In late 2014, UL initiated the development of an Outline of Investigation (OOI) for oxygen reduction fire protection systems in anticipation of the fourth quarter 2015 release of the first installation standard. The OOI provides the basis for UL certification to verify the safety and functionality of oxygen reduction fire protection systems.

Oxygen reduction fire protection systems are an emerging fire protection system technology that inhibits flaming ignition and fire growth within an enclosed space. The systems reduce the oxygen concentration in the enclosed space by displacing oxygen with a controlled supply of nitrogen (i.e., continuous inerting), which is provided by the system equipment. Ignition and fire growth are inhibited because of two basic phenomena: 1) less oxygen is available for combustion and 2) the additional nitrogen in the air absorbs thermal energy from what limited combustion that does occur.
Emerging Technology (continued from cover)

Oxygen reduction fire protection systems utilize “air separation” technology to provide the nitrogen supplied to the enclosed space. Air separation methodologies and equipment used in oxygen reduction systems have been used in the chemical industry since the 1980s. Three different air separation technologies are used by manufacturers: selectively permeable gas membrane, pressure swing adsorption (PSA) and vacuum pressure swing adsorption (VPSA).

Figure 1 illustrates the basic operation of an oxygen reduction fire protection system.

Commercial development of air separation equipment for use in fire protection applications began approximately 20 years ago. Research into the feasibility of reducing fire hazards by continuously inerting an enclosed space was initiated in the late 1960s by the U.S. Navy. Subsequently, oxygen reduction is employed as a means of fire protection on U.S. submarines today.

To date, manufacturers and customers in the U.S. have faced three significant challenges to using oxygen reduction systems.

First, there is currently no installation standard. The installation standard, to be published by the European Committee for Standardization (CEN), will be EN 16750: Fixed Firefighting Systems – Oxygen Reduction Systems – Design, Installation, Planning and Maintenance. This standard is currently in a pre-normative state and is expected to be published in the fourth quarter of 2015. It is expected that oxygen reduction system manufacturers will initiate a request to create an installation standard for the U.S.

Second, authorities having jurisdiction (AHJs) are typically unfamiliar with the technology because there are few U.S. installations. Of the few installations, two prominent examples are the installation that protects the Betsy Ross American Flag at the Smithsonian National Museum of American History, and the largest cold storage warehouse in North America in Richland, WA, which has 313,000 square feet of freezer space and a ceiling height of 116 feet.

Outside of North America, it is estimated that there are more than 900 installations of oxygen reduction fire protection systems, predominantly in Europe. Often, oxygen reduction systems are installed as the primary means of protection. Applications in Europe include warehouses, cold storage facilities, data centers, document archives, and museums.

Third, installations in the U.S. will be limited to normally unoccupied spaces or will be required to be treated as permit-required confined spaces. Compared with some European nations, occupational safety regulations in the U.S. specify a higher oxygen concentration to define the threshold for an oxygen deficient atmosphere. The design oxygen concentration within the enclosed space is determined based upon the types of materials contained within the space the types of materials contained within the space and the temperature and barometric pressure (i.e., elevation) in the space. For each type of material, the “ignition threshold” oxygen concentration varies and is determined by the test methods specified in the EN installation standard for liquids and solids. Design oxygen concentrations for existing installations typically fall between 15% and 17%.

The Occupational Safety and Health Administration (OSHA) has established a limit of 19.5% oxygen concentration as a threshold for respiratory hazard. Below 19.5% O₂, supplemental breathing apparatus such as supplied air respirators (SAR) or self-contained breathing apparatus (SCBA) are required. Personnel will need to treat a protected space as a confined space; effectively, all design oxygen concentrations will reside below 19.5% O₂.

As an example from Europe, the German Occupational Health and Safety Act allows the oxygen concentration of a work space to be divided into four risk classes. Table 1 summarizes the risk classes and safety measures required for employee health and safety.
The OOI requires an evaluation of the components within a system to address fire, electrical shock and mechanical hazards. Additionally, the OOI establishes a measure of reliability in the monitoring and control of a system. Oxygen reduction system manufacturers will need to work with UL to complete a functional safety analysis of the control system. The functional safety analysis is carried out to verify that an oxygen reduction system operates correctly (i.e., maintains the design concentration of oxygen) in response to its inputs (e.g., from oxygen sensors, monitoring instruments, etc.), and environmental factors (e.g., power outages, physical damage, etc.) as well as safely manages operator errors and potential component malfunctions. Finally, the OOI requires functionality testing. The functionality testing entails constructing and operating a complete representative oxygen reduction fire protection system in the laboratory to demonstrate control of oxygen concentration, and appropriate notification and system response to simulated system failures.

Through this new certification program, UL aims to enable manufacturers to achieve success in deploying safe and effective oxygen reduction fire protection system installations in the United States.

For additional information on UL's development of an Oxygen Reduction Fire Protection System certification program, please contact Adam Barowy, Research Engineer at adam.barowy@ul.com, or Pravin Gandhi, Research Director, at pravinray.d.gandhi@ul.com.

### Table 1

<table>
<thead>
<tr>
<th>Oxygen Concentration Range</th>
<th>Safety Measure</th>
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</thead>
<tbody>
<tr>
<td>20.9% to 17.0%</td>
<td>Employee training.</td>
</tr>
<tr>
<td>17.0% to 15.0%</td>
<td>Employee training, health examination, 30-minute break every 4 hours work.</td>
</tr>
<tr>
<td>15.0% to 13.0%</td>
<td>Employee training, health examination, 30-minute break every 2 hours work.</td>
</tr>
<tr>
<td>Below 13.0%</td>
<td>Supplemental breathing apparatus required.</td>
</tr>
</tbody>
</table>

Membrane Penetration Firestop Systems

By Luke Woods / Primary Designated Engineer

What are membrane penetration firestop systems and how has the penetration firestop standard evolved to evaluate them?

Recently, the ANSI/UL 1479 Standards Technical Panel (STP) drafted and adopted changes to the fire test standard ANSI/UL 1479, Fire Tests of Penetration Firestops, which add test criteria to evaluate various types of membrane-penetration firestop systems within vertical assemblies to the existing test criteria for through-penetration firestop systems. The changes include a new section for definitions relating to the various types of membrane-penetrations, a description of the test setup for membrane-penetrations, and the conditions of acceptance for membrane-penetrations.

The scope of ANSI/UL 1479 is to evaluate firestop systems that are installed to maintain the fire performance of a fire-resistance-rated assembly when the assembly is breached by a penetrating item. For example, when a firestop system protecting a plumbing pipe penetrates the gypsum membrane on one side of a fire-resistance-rated gypsum wall, this revised standard would be used to evaluate that firestop system. These changes to ANSI/UL 1479 are significant, since, until this point, the standard only provided test criteria for evaluating through-penetration firestop systems.

You may be wondering, “What is a membrane-penetration firestop system?” or even, “What is a penetration or through-penetration firestop system?” Here are the terms, as defined in the 2015 International Building Code (IBC):

1. PENETRATION FIRESTOP SYSTEM
   A through-penetration firestop or a membrane-penetration firestop.

2. MEMBRANE-PENETRATION FIRESTOP SYSTEM
   An assemblage consisting of a fire-resistance-rated floor-ceiling, roof-ceiling or wall assembly, one or more penetrating items installed into or passing through the breach in one side of the assembly and the materials or devices, or both, installed to resist the spread of fire into the assembly for a prescribed period of time.

3. THROUGH-PENETRATION FIRESTOP SYSTEM
   An assemblage consisting of a fire-resistance-rated floor, floor-ceiling or wall assembly, one or more penetrating items passing through the breaches in both sides of the assembly and the materials or devices, or both, installed to resist the spread of fire through the assembly for a prescribed period of time.

The building code goes on to require penetration firestop systems, both through and membrane type, to be tested in accordance with ANSI/UL 1479 (ASTM E814) to ensure the opening created by the penetration will not reduce the fire rating of the assembly breached. The various types of membrane-penetrations identified in the building code are box type penetrations (outlet boxes, gang boxes, hose cabinets, etc.) and utility penetrations (pipes, ducts, cables, etc.).

Let’s remember that fire-rated vertical and horizontal assemblies (walls and floors/floor-ceilings, respectively) must also meet building code criteria, which include testing in accordance with ANSI/UL 263 (ASTM E119). These assemblies must demonstrate ability to withstand the propagation of fire and hot gases (limit the average temperature rise measured at multiple points on the unexposed side of the assembly to 250° Fahrenheit and limit a single point on the unexposed side of the firestop assembly to 325° Fahrenheit), maintain load bearing capabilities (nonbearing assemblies are exempt from the load criteria), and withstand a hose stream impact (for vertical
Therefore, the firestop systems protecting penetrations within these assemblies need to maintain a similar level of performance. Failure of the firestop system to maintain a similar level of performance may compromise the fire rating of the assembly.

Unlike a through-penetration firestop system that penetrates entirely through the fire-resistance rated assembly, and as such can be seen from either side of the assembly, a membrane penetration firestop system may not be seen from the non-breached side of the assembly. For this condition, ANSI/UL 1479 requires membrane-penetration firestop systems to have a T rating equal to the F rating of the assembly. The International Building Code, Section 714.3.2, Exception 4 requires membrane-penetrations of wall assemblies by boxes other than electrical boxes (such as dryer boxes) to have an F and T rating not less than the required fire-resistance rating of the wall penetrated.

The collective intent here is to maintain a similar level of performance between the wall with a penetration and the wall without a penetration. For reference, the definition of F and T ratings are as follows:

**F Rating:** A penetration firestop shall remain in the opening during the fire test and hose stream test and shall comply with the following:

a) The sample shall withstand the fire test for the rating period without permitting the passage of flame through openings, or the occurrence of flaming on any element of the unexposed side of the sample.

b) During the hose stream test, the sample shall not develop any openings that would permit a projection of water from the hose stream beyond the unexposed side.

**T Rating:** A penetration firestop shall remain in the opening during the fire test and hose stream test and shall comply with the following:

a) The transmission of heat through the sample during the rating period shall not raise the temperature measured by any thermocouple on the unexposed surface of the firestop or on any penetrating item by more than 325°F (180°C) above its initial temperature. Also, the sample...
UL Training for Building Materials, Fire Suppression & Life Safety Technologies

UL offers technical training for the building material, fire suppression and life safety industries by providing the educational resources needed to develop, manufacture, install and deploy safer products throughout the global marketplace. This knowledge can help demonstrate a commitment to safety, advance an approach to risk management and risk prevention, keep pace with new technologies and regulations, and ultimately deploy safer products and improve speed to market.

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The following training programs are currently available for the building materials, fire suppression and life safety industries:

**Building Materials**
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- Dampers for Fire and Smoke Containment and Control
- NFPA 285 (Recorded Webinar)
- Testing and Certification of Commercial Roofing Products
- Third Party Certifications and Evaluation Reports for Code-Compliant Installations
- UL Certified Risk Professional (CRP) – Property Certificate Program

**Fire Suppression**
- Commodity Classification: A Critical Consideration in Automatic Fire Sprinkler Design
- Extinguishing Systems Used for Special Hazard Fire Protection

**Life Safety & Security**
- Alarms: Designing for Compliance to UL 681
- Alarms: Designing for Compliance to UL 2050 (Request Access)
- Fire Equipment Safety: Inspection of Aerial Units

To learn more about the training programs offered and to register for a course, please visit [ul.com/blsttraining].

Membrane Penetration (continued from page 5)

shall withstand the fire test during the rating period without permitting the passage of flame through openings, or the occurrence of flaming on any element of the unexposed side of the sample. For wall opening protective materials used with electrical and non-electrical box membrane penetrations, the T rating shall be equal to the F rating.

b) During the hose stream test, the sample shall not develop any opening that would permit a projection of water from the stream beyond the unexposed side.

But there is more work ahead for this STP and industry. While the test criteria for membrane-penetration firestop systems has recently been added to ANSI/UL 1479, the test method only provides guidance for such penetrations in a vertical fire resistance rated assembly. The STP that maintains and advances this standard must now work on providing guidance for horizontal rated assemblies. This group must consider what type of penetration firestop system challenges are presented, and how the test standard can help to rectify these challenges with focused test criteria such that field conditions can be considered safe as they have been evaluated by way of fire testing. This effort is already ongoing and will be the primary focus for this standard.

These membrane-penetration firestop systems can be found in the UL Fire Resistance Directory or online using UL Product Spec™ ([ul.com/productspec]) under the UL category XHEZ. If you have a desire to offer input or technical expertise, please consider participating as a formal member of the UL 1479 STP.

For additional information or comments please contact Luke Woods by email at Luke.Woods@ul.com or by phone at +1.617.365.8573.
UL’s new eLearning program is designed to educate fire departments about the aspects of aerial device maintenance and inspection requirements found in Chapter 19 of NFPA 1911, Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus (2012 Edition). Participants will gain an understanding of the requirements for testing methods, testing frequency, tools, safety considerations and the necessary qualifications for inspection personnel.

The program is comprised of 4 individual modules covering:

- Visual inspection of aerial components and structural members
- Critical bolt inspection and torqueing
- Aerial hydraulic systems
- Operational tests and load tests

These modules contain all inspection points required by Chapter 19 of NFPA 1911, 2012 Edition, and are organized in a logical and easy to understand format.

Continuing Education Units (CEUs) will be earned if all 4 modules are completed. For continued reference, the modules can be accessed for up to one year from the date they are started.

This Aerial Device eLearning program will help:

- Extend the life of aerial devices by evaluating key components on a consistent basis
- Ensure the safety and reliability of aerial devices by understanding key components and their functions
- Identify areas not in compliance with NFPA 1911, which provides an opportunity to mitigate costs by making repairs prior to scheduling annual aerial inspections with service centers or third-party inspection companies.

For more information on the eLearning course or to register, please visit ul.com/aerialdevices.
 TOUR OF UL NORTHBROOK LABS
In conjunction with National Fire Protection Association’s (NFPA) 2015 Conference & Expo in Chicago, UL offered a tour of its testing facilities to conference attendees. Approximately 140 made the trek from Chicago’s McCormick Place to UL’s Test Facilities in Northbrook, Ill. The tour group included conference attendees from all across the globe in professions such as Fire Protection Engineers, Fire Service, Code Authorities and Manufacturers. The test facility tour included detailed explanations of UL’s Large Scale test facility, Building Envelope Mock-Up facilities, and Floor and Wall Furnaces. Product test demonstrations included fire extinguisher effectiveness on a pool fire and windstorm testing simulating windborne debris that can be part of hurricanes, tornadoes, etc.
UL can coordinate tours for interested attendees of other conferences or industry associations. Those interested can contact Ms. Darlene Knauss by e-mail at Darlene.Knauss@ul.com or phone at +1.847.664.3985.