Production Leak Testing Best Practices

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Overview

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

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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

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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)

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Leak Test
Project Phases

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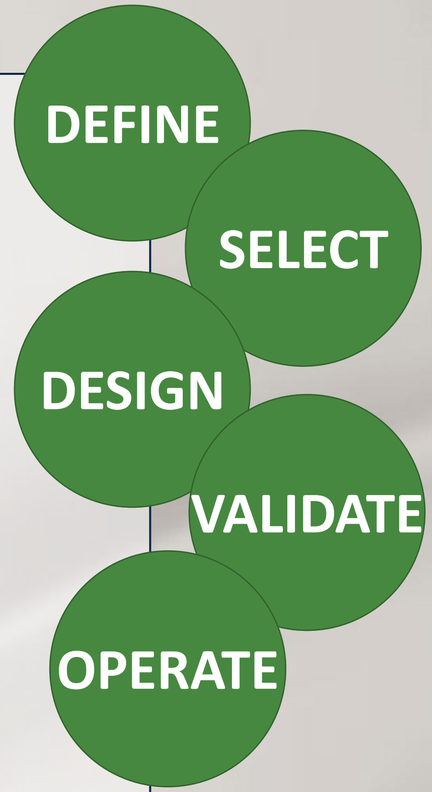
Goals of Production Leak Testing

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



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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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A. Defining Requirements

DEFINE

#1 Define requirements clearly and completely.

1	2	3	4
Test Requirements	**Production Requirements**	**Part Characteristics**	**Other Requirements**
Leak Rate Limit	Product Rate (TAKT Time)	Part Design and Interface	Equipment Budget
Test Pressure Conditions	Part Load/Unloading Method	Part Size/Volume	Machine Specifications
Leak Flow Direction	Data and Traceability	Part Materials	FAT/SAT – Validation and Testing Protocols
Leak Location?	Part Marking or Disposition	Part Condition – Cleanliness or Temperature	Project Schedule

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A. Defining Requirements

DEFINE

#1 Define requirements clearly and completely.

Resource: What to include in your leak test specification.

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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

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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:

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SELECT

B. Selecting Test Method
Keys to Success

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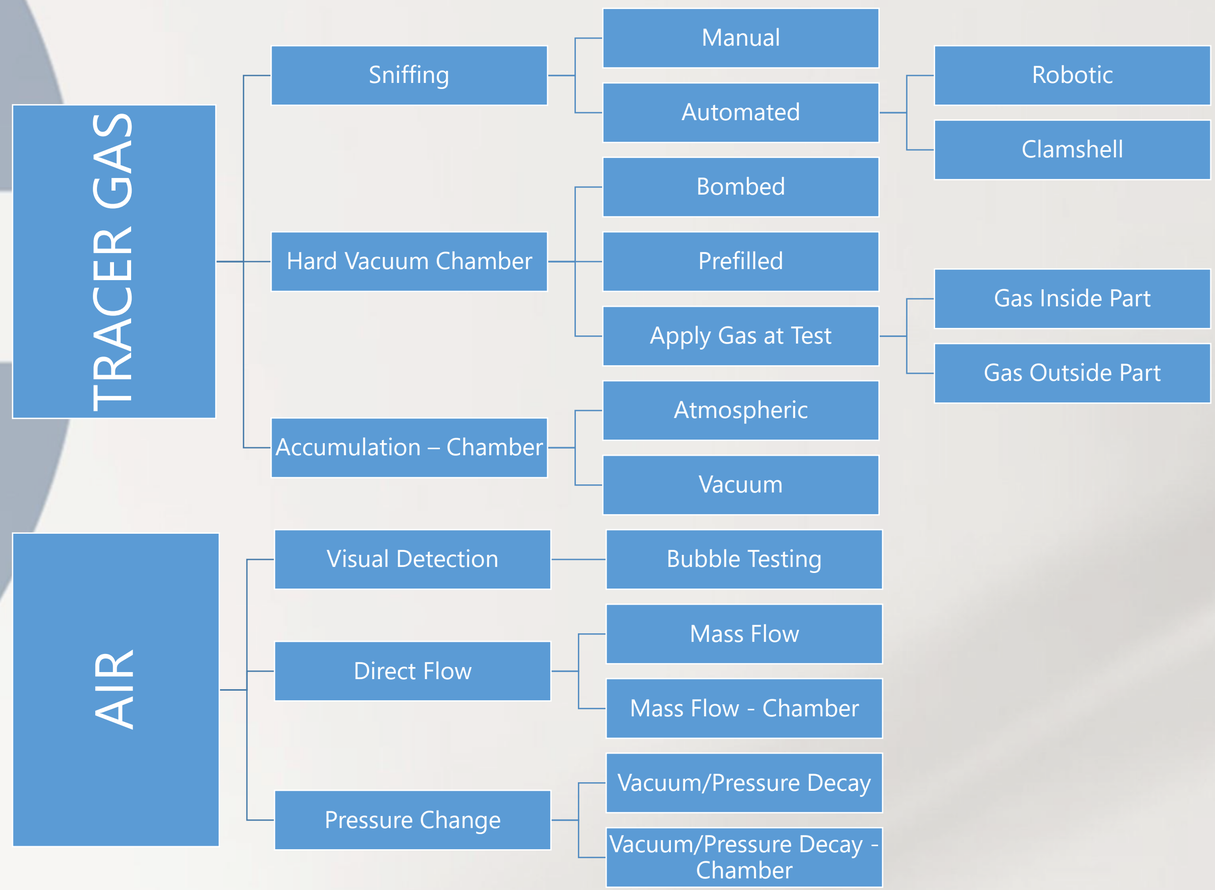
B. Selecting Test Method

SELECT

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



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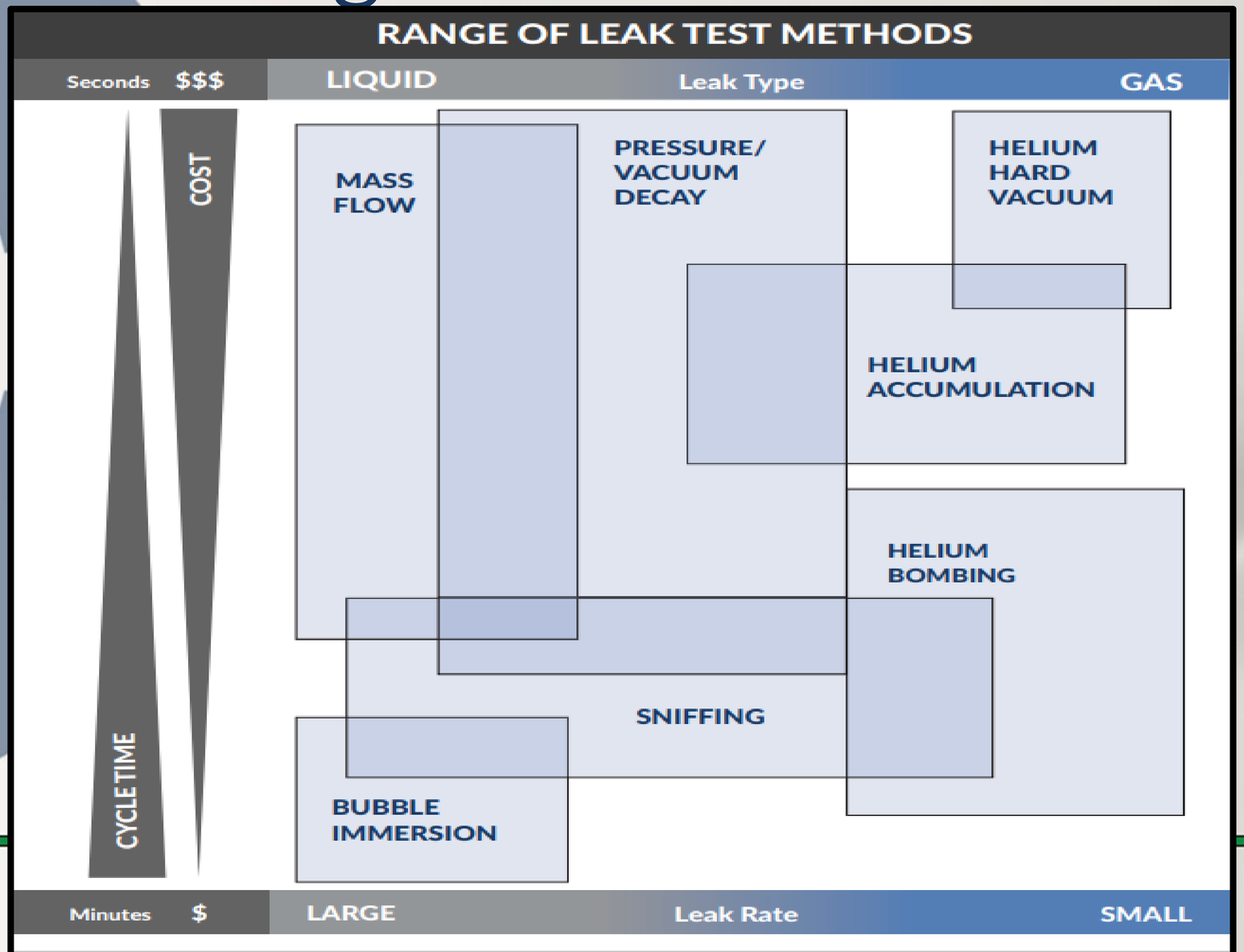
B. Selecting Test Method

SELECT



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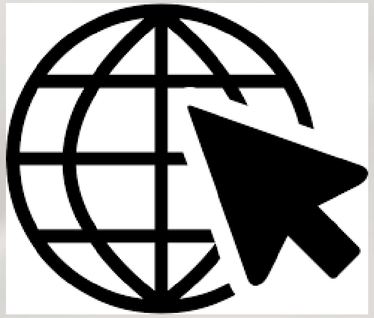
B. Selecting Test Method

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

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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.

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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

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C. Designing the System

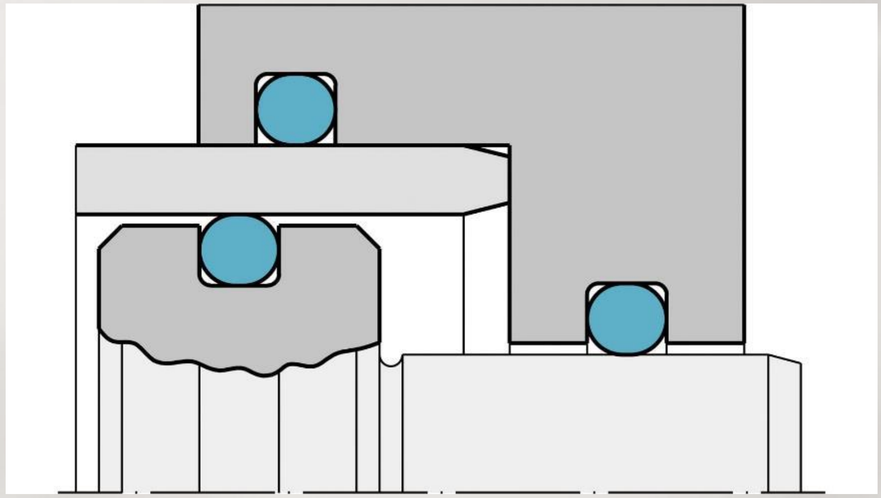
DESIGN

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



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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

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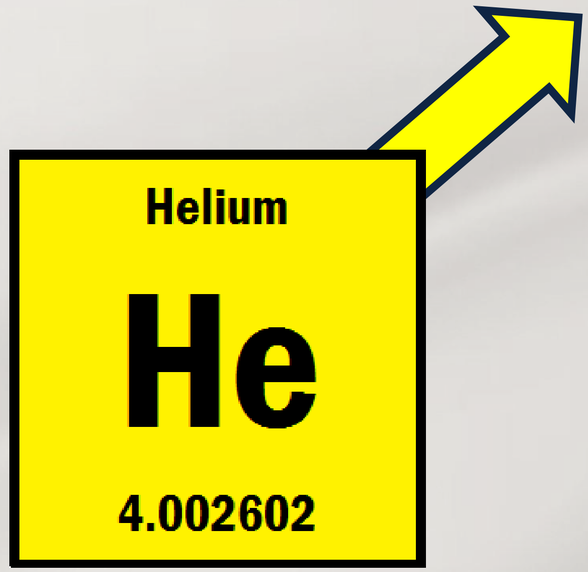
C. Designing the System

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

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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:

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VALIDATE

D. Validating the System
Keys to Success

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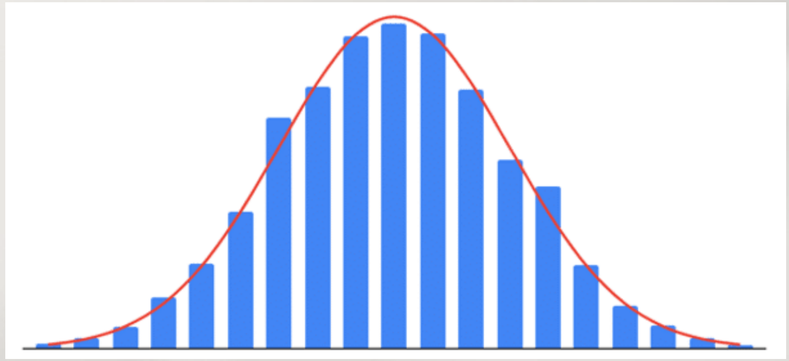
D. Validating the System

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



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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.

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D. Validating the System

VALIDATE

#5 Validate the system with a statistically robust method

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

<u>Open Style Calibrated Leak Standards</u>

- 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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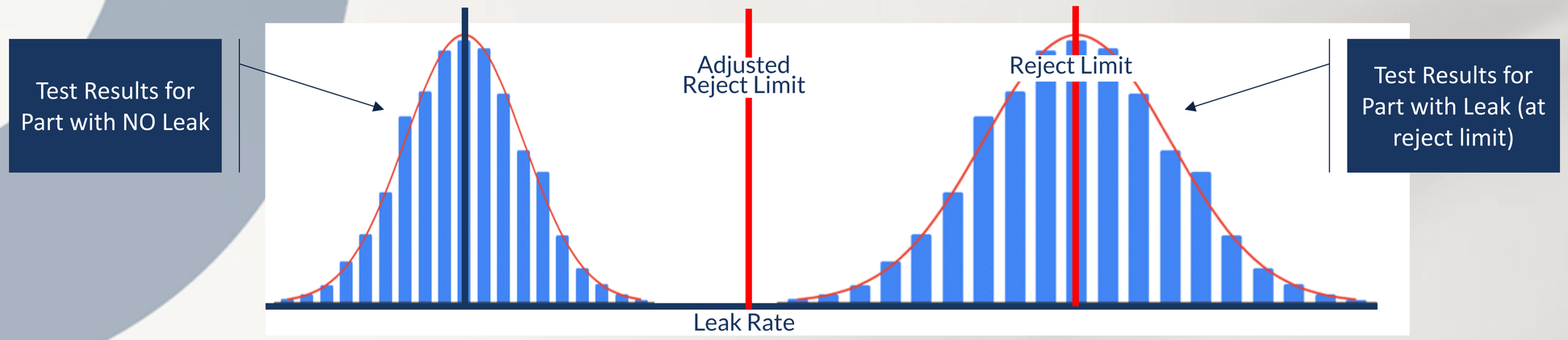
D. Validating the System

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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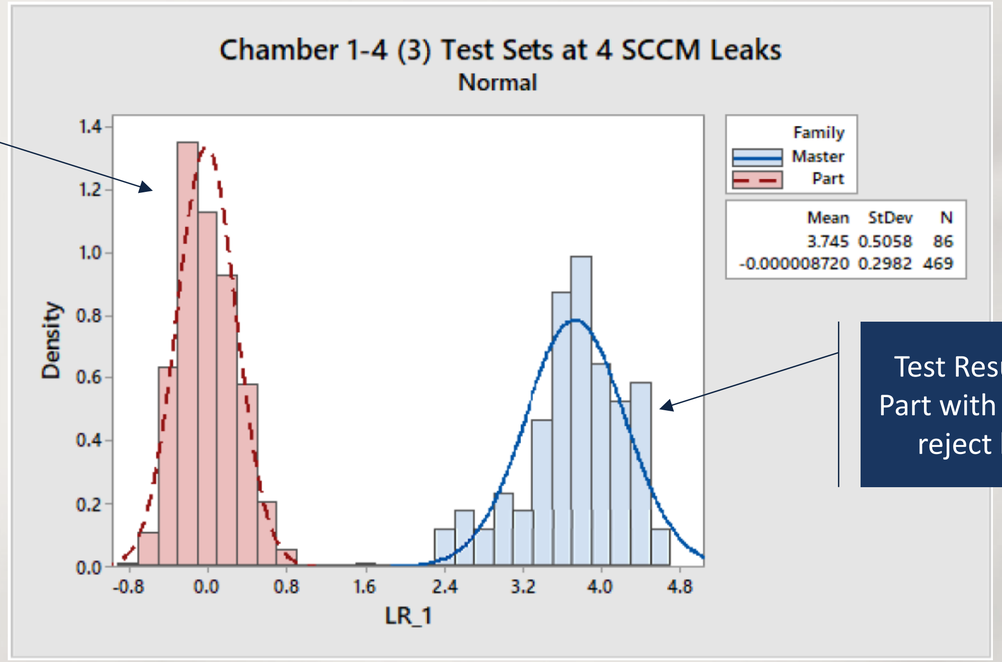
Validating the System

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

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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

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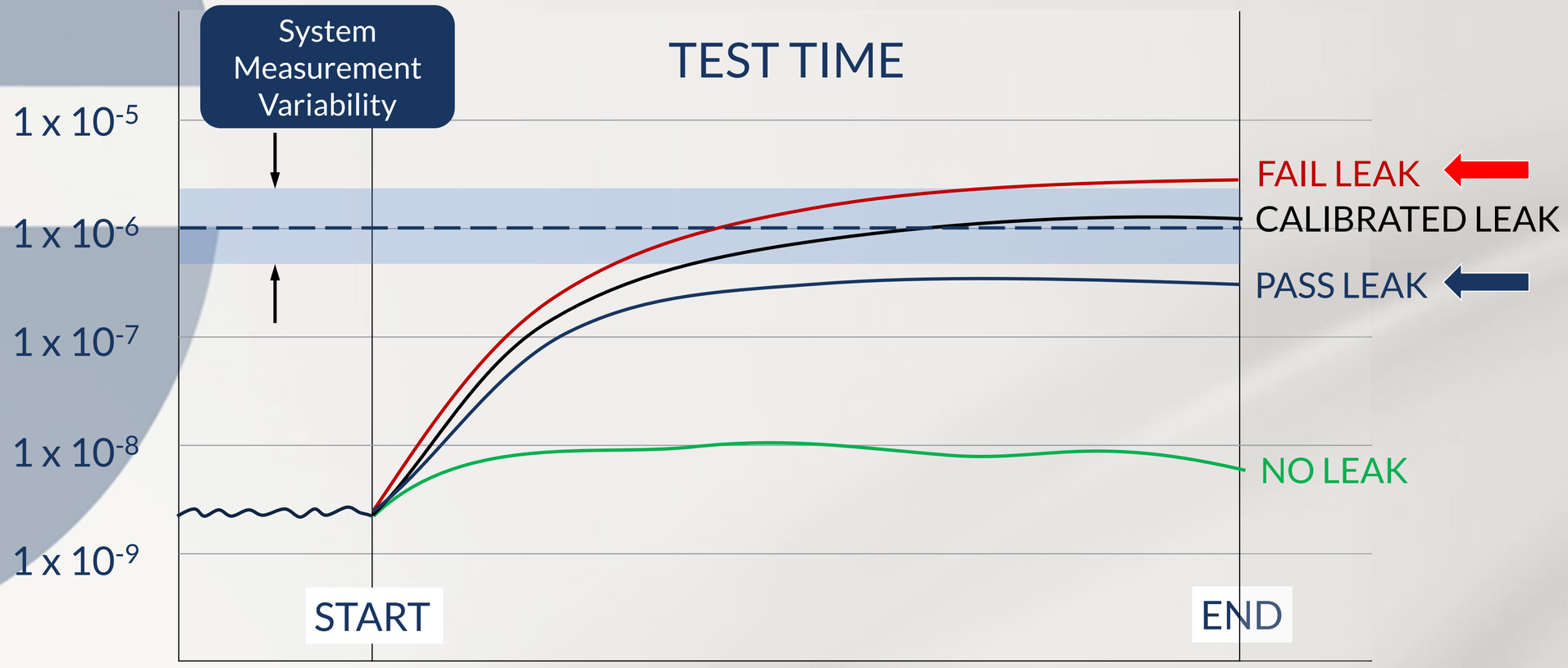
E. Operating the System

OPERATE

Typical Helium Hard Vacuum Leak Test



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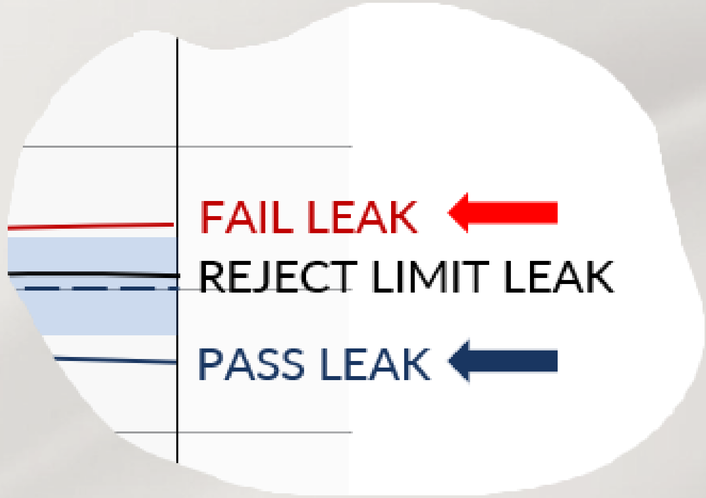
E. Operating the System

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

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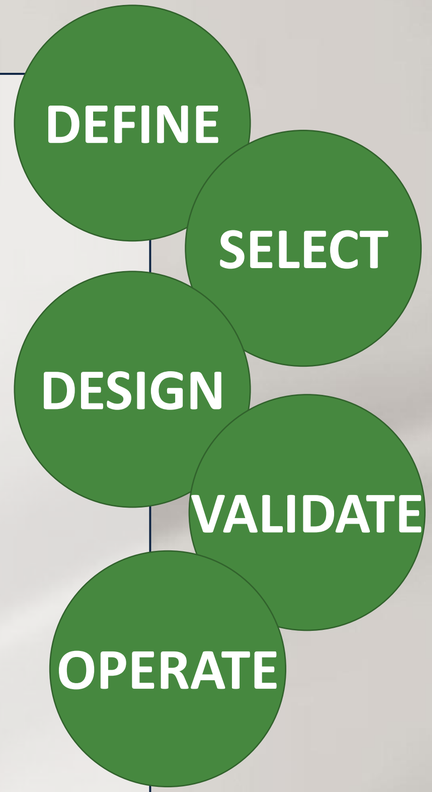
Each Phase of a Leak Test Project is Important

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



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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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Thank You

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