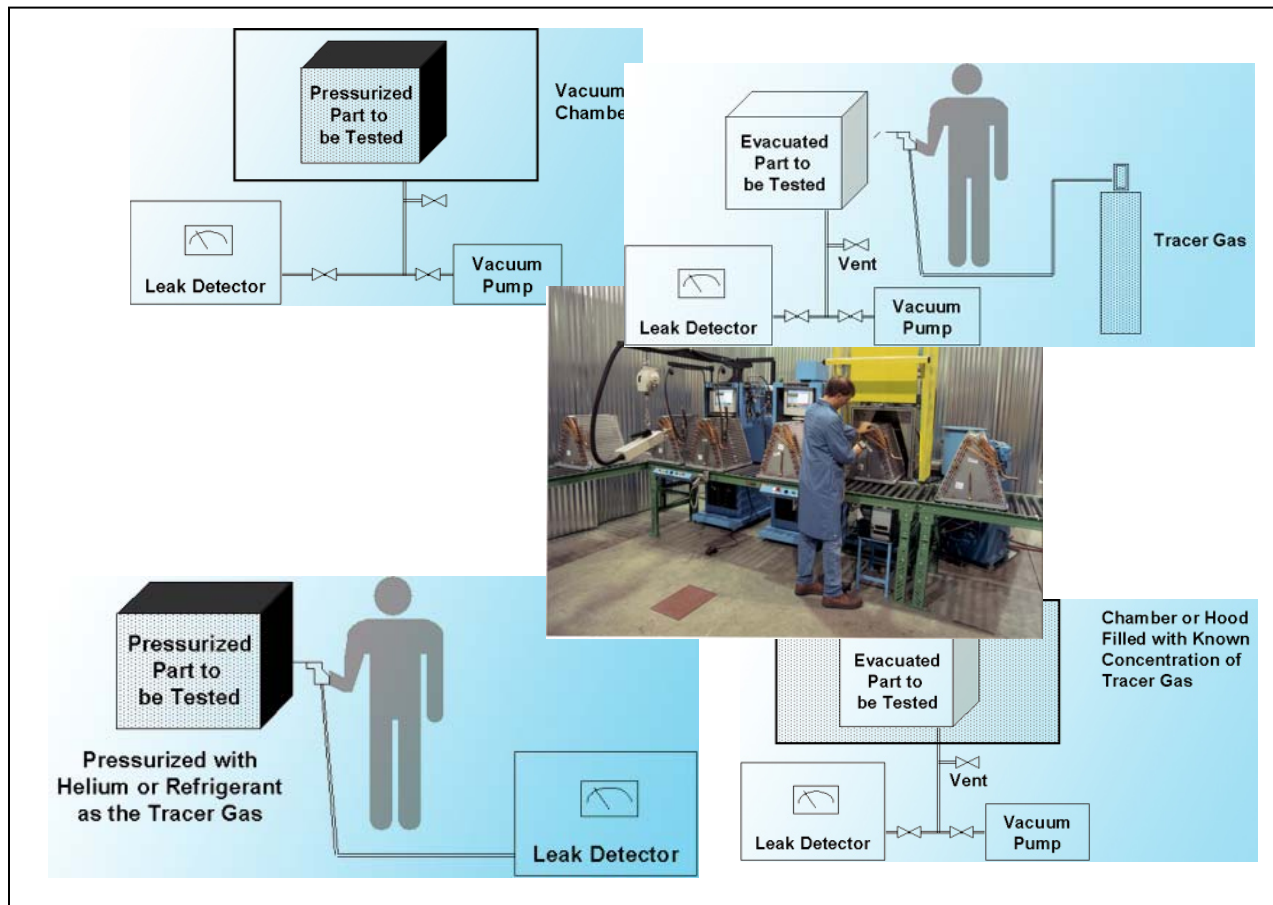
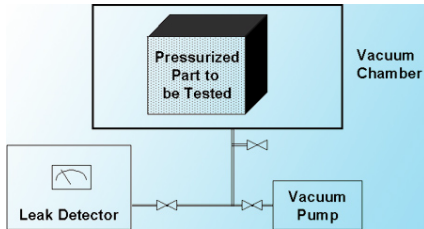




# *PRINCIPLES OF LEAK TESTING*



**“Notes on principles of operation and considerations in their application to research, development and production oriented Leak Testing.”**



# PRINCIPLES OF LEAK TESTING SYSTEMS

## PRINCIPLES OVERVIEW

The testing of components can be broken into two fundamental types, **Go-No-Go** and **Leak Location** Testing.

**Go-No-Go testing** evaluates the whole component or assembly for leaks to provide a Go-No-Go (Pass/Fail) indication allowing a component to move on in the manufacturing process or be rejected pending further action. Pressure Decay, Inside-Out and Outside-In vacuum tests would be classified as Go-No-Go tests. These are relatively quick ways of testing the component but, they do not pinpoint a leak if there is one present. VTI addresses pinpointing needs with Custom Systems designed with specific component geometry and manufacturing throughput issues in mind.

**Leak Location testing** is a much slower process than Go-No-Go testing, always requires manual intervention, but does pinpoint a leak on an assembly allowing corrective action to be taken, saving the part or assembly from scrap. VTI produces Repair Stations for this purpose. Sniffing or Spray testing are classified as Location tests. VTI addresses these needs with products such as the **SMARTSTATION HS, RS**, and **Polaris** systems.

## DESIGN CONSIDERATIONS

Consideration needs to be given to many issues beyond those related to the actual leak test. Systems are often an integral part of a manufacturing process requiring both mechanical and electrical integration.

Careful system design allows issues such as required throughput and failure handling to be accounted for and a handling method developed and incorporated into the manufacturing regime. Failed units can be routed through a Repair Station eventually being looped back into the main line for final verification. Small component failures can be ejected down a monitored chute which 'holds' the process until the failed part has been safely removed from the process flow. Bar code readers can scan units allowing plant computers to track production and build valuable information databases on productivity and repetitive fail points to continually optimize the production process.

In some cases, it is also possible to combine manufacturing steps into one system. For example, the fixtures used to hold the component for Leak Testing may be constructed such that they simultaneously check the component for manufacturing dimensional tolerances thereby eliminating additional handling which is a costly process step, saving process time.

VTI has extensive experience in the design of Custom Leak Test Systems. Let us take a look at the fundamental principles involved and see some examples.

## **PRINCIPLES OF LEAK DETECTION**

### **1) Pressure Decay/Vacuum Rate of Rise Testing**

Pressure testing can be used to detect larger leaks requiring correction prior to the component undergoing a more sensitive, Mass Spectrometer/Leak Detector test. Unless there is significant time available, Pressure Decay is the least sensitive of all the techniques discussed here but does have a very valuable role to play in the production scenario. The technique looks for a changing pressure in a sealed (and therefore constant if no leak is present) part and can be implemented in two ways:

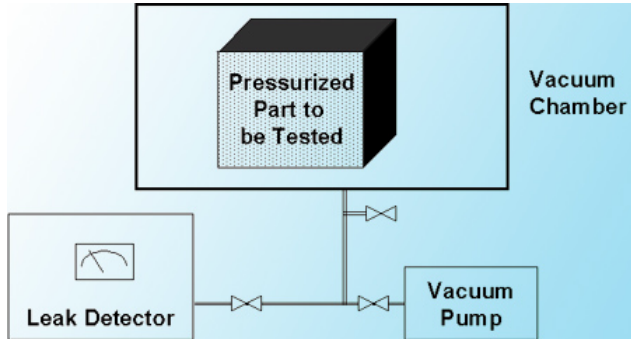
**Pressure of Decay** - The part to be tested is pressurized with gas and sealed. The system monitors the internal pressure and looks for a drop over time.

**Vacuum Rate of Rise** - The part to be tested is evacuated and sealed. The system monitors the internal pressure and looks for a rise over time.

Clearly, the more time spent, the better the sensitivity of the test. However, care must be taken not to confuse changes associated with temperature and out-gassing with the presence of a leak. This technique is very valuable in 'weeding out' major leaks, saving valuable Go-No-Go test time, uses less expensive (compared to Helium) air or dry nitrogen as the test gas. VTI systems can be supplied with 'dual ports' allowing two units to be tested in parallel. This doubles the sensitivity of the system without loss of production rate in the production scenario.



## Principles of Leak Testing



### 2) Inside-Out Go-No-Go Testing

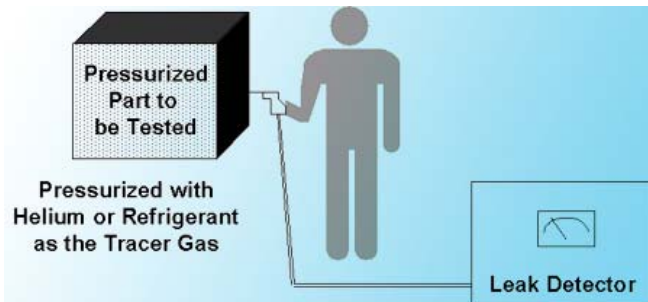
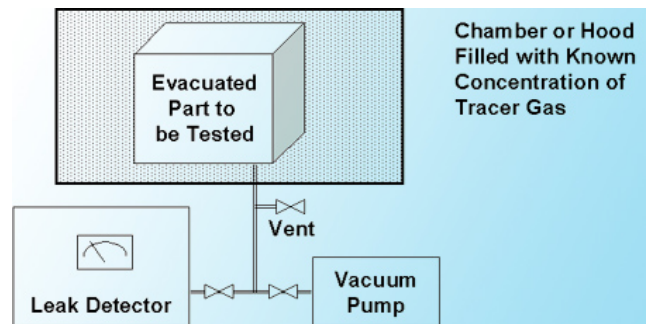
The component to be tested is pressurized with test trace gas, typically Helium, either pre-charged and inserted in a vacuum chamber or charged during evacuation. Any leak in the system will allow the trace gas to leak into the vacuum chamber where it will be detected by the leak detector.

***This is the preferred test technique for a number of reasons!***

The technique provides the greatest pressure differential between the trace gas source and detector (Pressurized gas to detector under vacuum) which provides the fastest response and highest sensitivity to a given leak. Automation of the test cycle is very easy and a Go-No-Go measurement is made making this an ideal solution in the production environment. If a leak is present, however, this technique will not locate the leak site. (See 4 below).

### 3) Outside-In Go-No-Go Testing

The component to be tested is connected to a vacuum pump and Leak Detector and evacuated. The part is held in a chamber or hood which is filled with a known Tracer Gas - typically Helium. The system (Leak Detector) then monitors for the ingress, hence the term Outside-In, of Tracer Gas to the part indicating the presence of a leak. This type of test is easily automated and, time permitting, can be more sensitive than sniffing. It does not, however, pinpoint the site of a leak and assumes the component does not have any major leak that would prevent pump-down to operational vacuum.

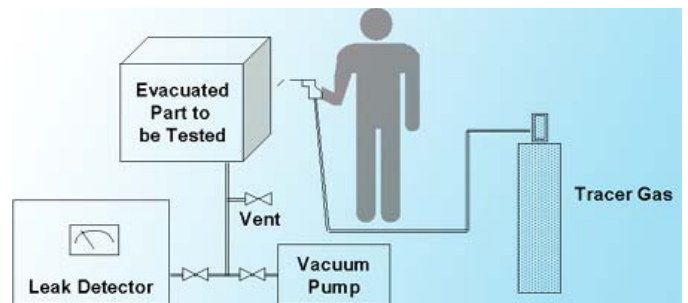


### 4) Sniffing Location Testing

This is the manual version of the Inside-Out test. The part to be tested is pressurized with trace gas but is then 'sniffed' using a sniffer wand on a leak detector rather than being placed within a vacuum chamber for a total go-no-go 'sniff' test. As the probe passes a leak, escaping (Inside-Out) trace gas is collected by the sniffer wand and detected by the leak detector. The location of the leak site is pinpointed in this way. The success of this technique is dependant upon the skill of the operator as probe speed and position are critical. It is usually reserved for small components or as a repair technique for pinpointing leaks in assemblies that have failed a general Inside-Out test.

### 5) Tracer Location Testing

This is similar to the Outside-In test except that the hood or chamber into which the evacuated part is positioned has been removed. The significant change is that an operator now probes around the part with a sprayer wand allowing trace gas to flow, selectively, around potential leak sites such as joints and fabrication seams. As the wand passes a leak, small amounts of trace gas that enter the part are detected by the leak detector. In this way, the location of the leak may be pinpointed, with accuracy, if care is taken. This technique can be more sensitive than Sniffing but the operator must be wary of tracer gas drift which can be confusing. It would take much longer to test a complete part in this way than with an automated system. This technique is usually reserved for testing components which have failed a general Outside-In test. VTI Outside-In systems have a spray wand to allow quick checks on key joints to be made on-line by an intervening operator.





Principles of Leak Testing

PRINCIPLES IN PRACTICE ...

The principles discussed on previous pages are illustrated below as practical implementations. Optimized integration into the manufacturing regime can be seen with the selective use of automation (to enhance throughput), by-pass repair line (allowing normal production flow to continue) and combination testing. More comprehensive information is available on each of these along with many more examples, on the web page. You can check the custom systems pages or browse in the Library.

AUTOMOTIVE AIR-CONDITIONING REFRIGERATION BATTERY TEST



A/C COMPONENT TESTER
Automated turntable system provides the throughput required by the production process.



REPAIR STATION
Maintain production efficiency by allowing normal flow to continue while recovering failed units.



TERMINAL POST TESTER
The lead-to-plastic interfaces of terminal posts for lead-acid batteries are helium leak tested.



A-COIL TEST STATION
A combination of Go-No-Go and final He leak test minimizes line delays identifying large leaks early.



AIR-BAG INFLATOR TESTER
Essential in providing critical test to 1x10^-5 atm-cc/s for key safety component with confirmed rejection.



BATTERY CASE TESTER
Inside-Out production tester for leak rate to 1x10^-4 atm-cc/s in production environment.

MORE INFORMATION...

A wealth of further information is available on the VTI website. In addition to visiting the CUSTOM LEAK DETECTION SYSTEMS web pages, you can visit extensive pages on CALIBRATED LEAKS and our range of MASS SPECTROMETRY PRODUCTS. We also have a wide range of VACUUM COMPONENTS, flanges, fittings and pumps and can carry out CUSTOM FABRICATION to your exact requirements. The staff at VACUUM TECHNOLOGY is always available to share their expertise in discussing any vacuum, engineering or fabrication challenge you may have.



Calibration Laboratory
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VTI's Calibration Laboratory is Accredited by the American Association for Laboratory Accreditation.