By Steve Somers, Vice President of Engineering

Plenum-Rated Products –
Seeing the Smoke Before the Fire

The well-worn idiom "where there's smoke, there's fire" may have literal implications for system designers today when selecting among products purported to have a "plenum rating." It happens that the term "plenum" is a bit of a misnomer for typical A/V equipment applications. An actual plenum is a compartment or space, such as a duct, actually handling environmental air distribution. Within air ducts, only specified air-monitoring instrumentation is allowable therein. Although "plenum" has become a shorthand moniker for what is really "other space used for environmental air," A/V equipment may only be located within these "other air spaces" if properly rated. For brevity, I will use the term "plenum" and "plenum-rated" to describe compliant products within a familiar context, but be aware that A/V equipment and cables may not reside within an actual air duct plenum.

Only plenum-rated products, cables, and raceways are permitted within environmental air spaces.
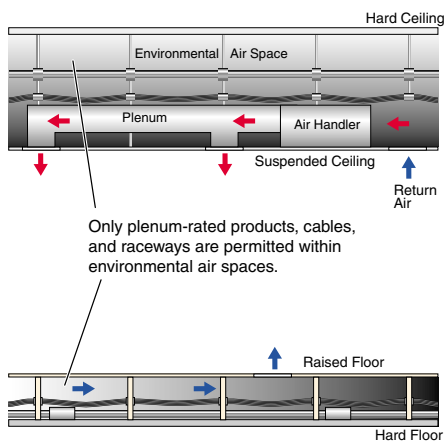
Plenums as well as other spaces handling environmental air are likely handling more "hot air" these days than just the heated air returning to the HVAC system. Not all safety label markings on products automatically represent plenum-approval. The typical recognized safety label, such as UL or ETL, indicates the product meets certain safety standards; however, verifying the product's applicability to air handling spaces requires that the system designer do additional research. Legal liability implications toward the system designer and installer could be far-reaching with product selections that affect the public safety. My goal here is to help "clear the smoke" obscuring the understanding of high temperature rated components and of bonafide plenum-rated product marking and testing.

Controlling construction costs while meeting basic public safety requirements requires innovation. Temperature-tolerant products, like plenum-rated cable, reduce the need for costly metallic conduit. The ability to utilize air-handling spaces for cable and equipment installation without conduit lowers cost. Yet, products installed in those air-handling spaces must conform to a higher safety standard. Experience gained from the grim aftermath of building fires lead to standards directing the minimum quality and type of products that may reside within air-handling spaces. Only products specifically tested for compliance with NFPA 262 (formerly UL 910) and UL 2043 are legal for installation within air-handling spaces while requiring little or no additional fire barrier, such as conduit or other baffles.

Local building codes govern the type, approval, and placement of cables and devices mounted within environmental air handling spaces of building structures. The local code authority, which is typically the city where construction occurs, adopts various fire safety codes generated by the National Fire Protection Association, or NFPA. The most well known code is NFPA 70, the National Electrical Code, or NEC.

Code or Standard – Which is it?
Sometimes the difference between a code and a standard is confusing. A code imposes mandatory conformance to a construction requirement that is administered by some local, state, or federal authority. A standard is a voluntary, agreed-upon evaluation method or level of performance recognized as desirable. Codes characteristically use modal verbs of obligation like "shall," "must," or "will." Standards use verbs like "can" or "may."

Many individuals perceive UL product approvals as government-mandated codes; they are not. Underwriters Laboratories approvals represent compliance with standardized safety testing administered by UL either directly or by a validated third party. Testing and conformance to UL safety requirements constitutes compliance to a standard. In fact, UL is a third party testing facility known in the U.S. as a private, not-for-profit National Recognized Testing Laboratory, or NRTL. The Occupational Safety and Health Administration, OSHA, of the U.S. Government approves NRTLs based on the menu of safety

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test standards for which each becomes qualified to administer. Although it is the eldest, UL is one of perhaps a dozen recognized NRTLs in the United States. Of course, the Canadian Standards Association is a recognized NRTL. UL's roots extend farther back than the NFPA as an instrumental force within the development of product safety testing for the public interest.

There are several private sector NRTLs capable of performing various, if not all, of the same safety testing regimes as UL. Among them are ETL, TÜV Rhineland, TUV America, and the Canadian Standards Association. Each NRTL provides its own unique listing mark of identification on products it has tested for compliance to specific safety standards. The mark of an NRTL is only as good as the scope of its recognition with OSHA. Consult OSHA's Web site at www.osha.gov for a specific list of those safety standards for which each recognized NRTL is qualified to administer. For the sake of familiarity, I will use UL's system for categorizing, listing, and marking products throughout the remainder of this article.

Meet the NFPA

The National Fire Protection Association, created in 1896, is an international non-profit organization whose mission is the creation of codes, standards, training, and education for the purpose of fire prevention and public safety. The National Electrical Code, NEC, was developed in 1897 through the membership of NFPA at the dawn of mass electrical power distribution in the United States. While Edison's electric light and various other convenience appliances heralded the widespread application of electricity, the lack of safety standards brought along with it the constant threat of electrical fires.

By necessity, insurance underwriters of the late 1800s guided the birth of the NFPA. The loss of lives and property to

destructive fires motivated its creation and subsequently NFPA 70, also known as the NEC, has become internationally recognized. Though the National Electrical Code uses the term "code," it is a recommended standard and is not considered code until adopted by a local authority of jurisdiction, such as the state and local government where building construction occurs.

Today, the NFPA's contribution to public safety comprises some 300 codes and standards. The NFPA origin is rich in history as an active force during the electrification of our industrial revolution.

Targeted for the low voltage audiovisual industry, here are a few key NFPA products of which one should become familiar:
• NFPA 70, the National Electrical Code
• NFPA 90A, limited combustibility in air-handling spaces, or plenums
• NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces (formerly UL 910, Steiner Tunnel test)
• NFPA 255, noncombustible or limited combustible building material products in air-handling spaces with a maximum smoke index of 50. Building materials and products supporting less than 100 kilowatts heat production are a subset of NFPA 255 and are qualified under UL 2043.

UL Class Now in Session

There are several product classifications bestowed by UL upon successful completion of one or more safety investigations. The most common are "UL Listed," "UL Classified," and "UL Recognized." Though the distinction may not be readily apparent, these forms of UL acknowledgement are quite different. A product is marked as "listed" when it conforms to specified, but general, safety standards in a standalone capacity as a complete system, like a toaster for example. A product carries the "classified"

rating when its safety conformance satisfies a narrow, specific application. The "recognized" category applies only to components that do not function as a complete system, such as a resistor or capacitor.

Systems designers need be aware that a product having a UL, or other NRTL mark, does not guarantee full safety compliance to all possible applications of the product. The best example of this is the product UL marked and listed against regular standards relating to electrical safety. The listing mark may not directly indicate the standard(s) against which the product is listed. A systems designer may assume that the listed product is therefore appropriate for use in environmental air spaces when, in fact, the product was not tested for that level of compliance. **In other words, a UL or other NRTL listing mark does not guarantee plenum applicability. How does one determine the full gamut of safety compliance for a product?**

Let's use UL as the example and look up a product listing. Go to www.ul.com on the Internet. Near the center of the home page, select the "Online Certifications Directory." A new window will open providing various choices for conducting a product search via listing company information, the UL category code, UL file listing number, or using keywords. The quickest method for verifying a product's compliance level is to locate the file

UL Trademark

The word "LISTED" in capital letters

Product Identity may be optional if mark is molded in

LISTED
CLASS 2 POWER SUPPLY
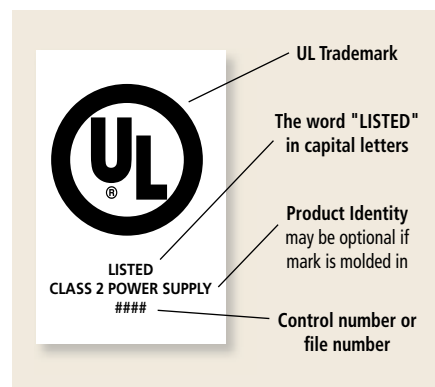####

Control number or file number

Figure 2: UL Mark example

number nearby the UL logo on the product label or within the print legend if the product is a cable. Refer to Figure 2. Load this file number into the UL File Number box on the search window. For example, entering S24172 will return the listing for Extron's SI 3CT LP and SI 26 CT speakers. Should the product file number not be found on the label, use company name and product information to load the various other descriptive fields within the search dialog utility to locate the product's UL listing details. Clicking on the highlighted listing number in the right-hand portion of the information window will retrieve the details for which the listing is applicable. Your search for this file number returns the category UEAY, which applies to speakers.

A visit to UL's classification guide for the category UEAY provides details on the scope of compliance for a product in this category. See Figure 3. In this case, speakers investigated for use in a general-utility signaling application with respect to fire and electric shock must comply with UL 1480. Keep in mind that UL 1480 covers only the basic safety testing
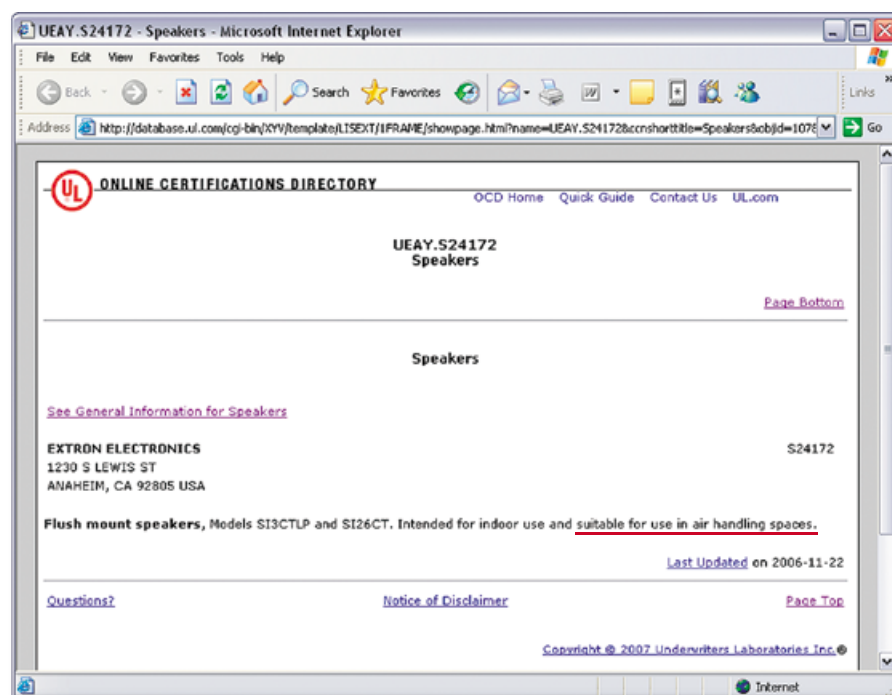

Figure 4: Actual Extron speaker listing showing plenum compliance rating.

requirements for this product category, not environmental air space compliance. Further testing in this category for compliance with plenum spaces requires successful compliance to UL 2043, but

is not mandated. Returning to the file number listing detail, the listing provides the compliant speaker models and the following sentence: "Intended for indoor use and suitable for use in air handling spaces." This statement is the only indication that the speakers are plenum compliant. Products not plenum-rated do not display the final phrase "…and suitable for air handling spaces." See Figure 4.

Suppose you find a product UL listed as suitable for air handling spaces; now what? Depending on the type of device, other components may be required in order to actually meet the plenum rating. Speakers, for example, may be suitable for air handling spaces only when accompanied by the specified back box assembly. This can only be determined by reading the details of the product's UL listing. Clicking on the highlighted "guide" link displays important information regarding the scope and limitations of UL certifications along with a general description of the UL marking authorized
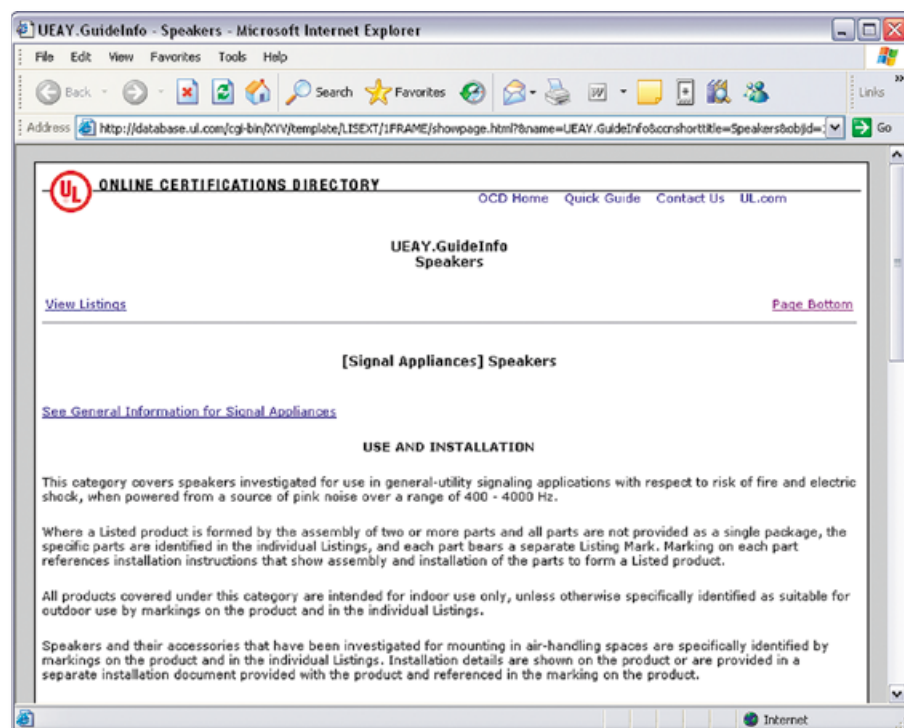

Figure 3: UEAY Classification Guide for Speakers
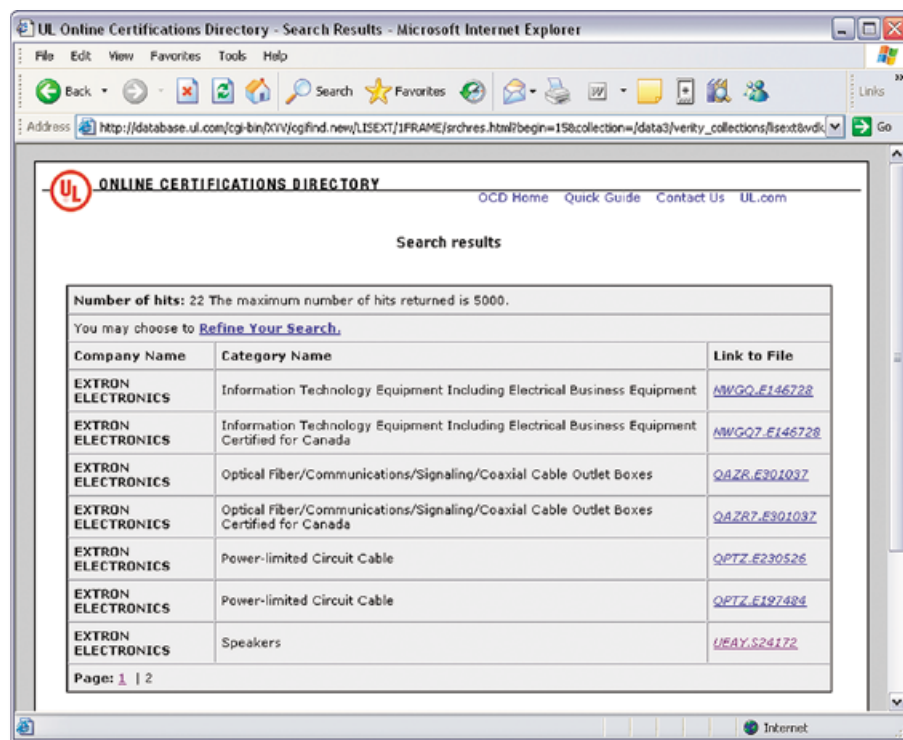
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Figure 5: Actual Extron product category listings within UL CCN search utility. Category listings may be opened by clicking on the hypertext.

for products in that category. Further, a back box may be listed singularly within a UL file listing. Adding any speaker assembly to a UL listed back box rated for air handling spaces does not automatically qualify the final speaker installation as plenum compliant. In summary, determine plenum compliance of products by researching their individual listings to uncover specific installation requirements. See Figure 5. UL organizes products into categories. Each category is identified by a four-place alpha character designation called the "category code" or CCN. Products of similar type fall into the same category, such as the UEAY category for signaling

speakers. A large percentage of Extron electronic products fit within the NWGQ category supporting audiovisual equipment.

Table 1 organizes applicable UL test standards against common category codes assigned to audiovisual products. Most Extron electronic A/V products fall within the NWGQ category code. Most all low voltage communications cables, like UTP, coax, and combination cables, reside within the DUZX category. On January 1, 2010, UL 1480, 6500, and 60950 retire to be superseded by UL 60065. This consolidation homogenizes basic safety

testing for audiovisual products on an international level through IEC. In all cases, plenum rating is only attained IF submitted products satisfactorily pass the elective test standards UL 2043 for electronic products and NFPA 262 for communications cables. **Table 2** contains reminders of items needing careful consideration when researching the applicability of a product or cable within an environmental air space.

The Fiery Duo

Plenum compliance testing for audiovisual products involves two standards for the evaluation of flame spread and smoke production among devices and cables. Testing discrete devices such as speakers, power supplies, or any standalone device resides within the jurisdiction of UL 2043 as long as heat release does not exceed 100 kilowatts. Testing for electrical and optical fiber cables resides under NFPA 262, formerly called UL 910. Each standard simulates typical air-handling space conditions while monitoring flame spread or heat release and smoke production. It is important to know that products, whether electronic or cable, are not required to be non-flammable in order to pass the plenum compliance tests. The specific test passage criteria are listed for each of the following test discussions.

UL 2043 simulates a rectangular volume of air space similar to an air handling space above an enclosed ceiling. A technician suspends the electronic product-under-test via a minimal metal framework approximately 24 inches above the live 12" x 12" gas burner centered within the test enclosure. A 36-inch tall fire-resistant enclosure 28 inches wide by 48 inches long provides the four-sided air-handling space. Air intake occurs through a 12-inch tall opening below the walls on all four sides. Exhaust heat and smoke rise into an air exhaust hood wherein heat and smoke sensors reside. The live flame applied to the product-under-test conforms to a heat release rate of 60 kilowatts. Refer to

UL Standard	2043	910 – now NFPA 262	444	1480	6500	60950	60065 (Jan 2010)
UEAY – Speakers	elective	N/A	N/A	Yes	N/A	N/A	Yes
UUMW – Fire Signaling	elective	N/A	N/A	Yes	N/A	N/A	Yes
AZSQ – A/V Apparatus	elective	N/A	N/A	N/A	Yes	N/A	Yes
NWGQ – IT Equipment	elective	N/A	N/A	N/A	N/A	Yes	Yes
DUZX – Communication Cable	N/A	elective	Yes	N/A	N/A	N/A	N/A

Table 1: Category codes and standards often applied to A/V equipment; UL 60065 (available now) supersedes 1480, 6500, & 60950 on January 2010.   N/A = not applicable

Device	Category	Important considerations for Plenum-rated products:
Audio Amplifier	AZSQ	• Plenum rating typically requires other peripheral components in order to be valid • Input and output cable types and/or protection may be specific to the listing • Always check the listing detail using the listing file number
Power Supply	NWGQ	• Plenum rating typically requires other peripheral components in order to be valid • Input and output cable types and/or protection may be specific to the listing • Always check the listing detail using the listing file number
Speaker	UEAY, UUMW	• Components may be rated singularly, not as a system • Often advertised singularly as suitable for use in air handling spaces, but actual UL listing usually requires a back box • Using a plenum-rated back box alone does not elevate any non-plenum rated speaker to a plenum rating • Always check the listing detail using the listing file number
Cabling	DUZX	• Plenum-rated cables include "P" suffix, such as CMP or CL2P • Plenum-rated cables are usually colored differently for easy identification • A group of plenum-rated cables are not automatically plenum-rated when bundled or jacketed as a group

Table 2: Important product considerations for environmental air applications

Figure 6. An electronic product passes this 10-minute stress test if:

• Heat release rate does not exceed 100 kilowatts
• Peak optical density of emitted smoke is less than 0.5
• Average optical density of emitted smoke is less than 0.15

The NFPA 262 test system, also known as the Steiner Tunnel, simulates a long, rectangular air duct space where cabling typically resides. Test specimens are prepared such that the 11.25-inch wide cable tray within the tunnel is filled with cables positioned side-by-side over about a 25-foot length. At 4.5 feet from one end of the cable group, a gas burner provides the ignition source. A calibrated airflow passes through the tunnel as the gas flame concentrates heat on the cable group. Within the tunnel's exit duct region are heat and smoke sensors measuring various specified parameters over the test period. View ports along the tunnel enable monitoring of the "burn" by a test technician. Refer to Figure 7. The cable specimen passes this 20-minute stress test to become plenum-rated if:

• Flame spread from point of application is less than 5 feet
• Peak optical density of emitted smoke is less than 0.5
• Average optical density of emitted smoke is less than 0.15

Plenum Cable Redux

Routing cable through environmental air spaces is now commonplace in locales not mandating metallic conduit. Eliminating the cost of materials and labor for conduit installation is a "no-brainer" in favor of the nominal cost premium and installation ease of plenum-rated cable. By virtue of its construction, plenum-rated cable is highly resistant to heat and flame spread. As shown in **Table 3**, plenum-rated cables reside at the top of the fire resistant list and must comply with the most rigorous test standard.

One of the most significant recent changes in plenum cable technology is removal of lead from cable polymer compounds. Lead acts as a stabilizer, which enhances production control of extruded polymers used for cable jacketing. The worldwide move toward lead-free products in recent years impacted raw cable production back before the acronym "RoHS" became common with green planet initiatives. Other, more benign, materials replaced lead but required a significant level of re-engineering and re-qualification to ensure cable designs could once again meet plenum flame-retardency goals.

Upon release of the 2002 NEC, unused plenum cables left in air handling spaces became a new focus of attention.

The NFPA realized that ever-changing communications networks within commercial installations are harboring vast amounts of bypassed, unused cables lying within the ceilings that contribute significant fire load, or fuel, to any instance of fire. Now called "abandoned cables," unused plenum cables must be removed from air spaces unless tagged for future expansion or designated usage. In other words, as commercial networks change, someone must take responsibility for cable removal or, conversely, cable management to ensure that remaining plenum cables have a planned use.
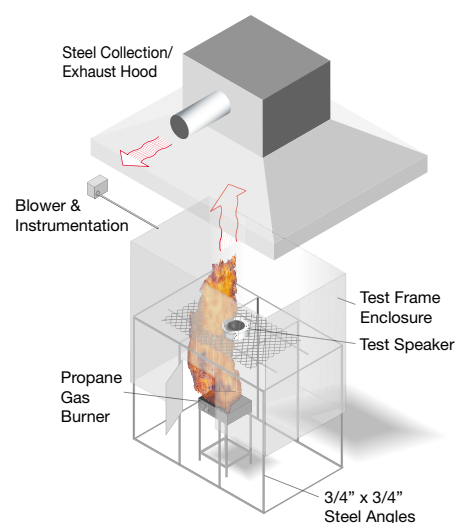
Steel Collection/
Exhaust Hood

Blower &
Instrumentation

Test Frame
Enclosure

Test Speaker

Propane
Gas
Burner

3/4" x 3/4"
Steel Angles

Figure 6: UL 2043 test setup
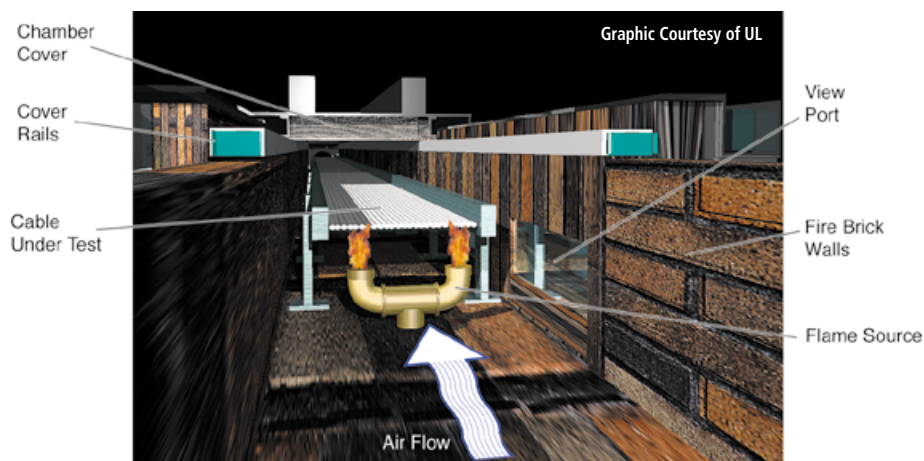
Extron

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Figure 7: NFPA 262 (UL 910 Steiner Tunnel) test setup

Cable safety approvals may be easily verified using the same UL file number look-up process described earlier. Most cable products in some way usually incorporate a simple designation within the product name, or model, to indicate plenum compliance. Some plenum-rated products qualified under UL 2043 may, in fact, only comply to plenum standards when used with plenum-rated cable qualified under NFPA 262.

On occasion, designers have asked Extron to bundle larger coaxial plenum cables, such as RG59 or RG6 types, into groups. This seems straightforward if one uses plenum-rated cable in order to construct the bundle. However, from UL's perspective, the entire bundle must comply with the NFPA 262 test standard as a unit. This compliance requires retesting. The amount of fire load available in this configuration typically guarantees that the bundle will not pass test requirements. I mention this because those system designers sourcing independently bundled plenum cables must take responsibility for the plenum rating in the final application. In other words, liability for the plenum rating shifts to the creator/installer of the bundled cables.

Product liability can extend from the manufacturer to include the system integrator when due diligence is not exercised. Some building inspectors regularly look for the UL, or other, mark on installed products. At a minimum, installation of non-compliant products within air handling spaces may lead to the withholding of building certifications until the offending equipment is replaced, thus adding significantly to the integrator's installation costs. Should an inspector find a UL-labeled product not actually compliant, the building inspector may significantly delay a project until the problem is rectified. Project delays translate to higher project costs.

Seeing Through the Haze

System designers must see through the advertising haze surrounding plenum-rated products in order to effectively manage projects and minimize liability. Not all products marked with UL labels necessarily pass the plenum testing regimes. In summary, here is what we have learned: The coined term "plenum" describes high-temperature-rated products and cable that may be placed within "other environmental air spaces." No A/V product or cables may be placed in an actual air plenum. Though non-plenum and plenum-rated products display the standard safety listing label, plenum-rated products must comply with additional voluntary, but rigid, flame and smoke tests. Plenum-rated products may not be modified on site without further, special NRTL sanction in order to maintain the plenum safety rating. Simple, effective Internet tools are available through UL and other NRTLs for thorough product safety verification. Fire safety testing for A/V products falls within UL 2043 and cable falls within NFPA 262. ALL unprotected components residing within an environmental air space must be plenum-rated. The 2002 and later versions of the NEC require that unused plenum cables be removed. Do your homework first. Be plenum responsible and safe!

Application	Cable Family							Fire Resistance
	MP	CM	CL2	CL3	FPL	PLTC	UL Test	
Plenum	MPP	CMP	CL2P	CL3P	FPLP	– –	NFPA 262	Most
Riser	MPR	CMR	CL2R	CL3R	FPLR	– –	1666	
General Purpose	MP, MPG	CM, CMG	CL2	CL3	FPL	PLTC	1581	
Dwelling	– –	CMX	CL2X	CL3X	– –	– –	VW–1	Least

Table 3: Cable marking designations for NEC application categories and their corresponding UL test specification