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# Safety & Performance Testing in the Wire & Cable Industry

*Listed vs. Verified; Marks, Logos and Programs*



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## Introduction

The purpose of this paper is to clarify safety and performance testing processes for cabling products, and to outline associated compliance marks. Elaborating on the rigorous safety and performance tests to which cabling products are subjected, we will clarify how compliance with these extensive tests relates to product marking, and how the marking effectively communicates to end users that a product has successfully passed all applicable testing requirements.

This paper doesn't intend to be a full comprehensive guide; it is rather intended to cover some of the most commonly used cable types. Here, we will cover two distinct portions of cabling products testing:

1. **Listings for Safety:** In the first section of this white paper, we will discuss the industry's primary safety standards and tests with emphasis on fire safety testing. We will further discuss mandatory safety requirements as enforced by the Authorities Having Jurisdiction (AHJ) as well as the accreditation process that third-party testing laboratories must undergo.
2. **Verification for Performance** (generally electrical transmission performance): In the latter section of this paper, we will briefly elaborate about the importance of meeting the transmission parameters for copper products. In addition, you will learn how to recognize compliant products and solutions.

## Listings for Safety

Safety listings for cabling products are critical to ensuring human safety. In North America, the majority of standards are written by Underwriters Laboratories (UL) and CSA-International (CSA), and are enforced by the Authorities Having Jurisdiction. Nationally Recognized Testing Laboratories (NRTLs) play an important role in independently testing products to relevant industry standards to verify compliance to safety requirements.

## Standards & Tests

Several standards relate specifically to certain cable types and tests. However, many standards are also harmonized between UL and CSA in order to cover the American and Canadian needs under the same document. Table 1 lists some of the primary standards for determining cable safety:

Cable Type	UL Standard	CSA Standard	Harmonized
Communications Cables	ANSI/UL 444	CSA 22 .2 No. 214	Yes
Optical Fiber Cable	ANSI/UL 1651	CSA 22 .2 No. 232	No
Flexible Cords and Cables	ANSI/UL 62	CSA 22.2 No. 49	Yes

**Table 1: Primary standards for cable safety**

Fire safety tests are among the important tests within these safety standards. Compliance with fire safety tests will ensure that cables will limit flame propagation in case of fire. Increasing the level of safety in day-to-day life, compliant cables can potentially offer additional time to exit a building in case of fire. We will now discuss two of the more widely used fire safety tests within the cable industry: the *Plenum test* and the *Riser test*.

The **Plenum test** is required for CMP & FT6 (communication cables), OFNP (optical fiber cables), CL2P & CL3P (power limited), FPLP (fire alarm), and CATVP (community antenna) rated cables. This test consists of both a flame spread and smoke density measurement. A test setup is illustrated in Figure 1. Compliance to this test indicates to the end user that the cables can be installed safely in Plenum rated environments, such as air handling spaces.

The Plenum rated cables shall undergo a 20 minute test, as defined in NFPA 262, and need to comply with the following requirements:

- The peak flame spread shall not exceed 5 feet
- The peak optical density shall not exceed 0.5
- The average optical density shall not exceed 0.15



**Figure 1: Steiner tunnel used for plenum cables conformance tests (NFPA 262)**

The **Riser test** is required, for CMR (communication cables), OFNR (optical fiber cables), CL2R & CL3R (power limited), FPLR (fire alarm), and CATVR (community antenna) rated cables. This test consists of both a flame spread and temperature measurement. A test apparatus is illustrated in Figure 2. Compliance to this test indicates to the end user and building owners that the compliant cables will not dangerously propagate fire when installed in riser environments, such as between floors.

More specifically, during this 30 minutes test, the flame propagation shall not reach 12 feet and, at any time during the test, the temperature at any position of the 12 feet height location shall not exceed 850 °F.

In order to meet the appropriate smoke and flame tests, the cable jacket and insulation materials must be specially formulated and processed (extruded) following very rigorous and tightly controlled manufacturing techniques.

In addition to fire safety related tests, electrical wire and cables must also comply with the following requirements:

- Long-term ageing of insulation and jacket properties
- High voltage withstand
- Cold temperature resistance to guarantee proper operation under cold environments
- Sunlight resistance (*outdoor rated cables only*)

Optical cables do not need to comply with as many additional requirements because they transmit photons (light), unlike electrons (electricity). Photons do not constitute a direct danger to humans because there is no risk of electric shock.



Figure 2: Riser Shaft (UL 1666)

### Authorities Having Jurisdiction (AHJ)

The Authorities Having Jurisdiction are governing bodies tasked with approving installations. An AHJ can be a fire marshal, a building inspector, a city code enforcer, a building owner, just to name a few. One of their responsibilities is to make sure that only properly listed products are installed in buildings. It is mandatory to comply with the requirements of applicable AHJs, and the use of listed products in any approved installation is strictly enforced.

### Third-Party Laboratories

In order to conduct safety tests and be recognized by AHJs, a test laboratory must hold certain accreditations. In the United States, accreditation from the Occupation Safety and Health Administration (OSHA) can indicate a lab's status as a Nationally Recognized Testing

Laboratory (NRTL). This accreditation is a requirement in order to test to certain safety standards.

During the NRTL accreditation process, a laboratory's operating procedures, methods, equipment, and personnel competence are thoroughly reviewed by an external source. Many internal and external audits are conducted to give manufacturers and end users confidence that a test laboratory that will perform the safety testing in accordance with all federally regulated codes and standards..

The need for third-party testing laboratories was envisioned by Thomas Edison who felt a need to separate the certification and manufacturing processes. In 1896, Edison founded Electrical Testing Laboratory (ETL), which is now the foundation of Intertek's global electrical testing business. Intertek's proprietary ETL Listed Mark is one of many safety and compliance certification marks issued exclusively by Intertek. Edison's legacy remains to this day due to the growing need to verify safety and quality concerns across electrical manufacturing industries.

## Products Marking & Labeling

Listed cables can be recognized by their print legend if they bear a NRTL's mark in parenthesis, such as "(ETL)", "(CSA)" or "(UL)". The mark may also be immediately preceded or followed by national designations, such as:

1. Products listed to a Canadian standard only are typically preceded by the letter "c", except if they certified by CSA where it is omitted: "c(ETL)", "(CSA)" or "c(UL)"
2. Products listed to an American standard only are typically followed by "us", except if they certified by UL where it is omitted: "(ETL)us", "(CSA)us" or "(UL)"
3. For products listed to both Canadian and American standards, or to a harmonized standard (which is the case for communication cables), both designators should be present: "c(ETL)us", "c(CSA)us" or "c(UL)us"

The flammability rating shall also be included on a cable's print legend:

1. For Plenum rated cables: "CMP", "OFNP", "CL2P", "FT6"
2. For Riser rated cables: "CMR", "OFNR", "CL2R"

Some other designations may also be found on a cable's print legend:

1. Outdoor cables: "CMX OUTDOOR"
2. Sunlight resistant cables: "SUN RES" or "SUNLIGHT RESISTANT"
3. Temperature rating for cables capable of withstanding a higher temperature rating than the minimum standard rating, for example "75C" can be found on some communication cables



In addition to a cable's print legend marking, the listing agency's logo shall also appear on the product packaging. Figure 3 illustrates the ETL Listed logo that will appear on products that have been listed for safety by Intertek.



Figure 3: ETL Listed logos

### Other Safety Concerns

We have discussed the main safety standards covered by the codes in North America, though this does not cover the full spectrum of safety related tests. Another important family of tests applies to Low Smoke Zero-Halogen rated cables (LSOH or LSZH). This cable classification is commonly used in Europe and maintains a testing philosophy that varies from North American practice. It consists of testing on the compounds used to make the cables as well as testing the finished cables.

- Compounds (plastic granules): shall not generate halogen and acid gases that are harmful to humans
- Finished Cables: test for flame propagation

Additionally, other standards exist that have been written toward very specific environments, including shipboard cables (IEEE 1580) and mine safety (Mine Safety and Health Administration, MSHA).

### Verification for Performance

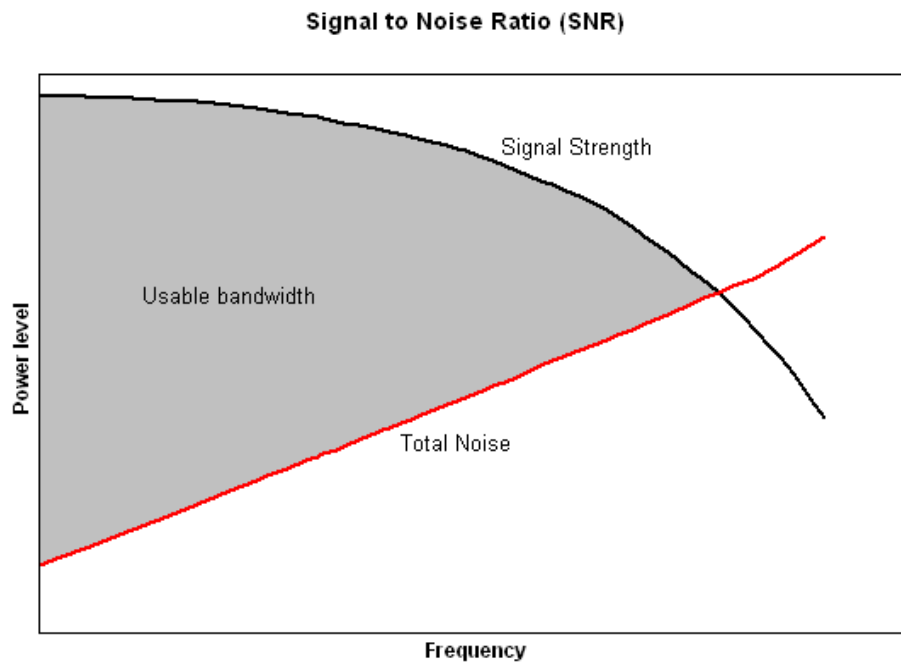
Unlike safety listing, performance verification is not required by any AHJ because it does not directly affect human safety. Performance verification is intended to give end users confidence that the product they purchase will perform as expected. Performance testing can also ensure interoperability and proper network operation, as defined in industry standards that are not mandatory in regulatory codes.

## Standards & Tests

The main standards for performance are:

1. ANSI/TIA-568-C.2
2. ISO/IEC 11801 and other referenced IEC sectional standards
3. EN 50173-1 and other referenced sectional standards
4. IEEE 802.3, Standard for Ethernet

The above standards set forth the transmission requirements that are required to provide sufficient operational bandwidth for the associated protocols. Generally, they are measured over the frequency range (e.g.: up to 500 MHz for Category 6A products). The operational bandwidth is defined by the Signal to Noise Ratio (SNR), as shown in Figure 4.



**Figure 4: Signal to Noise Ratio illustration**

In Figure 4, the black line shows the signal strength and the red line shows the total noise. The signal strength corresponds to the attenuation measurement and the total noise corresponds to a sum of some noise sources, such as:

- Internal crosstalk (NEXT and FEXT)



- Return loss
- External crosstalk (Alien NEXT and Alien FEXT)

Above the intersection point between the two curves, the noise is stronger than the intelligible signal, and data transmission is no longer possible except when noise cancellation algorithms are used by the active equipment. The grey shaded area is directly proportional to the transmission capacity of the cabling channel. The noise cancellation algorithms enable reduction of the total noise by sophisticated electronic circuits, which results in lowering the total noise (red curve), thus increasing the transmission capacity. The total transmission capacity (in bits per second) of the cabling channel can further be calculated using Shannon's Theorem, as elaborated by The Father of Information Theory, Claude Shannon.

### On-going Verification Program

Two types of third party testing for performance verification exist:

- Ongoing verified program (such as Intertek's ETL Verification Program)
- One-time performance testing

An ongoing verification program is more stringent and has more implications and obligations for manufacturers. A manufacturer voluntarily subjects themselves to on-going factory audits and random selection testing to ensure on-going compliance of their product(s). Products that are part of an on-going program for performance verification can bear a verification mark, such as the ETL Verified Mark:



Figure 5: ETL Verified mark for products that are part of Intertek's ETL Verified Program

As an alternative, one-time performance testing proves that representative samples have shown to be in compliance with the applicable standard, without necessarily being part of an on-going verification program with recurrent testing and factory audits.

## Verified Products Marking

In order to guarantee proper transmission capacity of the overall cabling channel and interoperability between products, the various products used to assemble a full channel must comply with several tests. Products that are part of an on-going verification program for compliance can be recognized as explained here:

### 1. Cables

Verified cables can be recognized using the following key elements on a print legend: a third-party verification agency, the word “Verified”, the test standard(s) and the product category. For example, such print legend can be “ETL VERIFIED TO ANSI/TIA-568-C.2 AND ISO/IEC 11801 CATEGORY 6A”. The verification mark(s) may also appear on the cable packaging (reels, spools or boxes).

### 2. Patch Cords

Two steps are needed to identify performance verified patch cords. First, the cable should be examined to indicate third-party verification, as explained in the previous section (Cable). This indicates that the cable used to manufacture the patch cord (also known as “cord cable” or “work area cable”) is part of a verification program. Further, the patch cord packaging should be examined to show the logo of a third-party verification agency. This shows that the finished products have also been independently tested and found to be in compliance with the standards, which gives the end user additional confidence that the quality of the workmanship involved with the patch cord manufacturing process will provide optimal connection point performance.

### 3. Connecting Hardware (jacks, patch panels, consolidation points)

Similarly to patch cords, verified connecting hardware for performance levels can be recognized with a third-party verification agency’s logo on their packaging. This mark gives the end user confidence that the product design and its manufacturing quality enable the product to perform at the expected performance with minimal impact on the overall channel noise.

## Other Performance Related Items

Verifications programs can be customized for participants who wish to further demonstrate their product’s high performance. Intertek has the flexibility to develop customized verification programs to assess compliance of a product up to a maximal frequency higher than what is prescribed in the relevant standards and/or additional margin. This provides the end user with an additional guarantee that products are independently verified to prove compliance to manufacturer’s claims.

## Conclusion

There are two main families of cabling products testing as we have discussed: safety testing and performance testing. They are independent of one another and can be defined as:

- **Listed Product**  
A product that has successfully undergone testing based on representative samples in order to assess compliance to applicable standard(s) for safety and is actively enrolled in Follow Up Services (FUS) in order to insure continued compliance. This is mandatory, as prescribed in regulatory codes.
- **Verified Product**  
A product that has successfully undergone testing based on representative samples in order to assess compliance to applicable standard(s) for transmission performance. This type of testing is done on a voluntary basis by manufacturers who submit their products for evaluation of performance characteristics.

Cabling products that bear third-party safety and performance verification marks give end users additional confidence that a product has been evaluated and is in compliance with the appropriate safety and performance requirements. Further, it demonstrates that the parameters intended to be measured in a laboratory environment have been verified to meet all applicable requirements. Some laboratory tests verify electromagnetic requirements (transfer impedance, balance, coupling attenuation), when applicable, which are generally not tested for in the field.

## ABOUT INTERTEK

There are miles and miles of cable in every network. We know what to look for to confirm safety and security. Intertek is a trusted leader in the evaluation of wire and cable to both safety and performance requirements. With over 20 years of testing experience in this space, we work to help prevent the introduction of noncompliant, counterfeit and underperforming cable into the network. Intertek has developed ETL Listed and ETL Verified programs specifically for the wire and cable industry. As you move forward we are here to help every step of the way.

Intertek is the leading quality solutions provider to industries worldwide. From auditing and inspection, to testing, training, advisory, quality assurance and certification, Intertek adds value to customers' products, processes and assets. With a network of more than 1,000 laboratories and offices and over 36,000 people in more than 100 countries, Intertek supports companies' success in a global marketplace. Intertek helps its customers to meet end users' expectations for safety, sustainability, performance, integrity and desirability in virtually any market worldwide. Visit [www.intertek.com](http://www.intertek.com).

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### External Links

- CCCA's paper about liability for contractors  
[www.cccassoc.org/blog/potential-liabilities-for-contractors](http://www.cccassoc.org/blog/potential-liabilities-for-contractors)
- Intertek's Listed products directory  
[www.intertek.com/ETLdirectory](http://www.intertek.com/ETLdirectory)
- ETL Verified products directory  
[www.intertek.com/cabling-products](http://www.intertek.com/cabling-products)
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