LACO TECHNOLOGIES

APPLICATION NOTE

NOTE #01-01

# LEAK TESTING HIGH VOLTAGE SWITCHGEAR

## SCOPE

This application note covers production leak testing of gas insulated high voltage switchgear and associated subassemblies.

## BACKGROUND

Gas-insulated high voltage switchgear typically use an SF6 gas to minimize arcing when the circuit breaker is activated. Leak testing of the subassemblies and finished product provide confidence that the sufficient pressurized SF6 gas will be contained inside the unit to prolong its functional life. Leak testing also minimizes maintenance and reduces environmental emissions.

A typical high voltage circuit breaker assembly consists of three breakers (one for each power phase) mounted on a common frame with an associated panel that contains control electronics and plumbing to manage the SF6 gas. The individual breakers are enclosed in "tanks" which contain the pressurized SF6 gas around the switch mechanism. Each breaker will also have a set of ceramic-insulated bushing extending from the tank spaced sufficiently to prevent arcing of the high voltage. SF6 leakage can occur in many locations including: porosity in aluminum tank castings, casting assembly seals, welds, ceramic insulators and associated joints, and interconnecting distribution piping.

Leak rate thresholds, or rejection limits vary from approximately $1 \times 10^{-4}$ to less than $1 \times 10^{-5}$ atmcc/sec SF6, and depend on breaker design, size, and other factors.

## DESCRIPTION

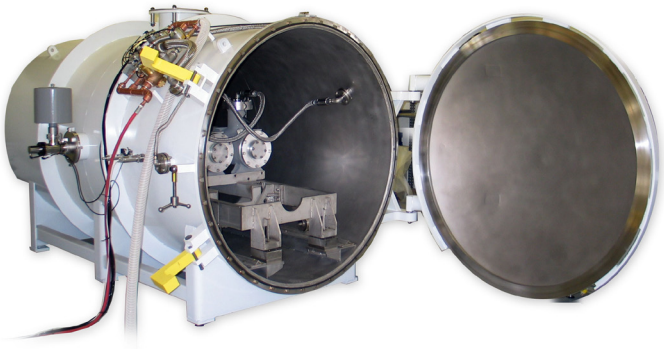
Several leak testing methods can be employed on the production floor to accomplish the goal of providing a leak tight product to the end user. Leak testing not only identifies and pinpoints unacceptable leaks (so they can be repaired), but also certifies the complete component or assembly is leak tight to the desired leak rate threshold. The leak testing method employed should achieve both of these goals.

Leak testing is commonly employed at the following assembly levels:

- Tank
- Breaker Assembly (single pole)
- Final Assembly

## DESCRIPTION (CONTINUED)

### Tank Leak Testing



Tank level leak testing is usually employed to screen out and repair defective tanks prior to assembly. Cracks and porosity defects in aluminum castings, and defects on machined seal surfaces are common leak types. The helium hard vacuum chamber leak test method will give the best sensitivity, fastest production cycle time as well as improved capability of locating leaks compared to other methods. Typically a tank (or multiple tanks) is assembled with temporary covers, placed in a vacuum chamber, connected to a helium source, and then pressurized with helium while in the vacuum chamber. A vacuum pump evacuates the chamber while a helium mass spectrometer leak detector monitors for leaks exiting the tank into the surrounding vacuum chamber. If a leak is detected, the tanks can be removed while still under pressure and a helium sniffer probe can be used to locate the leak(s). To reduce test equipment cost (but which sacrifices cycle time and leak rate sensitivity) one can also use the helium accumulation method for leak testing tanks. Instead of using a vacuum chamber, an accumulation cover captures the leaking helium and a helium leak detector measures the accumulated helium inside the cover and correlates it to a leak rate. The accumulation of helium takes place at atmospheric pressure.

Other test methods such as air pressure decay or bubble testing typically do not have the required sensitivity to effective leak test tanks. Manual sniffing of the tanks by an operator can be employed; however, this technique can be tedious (particularly if trying to find porosity leaks in the casting) and labor intensive and does not give an indication of the total or global leak rate of the tank.

Tanks can also be hydro tested or proof tested in addition to leak testing in order to meet ASTM requirements for pressure vessels. If an air proof test is substituted for a hydro test, often the proof test can be combined with the leak test and performed on the same equipment (see Application Note 01-02 Helium Leak Testing and Proof Testing of Pressurized Parts).

**EXTREME CAUTION AND NECESSARY SAFETY PRECAUTIONS SHOULD BE IMPLEMENTED PRIOR TO PRESSURIZING ANY VESSEL WITH GAS.**

If hydro testing is performed, it may be desirable to perform the tank leak test prior in order to prevent potential masking of leaks with water and to minimize the potential for residual water to impact or contaminate the leak test equipment.

### Breaker Assembly Leak Testing

Leak testing of an assembled breaker may be desirable to locate any leaks that may have been introduced into the assembly. Often manual sniffing of the assembly using either SF6 or helium as a tracer gas is sufficient to pinpoint leaks. Additionally, small, localized accumulation enclosures can be placed over portions of the assembly such as the ceramic bushing to improve the capabilities of the manual sniffing method.

### Final Assembly Leak Testing

Leak testing of the final assembly often includes manual sniffing of the piping associated with the SF6 gas distribution line. Either helium or SF6 can be employed as a tracer gas. Ideally, a global test to certify the final assembly's leak tightness is implemented to provide confidence of the overall leak integrity of the system. The tracer gas accumulation method is ideal for this application (using either helium or SF6 as the tracer gas). In this method the

## DESCRIPTION (CONTINUED)

complete assembly is placed inside an accumulation chamber (the size of small room) with the dead space minimized as much as practical. The assembly is pressurized with tracer gas and the gas escaping the leak(s) is accumulated in the chamber, measured, and correlated to a leak rate.

## PRODUCTS

LACO Technologies engineers equipment to implement all of the above leak test methods, including:

- TITAN VERSA Helium Sniffer Leak Detectors
- Helium Charge Systems (HCS) for proof testing and charging parts with tracer gas for sniffing applications.
- Turn-key, automated hard vacuum leak testing systems including the fabrication of leak test vacuum chambers.
- Turn-key, automated helium accumulation systems for tanks and assemblies using innovative accumulation enclosures.
- Turn-key, automated SF6 accumulation systems for final leak testing of complete circuit break assemblies incorporating high sensitivity SF6 instrumentation and innovative accumulation chamber concepts.

## SUMMARY

Several tracer gas leak test methods, at both the subassembly and final assembly level, can be employed for leak testing of high voltage switchgear. Consideration should be given to the methods' ability to both locate the leak and certify the global leak tightness of the system. Both SF6 and helium can be considered for tracer gas. Considerations in selecting the tracer gas include cost, convenience, test method flexibility, test method sensitivity, equipment cost

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## REFERENCES

- Application Note 01-02 Helium Leak Testing and Proof Testing of Pressurized Parts
- Technical Note A: Production Leak Testing What, Why, & How