

A Chamber Manufacturer's View of Automotive Corrosion Testing

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Topics

- Company and corrosion chamber market overview
- Automotive corrosion test method evolution
- What is important to control during a test and what is not (caveat: all tests shown need to be repeated)
- Conclusions, Dos and Don'ts of Corrosion Test Method Development

Q-Lab Corporation Overview



Founded in 1956

*Direct support in
North America,
Europe, China*

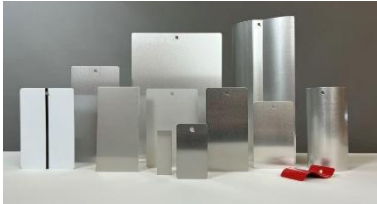
*Trained
distributors in
~50 countries*

Our Products

Q-FOG



QUV

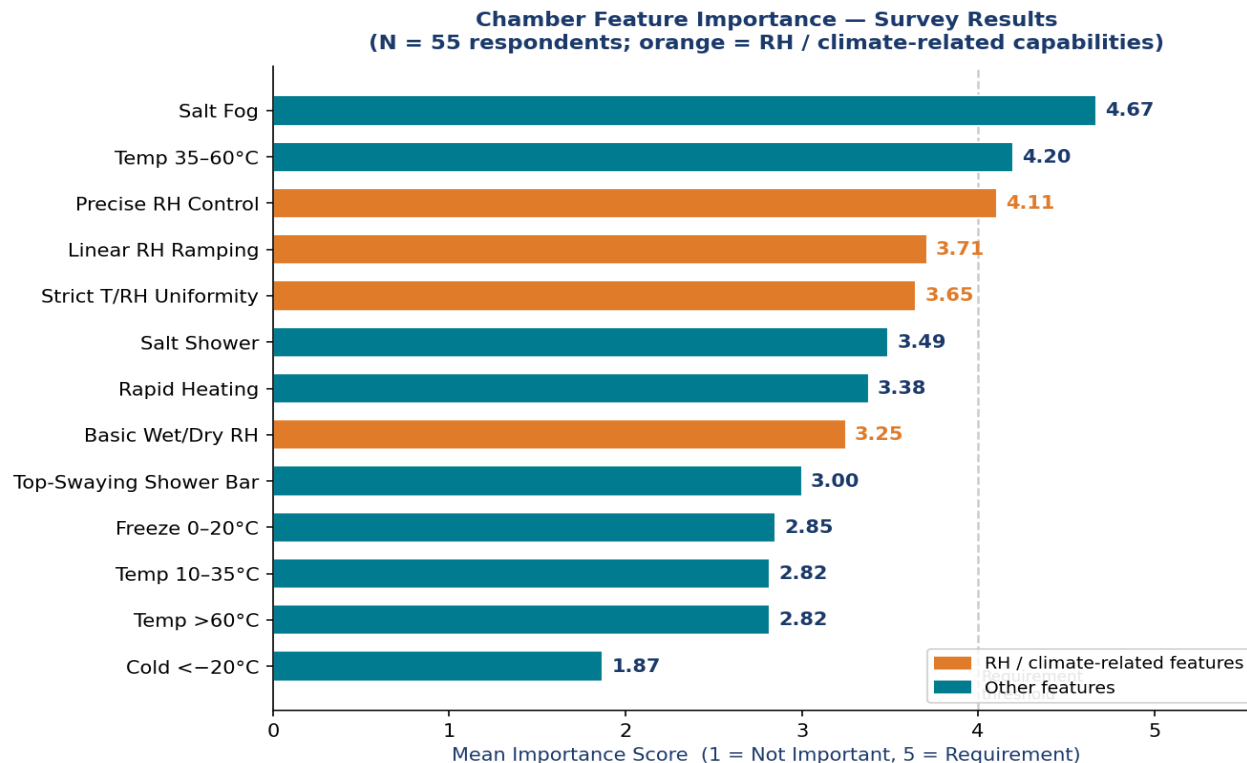


Q-PANEL



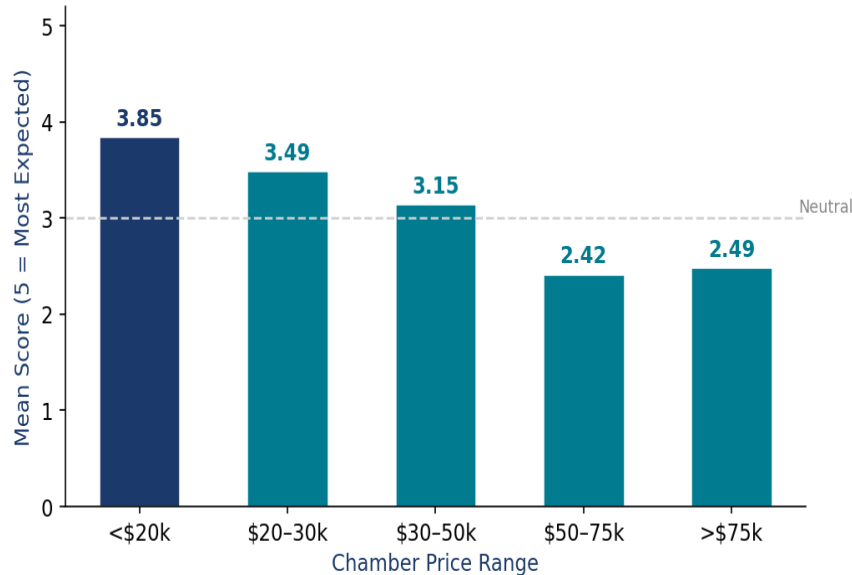
Q-SUN

What the Market Demands: Chamber Feature Importance

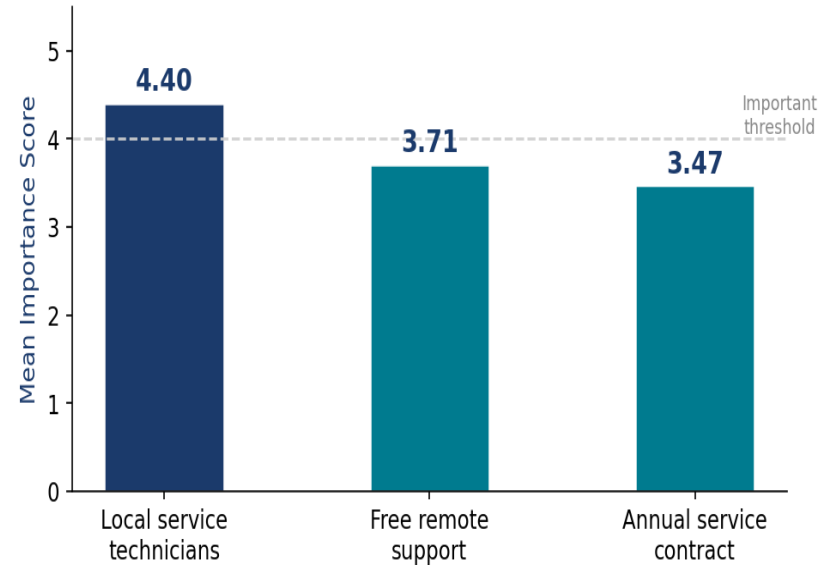


The Commercial Tension: Capability vs. Cost

Chamber Cost Expectations — Survey Results
(N = 55; 5 = most requested/expected price range)



After-Sales Service Importance — Survey Results
(N = 55; 5 = Strongly considered in purchase decision)



20 Years of Change in Automotive Corrosion Testing

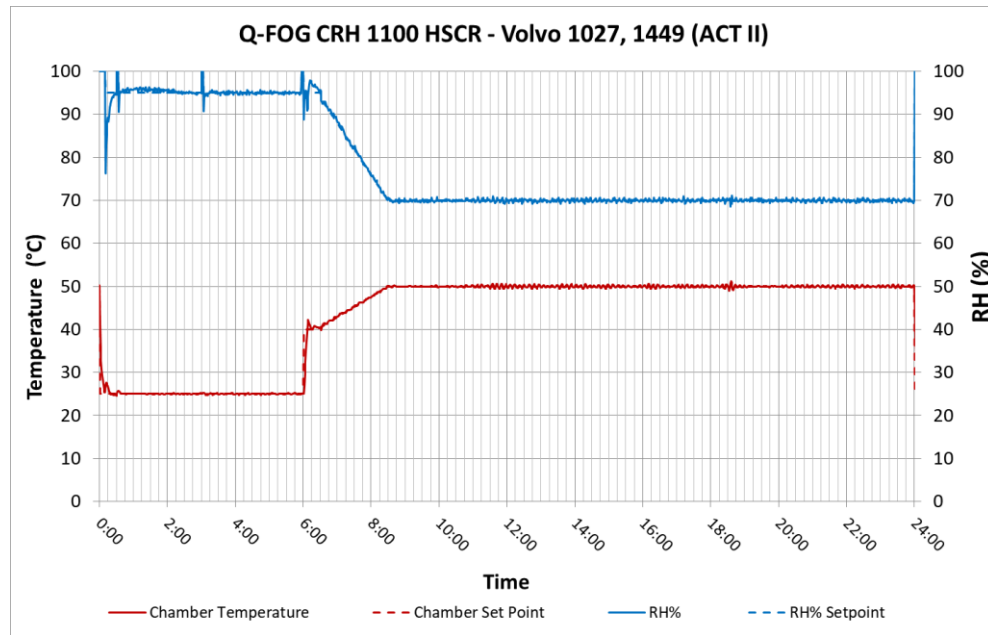
- Before 1990: Simple continuous salt fog dominated (ASTM B117, ISO 9227)
 - Chambers needed only basic temperature control and salt fog generation; move specimens to a different chamber for cycling when desired
- 1990s – 2000s: Wet/dry cyclic tests introduced for greater realism
 - Better correlation with field corrosion, but poor lab-to-lab reproducibility
- 2010s–present: Controlled RH integrated into cyclic corrosion standards
 - ACT1/2, GMW 14872, ECC1, VDA 233-102 all require precise RH transitions
 - *Corrosion chambers subject to climatic chamber requirements*
- The challenge: two distinct chamber design philosophies now required to coexist

Ford L-467 (Volvo ACT2)

- Chamber Volume – 1100 l
- Chamber Load – Empty
- Laboratory Room Temperature – 22-25 °C

Step	Function	Chamber Air Temp (°C)	RH (%)	Step Time (hh:mm)	Ramp
1	Subcycle*				
2	SHOWER	25		0:10	
3	RH	25	95	0:20	Auto
4	SHOWER	25		0:03	
5	RH	25	95	2:27	Auto
6	SHOWER	25		0:03	
7	RH	25	95	2:54	Auto
8	SHOWER	25		0:03	
9	RH	40	95	0:30	< 0:30
10	RH	50	70	17:30	Linear 2:00
11	RH	50	70	48:00	Auto
12	Final Step – Go To Step 1				

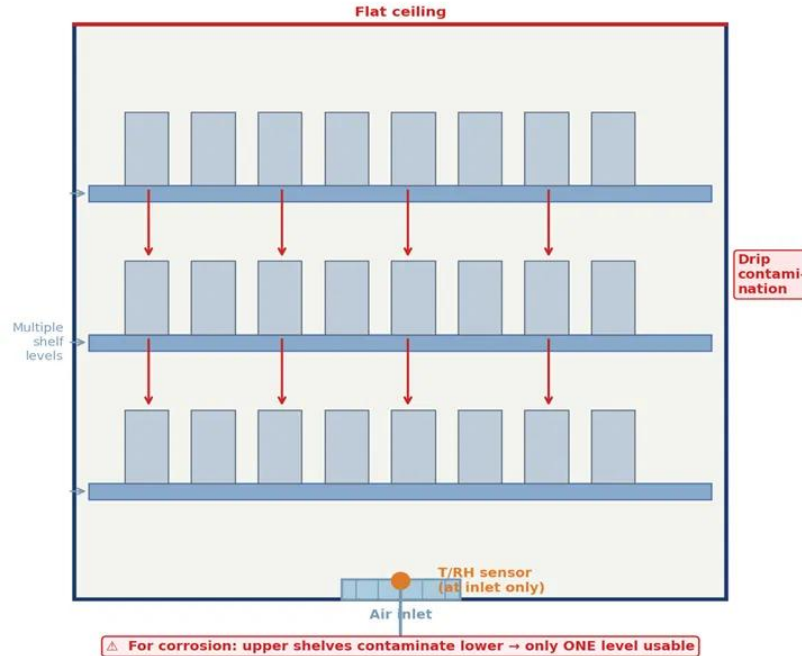
*Step 1: Subcycle Repeat Steps 2-10 5x



Two Chamber Worlds: Climatic vs. Corrosion

CLIMATIC CHAMBER

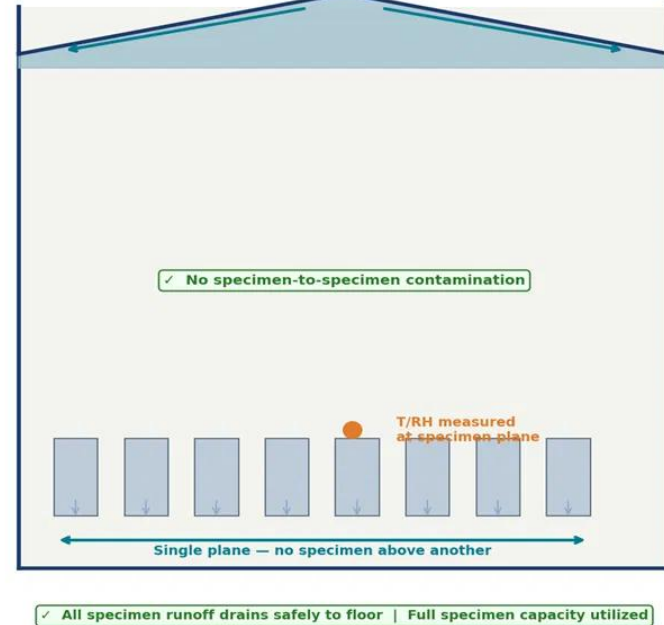
(when used for corrosion testing)



CORROSION CHAMBER

(purpose-built design)

Pitched ceiling: condensate drains to walls



Where Corrosion and Climatic Methods Conflict

- Physical design conflicts
 - Flat ceilings drip onto specimens — corrosion chambers require pitched ceilings
 - Multi-level shelves cause runoff contamination — corrosion needs single-plane arrangement
 - Climatic chamber materials are typically not suited for corrosion testing
- Measurement philosophy conflict
 - Corrosion standards require T/RH compliance at the specimen plane
 - Liquid salt water makes in-situ RH measurement technically demanding
 - Climatic chambers measure at air inlet or outlet — not the specimen zone

Summary of Environmental Conditions in Modern Automotive Corrosion Standards

Cycle	Solution	Spray Type	RH < 50%	50%≤RH<76%	RH≥76%
Ford L-467/Volvo (ACT2)	NaCl 0.5% pH uncontrolled	Shower	0%	66%	34%
GMW 14872	NaCl 0.9% CaCl ₂ 0.1% NaHCO ₃ 0.075% pH uncontrolled	Shower	46% (22% below RH30%)	16%	38%
Renault D17 2028 (ECC1)	NaCl 1.0% pH =4.0 (H ₂ SO ₄)	Fog	8%	62%	30%
VDA 233-102	NaCl 1.0% pH neutral	Fog	1%*	39%	60%
Volvo ACT1	NaCl 1.0% pH =4.2 (H ₂ SO ₄)	Shower	17%	31%	52%

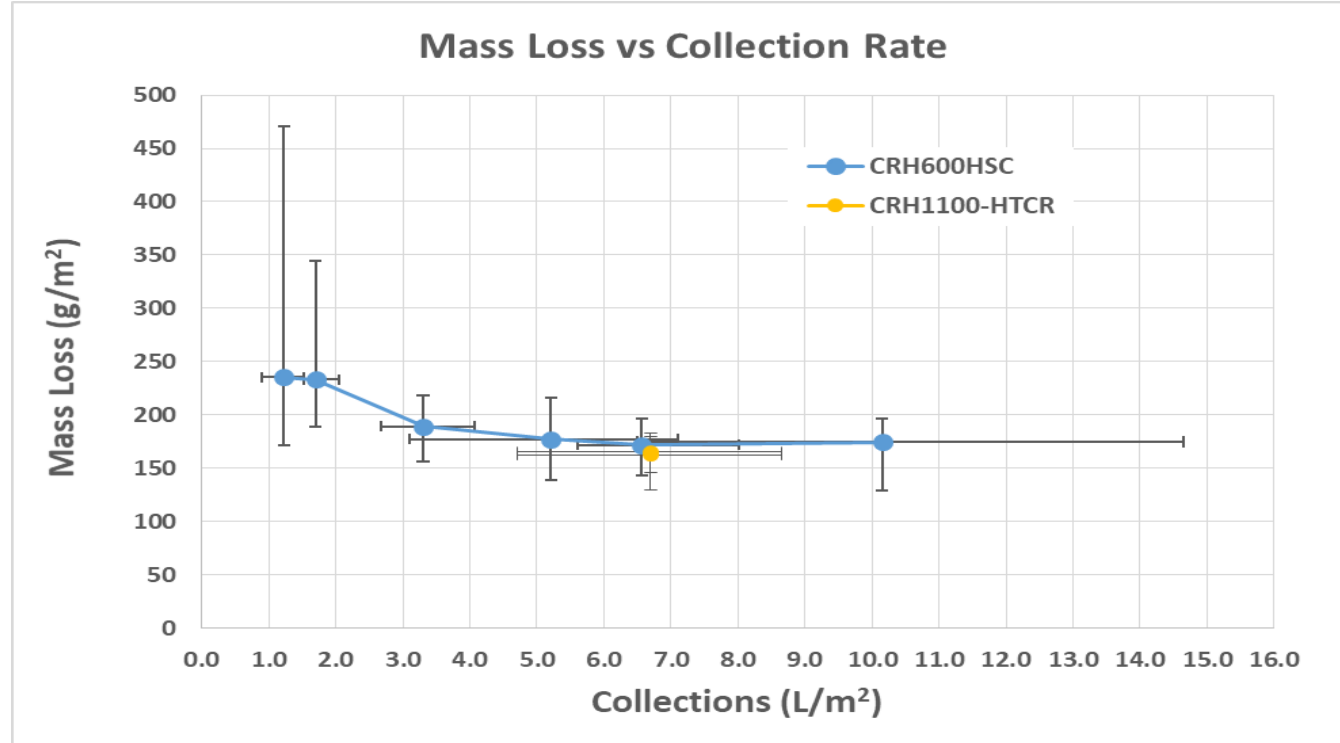
RH data taken from Q-FOG CRH

Why is *Precise* RH Control Necessary

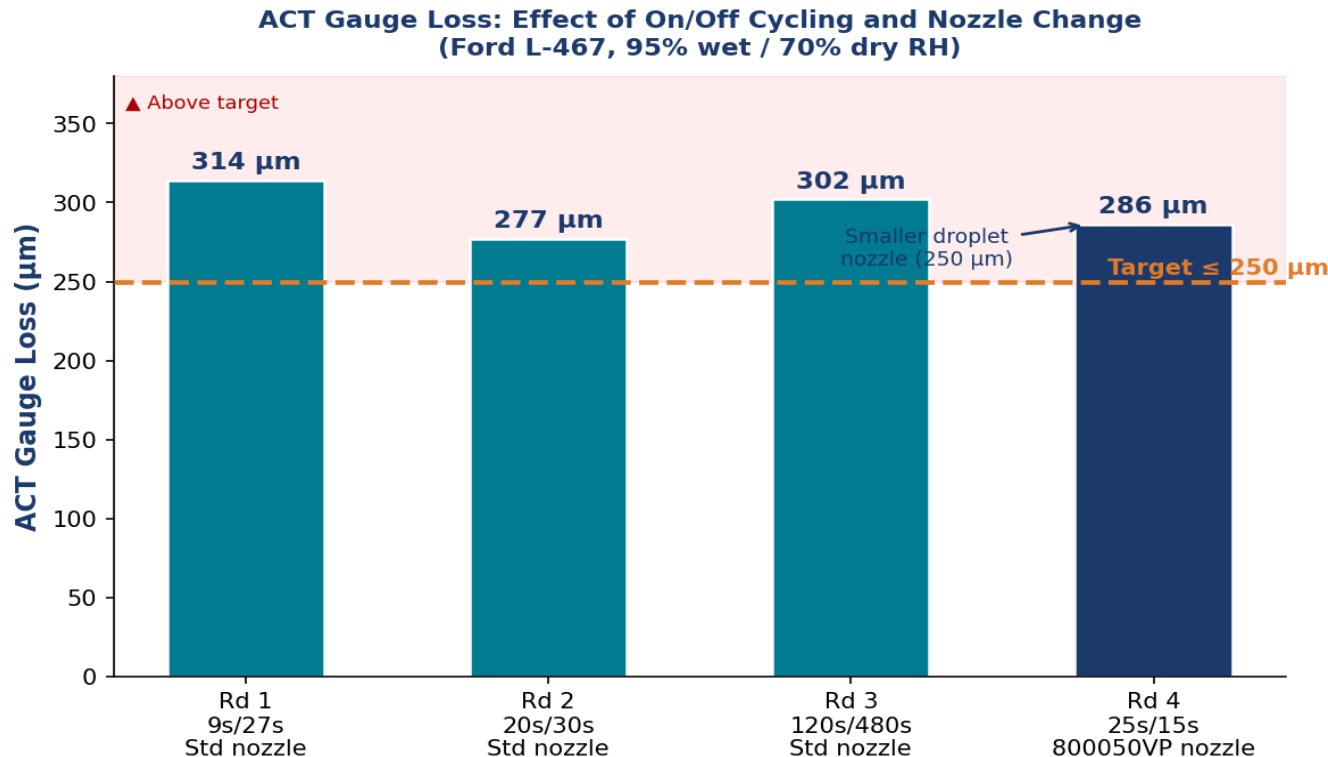
Wet/dry cyclic tests...

- Generally are more realistic than continuous salt spray
- Often have such poor reproducibility that many companies do not use them despite better realism

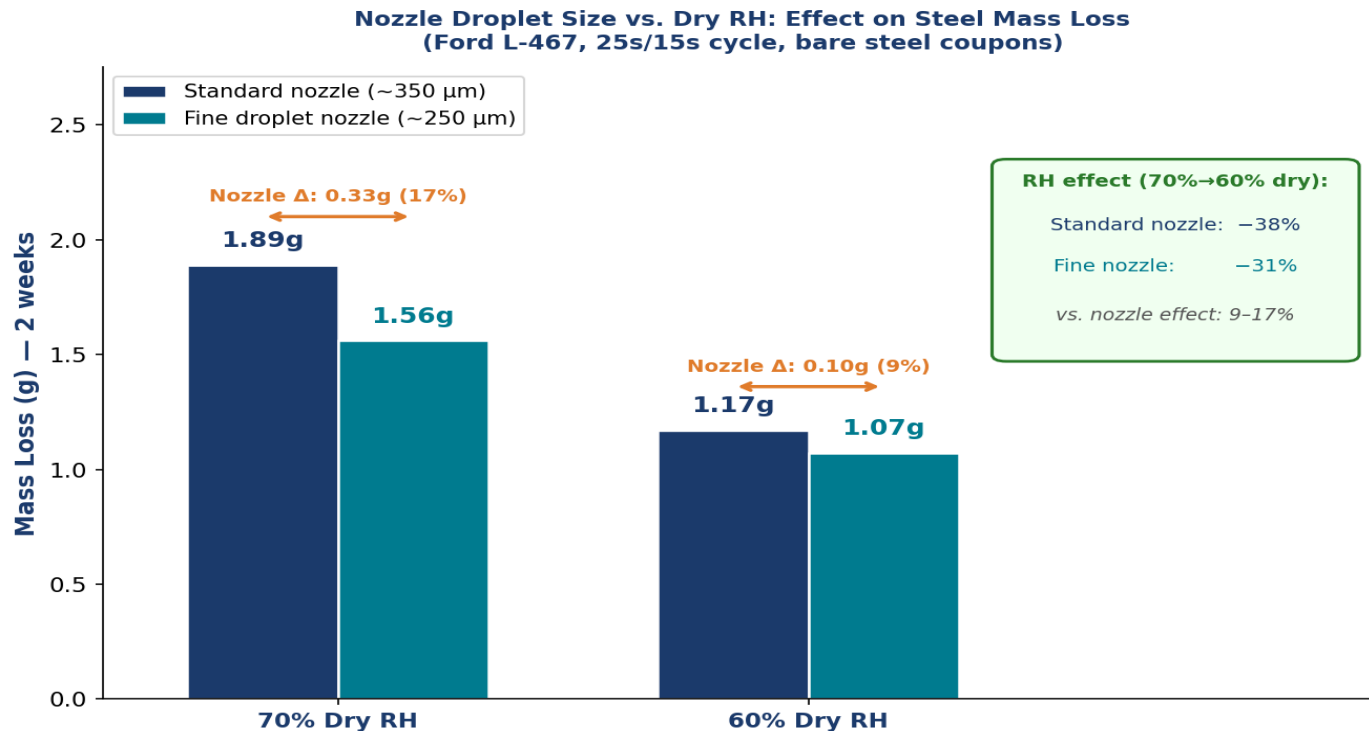
Spray Volume: A Threshold Effect on Corrosion Rate



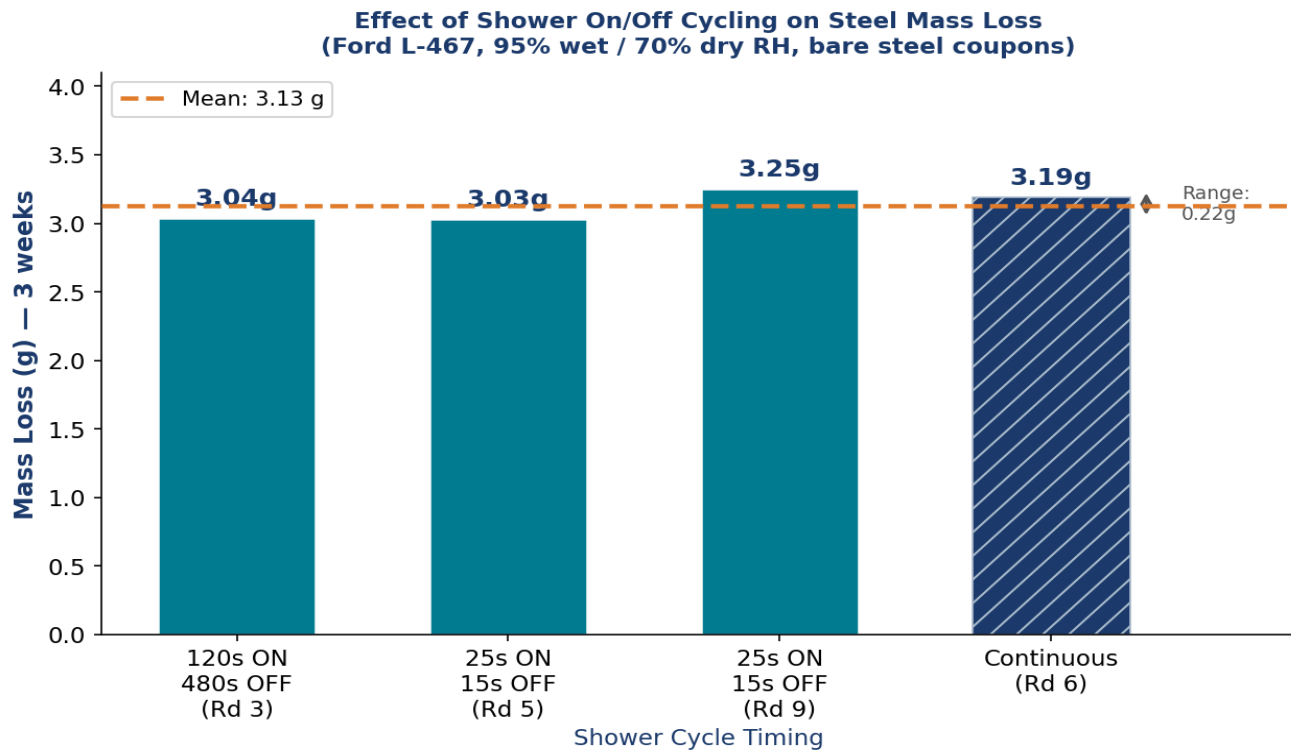
Droplet Size: Changing Nozzles Did Not Achieve Target



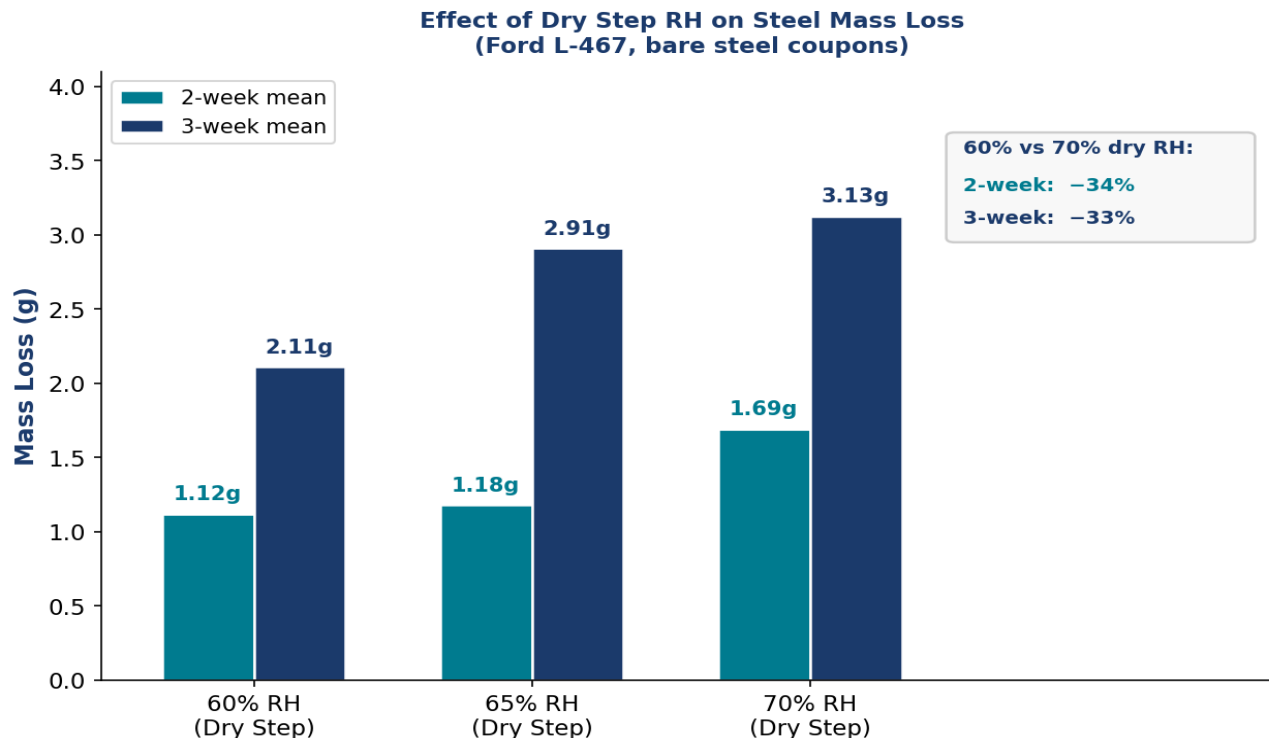
Nozzle Droplet Size vs. Dry Step RH: What Drives Results



Spray On/Off Cycling: No Significant Effect on Corrosion



Dry Step RH: The Variable That Does Matter



Relative Humidity and Corrosion

Controlling Step Transition Times

“Linear” transition

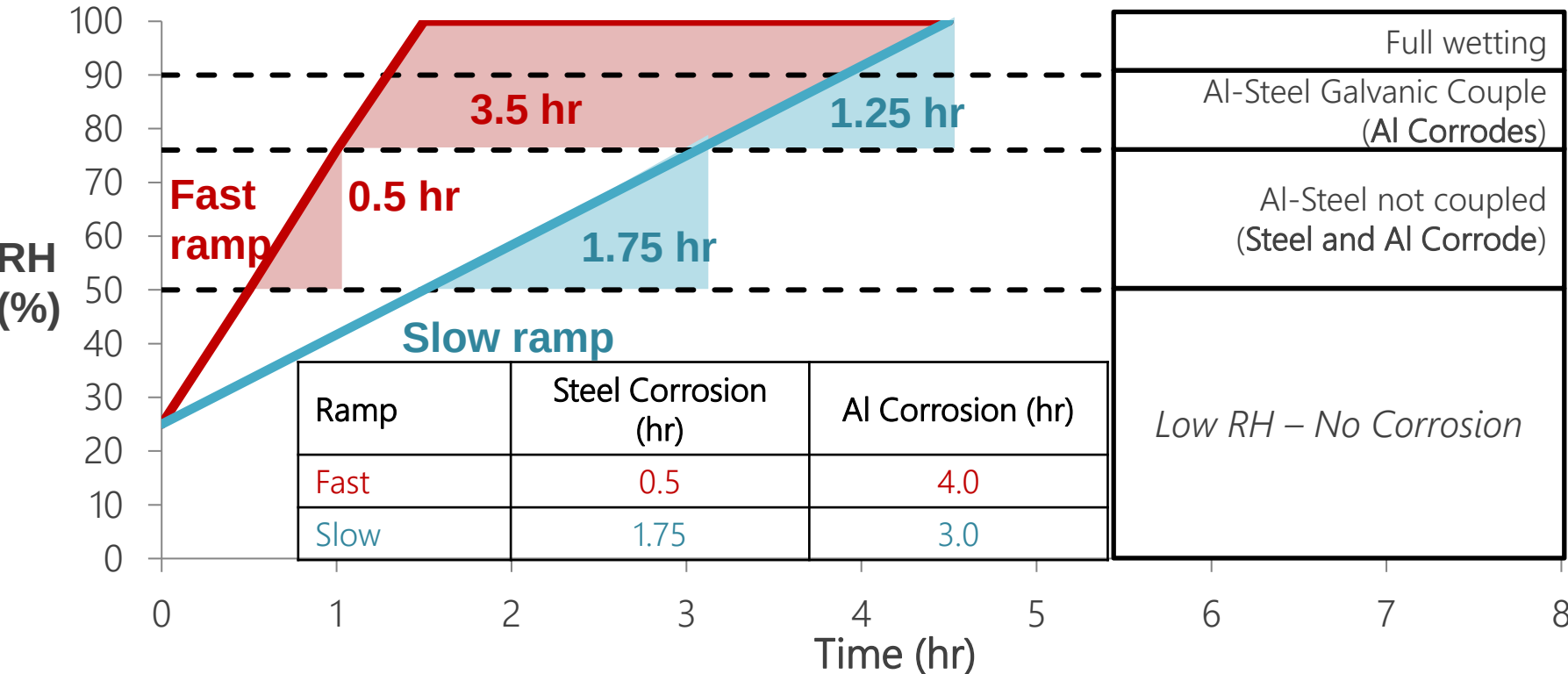
- Specify Time in test cycle to change test conditions
- Tester adjusts temperature & RH for linear transition from beginning to end of ramp time

“Less Than” transition

- Specify Time in test cycle to change test conditions
- Tester attempts to achieve conditions within specified time – effectively as fast as possible
- Fast “less than” transition times (e.g. JASO M609) designed to **minimize test variability...**

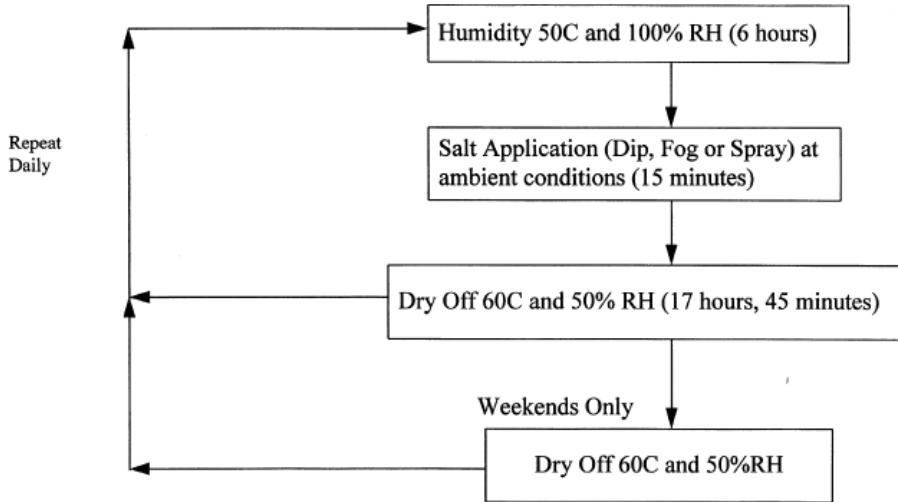
Galvanic corrosion during ramping

High RH, >76%

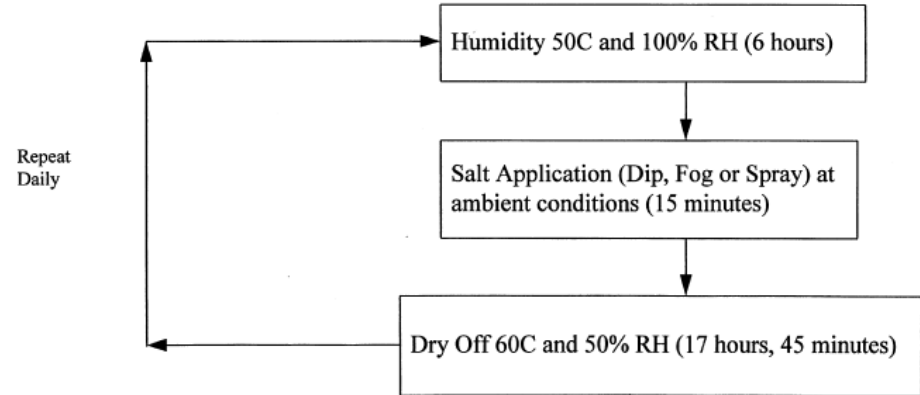


Case Study: SAE J2334

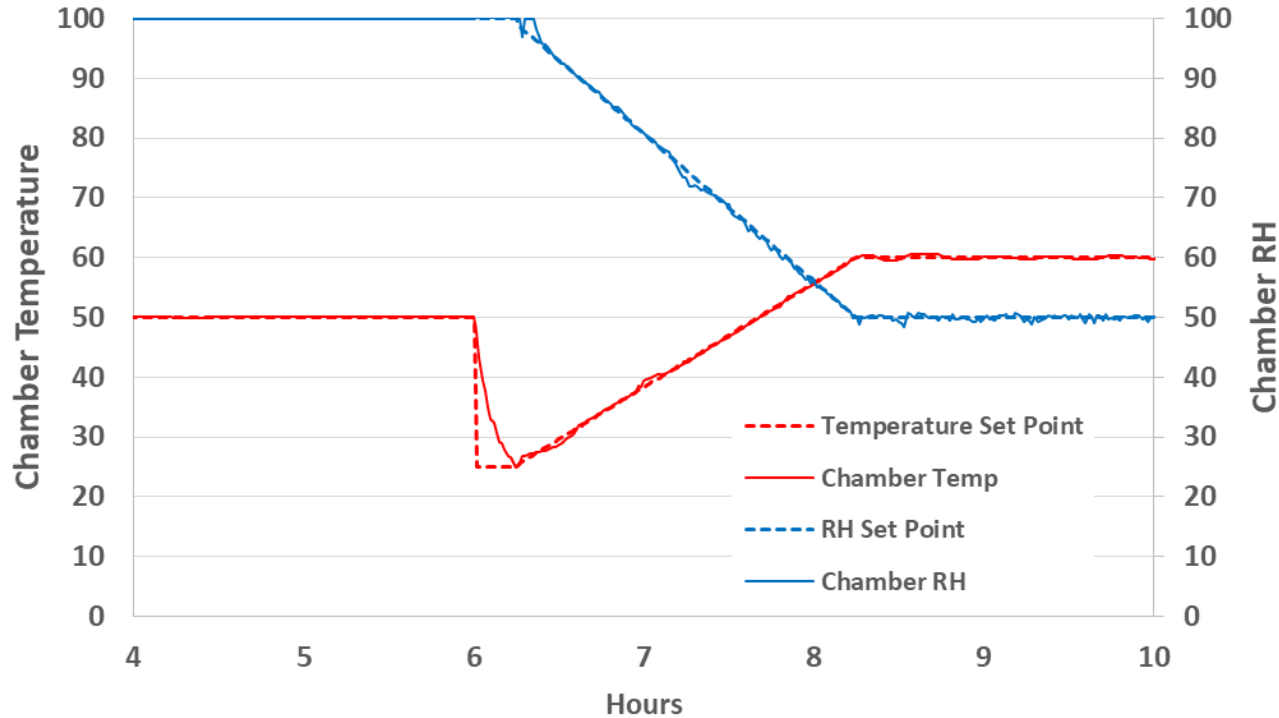
Cosmetic Corrosion LabTest Cycles SAE J2334 - 5 Day/Week - Manual Operation



Cosmetic Corrosion LabTest Cycles SAE J2334 - 7 Day/Week - Automatic Operation

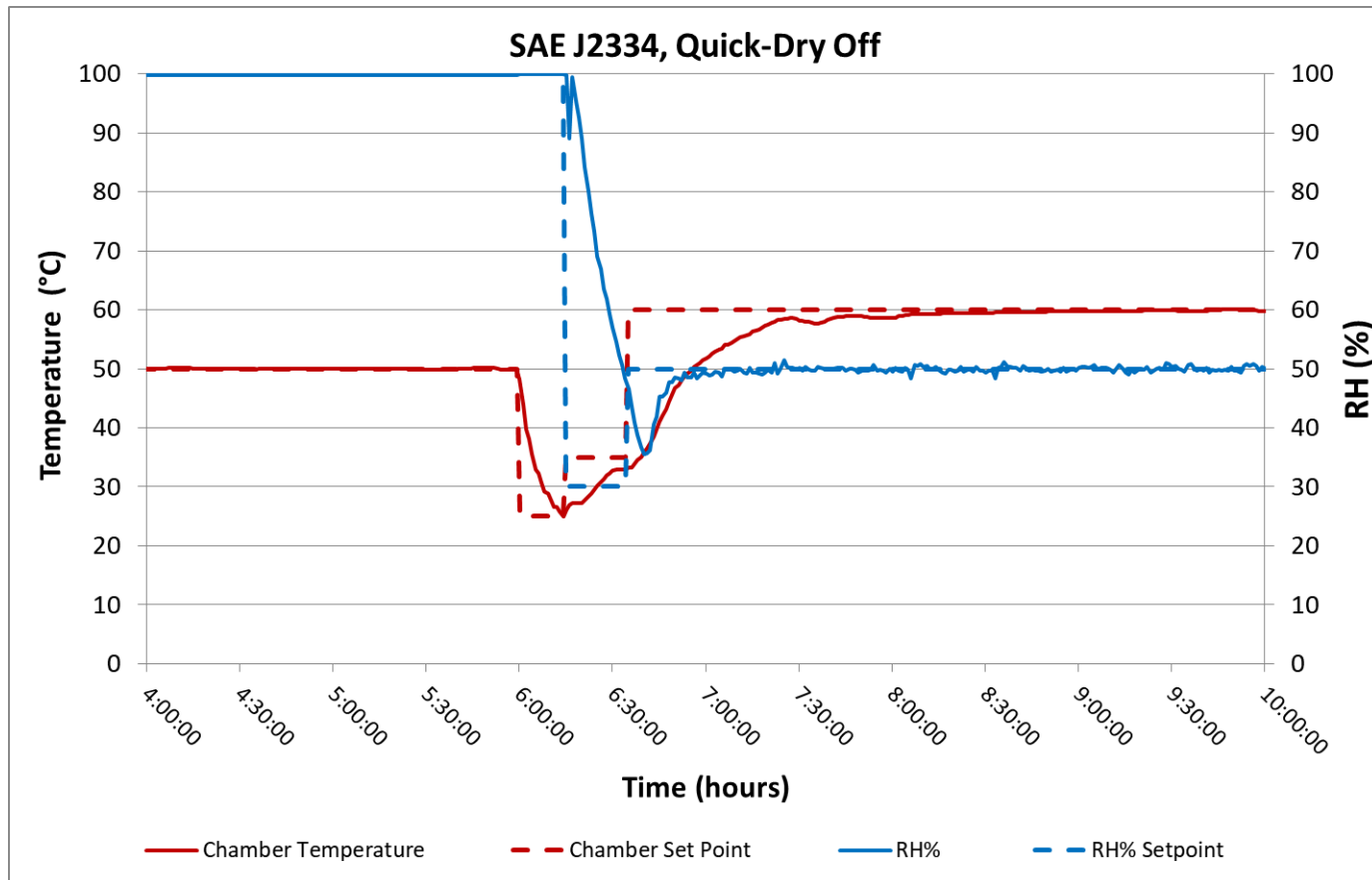


SAE J2334 Cycle (Slow Dry-Off)



***Zoomed in view
of the transition***

***During the
transition, the
time above the
Deliquescence
RH of NaCl is
about 1 hour***



Zoomed in view of the transition

During the transition the time above the Deliquescence RH of NaCl is about 10 minutes

Corrosion Coupon Mass Loss



Green bars represent test under slow dry-off conditions

Blue bars represent test under rapid dry-off conditions

Red lines represent tolerance of OEM standard

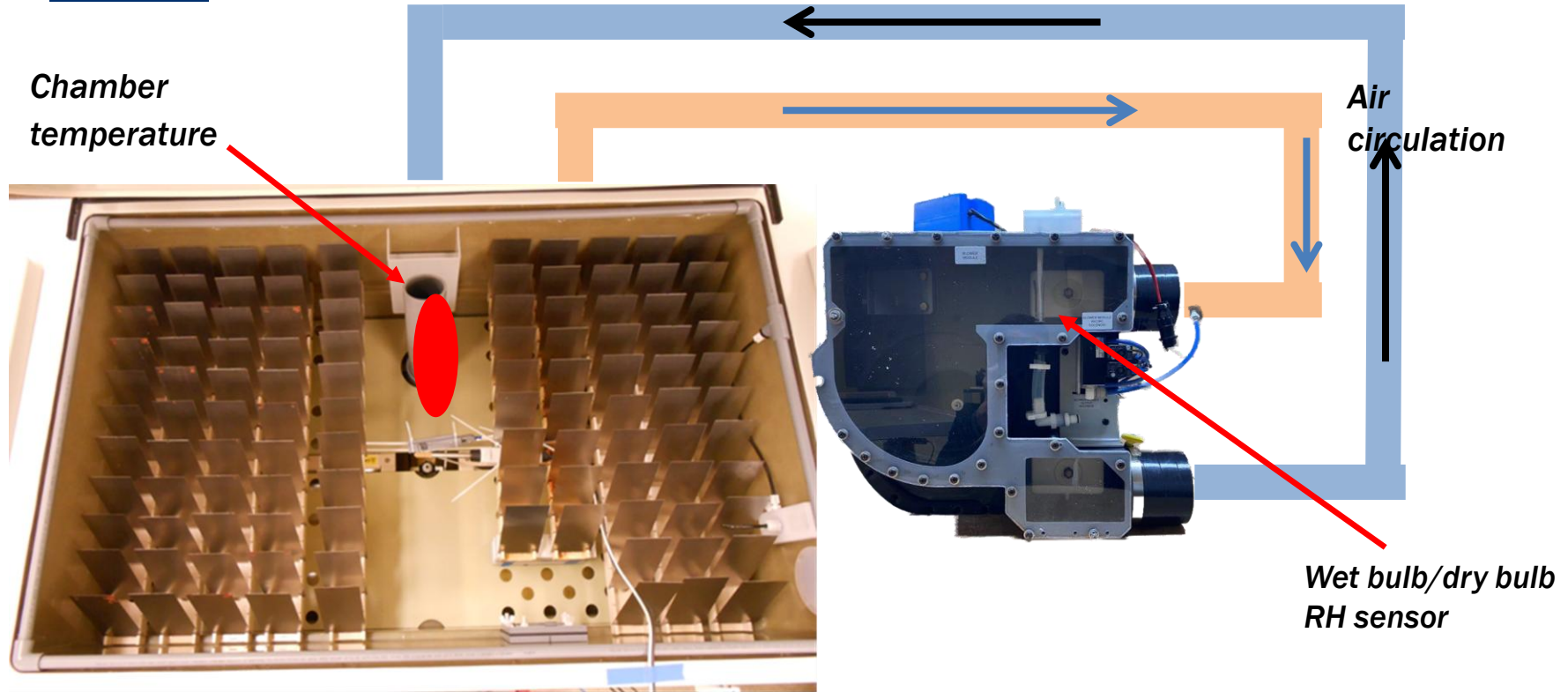
Under the rapid dry test, the coated panels once again passed the test

RH Measurement in the Q-FOG CRH

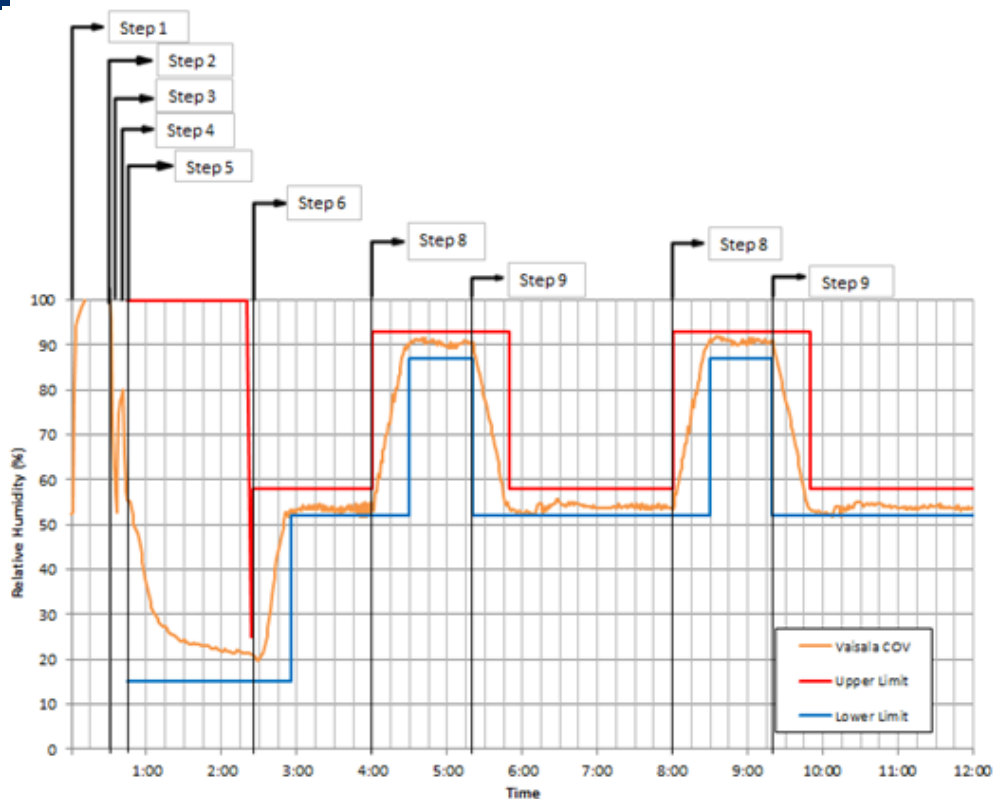
Psychrometric (wet bulb/dry bulb) sensor

- Accurate
- Easy to calibrate
- Fast response time
- Located in air circulation system & protected from salt spray
 - Rapid refresh of chamber air ensures conditions inside chamber equal those in circulation system
- Two point supplemental RH adjustment to fine tune accuracy for demanding applications

Q-FOG CRH Air Circulation System



RH Verification According to Renault D17 2028 (ECC1)



Verification of Q-FOG
RH sensor accuracy

Independent RH
sensor's
measurements must
remain within the limits
during the cyclic
transitions

Conclusions, Dos and Don'ts of Corrosion Testing

- For “shower” type spray, ensuring all specimens are dripping wet appears more important than any specific quantitative target
- Precise RH control within specimen area is critical (accuracy of measurement and uniform distribution of RH)
- There is a mismatch in the market between budgets and technical requirements

Conclusions, Dos and Don'ts of Corrosion Testing

Do

- Consider RH measurement difficulties and chamber non-uniformity when designing a test method (choose RH set point such that a $\pm 5\%$ variation has minimal impact on corrosion rates)
- Specify a transition as a linear one or require it to be completed in as short a time as possible for most chambers

Don't

- Over-specify parameters unless data supports a tight tolerance (spray volume, temperature and RH stability)
- Combine too many stresses into the test (freezing in a corrosion test?)

Thank you for your time.

Questions?

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We make testing simple. |

