

Challenges for Test-to-Field Correlation in Automotive Corrosion Testing

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Agenda

- What is Test-to-Field Correlation?
- GMW14872 – GM's Cyclic Corrosion Test
- Why Test-to-Field Correlation Matters
- Challenges to Correlation with Common Automotive Corrosion Mechanisms
- How GM closes gap between Testing and the Real World
 - Case Study – Hem Flange Survey
- Application focused TtF
 - Case Study – Aluminum Power Electronic Buyback
- Field buyback program recommendations
- Summary and Closing
- Q&A



Test-to-Field (TtF) Correlation

TtF translates lab results into real-world meaning

- Correlation established for GM's Component Lab Test: GMW14872:
 - Mass Loss collected from Bare steel coupon mounted on field vehicles
 - Vehicles operated in SEVERE environment (95th %ile)
 - General Corrosion mechanism correlation established
 - Crevice and galvanic mechanisms under-accelerated on test
 - Crevice: Correlation established by body component buyback
 - Galvanic: Correlation established via field mounted galvanic coupons
 - Hem Filiform not activated w/GMW14872
- Additional work still required to establish correlation for some applications (Aluminum Housings & sealing interfaces)



Table A2: Mass Loss Targets for Method 2 ^{Note 1} Cosmetic ^{Note 2} and Functional ^{Note 3}

Vehicle Area	Mounting Location of Component	Number of Salt Sprays (sp)	Test Exposure		
			Cosmetic Mass Loss Requirements (Penetration ^{Note 4}) and Number of Test Cycles ^{Note 5}	Functional Mass Loss Requirements (Penetration ^{Note 4}) and Number of Test Cycles ^{Note 5}	
Underbody (UB)	All	4 per cycle	Exposure A 0.84 g ± 0.14 g (38 µm ± 6 µm) 6 cycles ± 1 cycle	Exposure D 7.23 g ± 0.29 g (328 µm ± 13 µm) 48 cycles ± 5 cycles	Exposure E 10.84 g ± 0.43 g (492 µm ± 20 µm) 72 cycles ± 8 cycles

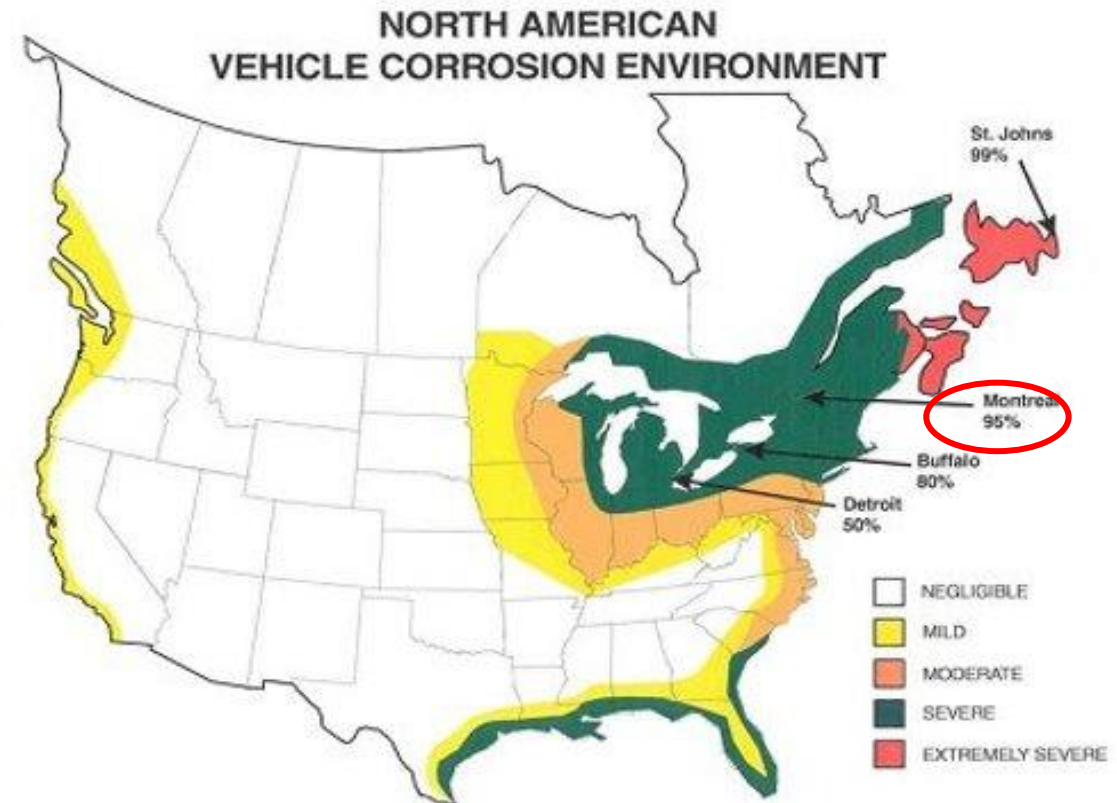
GMW14872 – GM's Cyclic Corrosion Test

Cyclic environmental exposure that accelerates corrosion:

- 10-15 years of general corrosion in just a few months
- 95th percentile environment (eg: Montreal)
- Correlated & controlled using **mass loss** of bare steel coupons
 - Salt Sprays & Mass Loss Targets vary per vehicle area / mounting location

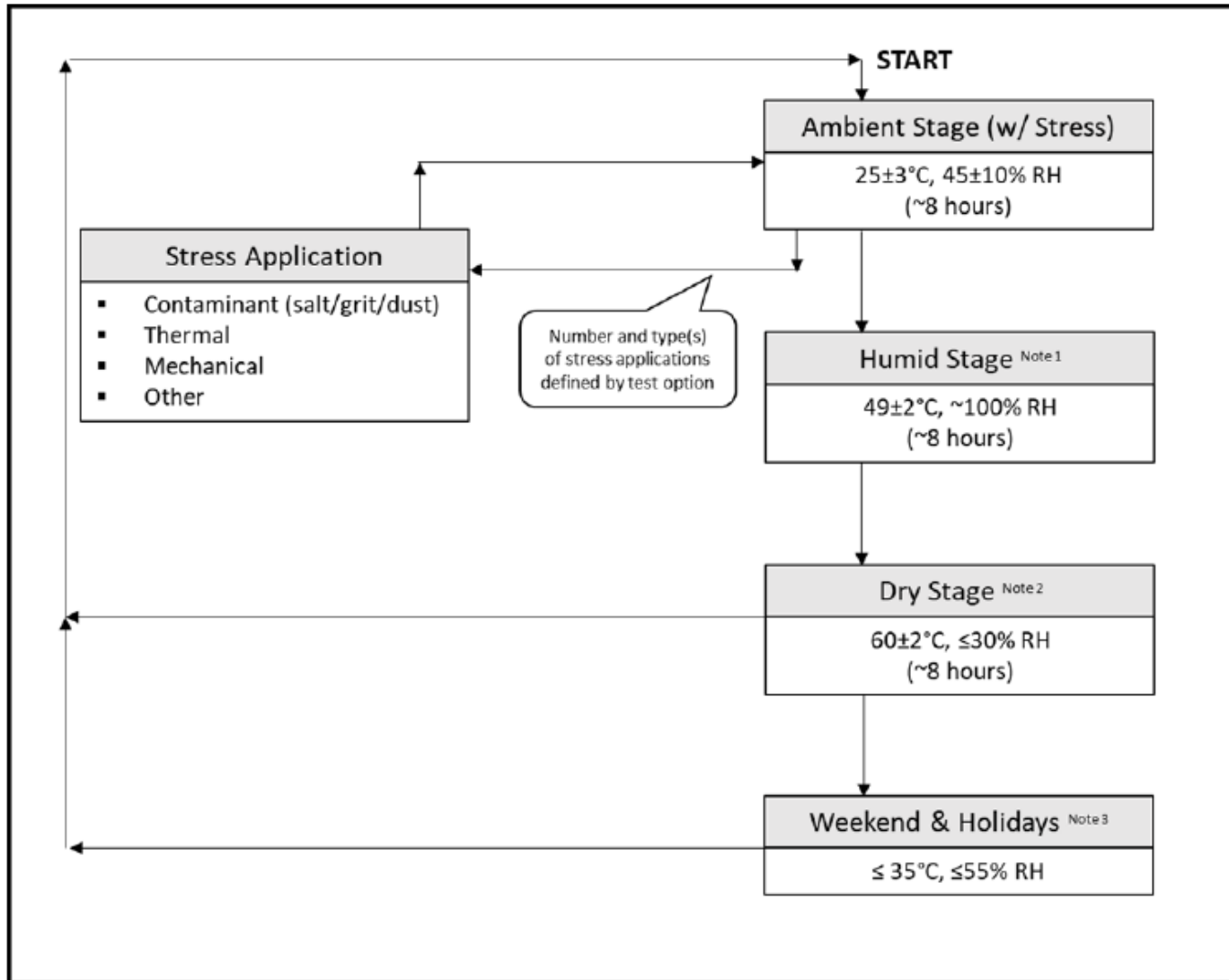


Bare Steel Coupons correlate General Corrosion Mechanism to the Field



GMW14872 – The Cook Book

Figure A1: Flow Diagram



GMW14872 – The Cook Book

Vehicle Area	Mounting Location of Component	Number of Salt Sprays (sp)	Test Exposure		
			Cosmetic Mass Loss Requirements (Penetration ^{Note 4}) and Number of Test Cycles ^{Note 5}	Functional Mass Loss Requirements (Penetration ^{Note 4}) and Number of Test Cycles ^{Note 5}	
				10 yr general corrosion (All)	15 yr general corrosion (All)
Underbody (UB)	All	4 per cycle	Exposure A 0.84 g ± 0.14 g (38 µm ± 6 µm) 6 cycles ± 1 cycle	Exposure D 7.23 g ± 0.29 g (328 µm ± 13 µm) 48 cycles ± 5 cycles	Exposure E 10.84 g ± 0.43 g (492 µm ± 20 µm) 72 cycles ± 8 cycles
Underhood (UH)	All – Splash Protection Not Defined (ND)	4 per cycle	Exposure B 1.32 g ± 0.13 g (60 µm ± 6 µm) 9 cycles ± 1 cycle	Exposure D 5.42 g ± 0.22 g (246 µm ± 10 µm) 36 cycles ± 4 cycles	Exposure E 8.13 g ± 0.32 g (369 µm ± 15 µm) 54 cycles ± 6 cycles
	Mid – Protected from Splash (PS)	1 per cycle	Exposure B 0.88 g ± 0.09 g (40 µm ± 4 µm) 8 cycles ± 1 cycle	Exposure D 3.61 g ± 0.14 g (164 µm ± 7 µm) 33 cycles ± 4 cycles	Exposure E 5.42 g ± 0.22 g (246 µm ± 10 µm) 49 cycles ± 5 cycles
	High – Protected from Splash (PS)	1 per cycle	Exposure B 0.44 g ± 0.04 g (20 µm ± 2 µm) 4 cycles ± 1 cycle	Exposure D 1.78 g ± 0.07 g (81 µm ± 3 µm) 16 cycles ± 2 cycles	Exposure E 2.75 g ± 0.11 g (123 µm ± 20 µm) 25 cycles ± 3 cycles

1 yr general corrosion (UB)

2 yr general corrosion (UH)

GMW14872 – The Cook Book

Table A2: Mass Loss Targets for Method 2 ^{Note 1} **Cosmetic** ^{Note 2} **and Functional** ^{Note 3}

Vehicle Area	Mounting Location of Component	Number of Salt Sprays (sp)	Test Exposure		
			Cosmetic Mass Loss Requirements (Penetration ^{Note 4}) and Number of Test Cycles ^{Note 5}	Functional Mass Loss Requirements (Penetration ^{Note 4}) and Number of Test Cycles ^{Note 5}	
				10 yr general corrosion (All)	15 yr general corrosion (All)
Exterior (EXT)	All	4 per cycle	Exposure C 3.94 g ± 0.28 g (179 µm ± 13 µm) 26 cycles ± 3 cycles	Exposure D 7.23 g ± 0.29 g (328 µm ± 13 µm) 48 cycles ± 5 cycles	Exposure E 10.84 g ± 0.43 g (492 µm ± 20 µm) 72 cycles ± 8 cycles
Secondary Surface (SS)	Outside the Weather Strip (O/WS)	1 per cycle	Exposure C 1.98 g ± 0.14 g (90 µm ± 6 µm) 18 cycles ± 2 cycles	Exposure D 3.61 g ± 0.14 g (164 µm ± 7 µm) 33 cycles ± 4 cycles	Exposure E 5.42 g ± 0.22 g (246 µm ± 10 µm) 49 cycles ± 5 cycles
	Inside the Weather Strip (I/WS)	1 per 5 cycles ^{Note 6}	Exposure C 0.40 g ± 0.03 g (18 µm ± 1 µm) 7 cycles ± 1 cycle	Exposure D 0.73 g ± 0.03 g (33 µm ± 1 µm) 12 cycles ± 2 cycles	Exposure E 1.10 g ± 0.04 g (50 µm ± 2 µm) 18 cycles ± 2 cycles
Interior (INT)	Low	1 per 5 cycles ^{Note 6}	Exposure C 1.30 g ± 0.09 g (59 µm ± 4 µm) 22 cycles ± 3 cycles	Exposure D 2.38 g ± 0.10 g (108 µm ± 4 µm) 40 cycles ± 4 cycles	Exposure E 3.57 g ± 0.14 g (162 µm ± 6 µm) 59 cycles ± 6 cycles
	Mid, High	1 per 5 cycles ^{Note 6}	Exposure C 0.40 g ± 0.03 g (18 µm ± 1 µm) 7 cycles ± 1 cycle	Exposure D 0.73 g ± 0.03 g (33 µm ± 1 µm) 12 cycles ± 2 cycles	Exposure E 1.10 g ± 0.04 g (50 µm ± 2 µm) 18 cycles ± 2 cycles

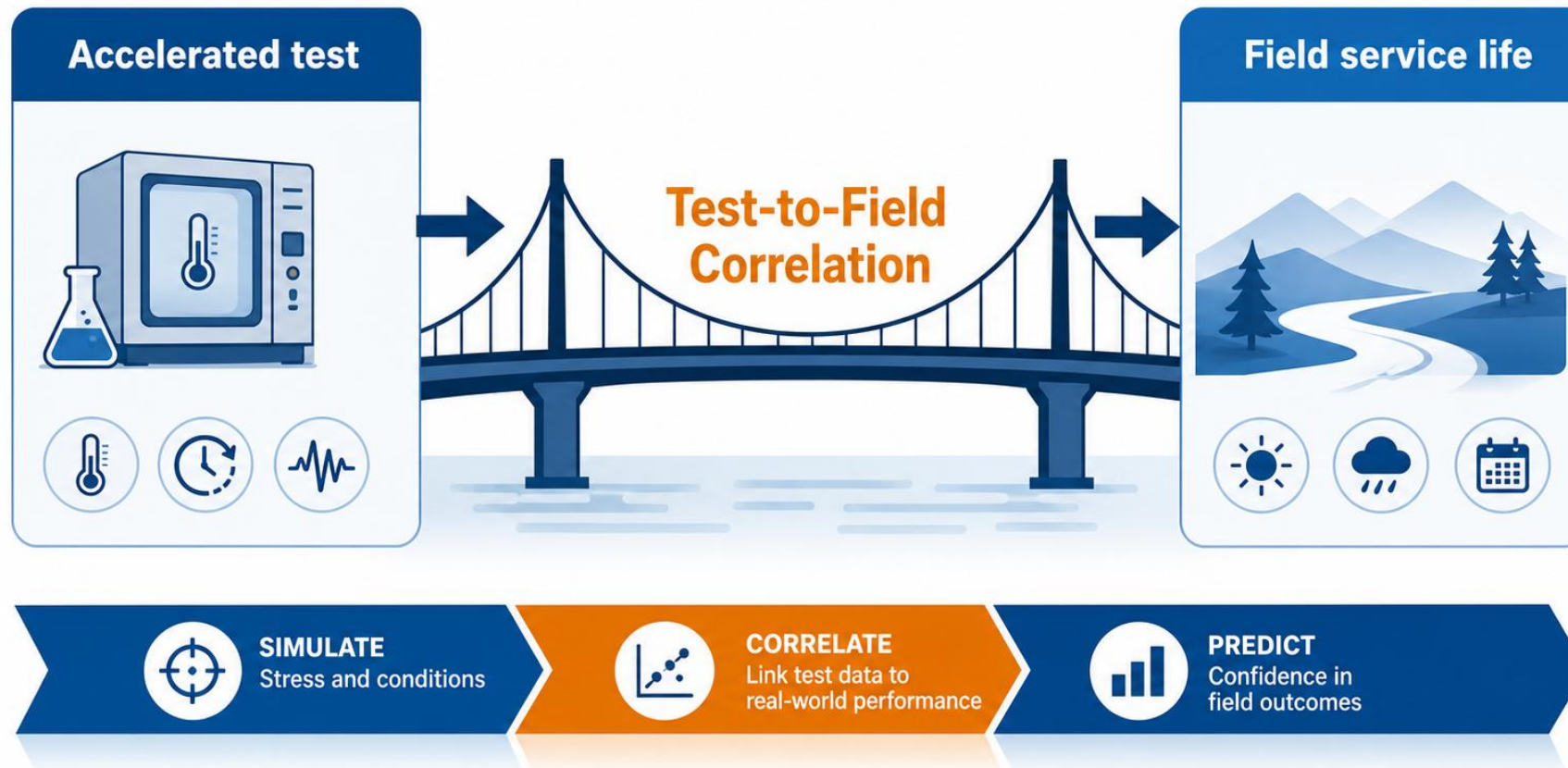
5 yr general corrosion



Why Test-to-Field (TtF) Correlation Matters

TtF helps right-size corrosion decisions.

- Avoids under-design and risk for field issues
- Avoids over-design and wasted cost
- Guides material, coating, and process choices
- No Obvious Functional Test failure does not mean a PASS, Post-Test Analysis is Critical



Challenges with Common Automotive Corrosion Mechanisms

Corrosion mechanism depends on environment, geometry, and material combination.

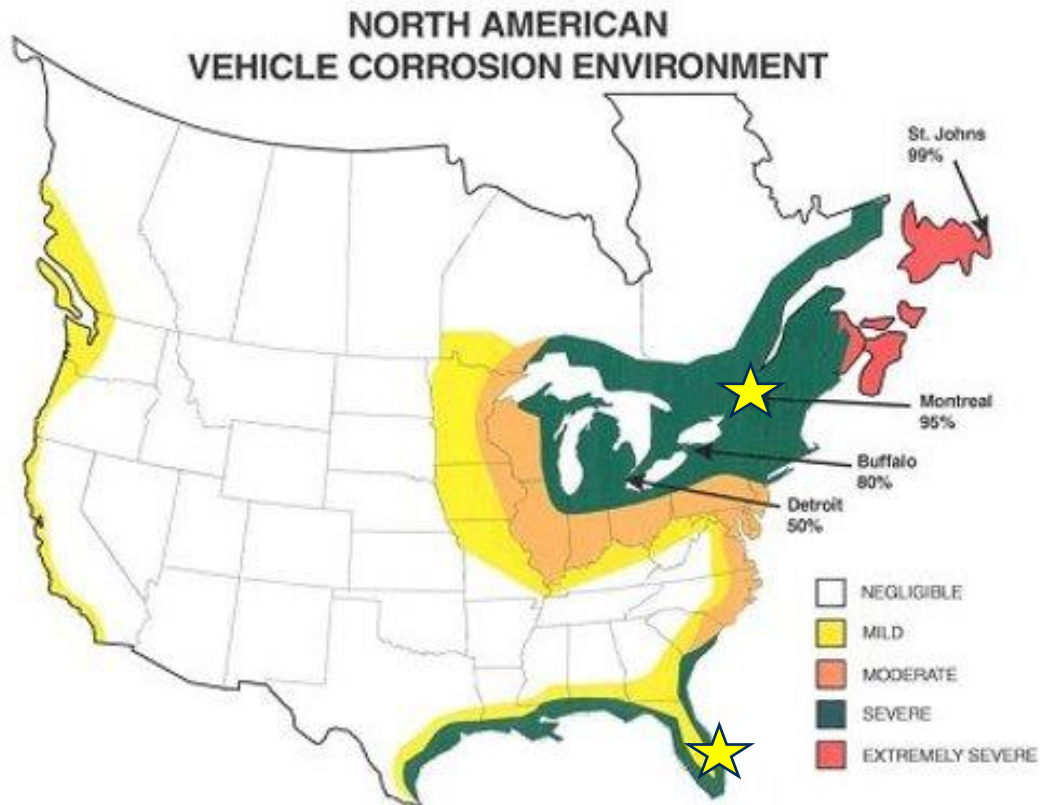
- **Galvanic:** GMW14872 Option 6 improves acceleration with 3% NaCl + fire clay
- **Crevice:** TtF is established for body sheet metal, but other components/material pairs still need correlation
- **Filiform:** GMW14872 does not activate aluminum closure-hem filiform; Filiform Test GMW15287 supports A-B comparison, but field correlation is still unknown
- Field surveys / data remain necessary to close gaps



Closing The Gap When Testing Isn't Enough

Unique challenges for Hem flanges - Need Field Surveys.

Targeted surveys support sealing optimizations and benchmarking needs.



Case Study: Hem Flange Survey

Target: 4-6 year old Vehicles

Survey Data helps make more-informed decisions



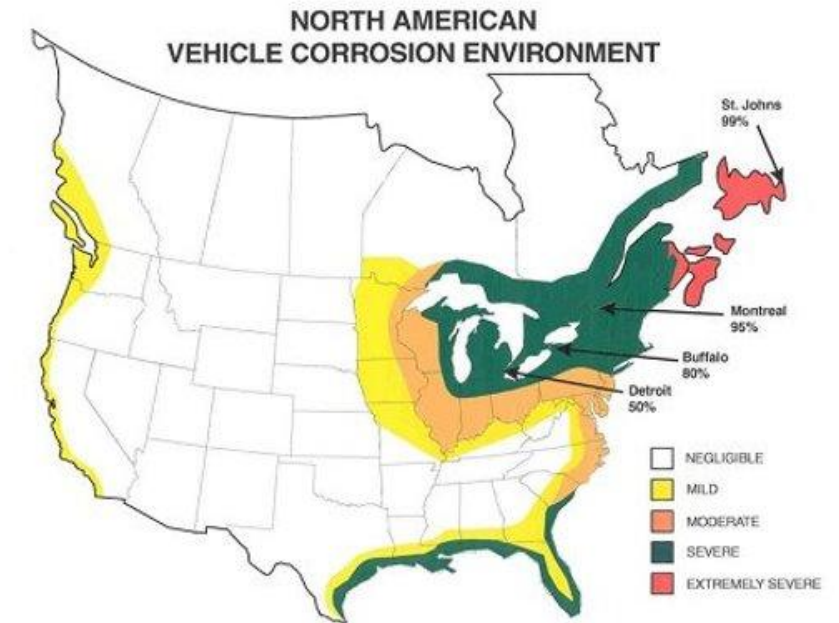
*Hood Hem Corrosion observed
on Vehicle Field Survey*



GM Strategy: Application Focused TtF

GM continues **Vehicle Surveys** and **Targeted Part Buybacks** to refine Test-to-Field correlation by component application in a 3-step process:

1. **Select:** Severe-region vehicles with desired field age and mileage
2. **Inspect:** Critical interfaces from buybacks or field surveys
3. **Correlate:** Compare corrosion between field and test, and use analysis to refine requirements and design guidance



Ensure part was used in the severe region purchased from

Capture final disposition / condition of vehicle part is coming from and usage history

How relevant is the component or sealing strategy? Still in use or fully/partially phased out?

Candidate Part	Corrosion Region	History	Relevance	Priority
Candidate A	Severe	High	High	High
Candidate B	Severe	Medium	High	High
Candidate C	Moderate	High	Medium	Medium
Candidate D	Moderate	Low	High	Medium



Case Study: Power Electronic Buyback

Aluminum Housing Buyback project to build crevice-corrosion TtF correlation.

Select: Vehicles with BEV2 Power Electronics with aluminum housings

Targeted vehicles with >5 years in service & minimum usage 10,000 mi/yr



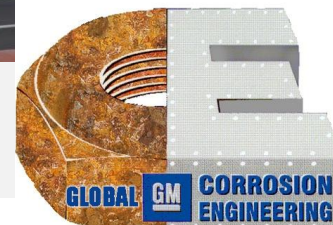
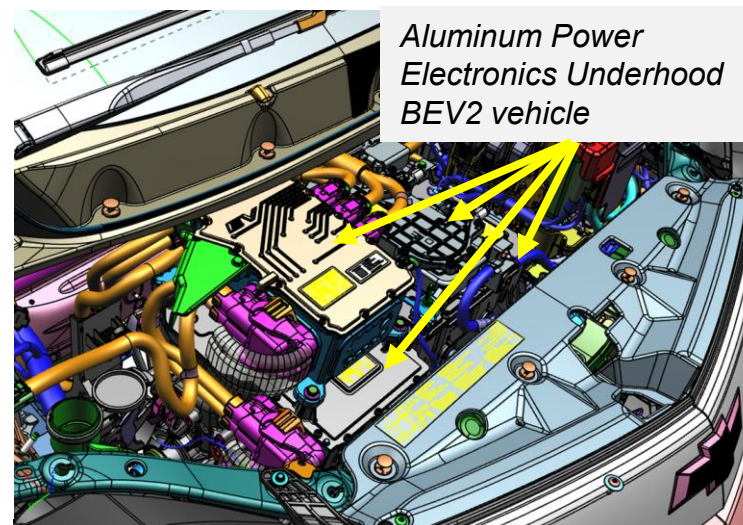
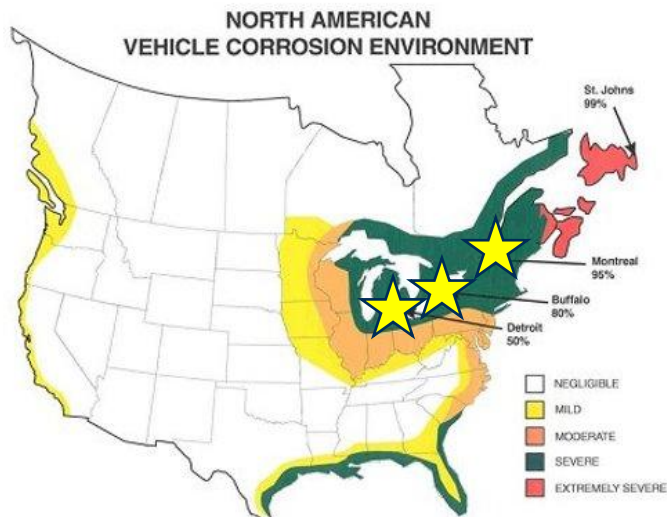
Chevy Volt (Hybrid)
Production Years:
2011 - 2019



Chevy Bolt (BEV)
Production Years:
2016 - 2023



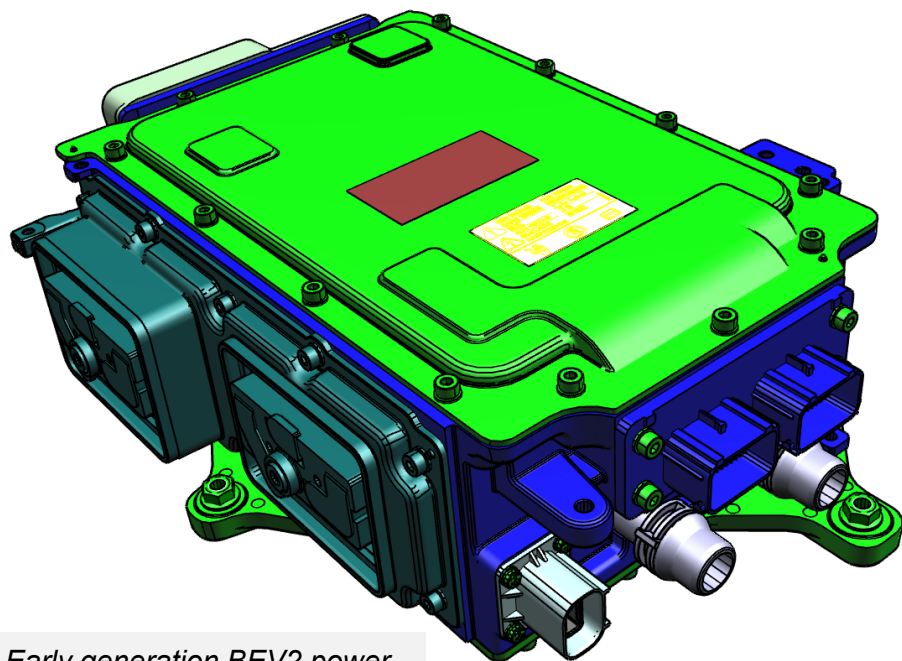
Chevy Spark EV (BEV)
Production Years:
2013 - 2016



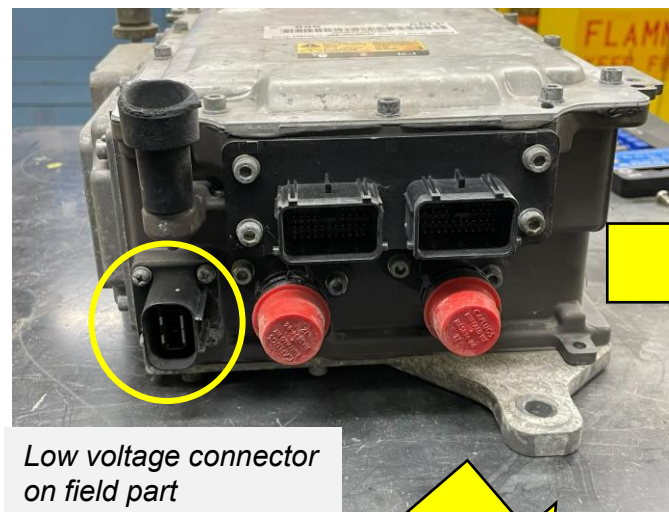
Case Study: Power Electronic Buyback

Inspect: Sealing interfaces with PIP / CIP Seals

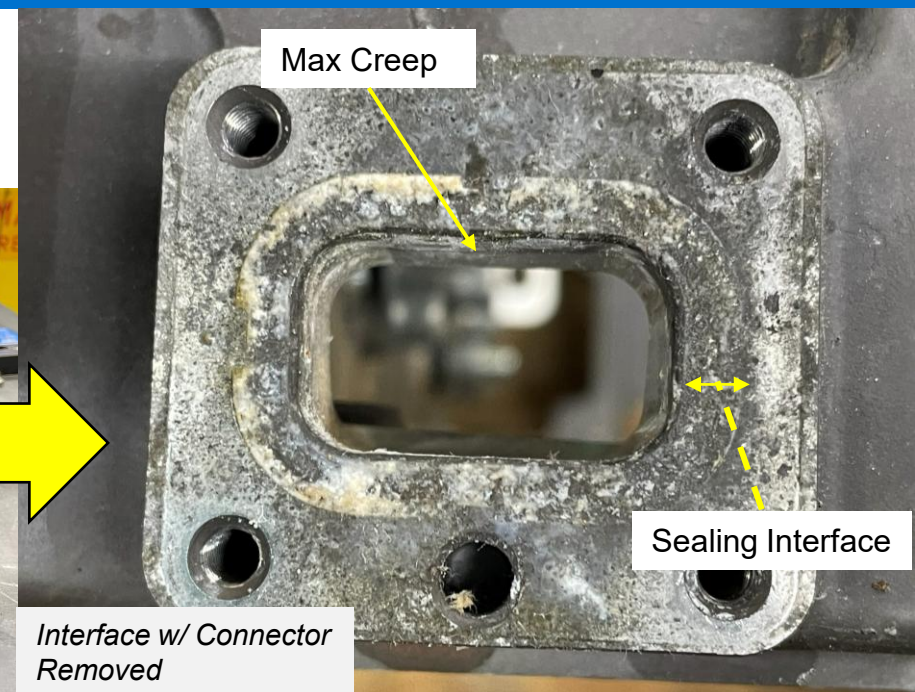
- Check for corrosion at connector mating surfaces
- Measure corrosion creep beyond sealing interfaces



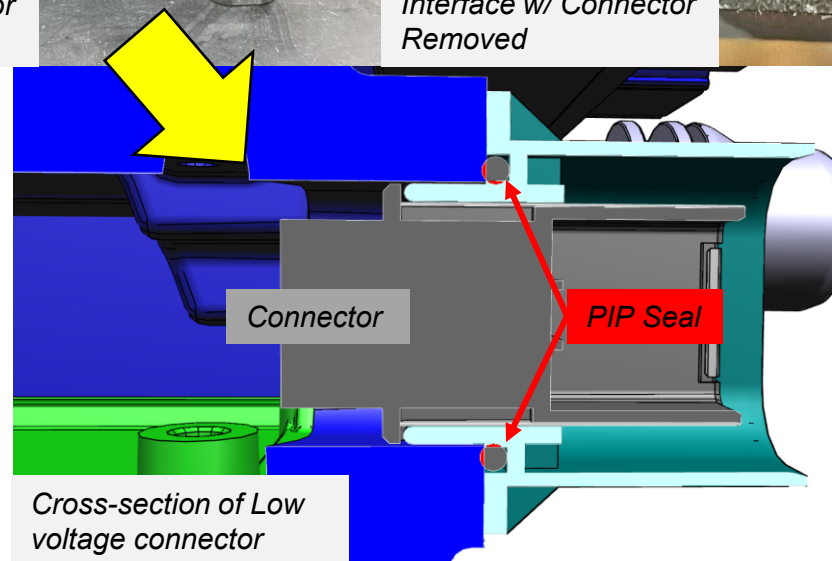
Early generation BEV2 power electronic component



Low voltage connector on field part



Interface w/ Connector Removed



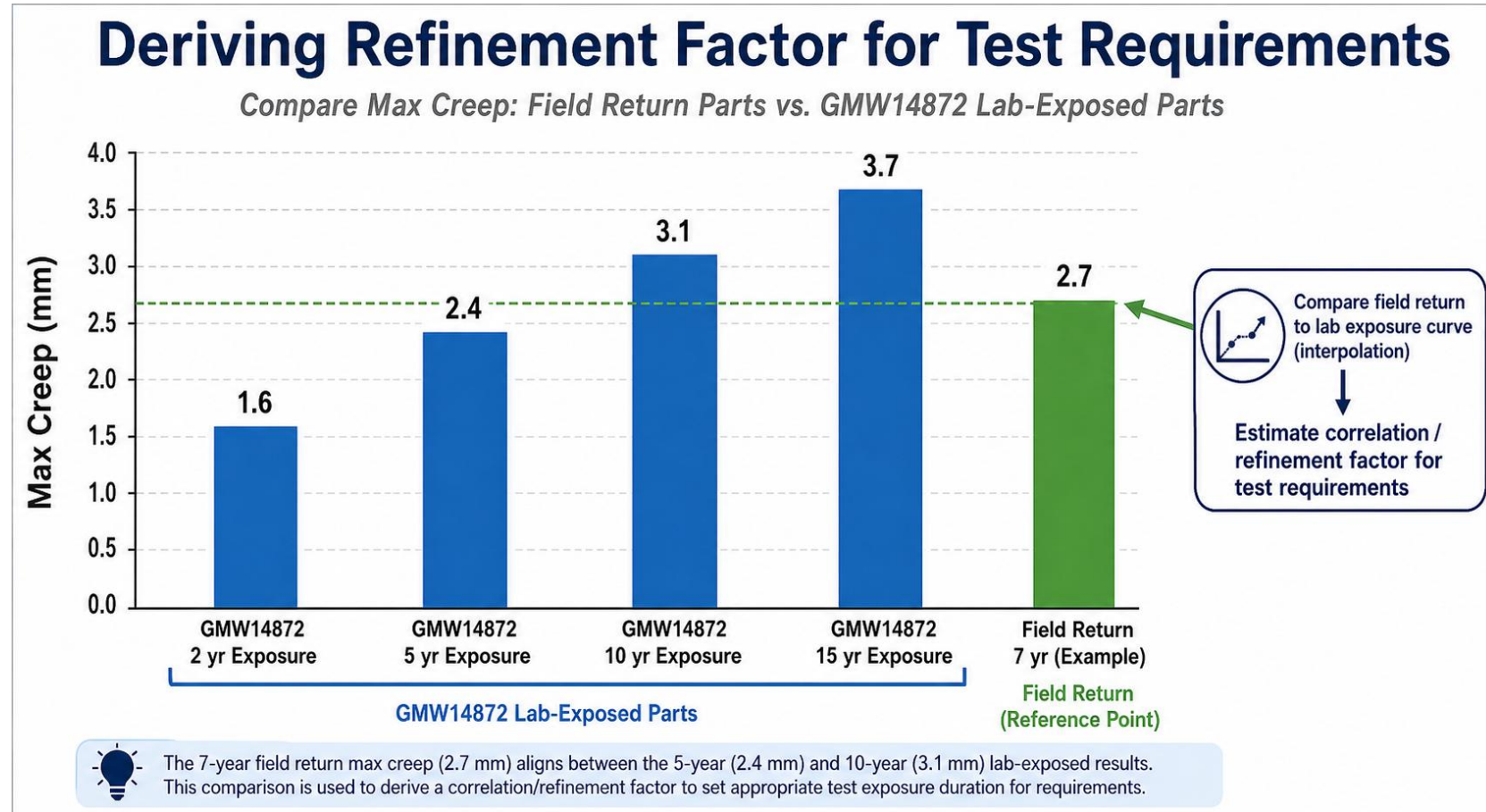
Cross-section of Low voltage connector



Case Study: Power Electronic Buyback

Correlate: Field performance with lab and vehicle results

- Determine Correlation Factor for creep around sealing surfaces by application
- Update component / subsystem validation requirements



Note: Diagram for illustrative purposes for reference only, values not from empirical study



Field Buyback Recommendations

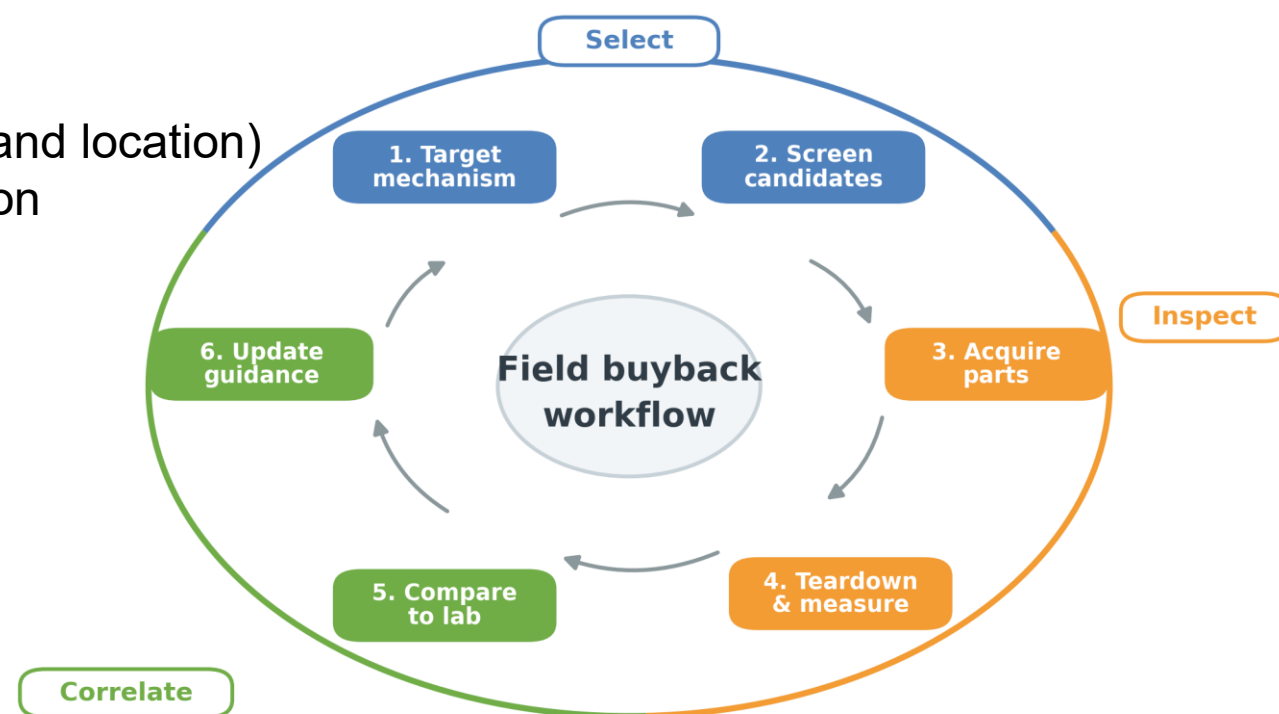
Proper planning is critical prior to executing a field part buyback project. Below is general guidance and challenges that should be anticipated:

Planning considerations

- Define mechanism, application, and interfaces first
- Screen for credible field exposure and history
- Prioritize by critical factors (eg: Seal strategy, material, and location)
- Standardize teardown, measurement, and documentation

Challenges encountered

- Limited part availability in target regions
- Cross-border sourcing complications
- Incomplete usage / exposure history
- Uneven historic lab / vehicle data coverage



Summary

In summary, TtF provides the bridge between accelerated testing and real service life.

- TtF is mechanism and application-specific
- No single correlation applies for all corrosion modes and applications
- GM used targeted field studies to develop GMW14872's correlation
- Buybacks and surveys are critical to establish TtFs & optimized vehicle designs



Thank You!

Questions?

