

EXRAD® HIGH VOLTAGE FX VS. WELDING CABLE COMPARISON

On the surface, welding cables appear to be a convenient and inexpensive choice for use in high voltage electric and hybrid vehicles. Welding cable is flexible and readily available in small quantities from a number of local distributors, perfect for prototype vehicles.

New innovative hybrid/electric vehicles place a much greater demand on cable than commodity cables, including welding cable, can handle. The complex electronics require shielding from the electrical interference that is created by the high energy / high voltage current traveling through the power cables. Weight reduction is the utmost consideration for electric and hybrid vehicles. Vehicles, including electrical components are expected to last 10 years. The environment in and around the vehicle is particularly harmful. There are gasoline, oils, and other fluids that will attack ordinary insulations. Temperature in and around the cables can reach 125°C and higher or in northern climates reach -40°C or lower.

SPECIAL DESIGN

EXRAD® FX high voltage cables are specifically designed for hybrid and electric vehicles. These cables come from a family of battery and power-train cables that have been time proven in automobiles, large trucks, construction and agricultural equipment.

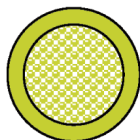
EXRAD® FX high voltage cables are designed for:

- Tight installation spaces, small bend radii, reduced “real estate”
- Continuous high power transmission
- Shielding against EMI/RFI
- Extreme temperatures
- Long life

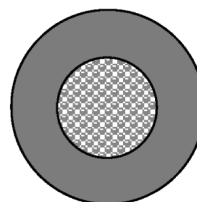
SIZE MATTERS

EXRAD® FX high voltage cables have very tough, flexible, thin insulation materials. These thin insulations outperform thicker insulations in abrasion and cut through. The thinner insulation allows for tighter bend radius & uses less space.

The illustration below illustrates the size difference of a 6 AWG EXRAD® unshielded high voltage cables in comparison to a 6 AWG welding cable.



EXRAD® 6 AWG:
.252” diameter



Typical 6 AWG
Welding Cable:
.370” diameter

IT'S A MATTER OF LIFE OR DEATH

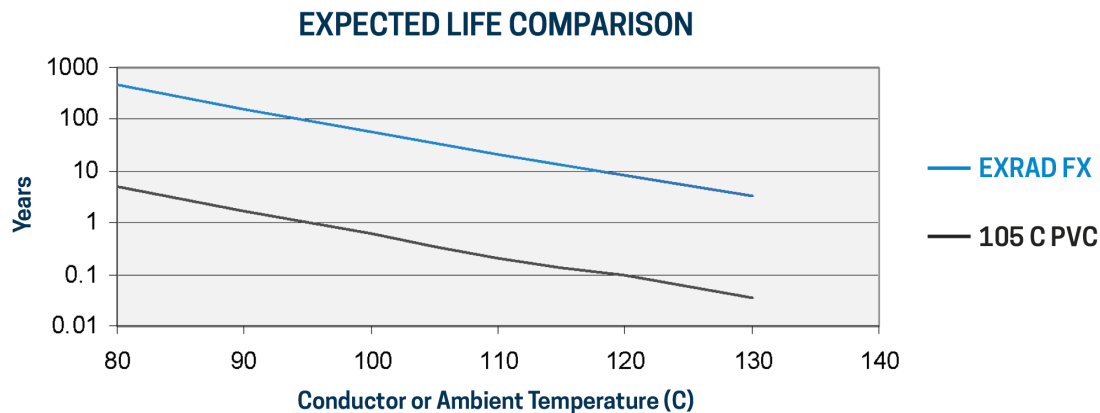
The life expectancy of a vehicle is typically over ten years. The life of a commercial vehicle is considerably long given the number of operations hours. A typical bus is expected to have a life of over 50,000 service hours.

The minute after anything is created; it begins to age through a process called oxidation. Over time, oxidation will degrade any material. The insulation on a wire will age over time and eventually become brittle and will no longer provide adequate insulation and eventually will short circuit. This aging process is accelerated with increased temperature.

EXRAD[®] FX high voltage cables are insulated with a material that slows the aging process even at elevated temperatures. EXRAD[®] products have 100 – 1000 times the life of typical welding cable insulations

Unlike normal battery cables, hybrid and electric vehicles conduct electricity nearly all the time. The electric current creates heat due to the conductor resistance. The heat generated by the current heats the cable from the inside out. This internal heat will age a cable just as fast as if the cable were exposed to heat from the outside.

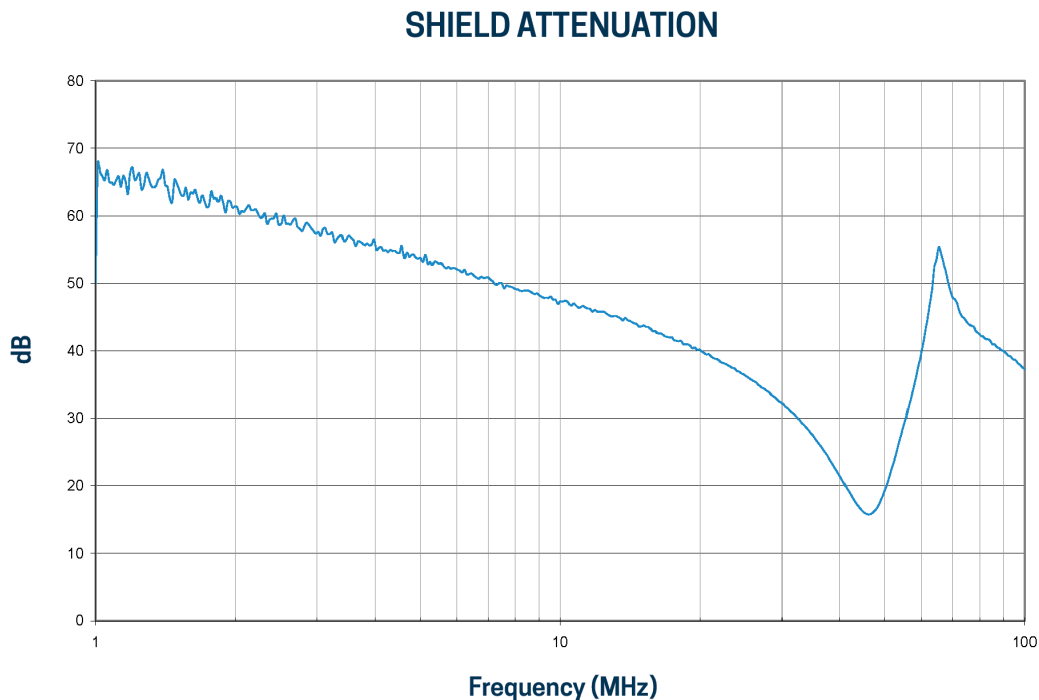
The chart below uses laboratory data in the form of an Arrhenius plot to predict the life in years of typical welding cable and EXRAD[®] FX high voltage cables. Typical ambient or conductor temperatures in a vehicle can reach 110°C or higher. Welding cable will last less than 1 year where as EXRAD[®] FX high voltage cables will last nearly 20 years



ELECTRICAL INTERFERENCE

In order to maximize power, electric and hybrid vehicles use pulse width modulation, (PWM). PWM generates electromagnetic interference and radio frequency interference that will disrupt other electronic components that can be critical to the safe operation of a vehicle. Welding cable has no shielding and therefore does not inhibit the electrical interference. The Champlain EXRAD[®] FX high voltage cables have efficient electrical shielding.

The chart below gives the typical performance measuring shield effectiveness to block the electrical interference. The higher the number the better the shielding effectiveness is.



OTHER CRITICAL PROPERTIES

Vehicles components are subject to dust, heat, cold, fluids and vibration to name a few of the hazards. SAE and ISO committees develop standards for wire and cables used in trucks and automobiles. These standards are designed to ensure wire will

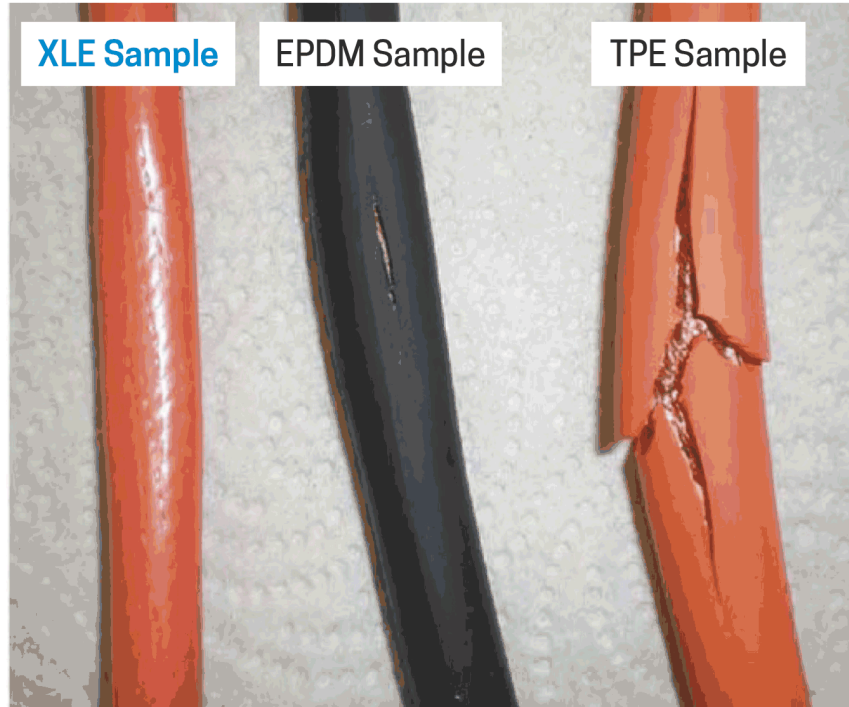
perform safely and adequately in the harsh environments that vehicles are subjected to on a regular basis. The committee members have years of experience in engineering, design and development work for the automotive and commercial vehicle industries. Listed below are actual test result and pictures illustrating the type of catastrophic failures that can and will occur using the wrong type of wire, such as welding cable!

TEST RESULT OF XLE VS. WELDING CABLES

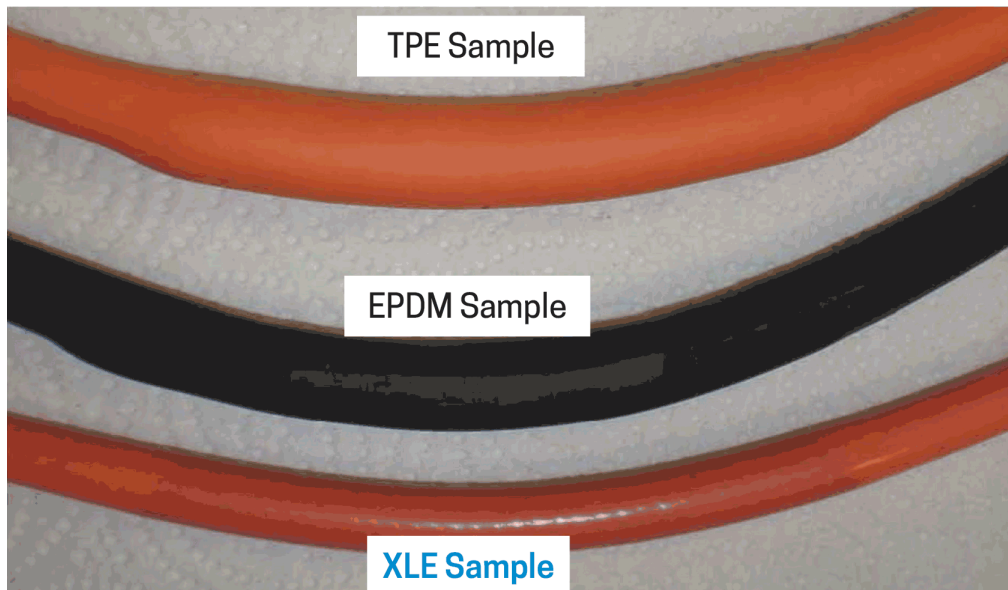
CLAUSE	TEST DESCRIPTIONS	XLE	EPDM	TPE
	Finished OD	0.3793	0.4519	0.4687
	Conductor OD	0.3077	0.3304	0.3324
	Wall thickness	0.036	0.061	0.068
7.1	Pressure at high temp class "c"	Pass	Pass	Pass
8.2	Impact	3/3 Pass	2/3 Fail	3/3 Fail
9.1	Sandpaper abrasion*	8425	5605	17965
11.1	Fluid resistance			
	Gasoline	10.4%	29.7%	39.1%
	Diesel Fuel	1.0%	18.6%	6.8%
	Ethanol	6.5%	0.5%	0.2%
	Dexron III	1%	10%	4%
	Engine Oil	0	3%	1%
	Power Steering	0	7%	4%
	Engine Coolant	0	-1%	0%

*TPE sample value is very high, it might have been caused by the tape under the insulation
 EPDM and TPE samples were very stiff to perform cold bend test

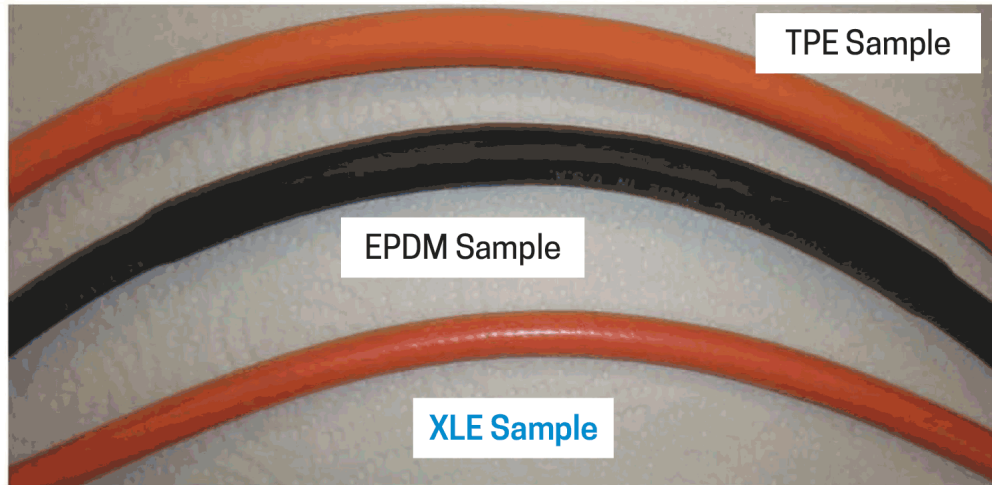
IMPACT TEST (-50° C AND 1.6 KG WEIGHT)



GASOLINE TEST (ISO 6722)



DIESEL FUEL TEST (ISO 6722)

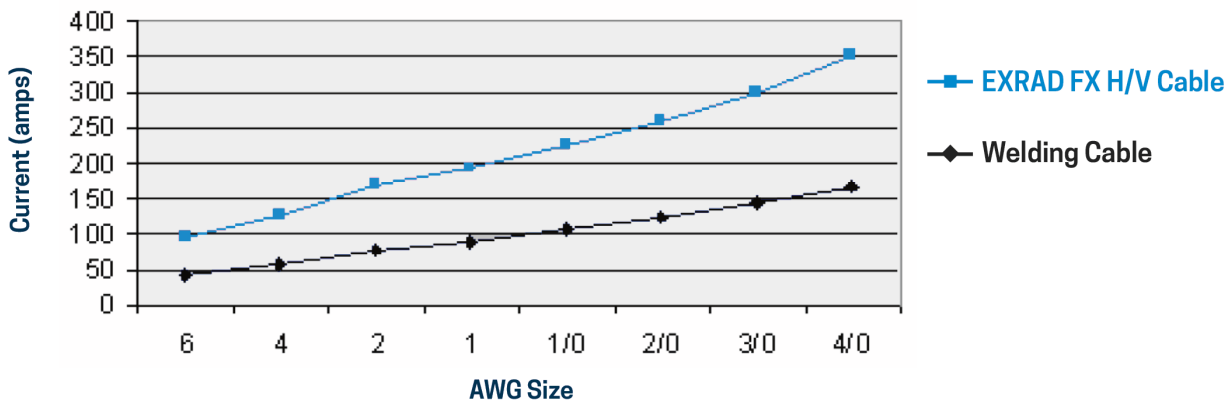


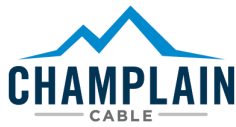
DOWNSIZE YOUR CABLE

Cost and weight are huge factors when designing a hybrid or electric vehicle. Costs and weight can be reduced by choosing EXRAD[®] FX high voltage cables. Electrical current generates heat which causes the conductor and insulation to become hot. EXRAD[®] FX high voltage cable insulations are designed for both high heat and long life. The graph below illustrates the higher current carrying ability of EXRAD[®] FX high voltage cables versus welding cable. At 75°C ambient, a single conductor of 6 AWG EXRAD[®] FX high voltage cable can safely carry as much current as a 1 AWG welding cable and still retain its long life.

*Note: All cable sizes and choices must be carefully evaluated and engineered.

CURRENT CARRYING CAPACITY 75C AMBIENT





MAKE THE RIGHT CHOICE

EXRAD® FX high voltage cables are used by leading manufacturers and designers of propulsion systems, hybrid vehicles, electric vehicles and lithium battery makers. Make Champlain Cable EXRAD® -FX high voltage cables your choice.

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