TEST METHOD 111

METHOD HUMIDITY TEST

111.1 General. The generator set must be capable of being exposed to the humid atmosphere of tropic or swamp areas with no damage or deterioration in performance.

111.2 Apparatus. The apparatus requirements of EGSA 107T , Test Methods 77 and 25 are necessary to perform this test. In addition, a test chamber must be used which is capable of maintaining the required humidity and temperature. The source(s) of heat and cooling for the chamber shall be so arranged that radiant heat (or cooling) shall not fall upon the unit being tested. Direct injection of CO_2 (carbon dioxide) shall not be permitted due to the acid formed by contact of CO_2 with water. The velocity of the air throughout the test area shall not exceed 150 feet per minute. The total external volume of the unit to be tested shall be not more than 50 percent of the total volume of the test chamber.

Distilled or demineralized water having a pH value of between 6.5 and 7.5 at 25 °C (77 ➡F) shall be used to obtain the desired humidity.

Thermometer meters and psychrometers must be provided for measuring temperature and humidity.

111.3 Procedure.

a. Perform test method 608.1 within 4 hours before the start of the humidity cycling.

b. After performing test method 608.1, but prior to the start of the humidity cycling, isolate the armature and field (exciter field only for brushless generators) and measure their insulation resistance's in accordance with test method 301.1, except that the values need not be corrected for temperature. Record the resistance values and ambient temperature at which they were measured.

c. Subject the set to continuous cycling for a total of five of the 48-hour cycles described in figure 111-I.

d. Remove the set from the test chamber immediately upon completion of c above. Within 1 hour after removal from the test chamber and without removal of moisture, measure the insulation resistance of all circuits initially measured under b in accordance with test method 25, except that the set shall not be operated prior to this test and measured values shall not be corrected for temperature.

e. Reconnect all circuits and perform test method 608.1 within 4 hours after removal from the test chamber.

f. Examine the set for corrosion or other physical damage resulting from the test.

g. Record all actual test conditions and results.

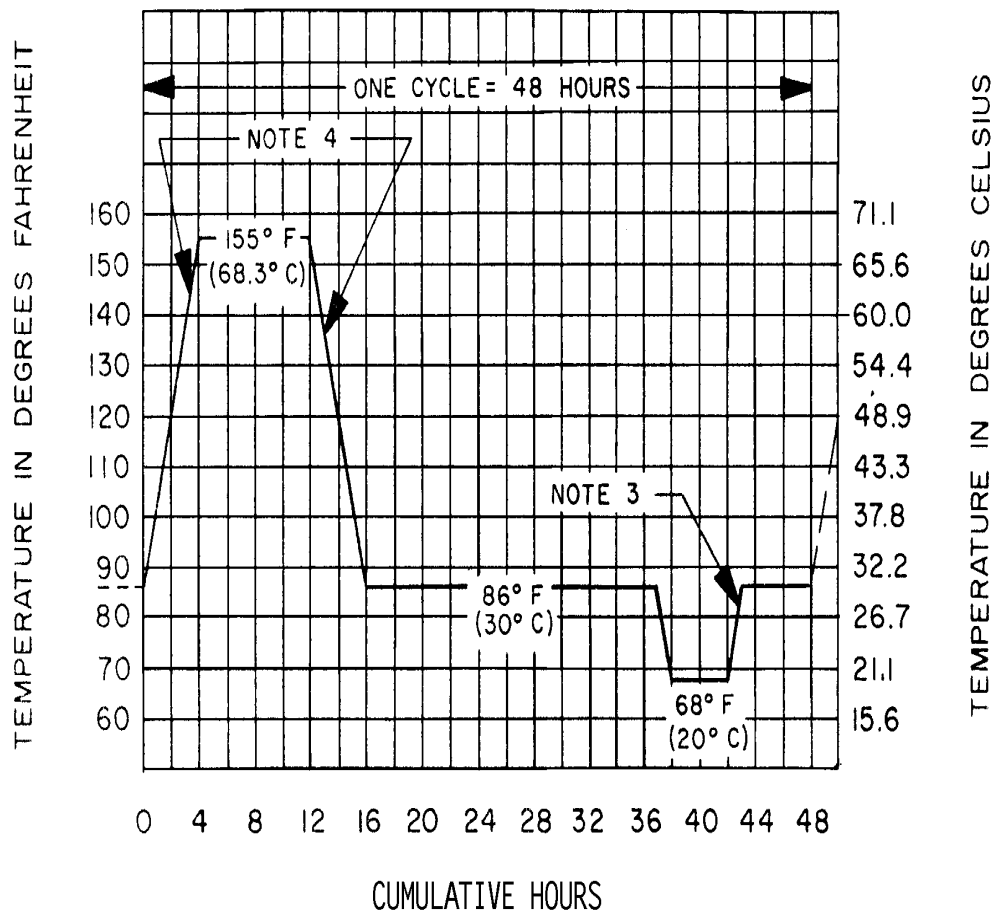
111.4 Results. Compare the results with the requirements of the contract.

111.5 Requirement document requirements. The following items will be specified in the individual contract:

a. Minimum acceptable insulation resistance value.

b. Temperature, humidity, cycling and duration, if different than specified herein.

c. Definition of temperature and humidity damage.



NOTES:

1. THE ACTUAL TEMPERATURE DURING THE CYCLE SHALL BE WITHIN 5°F (2.7°C) OF THE TEMPERATURE SHOWN ON THE CHART.
2. RELATIVE HUMIDITY SHALL BE MAINTAINED BETWEEN 90 AND 98% AT ALL TIMES DURING THE CYCLE.
3. THE MEASURED INCREASE IN TEMPERATURE FROM 68 ± 5°F (20 ± 2.7°C) TO 86 + 5°F (30 ± 2.7°C) SHALL NOT BE LESS THAN 18°F (10°C).
4. THE RATE OF TEMPERATURE CHANGE BETWEEN 86 F (30°C) AND 155°F (68.3°C) 86 ±°F (30 ± 2.7°C) THAN 15°F (8.3°C) PER HOUR.

FIGURE 711 1.1 Mositure resistance test cycle.

TEST METHOD 112

FUNGUS RESISTANCE TEST

112.1 General. The generator set must not permit the growth of fungi.

112.2 Apparatus. A mold chamber in which the temperature can be accurately controlled to ±1.8 F° (1 ➡C) and the humidity can be accurately controlled to ±2 percent relative humidity. The mold chamber shall have incorporated in it provisions for growth and feeding of the test organisms and shall have been in operation a minimum of 15 days prior to the start of this procedure. The minimum fungi types present in the mold chamber for the duration of this method shall be those specified in MIL-V-173 except that "aspergillus terrus" (PQMD 82J) may be substituted for "aspergillus flavus" (QM 380) whenever the latter is called for.

112.3 Procedure.

112.3.1 Preparation for test.

a. Test cultures shall be prepared in accordance with the methods specified in MIL-V-173. These organisms shall be introduced into the chamber on soil beds, untreated leather, cork, jute bags, and canvas strips which shall be so distributed that a uniform spore suspension will probably occur after 15 days.

b. The mold chamber shall be operated in accordance with the following cycle unless otherwise stated in the contract:

1. 8 hours at 85 ➡F (29.4 °C) and 90 percent relative humidity.
2. 8 hours to change to 75 ➡F (24.8 °C) and 95 percent relative humidity.
3. 4 hours at 75 ➡F (24.8 °C) and 95 percent relative humidity.
4. 4 hours to change 85 ➡F (29.4 °C) and 90 percent relative humidity.

112.3.2 Test.

a. The set or certain components of the set (specified in the contracts) shall be placed into the mold chamber along with at least two vegetable tanned leather strips and two cotton duck strips to act as controls and shall be thoroughly sprayed with suspensions of the test organisms of MIL-V-173. Record these conditions on the data sheet (see figure 112-I).

b. The set or samples under test shall be left in the mold chamber for 30 24-hour cycles unless otherwise specified in the contract.

c. At the end of the prescribed time, the set and control shall be removed from the mold chamber and examined thoroughly for effects due to fungi.

112.4 Results. Compare any fungi growth with that allowed by the contract.

112.5 Contract requirements. The following items must be specified in the individual contract:

a. The mold chamber cycle, if other than as specified herein.

b. The duration of this method, if other than as specified herein.

c. Allowable fungi growth on the set, if any.

d. Definition of set damage, if applicable.

e. Number and type of samples to be tested, if the complete set is not tested.

TEST METHOD 113

RAIN TEST

113.1 General. Since most generator sets are expected to be operated outdoors, without shelter of any kind, this test is performed to assure proper operation during a heavy rain storm.

113.2 Apparatus. Instrumentation for measuring load conditions and rain shall be as described in EGSA 107T . In addition, a test area capable of providing the required rainfall and wind conditions shall be provided.

113.3 Procedure.

113.3.1 Preparation for test.

a. Perform Test Method 77 of EGSA 107T (rated load only) within 4 hours before the start of the rain test.

b. Place the generator set in the rain environmental location with external connections made to simulate field installation conditions as closely as possible.

c. Connect the load instrumentation for the voltage connection and frequency specified in the contract.

d. The test area shall be at normal ambient temperature (68 to 86 F or 20 to 30 °C) at the beginning of the test and no further regulation of temperature is required.

113.2 Test.

a. A simulated rainfall of 8 ±1 inches per hour or as otherwise specified in the requirement document, shall be produced by water spray nozzles of such design that the water is emitted in the form of small droplets, rather than a fine mist. The temperature of the water shall be above 40 ➡F (4.44 °C). The spray nozzles shall be located so that the water drops impinge on the set at angles between 15 degrees and 45 degrees from the vertical. The water shall be dispersed as uniformly as possible over the entire area by means of a wind source producing wind velocities up and including 40 mph (18 m/s). The wind velocity shall be measured at the position of the set prior to placement of the set in the facility.

b. Open the set control panel doors, if provided. Subject the set to the water spray for 3 consecutive hours. Each side of the set shall be exposed to simulated blowing rain for 30 minutes beginning with the control panel end of the set. At the beginning of the last hour of the test, and with the simulated blowing rain on the control panel end of the set, perform Test Method 77 of EGSA 107T . Continue operating the set during the

simulated blowing rain until completion of Test Method 77 or completion of the third hours, whichever conditioner is the longer of the two.

c. Immediately after exposure to the simulated blowing rain and at the rain test site, examine the set for evidence of water penetration and damage. After completion of the examination of the set, start the set and perform Test Method 77 (rated load only).

113.4 Results. The data sheet shall indicate the length of test, quantity and incident angle of the water, wind velocity, any malfunction, water penetration, and water damage..

113.5 Contract requirements. The following items must be specified in the contract.

a. The voltage connection and frequency at which this method is to be performed.

b. Rainfall in inches per hour, if other than as specified herein.

c. Angle of rain impingement, if other than as specified herein.

TEST METHOD 114

SAND AND DUST TEST

114.1 General. Since most generator sets are expected to be operated outdoors, without shelter of any kind, this test is performed to assure proper operation in an airborne sand and dust environment.

114.2 Apparatus. Instrumentation for measuring load conditions and ambient temperature shall be as described in EGSA 107T Test Methods 1,2, and 10.

114.2.1 Test facility.

a. The required apparatus consists of a chamber or cabinet, together with necessary air conditioning and circulation equipment with its auxiliary control instrumentation, sand storage and moving equipment, and sand concentration measuring equipment, capable of maintaining and continuously monitoring the required conditions throughout an envelope of air surrounding the test item(s).

b. A data collection system, separate from the chamber controllers, shall be employed to measure test space conditions. Readout charts shall be readable to within at least 0.6 ➡C (1 ➡F).

c. Dehumidification, heating, and cooling of chamber test volume air for control of test conditions shall be achieved by methods that do not alter the chemical composition of the air, sand, or water vapor within the chamber test volume air.

d. Test facility design considerations.

l. The vibratory or screw type sand feeder shall be controlled to emit the sand at the specified concentrations. The feeder shall be located in such a manner as to ensure that the sand is uniformly in suspension in the air stream when it strikes the test item, to simulate the same effects as in the field.

NOTE: Uniform sand distribution is usually easier to obtain when the sand-air mixture is directed downward.

2. Because of the extremely abrasive characteristics of blowing sand at high velocity, it is not recommended that the sand be re-circulated through the fan or air conditioning equipment. Instead, it should be separated from the air downstream from the test chamber in a sand separator, collected in a separate receiver, and reintroduced into the sand tank or hopper. The fan should re-circulate only the sand-free conditioning air.

NOTE: The sand collected in the separator may be reused for other tests if, after analysis, it still conforms to 114.2.2d of this method.

114.2.2 Controls.

a. Test parameters. Unless otherwise specified herein, temperature and relative humidity measurements made during testing shall be continuous if measurements are in analog form, or at intervals of one every 15 minutes or less if measurements are in digital form. tolerances, etc., shall be described in EGSA 107T Any significant change of the test item temperature or chamber conditions shall result in the test item being reestablished at the required environmental conditions before continuation.

b. Relative humidity. Relative humidity in the test section shall be less than 30 percent throughout the conduct of the test.

c. Test variables. The test variables (temperature, air velocity, and dust concentration) shall be continuously monitored during the test. Humidity shall be verified just before or during each test.

d. Sand composition. Unless otherwise specified, the sand suggested to be used in the large particle test is silica sand and (at least 95 percent by weight SiO_2). The amount 1.0 percent $\pm$0.5 percent of the sand shall be retained by a 20-mesh screen (850 mm), 1.7 percent $\pm$0.5 percent by a 30 mesh screen (590 mm), 14.8 percent $\pm$1 percent by a 40 mesh screen (420 mm),37.0 percent $\pm$1 percent by a 50 mesh screen (297 mm), 28.6 percent $\pm$1 percent by 70 mesh screen (210 mm), 12.7 percent $\pm$1 percent by a 100 mesh screen (149 mm), and 5.2 percent $\pm$1 percent shall pass a 100 mesh screen. The sand shall be of subangular structure with a mean Krumbein number (roundness factor) equal to 0.2 and a hardness factor of 7 mohs.

e. Sand concentration. The sand concentrations shall be 1.4 grams per cubic meter.

f. Air velocity. An air velocity shall be maintained at a minimum of 20 mph.

114.2.3 Test interruption.

a. Undertest interruption. The abrasion, penetration, and collection of dust are cumulative effects that are not affected by interruption. The test item shall be reestablished at the prescribed temperature and the test continued from the point of interruption.

b. Overtest interruption. Any interruption that results in more extreme exposure of the test item than required herein should be followed by a complete physical examination and operational check (where possible) before continuation of testing. If a problem is encountered, the test should be reinitiated with a new test item.

114.3 Criteria. The failure of a test item to meet the requirements specified herein must be analyzed, and related information must be considered, such as:

a. Degradation allowed in operating characteristics while at the extreme conditions.

b. Necessity for use of special operating procedures or special kits during extreme conditions

c. The test item shall be considered to have failed the large-particle test when:

1. Abrasion of the test item exceeds the amount described herein.

2. The test item does not perform safely or operate adequately as described herein.

NOTE: The test plan shall contain procedures for determining the test item's degradation due to abrasion. These procedures shall describe parameters (such as amount of wear or loss of weight) or observable attributes (such as change of shape) which, if not within specified limits, are indications that the test item has failed because of abrasion effects. The permissible tolerances of the parameters and attributes shall be provided.

114.4 Procedure.

114.4.1 Preparation for test. Conduct the pretest checkout as follows:

a. Position the test item in the test chamber as near the center of the test sections as practicable. The test item shall have a minimum clearance of 15 cm (6 inches) from any wall of the test chamber and from any other test item (if more than one item is being tested). Orient the test item so as to expose the most critical or vulnerable parts to the sand or dust stream.

NOTE: The orientation of the test item may be changed during the test if required by the test plan.

b. Prepare the test item in its operational configuration in accordance with the requirement document.

c. Stabilize the test item at standard ambient conditions .

d. Conduct a complete visual examination of the test item with special attention to sealed areas and minute of openings

e. Document the results.

f. Conduct an operational checkout in accordance with the operator's manual. Perform Test Method 77.1 within 4 hours before the start of the sand and dust test.

g. Record results for compliance with the contract.

h. If the test item operates satisfactorily, proceed to 114.4.2. If not, resolve the problem and repeat steps a thru g.

114.4.2 Test.

a. Adjust the chamber temperature to the high operating temperature of the test item and maintain until temperature stabilization of the test item is achieved.

b. Adjust the air velocity to that required by the contract.

c. Adjust the sand feeder to obtain the sand concentration specified in the requirement document, depending upon the application of the test item.

d. Maintain the conditions of steps a through c for the duration specified in the test plan.

e. If operation of the test item during the test is required perform an operational test of the item during the last hour of the test and document the results. If not, proceed to step 6.

f. Turn off all chamber controls and allow the test item to return to standard ambient conditions. Remove accumulated sand from the test unit by brushing, wiping, or shaking, taking care to avoid introduction of additional sand into the test unit.

g. Conduct an operational checkout of the test item in accordance with the approved test plan. Within 4 hours after the completion of the test, perform Test Method 77 of EGSA 107T .

h. Document the results.

i. Visually inspect the test item looking for abrasion and clogging effects and any evidence of sand penetration.

j. Compare these data with the pretest data.

114.4.3 Data to be recorded.

a. Test item identification (manufacture, serial numbers, etc.).

b. Previous test methods to which the specified test item has been subjected.

c. Orientation and any change in orientation during test.

d. Results of each performance check (pretest, during test, and post-test).

e. Values of the test variables for each section of the test.

f. Results of each visual inspection.

g. Duration of each section of test.

114.5 Results. The results will be reviewed and compared to the contract for compliance. Inability to meet the voltage and frequency specified herein will constitute failure of the test.

114.6 Contract requirements. The following items must be specified in the individual contract.

a. The procedure to be followed.

b. The type of sand and dust to be used.

c. The frequency requirements specified in para 77.5a of Test Method 77

d. The voltage requirements specified in para 77.5b of Test Method 77.

e. The voltage connection and frequency at which this method is to be performed.

TEST METHOD 115

SALT FOG TEST

115.1 General. This test is performed to determine the resistance of generator set to the effects of an aqueous salt atmosphere.

115.2 Apparatus. Instrumentation for measuring load conditions and ambient temperature shall be as described in Test Methods 1,2, and 10.

115.2.1 Test facility. The apparatus used in performing the salt fog test in this method shall include:

a. A test chamber with:

1. Supporting racks designed and constructed so that they will not affect the characteristics of the salt fog mist. All parts of the test chamber and the supporting racks that come into contact with the test item shall be constructed of material or will be buffered with material that will not cause electrolytic corrosion. Condensation shall not be allowed to drip on the test item. No liquid that comes in contact with either the exposure chamber or the test item shall return to the salt solution reservoir. The exposure chamber shall be properly vented to prevent pressure buildup.

2. The capability to maintain temperatures in the exposure zone at 35 ➡C (95 ➡F). Satisfactory methods for controlling the temperature accurately are by housing the apparatus in a properly controlled constant-temperature room, by thoroughly insulating the apparatus and preheating the air to the proper temperature before the atomization, or by jacketing the apparatus and controlling the temperature ➡F the water or the air used in the jacket. The use of immersion heaters within the chamber exposure area for the purpose of maintaining the temperature within the exposure zone is prohibited.

b. A salt solution reservoir made of material that is non-reactive with the salt solution, e.g., glass, hard rubber, or plastic.

c. A means for injecting the salt solution into the test chamber. Caution must be exercised to prevent clogging of the nozzles from salt buildup. Atomizers used shall be of such design and construction as to produce a finely divided, wet, dense fog. Atomizing nozzles and the piping system shall be made of material that is non-reactive to the salt solution. Suitable atomization has been obtained in chambers having a volume of less than 0.34 m^3 (12 ft^3) under the following conditions:

1. Nozzle pressure as low as practical to produce fog at the required rate.

2. Orifices between 0.5 and 0.76 mm (0.02 and 0.03 inches) in diameter.

3. Atomization of approximately 2.8 liters of salt solution per 0.28 (10 ft^3) of chamber volume per 24 hours. When chambers with a volume considerably in excess of 0.34 m (12 ft^3), are used the conditions specified may require modification.

NOTE: A filter fabricated of noncorrosive materials shall be provided in the supply line and immersed in the salt solution reservoir.

d. Salt fog collection receptacles placed form 0.5 to 3 milliliters of solution per hour for each 80 square centimeters of horizontal collecting area (10 cm diameter) in an average test of at least 16 hours. A minimum of 2 receptacles shall be used, one placed nearest to any nozzle and one farthest from all nozzles. Receptacles shall be placed so that they are not shielded by the test item and will collect no drops of solution from the test item or other sources.

115.2.2 Controls.

a. Before injection into the test section, the salt solution shall be heated to within ± 6 ➡C (± 10 ➡F) of the test section temperature at the time of injection.

b. All water used during the salt fog tests shall be from steam or distilled, demineralized, or de-ionized water, and have a pH between 6.5 and 7.5 at 25 ➡C, or have a resistivity of not less than 250, 000 ohms/cm at 25 ➡C.

c. Test section air circulation: Air velocity in test chamber shall be minimal (essentially zero).

115.2.3 Test interruptions.

a. Undertest interruption. If an unscheduled test interruption occurs that causes the test conditions to exceed allowable tolerances toward standard ambient conditions, the test item should be given a complete visual examination, and a technical evaluation should be made of the impact of the interruption on the test results. The test must be restarted at the point of interruption and the test item re-stabilized at the test conditions.

b. Overtest interruption. If an unscheduled test interruption occurs that causes the test conditions to exceed allowable tolerances away from standard ambient conditions, the test should be stabilized to within tolerances and held at that level until a complete visual examination and technical evaluation can be made to determine the impact of the interruption on the test results.If the visual examination or technical evaluation results in a conclusion that the test interruption did not adversely affect the final test results, or if the effects of the interruption can be nullified with confidence, pre-interruption

conditions should be re-established and the test continued from the point where the test tolerances were exceeded.

115.3 Criteria. In addition to the failure criteria of the contract, the following must be considered. Any corrosion must be analyzed for its immediate or potential effect on the proper functioning of the test item. Satisfactory operation following this test is not the sole criterion for pass/fail.

115.4 Procedure.

115.4.1 Preparation for test.

115.4.1.1 Preparation of salt solution. The salt used for this test shall be sodium chloride (on a dry basis) not more than 0.1 percent sodium iodide and not more than 0.5 percent total impurities. Unless otherwise specified in the contract, a 5 ± 1 percent solution shall be prepared by dissolving 5 parts by weight of salt in 95 parts by weight of water. The solution shall be adjusted to, and maintained at, a specified gravity by using the measured temperature and density of the salt solution. Sodium tetraborate (borax) may be added to the slat solution as a pH stabilization agent in a ratio not exceed 0.7 g sodium tetraborate to 75 liters of salt solution. The pH of the salt solution as collected as fallout in the exposure chamber, shall be maintain between 6.5 and 7.2 with the solution temperature at + 35 ➡C (+ 95 ➡F). Only diluted chemically pure hydrochloric acid or chemically pure sodium hydroxide shall be used to adjust the pH. The pH measurement shall be made electrometically or colorimetrically.

115.4.1.2 Chamber operation verification. Unless the chamber has been used within 5 days, immediately before the test, and with the exposure chamber empty, adjust all test parameters to those required for the test. Maintain these conditions for one 24-hour period. Continuously monitor all test parameters to verify that the test chamber is operating properly.

115.4.1.3 Pretest standard ambient checkout. All items require a pretest checkout at room ambient conditions to provide baseline data. Conduct the checkout as follows:

a. Prepare the test item in its required configuration in accordance with the requirement document.

b. Record the room ambient conditions.

c. Conduct a complete visual examination of the test item with attention to:

1. High-stress areas.

2. Areas where dissimilar metals are in contact.

3. Electrical and electronic components - especially those having closely spaced, unpainted, or exposed circuitry.

4. Metallic surfaces.

5. Enclosed volumes where condensation has occurred or may occur.

6. Components or surfaces provided with coatings or surface treatments for corrosion protection.

7. Cathodic protection systems; mechanical systems subject to malfunction if clogged or coated with salt deposits.

8. Electrical and thermal insulators.

NOTES: Partial or complete disassembly of the test item should be considered if a complete visual examination is required. Care must be taken not damage any protective coatings, etc.

d. Document the results. (Use photographs, if necessary.)

e. Conduct an operational checkout in accordance with the operator's manual. Perform Test Method 77.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term), at rated load only, within 4 hours before the start of the test.

f. Record the results for compliance with the contract.

g. If the test item operates satisfactorily, proceed to 115.4.1.4. If not, resolve the problem and repeat the pretest standard ambient checkout at the most reasonable step above.

115.4.1.4 Preparation of the test item.

a. The test item shall be given a minimum of handling, particularly on the significant surfaces, and will be prepared for immediately before exposure. Unless otherwise specified, test items shall be free of contamination such as oil, grease, or dirt, which could cause a water break. The cleaning methods shall not include the use of corrosive solvents, solvents which deposit either corrosive or protective films, or abrasive other than a paste magnesium oxide.

b. Arrange the test item configurations as specified in the test plan.

c. Insert the test item into the test chamber.

115.4.2 Test.

a. Adjust the test chamber temperature to 35 ➞C (95 ➞F) and condition the test item for at least two hours before introducing the salt fog.

b. Continuously atomize a salt solution of a composition as given in 115.4.1.1 into the test chamber for a period of 48 hours or as specified in the contract. (Cycling periods of 24 hours each (wet and dry) may be required instead of constant wetting for 8 hours or longer.) During the entire exposure period, the salt fog fallout rate and pH of the fallout solution shall be measured at least at 24-hour intervals. (More frequent intervals are recommended. If fallout quantity requirements are not met, that interval must be repeated.)
Fallout shall be between 0.5 and 3 ml/80cm^2/hr.

c. Store the test item in the standard ambient atmosphere for 48 hours, or as specified in the equipment specification, for drying.

d. At the end of the drying period, unless otherwise specified, the test item shall be operated and the results documented for comparison with the pretest data. Within 4 hours after the completion of the test, perform Test Method 77, Frequency and Voltage Regulation, Stability andTransient Response Test (Short Term), at rated load only.

e. The test item shall be visually inspected in accordance with the guidelines given in 115.4.1.3. If necessary to aid in examination, a gentle wash in running water not warmer than 38 ➞C (100 ➞F) my be used.

115.4.3 <u>Data to be recorded</u>.

a. Previous test methods to which the test item was subjected.

b. Results of each visual examination and performance checkout performed on test item.

c. Areas of the test item visually and functionally examined and an explanation of their inclusion.

d Areas of the test item not visually and functionally examined and an explanation of their exclusion.

e. Test chamber operational information (interruptions, time schedule, etc.).

f. Test variables:

1. Salt solution pH.

2. Salt solution fallout rate (ml/cm^2/hr).

3. Resistance of initial water and type of water.

g. Preliminary failure analysis.

115.5 Results. Compare the results obtained with the requirements of the contract.

711.5.6 Contract requirements. The following items must be specified in the individual contract:

a. Temperature condition of the salt fog exposure.

b. Relative humidity of the salt fog exposure.

c. Chemical content of the salt used during this method.

d. Amount of salt in solution.

e. Specific gravity of salt solution.

f. pH of salt solution.

g. Number of hours of exposure to salt fog.

h. Degree or amount of permissible corrosive action.

i. The frequency requirements specified in para 77.5a of Test Method 77.

j. The voltage requirements specified in para 77.5b of Test Method 77

k. The voltage connection and frequency at which this method is to be performed.

TEST METHOD 116

IMMERSION TEST

116.1 General. The generator set must be capable of proper operation after total immersion.

116.2 Apparatus. Instrumentation for measuring load conditions ambient and liquid temperatures shall be as described in EGSA 107T . In addition a container of sufficient size and depth for total immersion of the generator set, and if procedure No. 2 is specified, an altitude chamber in which the container may be placed shall be required.

116.3 Procedures.

116.3.1 Procedure No. 1.

a. Perform Test Method 77.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term) (rated load only).

b. Protect the generator set for immersion only as specified in the contract or technical manual.

c. Completely immerse (to the depth specified in the contract) the generator set in a bath of tap water (or other liquid if so specified) for a period of 72 hours. During this period maintain the temperature of the water between 50 ➡F (10 °C) and 77 ➡F (25 °C) unless otherwise specified in the contract. At the end of the 72 hour period remove the generator set from the bath and inspect for leaks and any damage caused by immersion. Estimate andrecord amount of liquid penetration.
Perform Test Method 77.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).

116.3.2 Procedure No. 2.

a. Perform Test Method 77.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).

b. Protect the generator set for immersion only as specified in the contract or technical manual.

c. Completely immerse (to the depth specified in the contract) the generator set in a bath of tap water.

d. Place the container in an altitude chamber containing a view plate and reduce the pressure within the chamber to the value specified in the contract.

e. Maintain this reduced pressure for the specified period of time.

f. At the end of the specified time period return the pressure within the chamber to atmospheric and remove the generator set from the bath. Inspect the set for leaks and any damage caused by immersion. Estimate and record amount of liquid penetration.

g. Perform Test Method 77.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term) (rated load only).

116.4 Results. Compare the results obtained with the requirements of the contract.

116.5 Contract requirements. The following items must be specified in the individual contract:

a. Amount of protection to be given the set for immersion.

b. Whether procedure 1 or 2, or both, are to be performed.

c. Amount of liquid penetration allowable.

d. The voltage requirements specified in para 77.5a of Test Method 77.

e. The frequency requirements specified in para 77.5b of Test Method 77.

f. Voltage connection and frequency at which this method is to be performed.

g. Conditions of immersion:

1. Procedure 1:

(a) Immersion liquid to be used, if other than as specified herein.
(b) Temperature of immersion liquid, if other than as specified herein.
(c) Duration of immersion, if other than as specified herein.
(d) Depth of immersion.

2. Procedure 2:

(a) Pressure at which this method is to be performed.
(b) Duration of this method.
(c) Depth of immersion.

TEST METHOD 117

SOLAR RADIATION TEST

117.1 General. The generator set must be capable of withstanding the effect of solar loading without physical damage or compromises in operational ability.

117.2 Apparatus. Instrumentation for measuring load conditions and thermal temperatures shall be as described in EGSA 107T . In addition a chamber of sufficient size that is capable of maintaining and monitoring required conditions of temperature, airflow, and irradiation.

117.3 Procedure.

a. Perform Test Method 77.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term) (rated load only).

b. The set fuel tank and oil level will be filled to rated capacity

c. Thermocouples will be installed at the following locations:

    1. Engine compartment.

    2. Control cubicle.

    3. Fuel tank.

    4. Top, front, rear, and side surfaces of housing.

    5. Ambient (in accordance with EGSA 107T , para 21.4).

d. Expose the set to four, 24-hour, hot-dry test cycles described in MIL-STD-810, Test Method 505.3, Procedure I, paragraphs I-3.2a, and I-3.2b(1).

e. After completion of the four cycles, the set will be thoroughly examined for physical damage.

f. Perform Test Method 77.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term) (rated load only) after removal from the chamber.

117.4 Results. Compare the results obtained with the requirements of the contract.

117.5 Contract requirements. The following items must be specified in the individual contract:

a. Definition of damage.

b. The voltage requirements specified in para 77.5a of Test Method 77.

e. The frequency requirements specified in para 77.5b of Test Method 77.

f. Voltage connection and frequency at which this method is to be performed.

g. Observations regarding the heating effects resulting from exposure to solar radiation.

TEST METHOD 118

ALTITUDE OPERATION TEST

118.1 General. Atmospheric pressure decreases as altitude increases. Operation of a generator set is affected by a decrease in atmospheric pressure. It is imperative that the generator set function properly at altitudes above sea level.

118.2 Apparatus. Instrumentation for measuring load conditions and thermal instrumentation of the set shall be as described in EGSA 107T. In addition, a pressure chamber capable of maintaining the specified ambient temperature and pressure with the generator set operating at rated load for extended periods of time shall be as described in EGSA 107T , Test Method 113.3. A barometer to indicate atmospheric pressure within the test chamber and a psychrometer to measure relative humidity shall be required. In addition, the test recording equipment(s) shall be as described in EGSA 107T , Test Methods 1, 4, and 6 (unless otherwise specified in the contract).

118.3 Procedure.

a. Install appropriate thermocouples to measure the following temperatures.

NOTE: Not all sets will require instrumentation of all of the listed items. This list contains items normally instrumented, however, same sets may require additional thermal instrumentation). The thermal instrumentation shall be installed in accordance with the instructions in EGSA 107T , Test Method 23.

1. Engine coolant (engine outlet and inlet).
2. Fuel (discharge side of fuel pump and at fuel source).
3. Spark plug(s) (gasoline engines).
4. Exhaust gases (the exhaust manifold(s) of reciprocating engines shall be drilled and tapped as close as possible to the combustion chamber(s). For gas turbine engines, thermocouples shall be located in the tail pipe approximately one turbine wheel diameter from the last turbine stage).
5. Lubricating oil sump and gallery.
6. Oil cooler (inlet and cutlet).
7. Hydraulic oil sump.
8. Engine combustion air in (located at the inlet of the intake manifold).
9. Cooling air into the radiator (four thermocouples equally spaced around the circumference of the area swept by the fan blades).
10. Generator cooling air (inlet and outlet).
11. Generator stator frame (top and bottom, outside).
12. Generator exciter (stator housing for rotating exciters, transformers for the static exciters).
13. Generator voltage regulator (ambient air inside).
14. Control panel cubicle (ambient air inside).
15. Relay and control boxes (ambient air inside).

16. Average ambient air temperature (EGSA 107T ,Test Method 23).
17. Air entering generator set for housed sets.

b. Conduct an operational checkout in accordance with the operator's manual. Perform Test Method 77, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).

b. Place the instrumented generator set (including all fuels to be used during this method) in the pressure chamber. Obtain and maintain the ambient temperature within the chamber at the value specified in the contract until such time as all components are at the specified ambient temperature or until 24 hours have elapsed, whichever comes later. During all parts of this methods, the average of the eight ambient thermocouples (see EGSA 107T , Test Method 23) shall be not less than the specified temperature and of these eight thermocouples, none indicating more than 5 F° (2.78 C°) above or below the specified ambient.

c. Connect the load and field instrumentation for the voltage connection and frequency specified in the contract.

d. Unless otherwise specified, connect the signal input of the test recording equipment(s) to the convenience receptacle of the set or to the generator coil which is used as the voltage sensing input to the voltage regulator. (Power the test recording equipment(s) from the commercial utility.)

118.3.2 Test.

a. Operate the chamber at the altitude and ambient temperature specified in the requirement document until the temperature readings of all thermal instrumentation have stabilized at or above the specified ambient temperature.

b. With the set stabilized at the required altitude and temperature, turn on the test recording equipment(s) (if using recording meter(s), set the chart speed(s) to a minimum of 6 inches per hour), start the set within 5 minutes by explicitly following the operating instructions on the set. The altitude during all parts of this test shall be not less than that specified. (The air pressure to be maintained in the test chamber shall be that corresponding to the specified altitude, as given in table IV of the US Standard Atmosphere, see table I.)

c. After the set has started, maintain the specified ambient temperature and altitude and allow the set to stabilize at rated load, rated voltage, and rated frequency. Record all instrument readings including thermal instrumentation at minimum intervals of 10 minutes (if using recording meter(s), during this period the chart speed shall not be less than 6 inches per hour). If necessary, adjustments to the load, voltage and frequency may be made to maintain rated load at rated voltage and rated frequency. Adjustments to the voltage and frequency shall be limited to those adjustments available to the operator, specifically adjustments to the voltage and frequency adjust devices. On sets utilizing a droop-type speed control system as the prime speed control, the speed and

droop portions of the control may be adjusted. No other adjustments to the voltage and frequency control systems shall be made unless permitted by the contract. Adjustments to load, voltage or frequency controls shall be recorded on both the data sheet and the recording equipment(s) at the time of adjustment. Unless otherwise specified in the contract, stabilization shall be considered to have occurred when four consecutive voltage and frequency recorded readings of the generator line output either remain unchanged or have only minor variations within plus or minus one-half the long-term stability bandwidth with no evident continued increase or decrease in value after the last adjustment to the load, voltage, or frequency has been made.

d. Unless otherwise specified, operate the generator set in accordance with the instructions on the set or in the technical manual and perform the following methods at the specified ambient temperature, ambient air pressure, voltage connection and frequency:

1. Test Method 77.1, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term). (In addition to the required data, all thermal and pressure instrumentation as specified in Test Method 90.1 shall be read and recorded at the same time for the stabilization portion of this test.)

2. Test Method 90, Maximum Power Test.

Note: The above methods are listed in numerical order; however, they need not be performed in this order.

118.4 Results. Results shall be as specified in methods listed in 118.3.2(d). For the test performed in 118.3.2(b) the data sheet shall show the length of time required to start the set, whether or not the set operated and reasons for any difficult starting or uneven running. Compare these results with the requirements of the contract.

118.5 Contract requirements. The following items must be specified in the individual contract:

a. Altitude and temperature at which this method is to be performed.

b. Voltage connection and frequency at which this method is to be performed.

c. Maximum allowable short-term frequency stability bandwidth in percent of rated frequency.

d. Maximum allowable short-term voltage stability bandwidth in percent of rated voltage.

e. Maximum allowable frequency recovery time.

f. Maximum allowable voltage recovery time.

g. Maximum allowable frequency overshoot and undershoot.

h. Maximum allowable voltage overshoot and undershoot.

i. Maximum allowable frequency regulation (droop).

j. Maximum allowable voltage regulation (droop).

k. Minimum maximum power requirement.

l. Methods to be performed in addition to or other than those listed in 118.3.2(d).

TABLE I

ATMOSPHERIC TABLE

ALTITUDE IN FEET	ATMOSPHERIC mm Kg	PRESSURE in. Hg
0	760.0	29.92
1,500	719.7	28.33
2,000	706.6	27.82
3,000	681.2	26.82
4,000	656.3	25.84
5,000	632.4	24.90
6,000	609.0	23.98
8,000	564.9	22.24
10,000	522.6	20.58

TEST METHOD 119

STORAGE TEST
(EXTREME COLD)

119.1 General. The generator set must be capable of storage without damage in extreme low temperature environments.

119.2 Apparatus. Instrumentation for measuring load conditions, ambient and set temperatures shall be as described in EGSA 107T .

A controlled temperature room shall be used having sufficient capacity to maintain the specified extreme low temperature for the duration of this method. This controlled temperature room shall be as described in EGSA 107T, Test Method 13.2.

119.3 Procedure.

119.3.1 Preparation for test.

a. Install appropriate thermocouples to measure the following temperatures
The thermal instrumentation shall be installed in accordance with the instructions in EGSA 107T , Test Method 23

NOTE: Not all sets will require instrumentation of all the listed items. This list contains items normally instrumented; however, some sets may require additional thermal instrumentation)..

1. Engine coolant (engine outlet and inlet).
2. Fuel (discharge side of fuel pump and at fuel source).
3. Spark plug(s) (gasoline engines).
4. Exhaust gases (The exhaust manifold(s) of reciprocating engines shall be drilled and tapped as close as possible to the combustion chamber(s). For gas turbine engines, thermocouples shall be located in the tailpipe approximately one turbine wheel diameter downstream from the last turbine stage).
5. Lubricating oil sump and gallery for preproduction sets and sets and sump only for production sets.
6. Oil cooler (inlet and outlet).
7. Hydraulic oil sump.
8. Storage battery electrolyte (thermocouple(s) shall be so located that the electrolyte temperature at the center of the electrolyte is measured).
9. Engine combustion air in (located at the inlet of the intake manifold).
10. Cooling air into the radiator (four thermocouples equally spaced around the circumference of the area swept by the fan blades).
11. Generator cooling air (inlet and outlet).

12. Generator stator frame (top and bottom, outside).
13. Generator exciter (stator housing for rotation exciters, transformers for static exciters).
14. Generator voltage regulator (ambient air, inside).
15. Control panel cubicle (ambient air, inside).
16. Relay and control boxes (ambient air, inside).
17. Average ambient air temperature (EGSA 107T ,Test Method 21).
18. Air entering generator set for housed sets.
19. Heater coolant (air or liquid-into and out of the heater).
20. Heater exhaust.

b. Start and operate the generator set until the lubricating oil is warm enough to drain. Drain the coolant from the engine block, the radiator, coolant pump, heater, and all coolant lines. Be sure that the set is completely drained. Fill the coolant system with the proper grade of antifreeze. Fill and label a small transparent container (approximately 8 ounces) with a sample of the antifreeze used.

c. Drain the fuel from all fuel tanks, lines, strainers, pumps and filters. Flush tanks with low temperature fuel using approximately 10 percent of tank capacity. Clean all fuel strainers and replace filter elements. Install new gaskets on strainer and filter elements. Fill fuel tanks to approximately 10 percent rated capacity with fuels of the proper grade. Fill and label a small container (approximately 8 ounces) with a sample of each fuel used.

d. Drain the lubricating oil from the engine, filters strainers and lines. Install new filters and clean the strainers. Use new gaskets. Fill with proper grade lubricating oil. Fill a small container with a sample (approximately 8 ounces) of the oil used.

e. Operate the winterization and ether systems, as applicable. See that all controls work properly. It may be necessary to temporarily bypass some controls if the ambient temperature is too high. Do not operate the heater for longer than necessary to perform the checkout.

f. Operate any fuel priming pumps on the set with the discharge lines open to clear lines of normal ambient fuel.

g. On all units, as applicable, check the spark plugs, magneto, distributor, valve clearances, injector timing, etc. Check instruction manual or operating and servicing instructions to see that all set requirements or recommendations have been performed.

h. Start and operate the generator set for approximately 15 minutes at no lead to allow the arctic fuels and lubricants to thoroughly circulate. During this period open oil lines at gages and safety controls to drain normal temperature oil. Shut down the set and drain all set fuel tanks as well as the oil from the air cleaners. Fill set fuel tanks, except for

sets with gasoline engines. Fill and label a small container with a sample (approximately 8 ounces) of fuel used.

i. If a storage battery is part of the set fill it with electrolyte having the specific gravity recommended for arctic operation. Determine that the batteries have been cycled and completely charged (see EGSA 107T , Test Method 22) before placing them in the cold room.

j. Place containers of fuel, lubricant(s), and coolant in the cold room.

k. Place the generator set in the cold room. If the set is equipped with a three-way valve for an auxiliary fuel supply, connect the fuel supply to the engine thru the three-way valve using the auxiliary fuel hoses (length and size of hoses are specified in the contract) supplied with the generator set. This auxiliary fuel supply shall be in the cold room. Set the fuel supply valve in the auxiliary fuel position.

1. Connect the load and field instrumentation for the voltage connection and frequency specified in the contract.

m. Where temperature measurements are made by means of thermocouples, the thermocouple leads shall be brought out of the cold room to permit the temperature to be read by instruments located in normal ambient temperatures. All electrical instruments, except those provided as part of the generator set, shall be located outside the cold room with the exception of shunts used in determining field current.

119.3.2 Test.

a. For sets with gasoline engines, start the cold room and when the ambient temperature has reached approximately 0 ➡F (-17.7 °C) open the auxiliary fuel container and connect it to the generator set through the auxiliary fuel connection. (Note: The parameters of arctic fuel at temperatures above 0 ➡F (-17.7 °C) necessitates storing the fuel in sealed containers.) Fill and label a small container with a sample of the fuel used. Place this sample alongside samples of fuel, lubrication oil, and coolant taken previously, in preparation for test, in a location in the cold chamber where they may be observed.

b. For sets with gasoline engines, start and operate the set for approximately 15 minutes at no load to allow the arctic fuel to thoroughly circulate. Then shut down the set.

c. Expose the generator set to an ambient temperature of -40 ➡F (-40 °C) or as specified in the contract until the temperature of all components of the set stabilize at this value. During all parts of this method, none of the eight ambient temperature thermocouples shall read warmer than the specified extreme-cold temperature.

d. Expose the generator set to an ambient temperature of -80 ➡F (-62.2 °C) or as specified in the contract until the temperature of all components of the set stabilize at this value. Maintain the ambient temperature at -80 ➡F (-62.2 °C) for 24 hours after the stabilization is attained. During this period, inspect the set for evidence of distortion or cracking of the components, and leaks in fuel, lubrication, and cooling systems.

e. Raise the ambient temperature to -40 ➡F (-40 °C) and maintain this temperature until the temperature of all components of the set stabilize at this value.

f. Raise the ambient temperature to normal ambient temperature and maintain this t emperature until the temperature of all components of the set stabilize at this value.

g. Drain the arctic fuel, lubricating oil, and coolant from the set. Do not remove fuel strainers, filters, gaskets, etc. Refill the set with normal ambient fuel, lubricating oil, and coolant.

h. Start and operate the generator set at idle speed (reduced speed if no idle speed is attainable), inspect the set for leaks, faulty operation, etc. After the unit has been warmed up, increase speed to rated. Inspect the set again and then apply rated load and perform Test Method 77, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term).

NOTE: This method may be combined with Test Method 105, Starting and operating Test (Extreme Cold) in which case, steps e, f, g, and h of this method should be deleted and after stabilization at -80 ➡F (62.2 °C) the ambient temperature should be raised to -65 ➡F (-53.8 °C) and the set stabilized at this value before proceeding with Test Method 105.

119.4 Results. Compare the results with the contract requirements.

119.5 Contract requirements. The following items must be specified in the individual contract:

a. The frequency requirements specified in para 77.5a of Test Method 77.

b. The voltage requirement specified in para 77.5b of Test Method 77.

c. The voltage connection and frequency at which this method is to be performed.

d. Extreme cold temperature, if other than as specified herein.

e. Types of fuel, lubricant, and coolant to be used.

TEST METHOD 120

STORAGE TEST
(EXTREME HOT, +160 ➡F)

120.1 General. The generator set must be capable of storage without damage in extreme high temperature environments.

120.2 Apparatus. Instrumentation for measuring load conditions, field voltage and current, set and ambient temperatures shall be as described in EGSA 107T Test Methods 1,2, and 10.

120.3 Procedure.

120.3.1 Preparation for test.

a. Install appropriate thermocouples to measure the following temperatures.. This list contains items normally instrumented; however, some sets may require additional thermal instrumentation. The thermal instrumentation shall be installed in accordance with the instructions in EGSA 107T Test Method 23.

NOTE: Not all sets will require instrumentation of all of the listed items

1. Engine coolant (engine outlet and inlet).
2. Fuel (discharge side of fuel pump and at fuel source).
3. Spark plug(s) (gasoline engines).
4. Exhaust gases (the exhaust manifold(s) of reciprocating engines shall be drilled and tapped as close as possible to the combustion chamber(s). For gas turbine engines, thermocouples shall be located in the tailpipe approximately one turbine wheel diameter downstream from the last turbine stage).
5. Lubricating oil (sump and gallery).
6. Oil cooler (inlet and outlet).
7. Hydraulic oil (sump).
8. Engine combustion air in (located at the inlet of the intake manifold).
9. Cooling air into the radiator (four thermocouples equally spaced around the circumference of the area swept by the fan blades).
10. Generator cooling air (inlet and outlet).
11. Generator stator frame (top and bottom, outside).
12. Generator exciter (stator housing for rotating exciters, transformers for static exciters).
13. Generator voltage regulator (ambient air inside).
14. Control panel cubicle (ambient air inside).
15. Relay and control boxes (ambient air inside).
16. Average ambient air temperature (EGSA 107T Test Method 23).
17. Air entering generator set for housed sets.

b. Connect the load and field instrumentation for the voltage connection and frequency specified in the contract.

120.3.2 Test.

a. Perform Test Method 77, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term) at rated load only.

b. Place the instrumented be] set in a test chamber and expose the set to an ambient temperature of 90 ➡F (32.2 °C) until the temperatures of all components of the set stabilize at this value. During all parts of this methods, none of the eight ambient temperature thermocouples shall
read less than the specified temperature.

c. During a five hour interval, gradually raise the ambient temperature to 160 ➡F (71.1 °C) or as specified in the contract. Maintain this ambient temperature until the temperature of all components of the set stabilize at this value.

d. During a five hour interval, gradually reduce the ambient temperature to 90 ➡F (32.2 ➡C). Maintain this temperature until the temperature of all components of the set stabilize at this value.

e. Lower the ambient temperature to normal ambient temperature and maintain this temperature until the temperature of all components of the set stabilizes at this value. Inspect the set for any evidence of deterioration due to high temperature. Perform Test Method 77, Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term) at rated load only, at normal ambient temperature.

NOTE: This test may be combined with Test Method 110, High Temperature Test, in which case step d above should be deleted and the temperature gradually reduced to 125 ➡F (51.5 °C) in a 2-1/2 hour interval and maintained until stabilization of the temperature of all components of the set occurs. Perform steps e and f above before proceeding with Test Method 110.

120.4 Results. Compare the results with the requirements of the contract.

120.5 Contract requirements. The following items must be specified in the individual contract:

a. The frequency requirements specified in para 77.5a of Test Method 77.
b. The voltage requirements specified in para 77.5b of Test Method 77
c. The voltage connection and frequency at which this method is to be performed.
d. Extreme high temperature, if other than as specified herein.