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13. ABSTRACT

Describes a method for evaluation of heating and ventilating equipment operational and functional performance characteristics. Identifies supporting tests, facilities, and equipment required. Provides procedures for assembly, installation, and functional performance tests of fans, dehumidifiers, heaters, and packaged steam boilers. Not applicable to air conditioners, humidifiers, dehumidifiers employing other than refrigeration or sorption methods, nuclear and combined cycle steam generators, and special aircraft engine/cabin heaters.

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	ROLE	WT	ROLE	WT	ROLE	WT
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Boiler						
Dehumidifier						
Fan (ventilation)						
Heater						
Steam Generator						
Ventilation System						
Environmental Control System						

U.S. ARMY TEST AND EVALUATION COMMAND
SYSTEM SERVICE TEST OPERATIONS PROCEDURES

AMSTE-RP-702-109
*Test Operations Procedure 10-3-065 14 April 1972

HEATING, VENTILATING EQUIPMENT

SECTION I
GENERAL

1. Purpose and Scope. This Test Operations Procedure (TOP) describes service tests for evaluating the operational, performance and maintenance characteristics of heating and ventilating equipment to determine the degree such equipment meets the requirements of Materiel Needs (MN) and whether it is suitable for Army use. Testing is conducted using military personnel representative of those who will operate and maintain the equipment in the field and under all climatic and environmental conditions representative of those areas where the equipment will be used. These procedures are not intended for test of air conditioners, humidifiers, dehumidifiers employing other than the refrigeration or sorption methods, nuclear and combined-cycle steam generators, and special aircraft engine/cabin heaters.

2. Background. A wide variety of heating and ventilating equipment has been developed to accommodate the many conditions requiring such equipment for the more efficient employment of men and material in the field. Fuel for the operation of existing categories of equipment are gasoline, fuel oil, coal, wood or electricity.

*This TOP supersedes MTPs 10-3-066 (3 May 69), 10-3-067 (13 June 69), 10-3-068 (9 Jul 69), and 10-3-071 (2 Apr 70), including all changes.

a. Ventilation is accomplished by a variety of devices which, as a group, may be referred to as "fans". Types of fans are described either by their principal use (i.e., ventilating, exhaust, circulating, suction) and/or blade configuration (i.e., propeller, centrifugal, vane axial, tube axial).

b. In a hot, humid environment a fan, or fans, alone may not be entirely satisfactory in ventilating large storage structures. Dehumidification then becomes necessary. Dehumidifiers fall into two classes based on the method employed to remove unwanted moisture from the air: (1) by mechanically cooling the air below its dewpoint so that condensation occurs (refrigeration method), or, (2) by passing the moist air thru a sorbent material which will extract and hold water vapor (sorption method).

c. Heating equipment ranges from simple, portable, radiant space heaters through duct-type portable or trailer mounted units to semi-portable, packaged, steam or high temperature water generators.

3. Equipment and Facilities. Equipment and facilities required are defined in the documents listed in Section II.

SECTION II
TEST PROCEDURES

4. Supporting Tests. Common Service TOPs, the tests defined in Section III, and other published documents to be considered in formulating a service test plan are as follows:

	TEST SUBJECT TITLE	PUBLICATION NO.
a.	Operator Training and Familiarization	10-3-501
b.	Photographic Coverage	7-3-519
c.	Pre-operational Inspection and Physical Characteristics	10-3-500
d.	Safety	10-3-507
e.	Assembly and Installation (Refer to para 5)	
f.	Performance Tests	
	(1) Fans (Refer to para 6)	
	(2) Dehumidifiers (Refer to para 7)	
	(3) Heaters (Refer to para 8)	
	(4) Packaged Steam Boilers (Refer to para 9)	

	TEST SUBJECT TITLE	PUBLICATION NO.
g.	Qualitative Electromagnetic Interference	6-3-513
h.	Effects of Weather	6-3-509
i.	Maintenance Evaluation	10-3-504
j.	Reliability	2-3-507
k.	Human Factors Evaluation	10-3-505
l.	Surface Transportability (Vehicles)	2-3-519
m.	Air Portability, Internal	7-3-515
n.	Air Portability, External	7-3-516
o.	Durability	10-3-502
p.	Value Analysis	USAMC SUPPL 1 to AR 11-26

SECTION III
SUPPLEMENTARY INSTRUCTIONS

5. Assembly and Installation.

a. Objective. To determine the ease of assembly (if required) and installation of the test item.

b. Method. The test item is assembled (if required) and installed in its normal operating configuration using personnel, procedures, and tools described in the applicable technical manual or manufacturer's book of instructions. Electrical power, piping, ducting, etc., is connected as specified and all controls are manipulated to demonstrate absence of sticking or binding. Assembly and installation procedures are repeated as often as required, installing interchangeable subassemblies or components in different positions and varying the number of assembly/installation personnel used to insure statistical confidence in the results.

c. Data Required.

(1) Nomenclature of test item and interchangeable subassemblies or components.

(2) Recorded times to assemble and to install.

(3) Tools, equipment and materials required for assembly and/or installation.

(4) Difficulties encountered in assembly and installation.

(5) Number and MOS of personnel used for each operation.

(6) Interchangeability data (if appropriate).

(7) General comments by test personnel to include:

(a) Adequacy of instructions.

(b) Suggested changes; instructions/procedures.

d. Analytical Plan. The average times to assembly and install, for each configuration of equipment and the test team are computed. Comments of test personnel on difficulties encountered, adequacy of instructions, and suggested changes to instructions and procedures are summarized and analyzed. This information is compared with the requirements of the MN and specifications and then used to prepare recommendations relative to the suitability of the test item for Army use.

6. Fans.

a. Objective. To evaluate the capability of the test item to perform its primary function and the adequacy of all controls and indicators.

b. Method. The test item is installed in its operating position and if applicable, ducting is connected. Power is applied and all controls operated and indicators, if present, observed for proper functioning. The primary function of the test item is verified, if it is a device for the movement of air, noting air velocities at inlet and outlet. Appropriately placed thermometers are employed to measure the ambient air temperature and the temperature of the item or space being cooled by cooling fans. Readings are taken at intervals until stability is obtained. The test item is observed during operation in its normal position for signs of excessive noise and vibration or other induced motion in the housing.

c. Data Required.

(1) Nomenclature and functional use of the test item.

(2) Air velocities at inlet and outlet of test item designed for air movement (ventilating).

(3) Temperature readings at each time interval when test item provides cooling for an item or space.

(4) Any evidence of excessive noise or vibration.

(5) Comments of test operators in regard to:

(a) Ease of operation of test item.

(b) Any shortcomings or deficiencies.

(c) Degree to which test item performs its primary function.

d. Analytical Plan. Recorded data and comments of test operators are summarized and analyzed. The results are compared to the requirements of the MN and the analysis is used to prepare recommendations on the suitability of the test item for use by the Army.

7. Dehumidifiers.

a. Objective. To evaluate the capability of the test item to remove unwanted water vapor from the air.

b. Method. The test item is installed in a suitable storage structure in its normal operating configuration and the relative humidity of the air within the structure is ascertained. The test item is operated and readings of relative humidity are recorded every hour until stability is obtained. The control panel indicators and controlled air outlet of continuous recycling dry dessicant type dehumidifiers are monitored during operation and the cycling operation noted. The proper collection and disposal of condensate from refrigerant type dehumidifiers is verified by checking the container or drain during operation. The test item is examined during operation to determine the presence of excessive vibration.

c. Data Required.

(1) Nomenclature and principle of operation of the test item.

(2) Comments of test operators regarding ease of operation, adequacy of variables and displays to control and indicate the condition of the operation of the test item.

(3) Readings of relative humidity and time at hourly intervals thru out the test.

(4) Comments concerning the cycling operation or adequacy of condensate collection and disposition.

(5) Any evidence of excessive vibration.

d. Analytical Plan. A table comparing changes in the relative humidity within the structure with time is prepared and analyzed. The comments of test personnel regarding ease of operation, adequacy of variables and displays, condensate collection, dehydration cycling and whether vibration was considered excessive are summarized and analyzed. These results are compared with the requirements of the MN and specifications and the analysis are used to prepare recommendations on the suitability of the test item for use by the Army.

8. Heaters.

a. Objective. To evaluate the capability of the test item to perform its major function of providing heat.

b. Method. The test item is installed within or connected to the structure/item to be heated and operated until the temperature is stabilized at the desired temperature. Personnel occupying the structure being heated are questioned as to their opinion in regard to the evenness of heat distribution and general comfort. The maximum capability of the test item is ascertained by repeated testings under various types of ambient weather; e.g., cool, low humidity; cool, high humidity, moderately cold, average humidity; very cold, low humidity. Suitability of the test item for use in providing heat in the following applications is evaluated:

(1) Warmth for truck, tank and Army-type aircraft engines. Test vehicle or plane nomenclature and ambient temperature is noted.

(2) Preheating of engines before starting. Nomenclature of vehicles heated and ambient temperatures are recorded.

(3) Warmth in operator's compartments of vehicles for tactical readiness. Nomenclature of vehicles heated and ambient temperature is recorded.

(4) Heating of boxcars during loading and unloading operations. (The heater is not operated within the boxcar.) Size of boxcar(s) heated and ambient temperature is noted.

(5) Heating and ventilation of tunnels and sewers. Details of tunnel or sewer, i.e., length, height, width, (diameter) are recorded. (When used as a ventilating device, the heat source is not operated.)

c. Data Required.

(1) Nomenclature and type of heating device.

(2) Details of application, i.e., description of structure or item to be heated.

(3) Ambient weather conditions for each period of testing and time for structure to become comfortable.

(4) Comments of personnel in various areas of the occupied structure regarding adequacy of heating as it effects comfort and their ability to perform assigned tasks or habitate the structure.

(5) Details of each special application with comments of test personnel as to degree of success of the application.

d. Analytical Plan. The recorded data are arranged in tabular or graphic form and analyzed to determine adequate operation of the test item and conformance to the requirements of the MN. Comments of test personnel are summarized and analyzed and from these analyzes recommendations are prepared relative to the suitability of the test item for Army use.

9. Packaged Steam Boilers.

a. Objective. To determine the ability of the test item to meet the specifications stated in the MN.

b. Method. The test item is installed in its normal operating configuration. Ignition is provided and the boiler brought up to its rated capacity. The boiler is operated at rated capacity for a sufficient length of time to evaluate all controls and indicators and its stability of operation. Load is decreased to 50% of rated capacity and then increased to 125% of rated capacity and continued stability of operation noted. The test item is observed during all periods of operations for evidence of excessive vibration or noise (water-hammer).

c. Data Required.

(1) Nomenclature, including the specified capacity, of the test item.

(2) Comments of test personnel in regard to:

(a) Adequacy of instructions and ease of performing the procedures of start-up, maintaining operation, and shut-down.

(b) Adequacy of variables and displays to control and to indicate the conditions existing at critical internal and input-output locations.

(c) Conditions of overheating where they are undesirable or dangerous.

(d) Operating stability at 50%, 100%, and 125% of rated capacity.

(e) Any indication of vibration or water-hammer.

(f) Ability of test item to achieve its intended mission.

d. Analytical Plan. Recorded data are correlated, summarized and analyzed using tabulations and charts as appropriate. Comments of test personnel are summarized and analyzed. These analyses are then compared with the requirements of the MN and specifications to determine degree of conformance and are used to prepare recommendations relative to the suitability of the test item for use by the Army.

Recommended changes to this publication should be forwarded to Commanding General, U.S. Army Test and Evaluation Command, ATTN: AMSTE-ME Aberdeen Proving Ground, Maryland 21005. Technical information related to this publication may be obtained from the preparing activity, President, U.S. Army Armor and Engineer Board, ATTN: STEBB-MO, Fort Knox, Kentucky 40121. Additional copies of this document are available from the Defense Documentation Center, Cameron Station, Alexandria, Virginia 22314. This document is identified by the accession number (AD No.) printed on the first page.