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Air Conditioners
Air Conditioning Equipment

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Provides testing procedures for determining whether air conditioners meet specifications in applicable requirements documents.

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

DRSTE-RP-702-109
*Test Operations Procedure 10-2-145 13 June 1984
AD No.

AIR CONDITIONERS

1. SCOPE. This TOP describes tests for determining whether air conditioners meet the physical, performance, and maintenance requirements specified in governing documents.

*This TOP supersedes TOP/MTP 10-2-145 dated 10 May 1971.

The increased use by the Army of electronic gear housed in shelters has led to increased demand for air conditioners. These units are used to cool and heat (many contain electrical heaters) shelters containing communications, surveillance, target acquisition, fire control, data processing, missile, and other critical combat and combat support systems. The majority of these units are electric motor-driven, self-contained, one-piece items mounted to the walls of shelters. They usually can be mounted entirely in or out of the shelters. In some cases, the units are separated from the shelters, with ductwork to them. These units can be used in the following climates: hot/dry, warm/wet, intermediate, and cold.

The subtests in this TOP apply to self-contained single-unit air conditioners that are electrically powered. They have been selected to cover all areas that might be included in the course of a development test (DT). For an initial production test, use procedures in the purchase description. If, however, the procedures in the purchase description are sufficiently close to those in this TOP, the procedures in this TOP may be used.

This TOP does not cover gasoline-driven air conditioners.

2. FACILITIES AND INSTRUMENTATION.

2.1 Facilities.

ITEM	REQUIREMENT
Endurance cell	Similar to the psychrometric cell described below, without the air flow-measuring equipment. It cannot maintain the indoor and outdoor conditions as precisely as the psychrometric cell but can accommodate more than one test item in the partition between the two rooms.
Lifting/moving device	To move test item, meeting requirements specified by the test item manufacturer.
Temperature/altitude chamber	To condition test item(s) to specified temperatures
Vacuum pump and meter	Able to evacuate to 50 microns
Psychrometric charts/tables	Various manufacturers
Vibration testing machine	To subject test item(s) to applicable vibration test

Facilities required when testing the air conditioning unit:

Test room	Of sufficient volume and suitably rectangular to accommodate the insulated calorimeter "box" surrounding the refrigeration unit, including adjustable heating and air-circulating fans

ITEM (cont'd)	REQUIREMENT (cont'd)
	and auxiliary means to maintain average temperature of the test room within 2° C of the specified value. Mount six thermocouples in this test room.
Calorimeter "box"	Rectangular, with adequate volume to contain the following: The entire refrigeration unit Electric motor-driven fan of sufficient capacity and positioning that no uncirculated air pockets exist inside the "box" Electric heating elements (may be lamps coupled two in series to reduce voltage applied across each element, thereby minimizing radiant heat) installed in the center part of the "box" ceiling. Total watts consumed by these heating elements shall be no less than the BTU/hr rating of the test item divided by 3.413. Wattmeter connected to measure total electrical energy consumed by the fans and heating elements described above, as well as any electric light that may be used. 16 thermocouples mounted inside the "box".
Psychrometric cell	A chamber consisting of two rooms (an "indoor" and an "outdoor" room) used in measuring cooling capacity. Each room has apparatus for maintaining stated conditions and provision for measuring air flow. The partition between the two rooms has an opening in which the air conditioner to be tested is mounted (see ASHRAE STD 37-69[1*]).

*Footnote numbers correspond to reference numbers in Appendix A.

2.2 Instrumentation.

ITEM	MAXIMUM PERMISSIBLE ERROR OF MEASUREMENT*
High-pressure transducer 0 to 500 psig.	±2.0% absolute
Temperature transducer -34° to 77° C (-30° to +170° F) and -18° to 104° C (0° to 220° F) dry bulb	±0.05° C (capacity and air flow tests) ±0.5° C for other tests
Recording thermometer (distant reading, round chart) with temperature-sensitive bulb and recording charts	
Electronic halogen-sensitive refrigerant leak detector	
Tachometer	
Mercury or electronic barometer	±0.01 in. hg
Sound level-measuring equipment	See TOP 1-2-608[2]
Refrigerant moisture content indicator meeting requirements of test item manufacturer	
Low-pressure transducers 0 to 20 in. H_2O	±0.01 in. water
Voltmeters, ammeters, wattmeters	±0.50% full scale or ±1% of reading

3. REQUIRED TEST CONDITIONS. When received, the test item packaging will be carefully examined for evidence of rough handling during shipment. Then, unpack the item, and photograph it. Following initial inspection of the test item, instrument the unit with thermocouples at the evaporator air inlet and outlet and at the condenser air inlet and outlet. In addition, make provision to connect pressure gages to the suction and discharge lines. Install an elapsed time meter on each unit to assist in keeping a record of endurance and reliability hours.

4. TEST PROCEDURES. Use the following procedures unless specified otherwise by requirements documents or specifications.

4.1 Initial Inspection. Inspect the test item thoroughly inside and outside for any evidence of damage, loose parts, corrosion, bad finish, or other defects. Also examine the unit for missing components and evidence of poor finish or painting. Before further testing, check all units with a leak detector. If any units have leaks, give them the refrigerant system leak test (see para 4.7) to determine individual and total leak rates.

*Values may be assumed to represent ± 2 standard deviations; thus, the stated tolerances should not be exceeded in more than 1 measurement of 20.

Before starting any other tests, weigh each item to the closest ounce and measure to determine its physical characteristics. Next, remove the refrigerant charge from the unit and weigh again to the closest ounce to determine what charge was present. Then recharge the unit with the specified charge. Report units with improper charges.

4.2 Baseline Operational Test. Place the air conditioner in any ambient temperature between 21° and 29° C (70° and 85° F). Install sheet metal ducts on the evaporator return air inlets and evaporator air-discharge outlets. Each duct shall be at least 60 cm (24 in.) long and of the same cross-sectional dimensions as the respective openings. Mount two temperature-sensing devices in each duct 45 cm (18 in.) from the front of the air conditioner, each centered in a half of the cross section of the duct. (The locations are fixed to give average entering and exiting air temperatures.) Operate the air conditioner with the selector switch in the COOL position and the thermostat in the maximum COOL position for at least 2 hours. During operation, do the following:

a. Visually observe the refrigerant sight glass (should be clear) to ascertain that the air conditioner has a full charge.

b. Examine for abnormal operation such as excessive noise, misaligned components, etc.

c. Record air temperature at evaporator inlet and outlet (dry bulb °C) and at condenser inlet and outlet.

d. Record volts, amperes, and power inlet to air conditioner.

e. Record suction and discharge pressures.

NOTE: To obtain operational data, operate the unit in all modes (cooling, bypass, vent, high heat, low heat) under above conditions.

If the unit has a dual-speed condenser fan motor, activate the speed switch and determine whether it operates the motor within specified limits.

4.3 Initial Operation (24-hr). Install the unit in an enclosure and operate as outlined in para 4.2 for 24 hours. During this time, monitor the operating characteristics and observe the condition of the sight glass. After the 24 hours have elapsed, turn off the heat load. Switch the unit to high heat and run for 24 hours in this position. During this time, the thermostat will be bypassed by a timer so that full heating will be required for 45 minutes, and the timer will deactivate the bank of heaters on the thermostat for 15 minutes.

During the 24 hours of cyclic operation in the cooling mode, observe evaporator air temperatures, condenser air temperatures, refrigerant pressures, and the sight glass, and record any signs of improper operation.

During the 24 hours of cyclic operation in the high-heat mode, observe evaporator air temperatures, and record any signs of improper operation.

After both 24-hour runs, perform the baseline operational test (4.2). Compare the data obtained with those previously gathered to determine whether any components have failed or have caused a degradation in performance.

4.3.1 <u>Toxic Fumes</u>. Review the technical data package (drawings and specifications) for the air conditioning unit to determine if any material within the air handling equipment (i.e., insulators, supports for heating elements, gaskets, etc.) could thermally degrade to produce noxious fumes. Visually inspect the unit to ensure conformance with the technical data package. If no such materials are present, the toxic fumes test may be waived. If thermally degradable materials are present, conduct the toxic fumes test during initial operation as follows:

a. Operate the unit for 24 hours in the high heat mode.

b. Observe the operation, and record any unusual, unpleasant, or irritating odors produced within the enclosure.

c. If no odors are detected, collect a 20-liter air sample at the end of the test for chemical analysis.

d. Analyze the sample using a suitable general qualitative method (gas chromatography, long path infrared spectrophotometry, etc.).

e. Report any substances identified.

f. If odors were detected during step b above, collect samples every 4 hours for analysis.

g. Identify the compounds present, and select a suitable method for quantification.

h. Analyze and report results for each compound in parts per million (ppm).

4.4 <u>Safety Evaluation</u>. During all testing, inspect, operate, and maintain the test item with safety evaluation in mind. Note especially sharp corners or edges, protective devices, exposed high-voltage terminals, unshielded moving parts, and protection at fan openings.

Check the functioning of the automatic safety devices as follows:

a. Overpressure cutout. Restrict the air flow at the condenser outlet until the overpressure switch deactivates the compressor. Measure and record the pressure at which this happens. Perform this operation three times.

b. Overheating cutout. Operate the units in the high-heat mode, restrict the air discharge, and allow the temperature to rise. Measure the air temperature at the thermal cutout with a thermocouple when the heaters de-energize. Perform this operation three times.

c. Electric overcurrent. If possible, obtain a circuit breaker identical to that used as a main breaker in the test item for use in this test, instead of removing the breaker from the unit. Bench-test this breaker to determine whether it will trip at the manufacturer's "must trip" current rating. Check this by inserting a variable resistor with the breaker closed to give the "must trip" current for that breaker. Then turn off the breaker and after 15 minutes, turn it on again. Measure the time required for the breaker to trip at this current with a stopwatch.

d. Evaluate carrying handles or lifting eyes for adequacy.

e. Make sure decals that warn the operator/maintainer about hazardous conditions are placed appropriately.

4.5 Audio-Noise Test. Conduct this test in accordance with TOP 1-2-608, 4.1.1.1.c.

4.6 Electromagnetic Interference Test. The air conditioner shall not produce radiated or conducted electromagnetic emissions that exceed the requirements of Table II of MIL-STD-461A[3] for Class IIb equipment.

Determine the conducted and radiated emissions of the air conditioner, using procedures specified in MIL-STD-462[4], Methods CE03 and RE02. Run tests in the cooling and heating modes. Ensure that the heaters are up to temperature in the heating mode before measuring steady state noise levels. Make measurements, imposing all possible combinations of transients on all steady state operating conditions. Measure as specified in MIL-STD-462, and extract passing limits from curves in MIL-STD-461A.

4.7 Refrigerant Leak Test. Evacuate the system and charge with a dry nitrogen refrigerant gas mixture of 415 (or 420) psig. Use an electronic leak detector to measure all detectable leaks. As each joint or possible leak point is checked, mark it with paint. Use the percentage of refrigerant gas in the mixture to translate these leak rates into rates that would exist if the gas were 100% R-22; e.g., if the mixture contains 10% R-22, the leak rate measured would be multiplied by 10 to obtain the leak rate for pure R-22. Add all individual leaks to obtain the total system leak rate.

4.8 Evaporator Compartment Air Leakage Test. Attach a duct equipped with an air-circulating and measuring device to the fresh air inlet; it should be well sealed at the connection point. Seal the evaporator air discharge and return air openings carefully to prevent air leakage. Open the fresh air damper and, by means of the air-circulating device, subject the the evaporator compartment to a static pressure of 2.5 cm (water gage) for 30 minutes. At the end of this time, measure the pressure drop across the nozzle (or other metering device) and the temperatures (wet and dry bulb) of the air entering the device. Obtain the flow rate in standard cubic meters per minute (see para 6.1).

4.9 Ventilation Air Flow Test. Tightly connect an air-measuring nozzle to the fresh air inlet. Close the evaporator return air inlet grille, and turn on the evaporator fan to high speed. While maintaining 0.0-cm static pressure (water gage) by means of the air-circulating device, measure the pressure drop across the nozzle and the temperatures (dry and wet bulb) of the air through the nozzle. Calculate the flow rate in standard cubic meters per minute (see para 6.1).

4.10 Evaporator Coil Frost Test. Operate the air conditioner continuously for 12 hours in the cooling mode with air at 10° C (50° F) entering the condenser and air at 21° C dry bulb (16° C wet bulb) entering the evaporator inlet. Note any evidence of improper operation or formation of ice on the evaporator coil. In addition, monitor the parameters measured in para 4.2 periodically during the 12-hour run.

4.11 Capacity Test. Mount the test item in the partition of a psychrometric cell and seal it tightly, with the evaporator openings in the indoor room. Connect the air-measuring apparatus in the indoor and outdoor rooms to the outlets of the evaporator and condenser sections, respectively, and seal tightly so that no air can escape.

Capacity test the unit at the specified rating conditions (obtained from requirements documents). Use the air enthalpy method of section 3, ASHRAE 37-69 to measure the heat output and input on the condenser and evaporator sides, respectively. During this testing, keep the evaporator fan speed on high.

Before and after this test, weigh the unit to determine whether the proper charge was present.

4.12 Air Flow Test. Measure the evaporator air flow of the test unit with the fresh air inlet closed. Tightly connect an air flow-measuring apparatus to the evaporator air outlet opening. Construct the apparatus as shown in Figure 6 of ASHRAE STD 37-69; it will have a means of varying the air flow through it so that the static pressure at the evaporator air inlet can be varied down to zero. Run the test with the static pressure difference between the evaporator inlet and outlet held at zero (unless otherwise specified) and with the evaporator fan on high speed. Then determine the air flow by using the procedures in section 7 of ASHRAE 37-69. Measure and record the static pressure drop across the nozzle(s), and record the air temperatures, both wet and dry bulb. Then calculate the air flow rate and convert to standard cubic meters per minute (see para 5).

4.13 Heating Test. Conduct this test in an ambient temperature of 24° C (75° F). Operate the test item for 2 hours in the high heat mode with rated voltage applied and with the thermostat in the maximum increase position. Then record the air temperatures in and out of the evaporator, in addition to input frequency, voltage, and power per phase. The heating capacity of the unit is considered to be the total power input to the unit in watts (multiply by 3.413 to convert to Btu/hr).

4.14 Tilted Operation Test. Operate the test item in the cooling mode in an ambient temperature of 27° C ±2° (80° F ±3°) dry bulb and 24° C ±2° wet bulb for 12 hours. During this operation, tilt the test item 10° in each of the four possible directions, and operate for 3 hours in each direction. Observe the unit for evidence of malfunction or condensation being expelled from the unit into the evaporator airstream. After each 3-hour period, inspect the bottom of the unit and evaporator section for excess water accumulation.

While the test is being run, make sure only one drain hole is open at a time. Open the hole most likely to yield the least possible drainage, consistent with the probable method of mounting the unit in a shelter.

4.15 Vibration Test. Mount the test item to a vibration fixture, using only the mounting provisions on the unit. If the manual lists specific instructions for mounting the unit, follow them. Then test the unit by using the procedures and schedule for 3219 km (2,000 mi) of travel for trucks and semitrailers in TOP 1-2-601.[5] After vibration in each plane is completed, inspect the unit for visible signs of damage. At the end of the test, run a baseline operational test (4.2), and compare the data with those from a previously run test. Give the unit a refrigerant system leak test before and after this test to determine whether additional leakage has occurred.

4.16 High Temperature Storage and Operation. Instrument the test item, place it in a climatic chamber, and connect to power; raise the chamber temperature to 68° C (155° F) and maintain for 48 hours. Then lower the temperature to 49° C (120° F) and inspect the unit for signs of deterioration. After the unit has been at 49° C for at least 1 hour, operate it in the cooling mode for 1 hour with 49°-C air entering the evaporator and condenser air intakes. Near the end of the hour of operation, record the following data and compare with previously obtained data to assess unit operation:

a. Suction and discharge pressure
b. Evaporator inlet and outlet air temperatures
c. Condenser inlet and outlet air temperatures
d. Voltage, current, and power per phase

Turn the unit off, restart it, and run it for at least 15 minutes. Repeat this off/on cycle two more times, noting any evidence of abnormal operation when started and restarted and noting any bubbles in the sight glass.

Before and after this test, weigh the unit to determine whether the proper charge was present during the test.

4.17 Thermal Overload Protectors Test. Place the air conditioner in a stable ambient temperature (about 21° C [70° F]) long enough for the compressor motor windings to stabilize at this temperature (at least 4 hours). Stabilization can be determined by periodically measuring resistance. Then measure the three line-to-line resistances with an instrument (Kelvin bridge) that can read to 0.001 ohm, and record temperature by using thermocouples and a data logger. Place jumper wires around the circuit breaker to prevent the power supply from de-energizing during the following operations:

a. Position the selector switch at "cool" and the conditioned air thermostat at the maximum "warmer" setting.

b. Immerse the thermostat sensing bulb and the quench expansion valve bulb in water at a maximum temperature of 0° C, and operate the conditioner until the compressor thermal device actuates. The preferred method is to use a Seely motor tester so that the resistance can be read while the motor is running. If a Seely motor is not available, measure winding resistances as before at the time the compressor cuts off.

Next, operate the unit at an ambient temperature between 27° and 32° C (80° and 90° F). Lock the fan shafts by any convenient means, and operate the unit in the cooling mode until the thermal overload devices have stopped and started three times. De-energize the power supply and check the unit for continuity in all windings. In addition, unlock the motor shaft, and operate the air conditioner for 1 hour in the cooling mode at an ambient temperature between 27° and 32° C to check its operation.

4.18 Low Temperature Storage and Operation. Place the test item in an environmental chamber and subject it to -54° C (-65° F) for 48 hours. Then return the chamber to ambient temperature, remove the unit, and inspect it. Conduct a baseline operational test (4.2), and compare data obtained with previous data.

To simulate a user application, mount the air conditioner in the side of a small enclosure. Place the enclosure in an environmental chamber with the temperature inside and outside the enclosure being held at -46° C (-50° F) ±5° until the test item temperature stabilizes. Instrument the unit, and fit 61-cm (24-in.) (minimum length) ducts to the evaporator inlet and outlets. Position two temperature-sensing devices in each duct in the same way as for the baseline operational test (4.2).

Operate the unit in the heating mode for 1 hour with the -46°-C temperature maintained at the evaporator inlet. Measure the inlet and outlet temperatures. While the temperature is maintained at -46° C, turn off the unit for 15 minutes, restart it, and operate for at least 15 minutes.

To check the low temperature cooling, increase the temperatu utside the enclosure to -18° C (0° F) or that specified for the particular t; increase the temperature inside the enclosure to 21° C ±3°, and all he unit to stabilize. Then turn the unit on in the cooling mode and run fo our under these conditions. Near the end of the hour, measure the baseline characteristics and compare with previous data.

Before and after this test, weigh the unit to determine whether the proper charge was present during the test.

4.19 Humidity Test. Place the air conditioner in the test chamber and set up to simulate installed conditions. Vent the test chamber to the atmosphere to prevent pressure buildup. Make provision to prevent moisture from dripping onto the air conditioner from above. Before the test period begins, make sure the chamber temperature is between 20° and 38° C (68° and 100° F) with uncontrolled humidity.

During the first 2-hour period, gradually raise the temperature to 68° C (155° F). Maintain this temperature during the next 6-hour period. Do not allow the velocity of the air throughout the test area to exceed 45.7 m/m (150 ft/min). During the following 16-hour period, gradually reduce the chamber temperature to between 20° and 38° C. This constitutes one cycle. Maintain the relative humidity throughout the cycle between 95 and 99%. Use steam from distilled water with a pH value between 6.5 and 7.5 at 25° C (77° F) to obtain the desired humidity.

Repeat this cycle as many times as necessary to extend the total time of the test to 240 hours (10 continuous cycles). Afterwards, return the chamber temperature to between 20° and 38° C. Remove moisture from the air conditioner by wiping but without disassembly or applying heat from an external source. Air drying is not permitted. Inspect the unit and perform a baseline operational test. Compare the data collected with previous data.

4.20 Fungus Test. Give the test item the 28-day fungus exposure as designated in Method 508.3 of MIL-STD-810D.[6] The test item should be non-operational, but in an operational mode, i.e., not packaged.

4.21 Rain Test. Conduct this test with the air conditioner set up to simulate a user application. Mount the unit in a wall or sheet of plywood with the evaporator side inside for protection from the effects of rain, allowing maximum exposure for the other surfaces. Produce rainfall by means of water spray, and measure with a US Weather Bureau type gage. Conduct the test in two stages:

a. With the air conditioner not operating, subject each of the three exposed sides and the top to a simulated rainfall of 10 cm ±2.5 cm (4 in. ±1 in.) per hour for a total test duration of no less than 2-1/2 hours. Vary the direction of the rainfall from vertical to 45°. After exposure, remove all access doors, covers, and panels and examine for water penetration. Then operate the air conditioner for 15 minutes in the cooling mode and 15 minutes in the high-heat mode in order to ensure that no short circuits have been caused by any water penetrating the unit.

b. With the unit operating in the cooling mode, expose each of the three exposed sides to a simulated rainfall of 2.5 cm ±1.3 cm per hour combined with a horizontal wind of 64 km/hr ±8 km/hr (40 mph ±5 mph) for a total test duration of at least 4 hours. After this exposure, examine the unit and operate as after the previous exposure.

During both exposures, observe the unit for any signs of water penetration through the unit and out the evaporator side into the airstream or otherwise.

4.22 Salt Fog Test. Place the test item in a salt fog chamber as described in Method 509.2 of MIL-STD-810D. The salt solution will be 5% ±1% salt by weight. Conduct alternating 12-hour cycles of fog and drying for a total of 48 hours exposure of the unit to salt fog with the chamber and salt fog at a temperature of 35° C (95° F) and 48 hours of drying. After exposure, inspect the unit for signs of corrosion, paint peeling, or other damage. Following inspection, clean the unit of salt deposits by brushing or rinsing with tap water as necessary. Next, dry the unit to remove all moisture. Then check the unit by running a baseline operational test and comparing results with previous data.

4.23 Sand and Dust Test. Install the test unit in a van with the evaporator side just inside the van, allowing maximum exposure of the remainder of the unit outside. Particles ranging from very fine earth to 1 mm in diameter are blown at the condenser end of the unit at a speed of 24 km/hr (15 mph). Expose the air conditioner to this for 4 hours while operating in the cooling mode. Keep the evaporator fan on high speed and the fresh air damper closed. Test temperature should be within the operating range of the test item.

During this exposure, periodically record the evaporator inlet and outlet temperatures, condenser inlet and outlet temperatures, and the suction and discharge pressures. Assess the unit's ability to sustain cooling under the above conditions by examining these data. Periodically observe for bubbles.

4.24 Endurance Test. Install the test unit in the endurance cell, and expose the evaporator side to an ambient temperature of 29° C ±3° (85° F ±5°) for dry bulb and 21° C ±3° (70° F ±5°) for wet bulb. Expose the condenser side to an ambient temperature 35° C $\pm 3°$ (95° F $\pm 5°$). Cycle the unit in the cooling mode for 45 minutes and in the bypass mode for 15 minutes with the evaporator fan speed on high. Periodically record the operating characteristics and perform all scheduled maintenance as required by the manual. Keep a log and enter all operating data, accrued hours, failures, times to repair, and scheduled maintenance. For a development test, run a unit for 4,000 hours while other test durations will be as specified by the appropriate documents.

Before and after the test, weigh the unit and determine the charge to ascertain whether an appreciable amount was lost during the test.

4.25 Reliability Test. Three test samples of each model air conditioner are preferred for this test. Set up the items and operate them as described above (4.24) and maintain the same type of log. If endurance and reliability tests are to be performed, use data from the endurance test in the reliability evaluation.

Operate the three units so that there will not be more than a 10% difference between the highest and lowest number of hours accrued per unit. Electric motor-driven air conditioners should have a reliability of .95 for a 24-hour mission, and this is demonstrated at the 90% confidence level. A constant failure rate is assumed and the chi-squared distribution used to determine the mean-time-between-failures that will demonstrate the reliability with 90% confidence. This means that if a total of 1,080 hours are accrued without a mission-aborting failure, the reliability has been demonstrated as required.

4.26 Logistic Support.

4.26.1 Data Acquisition. Throughout the entire test program, service and maintain all units in accordance with maintenance literature. Record these services on analysis charts (see TECOM Suppl 1 to DARCOM 700-15[7]). Subject one unit of any class to a complete evaluation for all operator and organizational services. During the evaluation, service, adjust, inspect, replace or repair each item of each functional group contained in the logistic supportability allocation chart.

Record the following data for each maintenance action (except the Supportability Allocation Chart evaluation):

a. Scheduled or repair action
b. Task performed
c. Personnel used
d. Man-hours expended
e. Total down time
f. Failure classification
g. Maintenance levels required
h. Components involved
i. Component life period
j. Unit life period

4.26.2 Tools and Test Equipment. Throughout testing, evaluate authorized and special tools and test equipment used with the test item to determine their need and suitability for the intended purpose and prescribed support level. Use these tools and equipment for operator and organizational levels of support following the instructions in the literature. Evaluate special tools and equipment for higher levels of support on an as-required basis. Determine whether the mechanic has sufficient training and knowledge to employ the tool or test equipment properly and whether these special tools and test items perform the operation for which designed.

4.26.3 Equipment Publications. Analyze and evaluate all equipment support literature for simplicity, clarity, accuracy, adequacy, and consistency for all operator and organizational operations. Analyze higher support levels on an as-required basis only. Refer to the Technical Data/Equipment Publications Chart in TECOM Suppl 1 to DARCOM-R 700-15.

4.26.4 Repair Parts. Throughout testing, compare all repair parts used to support the test unit with those being replaced. Conduct an analysis of compatibility with the test item, including ease of installation and alignment.

4.26.5 Design for Supportability. During testing, monitor all support operations and observe the following factors:

a. Ease of access to components
b. Test points
c. Modular or subassembly construction
d. Protective devices
e. Interchangeability of components
f. Compatibility with common tools
g. Ease of packaging, carloading, and shipment

Keep a record of these factors and evaluate the overall logistic supportability of the unit.

5. DATA REQUIRED. All necessary observations, measurements, and data are listed in subparagraphs under 4.

6. DATA PRESENTATION. In most cases, data obtained do not need reduction; they are either compared with applicable criteria, or, in the case of operational data (4.2), a judgment is made regarding test item operation. The instances when some data reduction is necessary are listed below, with the title of the applicable subtest of 4.

6.1 Evaporator Compartment Air Leakage Test. Use the pressure drop across the air flow nozzle, together with the air temperatures and the constants associated with the particular nozzle (or other devices), to calculate the air flow. Then convert the air flow obtained to standard cubic meters per minute using the following formula[1]:

$$Q_s = Q_{mi}/(1.20V'_n)\ (0.075)$$

in which:

1.20 (or 0.075) = density of standard air in kg/m^3 (lb/ft^3)

Q_s = flow rate of standard air, m^3/min (ft^3/min)

Q_{mi} = measured flow rate, m^3/min

V'_n = specific volume of air at nozzle, m^3/kg (ft^3/lb)

6.2 Ventilation Air Flow Test.

Same as 6.1 above.

6.3 Capacity. Tabulate the data listed in Table II of ASHRAE 37-69, using the instruments specified in this standard to the tolerances also specified therein. Then calculate the capacity by using the instructions provided in the standard.

6.4 Air Flow Test. Calculate the air flow rate using the nozzle constants and formulas in ASHRAE 37-69. Convert the rate to standard cubic meters per minute as shown in the formula in 6.1 of this TOP.

6.5 Thermal Overload Protectors Test. Calculate motor winding temperatures (T_2) by using the formula[8]:

$$T = \frac{R_2(234.5 + T_1) - 234.5\ R_1}{R_1}$$

in which: T_1 = ambient temperature in °C when line-to-line resistance, R_1, in ohms was measured

R_2 = resistance of the windings at actuation of thermal device and is determined by plotting time versus resistance and extrapolating back to actuation time

Calculate motor winding temperatures (for a 3-phase device) and compare the average with the specified limits.

6.6 Logistic Support (data acquisition). Based on the data accumulated, make the following computations[9]:

a. Mean time to repair (MTTR)
b. Mean time between failures (MTBF)
c. Mean active down time (M)
d. Mean time between maintenance (MTBM)
e. Achieved availability (Aa) = $\frac{MTBM}{MTBM + M}$
f. Inherent availability (Ai) = $\frac{MTBF}{MTBF + MTTR}$

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APPENDIX A

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