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PROGRESS REPORT ON CONDENSER STANDARDIZATION
(MAY 1 TO OCTOBER 31, 1958)
QMREL-M PROJECT ORDER NO. 57-26

by

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U. S. DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

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The activities described in this report follow in sequence those reported in a letter addressed to R. J. Campbell and dated May 2, 1958.

I Activities During May 1958

Installation was completed of the condensing units for temperature control in the calorimeter and test room, together with most of the necessary control devices. Installation of electrical circuits for power and control equipment was continued.

Construction of the receiving and discharge chambers, in accordance with ASRE P.S.2.4, was completed, together with the connecting devices for adapting the condensers to the receiving chamber.

A multi-purpose instrument and system control center was erected adjacent to the test cell, and the instrumentation of this room was begun.

II Activities During June 1958

The air cooling unit for the test cell was received and its installation was completed together with the necessary controls, piping, and electrical circuits. Work on instrumentation in the control center continued throughout the month.

The components of the air circuit were treated for rust prevention and installed in the test room as an integral unit, including the flow nozzle, pitot tube, and air flow control damper. The receiving chamber was insulated as specified in the proposed standard. The exhaust blower was installed and the entire system was leveled and aligned.

The installation of pressure and temperature measuring instruments for the system was started during the month. Other instruments and equipment were installed as they were received.

Fabrication of the evaporator for the system was completed following receipt of the heating elements, and with its installation, construction of the major items of the calorimeter was completed.

The refrigerant circuit of the test apparatus, complete with a remote air-cooled Size A, Class 1 test condenser, motor, and fan mounted in the apparatus, was put in operation to try out the system. During this trial run, two of the evaporator heating elements burned out, apparently because the protective devices on the surface of the evaporator tubes failed to sense the heater element temperature. The calorimeter evaporator was dismantled to determine the extent of the damage and to replace the heating elements. It was decided to replace all the heaters with others of lower watt density, and the necessary elements were ordered.

III Activities During July 1958

Instrumentation of the test control room and installation of pressure and temperature measuring circuits in all related apparatus were completed.

The entire refrigerant circuit of the apparatus was dismantled and all parts were cleaned or replaced as necessary because of the decomposition of the refrigerant in contact with the overheated electric elements. Alterations were made to improve system operation and to reduce the likelihood of further major damage.

As agreed in a meeting between representatives from Quartermaster Research and Engineering Command and this Bureau, it was necessary, before testing any of the prototype condensers, to determine that the fan used with each test condenser was in conformity with the minimum air flow requirement of the purchase description. It was necessary, therefore, to thoroughly test each fan before tests of the corresponding condensers could be started.

In order to conduct a fan performance test in accordance with paragraph 4.2.2 of Purchase Description dated March 22, 1957, the fan orifice of a Size A Kramer Trenton condenser was removed and altered to conform to NAFM bellmouth design specifications. This alteration was completed during the month and the fan performance test phase was begun. It should be noted that the air circuit in the test apparatus required in ASRE Proposed Standard 2.4 is not identical to the fan testing apparatus described in NAFM Plate VI, which is referenced in the fan requirement of the purchase description.

IV Activities During August 1958

A Torrington E-1826-3 fan was mounted as shown in NAFM Bulletin No. 110, 2nd edition, Plate VI for the first series of fan tests. It was operated in an 18-5/16-inch bellmouth at 1140 rpm with one third of the blade pitch extending downstream of the bellmouth. Tests were made over a range of static pressure difference from 0.00 to 0.60 in. W.G. at standard air conditions of 68 F dry bulb and 50% relative humidity. In the static pressure range from zero to 0.25 in. W.G. the fan did not meet the minimum air flow requirements specified in Drawing 5-13-1863 of the Proposed Military Standard. It failed by as much as 15 percent in this operating range.

Following several refinements of the air circuit in the test apparatus other fans on hand of Torrington Series E-1826-3 were tested, all of which failed to meet the specified minimum capacity.

A telephone conversation with engineering personnel at the Torrington Manufacturing Company revealed that the whole shipment of Series E-1826-3 fans received by this Bureau were deficient in pitch depth by 3/16 inch or more. The design depth was 4-7/16". Series E-1826-3 fans of the correct pitch were requested and arrangements were made for a representative of this Bureau to visit the fan testing facilities of the manufacturer in Torrington, Connecticut.

V Activities During September 1958

An NBS representative went to the Torrington Manufacturing Company during the early part of the month to discuss with their engineering personnel the problem of obtaining proper fans for the condenser tests. Testing methods were compared, and Torrington test facilities were inspected at this meeting. The company promised prompt shipment of the proper fans for the small condensers and cooperation in furnishing correct fans for the larger size condensers when the need arose.

Three condensers, complete with motors and fans, shipped by the Kramer Trenton Company and received by this Bureau on February 6, 1958, NBS nos. 142-58, 143-58, and 144-58, were equipped with Torrington Series E-1829-3 fans. Tests were made using one of these fans which was short in pitch by 1/8" from the design depth for this blade of 4-15/16". This fan also failed

to meet the air flow requirements listed in the 1954 edition of the Torrington Airistocrat for the E-1829-3 fan, but only by a maximum of 3 percent at 0.00" H_2O S.P., and less than 3 percent at higher static pressures. These fans were designed for higher air delivery than the E-1826-3 series and could not be used for the condenser test because they deliver more than the required air flow specified in the purchase description. For example, the purchase description requires 2070 cfm at 0.2 in. W.G.; the E-1829-3 fan delivers 2160 cfm at 0.2 in. W.G. At lower static pressures, this disparity was greater.

The shipment of E-1826-3 fans of correct pitch requested from Torrington Manufacturing Company arrived, but they were of the blow-through instead of the requested draw-through type. They could not be used and shipment of the correct type was requested.

Before receiving the correct fans, alterations to the air side discharge chamber were made to bring this system into closer agreement with the requirements set forth in NAFM Fan Test Codes. These alterations consisted of lengthening the duct beyond the nozzle discharge, installation of an "egg crate" air straightener, and flaring of the air passage from the discharge of the bell-mount into the receiving chamber. In order to mount the fan motor in the receiving chamber, the connecting duct was eliminated. This change should be incorporated ASHE Proposed Standard 2.4.

A shipment of two E-1826-3 fans of correct pitch and rotation arrived at the end of September.

A Class 1, Size 3 Thermo King condenser was received for testing. It was shipped without fan, fan motor, shroud, or fan orifice.

VI Activities During October 1958

One of the new shipment of Torrington E-1826-3 fans was tested at standard air conditions and met the minimum air delivery requirement at 0 in. W.G. static pressure. Although the air delivery dropped to 5 percent below the required minimum at 0.25 in. W.G. static pressure, this performance represents an increase of 5 percent over previous tests with E-1826-3 fans. It is believed that adequate air delivery for the Size A condenser units can be obtained with a few minor adjustments to the air circulating system, now that an E-1826-3 fan of correct dimensions has been obtained.

Following the repair of a leak in the refrigeration circuit of the test apparatus, a test of a Size A, Class 1 condenser at "high rate" conditions was begun. With a refrigerant temperature at the condenser inlet of approximately 170 F, the electric heater installed in the compressor discharge line to control the discharge gas superheat burned out. It was removed and parts of the system contaminated by breakdown products were cleaned as necessary. The filter-dryer was replaced. New superheating heaters, constructed of steel alloy sheath instead of copper, and having a watt density less than half that of the previous heater were secured and installed.

The system was purged, recharged and again put into operation at the "high rate" condition. Despite the steps taken to prevent a recurrence of the failure of the main evaporator heaters, one element failed completely and another partially after less than one hours' operation. The evaporator section of the refrigerant side of the calorimeter was removed and rebuilt completely, using steel alloy sheath heaters of such size that, operating in still air, the element surfaces do not heat above 235 F. This was accomplished by operating at less than one half the manufacturer's design rate, on which the previous evaporator was designed.

At the request of the Quartermaster Research and Engineering Command, arrangements were made to begin tests of the Class 1, Size B condensers prior to testing the Size A units. A Class 1, Size B condenser was installed in the system. The fan orifice of a Kramer Trenton Size B condenser was removed and remodeled to conform to the correct bellmouth specifications for testing the E-2420-4 fan to be used with these condensers. None of the eight E-2420-4 fans on hand conformed to Torrington design specifications and one was sent to the NBS instrument shop to be reshaped to the correct blade pitch and depth. Tests of this corrected fan will be started immediately. The refrigerant circuit of the system has been checked out after rebuilding of the evaporator section and appears to perform satisfactorily. Tests of the Size B condensers will be started as soon as the proper fan performance is obtained.