observed under these conditions was 194°F. <u>Second</u>, the condenser fan was disconnected, and the cooler was allowed to continue in operation. The motor winding in the cooler reached temperature equilibrium after approximately 1 hour operation, and the protective device did not function during the test. The test was terminated at this time. The average conditions observed during the period of temperature equilibrium are listed in Table 4, which follows:

TABLE 4. OPERATING CONDITIONS OF COOLER SPECIMEN S-1 DURING SECOND MOTOR OVERLOAD PROTECTION TEST

Temperature of Compressor Dome, under protective element, °F	162.0
Temperature of Inlet Water to Cooler, °F	80.6
Temperature of Outlet Water from Cooler, °F	70.0
Temperature of Ambient Air, °F	92.2
Temperature of liquid refrigerant leaving the condenser, °F	140.2
Compressor Motor Current, amps	3.9

Based on present accepted practice in the design of hermetic motor-compressor units, it is the opinion of this Bureau that the compressor motor in the specimen cooler was satisfactorily protected against overload and against excessive temperatures caused by motor overload.

(9) Operation at Varying Water Pressures (Paragraph D-13a modified)

As required by the specification in paragraph D-13a, cooler specimen S-1 operated satisfactorily when connected to a water supply system at pressures ranging from 20 psig to 75 psig. The capacity test specified under paragraph F-3a and described under section 1 of this report was made with a supply water pressure of approximately 23 psig. The performance of the water regulator and valve under supply water pressures of 20 psig and 75 psig is discussed under section 5 of this report.

(10) Drain Capacity (Paragraph D-13b modified)

The drainage system of cooler specimen S-1 was free of internal trappings and did not cause stoppage of water in the bubbler basin.

(11) Overload Test (Paragraph F-3c, D-11a modified)

Cooler specimen S-1 was tested in accordance with the requirements of paragraph F-3c of the specification, which calls for 4 hours of continuous operation in 100°F ambient with water drawn at the rate of 300 percent of the required hourly capacity, with 60% spill through the precooler. The inlet water temperature was held at a temperature of approximately 80°F. The results of this test are summarized in Table 5, which follows.

The specimen cooler operated satisfactorily and without any indication of breakdown. The temperature rise of the motor running winding was determined by the resistance method and computed by the formula given in paragraph 4.2.3 of Federal Specification CC-M-636a, dated October 29, 1951. Table 5 shows that the temperature rise of the motor winding was well below the permissible rise for totally enclosed motors in this specification.

It is pointed out that Federal Specification CC-M-636a does not carry any reference to motors integral to a hermetically-sealed refrigeration compressor. It is believed that the coil winding temperature rise limits for totally enclosed type motors should serve as a guide to assist in judging hermetic motors.

Electrical components, external to the hermetically-sealed motor, appeared to be adequate and suitable on the cooler specimens.

TABLE 5. OVERLOAD TEST OF SPECIMEN S-1

Performance Characteristics	Required Performance	Observed Performance
Ambient temperature, °F	100	101.1
Drinking water, inlet temp., °F	-	82.1
Drinking water, outlet temp., °F	-	68.7
Ratio of drinking water flow to flow required for capacity, test,%	300	300
Spill through precooler, %	60	60.3
Electric power input, watts	-	328
Terminal voltage	110	110
Temp. rise of motor windings, °C	-	32.6

RESULTS OF INSPECTION

In order to determine compliance with other parts of the specification, both water cooler specimens were disassembled and a detailed analysis was made of certain components. Tests were made of the finish on the housing, and the thickness of the plating on chromium-plated parts was determined. The majority of these tests were made on cooler specimen S-1, while cooler specimen S-2 was inspected only to determine certain construction features, which, on cooler specimen S-1, did not comply with the requirements of the specification.

Results of Inspection on Specimens S-1 and S-2.

The following conclusions regarding compliance of specimens S-1 and S-2 with the requirements of the Federal Specification, as modified for this invitation, are based on the above mentioned tests and inspection of the disassembled coolers. The comparison between the inspection results and the specification requirements is made paragraph by paragraph using the numbering system in Federal Specification OO-C-566b, dated July 31, 1947, as modified to identify the requirement under consideration.

A-1. No comment required.

A-2. No label or marker is visible on cooler nameplate or cooler cabinet.

A-2a. Not to be determined by this Bureau.

A-2b. No comment required.

B-1. Sample cooler furnished was to be considered as Type I size 10.

C-1. All materials used appeared to be new. No materials unsuitable for their intended purposes were observed under the type of inspection requested.

C-1a(1). No tests were made. Inspection indicated the all bolts, nuts, pins, screws, and other fastenings and fittings had some sort of surface protection against corrosion.

C-1a(2). No tests were made. Inspection indicated that rust of cabinet material had formed around the holes drilled to receive sheet metal screws after original rust-proofing of the metal, around other openings, and near spot welds.

C-1a(3). Inspection indicated compliance.

C-1b. Inspection indicated compliance.

C-1c. Tests of chromium plating showed compliance.

C-2. There is no yardstick known to this Bureau for first-class workmanship. On specimen S-1 the cooling unit housing sections were joined with an insufficient number of spot welds to insure the rigidity necessary to prevent damage to the vapor seal.

On specimen S-2, an improvement was noted in the construction of the cooling unit housing with regard to spot welds and general rigidity of the housing. An extra plate, shown by the arrow on Fig. 6 was welded in below the front cooling unit housing panel and added greatly to the stiffening of the housing. In the opinion of this Bureau, the cabinet construction on specimen S-2 was adequate.

C-3. Inspection indicated compliance.

D-1. No comment required.

D-1a. See discussion of performance tests (section 2).

D-1b. See discussion of performance tests (section 3).

D-2. This Bureau is not in a position to determine compliance with the "current production" requirement. Cooler complied with all other applicable requirements of this paragraph.

D-2a. Cooler complied with requirements. In order to remove the high and low side as a unit from the cooler it was necessary to remove the insulation.

D-3a. Inspection indicated compliance.

D-3b. Inspection indicated compliance.

D-4. Tests showed that the exterior of the cabinet was covered with an organic finish and that both interior and exterior surfaces were painted.

D-4a. Paragraph not applicable.

D-4b. Tests indicated compliance.

D-5. Inspection indicated compliance. Acid-resisting test of vitreous-porcelain china was not made.

D-6. through D-6e Inspection and tests showed compliance.

D-6f. Paragraph not applicable.

D-7. Paragraph not applicable.

D-8. Inspection and tests showed compliance.

D-9. No comment required.

D-9a. Inspection indicated compliance on specimen S-1. Inspection indicated tin plating on the interior of tube used for water cooling and storage.

When attemps were made to determine whether the cooler specimen S-2 could be drained completely, it was found that the plug sealing off the drain connection at the rear of the cooler was stuck sufficiently tight in the casting that the two screws holding the drain plug casting to the back cabinet panel sheared off without loosening the plug. The casting, with the plug and the sheared-off screws, can be seen in Fig. 7.

When the cooler was opened subsequently for inspection of the cooling unit housing, it was found that the evaporator was mounted in the housing at an angle of approximately 15 degrees from the vertical. This can be seen in Fig. 8. This photograph is a top view of the evaporator housing, showing the cooling coil. While this probably would not affect the ability of the cooler to deliver cooled water, it is believed that an evaporator coil mounted at such an angle would not permit complete drainage of the water storage coil, as such drainage is entirely dependent on gravity flow of water.

The cooling coil in specimen S-1 was satisfactorily mounted in a vertical position and was capable of being drained.

D-9b. Inspection indicated compliance.

D-9c. Cooler complied. At one point in the precooler drain tube one internal dimension of the free area was less than 5/8 inch. This was caused by a splash plate in the top of the precooler which directs the flow of spilled water.

D-9d. Some discontinuities were observed in the vapor seal on specimen S-1. (See also discussion under paragraph C-2 regarding spot welding of cabinet sections.) The cooler complied with other requirements of this paragraph.

Inspection of specimen S-2 disclosed two voids in the insulation, each having a volume of approximately five cubic inches. It is believed that these voids were caused by the bubbler and glass filler lines which formed a bridge and prevented complete filling of the cooling unit housing with insulation.

D-10. No comment required.

D-10a. Cooler complied with requirements.

D-10b. Inspection indicated compliance.

D-10c. Paragraph not applicable.

D-10d. Refrigeration control did not comply with performance requirements. See discussion under performance tests (section 6).

D-10d(1) Cooler complied. See discussion under performance tests (section 7).

D-11a. Cooler complied with the requirements. It should be noted that it was necessary to install a starting capacitor to meet peak draw requirements. See discussion under performance tests (Section 11).

D-11b. Cooler complied with the requirements. See discussion of motor overload protection test (section 8).

D-11c. Paragraph not applicable.

D-11d. Cooler complied with the requirements.

D-12. Cooler complied with the requirements.

D-13a. On specimen S-1 the water tubes from the evaporator coil to the bubbler and glass filler outlets were not anchored in a suitable manner and hence were susceptible to twisting when bubbler or glass filler outlet cap was removed and replaced for any reason. Cooler complied with other requirements of this paragraph.

On specimen S-2 improvement was noted in the anchoring of the bubbler line, in that thicker rubber washers were used to provide frictional forces to lessen the likelihood of line twisting. However, a positive means of anchoring the bubbler and glass filler lines, such as stops or bosses, was not provided. A determination of the torque necessary to twist the bubbler line through 90 degrees was made. In preparation for this test, the bubbler assembly was removed and the "pal nut" anchoring the line was tightened securely. It was found that approximately 11.5 lb-ft (138 lb-in), was needed to twist the line 1/4 turn in about 45 seconds, the force being applied steadily during that time. The torque necessary to restore the line to its original position was approxi-

mately 6 lb-ft. (72 lb-in). Since the bubbler and guard assembly provided a maximum lever arm of 1-1/2 inches, a force of about 90 lbs. would have been required on the extreme end of the bubbler assembly to duplicate the original twisting effort described. It was found that such a force was not required to properly install the bubbler assembly.

Removal of the bubbler assembly, if it were stuck to the mounting stud by corrosion, or if the "pal nut" were not tight, could result in twisted lines. On the specimen coolers submitted, the glass filler and bubbler lines were sufficiently flexible to allow raising of the top such that a tool could be used to reduce the likelihood of line twisting.

In the opinion of this Bureau, positive anchoring of the bubbler and glass filler lines is superior to the anchoring method observed but satisfactory service can be expected from coolers identical to specimen S-2 as far as the likelihood of line twisting is concerned, if careful and intelligent servicing is practiced. However, the requirement in paragraph D-13a that "All piping and tubing shall be rigidly secured in proper position in such a manner that when connections are made to external drain or drains and water lines no strain will be placed on internal piping" was not complied with.

D-13b. Cooler complied with the requirements.

D-13c. Cooler complied with the requirements.

D-13d. Water containing parts of the cooler were subjected to a hydrostatic pressure of approximately 120 psig during the freezing test. No leaks were observed in joints or other water-containing parts. However, the bubbler stop valve leaked at a pressure of 120 psig, and continued to leak at a rate of approximately 1 gallon per hour when the pressure was reduced to 60 psig. An examination of the combination stop- and regulator-valve did not disclose any obvious ruptures, and it is believed that the leak was caused by particles of foreign matter which were forced into the valve seat. The refrigerant-containing parts withstood the hydrostatic pressure test.

D-14. Not to be determined by the National Bureau of Standards.

D-15. Cooler complied with requirements of this paragraph.

D-16. Not to be determined by the National Bureau of Standards.

E-1. Cooler complied with applicable requirements. See discussion under performance tests (section 1).

E-2 through E-7d. Paragraphs not applicable.

F-1 and F-2. Not to be determined by National Bureau of Standards.

F-2a. See discussion under paragraph D-13d.

F-3a through F-3d. Cooler complied with requirements. See discussion under performance tests (sections 1, 2, 3, and 11).

F-4. Paragraph not applicable.

F-5, F-5a, F-5b. No tests made.

F-6. No comment required.

G-1 through I-6. Not to be determined by the National Bureau of Standards.

CONCLUSION

The performance tests and inspection of the two specimen water coolers indicated some deviations from the requirements of Federal Specification 00-C-566b, as modified in the invitation for bids #2053. Of these deviations, those for which both test specimens provided less than was required are listed below:

1. Neither specimen met the performance requirements for the refrigeration control. (Paragraph D-10d)

2. Neither specimen met the requirement that lines should be rigidly anchored. (Paragraph D-13a)

Specimen S-2 was submitted by the manufacturer because of deficiencies in specimen S-1 with regard to discontinuities in the vapor seal, cabinet construction, refrigeration control, peak draw capacity, anchoring of the bubbler lines. This second specimen was satisfactory with respect to the vapor seal, cabinet construction, and peak draw capacity and showed improvement in the method of anchoring the bubbler and glass filler lines. It did not meet the performance requirements for the refrigeration

control or the construction requirements for rigid anchoring of the water lines. In addition the second specimen had voids in the insulation, a tilted evaporator which prevented free draining of the water, and a drain plug which could not be removed without twisting the water line connected to it. Inasmuch as these three deficiencies, the stuck drain plug, the misaligned evaporator coil, and the voids in the insulation, observed on cooler specimen S-2, were not noted on cooler specimen S-1, it is believed that they were not necessarily indicative of consistently poor production, but rather of need for improvement in quality control.

FIGURE 1

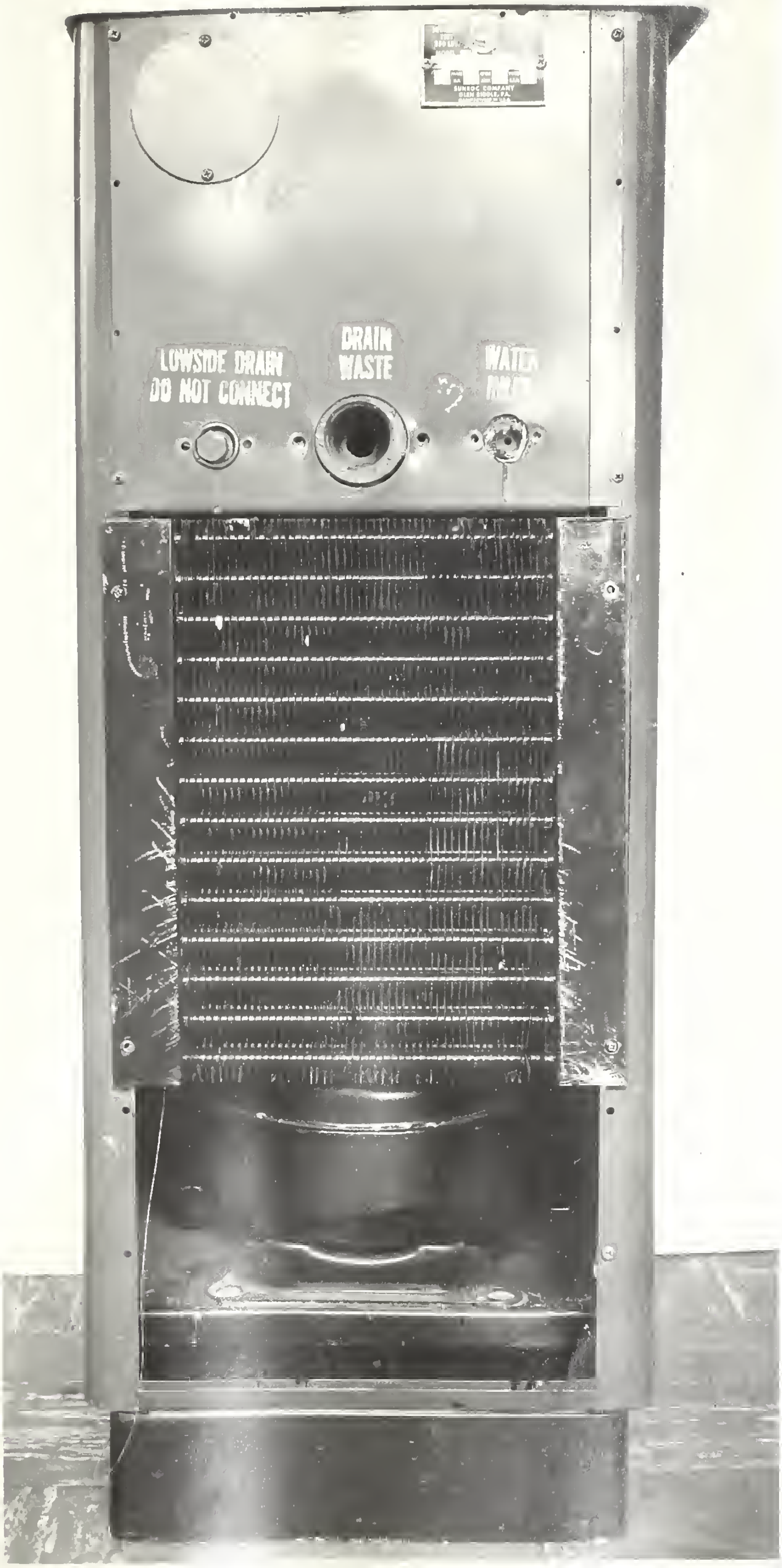

FIGURE 2

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IGURE 3

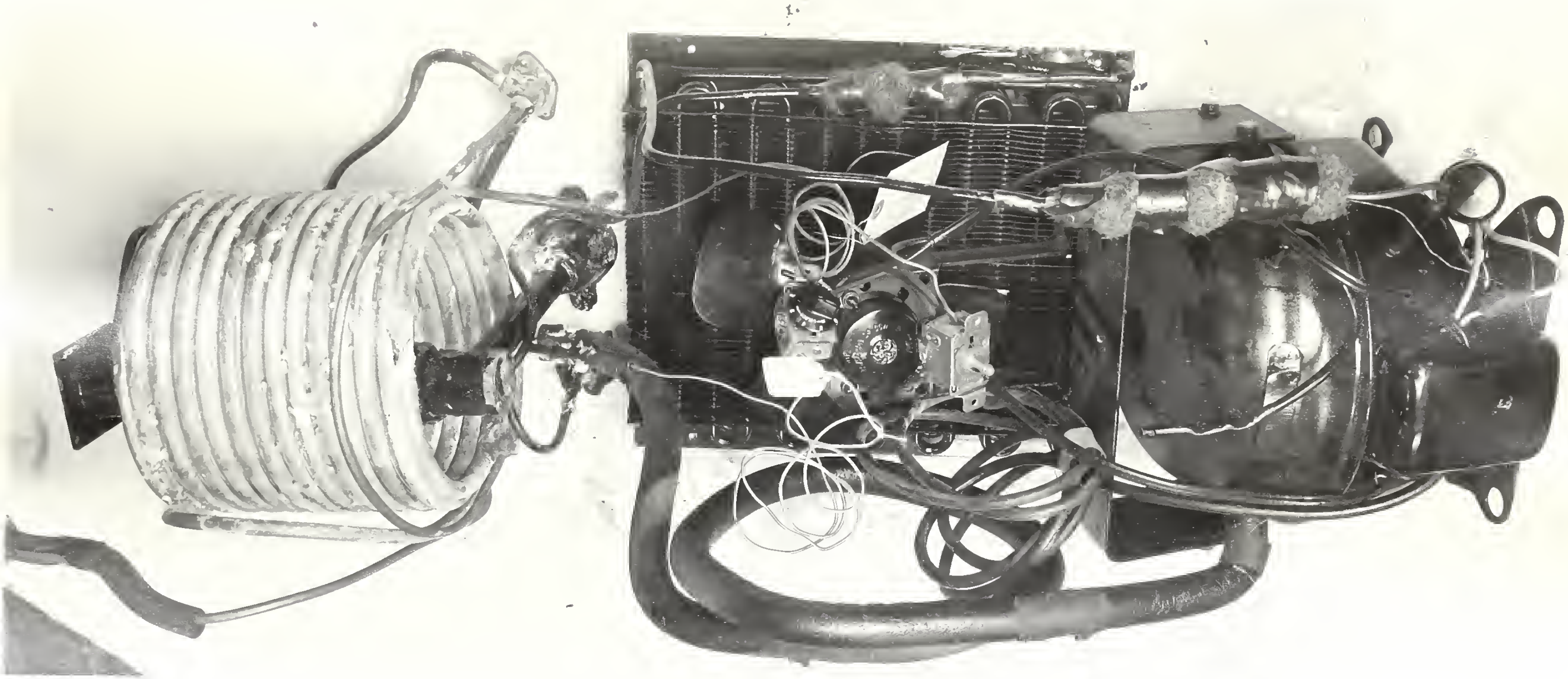

FIGURE 4

FIGURE 5

FIGURE 6

FIGURE 7

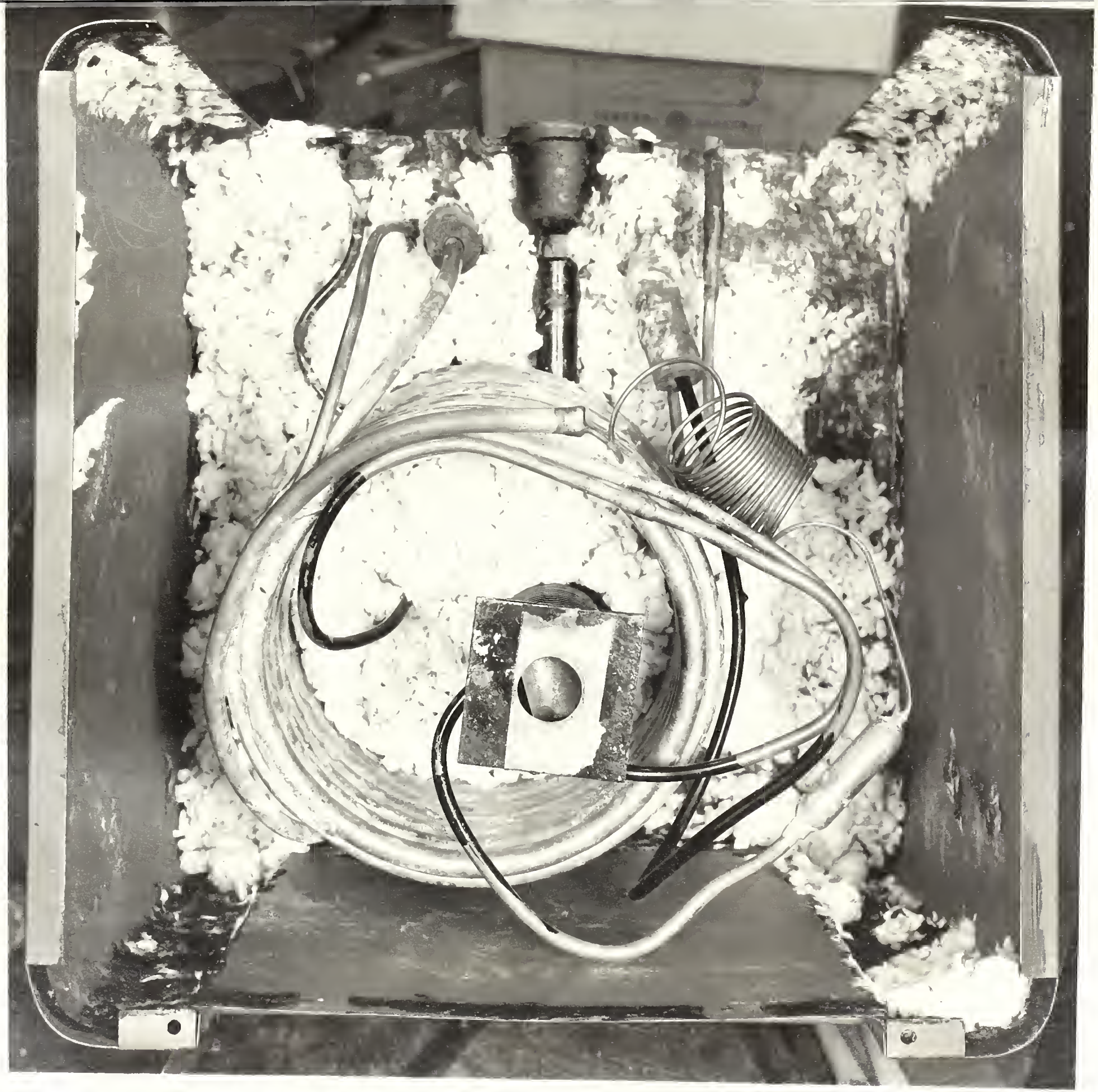

FIGURE 8

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