

A photograph of industrial equipment, possibly a leak testing machine, with a large black fan on the left and a control panel with various buttons and dials on the right. The image is overlaid with a semi-transparent blue filter.

INGRESS LEAK TESTING

Protecting Products from Their Environment

JP De Luca

Sales Manager | Leak Detection Product Manager





Overview

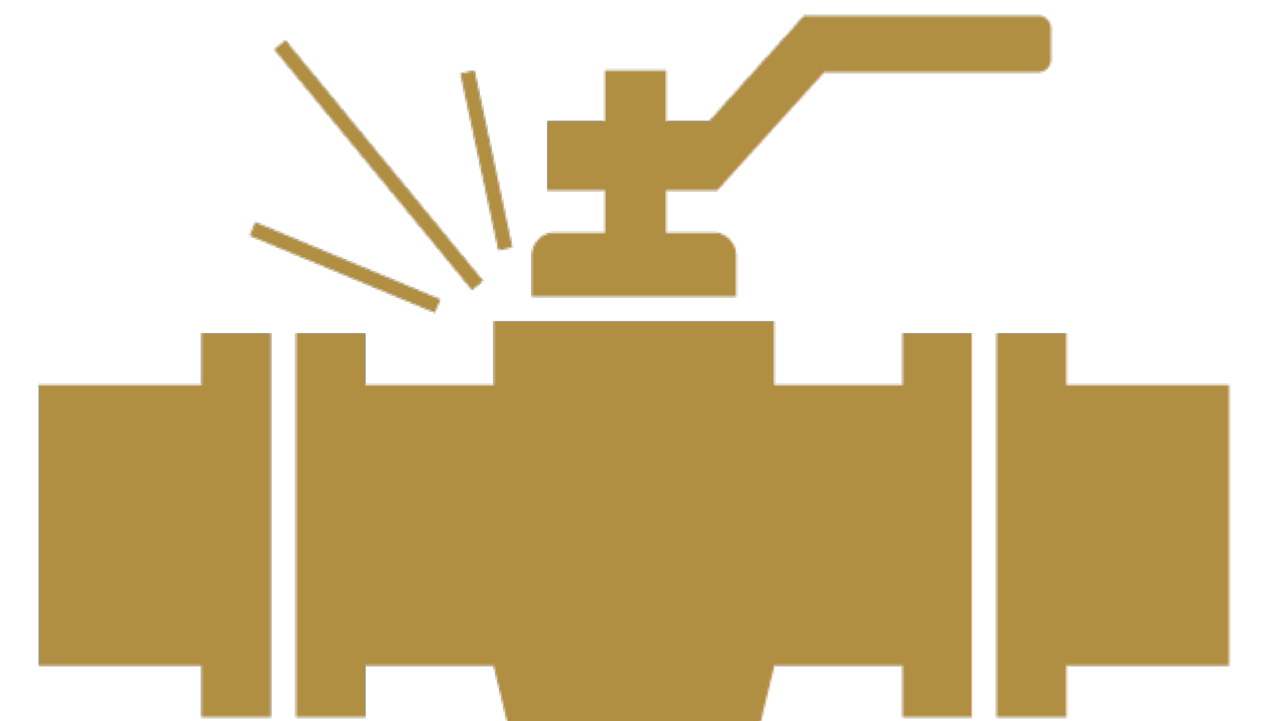
- Why Do You Need to Leak Test?
- Ingression Leak Testing Standards and Guidelines
- Establishing a Leak Rate
- Overview of Leak Testing Methods
 - Helium leak testing
 - Air/Nitrogen Leak Testing
- Selecting a Leak Test Method
- Examples of Ingress Leak Testing Solutions
- Conclusion

A grayscale photograph of an industrial manufacturing plant. The scene shows a complex arrangement of machinery, including conveyor belts, rollers, and various mechanical components. The lighting is somewhat dim, creating a sense of a busy, industrial environment. A large, semi-transparent blue overlay with rounded corners is positioned in the center-right of the image, containing white text. The overall composition is focused on the industrial setting, with the text overlay providing a clear message.

Why Do You Need to Leak Test?

Why Leak Test?

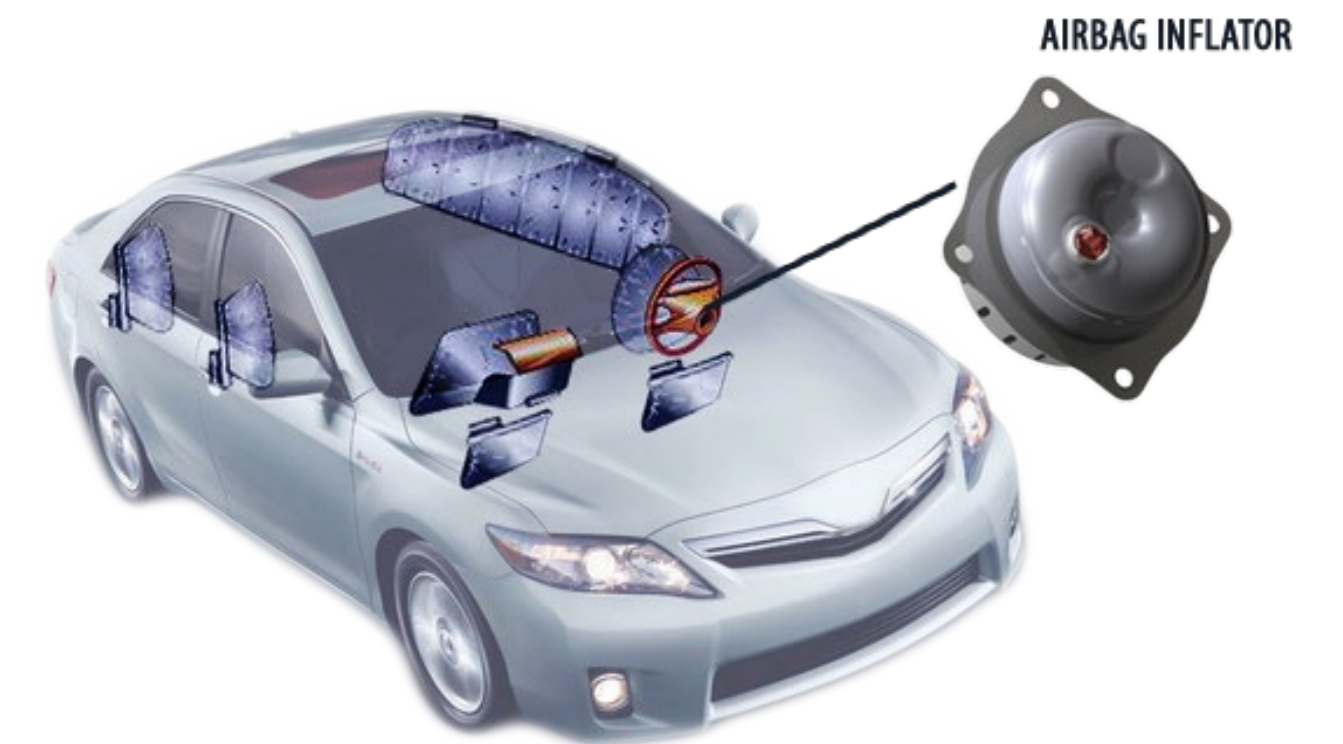
- Production leak testing is implemented to verify the integrity of a manufactured part. It can involve 100% testing or sample inspection.
- The goal of production leak testing is to prevent “leaky” parts from getting to the customer. Because manufacturing processes and materials are not “perfect”, leak testing is often implemented



Why Leak Test?

Prevent **OUT** Leakage

- Depletion of Gas in a Sealed Device or System
 - A/C System
 - Pressurized Airbag Inflator
 - Gas Storage Cylinder
- Leaking of Liquids in a Sealed Device or System
 - 55-gallon Drum
 - Liquid Cooling System
 - Drug Delivery System



Why Leak Test?

Prevent IN Leakage (Ingress)

- Ingression of Water or Dust
 - Handheld Electronic Device
 - Exterior Lighting
- Ingression of Water Vapor
 - Engine Control Module
 - Pyrotechnic Airbag Inflator
 - Electronic Sensors



Why Leak Test?

Prevent IN Leakage (Ingress)

- Ingression of Other Gases
 - Packaged Food Products
 - Pharmaceutical Products
- Ingression of Bacteria
 - Sterile Bioprocess Bags
 - Sterile Packaging



The background image shows a complex industrial machine, likely used for leak testing. It features a series of cylindrical chambers or test cells arranged in a row. Each chamber has a front panel with a handle and a small display or indicator. The machine is constructed from metal and has various pipes, hoses, and electrical connections. The overall scene is a factory or laboratory setting.

Ingression Leak Testing Guidelines & Standards

Ingression Leak Testing Standards & Guidelines

- International Electrotechnical Commission (IEC)
 - IEC 60529, International Protection (IP) Rating (also called Ingress Protection)
 - Dust and Water Ingression Protection for Electrical Enclosures

IPXX Code – Int’l Protection Marking, IEC Std 605329 (Ingress Protection Marking)

First Digit	Effective protection against solid ingress	Second digit	Effective projection against liquid ingress
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1	>50 mm	1	Dripping water (vertically falling drops).
2	>12.5 mm	2	Vertically dripping water at an angle of 15°.
3	>2.5 mm	3	Water falling as a spray at any angle up to 60°
4	>1 mm	4	Water splashing against the enclosure from any direction.
5	Dust protected	5	Water projected from any direction.
6	Dust tight	6	Water projected in powerful jets from any direction
		6K	Powerful water jets with increased pressure
		7	Immersion, up to 1 m depth
		8	Immersion, 1 m or more depth
		9K	Powerful high temperature water jets

Ingression Leak Testing Standards & Guidelines

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- MIL-STD-883K
 - Hermeticity of Microelectronic Devices
 - Humidity Ingression Protection – MIL-STD-883K

MIL-STD-883K Test Method Standard Microcircuits




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This document and process conversion measures necessary to comply with this change shall be completed by 25 August 2017.

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**MIL-STD-883K
w/CHANGE 2
22 February 2017
SUPERSEDING
MIL-STD-883K
w/CHANGE 1
20 July 2016**

**DEPARTMENT OF DEFENSE
TEST METHOD STANDARD
MICROCIRCUITS**



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GA/CGA Surface Mount.
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the perimeter of the pad.

Ingression Leak Testing Standards & Guidelines

- International Electrotechnical Commission (IEC)
 - IEC 60529, International Protection (IP) Rating (also called Ingress Protection)
 - [Dust and Water Ingression Protection for Electrical Enclosures](#)
- MIL-STD-883K
 - Hermeticity of Microelectronic Devices
 - Humidity Ingression Protection – [MIL-STD-883K](#)
- Integrity Testing for Pharmaceutical Industry
 - ASTM, USP, ISO, PDA, and others
 - Both Out-leakage and Bacteria Ingress
- ASTM
 - Multiple Standards

Ingression Leak Testing Standards & Guidelines

- For many applications there may exist no standards or guidelines for determining a leak rate criteria that will ensure appropriate ingression protection for your product
 - **Example 1:** Parts, under 15 psig of pressure, should not leak more than 1 small drop of liquid within 1 hour
 - **Example 2:** No moisture ingress after 1 hour of liquid exposure under a pressure of 30 psig
 - **Example 3:** No leak!

The background of the slide is a grayscale photograph of industrial machinery, likely a robotic assembly line. It features various mechanical components, including metal frames, cables, and what appear to be robotic arms or grippers. The lighting is somewhat dim, creating a technical and industrial atmosphere. A large, semi-transparent blue shape with rounded corners is overlaid on the right side of the image, containing the main title text.

Establishing a Leak Rate

Establishing a Leak Rate

- Understanding the operating conditions of the product
 - Will the product be submerged?
 - Will the product be implanted in a person?
 - Will the product be exposed to weather?
 - Will the product see different altitudes?
 - What is the internal operating pressure of the product?
 - What is the nature of the ingress?
 - What conditions might drive a contaminant into the product?
- Other Criteria
 - What is the expected life time of the product or its content?



Establishing a Leak Rate

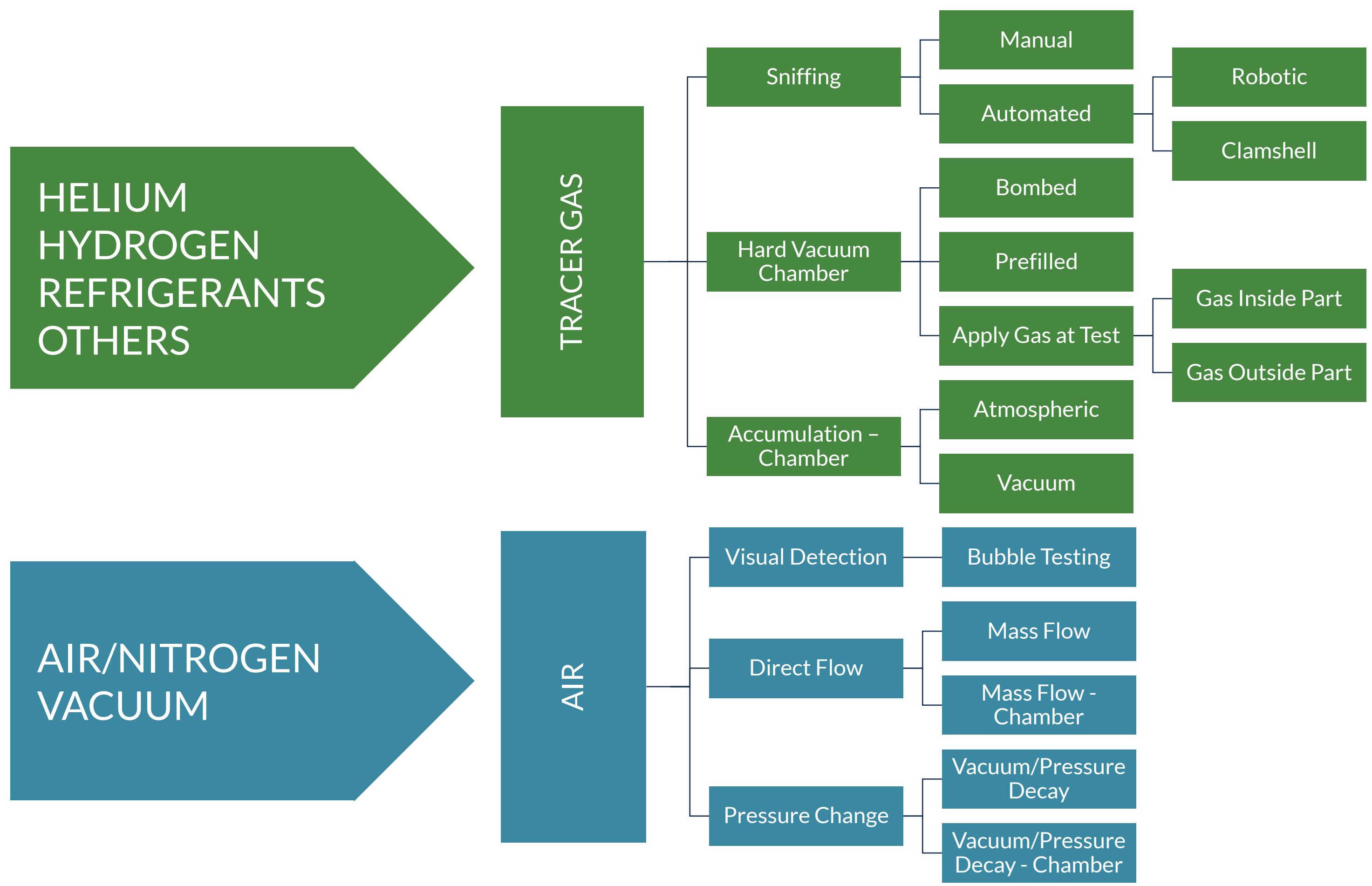
- Empirical studies may be necessary to determine what an ideal leak rate might be for a given product.
 - LACO has conducted many studies duplicating operating conditions, measuring ingress leakage (moisture ingress for instance)
 - LACO has extensive experience running tests using our built-in calibrated leak standards – **Micro Tube Capillary (MTC)** – in mockup parts to replicate various environmental conditions. Data collected is a great reference database to help our customers determine the required leak rate



The background image shows a complex industrial machine, likely used for leak testing. It features several large, cylindrical components and various mechanical parts. A blue semi-transparent overlay is positioned in the center, containing the title text. The overall scene is in grayscale, emphasizing the metallic and industrial nature of the equipment.

Overview of Leak Testing Methods

Common Production Leak Testing Methods

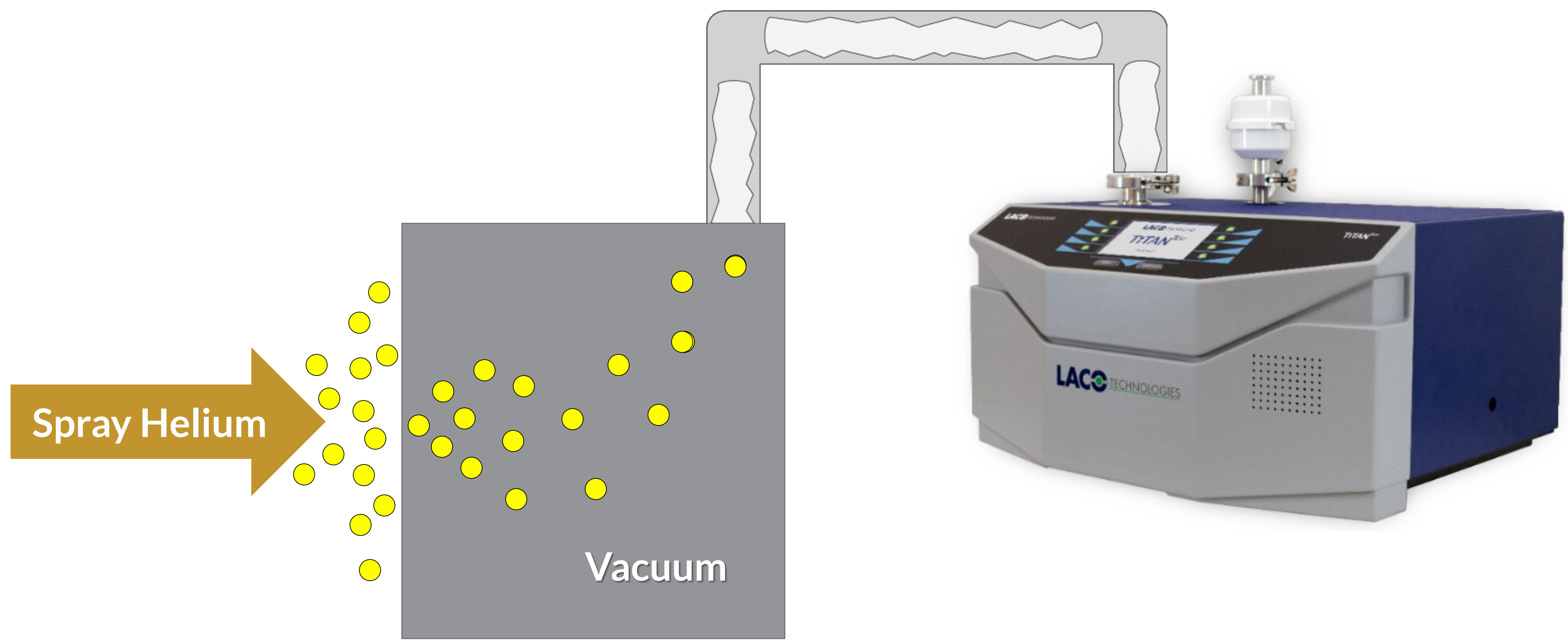


The background image shows a complex industrial machine, likely used for helium leak testing. It features a series of cylindrical chambers or test cells arranged in a row, with various pipes, valves, and mechanical components. The machine is mounted on a sturdy metal frame. The overall scene is a technical, industrial environment.

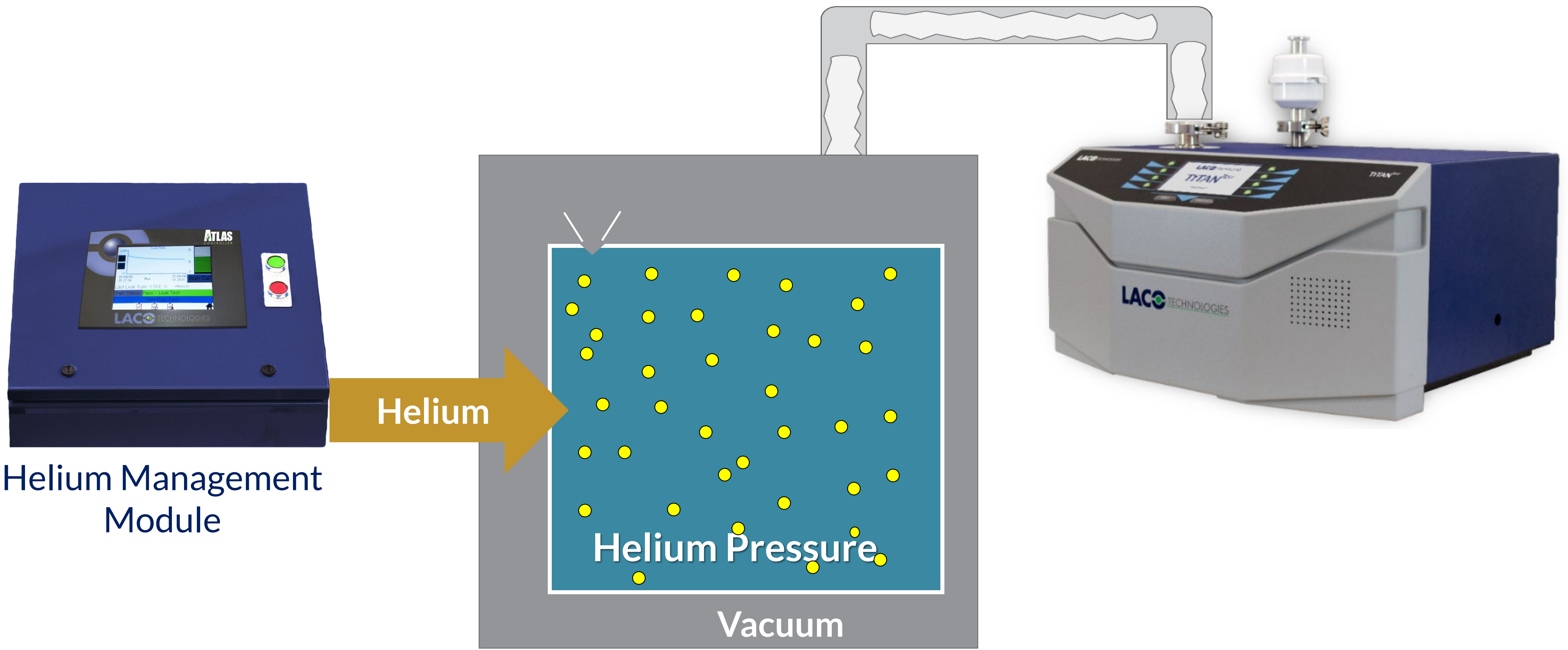
Helium Leak Testing

Hard Vacuum / Sniffing Methods

Hard Vacuum Test Outside-In: Helium Spray



Hard Vacuum Test Inside-Out



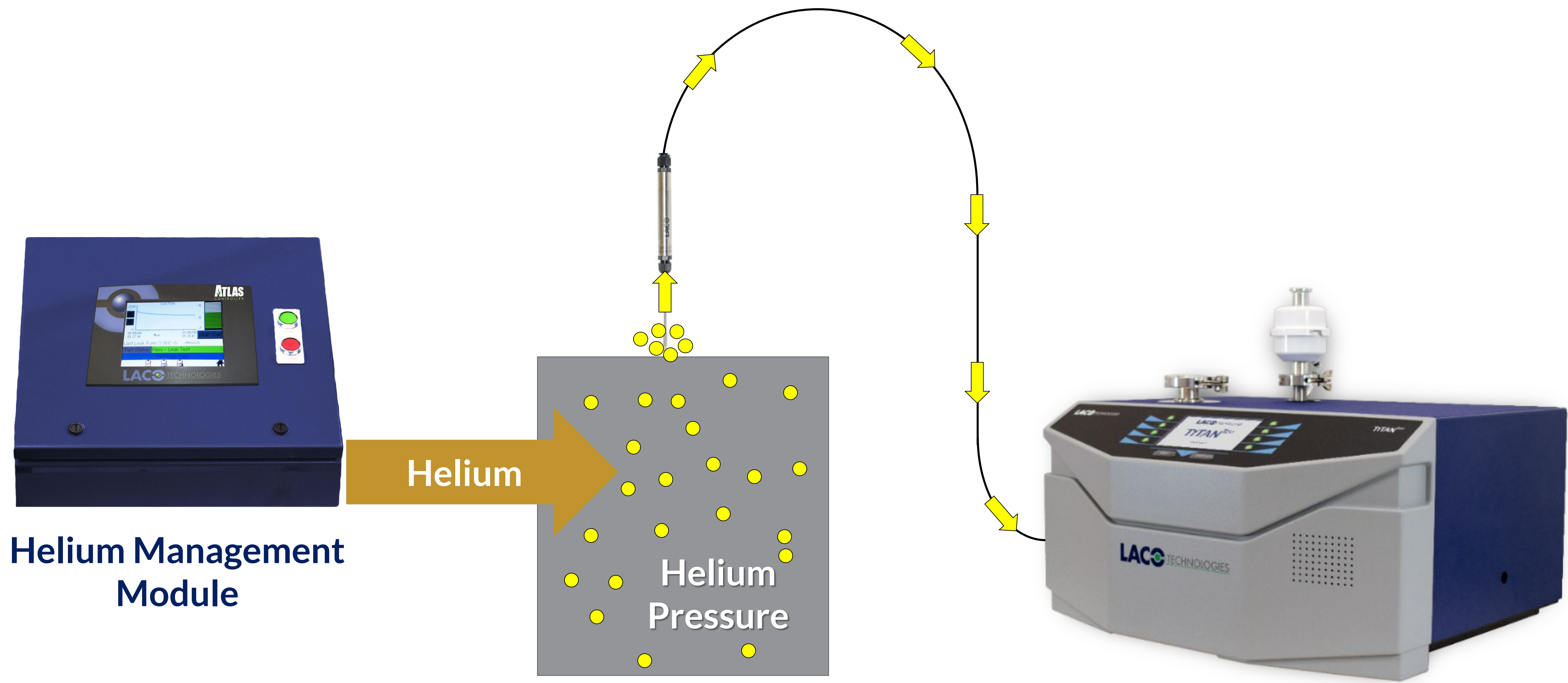
Helium Management Module

Helium

Helium Pressure

Vacuum

Helium Sniffing Test Principle



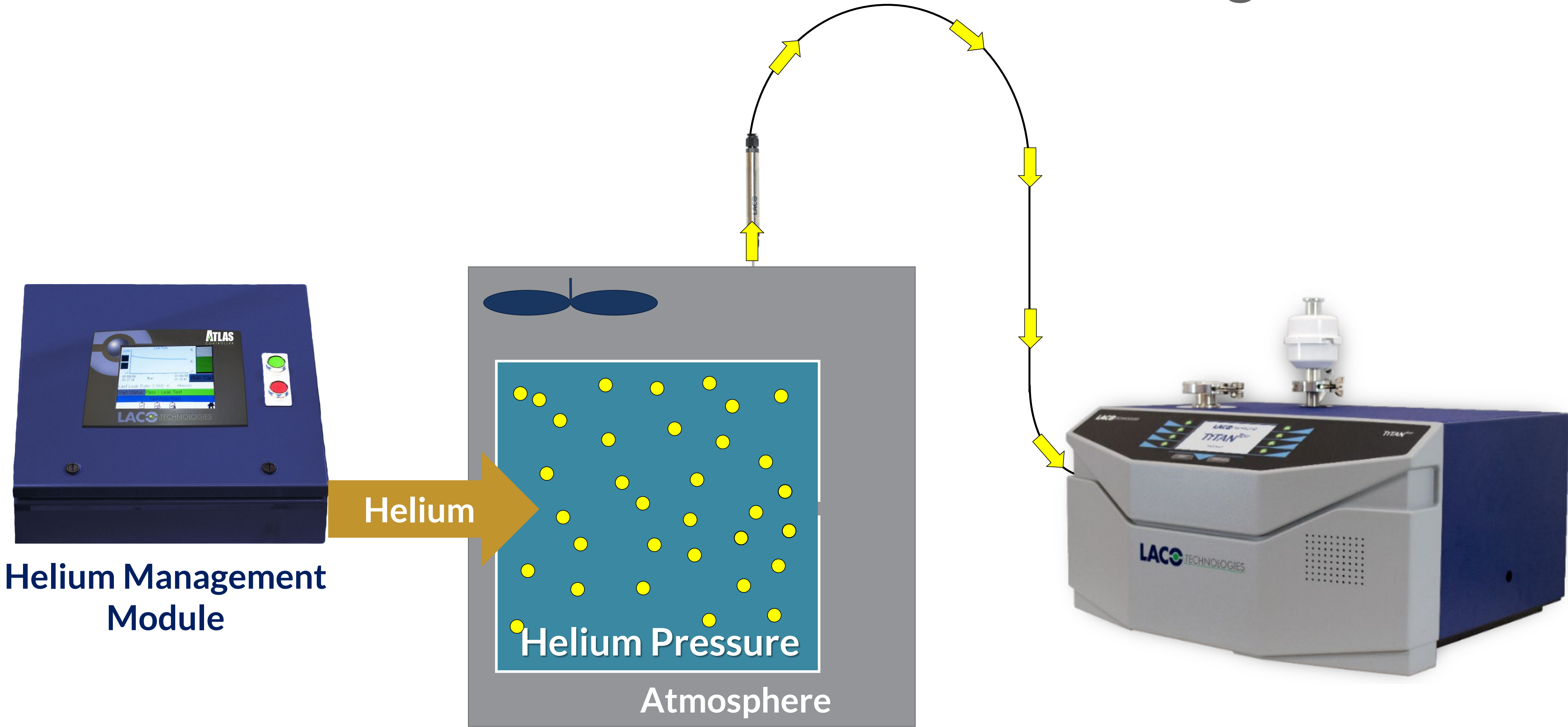
Helium Management Module

Helium

Helium Pressure

LACO TECHNOLOGIES

Accumulation Test Inside-Out: Helium Charged Part

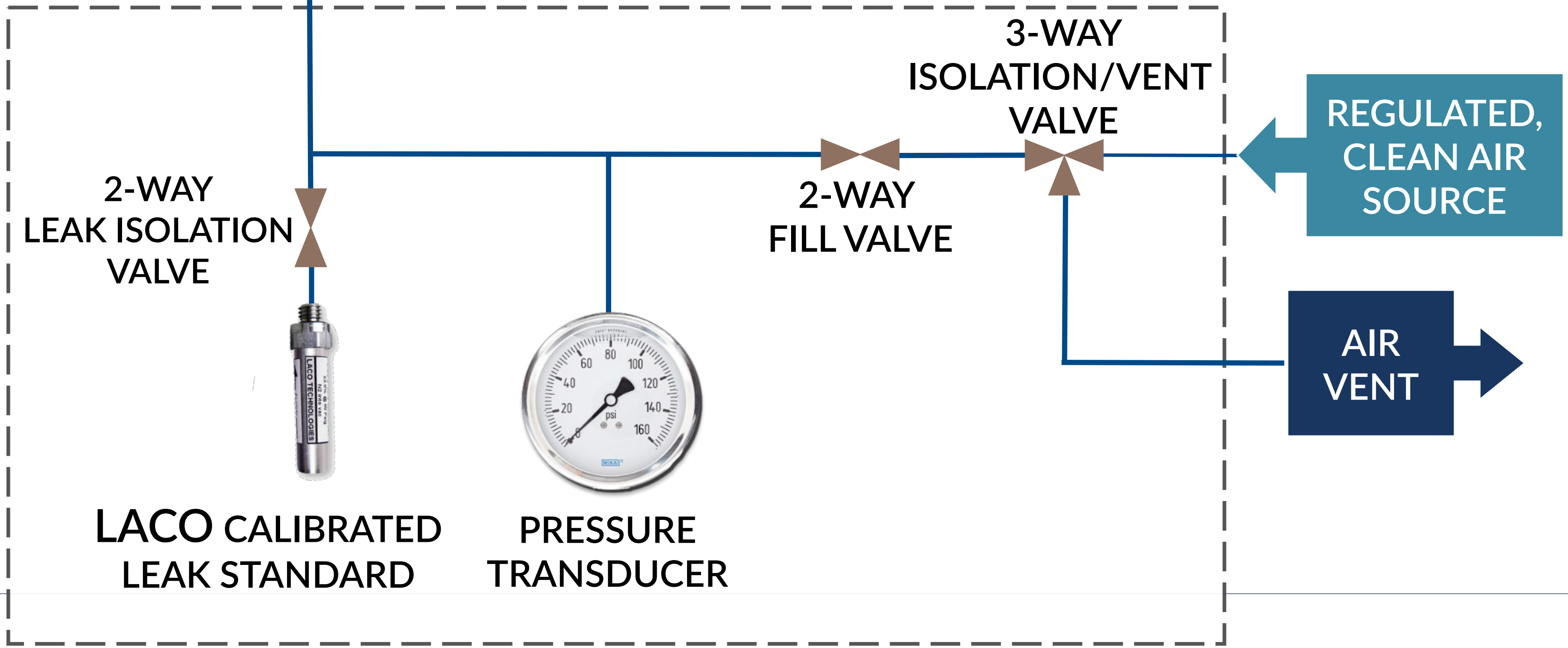
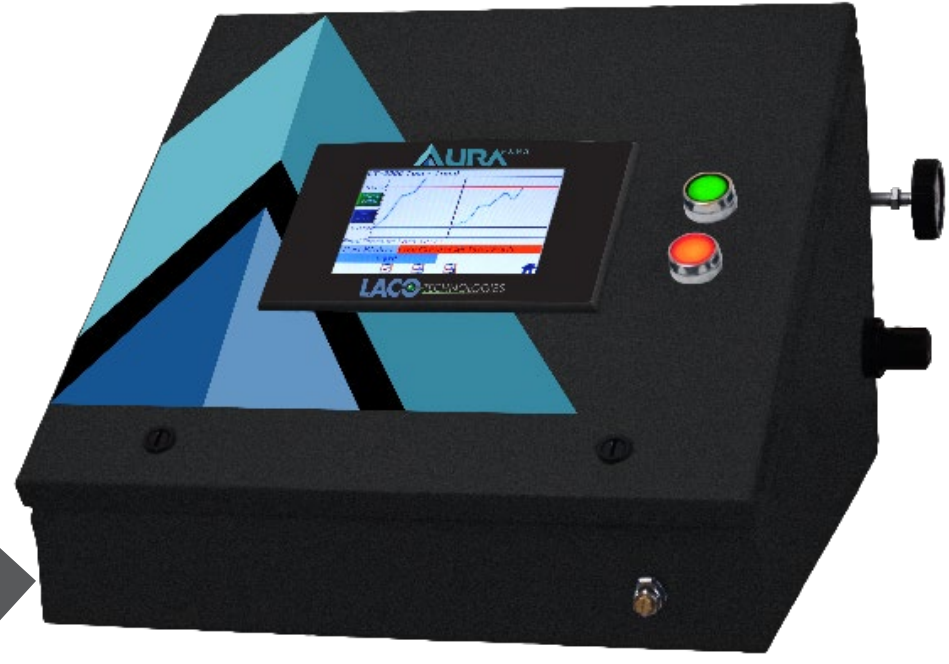
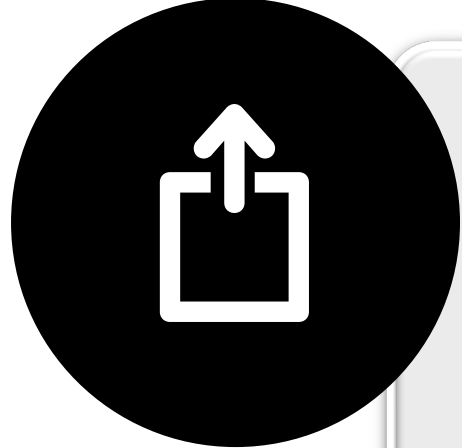


The background image shows a complex industrial testing facility. In the foreground, there are several large, cylindrical metal components, likely test chambers or sensors, arranged in a row. Behind them, a series of control panels or cabinets are visible, each with a small display or indicator. The overall scene is a clean, well-lit industrial environment. A dark blue, semi-transparent banner with rounded corners is overlaid on the right side of the image, containing the main title and subtitle in white text.

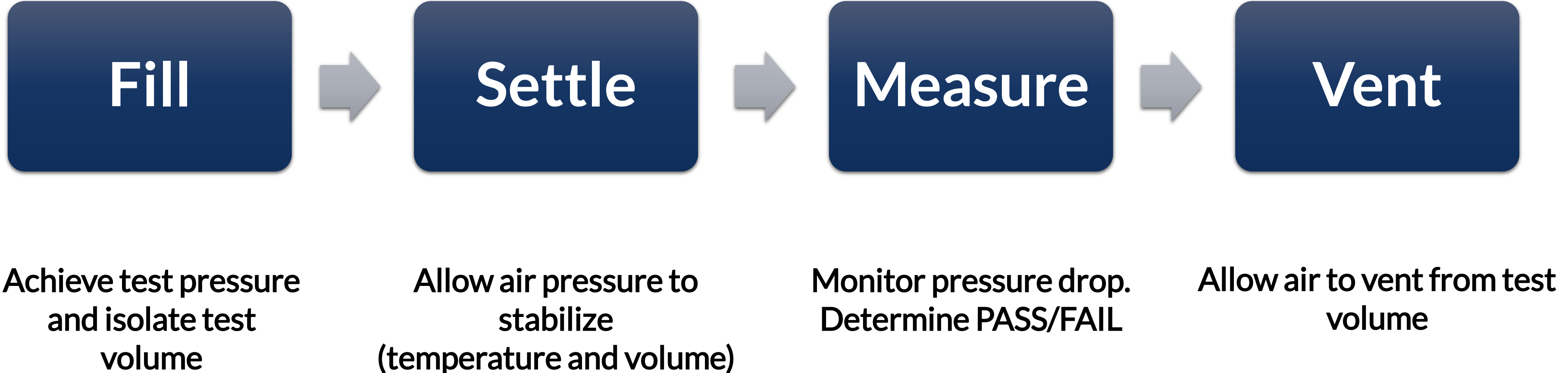
Air/Nitrogen Leak Test Testing

Pressure Decay / Mass Flow

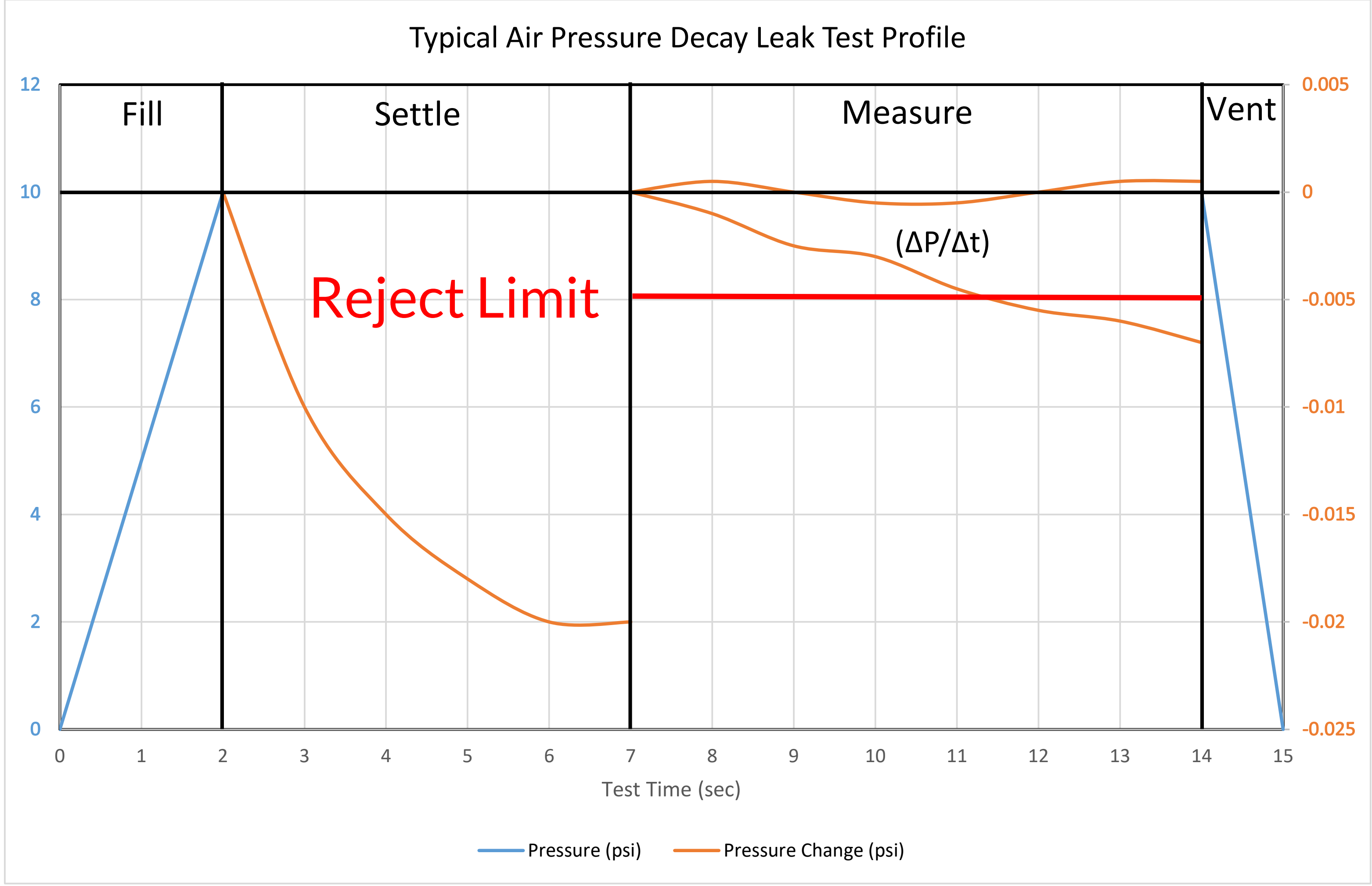
Air Pressure Decay Leak Testing – OPEN Part



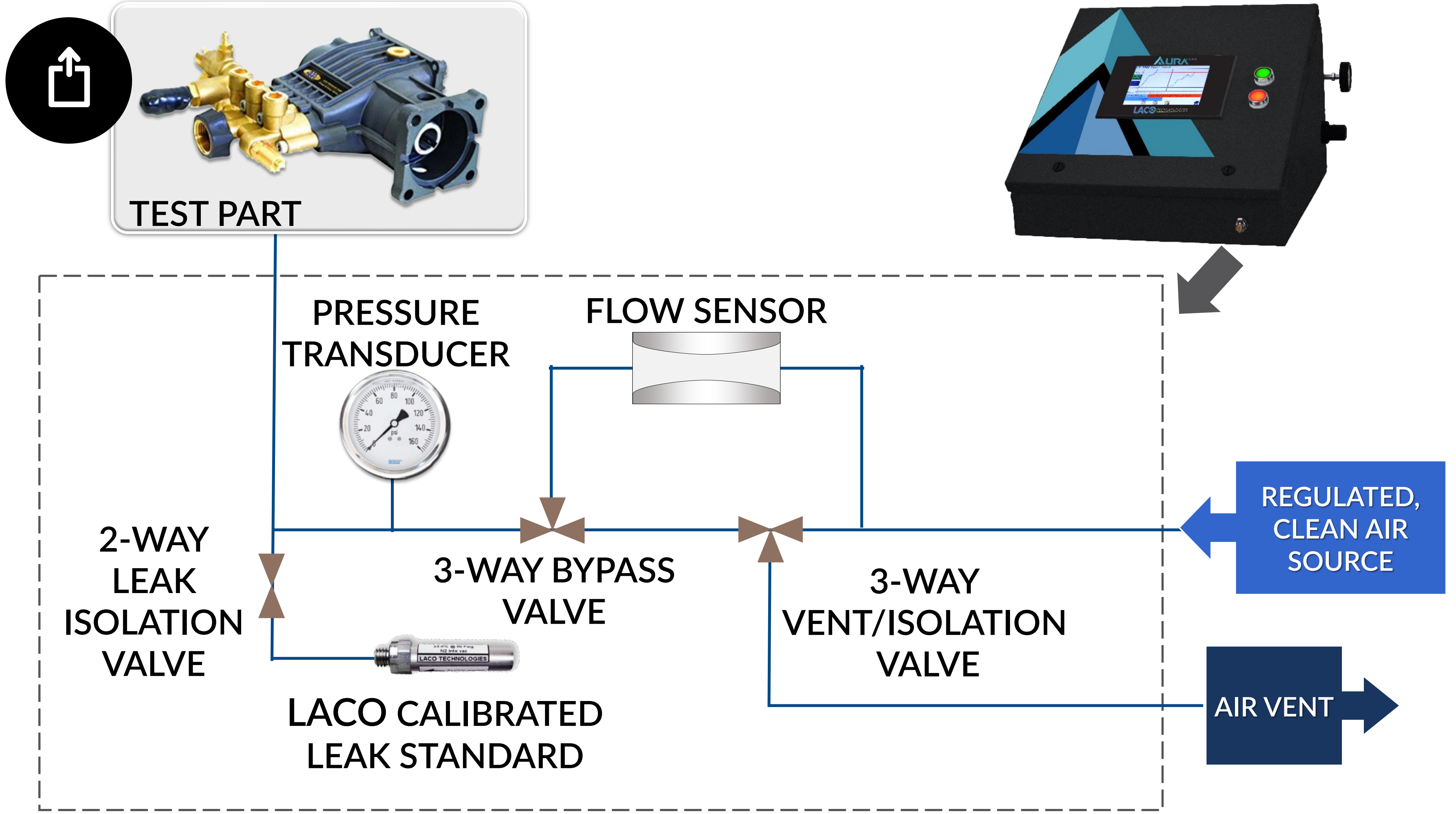
Air Pressure Decay Leak Test Basic Steps



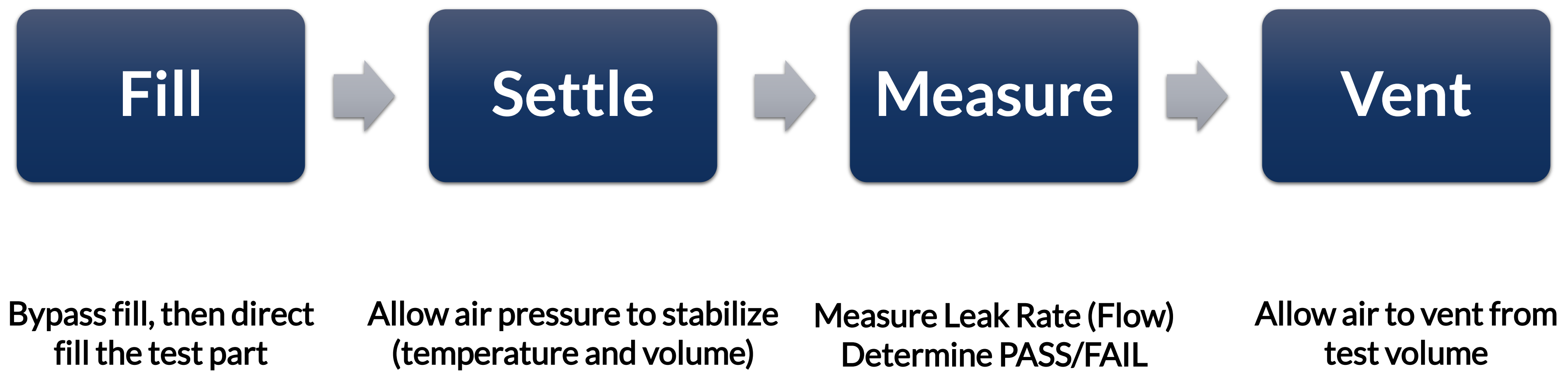
Basic Principle of Air Pressure Decay Leak Test



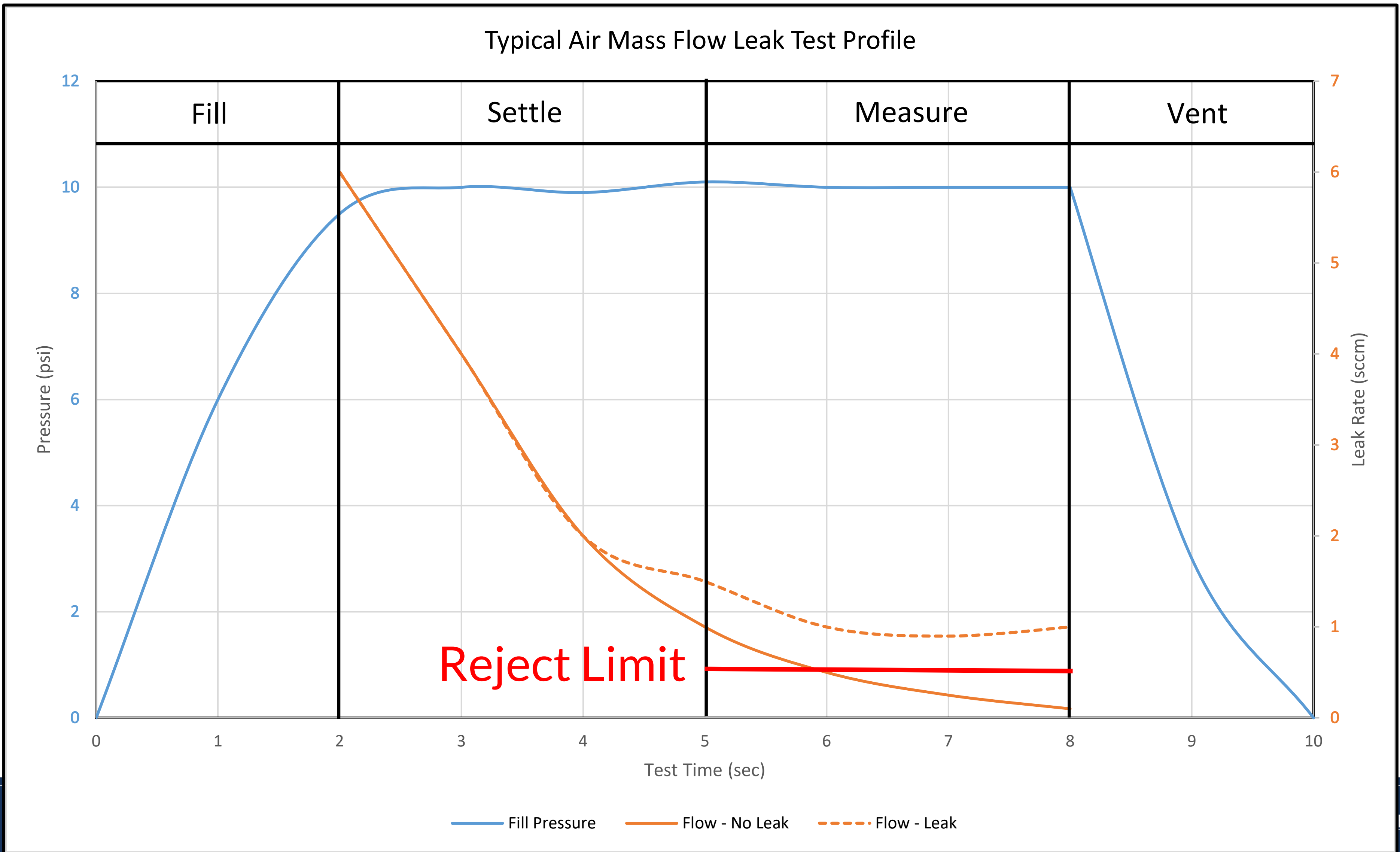
Direct Air Mass Flow Test – OPEN Part



Direct Mass Flow Test – Basic Steps



Basic Principle of Air Mass Flow Leak Test



Common Production Leak Test Methods with Associated Characteristics

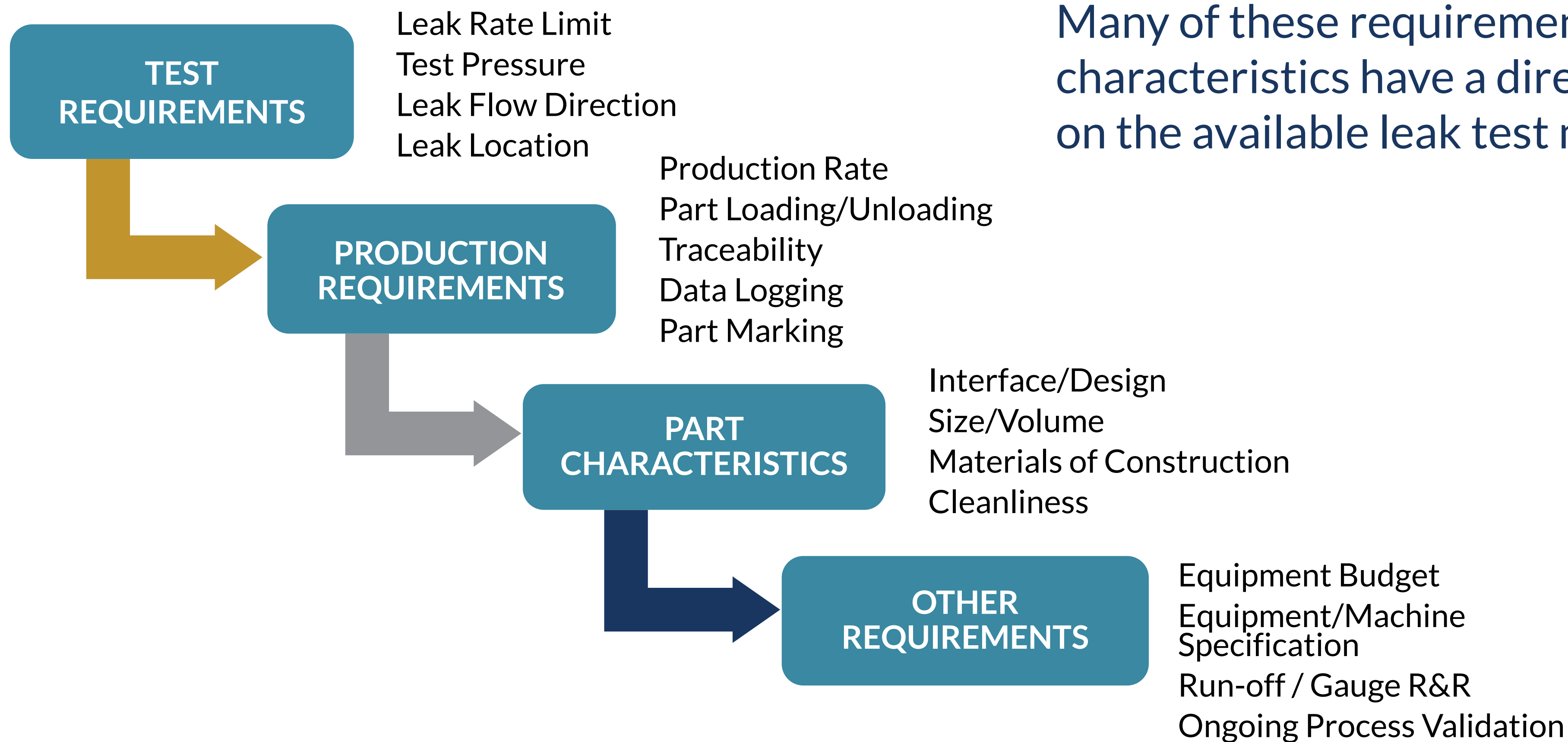
Method	Quantify	Locate	Global 1	Go / No Go	Test Media	Test Volume Dep. ²	Relative Cost	Typical Sensitivity (atmcc/sec)
Air Pressure (Vacuum) Decay	Yes	No	Yes	Yes	Air	Yes	Medium	0.01
Mass Flow	Yes	No	Yes	Yes	Air	Yes	Medium	0.01
Dye Liquid Tracers	No	Yes	No	No	Liquid	No	Low	0.001
Bubble Immersion	No	Yes	No	No	Air	No	Low	10 ⁻⁴
Thermal Conductivity Sniffing	Limited	Yes	No	Yes ³	Helium	No	Low	10 ⁻⁵
SF6 Sniffing	Limited	Yes	No	Yes ³	SF6	No	Low-Med	10 ⁻⁵ to 10 ⁻⁹
Halogen Sniffing	Limited	Yes	No	Yes ³	Halogens	No	Low-Med	10 ⁻⁴ to 10 ⁻⁹
Helium Mass Spec Sniffing	Limited	Yes	No	Yes ³	Helium	No	Med-High	10 ⁻⁷
Helium Mass Spec Atmosphere Accumulation	Yes	No	Yes	Yes	Helium	Yes	High	Approx. 10 ⁻⁴
Helium Mass Spec Hard Vacuum	Yes	Yes	Yes	Yes	Helium	No	High	10 ⁻⁹
Trace Gas Mass Spec Hard Vacuum	Yes	Yes	Yes	Yes	R134a, SF6, Air, H2, NO ₂ , CO ₂	No	High	10 ⁻⁷ gas dependent

1. The test method measures the global leak rate of the part, versus individual leaks.
 2. The test volume significantly affects the test cycle time and/or sensitivity.
 3. Result may be operator dependent.

The background image shows a complex industrial manufacturing environment. In the foreground, there are several large, cylindrical metal components, possibly parts of a turbine or engine, arranged in a row. Behind them, there are various mechanical structures, pipes, and electrical conduits. The overall scene is a detailed view of a factory floor. A semi-transparent blue overlay with rounded corners is positioned in the center of the image, containing the title text in white.




Selecting a Leak Test Method

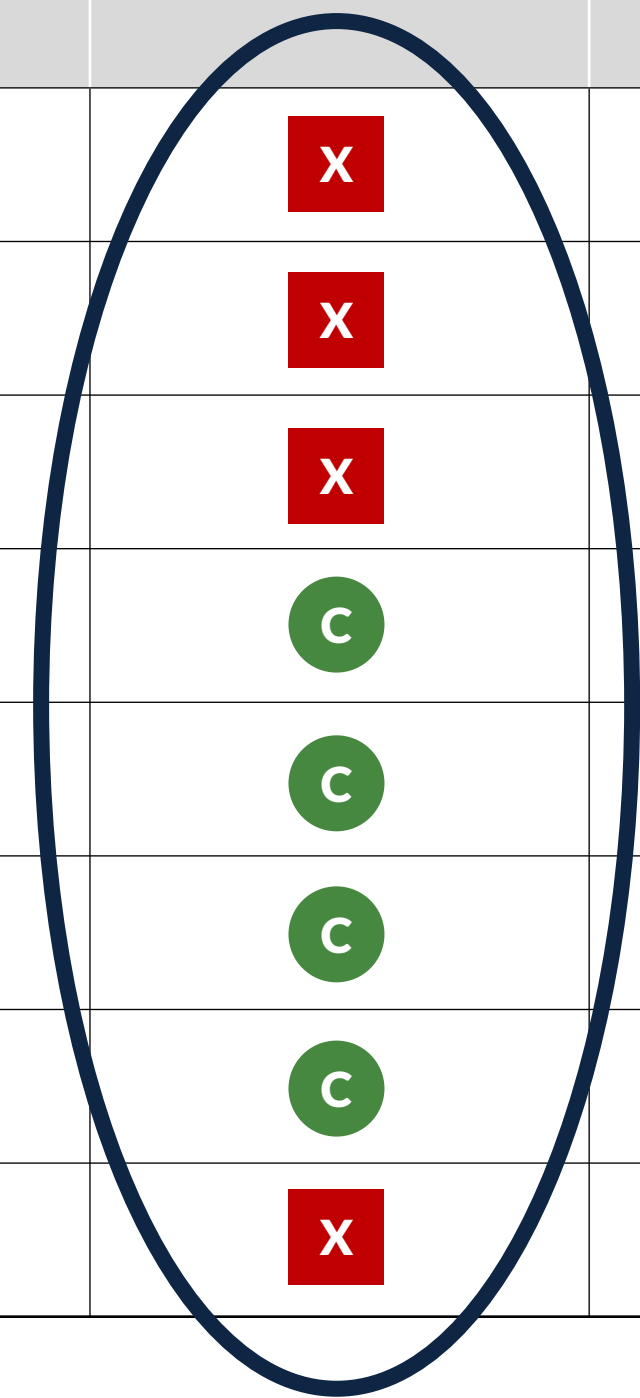
Selecting a Leak Test Method




Example of Method Selection

Method	Leak Rate Sensitivity (atmcc/sec)				
	> 0.01	0.01 – 10 ⁻⁴	10 ⁻⁴ – 10 ⁻⁶	10 ⁻⁶ – 10 ⁻⁸	< 10 ⁻⁸
Tracer Gas Leak Testing					
Helium Sniffing - Manual	P	C	C	X	X
Helium Sniffing - Robotic	P	C	C	X	X
Helium Sniffing - Chamber/Clamshell	C	C	P	X	X
Hard Vacuum Helium - Bombed	X	P	C	C	C
Hard Vacuum Helium - Prefilled	P	P	C	C	C
Hard Vacuum Helium - Gas Inside Part	X	P	C	C	C
Hard Vacuum Helium - Gas Outside Part	X	P	C	C	C
Helium Accumulation (Atm/Vac)	C	C	P	X	X

-  = Compatible
-  = Possibly Compatible, but not Ideal
-  = Not Compatible



A grayscale photograph of an industrial manufacturing environment. In the foreground, there is a complex assembly of machinery, including a large cylindrical component with a circular opening. In the background, a long conveyor belt system is visible, with several white cylindrical objects being processed. The overall scene is a typical industrial factory floor.

Examples of Ingress Leak Testing Solutions

Example of Ingress Leak Testing: Application #1

- **Part Description:** Sealed Pharmaceutical Packages
- **Leak Rate Requirement:** Comply with ASTM F2096 and ASTM D3078
Bubble Testing to Assess Package Integrity
- **Test Pressure:** Vacuum
- **Selected Leak Testing Method:** Bubble Leak Testing

Bubble Leak Tester



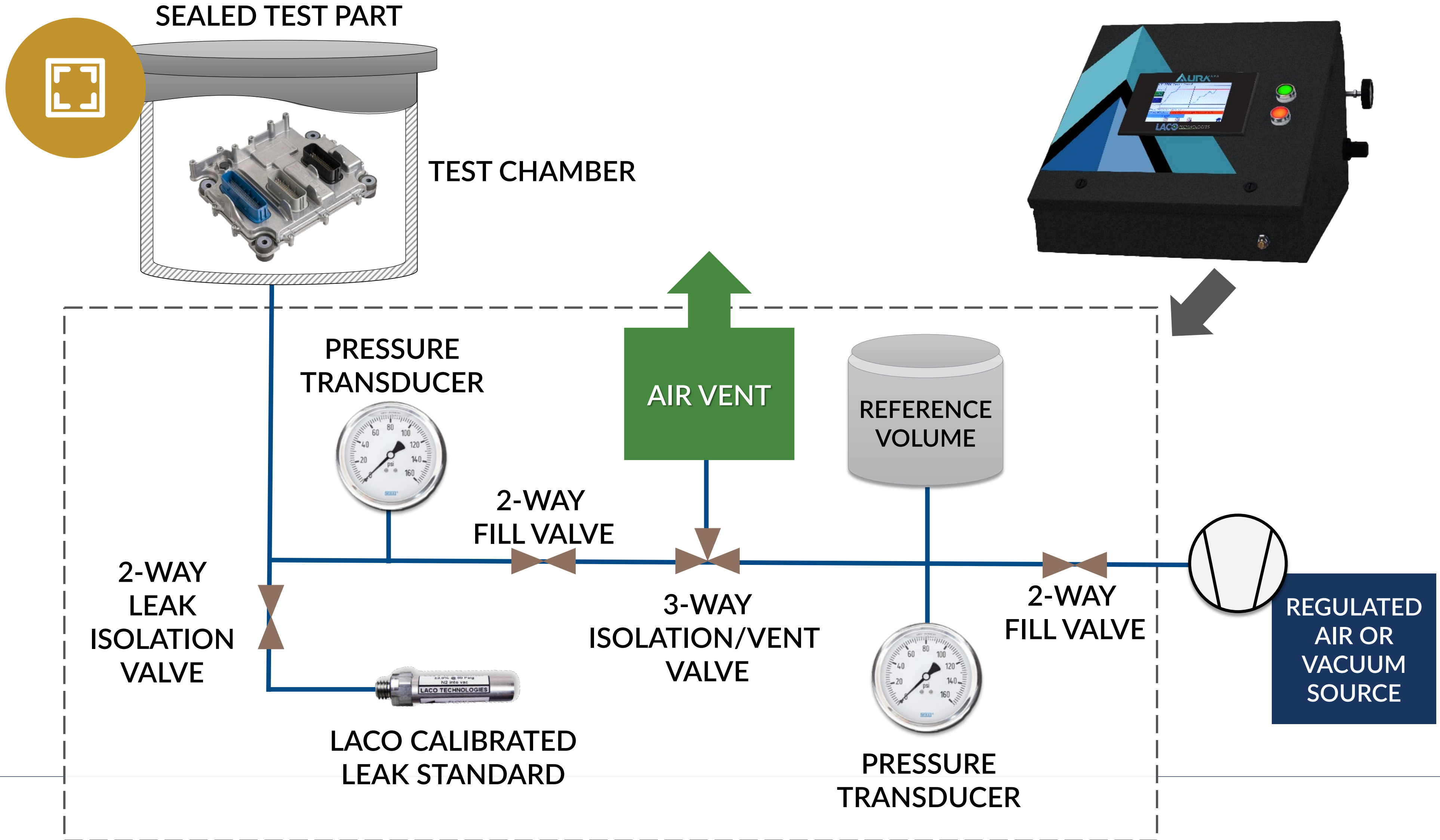
- Part is submerged under water
- A vacuum is generated above the water
- A pressure differential is created between the inside and the outside of the part
- Bubbles will form at leaking point(s)

Note: Size and stream of bubbles will vary based on the part leakage level

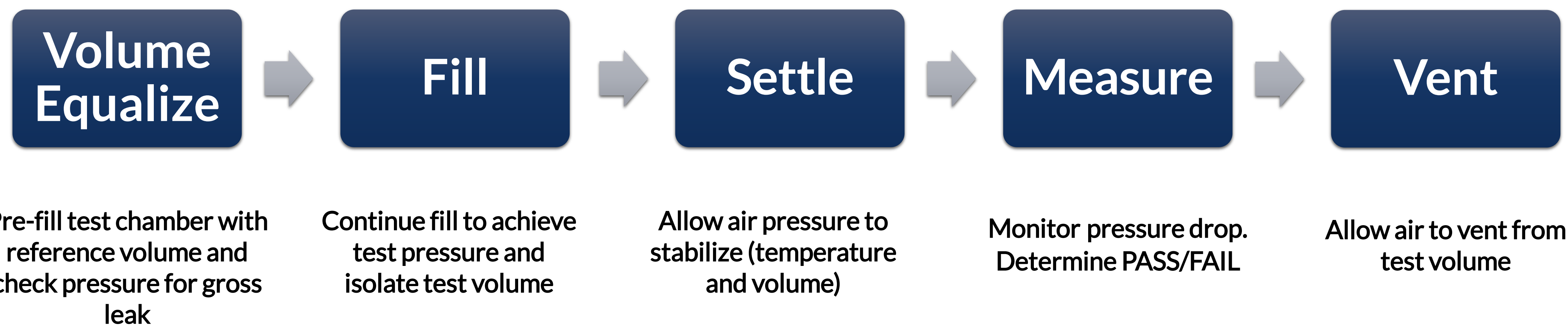
Example of Ingress Leak Testing: Application #2

- **Part Description:** Sealed Electrical Enclosure
- **Leak Rate Requirement:** Comply with the IP67 Standard
- **Leak Rate Specification:** 1 SCCM (typical) CM
- **Test Pressure:** 1.5 psig
- **Selected Leak Testing Method:** Pressure Decay

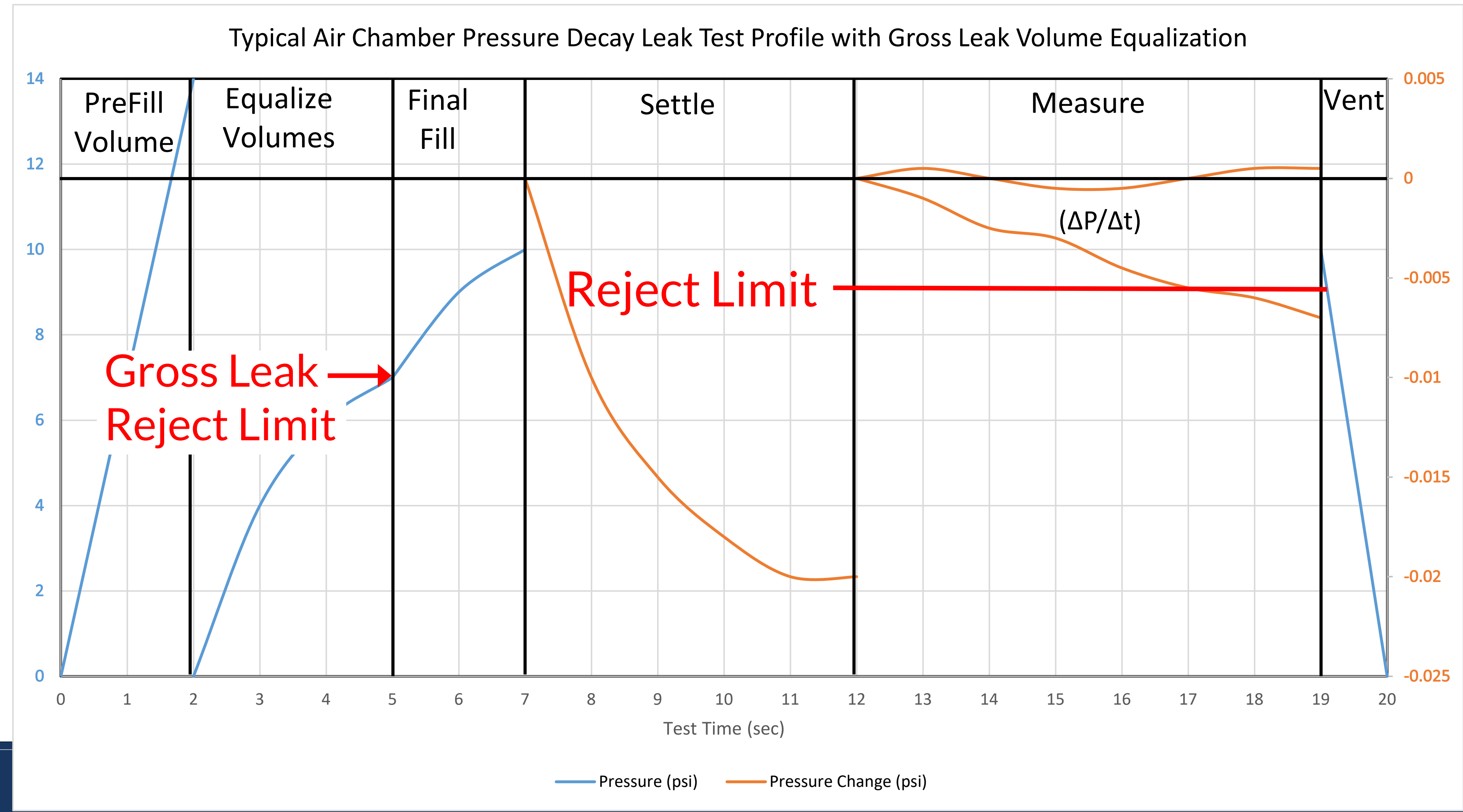
Air Pressure Decay Chamber Test – SEALED Part



Chamber Air Pressure Decay Leak Test Basic Steps



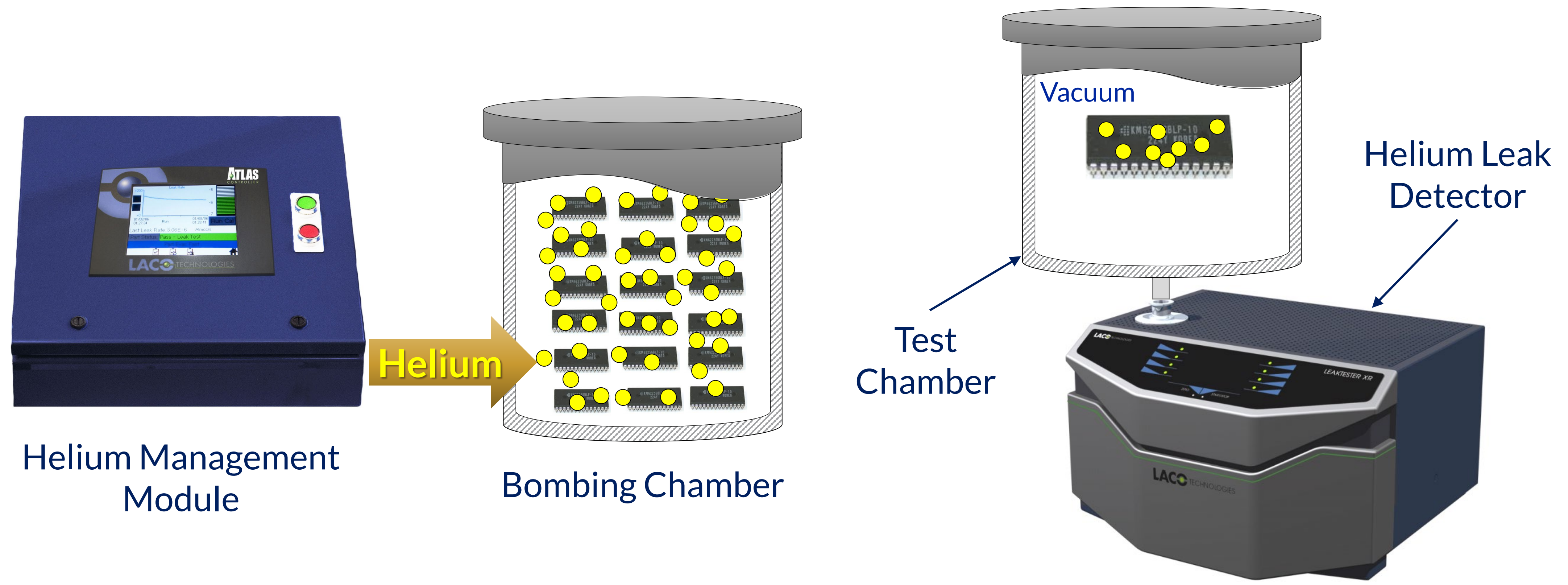
Basic Principle of CHAMBER Air Pressure Decay Leak Test



Example of Ingress Leak Testing: Application #3

- **Leak Testing Application:** Hermetically Sealed Device
- **Part Description:** Small Sealed Part
- **Leak Rate Requirement:** 1×10^{-8} atm.cc/sec
- **Leak Testing Method:** Helium Bombing Method
- **Using the MIL-STD-883K Standard**
 - Helium is forced into the part prior to the helium leak test process
 - Bombing Pressure: 90 psig
 - Pressurization Time: 5 hours
 - Dwell Time: 30 min.

Hard Vacuum Test Inside-Out: Bombing Method – MIL-STD-883K



Helium Management Module

Bombing Chamber

Test Chamber

Helium Leak Detector

Step 1: Helium bombing process
(several parts at a time)

Step 2: Helium leak testing process

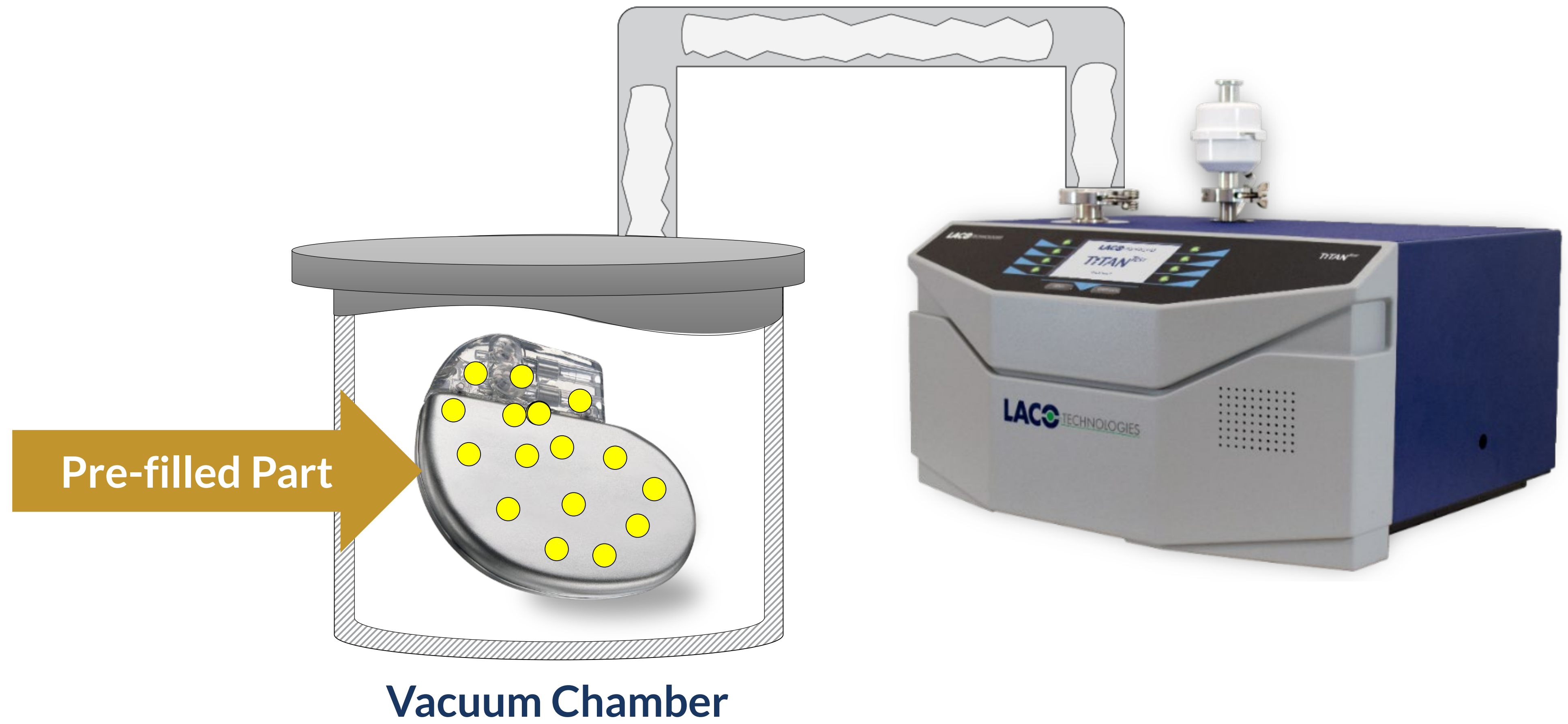
Alternative Solution To Helium Bombing Method

- The Bombing Method Requires
 - One or more bombing chambers
 - A helium management system (to evacuate, pressurize with helium and then vent the helium out of the bombing chamber)
 - The bombing time can be quite long – hours - (based on the leak rate requirements, the part internal dead space and the maximum bombing pressure the parts can withstand)
 - The bombing method has limitations in terms of leak rate sensitivity (MIL-STD-883K)
- The Alternative
 - Whenever possible, seal the parts within a helium controlled environment. This alternative is a good economical solution (App # 4)

Example of Ingress Leak Testing: Application #4

- **Leak Testing Application:** Sealed Part
- **Part Description:** Medical Implant
- **Leak Rate Requirement:** 1×10^{-9} atm.cc/sec
- **Leak Testing Method:** Helium Hard Vacuum with Test Chamber
- Part is welded in a controlled environment with a specific % of helium
- Helium is present in the part prior to the helium leak test

Hard Vacuum Test Inside-Out





Conclusion

Conclusion

- More and more applications are for ingress leak testing.
- The ingress can be of different nature and size, depending on the product, application requirements, standards, etc.
- Defining the correct leak rate for some applications can be challenging and require empirical studies, LACO has extensive experiences in running such studies and helping customers defining the correct leak rates.
- LACO is unique with offering the widest range of leak testing methods to all ingress leak testing requirements.

THANK YOU!

- Stop By Our Booth (#1438) to Validate Your Coupon for a FREE Calibrated Leak Standard
- Contact Us to Review Your Current Calibration and Validation Strategy
- LinkedIn Group: *Production Leak Testing*
- Blog: www.lacotech.com/posts
- Website: www.lacotech.com





RESOURCES

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6	Dust tight	6	Water projected in powerful jets from any direction
		6K	Powerful water jets with increased pressure
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		8	Immersion, 1 m or more depth
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