

# Electric & Autonomous Vehicles: The Future is Now..

## Electric Vehicle Leak Testing – Trends/Issues/Challenges

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Your Global Leak and Function Test Solution Experts



Part of the TASI Group of Companies

# CTS Presenters

## Leak Testing for eMobility Manufacturers

Expertise | Experience | Largest Selection of Solutions



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Sentinel 3520



Sentinel I28



TracerMate II



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# Unprecedented Times....Industry Disruption Is Everywhere!



Current Changes in Automotive Greatest Since Henry Ford!  
114 Years of Change

# An Overview of Topics

- ✓ A few words to provide perspective
- ✓ EV trends that impact suppliers in the leak test industry
- ✓ The issues impacting the leak test industry as EV becomes a reality
- ✓ Challenges the leak test industry faces as the EV industry grows

# A Little Perspective

- ✓ Awesome time to be in the automotive industry
- ✓ The most transformational period since Henry Ford!
  - ✓ From the Model T to the Mach E
- ✓ Car makers are drag racing to beat each other to market
- ✓ The pace of technology development is unprecedented
- ✓ Everyone is looking for the competitive edge through innovation

WHEN HENRY FORD MADE CHEAP,  
RELIABLE CARS PEOPLE SAID,  
'NAH, WHAT'S WRONG WITH A  
HORSE?' THAT WAS A HUGE BET  
HE MADE, AND IT WORKED.

ELON MUSK



# A Little Perspective

- ✓ Leak testing has become an increasingly important manufacturing process
- ✓ Water ingress into a battery is a more severe failure mode than ATF on the driveway!
- ✓ Leak testing companies are being presented with challenges that they may not have ever seen before



# Electric Vehicle Leak Testing: Trends We See

- ✓ Specifications are becoming increasingly stringent to prevent fluid ingress
- ✓ Legacy test methods from ICE applications are often not suitable for EV
- ✓ IPXX requirements are becoming a popular topic of discussion

## International Protection System Marking (IPxx)

1st Digit	Protection Against Solid Ingress	2nd Digit	Protection Against Liquid Ingress
0	Non-protected (not rated)	0	Non-protected or rated
1	> 50mm gap for entry	1	Vertically dripping water
2	> 12 mm gap for entry	2	Dripping water tilted at 15 deg
3	> 2.5 mm gap for entry	3	Spraying water at an angle up to 60 deg
4	1.0 mm gap for entry	4	Splashing water at any direction
5	Dust protected	5	Jets of water from any direction
6	Dust tight	6	Heavy seas or powerful jets of water
		6K	Powerful water jets with increased pressure
		7	Harmful ingress of water when immersed between a depth of 150 to 1000 mm (5.9 - 40 in)
		8	Continuous immersion in water
		9K	Powerful high temperature water jets

Example: IP67 = 6 dust tight + 7 protection from liquids, immersable to specification

# IPXX Attributes and Leak Testing

- ✓ IP67 is an attribute test for no visible water ingress
- ✓ You may correlate this into a measurable leak test
- ✓ 1 meter of water equals 1.44 psi of water pressure which is equal to 1.44 psig of air pressure
- ✓ No visible water can be converted to a non-water leak rate





# Water Flow Rate Correlation to Air Flow

- ✓ Flow through a hole has a ratio 1:85 of water flow compared to air flow
- ✓ Flow is affected by the physical characteristics of the leak path: length, path characteristics, and test pressure

## Comparative Gas to Liquid Flow

$$Q_g = .068 * P_a (u_L/u_g)(cP_g/cP_L) Q_L$$

Leak of Gas	$Q_g$	0	Leak Rate (Same as Conversion)	
Leak of Liquid	$Q_L$	1	Leak Rate (Same as Conversion)	
Avg Pressure	$P'_a$	20	Test Pressure/2	
Viscosity of Liquid	$u_L$	1.13		1.13 Water
Viscosity of Gas	$u_g$	0.018		0.018 Air
Change Pres Gas	$C P_g$	20	Test Pressure	
Change Pres Liquid	$C P_L$	20	Test Pressure	

**ANSWER**

$Q_g =$

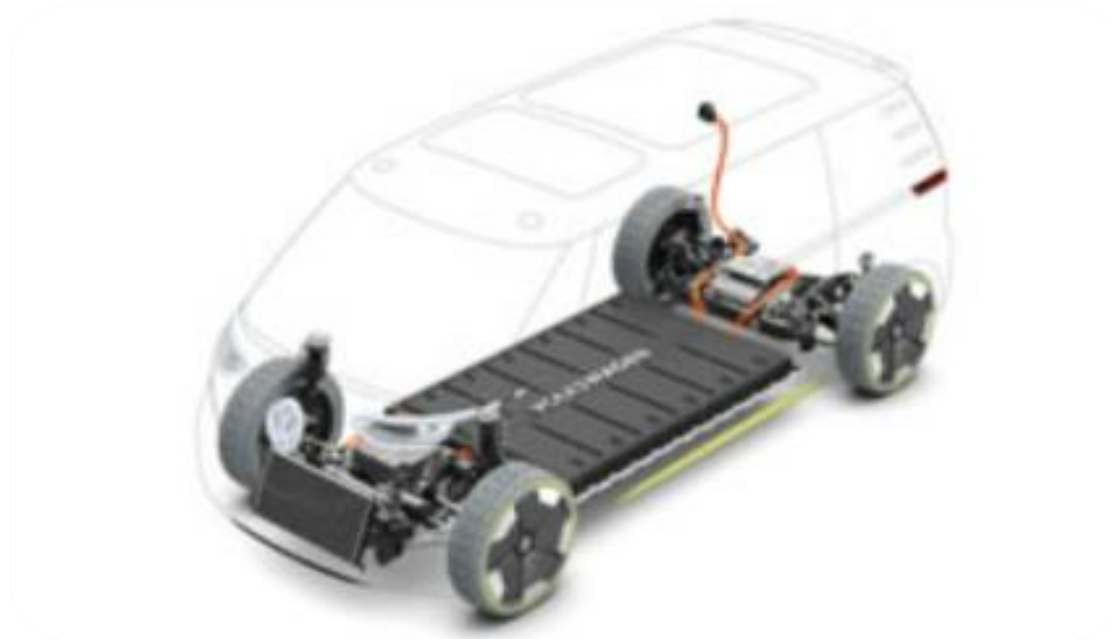
**85.4**



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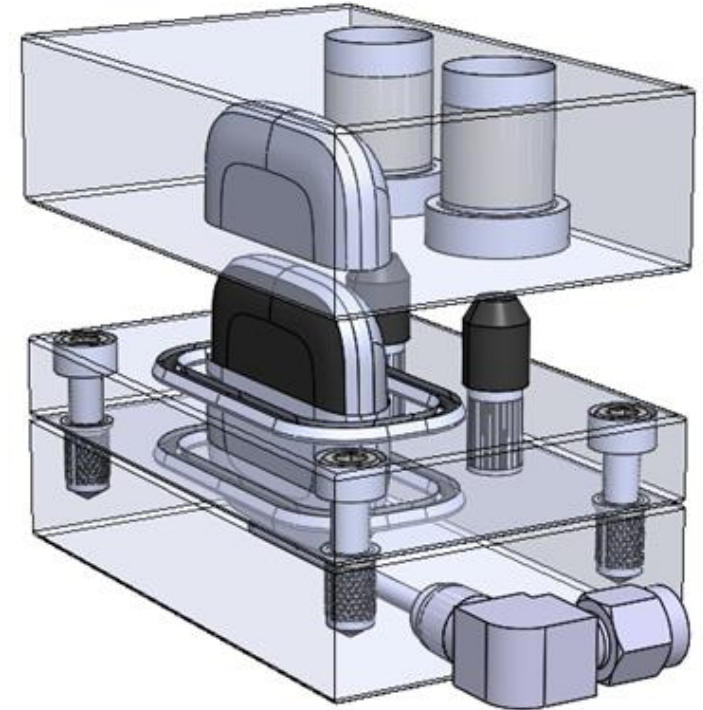
# Electric Vehicle Leak Testing: Trends We See

- ✓ Physical characteristics of EV components are driving the test method selection in many cases
- ✓ Sealed electrical components require different test methods



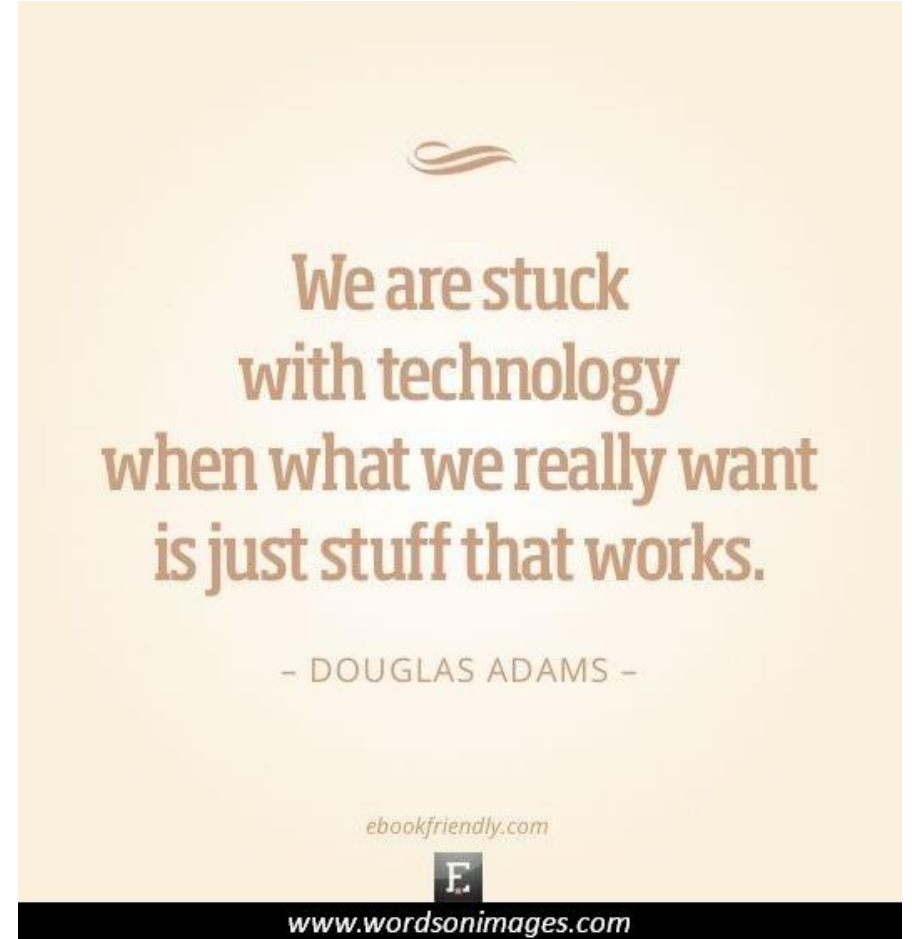
# Sealed Device Leak Testing – Electrical Enclosure Example

- ✓ A sealed part is a part that does not have a port to pressurize
- ✓ This part is placed into a close-fitting chamber and pressurized to IP67 pressure (1.5 psig)
- ✓ Key Requirement:  
The part must be gross leak tested for a large hole using a volumetric fill sequence
- ✓ Caution:  
Without a volumetric fill sequence the part may pass a fine leak test because it is filled with air pressure and has no pressure loss measurement (air has no where to go)



# Leak Testing Technology Trends

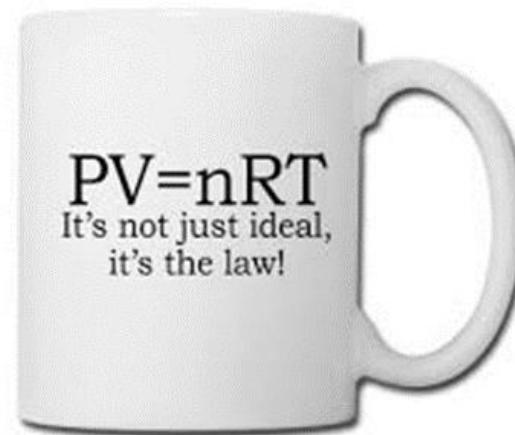
- ✓ Lower leak rates are driving technologies to be:
  - ✓ Higher resolution
  - ✓ More repeatable
- ✓ New part designs are driving technologies to:
  - ✓ Accommodate improved test cycle times
    - ✓ Fill, stabilize, test, exhaust
- ✓ Workforce issues are driving technologies to be:
  - ✓ User friendly
  - ✓ More intuitive requiring less training



# Electric Vehicle Leak Testing: Issues We Experience

- ✓ A library of test specifications doesn't exist for EV related components
- ✓ New ground is being plowed to develop the proper specifications
- ✓ Product designs are changing rapidly... Many changes impact the equipment design!

$$\text{Leak Rate} = \frac{(\text{Volume Tested} \times \text{Pressure Change})}{(\text{Atmospheric Pressure} \times \text{Test Time})}$$



# Part Designs are Changing Test Specifications

- ✓ Material Differences
  - ✓ Lighter weight (thinner materials)
  - ✓ Over molded products
- ✓ Refined manufacturing processes
  - ✓ Laser welding
  - ✓ Improved fastening systems
  - ✓ Adhesives with different joining properties
- ✓ Seal Designs
  - ✓ O-rings
  - ✓ Gaskets

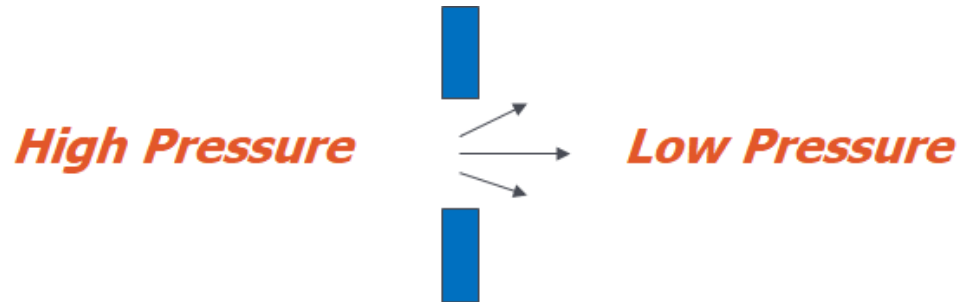
Lower Reject Rates



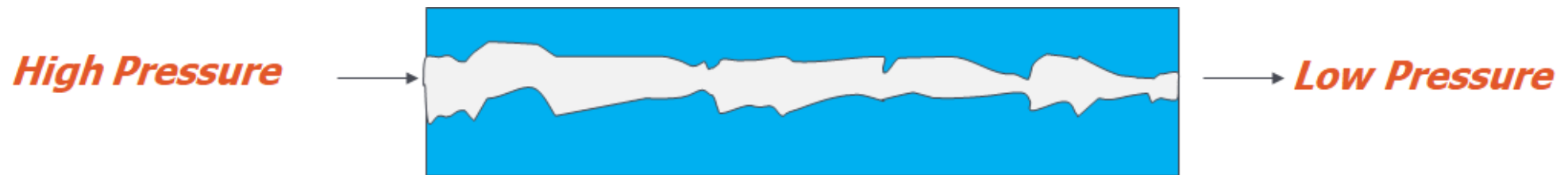
Higher Accept Rates

# Shorter Leak Path = Lower Leak Rates

- ✓ Thin Wall Flow Path (hole dia.  $> 10 \times$  length)



- ✓ Tortuous Path (most leak paths)
  - ✓ Length reduction
  - ✓ Tortuous path not as tortuous



- ✓ Higher Accept Rates with wider more repeatable sealed surfaces

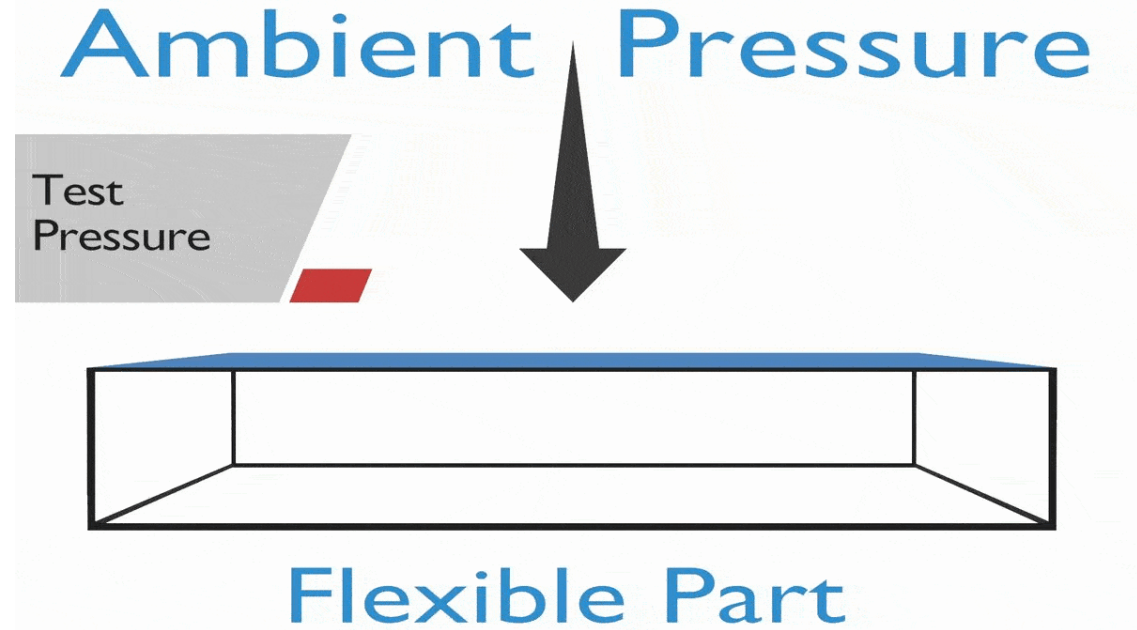
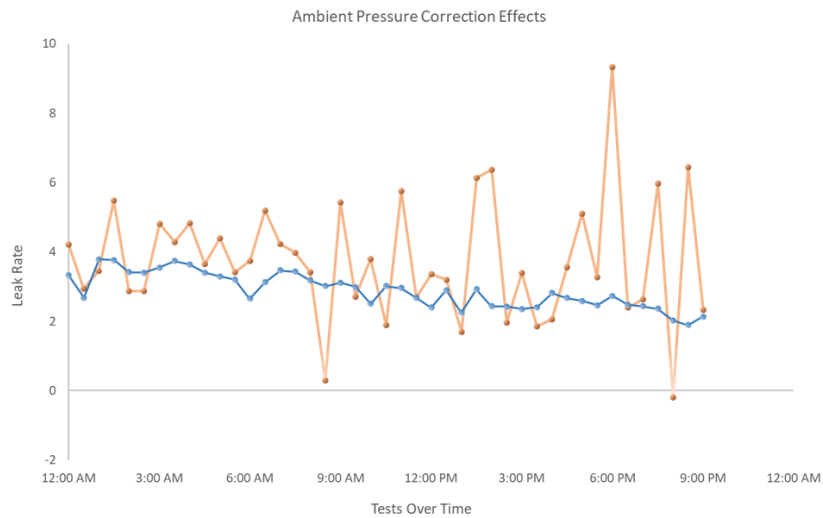
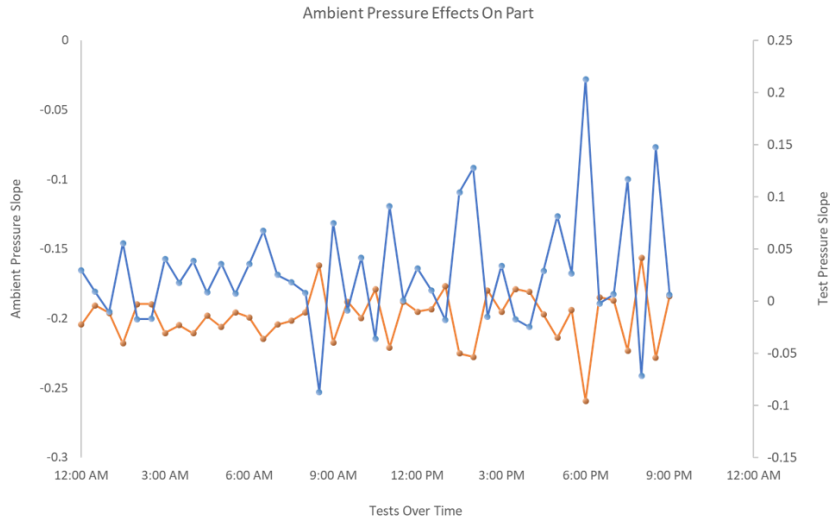
# Electric Vehicle Leak Testing: Issues We Experience

- ✓ The severity of a leak is much more severe
- ✓ Some EV components are large & flexible making them difficult to test
- ✓ More complex test methods had to be developed to create viable tests
- ✓ In-process electrical tests are creating temperature related issues





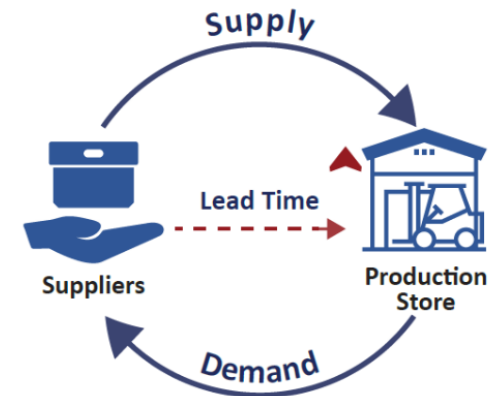
# Large Part Testing With Ambient Correction



- Slope Calculated Over All Data Points
- Ambient Pressure Correction
- High Resolution Sensor Measurement – .000004 psi
- Robust Industrial Solution

# Electric Vehicle Leak Testing: Challenges We Face

- ✓ In an effort to reduce cost, sub-optimal technology selection can occur
  - ✓ Test companies cannot defy the law of physics just to save cost
- ✓ The perfect storm is happening.. Compressed launch cycles converge with extended supplier lead times
- ✓ Chip shortage is resulting in availability issues with key electronic components
  - ✓ Components that took 12 weeks are now taking 52 weeks



# Electric Vehicle Leak Testing: Challenges We Face

- ✓ The engineering labor market is tight and access to talent is a major hurdle
- ✓ The literal use of “simultaneous engineering” is rendering equipment designs obsolete midway through the build process
- ✓ Supply and demand issues are creating inflationary pressures/reducing margins



# Solutions to Common EV Leak Testing Challenges

- ✓ Modular Designed Systems
  - ✓ Allows simpler assembly processes
  - ✓ Easier changeover and maintenance
- ✓ Higher Quantity of Standard Stocked Components
  - ✓ Maintain expected delivery dates
- ✓ Implement High Resolution Sensing Devices  
(DP differential pressure transducers and multiple ranged flow meters)
  - ✓ Allows reduced cycle times
  - ✓ Allows more repeatable leak testing
  - ✓ Allows lower leak rate measurement



# Test Solution Partnership: The Ultimate Objective

- ✓ As part of the production process leak testing cycle times and production through-put have an effect on each other.
- ✓ Budget and affective technology drive to a solution for the application.
- ✓ Key to finding the correct solution is working together in partnership with customer to understand current production needs and be able to apply a scaled solution as production needs increase in the future

# Questions?

Want to talk specific applications,  
visit CTS at Booth #1723

## Better Together

CTS, innomatec, Sciometric, and Sierra are subsidiaries of the TASI Group, within TASI's Product Integrity Division. We are unified by the fact that we are "Better Together". Together, we deliver the broadest leak test portfolio in the industry. Together, we serve our customers through a global network of offices and partners. Together, we will harness the power of the Industrial Internet of Things and bring all of its potential to industrial companies worldwide.



## CTS Corporate Headquarters

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