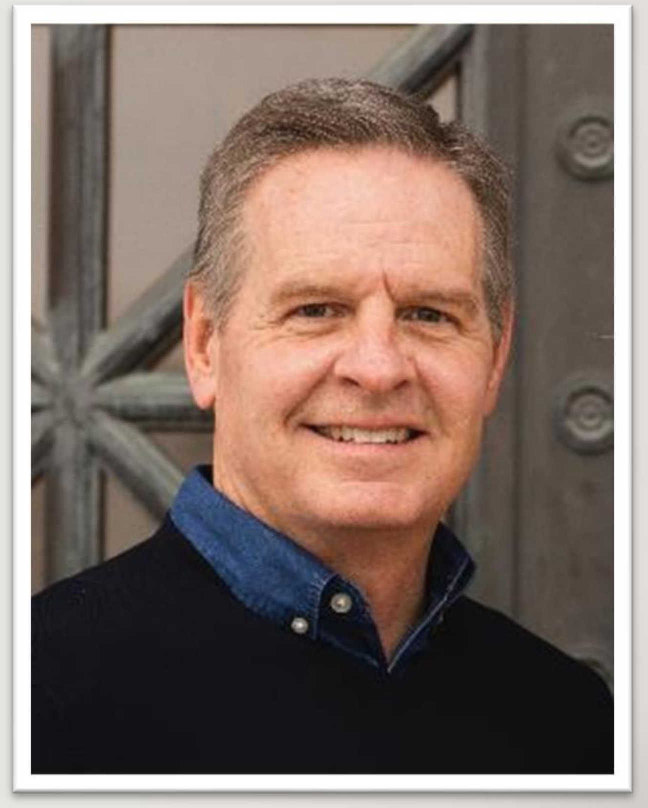
Production Leak Testing Best Practices



Paul Chamberlain

President/CEO
LACO Technologies, Inc.

Overview

- Introduction to LACO Technologies
- Review of Leak Test Project Phases
- Six Keys to Success by Phase
- Conclusion & Summary

About
LACO Technologies

Founded:	1975
Headquarters:	Salt Lake City, Utah USA
Employees:	90+ direct employees
Support Network:	15+ global reps, distributors and ASFs
Customer Reach:	Over 900 customers in 40 countries
Quality System:	ISO 9001:2015 & ISO 17025:2017

QUALITY MANAGEMENT SYSTEM CERTIFIED ISO 9001:2015
Certificate Number: 13314

A2LA ACCREDITED
CALIBRATION CERTIFICATE NUMBER: 1530.01

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LACO is a leading manufacturer & supplier of **Leak Testing Systems, Instruments & Accessories**.

In-house core competencies include:

- Engineering, Manufacturing, Calibration Laboratory, and Service & Repair

Leak Testing Technology (LTS Division)

- Turnkey Production Systems
- Instruments (Leak Detectors)
- Accessories (Calibrated Leaks, etc.)
- Services (Repair, PM, Calibration)

Leak Test

Project Phases

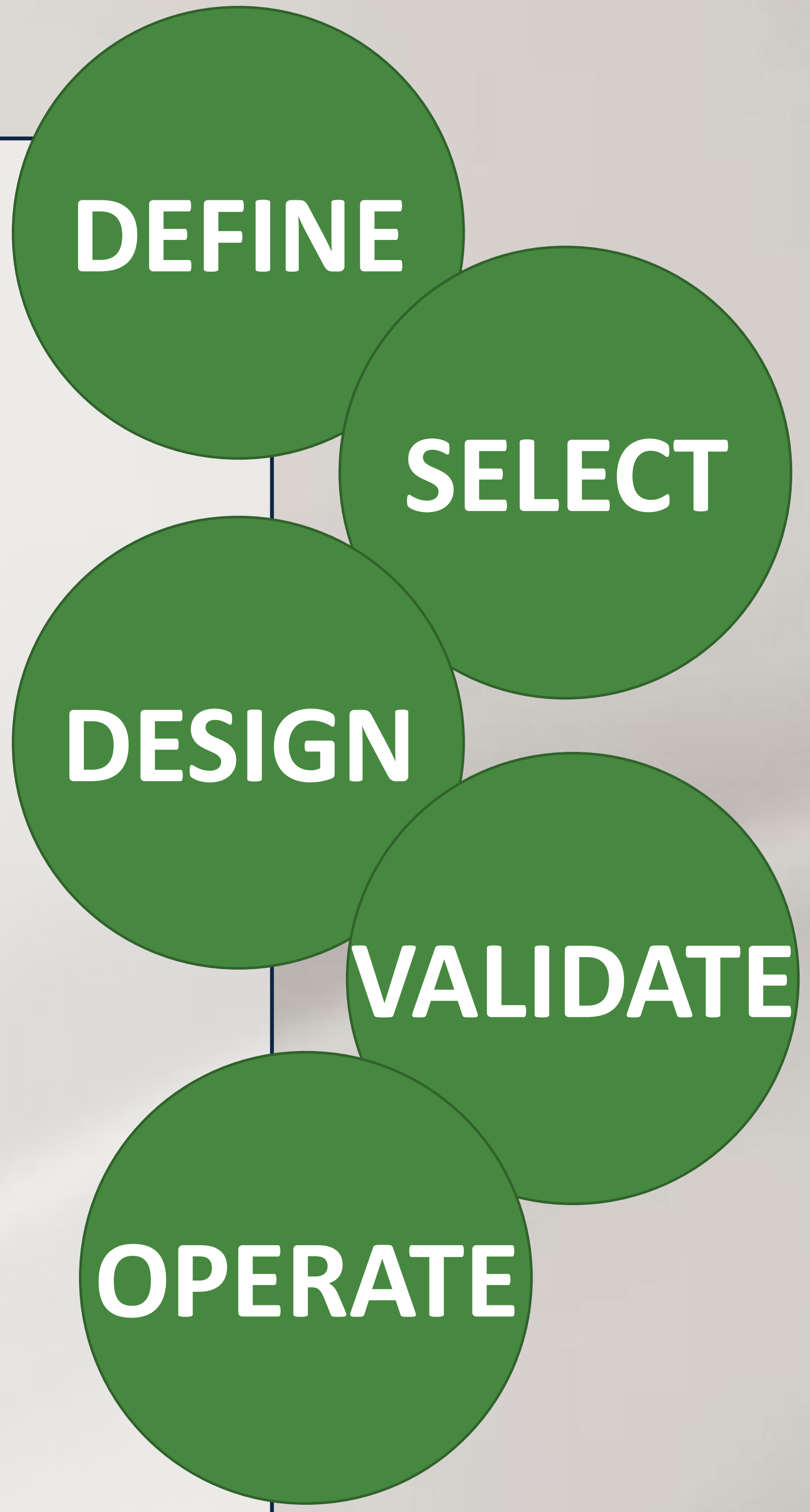
Goals of Production Leak Testing

1. Ensure integrity so that your product functions with:
   - Safety
   - High Performance (and long life)
   - Customer Satisfaction

2. Implement a successful leak test process with:
   - High Reliability (trust the results, low down time)
   - Production Efficiency (meet demands)
   - Minimal Cost (capital, operating)

Each Phase of a Leak Test Project is Important

A. Define requirements
B. Select the test method
C. Design and Build the system
D. Validate the system
E. Operate the system



Common Challenges in Leak Testing

- Improper or incomplete definition of the leak test requirements leading to a solution that is inadequate or not optimized.
- Lack of understanding of the leak test process and factors that can influence the test results.
- Inadequate testing and validation of the leak test process.
- Lack of a clear plan to keep the system properly calibrated, validated, and maintained.

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DEFINE

A. Defining Requirements
Keys to Success

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DEFINE

A. Defining Requirements

#1 Define requirements clearly and completely.

1	2	3	4
Test Requirements	[redacted]		
Leak Rate Limit			
Test Pressure Conditions			
Leak Flow Direction			
Leak Location?			

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A. Defining Requirements

DEFINE

#1 Define requirements clearly and completely.

Resource: What to include in your leak test specification.

A. Defining Requirements

DEFINE

#2 Ensure leak rate limit is properly defined and expressed.

- Sometimes it is easy…..
- But often it requires rigorous work to nail down the proper leak rate limit. The leak rate limit…
  - Impacts the chosen test method
  - Impacts the test cycle time
  - Impacts the cost of the leak test solution

A. Defining Requirements

DEFINE

#2 Ensure leak rate limit is properly defined and expressed.

- Include the following when defining the leak rate limit:
  - Recommended test method (could also reference a standard procedure)
  - Test pressures (upstream and downstream)
  - Test gas (air, helium, etc.) and concentration, if applicable
  - Flow direction
  - Measurement or test time may also be important for some applications

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A. Defining Requirements

DEFINE

#2 Ensure leak rate limit is properly defined and expressed.

There are many methods and tools to help establish the proper leak rate limit. The following resource can be helpful:

SELECT

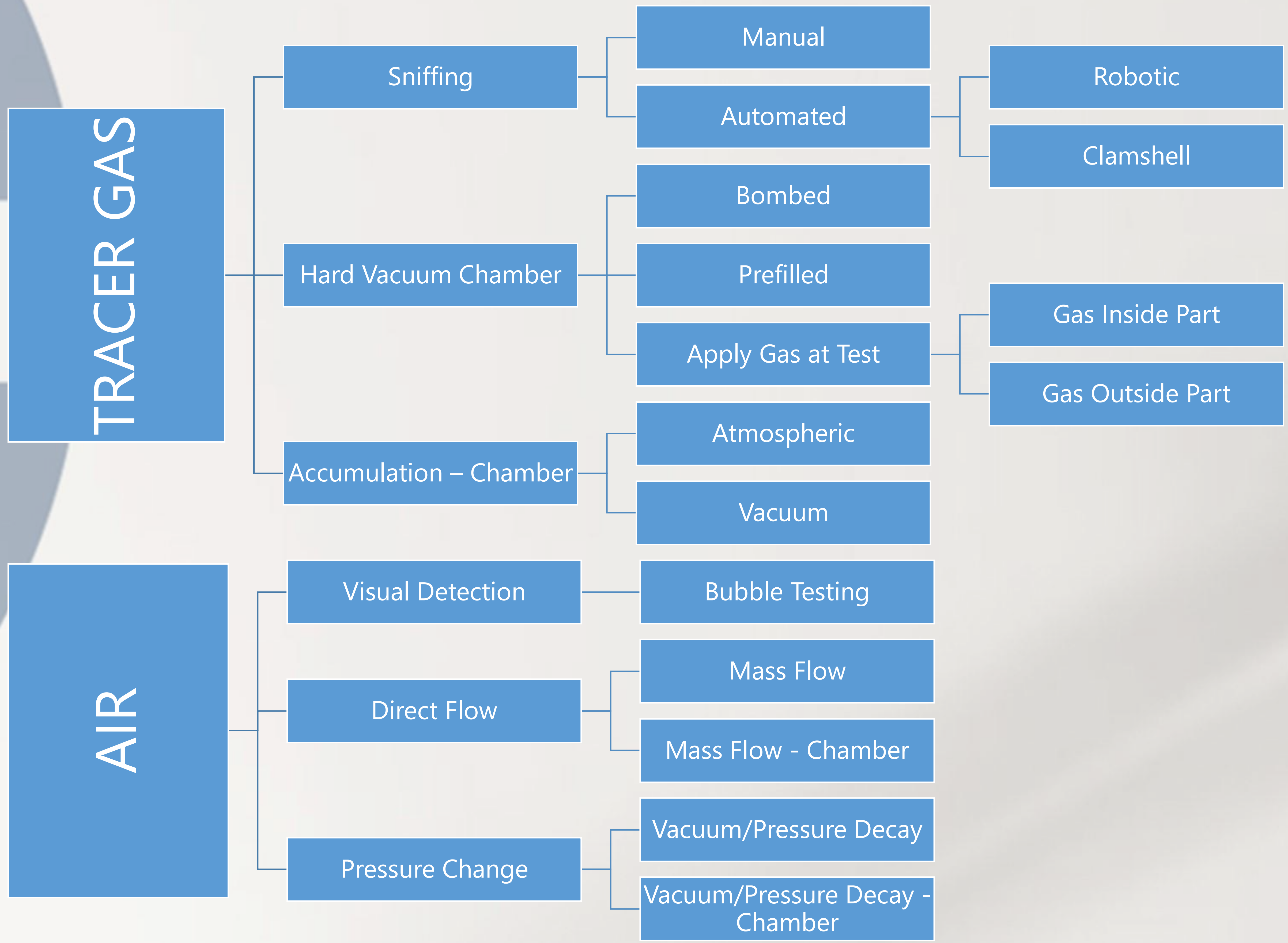
B. Selecting Test Method Keys to Success

LACO TECHNOLOGIES

SELECT

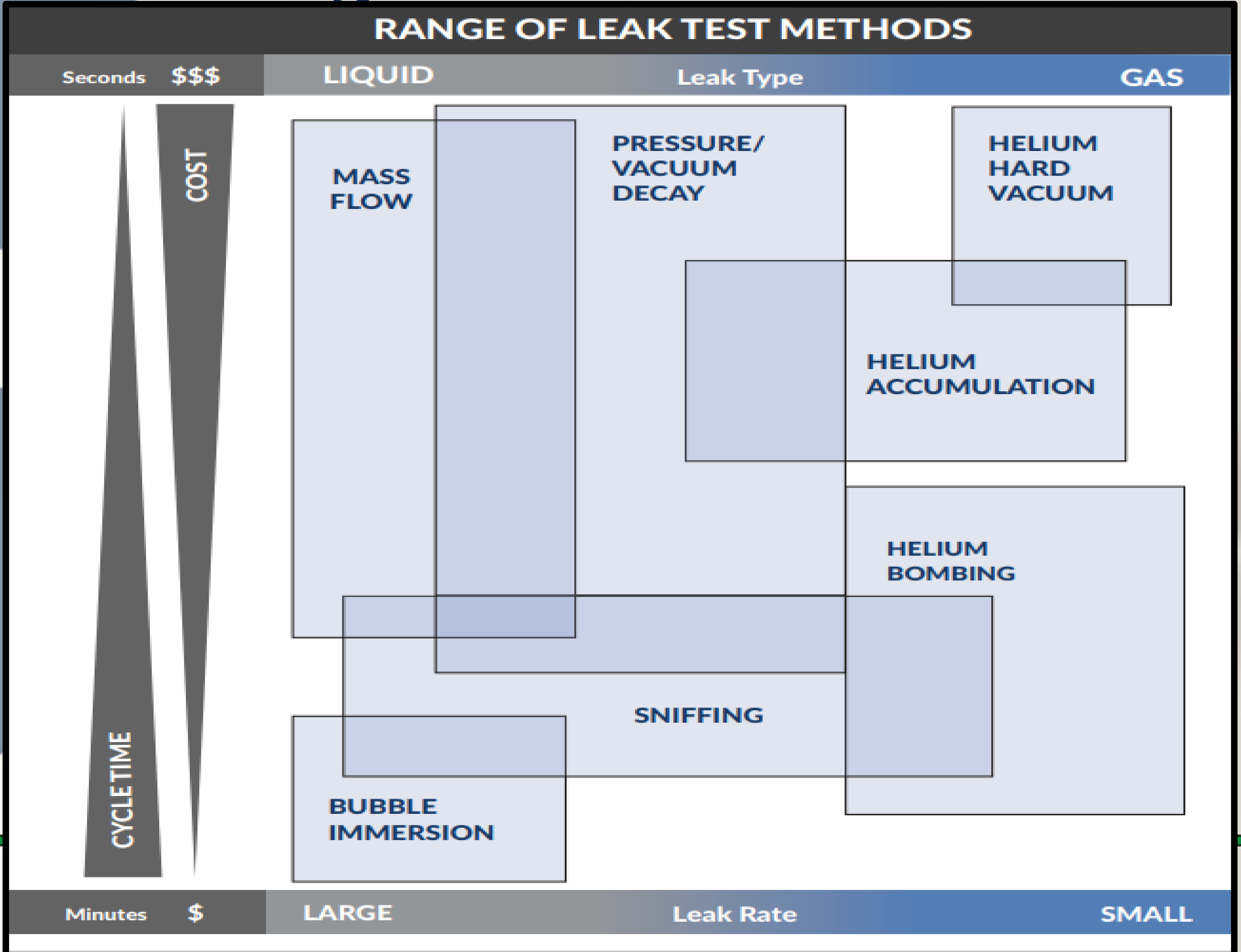
B. Selecting Test Method

#3 Select a test method to match the leak rate limit



B. Selecting Test Method

SELECT



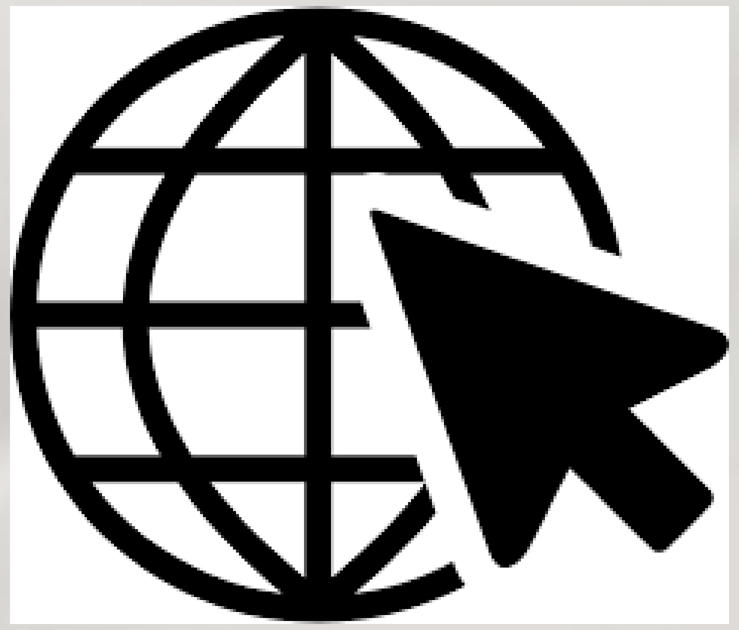
B. Selecting Test Method

SELECT

#3 Select a test method to match the leak rate limit

TEST METHOD	TYPICAL BEST SENSITIVITY* (atmcc/sec / sccm)	LEAK LOCATION CAPABILITY	GLOBAL TEST METHOD
Helium Hard Vacuum	1×10^{-9} / 6×10^{-8}	Yes (only for outside-in spray method)	Yes
Helium Accumulation	1×10^{-5} / 6×10^{-4}	No	Yes
Helium Sniffing	1×10^{-6} / 6×10^{-5}	Yes	No
Helium Hybrid Accumulation Test System (HATS)	1×10^{-6} / 6×10^{-5}	No	Yes
Pressure/Vacuum Decay	1×10^{-3} / 0.06	No	Yes
Mass Flow	1×10^{-2} / 0.6	No	Yes
High Sensitivity Vacuum Decay	1×10^{-4} / 0.006	No	Yes
Bubble Immersion	1×10^{-3} / 0.06	Yes	No

More resources here:



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DESIGN

C. Designing the System
Keys to Success

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C. Designing the System

DESIGN

#4 Design the system based on sound understanding of the leak test method.

Examples

- Air leak testing a water filter cartridge
- Tooling design for air leak testing
- Seal selection for helium leak testing
- Proper gas management for helium leak testing

C. Designing the System

DESIGN

Example: Air leak testing a water filter cartridge

Challenge: High speed and sensitive leak test on a water filter cartridge filled with filter media.

Option 1: Traditional Pressure Decay
- Pressurize inside volume of the cartridge and monitor pressure drop.

Option 2: Downstream/Chamber Pressure Decay
- Pressurize inside volume of the cartridge and monitor pressure drop in a sealed chamber on the outside of the cartridge.

C. Designing the System

DESIGN

Example: Air leak testing a water filter cartridge

Option 2: Downstream/Chamber Pressure Decay

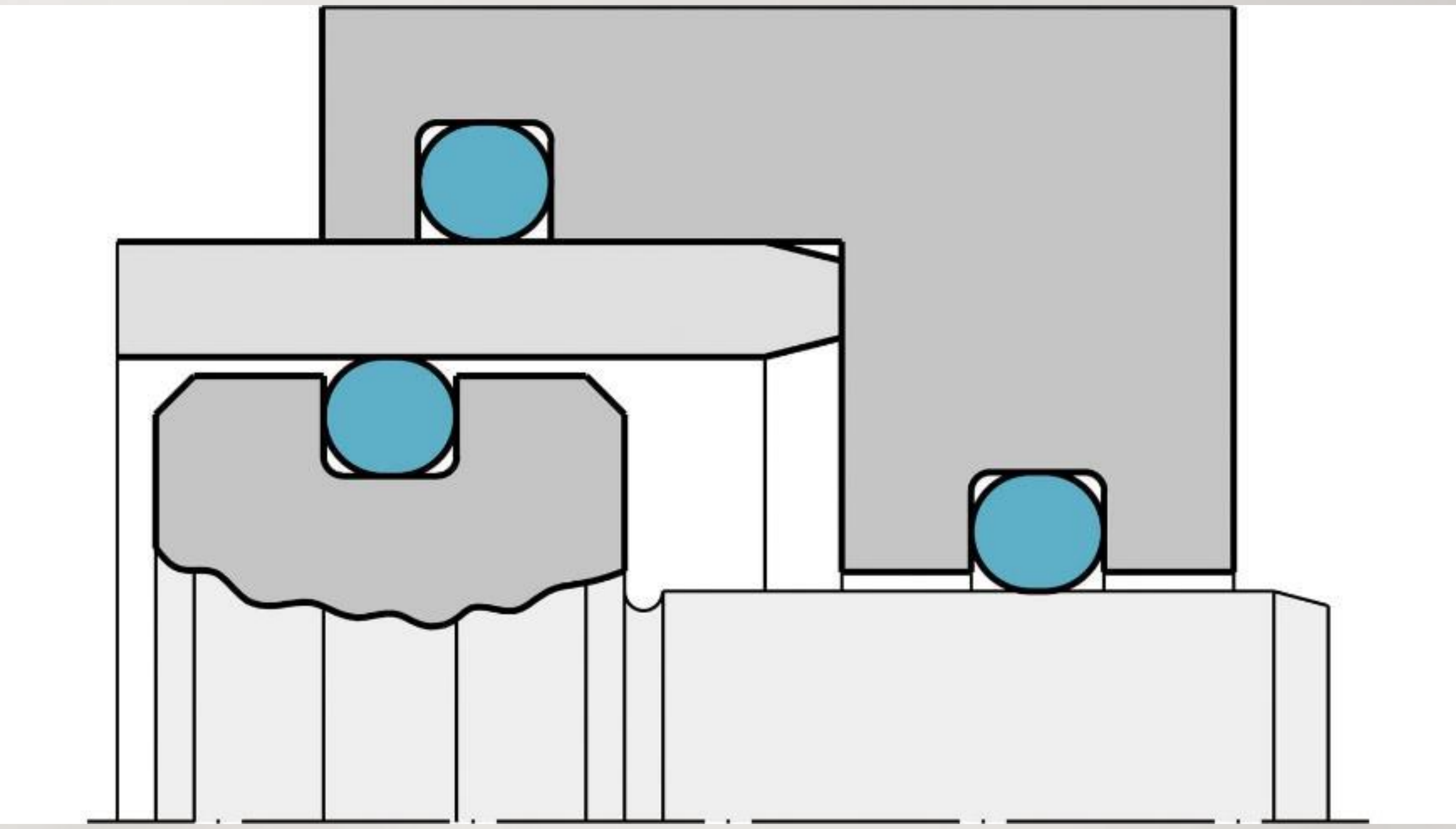
- Minimized adiabatic heating from air fill
- Minimize pressure instability from absorption into filter media
- Minimize test volume using a tight-fitting outer test chamber
- Measure pressure rise in the outer test chamber near atmospheric pressure – better resolution

C. Designing the System

DESIGN

Example: Tooling design for air leak testing

Challenge: For air leak testing to be successful the tooling that is part of the test circuit must be low volume and stable during the measurement.



Design Factors

- Optimize/minimize test volume
- Seal materials (type, hardness)
- Seal design (o-ring, quad ring, molded)
- Clamping design and method

C. Designing the System

DESIGN

Example: Seal selection for helium leak testing

Challenge: Design leak testing seals that minimize the permeation and trapping of helium.

Design Factors

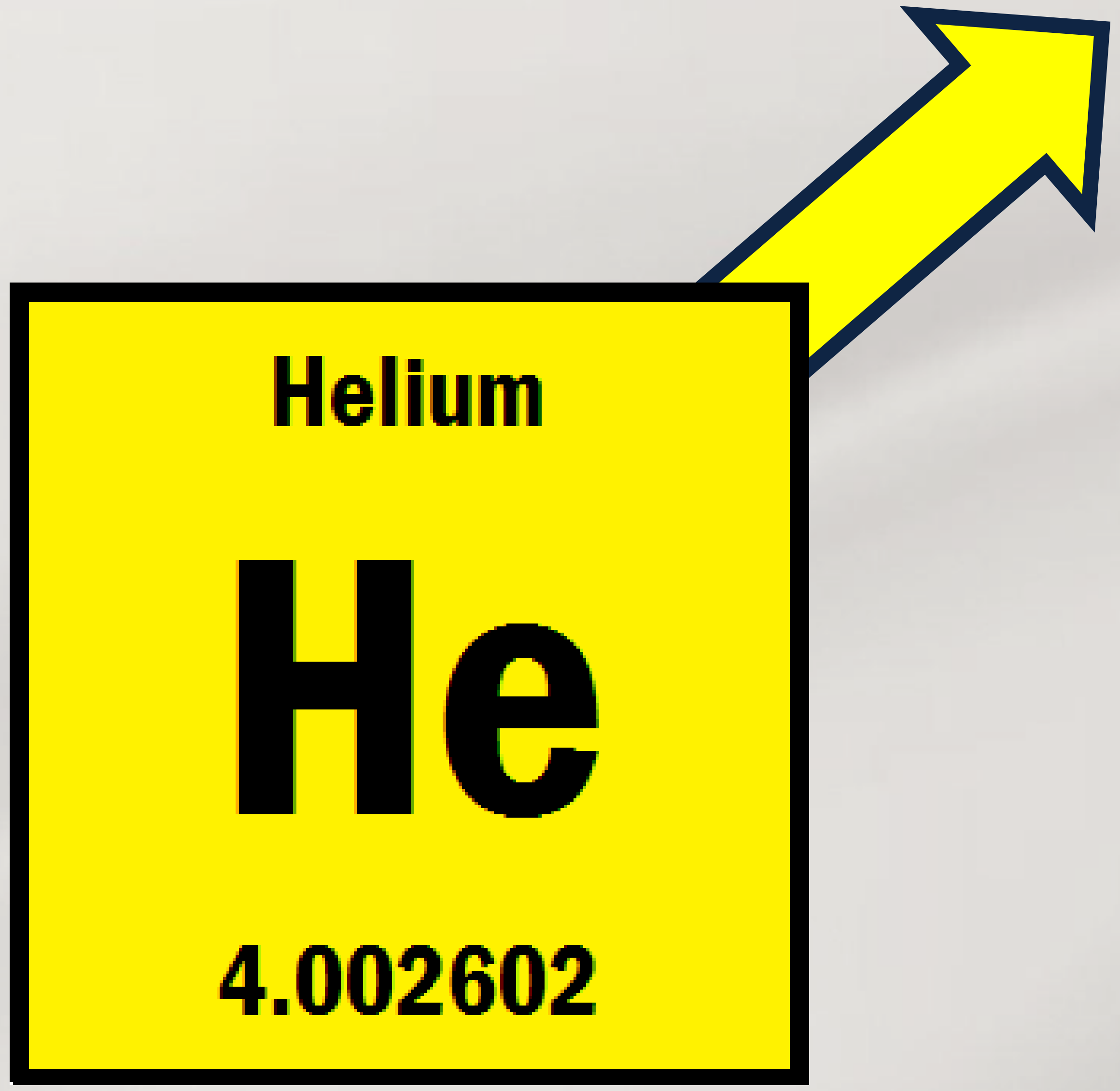
- Seal materials (minimize permeation)
- Seal design (shape, size)
- Ease of seal change-out

C. Designing the System

DESIGN

Example: Proper gas management for helium leak testing

Challenge: Design gas charge manifold and sequencing to effectively remove helium at the end of the test.



Design Factors

- Post test purge and evacuation method
- Proper vacuum pump for helium evacuation
- Proper ventilation of helium out of the test area

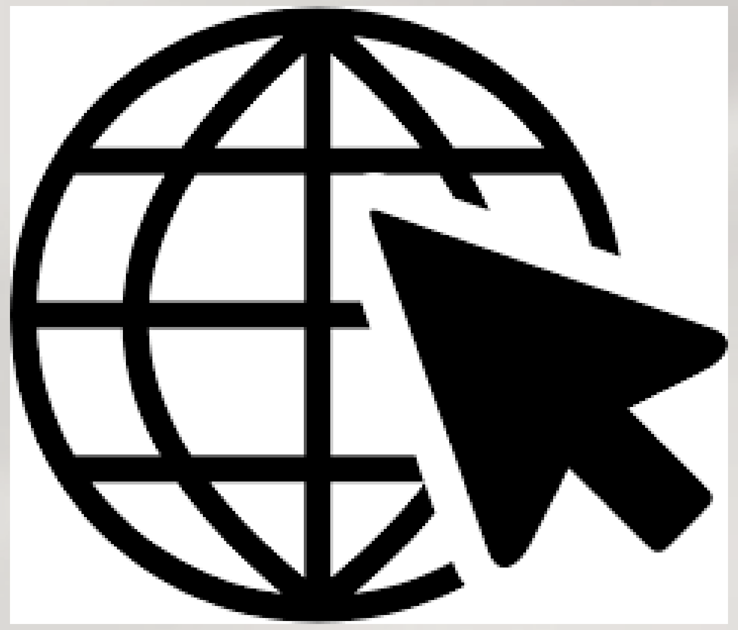
C. Designing the System

DESIGN

Example: Proper gas management for helium leak testing

Solution: LACO's Atlas controller with integrated tracer gas charging ensures proper gas management – for sniffing or hard vacuum chamber testing.

More resources here:



VALIDATE

D. Validating the System
Keys to Success

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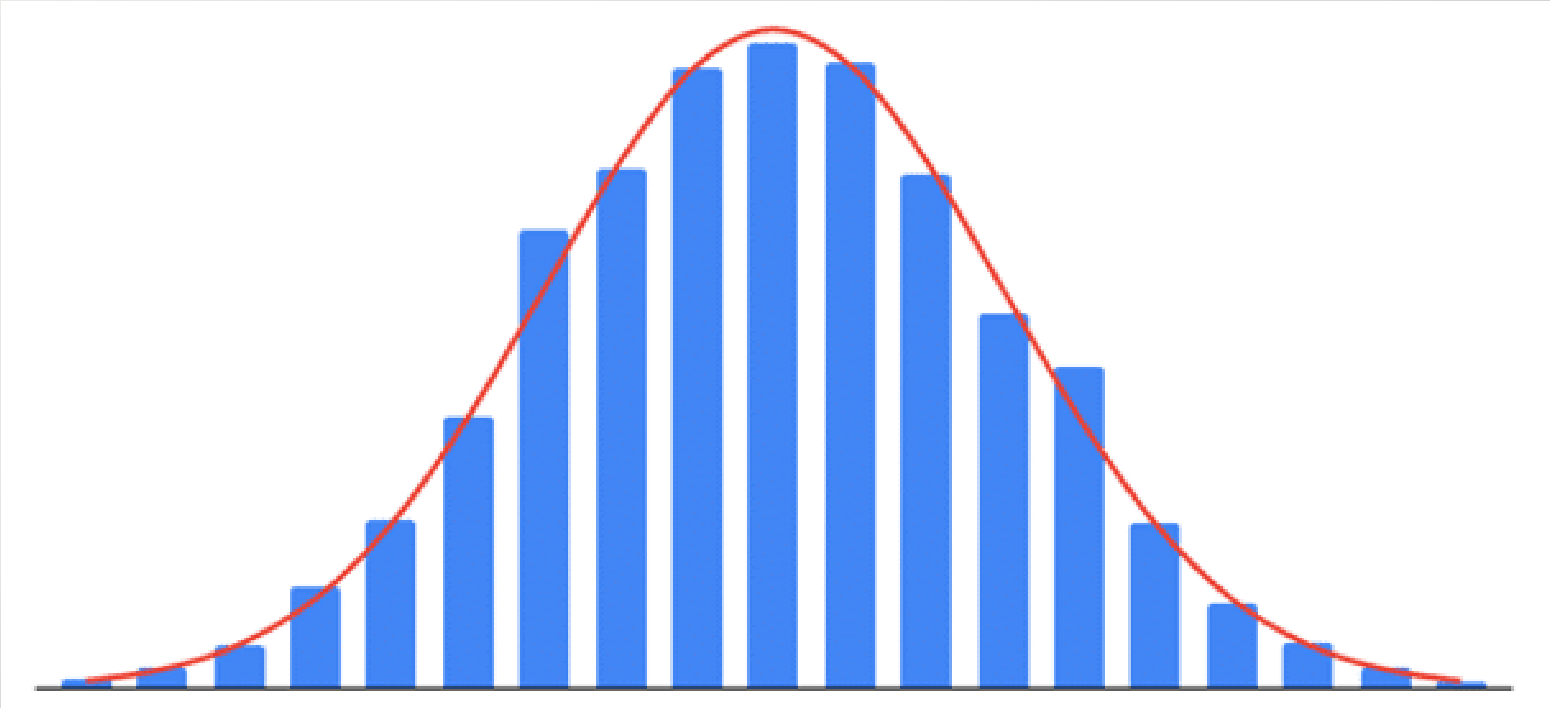
D. Validating the System

VALIDATE

#5 Validate the system with a statistically robust method

- How do you know the system will properly test before putting it into production?
- All measuring systems have variability.
  - The instrument
  - The test part itself
  - Environmental factors
  - Production operator
- Need high confidence in the system
  - No false passes
  - No false failures



D. Validating the System

VALIDATE

#5 Validate the system with a statistically robust method

Validating a system properly requires the use of calibrated leak standards.

A calibrated leak standard is:

- a robust and stable orifice
- calibrated to a flow (leak) rate under specified pressure conditions
- attached to a gas reservoir (typically helium), or
- an "open style" design where the gas is supplied by the system.

D. Validating the System

VALIDATE

#5 Validate the system with a statistically robust method

"Open style" calibrated leak standards are always the best for use in calibrating and validating a leak test system. They not only simulate the leak but validate the gas fill process.

Open Style Calibrated Leak Standards

- Are built and calibrated to the reject limit
- Are attached to the part or the leak test circuit to create a simulated leaking part
- Go through the leak test cycle with the part to create a signal that represents a part leaking at the reject limit.

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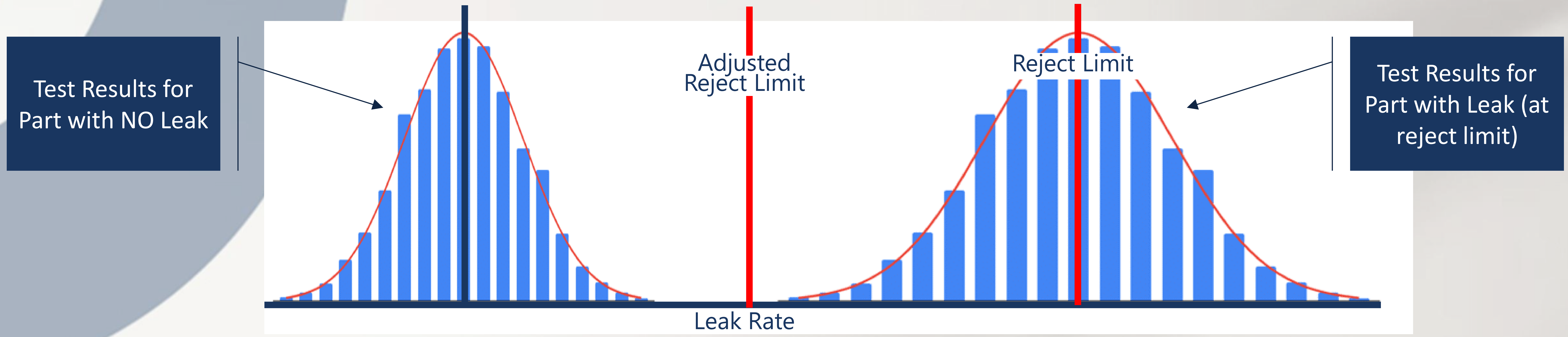
D. Validating the System

VALIDATE

#5 Validate the system with a statistically robust method

- LACO has developed a dual distribution (bi-modal) technique to validate a leak test process.
  - Determines the statistical capability of the system to distinguish between non-leaking parts and parts with leaks AT THE REJECT LIMIT.



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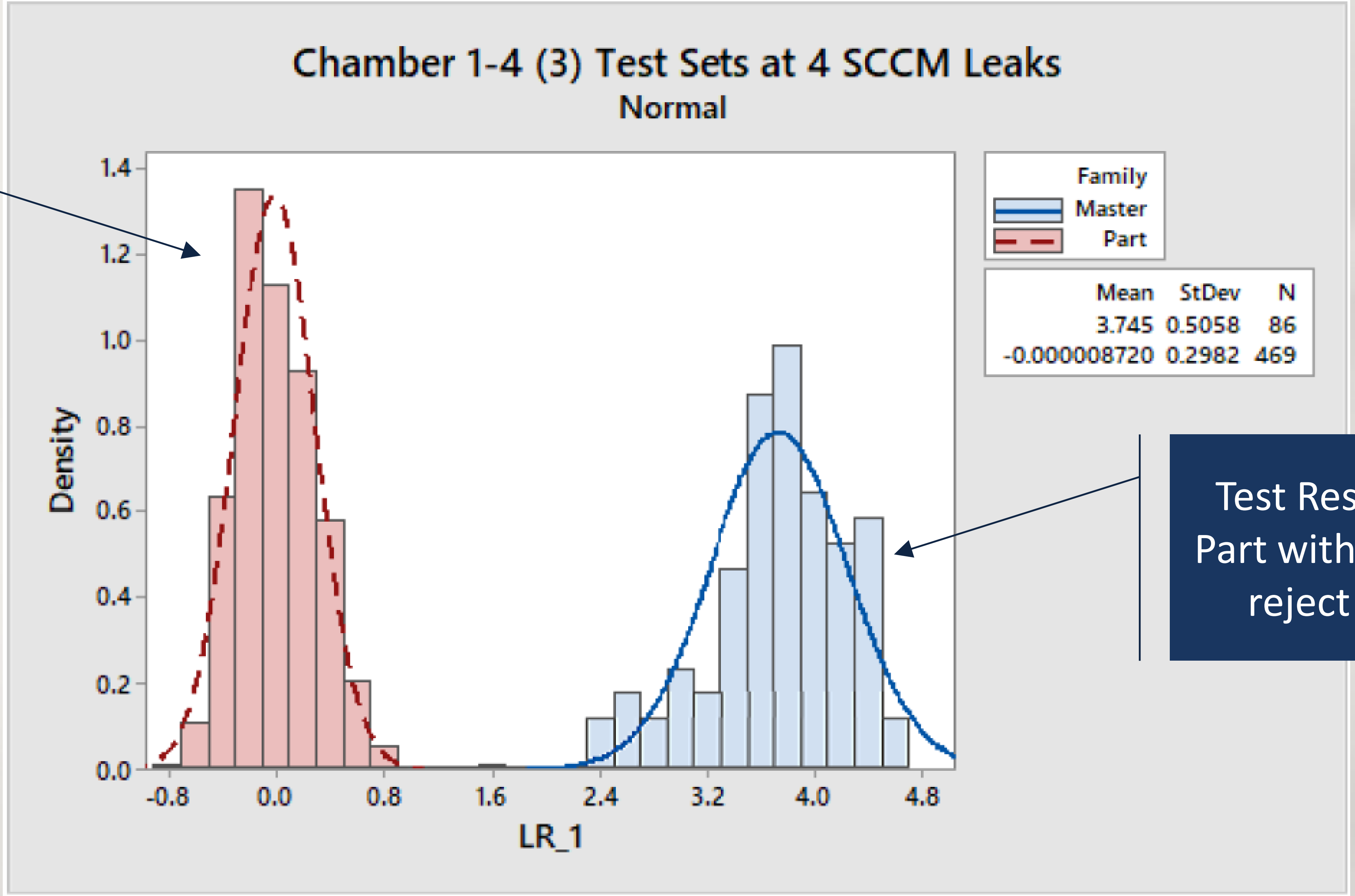
Validating the System

VALIDATE

Example: High Speed Pressure Decay Leak Testing of Fire Protection Sprinklers

- NOTE: In production leak testing, faster cycle times often correlation to more variation.

Test Results for Part with NO Leak



Test Results for Part with Leak (at reject limit)

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Validating the System

VALIDATE

#5 Validate the system with a statistically robust method

For more information on how to implement this dual distribution validation method see the following Application Note:

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OPERATE

E. Operating the System
Keys to Success

E. Operating the System

OPERATE

#6 Implement an ongoing system calibration and validation protocol that instills confidence.

- Leak test systems should be calibrated routinely under actual test conditions using a calibrated leak standard.
- Additionally, leak test systems should be validated according to a plan (at least daily).
  - Why? Leak test system measurements can be influenced by many factors, including environmental factors and test part influences. Validating a leak test system on a regular, ongoing basis provides trust and confidence in the test results.

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E. Operating the System

OPERATE

Example: Vacuum Chamber Helium Leak Testing of A/C System Coil

Actual Test Part For Validation

+

Calibrated Leak

OR

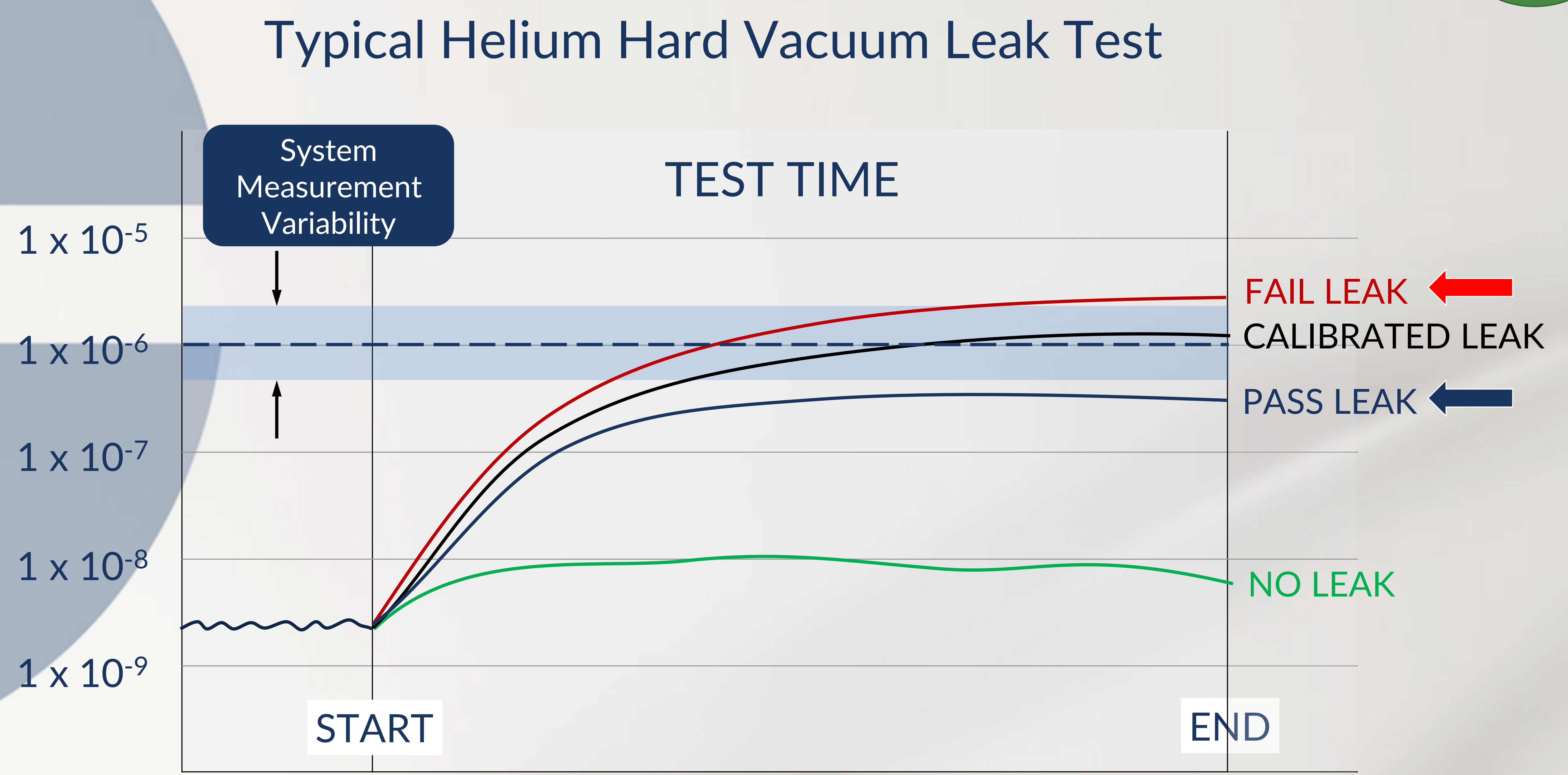
Dummy Part Used For Validation

+

Calibrated Leak

E. Operating the System

OPERATE

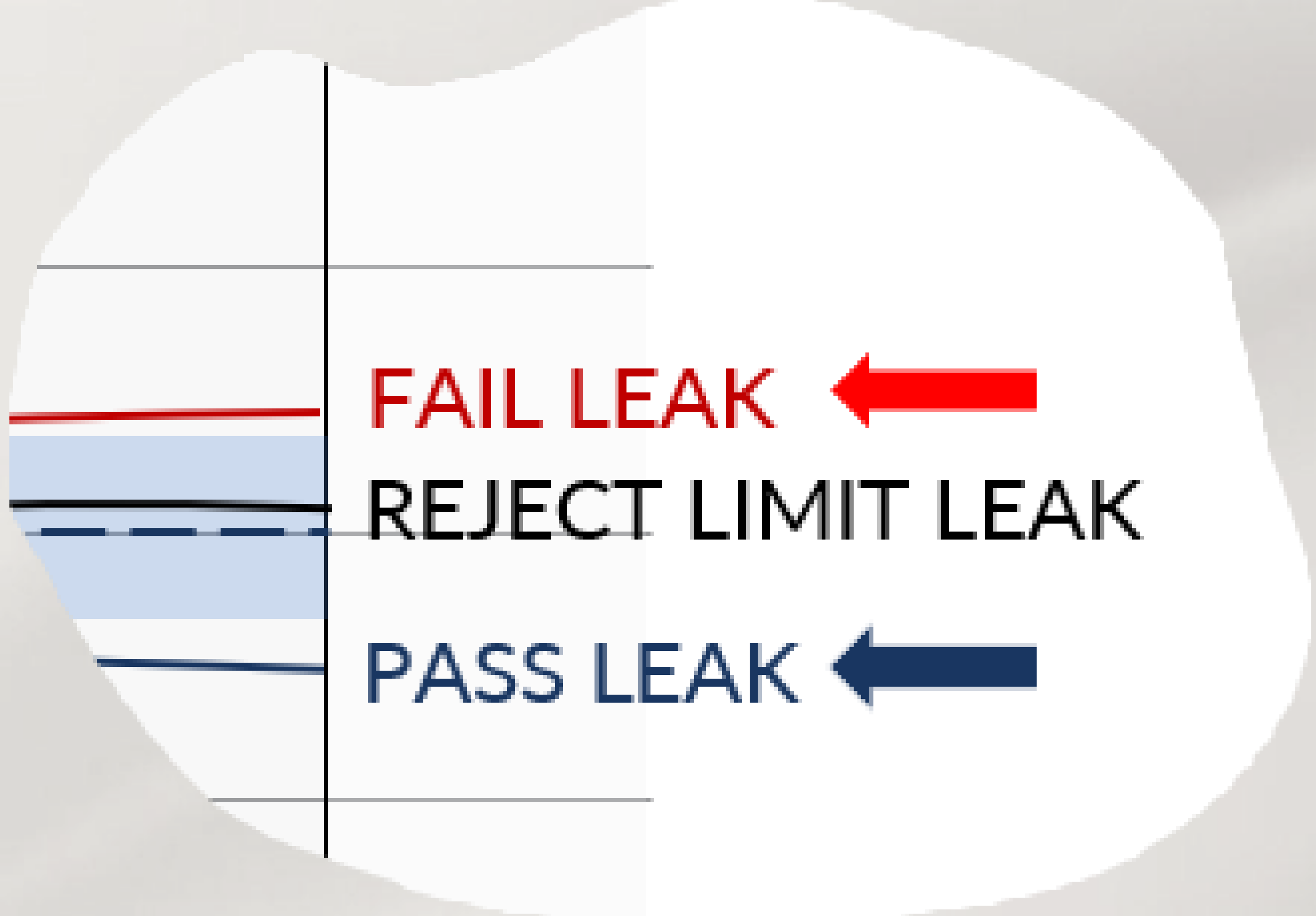


E. Operating the System

OPERATE

#6 Implement an ongoing system calibration and validation protocol that instills confidence.

- Ongoing validation can be done with two calibrated leak standards – one above and one below the reject limit or can be done with one at the reject limit.
- Best practice is to trend this validation data on an SPC chart.



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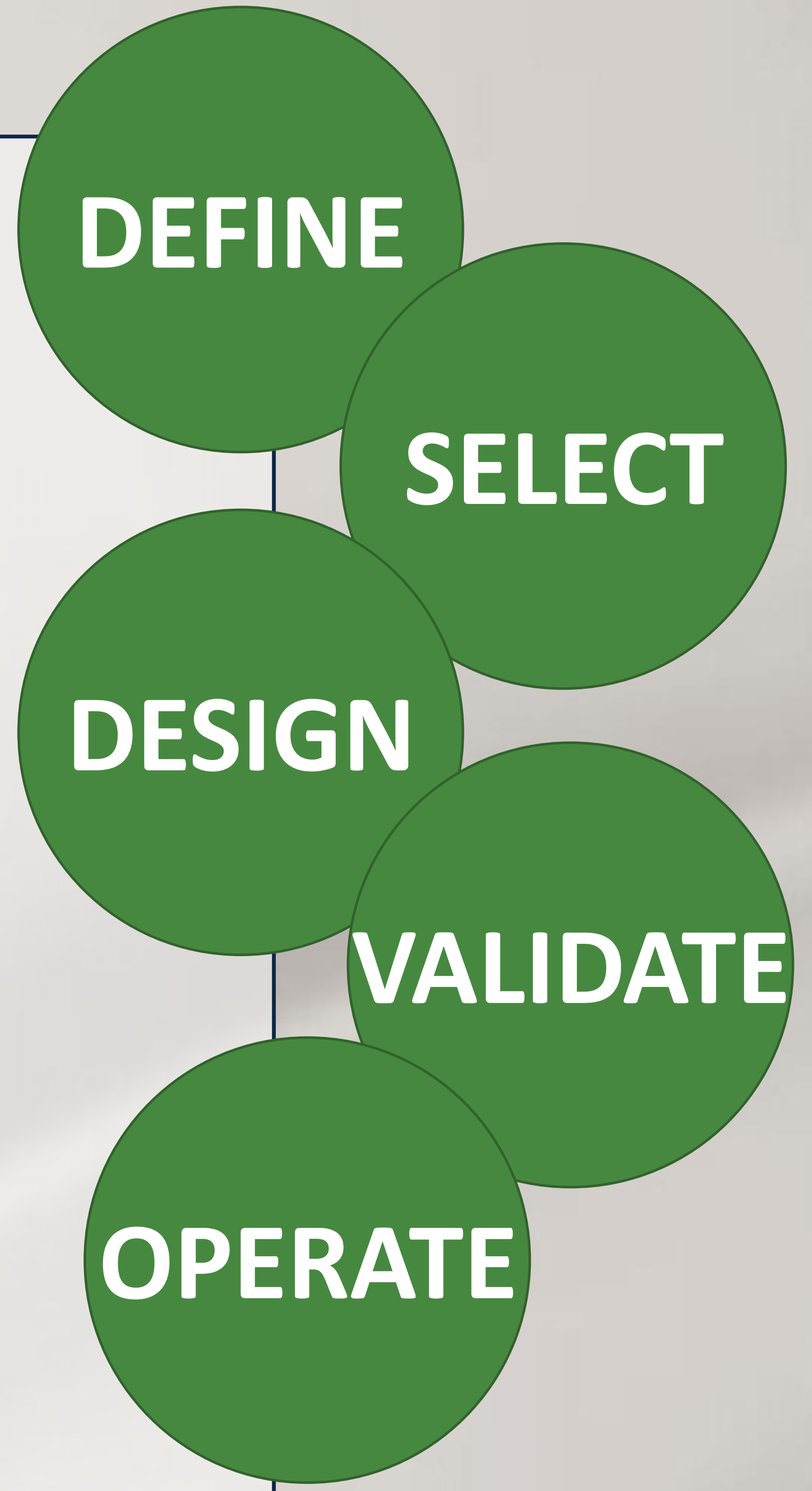
Conclusion & Summary

Each Phase of a Leak Test Project is Important

A. Define requirements
B. Select the test method
C. Design and Build the system
D. Validate the system
E. Operate the system



Summary of Leak Testing Best Practices -Keys to Success

1. Define requirements clearly and completely.
2. Ensure leak rate limit is properly defined and expressed.
3. Select a test method to match the leak rate limit.
4. Design the system based on sound understanding of the leak test method.
5. Validate the system with a statistically robust method
6. Implement an ongoing system calibration and validation protocol that instills confidence.

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www.lacotech.com

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LACO Technologies,
The only leak test company that offers a complete range of solutions - from leak test instruments and accessories, to turn-key systems. We truly understand the best practices that will make your leak testing process a success.

Thank You