JASO M 609:2024

A Modernized Corrosion Test for Automotive Applications

Q-Lab Corporation

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Q-Lab's Winter Corrosion Webinar Series

Today is the first of two webinars this winter from Q-Lab focusing on laboratory corrosion testing

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Date	Topic
04 Dec	Modern Corrosion Testing
11 Dec	JASO M 609 – What's New in the 2024 Revision

Administrative Notes

You'll receive a follow-up email from info@email.q-lab.com with links to take a survey and download the presentation content

Use the **Q&A feature in Zoom** to ask us questions today!

Agenda

- Review of JASO M 609-91
  - History and implementation
  - Test conditions and performance requirements
  - Limitations and concerns
- Presenting the new JASO M 609:2024
  - Motivation and goals
  - Corrosion Types and Test Methods
  - Specimen preparation
  - Evaluations

JASO M 609-91

Corrosion Test for Automotive Materials

The original fast-transition corrosion test

JASO = Japanese Automotive Standards Organization

Yes, “91” means the year 1991

JASO M 609-91 - Development

Goal: "A method to determine corrosion resistance of steel sheets for automobile uses by a cyclic corrosion test"

Motivation: Previous cyclic corrosion was not always well-correlated to actual exposures, resulting in different companies using different tests

Approach: To better standardize corrosion testing in the Japanese auto industry, JASO conducted an interlaboratory study with over 4,000 specimens, with the following goals for the resulting test:

1. Accelerated, but also correlated to actual service in market
2. Able to be used to evaluate both cosmetic and perforation corrosion
3. Must include salt fog, drying, and wetting phases
4. Interlaboratory comparison must include international participation
5. Test can be performed in available laboratory equipment

JASO M 609-91 - Test Requirements

- Salt solution
  - 5% NaCl
  - Collections 1-2 mL/hr (by reference to JIS Z 2371, a clone of ISO 9227)
  - Standard says “Spray” but this deposition rate is “Fog” in our terminology
- Test specimens
  - 70 × 150 × 0.7 mm (or different, by agreement), oriented 15-20° from vertical
  - Guidelines for cleaning, thickness and mass loss measurement, scribing, and masking
- Duration
  - 30-180 cycles (240-1440 hours) recommended
- Evaluations
  - Unpainted: measure corrosion depth and mass loss
  - Painted: measure paint creep from scribe and delamination (peel-off)

JASO M 609-91 - Test Cycle

Step Type	RH	Temperature	Time	Transition Time
Fog	n/a	35 °C	2 hours	<30 min
Dry	20-30 %	60 °C	4 hours	<30 min
Humid	≥95 %	50 °C	2 hours	<15 min

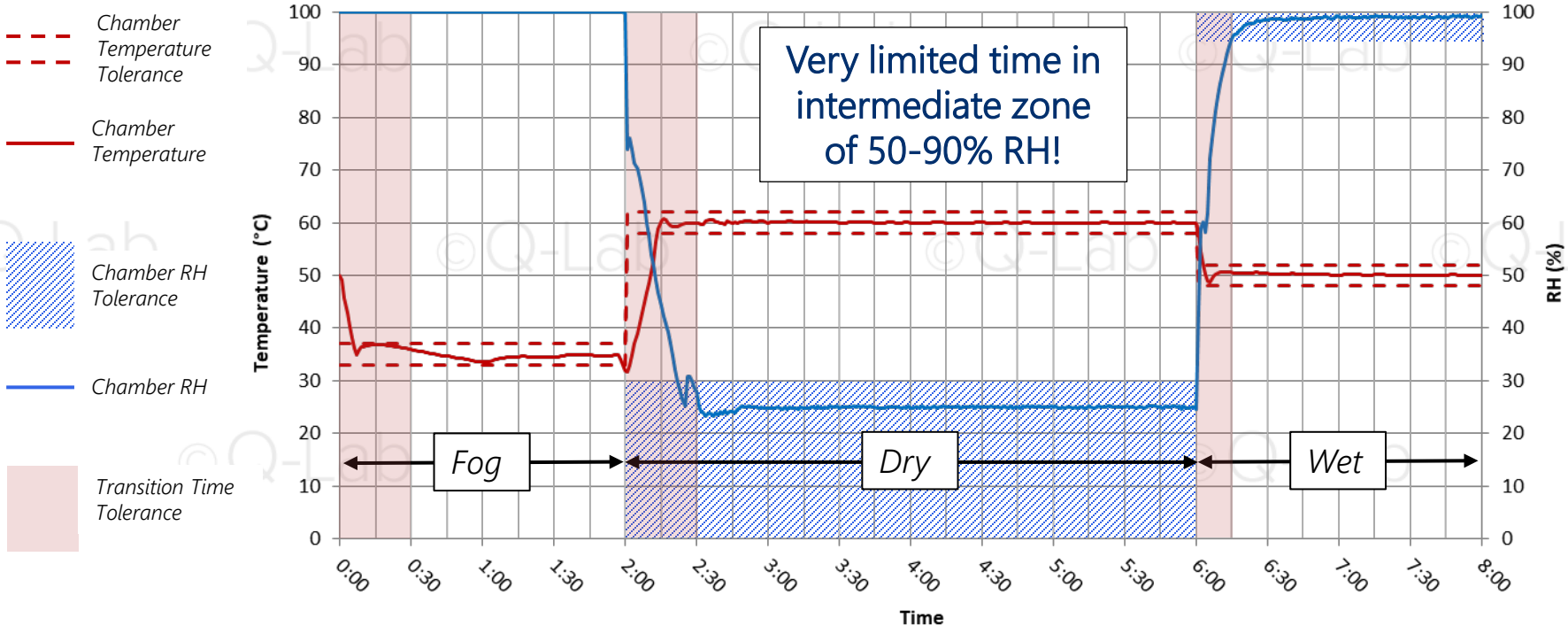
- Rapid transitions are intentional: “the shorter the better to minimize the influence on test results”
- Same cycle is in JASO M 610 *Cosmetic Corrosion Test Method for Automotive Parts*
- This cycle with the Fog and Dry durations switched is sometimes called CCT-I (Nissan NES M0007, RNES G00006)
- Variants may or may not include the fast transition time requirements

JASO M 609-91

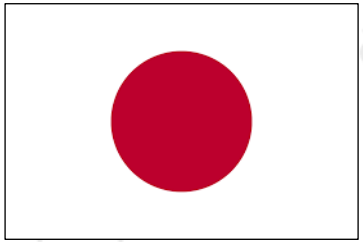
Rapid Ramp Heaters

- Fast transitions in JASO M 609-91 required more heating power than typical corrosion testers of the time
- Q-Lab developed **Rapid Ramp Heaters** in 2020 to meet the specific challenges of this test
- All 3Φ Q-FOG CRH corrosion testers now feature Rapid Ramp Heaters (RRH)
- Q-FOG CRH testers equipped with RRH can meet the demanding transition requirements *even in a full chamber*

Q-FOG Test Performance (full chamber)



Limitations of JASO M 609-91



- Problems observed
  - Different corrosion chambers produced different results (reproducibility)
  - Corrosion rates varied among metals from test to test (repeatability)
  - Corrosion behavior did not match actual service (correlation)
- Reasons / Areas for Improvement
  - Only full wetting, dry, uncontrolled room/ambient conditions possible
  - No control of RH transition times; variable specimen dry-off rates
  - No time spent in critical RH intermediate zones (salt DRH)
  - Slow application of salt solution from fog
- *Time to make some updates…*

JASO M 609:2024

Corrosion Test Methods for Automotive Parts and Materials

A **major** overhaul!

JASO M 609:2024 - Motivation

- Almost 30 years had passed since the establishment of JASO M 609/610.
- While major test methods in Europe and the USA had evolved and modernized, Japan's had not.
- JASO M 609 often did not match corrosion in actual service
- Most Japanese auto manufacturers were not performing JASO M 609, and companies who were running it typically were doing so at customer request, meaning they often had to run both JASO and the OEM's cycle
- Goal: "[increase] market applicability by enhancing the clarity of test result market correlation obtained from those test methods and promoting widespread use of these standards"

JASO M 609:2024 – Preface and Scope

Preface: This standard is a revision of JASO M 609 (*Corrosion Test Methods for Automotive Materials*) and JASO M 610 (*Cosmetic Corrosion Test Methods for Automotive Parts*), with the aim of enhancing their correlation with actual automotive corrosion observed in the market. It reclassifies and revises the types of tests related to appearance corrosion and perforation corrosion.

Scope: This standard specifies methods for evaluating the corrosion resistance (cosmetic corrosion and perforation corrosion) of steel materials used in automobiles, as well as automotive parts and materials with surface treatments applied to such steel substrates. The evaluation is conducted using combined cycle tests.

Note: this incorporates both M 609 and M 610 but retains the M 609 designation, so it's important to note the year when citing this test

Requirements and Concerns

- Requirements
  - Improve correlation to real-world corrosion behavior
  - Compatible with generally-available equipment
  - Offers good repeatability and reproducibility
- Concerns
  - Will this be adopted?
  - Will it correlate well to automakers' individual tests?
  - Will it be applicable to aluminum as well as steel?

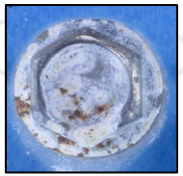
Data Collected on Field Corrosion

Basis for standard development

Corrosion Indicator			Field Ranking / Description
Cosmetic	Blister width	Phosphating	(*Large*) ← Steel (w/o phos) > Steel (w/ phos) → (*Small*)
		Plating	(*Large*) ← Steel > Coated steel (thin) > Coated steel (thick) → (*Small*)
	Red rust in plating		(*Long*) ← Zn-Ni plating > Zn plating → (*Short*)
Perforation	Corrosion at lap joint		Perforation Corrosion Index: approximately 80 ~120
	Coating weight on lap joint		Pitting depth determined by the amount of coating, regardless of the type of zinc-based alloy

Adapted from "JASO M 609:2024, Japan," by Hiroshi Kawaguchi

Testing to Determine Best Methods

Materials Under Test		Duration (weeks)	Evaluation Criterion
Painted panel	Cold-rolled steel	4	Blister width 
	Cold-rolled steel + phosphate	12	
	Galvannealed steel	16	
	Galvanized steel	16	
Plated bolt	Zn + trivalent chromate	16	Red rust 
	Zn + 15% Ni + trivalent chromate	16	

Adapted from "JASO M 609:2024, Japan," by Hiroshi Kawaguchi

Evaluating and Selecting Test Methods

Candidate test	Painted Panel Blistering		Plating Bolt
	CRS	CRS/Ga / GI	Zn-Ni/Zn Rust
Old JASO	✓		✓
1	✓	✓	✓
2	✓	✓	✓
3	✓	✓	✓
4	✓		✓
5	✓		✓
6	✓		✓
7	✓		✓
8		✓	✓
9	✓		✓

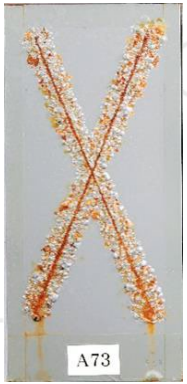
- Candidates 1, 2, and 3 had the best correlation to cosmetic field corrosion
- These were selected for JASO M 609:2024 (now called Methods A and B)
- Both were publicly disclosable (candidate 3 was not)
- Method C (perforation) chosen by similar method, using depth of corrosion (pitting) as metric

Adapted from "JASO M 609:2024, Japan," by Hiroshi Kawaguchi

JASO M 609:2024 – Test Structure

- Three Methods now included (A, B, C)
  - A or B can be used for **Cosmetic Corrosion**
  - C is used for **Perforation Corrosion**
  - 24-hour cycles with different conditions
  - Variety of salt solution and application

Cosmetic



Perforation

- Corrosion types defined:
  - **Cosmetic Corrosion** visually degrades the surface appearance due to environmental factors such as rain, sea salt particles, or deicing salts. Includes red rust and paint blistering.
  - **Perforation Corrosion** causes thinning of the metal at joint areas due to environmental factors like rain, sea salt, and deicing salts (pitting included)

Images from "JASO M 609:2024, Japan," by Hiroshi Kawaguchi

JASO M 609:2024 – Method A

Step Type	RH	Temperature	Time	Transition Time
Fog	n/a	50 °C	0:10	<10 min
Dry	<30 %	60 °C	2:35	<30 min
Humid	95 %	60 °C	1:15	<30 min
Subcycle (repeat 5×)				
Dry	<30 %	60 °C	2:40	<30 min
Humid	95 %	60 °C	1:20	<30 min

- Only 10 min of salt fog exposure per day (same preparation / collection requirements as previous)
- Higher temperatures in Fog (35 ° C) and Humid (50 °C) steps than 1991 version
- Retains fast transition requirements from 1991 version

JASO M 609:2024 – Method B

Step Type	RH	Temperature	Time	Transition Time
Fog (Shower)	n/a	50 °C	1:00 (0:15)	*Not specified*
Dry	50 %	60 °C	8:00	<60 min
Humid	≥95 %	50 °C	4:00	<30 min
Dry	50 %	60 °C	7:00 (7:45)	<60 min
Humid	≥95 %	50 °C	4:00	<30 min

- Allows use of either salt Fog or direct Shower
  - 1% NaCl – a more dilute solution
  - Shower collections 15-75 mL in 5 min, which is ~200-400× the volume of Fog
- Higher temperature in salt step (50 °C) than 1991 version
- Transition requirements are still minima, but more relaxed than 1991 version

JASO M 609:2024 – Method C Fog or Shower

Step Type	RH	Temperature	Time	Transition Time
Fog (Shower)	n/a	35 °C (25 °C)	5:00 (0:15)	n/a
Dry	25 %	50 °C	7:00	1:00 Linear
Humid	85 %	50 °C	11:30 (16:15)	0:30 Linear
Transition to salt	n/a	35 °C	0:30	0:30 Linear

- Allows use of salt Fog, direct Shower, or Immersion
  - Even more dilute solution (0.5% NaCl)
  - Shower is much shorter than Fog
- Lower temperature in dry step than 1991 version
- Includes controlled, linear transitions between steps
- Specification for an intermediate RH (85%) rather than just fully wet or dry

JASO M 609:2024 – Method C Immersion

Step Type	RH	Temperature	Time	Transition Time
Immersion	n/a	*Room Temp*	*30 min*	*None specified*
Dry	25 %	50 °C	7:00	*<60 min*
Humid	85 %	50 °C	16:30	*<30 min*

- Immersion is significantly different than the other Method C versions
- Q-FOG CRH testers are not designed to perform this condition
- Immersion split into 15 min Soak and 15 min Handling
- Transitions are back to being less-than requirements

Commentary on Methods

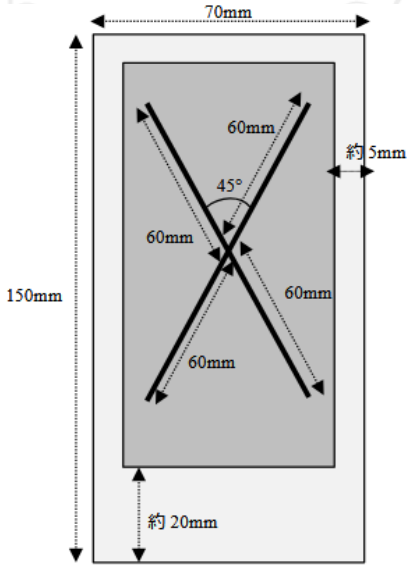
- Differing opinions on validity of Method A vs Method B
  - Testing was done on a limited specimen set, so both were included
  - They may be unified at a later date
- Transition times
  - Careful to specify that uncontrolled transitions should be done rapidly
  - Method C clearly indicates controlled transitions and conditions
- Salt solution
  - Some discussion how to best incorporate 0.5%, 1%, and 5% concentrations and still reference JIS Z 2371

Described in notes as "matters that became problematic"

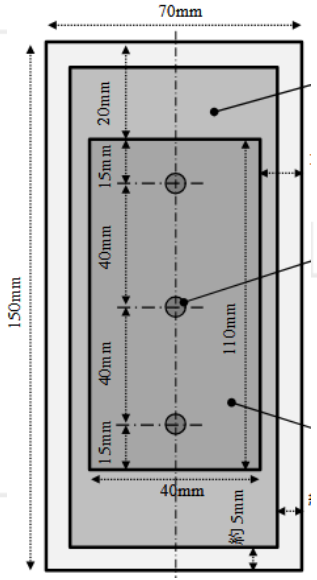
Specimen Preparation

- Methods A and B have same recommended sizing as 1991 version
- Method C spot welds a smaller plate onto the primary specimen
- Clear guidance on scribing and sealing
- Recommended min. 3 specimens
- This is all Informative (non-mandatory)

Methods A/B (Cosmetic)



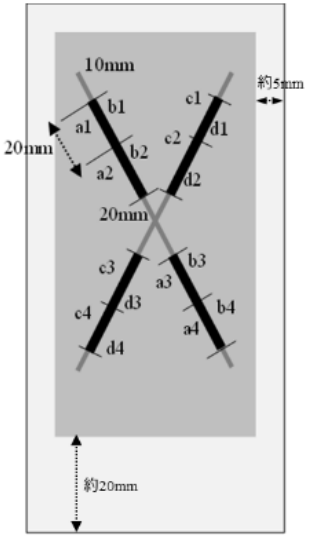
Method C (Perforation)



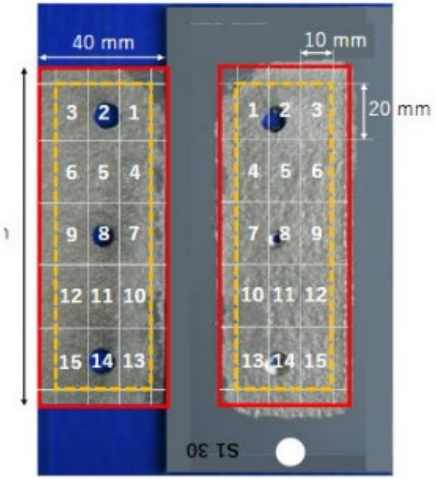
Evaluations

- Methods A and B specify a “paint film blister width” method like scribe creep
- Method C calls for measurement of depth of pitting corrosion
- This is also Informative (non-mandatory)

Methods A/B (Cosmetic)

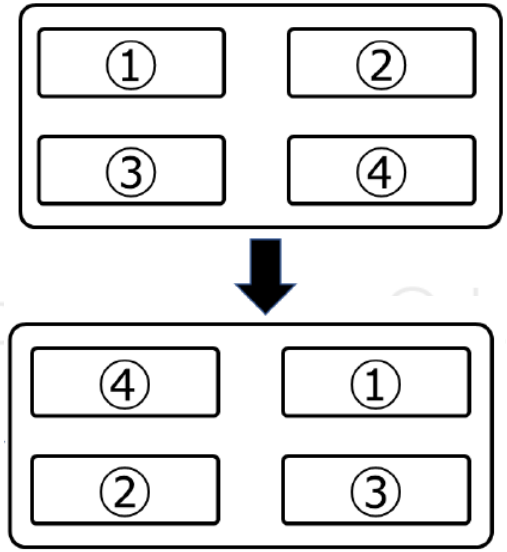


Method C (Perforation)



Miscellaneous notes

- Repositioning during testing is recommended but not required (see image at right)
- Test specimen angle now allowed to be between 15-25° (15-20° in 1991 revision)
- Immersion has several additional details because of its unique nature - weekends can be excluded, 15 min handling phase is explained, solution is refreshed every 15 cycles, specimen orientation rotated 180° periodically
- Chemical cleaning (as opposed to grit blasting) is specified for rust removal



Recommended repositioning for long-term tests

Conclusions

- JASO M 609:2024 is a **major** revision to the 1991 version of JASO M 609, a pioneering standard in automotive corrosion testing
- The authors sought to include new test protocols with better correlation to actual corrosion in service environments
- Three Methods are introduced, **much** different than 1991 version
  - Different NaCl salt **concentrations** (5%, 1%, 0.5%)
  - Different **electrolyte application techniques** (shower, fog, immersion)
  - Different **test cycles** (higher temperatures, introduction of **linear transitions**)
- Differences in test cycle, specimen preparation, and evaluations depending on corrosion type (**Cosmetic** or **Perforation**)

Thank you for your time.

Questions?

info@q-lab.com

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