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AUTHORITY

USATEC ltr, 14 Dec 1970

U. S. ARMY TEST AND EVALUATION COMMAND
COMMON SERVICE TEST PROCEDURE

ENGINE DRIVEN ELECTRICAL POWER GENERATORS

1. OBJECTIVE

The objective of this materiel test procedure is to present the service test methodology, testing techniques, and minimum testing requirements for determining the serviceability and operability of power requirements provisions associated with items of missile and rocket systems as prime power sources.

2. BACKGROUND

Power requirements of missile and rocket systems, including radars for target detection and fire control, are normally satisfied by engine-driven generators deployed with the weapons systems and operating in the same military environment. Such generators may be self-propelled, towed, or mounted on the equipments they are to power. Prime movers may be internal combustion engines or gas turbines. Fuels may be specialized, but typically will be types available in the logistic support of movement elements of the weapons systems.

Scope of service testing specified for the subject weapons system and its components will establish the test exposures in simulated tactical environments for power requirements provisions. Accordingly, testing under this MTP will consist primarily in monitoring the relevant properties of power generators as they are operated and maintained during weapons system service tests.

As new or improved missile and rocket systems are service tested, concurrent evaluations of the power sources will be included in the test program. Comparison of all applicable qualities of the systems with requirements of their respective Qualitative Materiel Requirements (QMR) or Small Development Requirements (SDR) must be accomplished by the test officer.

3. REQUIRED EQUIPMENT

a. Appropriate generator test set including dummy loads (load boards).
b. Associated weapons system elements.
c. Test item maintenance package.
d. Maintenance and repair shop facilities.
e. Photographic equipment, still and motion picture cameras and film (black and white or color).
f. Voice recorder and tape.
g. Stop watches.
h. Time lapse meters.
i. Sensors for RF radiation.
j. Electrical instruments to measure and record voltage, current, frequency, phase, wattage, temperature, etc.

k. Fuel sample containers.

l. Meteorological instrumentation (temperature, humidity, pressure, wind velocity, precipitation).

m. General and special tools and ancillary items required for measurement, inspection, repairs and maintenance of the test item.

4. REFERENCES

A. AR 70-10, Army Materiel Testing.
B. AR 70-38, Research, Development, Test and Evaluation of Materiel For Extreme Climatic Conditions.
C. USATECOM Regulation 385-6, Verification of Safety of Materiel During Testing.
D. USAMC Regulation 385-12, Verification of Safety of Army Materiel.
E. USAMC Regulation 385-224, AMC Safety Manual.
F. USATECOM Regulation 705-4, Equipment Performance Report.
G. Army Regulation 705-50, Army Materiel Reliability and Maintainability.
H. USAMC Regulation 750-15, Maintenance of Supplies and Equipment.
I. MTP 3-1-002, Confidence Intervals and Sample Size.
J. MTP 5-3-500, Preoperational Inspection and Physical Characteristics.
K. MTP 5-3-502, Manuals and Technical Literature.
L. MTP 5-3-507, Human Factors Engineering (Compatibility of Man/Machine by Observation).
M. MTP 5-3-510, Safety Hazards.
N. MTP 5-3-527, Field Storage - Missiles and Rockets.
O. MTP 10-3-501, Operator Training and Familiarization.
P. MTP 10-3-504, Maintenance Evaluation.

5. SCOPE

5.1 SUMMARY

The procedures given in this MTP provide general guidance for determining the degree to which power generation equipment meets current military requirements in support of missile and rocket systems.

The specific tests to be performed and their intended objectives are described in succeeding paragraphs: (These tests need not be conducted in the order presented; some may overlap or be performed simultaneously).

a. Manuals and Technical Literature - The objective of this subtest is to determine the adequacy of training, operation, and maintenance instructions accompanying power generation equipment.

b. Preoperational Inspection and Physical Characteristics - The objective of this subtest is to verify the functional integrity, physical characteristics, arrival condition and dimensions of the power generation equipment.

c. Performance Characteristics - The objective of this subtest is

to provide a confirmation of the electrical output of power generation equipment under simulated tactical operating conditions of varying and extreme loads, and its compatibility with system requirements.

d. Operational Characteristics - The objective of this subtest is to determine the capability of average trained personnel to emplace, interconnect, energize, control, de-energize, and march order power generation equipment.

e. Durability and Reliability - The objective of this subtest is to determine the effects of transportation over tactical type terrain, and of the Mean Time Between Failures (MTBF) during operation.

f. Maintenance - The objective of this subtest is to determine the suitability of procedures and provisions for preventive maintenance, and of the adequacy of procedures and supporting provisions for effecting corrective maintenance, including determinations of Mean Time To Repair (MTTR) under service test conditions.

g. Human Factors Engineering - The objective of this subtest is to determine the suitability of power generation equipment, interconnecting facilities, and controls for operation by average trained personnel without excessive stress, fatigue, or human errors attributable to equipment design, vibration or noise, or to shortcomings in applicable published instructions.

h. Safety - The objective of this subtest is to confirm the safety of the test item and determine the safety hazards (to personnel and equipment) inherent in the test item or in applicable operational and maintenance instructions.

i. Security - The objective of this subtest is to determine the susceptibility to detection of power generation equipment, including observations of unsatisfactory acoustic, infrared, and radio frequency radiation, and visual checks of exhaust.

5.2 LIMITATIONS

This procedure is limited to evaluations of prime power generators supplying power requirements of missile and rocket systems during service tests of the systems. Excluded are power generators which are driven by power take-off from vehicle propulsion prime movers, batteries, fuel cells, radioisotope power supplies, and power supplies of whatever nature installed in the flight components of missile and rocket systems. Although this procedure is designed for use in conjunction with service tests of the associated system, it may be adapted for evaluation of independent items of prime power generators.

6. PROCEDURES

6.1 PREPARATION FOR TEST

a. Select and schedule suitable transportation and operational areas at representative environmental locations, as required by applicable test directive or other appropriate documentation.

b. Upon establishing the scheduled availability of the test item(s), coordinate the availability of the following:

1) Engineering safety release or other safety statement.

2) Maintenance support facilities, spare parts, and personnel.
3) Equipment, special facilities, and instrumentation with special equipment not readily available at the test site. All test equipment and instrumentation selected shall be in keeping with the state-of-the-art, with calibrations traceable to the National Bureau of Standards.

c. Select test personnel (soldiers), with the exception of service test supervisors, who are representative of those expected to operate and maintain the test item in the field. Some should be left-handed, some should wear glasses, and some should represent the physical extremes of size.

d. Ensure that service personnel have been assigned who are trained in the operation and maintenance of the power generation equipment in accordance with applicable sections of MTP 10-3-501, and other applicable publications. Record for all service personnel:

1) Identity and rank.
2) MOS.
3) Training time in MOS.
4) Experience in MOS.
5) Training time on subject test item.
6) Experience in Test Item Crew.

e. Prepare a scenario for a standard operational day (for systems which would normally operate in more than one mode).

f. Prepare record forms for systematic entry of data, chronology of test, test results, and such observations and measurements that would be of value in analysis and final evaluation of the test item.

g. Prepare a test item sample plan to ensure that enough samples of all measurements are taken to provide statistical confidence of final data in accordance with MTP 3-1-002. Provisions shall be made for sample plan modification during the test progress as may be indicated by monitored test results.

h. Ensure that appropriate security measures are instituted to safeguard classified materiel and data, as applicable, and that arrangements for supporting and participating agencies, activities and facilities have been made.

i. Review the technical literature and prior test documentation on the test item to evaluate:

1) Features influencing the Plan of Test, requiring inclusion of additional procedures and/or observations, or avoidance of unnecessary procedures.
2) Extent of prior engineering testing, for the purpose of avoiding overlap or duplication in service tests.

6.2 TEST CONDUCT

NOTE: 1. Safe test procedures shall be followed throughout all phases of testing. All test operations shall be observed by cognizant test personnel and any unsafe or potentially

unsafe condition shall cause testing to be suspended until safety hazards are understood and remedied.

2. The Plan of Test will contain provisions, within the framework of the Test Directive, for additional exploration and documentation of unusual instances of test item performance, either of a deficient or superior nature. Operational steps and safety instructions contained in manuals shall not be violated.
3. Tests shall be conducted concurrently or in conjunction with other tests whenever possible, to minimize the use of facilities and personnel. Tests for the purpose of collecting Engineering Test type data shall be conducted only if such data are not available from Engineering Tests.
4. Test conditions will be established and maintained as closely as possible in conformity with requirements specified in the applicable system test MTP's.

6.2.1 Manuals and Technical Literature

Conduct evaluations of operation and maintenance manuals covering the subject power generation equipment in accordance with applicable sections of MTP 5-3-502, including the following:

a. Completeness of instructions, diagrams, schematics, illustrations, and parts lists.

b. Suitability of allocations of maintenance operations to applicable maintenance echelons.

c. Capability of average trained personnel to accomplish operational and maintenance procedures in accordance with instructions prescribed in the technical publications.

6.2.2 Preoperational Inspection and Physical Characteristics

a. Accomplish in accordance with applicable sections of MTP 5-3-500, including, for the power generation equipment, the following:

1) Integrity and serviceability of all components, including cables and connectors.
2) Dimensions and weights of separately transportable equipment, and dimensions and weights of equipments mounted on tactical vehicles but subject to replacement in event of failure.

b. Record for each principal component:

1) Nomenclature and Model No.
2) Serial No.
3) Manufacturer.
4) Elapsed operating time.

6.2.3 Performance Characteristics

Operate the power generation equipment under simulated tactical operating conditions. Observe and record the following:

a. Voltage, frequency, and current: values at constant demands representative of system requirements.
b. Regulation of voltage and frequency under variable demand conditions.
c. Voltage, frequency, current, phase relationships and regulation performance at the limits of demand tolerance envelope.
d. As applicable, performance comparisons between local and remote operation.
e. Prime mover performance under conditions of steps a through c: exhaust visibility, cooling, lubrication, fuel consumption, recovery time.

6.2.4 Operational Characteristics

6.2.4.1 Normal Weather Conditions

Observe and record the activities associated with the following operations involving power generation equipment under weather conditions consisting of moderate temperatures, clear skies, and daylight:

a. Emplacement and march ordering of separately mobile power generation equipment, or emplacement and march ordering of items having power generation equipment mounted thereon. Record the following:

1) Times for emplacement and march order.
2) Observations concerning ease or difficulty of accomplishment of emplacement and march order.

b. Interconnecting, energizing, and de-energizing power generation equipment, including the following:

1) Observations concerning adequacy of power receptacles and their compatibility with power cables.
2) Times to interconnect and energize the system.
3) Capabilities of manual and automatic controls to effect control of power delivery and safe shutdown sequences.
4) Observations concerning ease or difficulty of accomplishment of personnel assignments.

6.2.4.2 Adverse Weather Conditions

Repeat the operations and observations required under paragraph 6.2.4.1 under adverse weather conditions, consisting of the following, as applicable:

a. Moderate temperatures with rain.
b. Frigid temperatures with:

1) Snow

2) Sleet or icing conditions.

c. Hot temperatures with:

1) High humidity.
2) Low humidity.

d. Darkness (blackout).

6.2.5 Durability and Reliability

During roadability and battlefield mobility tests, and operational tests, as scheduled for the basic system, observe and record data on the durability and reliability of power generation equipment in accordance with applicable sections of MTP 10-3-504. Transportation and maneuvering exposures shall consist of primary and secondary roads, trails, and cross-country tactical type terrain as specified for the system. Mileages over each course shall be consistent with mileages as prescribed for testing the system. Operating times for the power generation equipment shall be equal to operating times specified for the system during service tests. Record the following:

a. Mechanical and structural defects as ascertained during periodic inspections, and time frames when defects occurred.
b. Failures during operation of prime mover, electrical, or electronic parts, and times when failures occurred.
c. Deficiencies and shortcomings as defined in USATECOM Regulation 705-4 and reported on STE Form 1025.

6.2.6 Maintenance

Observe and record maintenance operations at applicable maintenance echelons as conducted on the power generation equipment, in accordance with applicable sections of MTP 10-3-504, including the following:

a. Adequacy of schedules and procedure instructions for preventive maintenance, and availability of tools and supplies.
b. Times required to effect repairs.
c. Adequacy of troubleshooting and repair procedures, and availability of tools, test equipment, and spare parts.

6.2.7 Human Factors Engineering

Observe and record experiences of personnel and features of power generation equipment concerned with man-machine compatibility, in accordance with applicable sections of MTP 5-3-507, including the following:

a. Observations of stress, fatigue, discomfort, confusion, or errors experienced by operating and maintenance personnel.
b. Legibility of dials, markers, etc., including effectiveness of color coding and adequacy of illumination.

c. Favorable location of controls and accessibility of equipment for maintenance.
d. Adequacy of instructions, including clarity and proper sequences.
e. Objectionable levels of noise and vibration.

6.2.8 Safety

Observe and record safety hazards associated with installation, operation, and maintenance of power generation equipment, in accordance with applicable sections of MTP 5-3-510, including the following:

a. Adequacy of recommended precautions contained in safety release.
b. Mechanical hazards: sharp edges and corners, preloaded parts, hot parts, moving parts. Adequacy of protective guards and shields.
c. High voltage protection: interlocks, shielding, bleeder circuits, grounding.
d. Adequacy of caution and warning placards.

6.2.9 Security

Conduct surveillance operations as applicable, on the ground and from the air, to evaluate the susceptibility to detection of power generation equipment, including the following only as necessary to document unacceptable conditions:

a. Noise levels, with attention to sound radiation from engine exhausts, gas turbine compressors, gear boxes. Record distances at which observed noise levels exceed requirements specified in QMR, SDR, or other applicable specification for the equipment or basic system.
b. Infrared radiation, noting any qualitatively severe intensities and directional effects.
c. Radio frequency effects, including detectability on independent sensors and interferences observed in the basic system.
d. Visual surveys of engine exhaust plumes, including effects of varying loads and condensation phenomena in cold weather.

6.3 TEST DATA

6.3.1 Preparation for Test

a. Record data as applicable on training of personnel as collected under MTP 10-3-501.
b. Record the following for all service personnel:

1) Serial number and rank.
2) MOS.
3) Training time in MOS, weeks.
4) Experience in MOS, months.
5) Training time on test item, weeks.
6) Experience in test item crew, weeks.

c. List publications reviewed and narrative statement of conclusions influencing test planning.

6.3.2 Test Conduct

Test data of an Engineering Test nature will be recorded only if such data are not available from Engineering Tests.

6.3.2.1 Manuals and Technical Literature

Record data as collected under applicable sections of MTP 5-3-502. Use DA Form 1598 to record comments on text of publications. Record observations and comments concerning success or difficulties experienced by personnel in accomplishing installation, operation, or maintenance operations in narrative form, supported by still or motion picture photography and tape recorded comments of operators.

6.3.2.2 Preoperational Inspection and Physical Characteristics

Record data as collected under applicable sections of MTP 5-3-500. Record any discrepancies between physical equipment inventory and shipping documents. Photograph defective or damaged parts or packaging. Record dimensions in feet and inches, weight in pounds. Record the following data for each principal component:

a. Nomenclature and Model No.
b. Serial No.
c. Manufacturer.
d. Elapsed operating time, hours.

6.3.2.3 Performance Characteristics

a. Record electrical output characteristics (voltage, frequency, current, phase) on strip chart recorders or equivalent. Record transients and fluctuations on oscillographs or equivalent.

b. Record engine temperatures in degrees F, fuel consumption in gallons per hour at steady loads. Record unusual exhaust phenomena on motion picture film.

6.3.2.4 Operational Characteristics

6.3.2.4.1 Normal Weather Conditions

Record the following:

a. Ease or difficulty experienced by personnel in accomplishing emplacement and march order, interconnecting and energizing, operation of controls. (Record times for emplacement and march order in minutes. Record times for interconnecting and energizing the system in minutes and seconds).

b. Inadequate or incompatible power receptacles or cable connectors.

c. Unsuccessful or deficient performance of manual and/or automatic controls in power regulation or shutdown operations.

NOTE: Use still and motion picture photography, voice tape recordings, and narrative form notes to record the above observations.

6.3.2.4.2 Adverse Weather Conditions

Record the following:

a. Data as defined in paragraph 6.3.2.4.1 during adverse conditions.
b. Concurrently with a, above record the environmental data:

1) Ambient temperature, degrees F.
2) Relative humidity, percent.
3) Wind direction and velocity, miles per hour.
4) Precipitation, kind and inches per hour.
5) Illumination (daylight, twilight, moonlight, starlight, darkness).

6.3.2.5 Durability and Reliability

Record data as collected under applicable sections of MTP 10-3-504, including the following:

a. Time frames in hours, and nature of terrain, relative to mechanical and structural defects.
b. Elapsed times on equipment, in hours and minutes, when failures occur in prime mover, electrical, or electronic parts, for eventual computation of Mean Time Between Failures (MTBF).
c. Photographs as required to document deficiencies or shortcomings.

6.3.2.6 Maintenance

Record data as collected under applicable sections of MTP 10-3-504, including the following:

a. Observations concerning inadequacies in preventive maintenance schedules or procedure instructions, or unavailability of tools and supplies.
b. Mean Time To Repair (MTTR) for corrective maintenance operations.
c. Observations concerning difficulties connected with procedures for troubleshooting and repairs, or unavailability of tools, test equipment, or spare parts.

6.3.2.7 Human Factors Engineering

Record data as collected under applicable sections of MTP 5-3-507, including the following:

a. Narrative comments, supported by motion picture photography and tape recorded statements of operators, concerning instances of stress, fatigue,

discomfort, confusion, or errors during performance of duties.

b. Photographs of illegible dials, markers, etc., and narrative comments on ineffectual color coding and inadequate illumination.

c. Photographs of inconveniently located controls and inaccessible equipment.

d. Comments in narrative form describing inadequate, unclear, or improperly sequenced instructions.

e. Comments on objectionable noise and vibration levels, supported as necessary by acoustic and accelerometer measurements.

6.3.2.8 Safety

Record data as collected under applicable sections of MTP 5-3-510, including the following:

a. Adequacy of safety precautions and other pertinent conditions as stated in the safety release.

b. Photographs of mechanical hazards or inadequate protective guards and shields.

c. Comments concerning adequacy of high voltage protection, including evaluations of interlocks, shielding, bleeder circuits, and grounding.

d. Comments concerning adequacy of caution and warning placards, including number of hazards so identified, location and legibility of placards.

6.3.2.9 Security

Record the results of surveillance operations, including the following as required for documentation:

a. Distance from source, meters, to limits of excessive noise.

b. Relative bearing from equipment, degrees, of perceived intense infrared radiation.

c. Presence of RF radiation from power sources in electronic or communications equipment associated with the system under test, or in test instrumentation.

d. Photographs of noteworthy exhaust plumes, annotated to show ambient conditions of wind, temperature, relative humidity. Record power demand conditions for each photograph.

6.4 DATA REDUCTION AND PRESENTATION

Data, including observations and comments of operators, obtained from each section under Test Conduct, paragraph heading 6.2, shall be summarized, compared, and evaluated according to procedures described in the individual referenced MTP's or equivalent current practice where not covered by MTP's. Appropriate charts, graphs, and tables shall be used to display summaries and comparisons of test data. Coordinates and other features of charts, graphs, and tables will be selected for clarity and uniformity with like presentations in other reports. Special consideration in data presentation shall be given to any condition or circumstance which may have significantly influenced the test results.

All photographs, motion pictures, recorder tapes, and other records shall be explicitly identified and referenced; significant frames, transcriptions, and samples shall be selected for illustrative purposes. All illustrations shall be completely identified.

All qualitative data accumulated shall be evaluated against the QMR or SDR and TC to determine the degree of fulfillment demonstrated, compared with performance specifications.

Data collected under adverse weather conditions shall be separately compared with data collected during normal weather conditions.

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11. SUPPLEMENTARY NOTES
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13. ABSTRACT

This Army Service Test Procedure describes test methods and techniques for evaluating the performance and characteristics of prime electrical power generators (engine driven) associated with missile and rocket systems, and for determining the suitability of the tested items for service use in the U. S. Army. The evaluation is related to criteria expressed in applicable Qualitative Materiel Requirements (QMR), Small Development Requirements (SDR), Technical Characteristics (TC), or other appropriate design requirements and specifications.

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