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SUMMARY OF RESEARCH AND DEVELOPMENT WORK

DONE FOR OQMG from OCT. 1, 1951 to OCT. 1, 1952

by

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for

Office of the Quartermaster General

NBS

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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I. INTRODUCTION

During the year starting October 1, 1951, and ending September 30, 1952, the work done by the Heating and Air Conditioning Section of the National Bureau of Standards for the Office of the Quartermaster General of the United States Army varied widely in the field of refrigeration and related subjects. Work was done on portable warehouses and refrigerating units for these warehouses, water coolers, air conditioners, and a variety of other equipment. Results of these investigations were transmitted to OQMG by means of personal contacts, letter reports, quarterly reports, and regular reports on particular items. The following represents a summary of all the work done during the twelve months ending October 1, 1952.

II. WORK PERFORMED

a. Warehouses

Tests were made of a nominal 150- cu ft warehouse to determine its overall heat transmission coefficient. This warehouse was manufactured by the General Development Corporation of Elkton, Maryland. It was of the non-demountable, portable type, and was provided with an opening for the refrigerating unit. An access door was provided on the opposite side of the refrigerating unit opening. The heat transmission coefficient of this warehouse was found to be 27.1 BTU/hr per degree temperature difference. The opening for the refrigerating unit was blanked off for this test with a panel of 3/4 in. plywood.

Tests were made of a nominal 150-cu ft warehouse to determine its overall heat transmission coefficient. This warehouse was manufactured by the Brown Trailer Company, Spokane, Washington. It was of the non-demountable, portable type, and was provided with an opening for the refrigerating unit. An access door was provided on the opposite side of the refrigerating unit opening. The heat transmission coefficient of this warehouse was found to be 27.1 BTU/hr per degree temperature difference. The opening for the refrigerating unit was blanked off for this test with a panel of 3/4 in. plywood.

A demountable, lightweight, 600-cu ft walk-in refrigerator manufactured by the Alexander H. Kerr Company of Burbank, California, was tested to determine its overall heat transmission coefficient and studied with regard to certain construction features. The three-inch thick panels were formed of a glass fiber sheeting approximately 3/64 inch thick glued over a peripheral wooden frame and employing a lightweight, foam-type

insulation. Stiffness for the panels was provided by ribs running longitudinally through the panels made out of the same material as the surface of the panels. The glue used to attach several panel surfaces had loosened. The single-gasket door did not effect a continuous seal. The heat transmission tests were made with the opening for the refrigerating unit sealed by a plywood panel, which was covered with rock wool batts. For the first "U-Factor" test, all cracks between panels, door, etc. and other openings were sealed with masking tape and shellac. The "U-Factor" for this test was 67.2 BTU/hr (°F temperature difference). For the second test all of this sealing material was removed from cracks, etc., and the heat transmission coefficient then was 84.3 BTU/hr (°F temperature difference).

b. Warehouse refrigerating units

Tests were completed to determine the capacity, dependability, and structural soundness of two 1/3 ton, plug-type, gas engine-driven refrigerating units developed for use with demountable or portable refrigerators. One unit was manufactured by the U. S. Thermo Control Company, of Minneapolis, Minnesota, and the other by Carrier Corporation, of Syracuse, New York. Although both units performed satisfactorily for the most part during the tests, certain operating difficulties were observed. Approximate capacities at conditions of 0°F refrigerator temperature and 110°F ambient temperature were 4000 BTU per hour for the Thermo-King unit and 3800 BTU per hour for the Carrier unit. Both units were compact and arranged for automatic operation.

Operational tests of a model Q-15-E Thermo-King plug-type electric motor-driven refrigerating unit for use with portable or demountable refrigerators were completed. The unit was manufactured by the U. S. Thermo Control Company of Minneapolis, Minnesota. Two inter-connected hermetic motor compressor units were employed to furnish capacity range. The observed capacity with both compressors in operation at 70°F ambient temperature was 2400 BTU/hr with air at a temperature of -19.5°F entering the evaporator, 4300 BTU/hr at 0°F, and 9700 BTU/hr at 35°F. At 90°F ambient temperature a capacity of 3400 BTU/hr was observed with evaporator air inlet temperature at 0°F and 7700 BTU/hr at 35°F. At 110°F ambient temperature the lowest entering air temperature obtainable in the test calorimeter was 2°F with an indicated unit capacity of 2900 BTU/hr and at 35°F entering air temperature the capacity was 6700 BTU/hr. Capacities observed at 125°F ambient temperature were 3100 BTU/hr with 9.5°F entering air and 5200-5800 BTU/hr with 35°F entering air.

c. Water Coolers

A Type I, Size 10 electric drinking water cooler manufactured by the Sunroc Company of Glen Riddle, Pennsylvania was tested to determine its compliance with the performance requirements of Federal Specification OO-C-566b. The tests were made at the request of the Chicago Quartermaster

Depot. As submitted, the cooler specimen complied with all performance requirements of the specification with the exception of the thermostat test. A different thermostat was installed by representatives of the manufacturer, and after some internal adjustment of the second thermostat, the cooler passed the thermostat test. A letter report on these tests was submitted to the Chicago QM Depot and the inspector concerned, and the final report is now being reviewed prior to publication.

A Type III, Size 20 cafeteria cooler manufactured by Filtrine Manufacturing Company of Brooklyn, New York was tested to determine its compliance with the performance requirements of Federal Specification OO-C-566b. These tests were also made at the request of the Chicago QM Depot. The cooler submitted failed during the Maximum Operating Test, when it developed a refrigerant leak in the fusible plug of the receiver. The cooler was repaired by a representative of the manufacturer; however, it was decided that a second specimen should be submitted for a continuation of the tests. This cooler passed three of the seven performance tests, the thermostat test, the freezing test, and the motor overload protective test. It failed to comply with the capacity, peak draw, maximum operating, and overload test requirements. A letter report was sent to the Chicago QM Depot and the inspector concerned, in which it was recommended that these coolers not be bought unless major design changes were made.

A complete revision of Federal Specification OO-C-566b on electric drinking water coolers was written at the request of OQMG and submitted to the Technical Committee on Refrigeration and Air Conditioning of the General Services Administration. The revision was submitted to Industry for comments, and is now being circulated among Government departments for comments.

d. Water-Vapor Transmission in Refrigerated Warehouses

A new project on Water Vapor Transmission in Refrigerated Warehouses was initiated at the National Bureau of Standards under the sponsorship of the Office of the Quartermaster General, about May 1, this year. The object of this project was to conduct research that would establish, if possible, a criterion of permeability for the interior and exterior surfaces of prefabricated refrigerator panels, including the breaker strips at the edges, which would prevent water or frost from accumulating inside such panels for a range of vapor pressure differences and a range of temperature differences for different types of insulation in different panel orientations.

A thorough search of the literature pertaining to water vapor transmission and its accompanying design problems was completed prior to the development of the design of apparatus for this project. A bibliography and abstracts resulting from this literature survey have been transmitted to the Office of the Quartermaster General.

The test apparatus was designed to accommodate a 4 ft by 8 ft test panel with thicknesses up to 12 in. and for temperatures as low as -20°F on the cold side and 150°F on the warm side. The humidity and temperature of the air on both sides of the test panel will be controlled and the resulting heat and water vapor transfer through the test panel will be measured. The apparatus is so designed that it may be rotated through an angle of 180 degrees simulating heat and vapor flow in walls, floors and ceilings. The framing, insulation and vapor-proofing of the larger sections are completed, together with the trunnion for rotating the apparatus. Cantilever weighing devices for measuring the moisture evaporated and the moisture adsorbed have been built and installed. The desiccant chamber was completed as well as the refrigeration system for cooling the space on one side of the test specimens. Electric wiring and a thermocouple system are being installed. The apparatus will be completed as soon as the hygrometric equipment is received. This apparatus was ordered about six months ago, and its non-delivery is delaying progress on the apparatus at the present time.

e. Miscellaneous Testing

Jackes-Evans Electric Solenoid Valve

A study of several electric solenoid valves manufactured by Jackes-Evans Mfg. Co. of St. Louis, Missouri was made by installing them in the refrigerant liquid line of the secondary refrigerant calorimeter. Tests were made to determine proper opening and closing of the valves in positions other than horizontal mounting. The first valve submitted was found to be unsatisfactory; however, the second valve appeared to perform adequately in various mounting positions.

Emery-Thompson 26-cu ft Refrigerator

Tests on a 26 cu ft portable, chest-type freezer manufactured by Emery-Thompson Machine and Supply Company were completed. The refrigerator was equipped with a 1 HP Copeland mechanically sealed hermetic condensing unit, for use on single-phase, 220 volt, alternating current. Tests were made to observe the lowest box temperatures obtained at ambient temperatures of 70°F, 95°F, and 120°F. In addition, observations were made of the "pull-down" characteristics of the refrigerator at 70°F ambient. The lowest box temperatures obtained at the above ambient temperatures were -38.2°F, -22.1°F, and -6.8°F, at 70°F, 95°F, and 120°F ambients, respectively. The power consumptions at these conditions were 654, 742, and 838 watts, respectively. At an ambient of 70°F , the pull-down time from 70°F to 0°F was 50 minutes, to -20°F was 2 hours, to -30°F was 3-1/2 hours, and to -38°F was 9-1/2 hours. The unit was equipped with two low-pressure controls, one set for above-freezing temperature operation, the other set to obtain a box temperature of approximately0°F. A three-position selector switch with positions marked "High", "Low", and "Off" was located in the front of the machine compartment, and the desired pressure control could be included in the electrical circuit through positioning of this switch.

The test apparatus was designed to accommodate a 4 ft by 8 ft
test panel with thicknesses up to 12 in. and for temperatures as low
as -30°F on the cold side and 120°F on the warm side. The cooling and
temperature of the air on both sides of the test panel will be controlled
and the resulting heat and water vapor transfer through the test panel
will be measured. The apparatus is so designed that it can be moved
through an angle of 180 degrees elevation and can rotate 360 degrees in
floors and ceilings. The heating, humidifier and refrigeration
for larger systems are duplicated, together with the controls for
rotating the apparatus. Controlled weighing devices for measuring the
moisture transmitted and the moisture retained have been built and
installed. The electronic computer has completed as well as the initial
data system for recording. The system is now in the final stage of
electric wiring and a thermocouple system has been installed. The
apparatus will be completed by June of the current calendar year.
This apparatus has achieved fame in the upper-air laboratory
conditions in climatic chambers to the economics of the present time.

e. Humidifiers Testing

Room-Type Electric Humidifier Study

A study of several electric humidifiers was made during the
calendar year 19__ at St. Louis. Purpose of study was to investigate the
in the refrigerated liquid line of the evaporator coil. Humidifier
Tests were made to determine proper cooling and operation of the valves
in providing water from humidified chamber. The first valve installed
was found to be unsatisfactory however, the second valve operated to
perform adequately in various operating conditions.

Heat Exchanger Study of Air Conditioner

Tests on a 20 ton AC package, heat-pump air conditioner manufactured by
Heat-Exchanger Service and Supply Company were completed. The heat exchanger
was equipped with a 1 HP Dayton centrifugal blower, belt-driven, centrifugal
unit, for use in electric-power, air with electric power. Tests
were made to observe the latent and temperature efficiency at various
temperatures of 70°F, 0°F, and 110°F. In addition, tests were made
with the pull-down, temperature of the refrigerator at 0°F
centers. The lowest air temperature obtained at the return center
temperatures were -10.5°F, -9.5°F, and -4.5°F, at 70°F, 0°F, and 110°F
respectively, respectively. The power consumption of these conditions were
[illegible], and 0.0 watts, respectively. At the temperature of 110°F, the
pull-down time from 70°F to 0°F was 30 minutes, to -40°F was 1 hour,
to -70°F was 2-1/2 hours, and to -90°F was 4-1/2 hours. The unit was
equipped with the heat-exchanger equipment, and not for air-conditioning
temperature conditions, the units act as a heat exchanger of
approximately 0. A heat-exchanger equipment with a 1 HP pulsating
[illegible], 1 HP, 1 [illegible] was located in the [illegible] of the outside compressor,
and the indoor evaporator coil could be located in the [illegible] in the [illegible]
climate through pulsations of this unit.

Canvas Cover for Ice Cream Storage

Two insulated canvas water-can covers, U. S. Army Stock No. 24-C-7074 were tested for OQMG to determine their suitability for use as ice cream containers and to determine how long ice cream hardened at 0°F would stay in edible condition. The ice cream used for this test was packed in commercial 2-1/2 gallon containers, two of which were placed into each insulated canvas cover. The tests were made at 70°F ambient and 110°F ambient. It was found that ice cream would be maintained in an edible condition from 14 to 26 hours in an ambient temperature of 70°F and from 10 to 18 hours in an ambient temperature of 110°F, the canvas covers being at ambient temperature when the ice cream was placed into them. When the canvas covers were precooled at 0°F for several hours before placing ice cream into them, the melting time of the ice cream could be increased from two to six hours in most cases. A letter report on those tests was forwarded to OQMG on June 19, 1952.

General Electric Transportable Air Conditioner

Tests were completed of a sectional-construction, electric motor-driven package type air conditioning unit manufactured by the General Electric Company, Bloomfield, N. J., for the OQMG, to determine capacity and suitability for use in the Mobile Petroleum Laboratory. This unit was identified as G. E. Mod. No. FF-15. It was equipped with a 2-HP electric compressor motor and was designed to operate on 208 volt 3 phase 60 cycle current and to produce a net cooling capacity of 18,000 BTU/hr, at 95°FDB-75°FWB ambient temperature and 80°FDB-67°FWB within the controlled space.

Tests were made with the unit completely within the controlled space and outside of the controlled space, at conditions of 95°FDB-75°FWB and 80°FDB-67°FWB, and 125°FDB-85°FWB and 90°FDB-80°FWB.

After several adjustments and alterations to the unit by a representative of the manufacturer, the following approximate net cooling capacities were observed. At the 125°FDB ambient condition the capacity was approximately 11,100 BTU/hr when the entire unit was in the controlled space and 14,600 BTU/hr when the condensing section was outside the controlled space and only the evaporator section was inside the controlled space. At the 95°FDB condition the capacity was approximately 12,800 BTU/hr with the entire unit in the controlled space and 15,300 BTU/hr with the unit divided.

The dimensions of the 5-section unit, assembled, were 65" high x 42" wide x 14" deep, and the weight was 508 lbs.

Problems of excessive air leakage and exchange of air between condenser and evaporator sections, as well as certain mechanical difficulties such as failure of flexible refrigerant lines, resulted in the manufacturer requesting permission to submit another specimen for the remainder of the tests. Although this was acceptable to OQMG, no such unit has yet been submitted.

Drifreez Refrigerant Dehydrator

Tests have been completed to determine resistance to vibration of a refrigerant dehydrator identified as "Drifreez" by the manufacturer, the Berma Corporation of New York. No breakdown was evident following more than 100 hours of operation at a vibration test at 0.0375 in. amplitude at 3300 cycles/min.

Tests to determine the rate of moisture removal, and drying ability and total moisture removal capacity of the 3/8 in. line size Drifreez dehydrator, which employs approximately 43.5 grams of calcium carbide as the desiccant, are nearly complete. This size appears to be able to remove approximately 20 grams of water from liquid dichlorodifluoromethane refrigerant with a final system wetness in the vicinity of 60 ppm. An end dryness less than 6 ppm under ideal conditions appears to be possible with this desiccant. The rate of drying appears to be slow, the sample tested required 8 days to remove 25 grams from the test system. Comparative tests with a silica gel dehydrator of approximately 12 cu in. silica gel capacity are being made and a means of presenting data in comparative style is being studied.

Tests and chemical analyses are also being made to determine the possible hazards contingent on using this calcium carbide dehydrator. Preliminary tests of system-gas mixtures containing 2% acetylene (formed by reaction of water with calcium carbide) indicate no explosion risk. More work remains to be done in this regard, however, before final statements can be made regarding explosion hazards.

It is hoped that comparative studies of the several types of dehydrators currently in use can be made, utilizing the apparatus for continuously-indicating system wetness developed for tests of the Drifreez dehydrator.

Tent Heater Fan Sample

Two different types of propeller fans were tested to determine relative efficiency, power input and capacity. One specimen was a Torrington fan, the other was a Herman-Nelson fan. Both specimens were intended for use on the gasoline-fired tent heater to circulate the heated air. Considerable difficulty was experienced in measuring power input since the fan was mounted on the engine shaft and the engine body was located directly in the fan inlet. This made it necessary to use an actual engine body with a shaft extending through the engine to the dynamometer shaft. As outlined in a letter-report dated September 9, 1952, fan specimen T (Torrington) on the hot run with the open duct, moved 2160 cfm (corrected to standard air) with 1.53 total horsepower input (measured at engine coupling) and on the cold run with the open duct moved 2190 cfm with 1.58 horsepower input, and fan specimen S (Herman-Nelson)

at corresponding conditions moved 2035 cfm with 1.16 horsepower input and 2100 cfm with 1.23 horsepower input. Fan speeds were held at 3450 rpm. A second tent heater has been received for further fan tests.

Gasoline Lanterns

Specimen Kooklite gasoline lanterns manufactured by the American Gas Machine Company were tested to determine the effect of using orifice cleaners and leaded gasoline on the luminosity of the lanterns over a period of time. The tests indicated that the chemical and physical properties of the two gasolines used were of greater importance to the generator or orifice life than leading the gasoline or the orifice cleaning operation. A gasoline complying with the Federal Specification permitted the lanterns to operate more than 200 hours with a terminal luminosity greater than 60 candlepower when either leaded or unleaded fuel was used. When a base stock gasoline was used, the luminosity of the lanterns fell to the minimum of 60 candlepower in periods of time ranging from 50 to 120 hours. With this gasoline use of the orifice cleaner had no apparent effect on the length of time the lantern would operate with a given orifice.

f. Consultations and Demonstrations

Aqua-Therm Stabilizer

Two sizes of a device identified as Aqua-Therm stabilizers, and manufactured by M. S. Industries, Inc. of Washington, D. C., were studied with regard to patent claims and probable performance to determine if they would be of sufficient value to the military to warrant a series of tests. The results of this preliminary study were set forth in a letter dated July 8, 1952. It was decided that no tests should be made, and both units have been crated at the request of the Office of the Quartermaster General ready for shipment to Jeffersonville Quartermaster Depot upon receipt of shipping instructions.

Aqua-Fog Evaporative Condenser

Tests and demonstration of a new type of water-evaporative-cooled condenser for refrigerating systems of 5 HP or less were set up and made for the Refrigeration Section, Military Planning Division, Office of the Quartermaster General. The principal feature of the condenser being demonstrated was a motor driven wheel, turning at a speed of approximately 3400 rpm, and throwing a stream of water of varying particle size over a bank of horizontal refrigerant-condensing tubes, which eliminated the water-pump and nozzle combinations usually used for this type of device. The demonstration and tests were presented to a group of engineering representatives from several interested Government agencies. The device was identified by the name "Aqua-Fog .

g. Miscellaneous

A final report on calorimeter tests of a York 5-HP compressor was

submitted in January 1951.

A final report on tests of the Bakery Water Chillers was prepared and is now being reviewed.

A consolidated report of all warehouses tested until December 1951 has been prepared and is now being reviewed.

A consolidated report of all warehouse refrigerating units tested until September 1952 is now being prepared.

h. Construction

An insulated testing enclosure was provided and equipped in Building 35 of NBS. This test room is smaller than the facilities in the West Building, and is hence well suited for the testing of small appliances such as water coolers, chest-type refrigerators, and ice cream machines. The room can be used over a temperature range of approximately +30°F to 150°F, and is equipped with fully automatic temperature controls. The test room was finished in May 1952 and has been in continual use since then.

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