



Accelerated corrosion test, version II – ACT II

Cyclic atmospheric corrosion test with salt load

Orientation

The Ford standard CETP 00.00-L-467 is equivalent to this standard.

Contents

1 Scope and field of application

2 Test method

- 2.1 Test exposure conditions
- 2.2 Start and end time of test

3 Test equipment and accessories

- 3.1 Test chamber layout
- 3.2 Climate control
- 3.3 Recommendations on test chamber functionality
- 3.4 Exposure to salt solution
- 3.5 Supporting requisites and accessories

4 Test object conditions

- 4.1 Geometric requirements
- 4.2 Test object preparation
- 4.3 Duration of test
- 4.4 Test object evaluation

5 Quality assurance

- 5.1 Control and calibration
- 5.2 Deviation handling

6 Acceptance criteria

7 Test report

Appendix 1 Test corrosivity

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1 Scope and field of application

This standard specifies a laboratory-accelerated atmospheric corrosion test. The objective of the test is to allow evaluation of the corrosion resistance of metals in environments where there is a significant influence of chloride ions, mainly as sodium chloride from a marine source or by winter road de-icing salt. It serves as a general-purpose atmospheric corrosion test and applies to a variety of materials, coatings, and interactions of materials, both in the form of test pieces or designed components. The test can be used as a design verification method in order to (a) develop and qualify new corrosion resistant products, (b) develop new pretreatments and finishing processes, (c) select materials and, (d) perform quality control of the finished product. The standard specifies controlled conditions for equipment and procedures to allow the test to be performed with a high degree of repeatability and reproducibility. It is designed to be suitable to run in various climate chambers, either as a fully automated procedure or with partly manual operations. The workday test procedure consists of:

- A 6-h wet phase at room temperature, with intermittent exposure to salt solution (0,5 % NaCl)
- A 2,5-h transition phase with drying under climate control
- A 15,5-h phase with constant temperature and humidity (50 °C, 70 % RH).

After repeating this procedure Mon-Fri, a 48-h weekend phase under continued constant climate control (50 °C, 70 % RH) is added.

This standard method, hereby denoted ACT II, differs in some corrosion aspects from its earlier released relative, VCS 1027,149, hereby denoted ACT or ACT I:

- The corrosion rate for steel is approximately 50 % higher with respect to paint undercutting in confined mode (crevices, etc), but only 10 % higher for general corrosion in open mode.
- The corrosion rate for zinc is in the order of 30 % lower for open corrosion, but 10-30 % higher for under-paint corrosion of galvanized steel.
- The test method in this standard is applicable to painted aluminium, contrary to VCS 1027,149.
- This method is better suited to corrosion testing of magnesium (due to longer time of macro wetness), especially when under bimetallic influence.
- The testing environment in this standard is similar in effect to that of the salt load/climatic part of the Volvo Proving Ground corrosion test procedure and yields corresponding results.
- This test is less efficient regarding pitting of aluminium and staining of anodized aluminium, due to the lower frequency of humid to semi-dry cycles.
- Austenitic stainless steels may exhibit exaggerated red rust due to the comparatively high exposure temperature combined with cyclic drying (above critical pitting temperature).

2 Test method

2.1 Test exposure conditions

There are three basic exposure modes in the daily test scheme:

1. A continuous wet phase at 25 ± 2 °C where the test pieces are exposed to a 0,5 % NaCl solution. The wet condition is maintained by intermittent spray exposure and with a temperature control without drying, or with the humidity control set high enough to not cause any practical drying.
2. A two-step transition from wet to controlled humidity climate.
3. A period under constant temperature/humidity control; $50 \pm 0,6$ °C and 70 ± 3 % RH. This is also the condition during weekends.

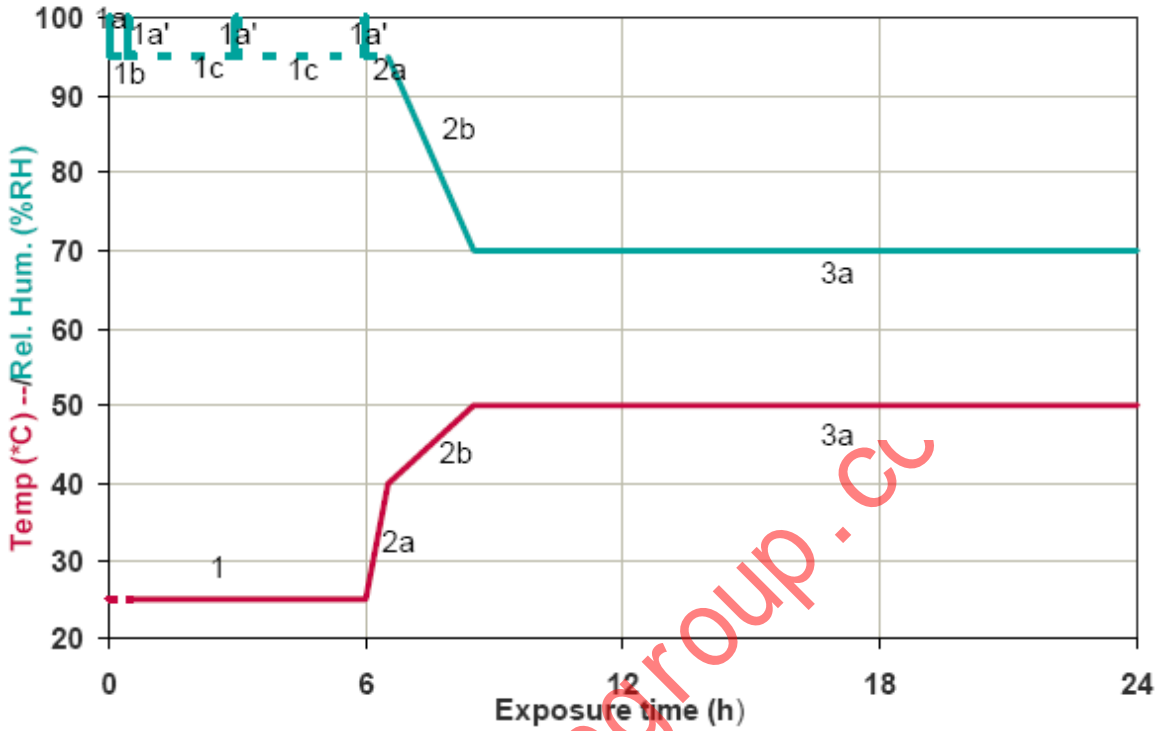


Fig. 1 Workday (i.e. Mon-Fri) test cycle

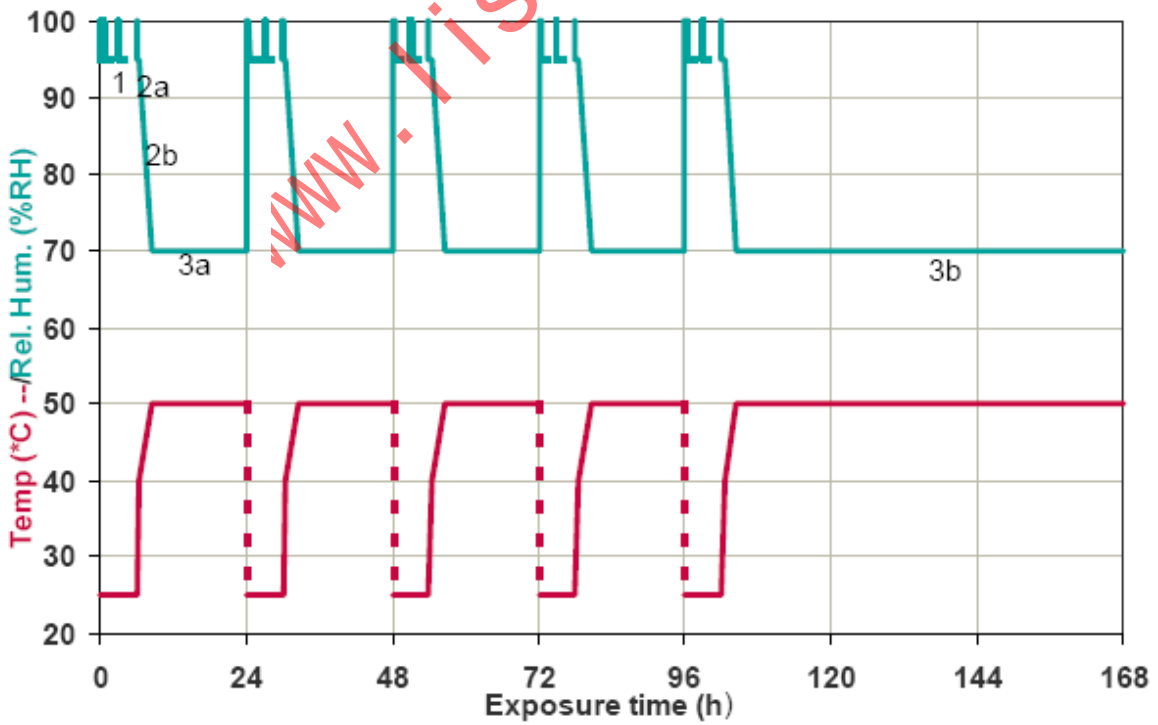


Fig. 2 Complete weekly programme

Table 1 Climate program, step by step in automated mode

Step	Time elapsed		Duration of step		Climate settings at start of step		Comments
	no	h	m	h	m	T (°C)	
1a	0	0	0	10*	50*	70*	Spray thoroughly 0,5 % NaCl to wet and cool
1b	0	10	0	20	30-50	wet	Cool chamber with maximum capacity
1a'	0	30	0	3	<30	wet	Spray to regain wetness (cooling dries)
1c	0	33	2	27	<30	wet (95)	25±2 to be reached within 1 h from start (1a)
1a'	3	0	0	3	25±2	wet	Secure and support wetness by spraying
1c'	3	3	2	54	25±2	wet (95)	wet (95) = OK to set to 95 % RH
1a'	5	57	0	3	25±2	wet	Defines wet condition before climate control
2a	6	0	0	30	25±2	wet (95)	Start of quick temperature rise without drying
2b	6	30	2	00	40±0,4	wet (95)	Start of slow drying by diffusion
3a	8	30	15	30	50±0,4	70±2	Panels shall be free from visible wetness
3a	24	00	-	-	50±0,4	70±2	End of "workday" procedure
Repeat steps 1a - 3a another four times							
3b	120	00	48	00	50±0,4	70±2	Phase in with weekends in case of manual operations in "workday" procedure
3b	168	00	-	-	50±0,4	70±2	
Repeat steps 1a-3b for required number of weeks							

* Provided proceeding from step 3a or 3b.

2.1.1 Operations within the wet phase at 25 ± 2 °C

Exposure to 0,50 ± 0,05 % NaCl solution shall be performed at least in the beginning, middle and at the end of the 6-h wet phase. The wet phase is either incorporated in a fully automated test procedure or subjected to partly manual operation.

2.1.1.1 Fully automated test procedure

In automated mode, the first spray event may consist of a longer period of spray (1a - up to 10 minutes) in order to cool the test objects and the chamber more efficiently from the 50 °C, 70 % RH condition. When all test operations are performed within the same climate chamber, it is essential to follow up with efficient cooling after the first spray event, in order to reach a temperature below 30 °C within the first 30 minutes of the wet phase (1b). After such cooling, which implies some drying, it is recommended to have another short spray event to ensure that the solution on the panels have the stipulated concentration (1a' in table 1/ figure 1). The final targeted temperature of 25 ± 2 °C shall be reached within the first hour.

2.1.1.2 Test procedure with partly manual operation

In an exposure case where the spray is applied manually into a stay-open chamber, or the test objects are moved to another chamber or lab bench for spraying at wet-phase exposure, cooling within the stipulated time is usually not a problem. Note that the spraying conditions described in section 3.4.2 shall apply. During the remaining time of the wet phase (1c), the test objects must not dry significantly. This is accomplished by ensuring that the temperature control is maintained without significant removal of humidified air. If the wet phase is performed in a trough on a bench or in an unheated chamber, it may be sufficient to just keep the panels in a closed volume between the spray events. In the fully integrated test condition, the climate control can be set to 25 °C, 95 % RH, which secures against any significant drying, without the risk of supplying humidity, which might occur if the humidity is set to, e.g., 99 % RH.

The short spray event after approximately 3 h (1a') renews the wet film on the test pieces and secures against drying. The final spray event (1a') is to ensure consistent starting conditions when entering the transition to controlled humidity climate.

NOTE 1: The spraying scheme in table 1 does not have to be strictly followed, provided there is a spraying period at the beginning, middle and at the end of the 6-h wet period and the total amount of precipitation follows section 3.4.

NOTE 2: Continuous spraying with atomizing nozzles for salt mist is not an option.

2.1.1.3 Requirements on sodium chloride solution

The test solution shall be prepared by dissolving sodium chloride in deionized water to a concentration of $0,50 \pm 0,05$ % (by weight). Food-grade sodium chloride is a permissible option (provided without sodium iodide additions).

2.1.2 Transition to controlled humidity conditions

For both fully automated and partly programmable procedures, ramp up from 25 °C and nominally set 95 % RH to 40 °C, 95 % RH during 30 min (2a). Slowly dry the wet corroding surfaces going from 40 °C, and set 95 % RH to 50 °C, 70 % RH for 2 h (2b).

NOTE: At the end of this procedure, there shall be no visible wetness on any corroding surface and the actual values must be within the set allowed limits.

(For information: The reason for this two-step procedure with a quick temperature rise followed by slow drying at comparably high humidity is to favour drying by diffusion rather than drying by convection, since the latter varies considerably between different types of cabinets. Such variability is likely to have considerable impact on the test result.)

2.1.3 Constant climate conditions

Constant conditions of $50 \pm 0,6$ °C, 70 ± 3 % RH will prevail until a 24-h cycle is fulfilled, i.e. for 15,5 h. (3a) These constant exposure conditions are prolonged during "weekends", i.e. the last 48 h of the week cycle (3b) after finalizing the 5th "workday" cycle.

2.2 Start and end time of test

For a continuously running chamber, the regular start of a new test is just before the first precipitation (table 1, Step 1a) in the weekly scheme, i.e. at the end of the "weekend" constant temperature/humidity phase. However, for a test that is known to be run longer than 3 weeks and there is need to save time, it may be permissible to start a test also before the second or third rain event (i.e Tuesday and Wednesday respectively, if the climate programme is in phase with real week-days).

A test with regular start is ended at the end of the weekend humidity exposure. If started on the second or third day with precipitation (Tuesday or Wednesday), the corresponding delayed start time is added after the weekend humidity exposure.

3 Test equipment and accessories

3.1 Test chamber layout

The necessary, permanently installed facility to conduct the test consists of a programmable humidity chamber of good quality. It is preferably equipped with an integrated rig for spraying salt solution of the required amount and accuracy, cooling capacity and a good internal circulation system for the conditioned air (figure 3). The exposure chamber shall be designed so that the test conditions described in the subsequent sections can be obtained, controlled, and monitored during the test.

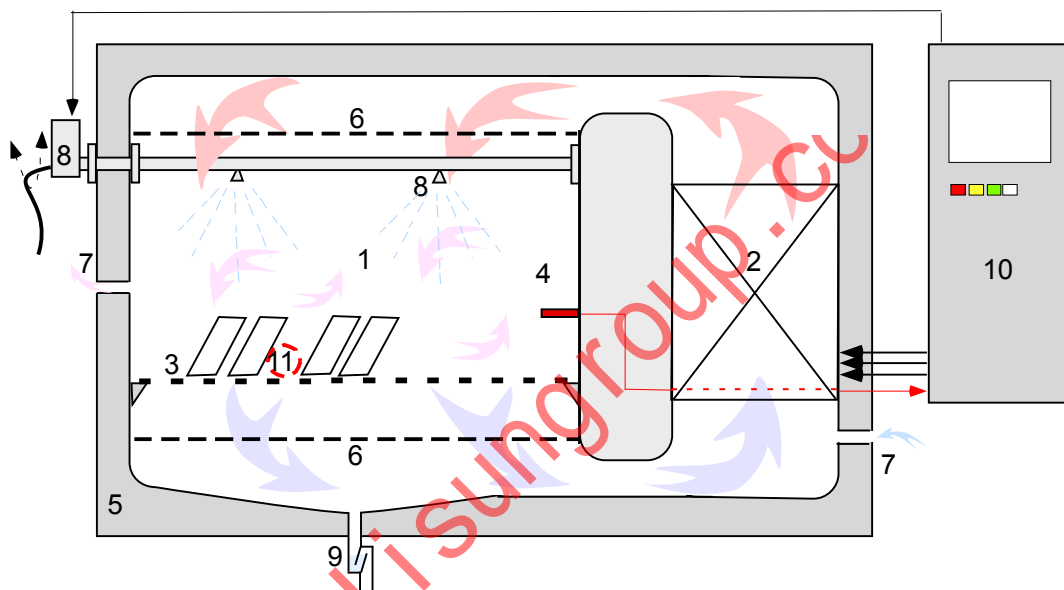


Fig. 3 Schematic view of a climate chamber equipped with functions suited for performance of the described test procedure:

1. Chamber test space, 2. Climatization unit, including fan, heating, cooling and humidification, 3. Test plane with test objects, 4. Temperature/humidity sensor for regulation, 5. Insulated walls/lids, 6. Possible diffusors for improved air distribution, 7. Fresh air inlet/"bleed", 8. Rain rig with nozzles and motor for swaying mode, 9. Gutter, 10. Control/ steering/recording unit, 11. Position for monitoring/calibration of climate with independent temperature/humidity sensor.

3.2 Climate control

The humidity and temperature levels of the chamber during the test cycle shall be continuously monitored. The sensors shall reflect the climate conditions in the test plane (figure 3, item 4). The mean value of the constant temperature/relative humidity climate conditions must be within $\pm 0,4$ °C and ± 2 % relative humidity (RH) respectively vs. the real, set value, i.e. these are the max tolerable mean offsets caused by the sum of calibration errors. At annual calibration, this degree of accuracy must be fulfilled for the following three constant conditions: 25 °C, 95 % RH; 50 °C, 95 % RH; and 50 °C, 70 % RH. At bimonthly control, during normal operation, this accuracy shall be fulfilled at the constant climate conditions (50 °C, 70 % RH) during a workday cycle. The maximum allowed short-term fluctuations in relative humidity overlaid on the calibrated mean value is ± 3 % RH, which implies a maximum allowed short-term temperature fluctuation of $\pm 0,6$ °C. Figure 4 exemplifies the requirement on relative humidity.

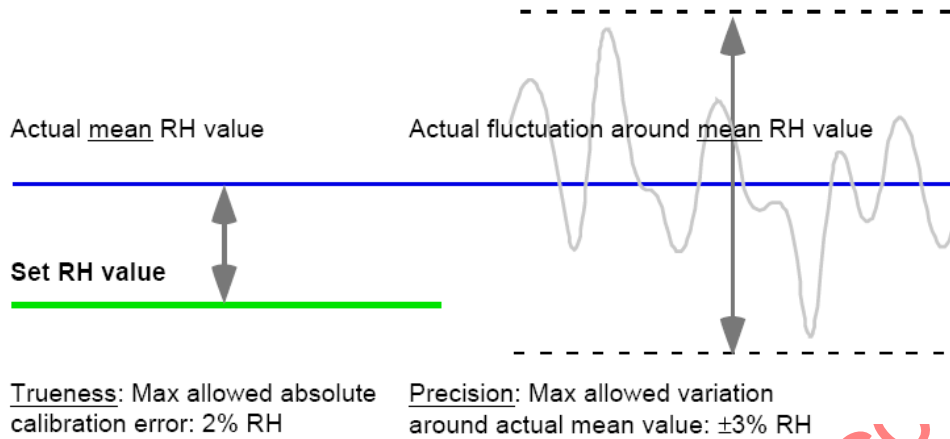


Fig. 4 Accuracy requirement on humidity deviations from set value

The chamber-controlling software/hardware must be designed so that the relative humidity may be changed linearly with time as depicted in the illustrated test conditions in figure 1. In the 2-stage ramping, from a wet chamber at 25 ± 2 °C to humid conditions at 50 °C, 70 % RH, the first heating stage to 40 °C should be reached within 30 minutes without test objects drying, which is secured by a nominal relative humidity setting to 95 % RH. The second 2-h ramp must reach the stipulated final 50 °C, 70 % RH at the end of the ramp.

NOTE: For each new exposure situation, this condition must be verified by a stand-alone monitoring device (section 3.5, item 6) with the sensor positioned among the actual test objects in their actual average plane of exposure (figure 3, item 11). For monitoring: Deploy the sensor directly after the last spray event of the workday wet phase.

In automated testing, forced cooling is necessary when proceeding from 50 °C, 70 % RH controlled constant conditions to macro-wet conditions at 25 °C. The chamber must achieve a cooling from 50 °C to 30 °C within 30 minutes with the targeted 25 °C met within 1 hour. If spraying is applied manually, then cooling the test objects by letting the chamber be open with test objects kept wet may provide an option that does not require the use of a built-in cooling unit. It must be verified by temperature monitoring that cooling requirements are fulfilled under such conditions for the intended chamber type and test object load.

3.3 Recommendations on test chamber functionality

In order to meet the temperature and humidity accuracy requirements throughout the test area, the chamber shall be equipped with means to provide well-distributed circulation of conditioned air (meaning a local air velocity of at least a few cm/s over all parts of the test area (figure 1 exemplifies such a condition)). Sufficient insulation of the chamber walls and lids is required in order to avoid excessive condensation on these surfaces. The more efficient air circulation, the less insulation is required.

Wall heating shall be avoided, due to that heating by radiation tends to keep test piece placed close to the chamber walls locally too dry to be within humidity specification (or a screen shall be installed to avoid such an effect). Provided the internal air circulation is efficient, wall heating is not required. The chamber air must be continuously renewed by a purge of not less than 1 m³/h per m² of test area (exemplified by figure 1, item 7). This to ensure that the CO₂ level is not significantly depleted under any exposure conditions. Fresh air can be added dry from a compressed source or taken from ambient conditions, unless significantly polluted (50 ppb is the maximum acceptable SO₂ content).

3.4 Exposure to salt solution

3.4.1 Automated spraying rig

For a fully automated procedure, the chamber shall be equipped with a spray device capable of producing a finely distributed, uniform spray falling on the test objects. The most reliable way of receiving a fairly uniform downfall is by installing a moving spray device, like the swaying rail with overlapping nozzles, depicted in figure 5. The spraying device shall be made of corrosion-resistant materials. Plastics is recommended.

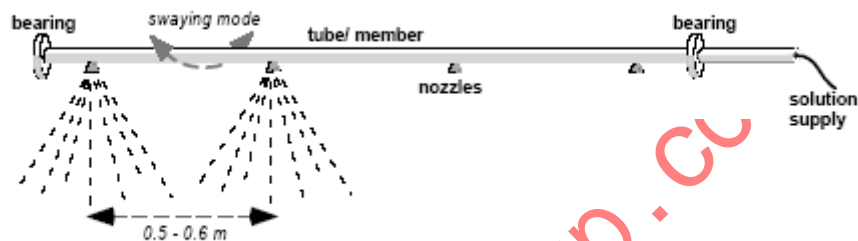


Fig. 5 Example of spray rig for obtaining uniform salt solution downfall

A target *average* precipitation rate distributed over the workday 6-h wet period of this test procedure period is 5 L/m^2 , and shall not exceed 10 L/m^2 . For any *local position*, the total precipitation over the 6-h period must not be lower than 3 L/m^2 and not exceed 15 L/m^2 . Suggested nozzle type: Spraying Systems Uni Jet 800050VP. Mount the nozzles on a supporting tube 50-60 cm apart and about 1 m above the test objects. The nozzles shall be adjusted so that the fan plumes are in line with the tube/supporting rail. An individual filter at each nozzle is strongly recommended to avoid any contaminations in the tiny slots. These low-cost plastics nozzles have a reliable function, but must be inspected in microscope at delivery in order to discard those with defective slot cuts. Stainless nozzles, even in 316 alloy, will be impaired by corrosion under the actual test conditions. Atomizing salt-spray nozzles shall not be used, since they generate a too low precipitation rate to give sufficient leaching effect on the test objects. Achieving a uniform downfall with these types of nozzles can be difficult.

An automated spray-rig is allowed to be separated from the humidity chamber, i.e. the test objects are moved between these two units on a work-day basis.

3.4.2 Manual spraying option

If there is no possibility to use an automated device for spraying, a manual spraying of the test object is allowed, either in or outside the test chamber, provided: 1. The minimum precipitation rate of 5 L/m^2 per 6-h wet session is fulfilled, 2. The spraying events are distributed over the 6-h period, so that the test pieces are kept constantly wet, and 3. The temperature requirement is fulfilled.

NOTE: Salt solution sprayed onto test objects must not be reused.

3.5 Supporting requisites and accessories

The following elements are usually required to conduct the test procedure:

1. Compressed, clean air of 4 - 6 bar for cleaning salt solution from spray nozzles, as a source for the renewal of chamber air and for humidification, supplied by spray humidifiers.
2. A low-conductivity water supply (20 μ S max) for humidification or evaporative spray humidifiers and for the preparation of salt solutions.
3. A tank for preparation and storage of salt solution or, alternatively, a system for direct on-line mixing of water and saturated NaCl solution to the actual concentration (0,5 \pm 0,05 % by mass)
4. A conductivity meter with built-in temperature compensation for preparation and control of item 5 below.
5. 0,5 % NaCl salt solution (conductivity: 8,2 \pm 0,8 mS/cm at 20 °C) for salt application. A carefully prepared 0,50 % by mass NaCl solution is used as a calibration standard at each measurement.
6. A high-quality device for independent control of temperature and relative humidity shall be accessible. This instrument shall on a stipulated regular interval be used for independent monitoring and calibration of the conditions in the actual test plane of the exposure chamber. The total measurement error must not exceed 0,1 °C.
7. Racks of inert material for support and aligned fixation of test objects must not hamper a free air-flow around the test objects, nor collect standing wetness. The test objects in a rack must not screen one another from the salt solution downfall and they shall be exposed at the stipulated exposure angle to the spray (15-20° inclination from the vertical).
8. Pressurized hand-spray equipment for application of the 0,5 % NaCl solution if a manual spray procedure is used. The capacity must be sufficient to meet the downfall requirement (section 3.4.1).
9. Funnels, beakers/measuring glasses and a balance with at least 0,1 g accuracy for monitoring and calibration of salt solution downfall throughout the test plane of the exposure chamber.

4 Test object conditions

The test object preparation before exposure, the test object orientation during exposure, the test duration and the evaluation after exposure are usually stipulated in the engineering test standards addressing this test procedure.

4.1 Geometric requirements

4.1.1 Test object orientation

Components or test objects in the chamber shall be placed on/mounted to non-corrosive surfaces in the appropriate agreed-upon position. If the item is flat, the test surface shall be within a 15-20° angle from the vertical. Note that the inclination determines the amount of wetness collected on the flat test object, and hence the salt load when this film is subjected to climate control, which in turn influences the test result.

4.1.2 Test object support

If it is necessary to suspend the objects, the material used shall be of non-metallic inert. The test stands must not obstruct the passing of air, nor disable proper drainage (the photo in figure 6 shows an example of open well-drained supports for flat panels).

4.1.3 Test object exposure to salt spray

If an automated spray rig is used, the spray heads must be sufficiently far from the component or test pieces to allow uniform contamination. Bulky components must not obstruct the spraying onto nearby test objects. Flat test objects in angled position must have their full horizontally projected surface exposed to spray collection (see drawing in figure 6). This will also support sufficient air circulation around the specimens. Other test object geometries than flat panels must comply with these requirements as far as practically possible.

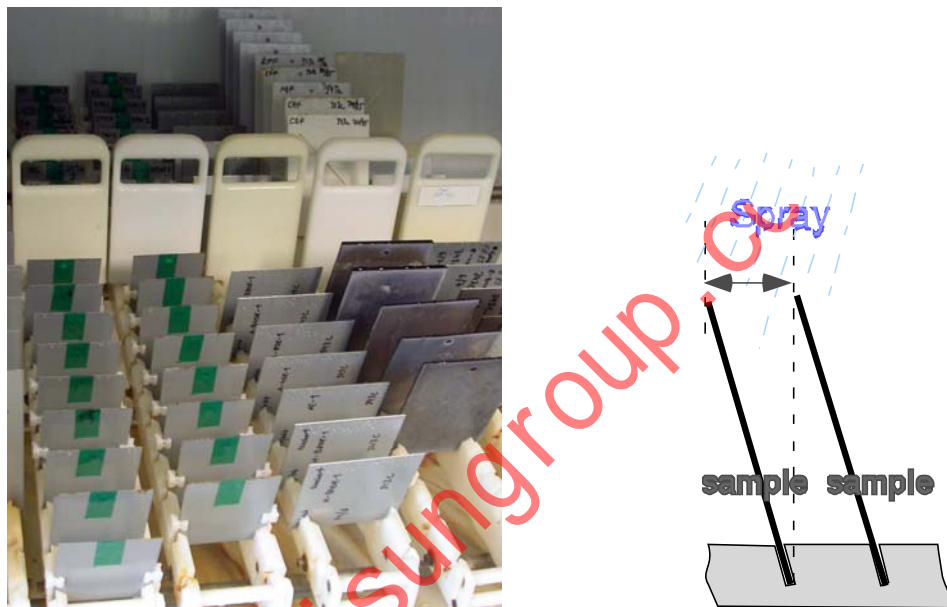


Fig. 6 Example of open and well drained fixtures for flat test panels (left) and minimum recommended stacking distance of panels (right)

4.1.4 Components

Component parts are to be in vehicle orientation position if at all possible. The salt solution spray shall reach the areas of interest and there meet the precipitation requirements given in section 3.4.1.

4.2 Test object preparation

4.2.1 Painted and scribed panels

The test is optimized for exposing scribes in horizontal position on panels oriented at the angle stipulated in section 4.1.1. Scribe orientation has a similar effect on salt collection as the panel orientation. The scribed line, or other type of damage, shall be positioned so that a collecting area for precipitation is left above the exposed area of interest. There is a separate standard for scribing ([VCS 1021,29](#)).

4.2.2 Components

Interested parties shall agree on the location within the components where the corrosion is to be observed.

4.2.3 Additional test conditions

Interested parties shall agree to any pre-conditioning, masking of edges, pre-testing, cleaning, or any other test object preparations.

4.3 Duration of test

The number of test cycles shall be determined by the specification covering the component or object being tested. When not specified, the test period shall be agreed by the requester and the corrosion testing department.

4.4 Test object evaluation

4.4.1 Photo documentation

Interested parties shall agree to any photographic details throughout the test and the areas to be examined and any assessments that are required.

4.4.2 Test object storage

For corroded test objects of steel base or aluminium, it is important to evaluate the test objects no more than one week after finished test, stored under ambient conditions. If this cannot be done, the test objects shall be kept in desiccators.

5 Quality assurance

5.1 Control and calibration

Refer to the requirements on climate in section 3.2.

5.1.1 Control before test start

- Run and monitor the test cycle at least a 24-h period before starting the test, provided not already in continuous operation.

5.1.2 Workday inspection

- Check that the monitored temperature and humidity values are in accordance with set values.

5.1.3 Weekly inspection

- Check that the spray nozzles deliver the intended uniform spray pattern and that the spray rig works properly.
- Check that the salt solution is within $0,50 \pm 0,05$ % by mass. of NaCl solution, most conveniently with a conductivity meter (8,2 mS/cm). Use a reference standard solution with the stipulated water quality (section 3.5). (With the given requirements on water purity and salt quality met, solution pH does not need to be checked.)
- Check storage tanks and other supply sources.

5.1.4 Bimonthly control

- Monitor the climate with an independent control device (section 2.5) during test operation by placing the device in the chamber test plane just after the last spray of a wet phase and remove it before the first spray of the next wet event.

5.1.5 Annual calibration

- Clean and service the complete equipment.
- Monitor the climate with an independent control device at the three different settings given in section 3.2.
- Check that the salt solution spray downfall is within specification.

5.1.5.1 Recommended procedure for controlling salt solution spray precipitation ("Pluviometry")

Check that the salt solution spray downfall is within specification by collecting the solution in a matrix of equally distanced beakers of defined collecting area. Cylindrical beakers of 6-10 cm diameter without collar are recommended. They shall be spaced approx. 15 cm from each other along the swaying tube/rail throughout the whole test length, adjusted so that there is always a beaker directly under a nozzle and one just between two nozzles. For a symmetrically positioned rain rig, three such rows of beakers are recommended; one under the tube/ rail, another parallel with the tube rail at either of the long-sides where the test area ends, and a third row in between these positions, which can have a reduced number of beakers, see example in figure 7. The collected amount of precipitation in each beaker during one 6-h wet period shall be measured using a 25-50 ml measuring glass or gravimetrically (weigh beaker before and after collection).

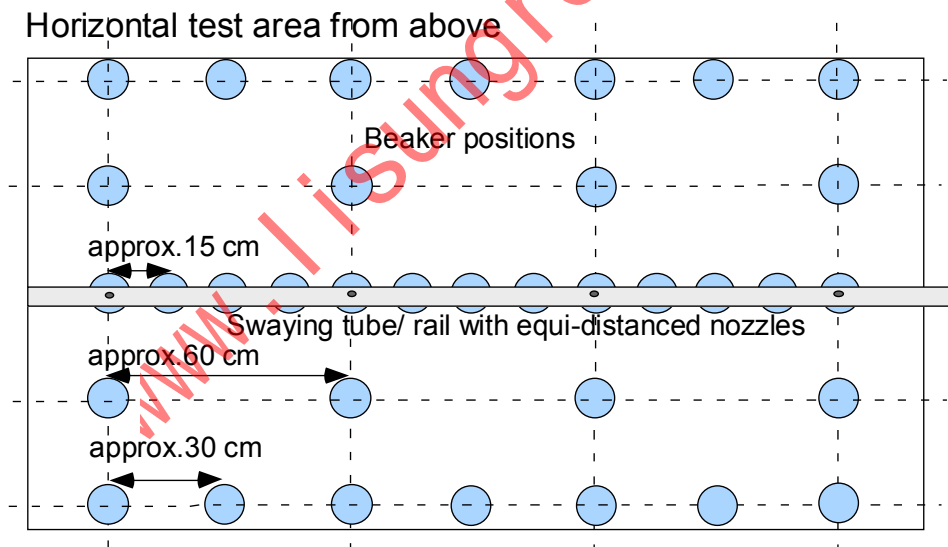


Fig. 7 Example of positioning of beakers for collecting the salt-solution spray downfall in a test plane

5.2 Deviation handling

General: Any deviation during the test shall be recorded and its consequence on the test result shall be discussed with the test requester.

5.2.1 Test interruption

In case of a temporary chamber failure, an intended holiday stop or at annual service of the equipment: Store the test objects at room temperature (18-28 °C) at 50-60 % RH for at most a week. These storage conditions will keep established corrosion cells at low activity without irreversibly quenching the corrosion activity, which may result from dry storage. If the stop is longer, store the test objects in a freezing cabinet (min. -18 °C). These storage conditions will keep established corrosion cells preserved without significant activity.

Be careful to thaw at ambient laboratory conditions before resuming the climate exposure.

The test "clock" was stopped at the failure event. When ready for restart, continue the interrupted exposure by re-running the last or next precipitation event, depending on which was the closest in time from the event of failure, i.e. always re-start with wetting the panels, and re-start the test "clock" from this point.

6 Acceptance criteria

The specific testing conditions, test duration and corrosion acceptance criteria shall be given in the engineering specification or Volvo Cars standard, which addresses this test method. If not established, the acceptance criteria are determined by the subject-matter experts in the Volvo Corrosion group and/or the Volvo Surface Treatment testing department in cooperation with the test requester.

7 Test report

The test report shall include all pertinent information agreed upon with requester. This may include number of cycles completed, pictures taken, special objects preparation, or positioning of the objects. For each series of test objects, the following information shall be included:

- Specification of the material that was tested
- If the test object was subjected to intentional damage in the coating, the shape and the location of the damage shall be described, as well as how the damage was achieved. The orientation of the damage during testing shall also be specified
- Description of the preparation of the test object, including any cleaning applied before testing and any protection given to edges
- Information of reference material or materials with which the test object was compared
- How the test object was examined and which properties that were assessed, see section 4
- Reference to this standard

Appendix 1 Test corrosivity

Material tested	Corrosion rate in metal mass loss obtained after test (μm)		
	According to this standard (15-20° inclination from vertical)	On-vehicle test, vertical exposure, corrosive markets in northern/central Europe	According to corrosivity class C5 in ISO 9223, first year data
Cold-rolled carbon steel in open exposure	208 \pm 12 (ref 1) average 6 weeks 260 - 310, average 8 weeks NOTE: Steel type has significant influence on corrosion rate	54 \pm 13 (ref 1, 2) - 5 regions with deicing salt, 1 year 70 - 110 (2 years - SE, GB, DE)	80 - 200
Cold-rolled carbon steel in crevice exposure	190 - 250 average 6 weeks 565 \pm 50 max 6 weeks (ref 1) 300-360 (average 8 weeks) Penetration of 0,8 mm steel at 8-10 weeks (10 cm ² test area)	80 - 180 (2 years - SE, GB, DE)	-
Hot-dip galvanized, GI50, in open exposure	Red rust formation started (6 weeks)	Red rust formation started in dirty positions (2 years - SE, GB, DE)	-
Hot-dip galvanized, GI50, in crevice exposure	Zinc layer consumed within 4 weeks, penetration of 0,8 mm steel within 18 weeks (10 cm ² test area)	12 as max average base steel corrosion after full zinc coating consumed (2 years - SE, GB, GE)	-
Pure zinc	11 \pm 0 (ref 1) - 6 weeks	6,7 \pm 2 (ref 1, 2) - 5 regions with deicing salt, 1 year	4,2 - 8,4

NOTE: The test is optimized to gain highest possible corrosion rate in crevices, such as formed by joint overlaps and in hem flanges. Scribe under-paint creep on mild steel in VCS 1027,1449 is approximately 50 % higher than that of VCS 1027,149 in six weeks exposure, whereas for zinc-coated steel, the corresponding difference is about 10-30 %.

1. A. LeGac, N. LeBozec and D. Thierry, Accelerated Corrosion Tests for Application in the Automotive Industry, Institute de la Corrosion, Brest, IC report 2009-2, - restricted to participants
2. B. Rendahl, N. LeBozec, Assessment of corrosivity in global vehicle environment, Swerea KIMAB 2009-563 - restricted to participants