



FROM: Codes & Standards

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RE: Chemical Exposure (Oil & Gasoline) Tests

Technical Document

This Technical Paper from Codes & Standards will focus on the chemical exposure tests associated with a select few wire and cable products. There are many different chemicals that can affect wire and cable over time, but one of the most utilized chemicals in industrial environments is oil. Oil is frequently found in machinery or used with various equipment for industrial applications. Oil can be applied to a gear system driven by motors to prevent premature wear down. Oil can also act as a coolant applied to machines to keep metal from becoming too hot. With the possibility of oil coming in contact with wire and cable for a short amount of time during installation, some standards have included Oil Resistance Tests to ensure a level of survivability, if chemical exposure is present.

The exposure to oil has the ability to damage polymers and degrade the jacket or insulation of conductors over time. Another chemical that is present in industrial environments is gasoline. A combination of gasoline and oil can be a fire hazard, but it can also have a negative impact on the physical characteristics and performance of wire and cable. One way to ensure that the insulation and jacket material can withstand exposure to oil and gasoline is to make sure your wire product are rated for Oil Resistance or Gasoline & Oil Resistance. These are two chemical exposure tests that exhibit harsh and long duration of chemicals to wire and cable products within UL 44 and UL 83 Standards.

Product Safety in UL Standards

- **Oil Resistance Test (PR I or PR II)**
- **Gasoline & Oil Resistance Test (GR I or GR II)**

Installing conductors in any application requires professional skills and knowledge related to the construction and operation of the electrical equipment, installation procedures, and safety training to recognize and avoid the hazards involved. However, every job is different and there are often times when the contamination of a job occurs before or after the installation. In some cases, oil and gasoline from other equipment might expose conductors and cables to the chemicals that could affect the performance and safety of the equipment. One way the Standards Development Organization has tried to ensure the safety of products in adverse conditions is to provide standards that require a more robust testing than the application of the product. In any UL Standard, Product Safety is of utmost importance and you will find an extensive list of tests that would ensure that the wire and cable products are robust enough to function despite exposure to situations where the product might be crushed, impacted, or exposed to chemicals. For the purpose of this Technical Paper, we will look at two UL Standards that provide additional product safety from chemical exposure of oil and gasoline.

UL 83 is the Standard for Safety, Thermoplastic-Insulated Wires and Cables. This UL Standard specifies the requirements for 600 V, single conductor, thermoplastic wires and cables in Canada, Mexico, and the United States. In the US, Types THHN and THWN-2, with a jacket of nylon extruded tightly over the insulation would be part of the thermoplastics products tested in UL 83. For our thermoset products, we reference UL 44, which covers the Standard for Safety, Thermoset-Insulated Wire and Cables, and includes the requirements for single-conductor and multiple-conductor thermoset-insulated wire and cables rated 600 V, 1000 V, 2000 V, and 5000 V for use in accordance with rules of Canadian Electrical Code, Mexico, and the United States National Electrical Codes. The common types of wire products for UL 44 Standard are Types XHHW, XHHW-2, RHH, and RHW-2. Conductors from UL 83 and UL 44 are used in many applications including residential, commercial, and industrial locations that add to the risk of damage or chemical exposure. Thus, there need for a standard to design and test a product that is robust enough to be used in these various applications.



UL adopted two widely used Product Safety Standards that included several tests to allow wire and cable products to withstand harsh environments. In particular, UL 83 and UL 44, includes two tests which compromises conductors to chemical exposure. The first test, Oil Resistance Test is an optional test, but having a product which conforms to this tests gives customers the assurance of safety, if it is exposed to oil. There are two levels to the Oil Resistance Test which your product can be rated. The level or rating is based off the length of time the product is exposed to oil and the designated temperature, at 60°C or 75°C. Both tests require the sample to be immersed without the removal of the nylon jacket. The wire will be immersed in IRM 902 oil for 96 hours at 100°C for the 60°C test and for 60 days for the 75°C test. To be marked PR I, for the 60°C test, the retention of the tensile strength and elongation of the insulation shall not be less than 50% of the unconditioned wire. To be marked PR II, for the 75°C test, the retention of tensile strength and elongation of the insulation shall not be less than 65% of the unconditioned value. See Table 1 for a breakdown of the tests and passing conditions.

The second chemical exposure test in the Product Safety Standard, includes both oil and gasoline. This test is in both UL 83 and UL 44. The Gasoline and Oil Resistance test is also optional in both standards. In order for you to meet the requirements of this test for marking GR I or GR II, the specimen must meet and pass the Oil Resistance Tests (PR I or PR II) and then it will be immersed in water saturated with equal volumes of Iso-octane and Toluene (ASTM Reference Fuel C) maintained at 23°C +/- 1°C. The retention of tensile strength and elongation of the insulation shall not be less than 65% of the unconditioned value. If the wire successfully meets both conditions, then the product can be marked GR I or GR II. See Table 1 for a breakdown of the tests and passing conditions.

In summary, Encore Wire has maintained products that meet and exceed many of the UL Standards. We continue to ensure that our wire and cable products are protected against many situations that are not foreseeable, such as being crushed, impacted, or exposed to adverse chemicals. Products with ratings for Oil Resistant or Gasoline & Oil Resistant, are just another example of Encore Wire's commitment to providing a product that is robust enough to be used in residential, commercial, or industrial applications.

Below are examples of these ratings on the Print Legend. Both our THHN/THWN-2 and XHHW-2 products are rated for Gasoline & Oil Resistance at 75°C (GR II or GR 2).

THHN/THWN-2 PRINT LEGEND:

SOLID CONDUCTOR SIZES 14 AWG THROUGH 10 AWG: ENCORE WIRE CORPORATION (SIZE) AWG TYPE THHN OR THWN-2 **GR II** VW-1 600 VOLTS (UL) OR AWM OR C-(UL) TYPE T90 NYLON OR TWN 75. DATE/TIME/OPER/QC
14 AWG THROUGH 8 AWG: ENCORE*WIRE*CORP*(SIZE)*TYPE*MTW*OR*THHN*OR*THWN-2***GR2***VW-1*600V*(UL)*OR*AWM*OR*C(UL)*TYPE*T90*NYLON*OR*TWN*75 SUPERSLICK ELITE
6 AWG THROUGH 1 AWG: ENCORE*WIRE*CORP*(SIZE)*TYPE*MTW*OR*THHN*OR*THWN-2***GR2***SUN-RES*VW-1*600V*(UL)*OR*AWM*OR*C(UL)*TYPE*T90*NYLON*OR*TWN*75*DATE*TIME*OPERATOR*QC SUPERSLICK ELITE
1/0 AWG THROUGH 1000 KCMIL: ENCORE*WIRE*CORP*(SIZE)*TYPE*MTW*OR*THHN*OR*THWN-2***GR2***SUN-RES*VW-1*FT4*IEEE*1202*600V*FOR*CT*USE*(UL)*OR*C(UL)*TYPE*T90*NYLON*OR*TWN*75*DATE*TIME*OPERATOR*QC SUPERSLICK ELITE

XHHW-2 PRINT LEGEND:

14 AWG THROUGH 10 AWG: ENCORE*WIRE*CORP*(SIZE)*TYPE*XHHW-2*600V/1000V***GR2***FT2*XLPE*(UL)*OR*C(UL)*RW90*600V* SUPERSLICK ELITE
8 AWG THROUGH 1 AWG: ENCORE*WIRE*CORP*(SIZE)*TYPE*XHHW-2*600V/1000V***GR2***SUN-RES*FT2*XLPE*(UL)*OR*C(UL)*RW90*600V*DATE*TIME*OPERATOR*QC SUPERSLICK ELITE
1/0 AWG THROUGH 1000 KCMIL: ENCORE*WIRE*CORP*(SIZE)*TYPE*XHHW-2*600V/1000V***GR2***SUN-RES*FT2*XLPE*FOR*CT*USE*(UL)*OR*C(UL)*RW90*600V*DATE*TIME*OPERATOR*QC SUPERSLICK ELITE

TABLE 1 – OIL & GASOLINE RESISTANCE TESTS

		CHEMICAL TESTS		
Standards	Oil Resistance @ 60°C IRM 902 Oil PR I	Oil Resistance @ 75°C IRM 902 Oil PR II	Gasoline & Oil Resistance @ 60°C GR I	Gasoline & Oil Resistance @ 75°C GR II
UL 44 / UL 83	Immerged in Oil 96 hours at 100°C	Immerged in Oil 60 days or 1440 hours at 75°C	Must pass Oil Resistance Test (immersion at 96 hours) and 30 days of immersion in water saturated with equal volume of Iso-octane and Toluene maintained at 23 +/- 1°C	Must pass Oil Resistance Test (immersion at 1440 hours) and 30 days of immersion in water saturated with equal volume of Iso-octane and Toluene maintained at 23 +/- 1°C
	50% or greater Elongation after immersion	65% or greater elongation after immersion	shall retain 65% or greater elongation after immersion	shall retain 65% or greater elongation after immersion

Frequently Asked Question

1. Why do some wire & cable products withstand oil or chemicals better than others?

Most insulating compounds have plasticizers that help protect the insulation from absorption of chemicals. However, excessive exposure to oils and chemicals can breakdown these plasticizers and be absorbed into the insulation causing fatigue and deterioration of the insulated jacket.

2. If our wire and cable product are rated for Oil & Gas Resistance, can it be exposed or immersed for excessive amounts of time?

Although some of our wire and cable products have been rated for Oil & Gas Resistance, most of these products are not designed to be the primary use or application in oil and gas environments. The ratings for our products help consumers who might be installing these products in industrial environments that might expose these products to oil and gas for a short period. It is best to ask the customer of the product if it is going to be used in an adverse environment that is different from the normal exposure of wire and cable.

3. How can you tell if a wire and cable product has been exposed to oil?

Typically, when wire and cable are over exposed to oil & gasoline, it will show signs of swelling of the insulation or jacket. Oil exposure will also cause hardening of the insulation that can drastically affect the flexibility and elongation capabilities of the insulation.



4. Is it safe to put pulling lubricant (oil) on wire and cable for the purpose of improving the ease of the pull?

Encore Wire's SuperSlick Elite products should provide the easiest pull for installers. However, there are installers who want the extra assurance that the pull will not have any problems. It is perfectly fine to add pulling lubricant to wire and cable for this purpose. Most commercial lubricants will work perfectly fine with the SuperSlick Elite.