

MIL-STD-883G

METHOD 1009.8

SALT ATMOSPHERE (CORROSION)

1. PURPOSE. This test is proposed as an accelerated laboratory corrosion test simulating the effects of seacoast atmosphere on devices and package elements.

1.1 Terms and definitions.

1.1.1 Corrosion. Corrosion is the deterioration of coating or base metal or both by chemical or electrochemical action.

1.1.2 Corrosion site. A corrosion site is the site at which the coating or base metal or both is corroded. The location of corrosion.

1.1.3 Corrosion product (deposit). The effect of corrosion (i.e., rust or iron oxide, nickel oxide, tin oxide, etc.). The product of corrosion may be at the corrosion site, or may flow or run (due to action of liquid carrier of salt) so as to cover noncorroded areas.

1.1.4 Corrosion stain. Corrosion stain is a semitransparent deposit due to corrosion products.

1.1.5 Blisters. A blister is a localized swelling and separation between the coating(s) and base metal.

1.1.6 Pinhole. A pinhole is a small hole occurring in the coating as an imperfection which penetrates entirely through the coating.

1.1.7 Pitting. Pitting is the localized corrosion of coating or base metal or both, confined to a point or small area, that takes the form of cavities.

1.1.8 Flaking. Flaking is the separation of small pieces of coating that exposes the base metal.

2. APPARATUS. Apparatus used in the salt-atmosphere test shall include the following:

- a. Exposure chamber with fixtures for supporting devices. The chamber and all accessories shall be made of material (glass, plastic, etc.) which will not affect the corrosiveness of the salt atmosphere. All parts within the test chamber which come in contact with test specimens shall be of materials that will not cause electrolytic corrosion. The chamber shall be properly vented to prevent pressure build-up and allow uniform distribution of salt fog.
- b. Salt solution reservoir adequately protected from the surrounding ambient. If necessary, auxiliary reservoirs may be used for long duration tests in accordance with test conditions C and D (see 3.2).
- c. Means for atomizing the salt solution, including suitable nozzles and compressed air or a 20 percent oxygen, 80 percent nitrogen mixture (the gas entering the atomizers shall be free from all impurities such as oil and dirt).
- d. Chamber-heating means and controls.
- e. Means for humidifying the air at temperature above the chamber temperature.
- f. Air or inert gas dryer.
- g. Magnifier(s) 1X to 3X, 10X to 20X and 30X to 60X.

3. PROCEDURE.

3.1 Maintenance and conditioning of test chamber. The purpose of the cleaning cycle is to assure that all materials which could adversely affect the results of the subsequent tests are removed from the chamber. The chamber shall be cleaned by operating it at 95°F ±5°F (35°C ±3°C) with deionized or distilled water as long as necessary. The chamber shall be cleaned each time the salt solution in the reservoir has been used up. Several test runs therefore could be run before cleaning, depending on the size of the reservoir and the specified test condition (see 3.2). When long duration conditions (test conditions C and D, see 3.2) are required, the reservoir may be refilled via auxiliary reservoirs so that the test cycle shall not be interrupted. After the cleaning cycle, on restarting the chamber, the reservoir shall be filled with salt solution and the chamber shall be stabilized by operating it until the temperature comes to equilibrium, see 3.1.4. If operation of the chamber is discontinued for more than one week, the remaining salt solution, if any, shall be discarded. Cleaning shall then be performed prior to restarting the test chamber. Intermittent operation of the chamber is acceptable provided the pH and concentration of the salt solution are kept within limits defined in 3.1.1.

3.1.1 Salt solution. The salt concentration shall be 0.5 to 3.0 percent by weight in deionized or distilled water as required to achieve the deposition rates required by 3.1.4. The salt used shall be sodium chloride containing on the dry basis not more than 0.1 percent by weight of sodium iodide and not more than 0.3 percent by weight total impurities. The pH of the salt solution shall be maintained between 6.5 and 7.2 when measured at 95°F ±5°F (35°C ±3°C). Only CP grade (dilute solution) hydrochloric acid or sodium hydroxide shall be used to adjust the pH.

3.1.2 Preconditioning of leads. Unless otherwise specified, the test specimens shall not be preconditioned. If required (see 4.c.), prior to mounting specimens for the salt atmosphere test, the device leads shall be subjected to the bending stress initial conditioning in accordance with test condition B1 of method 2004. Where the specific sample devices being subjected to the salt atmosphere test have already been subjected to the required initial conditioning, as part of another test employing the same sample devices, the lead bend need not be repeated.

3.1.3 Mounting of test specimens. The test specimens shall be mounted on the holding fixtures (plexiglass rods, nylon or fiberglass screens, nylon cords, etc.) in accordance with the applicable orientation(s) below. Specimens shall also be positioned so that they do not contact each other, so that they do not shield each other from the freely settling fog, and so that corrosion products and condensate from one specimen does not fall on another.

- a. Dual-in-line packages with leads attached to, or exiting from, package sides (such as side-brazed packages and ceramic dual-in-line packages): Lid upward 15° to 45° from vertical. One of the package sides on which the leads are located shall be oriented upward at an angle greater than or equal to 15° from vertical (see figure 1009-1a).
- b. Packages with leads attached to, or exiting from the opposite side of the lid (such as TO cans, solid sidewall packages, and metal platform packages): Lid 15° to 45° from vertical. One-half of the samples shall be tested with the lid upward; the remaining samples shall be tested with the leads upward (see figure 1009-1b). For packages with leads attached to, or exiting from the same side as the lid, only one orientation (lid and leads upward) is required.
- c. Packages with leads attached to, or exiting from package sides, parallel to the lid (such as flatpacks): Lid 15° to 45° from vertical. One of the package sides on which the leads are located shall be oriented upward at an angle greater than or equal to 15° from vertical. For packages with a metal case, one-half of the samples shall be tested with the lid upward; the remaining samples shall be tested with the case upward. All other packages shall be tested with the lid upward (see figure 1009-1c).
- d. Leadless and leaded chip carriers: Lid 15° to 45° from vertical. One-half of the samples shall be tested with the lid upward; the remaining samples shall be tested with the lid downward (see figure 1009-1d).
- e. Flat specimens (e.g., lids only and lead frames only): 15° to 45° from vertical.

NOTE: In cases where two orientations are required for testing, the specified sample size shall be divided in half (or as close to one-half as possible). In all cases, inspections following the test in accordance with 3.4 shall be performed on all package surfaces.

NOTE: Precautions may be used to prevent light induced photovoltaic electrolytic effects when testing windowed UV erasable devices.

3.1.4 Chamber operation. After conditioning of test chamber in accordance with 3, a salt fog having a temperature of 95°F minimum (35°C minimum) shall be passed through the chamber for the specified test duration (see 3.2). The exposure zone of the chamber shall be maintained at a temperature of 95°F ±5°F (35°C ±3°C). The fog concentration and velocity shall be so adjusted that the rate of salt deposit in the test area is between 20,000 and 50,000 mg/m²/24 hours. Rate of salt deposit may be determined by either volumetric, gravimetric, or other techniques at the user's option. The salt solution collecting at the bottom of the chamber shall be discarded.

3.2 Length of test. The minimum duration of exposure of the salt atmosphere test shall be specified by indicating a test condition letter from the following table. Unless otherwise specified, test condition A shall apply:

<u>Test condition</u>	<u>Length of test</u>
A	24 hours
B	48 hours
C	96 hours
D	240 hours

3.3 Preparation of specimens for examination. Upon completion of the salt exposure test, the test specimens shall be immediately washed with free flowing deionized water (not warmer than 100°F (38°C) for at least 5 minutes to remove salt deposits from their surface after which they shall be dried with air or inert gas, and subjected to the inspections below.

3.4 Failure criteria. All inspections shall be performed at a magnification of 10X to 20X, unless otherwise specified in this procedure (see 3.4.1b and 3.4.1c).

NOTES:

1. Corrosion stains shall not be considered as part of the defective area of 3.4.1a.
2. Corrosion products resulting from lead corrosion that deposit onto areas other than the lead shall not be considered as part of the defective area of 3.4.1a.
3. Corrosion at the tips of the leads and corrosion products resulting from such corrosion shall be disregarded.
4. Portions of leads which cannot be further tested in accordance with 3.4.1b, due to geometry or design (such as standoffs on pin grid arrays or the brazed portion of leads on side-brazed packages), shall be subject to the failure criteria of 3.4.1a.

3.4.1 Finished product. No device is acceptable that exhibits:

- a. Corrosion defects over more than 5 percent of the area of the finish or base metal of any package element other than leads such as lid, cap, or case. Corrosion defects to be included in this measurement are: Pitting, blistering, flaking, and corrosion products. The defective area may be determined by: Comparison with charts or photographs of known defective areas (see figure 1009-2), direct measurement using a grid or similar measuring device, or image analysis.

- b. Leads missing, broken, or partially separated. In addition, any lead which exhibits pinholes, pitting, blistering, flaking, corrosion product that completely crosses the lead, or any evidence of pinholes, pitting, blistering, flaking, corrosion product, or corrosion stain at the glass seal shall be further tested as follows:

Bend the lead through 90° at the point of degradation in such a manner that tensile stress is applied to the defect region. Any lead which breaks or shows fracture of the base metal through greater than 50 percent of the cross-sectional area of the lead shall be considered a reject. In the case of multiple defects the bend shall be made at the site exhibiting the worst case corrosion. On packages exhibiting defects on more than ten leads, bends shall be made on a maximum of ten leads exhibiting the worst case corrosion. The examination of the fracture shall be performed with a magnification of 30X to 60X.

- c. Specified markings, which are missing in whole or in part, faded, smeared, blurred, shifted, or dislodged to the extent that they are not legible. This examination shall be conducted with normal room lighting and with a magnification of 1X to 3X.

3.4.2 Package elements. When this test is performed on package elements or partially assembled packages during incoming inspection or any time prior to completion of package assembly as an optional quality control gate or as a required test (see 4.d), no part is acceptable that exhibits:

- a. Corrosion defects over more than 1.0 percent of the area of the finish or base metal of lids or over more than 2.5 percent of the area of the finish or base metal of any other package element other than leads (such as case). Corrosion on areas of the finish or base metal that will not be exposed to surrounding ambient after device fabrication shall be disregarded. This inspection shall be performed according to the procedure in 3.4.1a.
- b. Leads with final lead finish that are rejectable in accordance with 3.4.1b.

4. SUMMARY. The following details shall be specified in the applicable acquisition document:

- a. Test duration, if other than test condition A (see 3.2).
- b. Measurements and examinations after test, when applicable for other than visual (see 3.4).
- c. Requirement for preconditioning, if applicable, and procedure if other than in 3.1.2.
- d. Requirement for incoming inspection of package elements or partially assembled packages (see 3.4.2), when applicable.

FIGURE 1009-1a. Dual-in-line packages with leads attached to, or exiting from package sides (such as side-brazed packages and ceramic dual-in-line packages):

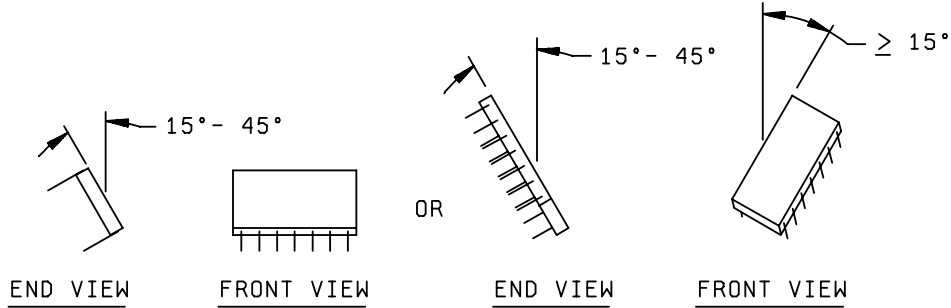
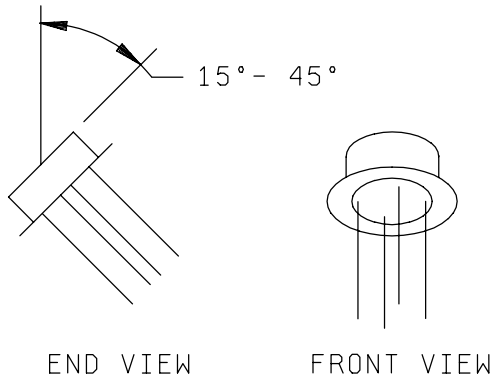


FIGURE 1009-1b. Packages with leads attached to, or exiting from opposite sides of lids (such as TO cans, solid sidewall packages, metal platform packages, and pin grid arrays):

1. TO cans:

a. Expose one-half of samples with caps upward:



b. Expose other one-half of samples with leads upward:

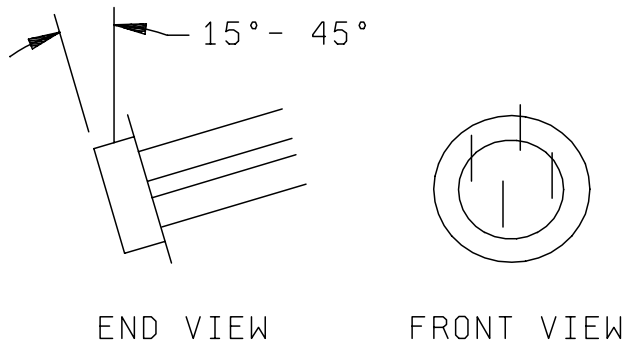
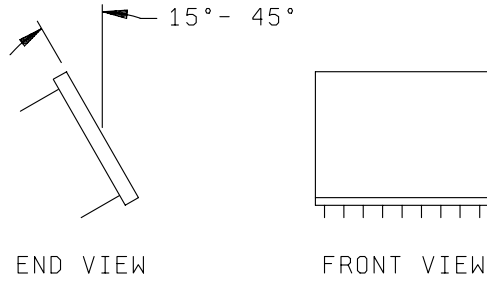


FIGURE 1009-1. Example sample orientations.

2. Solid sidewall packages, metal platform packages, and pin grid arrays:

a. Expose one-half of samples with lids upward:



b. Expose other one-half of samples with leads upward:

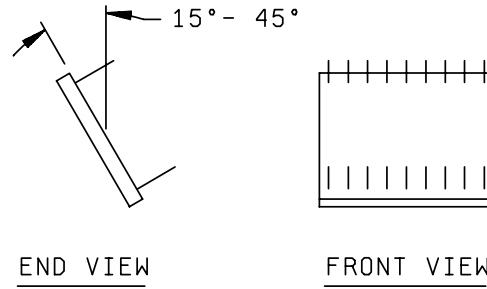
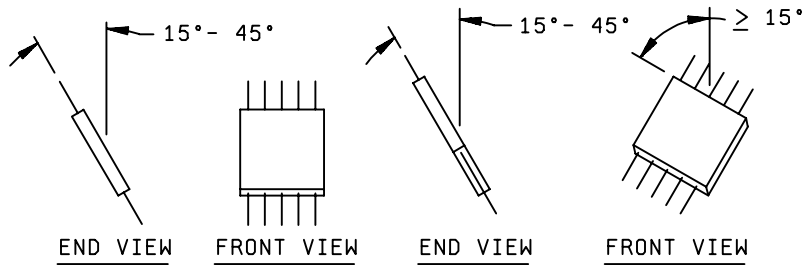


FIGURE 1009-1c. Packages with leads attached to, or exiting from package sides, parallel to lid (such as flatpacks):

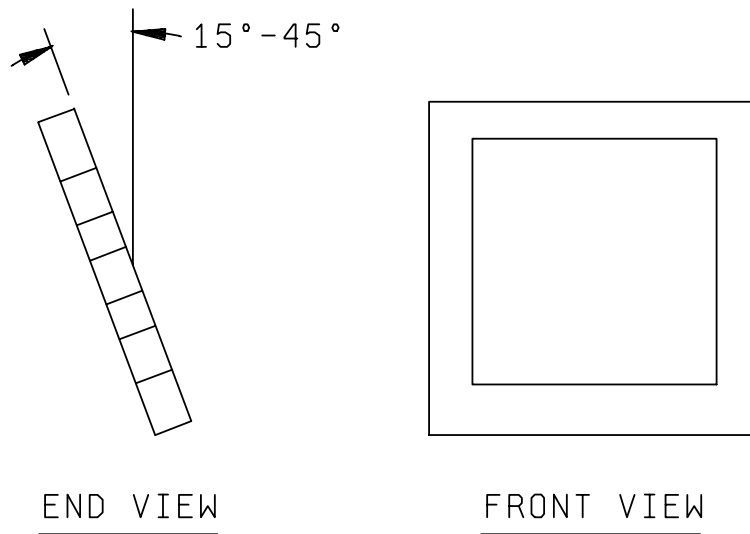


NOTE: If the case is metal, one-half of the samples shall be tested with the lids exposed upward, the other one-half with the cases exposed upward.

FIGURE 1009-1. Example sample orientations - Continued.

FIGURE 1d. Leadless or leaded chip carriers:

1. Expose one-half of samples with lids upward:



2. Expose other one-half of samples with lids downward:

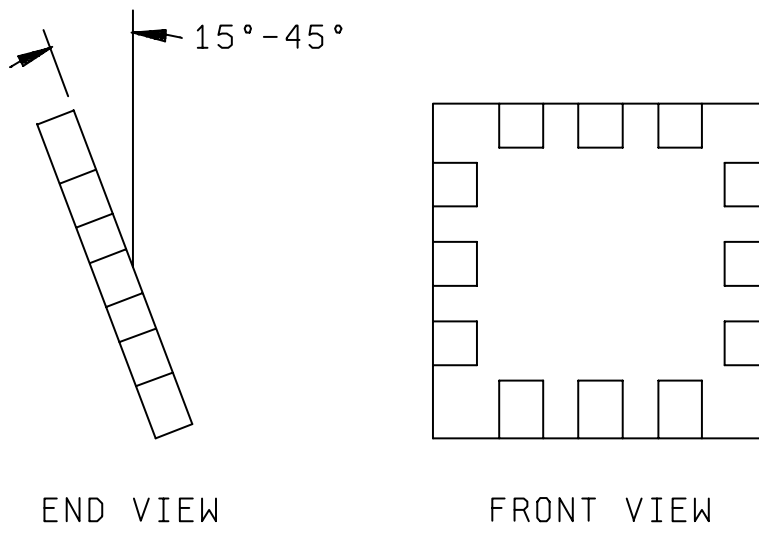


FIGURE 1009-1. Example sample orientations - Continued.

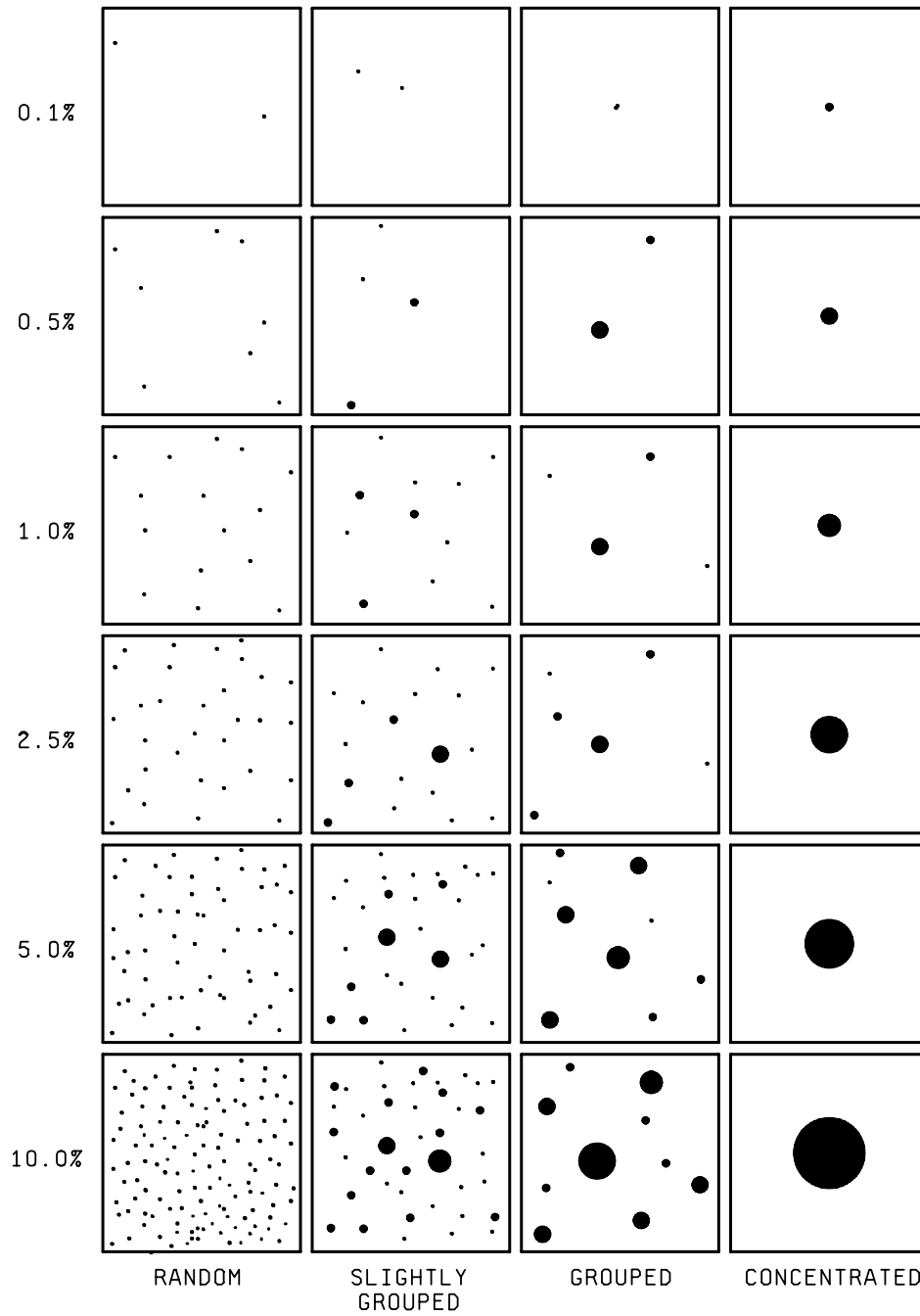


FIGURE 1009.2. Corrosion area charts.