

LACO TECHNOLOGIES USER MANUAL



CALIBRATED LEAK STANDARDS

CONTACT US



PHONE/FAX

Toll Free: 800.465.1004

Phone: 801.486.1004

Fax: 801.486.1007

ADDRESS

LACO Technologies, Inc.
3085 West Directors Row
Salt Lake City, UT 84104

WEB

www.lacotech.com

info@lacotech.com

CONTENTS

1.	SCOPE.....	1
2.	SAFETY.....	1
3.	OVERVIEW.....	2
4.	BASIC OPERATION.....	6
5.	MAINTENANCE	17
6.	CALIBRATION OF LEAKS	18
7.	SHIPPING INSTRUCTIONS	18
8.	WARRANTY INFORMATION.....	19
9.	APPENDIX A: LEAKS WITH PRESSURE GAUGES	20
10.	APPENDIX B: LEAKS FLOWING TO ATMOSPHERE	21

1. SCOPE

This manual contains safety, operation, and maintenance information for Calibrated Leak Standards. LACO leak standards are designed to ensure safety when used properly. It is the responsibility of the user to follow safety-related warnings, cautions, notes, and other requirements described in this manual.

LACO Technologies, Inc. is committed to full customer support of every aspect of its Calibrated Leak Standards. Call or email LACO for technical sales and support.

2. SAFETY

The following safety precautions should always be followed. LACO Technologies, Inc., is not responsible for damage to persons or equipment that results from improper or inappropriate use of a leak standard.

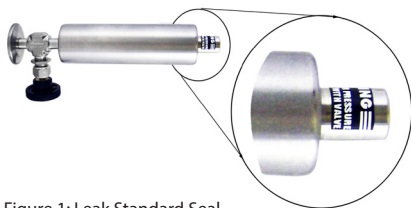


Figure 1: Leak Standard Seal

Table 1: Safety Precautions

COMPONENT	PRECAUTION
TAMPER-RESISTANT SEALS	Do not open or break tamper-resistant seals.
VENTING	When venting a refillable reservoir, point valve away from face, body, and other people. For refill instructions, see Section 4.2.
PRESSURIZING RESERVOIRS	DOT-approved reservoirs (which are clearly marked on the outside of the bottle) can be safely pressurized to 1800 psig, while LACO's standard 115cc reservoir has a maximum pressure rating of 400 psig. WARNING Do not over-pressurize a refillable reservoir.

Table 1: Safety Precautions

COMPONENT	PRECAUTION
MAINTAIN SEAL INTEGRITY	Special precaution should be taken regarding certain LACO Technologies custom fill valves having metal/solder tamper-resistant seals (see Figure 1). Under no circumstances should this seal be broken, loosened, melted, or removed. Doing so may result in serious injury to persons or damage to property. Should this seal be compromised by accidental or other means, contact LACO Technologies immediately for further safety precautions. WARNING Do not attempt to re-pressurize a reservoir that was not designed for user refilling.
GASSES	Do not use gas other than what is specified on the calibration label and certificate.
HAZARDOUS GASSES	Do not use toxic or hazardous gases with any leak standard.
LEAK STANDARD CARE	Do not drop, throw, puncture, incinerate, or otherwise compromise a pressurized reservoir. Do not re-pressurize a reservoir that has been damaged.
TEMPERATURE	Do not heat reservoir above 50 °C; do not cool below -20 °C.
LEAK STANDARD DAMAGE	If physical signs of damage to a leak standard are evident, discontinue use and return it to the factory (LACO Technologies) for repair.

3. OVERVIEW

A leak standard is a device that, under prescribed conditions, emits a controlled flow of a specified gas. This device consists of a leak element (either a physical orifice or a gas-permeable membrane) that allows gas to pass through to the outlet of the device at a controlled rate. The rate, called the leak rate, can be accurately quantified by means of calibration.

The calibrated leak rate of standards manufactured by LACO will be within the customer-requested value, plus or minus a manufacturing tolerance. Several manufacturing tolerances are available. Practical limitations in controlling the variables that contribute to leak rate means that the calibrated leak rate of the leak standard will normally not exactly match the requested leak rate.

3.1 SPECIFICATIONS

Table 2: Leak Specifications

	MICROTUBE CAPILLARY
GAS	Helium/Other gases*
LEAK RATE RANGE	10 ⁻⁹ to 1 atmcc/sec
TEMPERATURE COEFFICIENT	0.1%/°C Reservoir style
	-0.5%/°C Open style
DEPLETION RATE	Target value: <3%/year; actual depletion rate is dependent on pressure, reservoir size, and leak rate.
CALIBRATION UNCERTAINTY	Refer to section 3.1.10.

*Non-hazardous, non-radioactive

LACO Calibrated leak standards are manufactured with our proprietary microtube capillary leak elements. Our microtube capillary has undergone a rigorous validation process to verify the reliability of the leak standard.

Table 3: Leak Element Comparison

LEAK ELEMENT	GASES	LEAK RATE	TEMP COEF.	CLOG-GING	VACUUM RESPONSE	STABILITY	DURABILITY	PRES-SURE RE-SPONSE
Glass Permeation	Helium Only	10 ⁻⁷ - 10 ⁻¹⁰	4% per °C	None	Fair	Excellent	Breakable	Fair
Teflon Permeation	Helium Only	10 ⁻⁴ - 10 ⁻⁸	2% per °C	None	Fair	Fair	Unbreakable	Fair
Metal Capillary	All Gases	10 ⁻¹ - 10 ⁻⁶	0.2% per °C	Frequent	Excellent	Varies	Unbreakable	Excellent
Microtube Capillary	All Gases	10 ⁻¹ - 10 ⁻¹⁰	0.1 % per °C	Very Rare	Excellent	Excellent	Unbreakable	Excellent

3.2 COMPOSITION OF A LEAK STANDARD

NOTE For available calibrated leak standard configurations, please contact a LACO Technologies sales engineer.

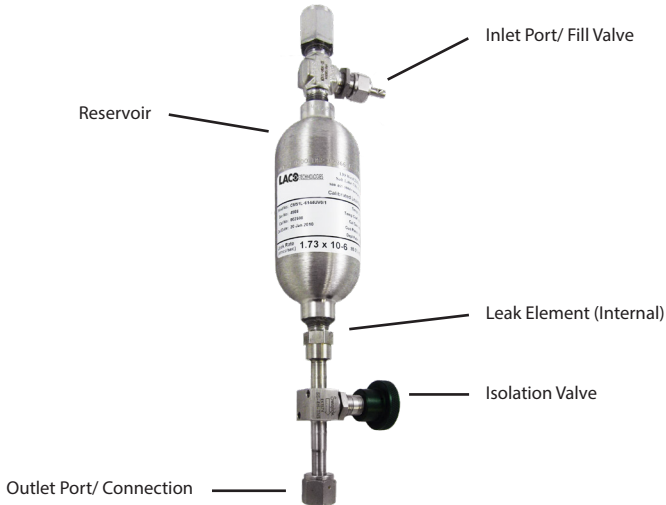


Figure 2: Sample Leak Standard

3.2.1 INLET PORT OR FILL VALVE

The presence and type of inlet port or fill valve depend upon the requirements and style of the leak standard. Leak standards that require periodic re-pressurizing are typically supplied with a pressure gauge as part of the leak standard, while leak standards that have an external gas pressure source generally will not have a pressure gauge supplied. Still, other leak standards have factory-sealed fill valves and are designed to be re-pressurized only by the factory.

3.2.2 PRESSURE GAUGE

A pressure gauge may be supplied with the leak standard and is typically supplied with leak standards designed to be refilled by the customer. For refill instructions, see Section 4.2.

3.2.3 LEAK ELEMENT

A leak element may be one of the following types:

- Microtube capillary (a physical orifice)
- Metal capillary (a physical orifice)
- Glass permeation (a solid glass membrane)
- Teflon permeation (a solid Teflon membrane)

LACO Technologies manufactures leak standards with microtube capillary leak elements. The information in this manual applies specifically to microtube capillary leak standards.

3.2.4 RESERVOIR

All leak standards require a supply of gas; some have a built-in reservoir that contain a supply of gas, while others, having no built-in reservoir, need an independent, regulated supply. These are typically called open style leak standards.

3.2.5 OUTLET PORT/CONNECTION

Depending upon the leak style, the outlet port of the leak standard is connected to a vacuum system, leak detector, or some other process system. Or, a sniffer probe is placed near or inside the port.

3.2.6 ISOLATION VALVE

An isolation valve at the outlet port may be supplied for convenience in operating the leak standard. The purpose of the valve is to temporarily isolate the leak signal from the rest of a system. Closing the valve does not stop the flow from the leak and gas can build up in the leak outlet while the valve is closed. After opening the valve, it is best to allow some extra time for the leak signal to stabilize before taking a reading. It is recommended to store leaks with the isolation valve open to prevent gas buildup or saturation of the leak element.

Leak standards are available in many types and configurations. Proper use and care of a leak standard is dependent upon its type and style.

4. BASIC OPERATION

4.1 USING INFORMATION ON LABEL

All leak standards include a calibration label bearing important calibration information; where size permits, important physical data regarding the leak standard is also included. In all cases, such information is also found on the calibration certificate.



	
Calibrated Leak Standard	
<small>3085 West Directors Row Salt Lake City, UT 84104 801-486-1004 • lacotech.com</small>	
	
Mod No: Sample Leak	Temp: 23.0°C
Ser No: Sample SN	Temp Coef: 2.0%/°C
Cal No: 721338	Cal Gas: Helium
Cal Date: 1 Jan 2010	Decay Rate: 15%/year
Due Date: 1 Jan 2011	
Leak Rate (atmcc/sec) $5.00 \times 10^{-7} \pm 8.0\%$ into vac	

Figure 3: Leak Calibration Label

Table 4: Label Information

COMPONENT	DESCRIPTION
MODEL NUMBER	A number that denotes the specifications of the leak standard, including (but not limited to) leak element type, calibration gas, nominal leak rate, number of calibration points, isolation valve type, reservoir type, and connection type.
SERIAL NUMBER	A unique number that identifies the leak standard.
CALIBRATION NUMBER	A number unique to the calibration of the leak standard and its resulting data, and which identifies that calibration.
CALIBRATION TEMPERATURE	The temperature at which the calibration was performed. Because temperature affects leak rate (see Temperature Coefficient below), calibration temperature is an important factor. Leak standards should be used within a window of ± 10 °C of the calibration temperature.

Table 4: Label Information

COMPONENT	DESCRIPTION
TEMPERATURE COEFFICIENT	<p>The leak rate of a calibrated leak standard will vary according to the temperature of the standard. For temperatures within a few degrees of the calibration temperature, this variation can be assumed to be linear. The temperature coefficient is reported in % / °C and allows for a leak rate correction when the standard is used at a temperature other than the calibration temperature. The correction is made using Equation 1 below.</p> <p>For some designs, such as LACO's microtube capillary standards, the temperature dependence is very low and can often be neglected within a few degrees of the calibration temperature.</p> <p>EQUATION 1:</p> $Q_{COR} = Q_{CAL} + \frac{(Q_{CAL} \times C_T \times [T - T_{CAL}])}{100\%}$ <p>WHERE: Q_{cor} is corrected leak rate (in the same leak rate unit that is on the label), Q_{cal} is leak rate on calibration label, C_T is temperature coefficient on label (%/°C), T is ambient temperature at time of leak standard use (°C), T_{cal} is calibration temperature on label (°C).</p> <p>EXAMPLE: The label on a leak standard shows a leak rate of 2.00×10^{-6} atmcc/sec, a calibration temperature of 23.0 °C, and a temperature coefficient of 2.0%/°C; the ambient temperature during use of the leak standard is 21.0 °C. The corrected leak rate value, according to the above equation, is:</p> $Q_{COR} = 2.00 \times 10^{-6} \text{ atmcc/s} + \frac{(2.00 \times 10^{-6} \text{ atmcc/s} \times 2.0\% / ^\circ\text{C} \times [21.0^\circ\text{C} - 23.0^\circ\text{C}])}{100\%}$ $Q_{COR} = 1.92 \times 10^{-6} \text{ atmcc/s}$
CALIBRATION GAS	<p>The gas used in the leak standard and gas used in calibration.</p>

Table 4: Label Information

COMPONENT	DESCRIPTION
CALIBRATION PRESSURE	<p>Gas pressure needed to achieve the leak rate on the label. For open style or refillable leak standards, this pressure must be supplied during use. Do not exceed this pressure, as doing so may damage the leak standard and/or cause personal injury.</p> <p>Pressure in leak standards supplied with a pressure gauge should be monitored and refilled using the supplied gauge as the pressure reference (not a different gauge), as calibration of the leak standard was performed using the supplied gauge. Open style leak standards not supplied with a pressure gauge should be pressurized using a reference pressure gauge that has been calibrated traceable to national and international standards (e.g. NIST). In many cases, the calibration pressure is denoted in relative terms (e.g. PSIG), meaning atmospheric pressure variations (due to elevation) affect this value. A correction factor to the pressure may need to be applied in these cases.</p> <p>The calibration certificate will note when a correction factor may be needed, and document LF-110, "Addendum to Calibration Certificate—Leaks with Pressure Gauges" is included with the certificate as a reference for making this correction. See Appendix A for details.</p>
LEAK DECAY RATE	<p>For leak standards with gas reservoirs, the leak rate will drop as the pressure in the gas reservoir depletes. All reservoir leak standards (except for those with zero volume valves) are normally stored with the isolation valve (if equipped) open. Thus, the gas reservoir continuously depletes as the gas leaks through the leak element.</p> <p>The leak decay rate estimates the change in leak rate as a function of elapsed time from the calibration date, assuming the leak is stored at ambient temperatures and is constantly leaking gas from the reservoir through the leak element. The leak decay rate, expressed in percent of original leak rate per unit time, should only be used as a guide to determine when a calibrated leak standard should be recertified, and not to accurately predict the leak rate at some future date. This can help in determining the appropriate recalibration interval for leak standards. In general, the higher the depletion rate, the shorter the recalibration interval should be.</p> <p>The depletion estimation can be performed using Equation 2 below:</p> <p>EQUATION 2:</p> $Q_{COR} = Q_{CAL} - \frac{Q_{CAL} \times D_R \times T}{12 \text{ months / year} \times 100\%}$

Table 4: Label Information

COMPONENT	DESCRIPTION
LEAK DECAY RATE	<p>WHERE: Q_{cor} is corrected leak rate (in the same leak rate unit as on the label), Q_{cal} is leak rate on calibration label, D is depletion rate on label (usually %/year), T is approximate time in months since calibration.</p> <p>EXAMPLE: The label on a leak standard shows a leak rate of 2.00×10^{-5} atmcc/sec, with a depletion rate of 5.0%/year and a calibration date of Jan. 1, 2004. If the current date is July 1, 2004, the corrected leak rate of the leak standard is</p> $Q_{COR} = 2.00 \times 10^{-5} \text{ atmcc / s} - \frac{2.00 \times 10^{-5} \text{ atmcc / s} \times 5.0\% / \text{year} \times 6 \text{ months}}{12 \text{ months / year} \times 100 \%}$ $Q_{COR} = 1.95 \times 10^{-5} \text{ atmcc / s}$ <p>Many leak standards are equipped with an isolation valve; while storing such a leak standard with the isolation valve closed may reduce the depletion rate in some cases, this technique should not be considered an alternative to recalibration, or justification to disregard depletion rate. Where depletion rate is a significant issue, a special valve, called a "zero-volume" valve, can be supplied with new leak standards. When kept closed during non-use, a zero-volume valve effectively reduces the depletion rate to zero.</p>

Table 4: Label Information

COMPONENT	DESCRIPTION															
LEAK RATE	<p>The measured value of the leak rate of the leak standard, as determined by calibration. Leak rate values are also expressed in terms of the outlet pressure conditions, which are typically vacuum or atmosphere.</p> <p>Appendix B describes corrections that may be required for leaks flowing to atmospheric pressure. Table 5 below includes conversions between different leak rate units.</p> <p>Table 5: Leak Rate Conversion</p> <table border="1"> <thead> <tr> <th>CONVERT FROM</th> <th>MULTIPLY BY</th> <th>CONVERT TO</th> </tr> </thead> <tbody> <tr> <td>atm-cc/sec</td> <td>1.013</td> <td>mbar-liter/sec</td> </tr> <tr> <td>atm-cc/sec</td> <td>0.76</td> <td>torr-liter/sec</td> </tr> <tr> <td>torr-liter/sec</td> <td>1.33</td> <td>mbar-liter/sec</td> </tr> <tr> <td>Pa-m³/sec</td> <td>9.87</td> <td>atm-cc/sec</td> </tr> </tbody> </table> <p>To convert from volumetric flow units to mass flow units use Equation 3.</p> <p>EQUATION 3:</p> $Q_{MASS} = Q_{VOL} \times \frac{31,500 \times MW}{0.0821 \times T}$ <p>WHERE: Q_{mass} is the mass leak rate in grams/year, Q_{vol} is the volumetric leak rate in atmcc/sec, MW is the molecular weight of the gas grams/mole, T is the absolute temperature K (typically 298), 0.0821 is the ideal gas constant. 31,500 converts seconds to years and cc to liters.</p> <p>EXAMPLE: A leak standard of R134a refrigerant has a volumetric leak rate of 1.00×10^{-5} atmcc/sec. Its molecular weight is 102.03 grams/mole. Using equation 3 above, the mass leak rate is 1.31 grams per year, or, dividing by the molecular weight, MW, the molar leak rate is 0.013 moles per year at 298 °K.</p>	CONVERT FROM	MULTIPLY BY	CONVERT TO	atm-cc/sec	1.013	mbar-liter/sec	atm-cc/sec	0.76	torr-liter/sec	torr-liter/sec	1.33	mbar-liter/sec	Pa-m ³ /sec	9.87	atm-cc/sec
CONVERT FROM	MULTIPLY BY	CONVERT TO														
atm-cc/sec	1.013	mbar-liter/sec														
atm-cc/sec	0.76	torr-liter/sec														
torr-liter/sec	1.33	mbar-liter/sec														
Pa-m ³ /sec	9.87	atm-cc/sec														

Table 4: Label Information

COMPONENT	DESCRIPTION
UNCERTAINTY	<p>Measurement uncertainty is a function of the calibration process and not a physical property of the calibrated leak standard. It is expressed as a percent of the leak rate and defines a window centered on the calibrated leak rate in which the true leak rate likely falls. LACO reports measurement uncertainty according to accepted international methods, using a coverage factor of $k=2$, which implies that the true leak rate value falls within the uncertainty window with a 95% confidence.</p> <p>Uncertainty should not be confused for manufacturing tolerance.</p>

4.2 REFILLING

Leak standards with a built-in pressure gauge may require being re-pressurized periodically due to gas depletion (see 'Depletion Rate' in Table 4 above). Re-pressurization is recommended when the gas pressure shown on the gauge has changed more than 2% from the calibration pressure (as indicated on the calibration label and certificate). Leak standards that do not have a pressure gauge should not be refilled; rather, it should be returned to the factory for recalibration.

If re-pressurization is necessary, the following steps should be carefully followed to avoid damaging the leak standard, altering the calibration, or causing personal injury. Only clean, dry gas of 99.95% purity or better should be used. Ensure that all valves, hoses, and piping are clean and particle free before using them to refill leak standards.

4.2.1 REFILLING WITH A VACUUM PUMP

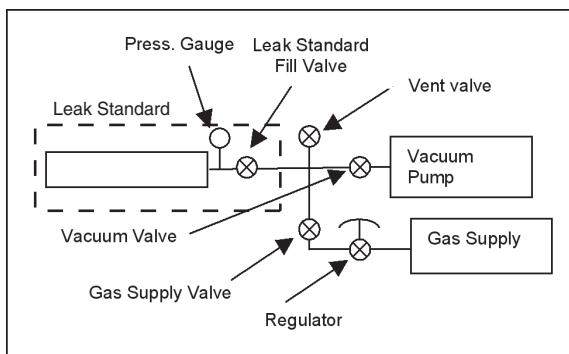


Figure 4: Refilling a Leak Standard with a Vacuum Pump

1. After ensuring that the fill valve is *closed*, remove the protective cap from the valve.
2. Connect the fill valve to a configuration similar to the diagram above.
3. With the vent valve and gas supply valve closed, start the vacuum pump and open the vacuum valve; allow several seconds to adequately evacuate all air from the system. Vacuums below 1 torr are sufficient.
4. Close the vacuum valve.
5. Open the fill valve on the leak standard.
6. Open the gas supply valve and slowly increase pressure using the regulator until the leak standard pressure gauge indicates the desired pressure. Let sit for 1-2 minutes to minimize thermal effects. Adjust regulator if necessary.
7. Tightly close fill valve and close gas supply valve.
8. Slowly open vent valve to release pressure in the system
9. Remove the leak standard and replace protective cap on fill valve.

4.2.2 REFILLING WITHOUT A VACUUM PUMP

Figure 5: Refilling a Leak Standard without a Vacuum Pump

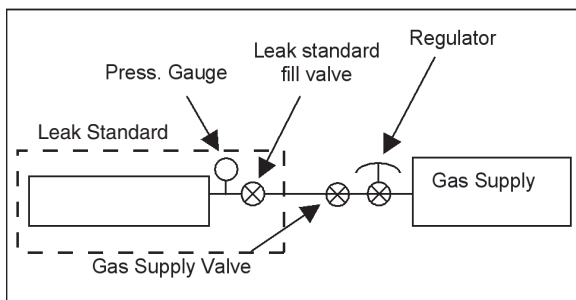


Figure 5: Refilling a Leak Standard without a Vacuum Pump

NOTE: Use this procedure only if a vacuum pump is not available

1. After ensuring that the fill valve is *closed*, remove the protective cap from the valve.
2. Loosely connect the fill valve to a configuration similar to the diagram above.
3. With the fill valve closed, open the gas supply valve and purge the connecting tube of air by allowing the calibration gas (at low pressure) to flow through the line and the loose connection for several seconds.
4. Tighten the fill valve connection.
5. Adjust the regulator to the approximate pressure required in the leak standard.
6. Open the fill valve and wait 1-2 minutes to minimize thermal effects.
7. Adjust pressure as needed.
8. Close fill valve.
9. Close regulator and remove leak standard.

4.3 USE IN VACUUM AND SNIFFING APPLICATIONS

4.3.1 USE APPROPRIATE CONNECTIONS

Leak standards that leak into vacuum should be connected to the vacuum system with an appropriate connection. For example, flange connections should use a clean, properly sized and centered o-ring, with a proper clamp. Tapered thread connections should be sealed with Teflon tape or other thread-sealing material.

4.3.2 LEAK STANDARD EXPOSURE

Avoid connecting leak standards to vacuum systems where an oil-sealed rotary vane pump will be continually pumping on, or exposed to, the leak standard. Over time oil may backstream from the pump to the leak standard and contaminate it with oil. A leak standard that has oil at its outlet port is likely contaminated and should be returned to the factory for recalibration and/or repair. See Section 8 for Warranty Information.

4.3.3 USING SNIFFER PROBES

Leak standards that leak into air (atmosphere) have several considerations unique to their application when used to calibrate a sniffer leak detector. An appropriately sized probe should be used to minimize errors. When inserting a sniffer probe to the outlet of a sniffer-compatible leak standard, insert the probe as far as possible to the leak outlet. A close fit to the probe helps avoid dilution of the tracer gas signal and a more accurate reading. Do not press the probe hard against the outlet as this can create a suction seal against the outlet and interfere with leak flow. Ensure that the probe is in a stable position throughout the entire measurement, as movement can introduce noise or instability to the reading. For more in-depth guidance or troubleshooting, contact LACO Technologies for help.

4.4 DUAL RESERVOIR LEAK STANDARDS

Some halogen leak standards use a dual-reservoir to contain refrigerant in both gas and liquid form. These leak standards require special instructions and care.



Figure 6: Sample Halogen Leak Standard

- Pressure may be adjusted to obtain any leak rate that is within the range specified on the calibration curve (supplied with the calibration certificate (and/or attached to the leak standard) for calibrations of three or more points. Pressure, as indicated on the gauge, must match the pressure value corresponding to the desired leak rate from the calibration curve.
- To increase pressure: ensure that the leak standard is upright and sitting flat; slowly open the Increase valve while monitoring the pressure gauge; when the desired pressure is reached, close the valve. Do not exceed the maximum pressure of the gauge, as this may damage the gauge.
- To decrease pressure: slowly open the “decrease” valve; when the desired pressure is reached, close the valve.
- Do not freeze; if possible, store and use at room temperature.
- Do not expose to temperatures greater than 120 °F (49 °C), as explosion may occur.
- Do not attempt to recharge the primary reservoir with refrigerant. If recharging is necessary (as indicated by the inability to reach the highest calibration pressure), return it to the factory.
- Take special care not to touch the leak port, as this may lead to plugging of the capillary leak element.

4.5 OPEN STYLE TRACER GAS LEAK STANDARDS

Open style leak standards that a tracer gas must have the gas properly supplied to the inlet of the leak standard in order for the leak to perform properly. For example, if the leak standard was calibrated with 100% helium at a specified pressure, then it is important that any air that is in the helium supply line is properly removed, otherwise the helium supplied to the leak element of the leak standard will be diluted with the existing air in the supply line even when the correct helium pressure is supplied. In general, the same principles that apply to filling a helium reservoir leak standard as outlined in Section 4.2.1 apply to supplying tracer gas to an open style leak standard.

Use the following guidelines when supplying tracer gas to the inlet of an open style leak standard.

1. Always ensure gas supply lines have been cleaned and purged and are free from any moisture, oils, or particle contamination. In addition to having clean supply lines it is desirable to also provide particulate filtration as well.
2. If the leak standard is to be mounted to a part to simulate a leak, ensure that the leak standard is protected from damage (from abusive or careless handling) or contamination (particles or liquids). In these applications, the tracer gas supplied to the leak is intended to be the same as is supplied to the actual part under test conditions. It is important that the leak standard is exposed to the same source of gas using the same filling protocol as is used during a normal leak test on the part. This will ensure that the leak standard responds to the system in the same way that an actual leak on the part will respond.
3. When connecting the leak standard to the tracer gas source for the first time, use one of the following methods to ensure air is removed from the supply lines. See Section 4.2.1 for additional details.
 - a. Evacuate the line between the tracer gas source isolation valve and the leak standard to an absolute pressure no higher than 1 torr (1.3 mbar) prior to supplying the gas to the leak standard.

- b. If no vacuum pump is available, use tracer gas to purge the line between the gas source isolation valve and the leak standard by loosening the connection to the leak standard and allowing tracer gas to flow through the line for a few seconds. When doing this, take care not to contaminate the test area with tracer gas as this could potentially impact leak rate readings.
4. If the leak standard is to be connected to an intermittent supply of tracer gas, controlled by an isolation valve, then it is recommended that the gas supply line be configured with a three-way valve and vacuum pump.
5. When replacing the tracer gas supply, such as when changing out a gas bottle, ensure that the supply lines are purged or evacuated as outlined in point 3 above.

5. MAINTENANCE

- Store leak standards at moderate temperatures; do not expose leak standards to temperatures less than $-20\text{ }^{\circ}\text{C}$ or greater than $50\text{ }^{\circ}\text{C}$, or store them for long periods of time at extreme temperatures.

Note: storage temperatures are different from use temperatures. Use temperature should be near the calibration temperature

- Store leak standards in a clean, dry area; protect from dust, moisture, oil, and other potential contaminants. Place cap or other clean covering over leak ports during storage. Protective carrying/storage cases are available from the factory.
- Leak standards with a permeation leak element should be stored with the isolation valve (if equipped with one) open.
- Do not attempt to clean a potentially contaminated leak element; if operability is in question, return the item to factory for repair evaluation.
- Ensure that flanges, threads, and other connecting surfaces are protected from scratches, dings, etc.

6. CALIBRATION OF LEAKS

All LACO leak standards are backed by our lifetime product warranty (see Section 8) and include a NIST traceable calibration certificate. Our calibration lab is accredited to A2LA, ISO 17025-2017 and ANSI Z540-1-1994 standards.

LACO uses several methods to measure and calibrate leak standards. The calibration method selected for any given leak depends on the calibration gas, the range of the leak standard, the outlet conditions of the leak standard (vacuum or atmospheric pressure), and the desired uncertainty.

LACO uses two types of calibration methods: primary and secondary or 'transfer standard' methods. The primary calibration methods incorporate measurements of basic physical properties such as time, volume, and pressure. These methods measure the leak rate of the leak standard under test by measuring the pressure or volume change induced by gas flowing into a known system. The secondary calibration methods use a calibration transfer standard that has been calibrated on a primary system or at a primary standards laboratory. The leak rate of the leak standard under test is measured and compared to that of the known reference standard. The actual calibration method used on a particular leak standard is referenced by the calibration procedure on the certificate of calibration.

7. SHIPPING INSTRUCTIONS

Leak standards equipped with a pressurized gas reservoir may be subject to special shipping requirements. Consult local and federal requirements to ensure that you are in compliance when shipping and transporting leak standards.

When returning a leak standard to LACO for repair or calibration, contact our sales team to obtain shipping information and a Return Materials Authorization (RMA) number. Always package the leak standard in a sealed package to protect it from dust and moisture.

Materials with compressed gases or hazardous gases may be classified as hazardous goods and should be marked as hazmat and prepared and shipped by a certified individual (some couriers can also provide this service). Check with the shipping courier for guidelines and regulations to follow while shipping hazardous goods.

8. WARRANTY INFORMATION

LACO leak standards are intended for use as reference standards for gas leak flow. Any use beyond this purpose may be beyond the scope of the leak standard design, and performance in such uses is not guaranteed.

For new leaks manufactured by LACO Technologies, the following standard 12-month warranty applies: LACO leak standards are warranted to be free from manufacturing defects for 12 months from the date of manufacture. This warranty does not cover damage to leak standards due to mishandling or improper use. Improper use may include but is not limited to: subjecting the leak to liquid or particulate contamination, over-pressurizing the leak, or disassembly—including breaking any of the seals on the leak.

If a warranty request is made, LACO Technologies will evaluate the leak and at its own discretion, may repair or replace the leak standard. The customer is responsible for any and all shipping charges involved in a warranty claim. To fulfill a warranty request, contact LACO Technologies to get a warranty RMA. This document must be received prior to shipping any leak standard to LACO. Items returned under warranty that are found to be functioning properly or to meet original purchase order requirements may incur a standard calibration or evaluation fee.

The following limited lifetime warranty applies beyond the standard 12-month:

Any LACO leak standard that is found to be nonfunctional at the time of calibration at a LACO calibration lab shall be repaired or replaced free of charge, so long as it is determined that the defect is not a result of mishandling or improper use, as defined herein. This limited lifetime warranty does not include isolation or fill valves and pressure gauges assembled to the leak standard. The customer is responsible for the calibration cost and for any and all shipping charges.

This warranty statement is considered an addendum to Terms of Sale (Document # AOM-01-104) which can be found on the LACO website, www.lacotech.com.

9. APPENDIX A: LEAKS WITH PRESSURE GAUGES

This appendix applies to calibrated leaks supplied with reservoir pressure gauges and for calibrated leaks without reservoirs where the customer supplies a pressure gauge.

The leak rate of gas leak standards is related to the *absolute* gas pressure applied to the leak element. A typical bourdon tube pressure gauge supplied on calibrated leaks measures gauge or *relative* pressure, which changes with elevation. Use the following formulas to convert the pressure reported on the calibration certificate to the correct pressure at your elevation (barometric pressure).

9.1 CALCULATE ABSOLUTE PRESSURE FROM CALIBRATION CERTIFICATE

EQUATION 4: $P_{\text{absolute, atm}} = P_{\text{atmospheric}} + P_{\text{leak}} / 14.7$

WHERE: $P_{\text{atmospheric}}$ = atmospheric (barometric) pressure at calibration reported on calibration certificate in atmospheres.
 P_{leak} = gas pressure reported on the calibration certificate in psig.

9.2 CALCULATE THE GAUGE PRESSURE FOR LOCAL ATMOSPHERIC (BAROMETRIC) PRESSURE

EQUATION 5: $P_{\text{leak, psig}} = (P_{\text{absolute}} - P_{\text{atmospheric}}) \times 14.7$

WHERE: P_{absolute} = pressure calculated from Equation 4 in atmospheres.
 $P_{\text{atmospheric}}$ = local atmospheric pressure measured from a barometer or Table 6 below, in atmospheres.

Table 6: Elevation vs. Atmospheric Pressure

ELEVATION (FEET)	AVERAGE ATMOSPHERIC PRESSURE (ATM)
0 (sea level)	1.00
1,000	0.964
2,000	0.930
3,000	0.896

Table 6: Elevation vs. Atmospheric Pressure

ELEVATION (FEET)	AVERAGE ATMOSPHERIC PRESSURE (ATM)
4,000	0.864
5,000	0.832
6,000	0.802
7,000	0.771
8,000	0.742
9,000	0.715
10,000	0.688

10. APPENDIX B: LEAKS FLOWING TO ATMOSPHERE

This appendix applies to calibrated leaks that flow to atmospheric pressure where the atmospheric pressure during the calibration of the leak may be different compared to the atmospheric pressure during the use of the leak.

The leak rate of gas leak standards is related to the absolute gas pressure applied to the leak element and the atmospheric pressure at the leak outlet. A correction must be made to leaks used at a different atmospheric pressure from the calibration atmospheric pressure. The atmospheric pressure can generally be estimated by knowing the elevation. Use the following formulas to correct the leak rate for your atmospheric conditions.

10.1 CONVERT PRESSURE TO ABSOLUTE PRESSURE

EQUATION 6: $P_1 = P_{\text{atmospheric}} + P_{\text{leak}}/14.7$

WHERE: P_1 = absolute pressure applied to the leak in atmospheres.
 $P_{\text{atmospheric}}$ = atmospheric (barometric) pressure at calibration reported on calibration certificate in atmospheres.
 P_{leak} = gas pressure reported on the calibration certificate in psig

10.2 CALCULATE THE LEAK CONSTANT, K

EQUATION 7: $Q = K (P_1^2 - P_2^2)$ for viscous flow leaks,
or $K = Q / (P_1^2 - P_2^2)$

WHERE: Q (atmcc/sec) = leak rate of the gas under calibration conditions
 P_1 (atm) = absolute pressure applied to the upstream side of the leak calibration certificate in atmospheres (see Equation 6 above).
 P_2 (atm) = atmospheric pressure reported on the calibration certificate.
 K = leak constant (units of cc/atm-sec)

10.3 CALCULATE THE CORRECTED LEAK RATE

Using Equations 6 and 7 above, the leak constant K, and Table 7 below, calculate the corrected leak rate. Calculate P_1 from equation 6 above using atmospheric pressure from Table 6 above. Use atmospheric pressure from Table 6 for P_2 .

Table 7: Leak Rate Calculation

STEP	DESCRIPTION
CALIBRATION CERTIFICATE READS:	Leak Rate: 5.0×10^{-3} atmcc/sec Pressure: 20 psig Air Barometric Pressure: 0.85 atmospheres
CURRENT CONDITIONS:	Barometric Pressure: 1 atm (sea level)
STEP 1 (EQ. 6)	At current conditions: $P_1 = (1.0) + 20/14.7 = 2.36$ atm
STEP 2	$Q_{\text{corrected}} = 1.20 \times 10^{-3} (2.36^2 - 1.0^2)$ $= 5.49 \times 10^{-3}$ atmcc/sec