WHITE PAPER
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EXZEL™ LSZH Cable Solutions

For Industrial, Electronics, Control & Instrumentation Applications

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TABLE OF CONTENTS

INTRODUCTION

Within this white paper, General Cable will discuss the benefits and characteristics of Low–Smoke, Zero-Halogen (LSZH) cables.

LSZH CABLES

The increasing demand of LSZH cables has been driven by published concerns for safety of humans and electronic circuits during fire, the protection of the ozone layer, non-toxic elements to water table and landfills when discarded, and an increase in requirements/specifications by the European and the International communities.

LSZH cables mean the insulation and jacket compound are free of halogenated materials like Fluorine (F), Chlorine (Cl), Bromine (Br), Iodine (I) and Astatine (At), which are reported to be capable of being transformed into toxic and corrosive matter during combustion or decompositions in landfills.

During combustion, LSZH cables produce low levels of halogen gases, which have a minimal effect on the human respiratory system when inhaled, as well as a low level of Hydrogen Chloride (HCl), which is non-damaging to electronic circuits or machinery. Also, a low level of white smoke is generated, improving visibility by increasing the chances of people to visually find their way out to safety during fire.

- LSZH cables emit no more than 0.5% of Hydrogen Chloride (HCl)
    - 10-25% considers irritant
    - (HCl) >25% considers corrosive

Low Smoke Fume, or LSF, is another term used by certain manufacturers for LSZH cables, but there are no standards for LSF. This means manufacturers can label their products LSF as long as they give off reduced (HCl) emissions. LSF cable is, in fact, just reduced HCl emissions, giving off <15% (HCl).

EXZEL™ LSZH CABLE CONSTRUCTION

General Cable's **Carol® Brand *EXZEL*™** product line has been developed to address the industry's need for LSZH products that are UL listed, flexible, flame-retardant and resistant to oil and sunlight. The *EXZEL* LSZH cables may be used and installed in places where safety, performance and concern for the environment are important.

EXZEL™ Product Construction:

Conductor: Fully annealed stranded tinned copper per ASTM B-33 for ease of termination and soldering.

Insulation: FR-LSZH (105°C) with low dielectric constant for lower capacitance than PVC.

Fillers: Fibrillated FR-LSZH Polyolefin as needed for roundness.

Drain Wire: Same size as insulated conductors for proper grounding.

Foil Shield: Aluminum/Polyester/Aluminum tape; 100% Shield effectives.

Braid Shield: Tin-plated copper for ease of termination and soldering; tin plating is chemical and corrosion-resistant with 85% nominal braid coverage for better shield effectiveness against EMI/RFI.

Jacket: FR-LSZH (105°C) Flexible Sunlight- and Oil-Resistant with over 40% Limited Oxygen Index (LOI) to meet tray cable flame test, CSA FT-4 and IEC low smoke and low toxicity requirements.

Construction: 12 AWG thru 28 AWG in any combinations up to 30/conductors. Also available as unshielded, foil-shielded, foil + braid shield or in any combination of shields or jacket colors as required.

Application: FR-LSZH cables are suitable for instrumentation, industrial, control, power, data, wireless, audio, video and broadcast, with recommended usage in confined and populated places like shipboard, tunnels, mines, transit, trains, subway, manufacturing facilities, schools, college campuses, hospitals, studios and office buildings.

EXZEL™ LSZH UL AND INDUSTRY COMPLIANCES

- CM, CMG per UL Subject 444, c(UL) CSA C22.2 No. 214-08 and NEC Article 800
- CL2, CL3, PLTC; PLTC-ER per UL Subject 13 and NEC Article 725
- -ER for Exposed Run, Impact and Crush per UL-13/par.20/21
- OIL RES -I-: Per UL-13/Par.40.2; and UL-2556
- Sunlight Resistance: Per UL-13/Par.26 and UL-2556; 720-hour weather ability test
- -40°C to +105°C per UL listings

Note:
- *EXZEL* FR-LSZH cables are available in CMR rating if required
- PLTC may be substituted for CL2 and CL3 type cables
- *EXZEL* FR-LSZH cables can be approved for UL-LS Low Smoke rating to UL-1581

EXZEL™ LSZH FLAME AND SMOKE COMPLIANCES

- Vertical Tray Cable Flame Test, IEEE-383 (70,000 BTU) and CSA FT- 4 / IEEE 1202 flame test per UL-1685
- IEC 60332-1 & -3 Cat. A: Flammability
- IEC 61034-1 & 2 and MIL-DTL-24643B and NES 711 Smoke Index Emission
- IEC 60754-1 & 2; MIL-DTL-24643B: Halogen Content and Acid Gas Generation

EXZEL™ LSZH LISTED ADVANTAGES

PLTC:

Power Limited Tray Cable (300V) can be used for Class 2 and Class 3 wiring per NEC Article 725 and is also suitable for installation in Class -I- and Class -II- Division 2 Hazardous Locations as specified by NEC Article 500 and Article 501.10 Paragraph (B)(4).

PLTC-ER:

(ER) stands for Exposed Run rating as listed by UL Subject 13 and defined by NEC Article 725 as: "That complies with the crush and impact requirements of type MC cable and is identified for such use shall be permitted to be exposed between the cable tray and the utilization equipment or device."

- The use of PLTC-ER rated cables translates into a great cost savings and flexibility by the installer or end user by eliminating the need for metal conduit and labor during new installation or maintenance for the life of the cable.

Note: The new (ER) rating by NEC Article 725 has no limit on the footage run between the tray cable and the final termination without conduit.

OIL RES-I-:

This is a very important feature to consider when it comes to industrial installation. Due to the (ER) rating, the exposed cable run between the cable tray and point of termination could be routed through or between machinery and subjected to constant contact with oil, or oily substances due to oil leaks by equipment or constant oil spray used by some machines as a coolant (i.e., lathe machines).

When oil comes in contact with a regular PVC or LSZH jacketed cables that are not rated for oil resistance, the oily fluids after time will migrate into the compound, causing it to soften and crack by allowing more oils to migrate into the inner conductors, ultimately causing an electrical shortage between the conductors and shields, which may in turn damage the final equipment.

It may also attack the plasticizer used in PVC by drawing it out, or leaching, and causing the jacket compound to soften, crack and sometimes totally disintegrate, exposing the inner conductors to more hazards and damage by electrical shorts and down-time for repair.

In both cases, when the jacket compound fails due to exposure to oil, the entire cable will fail because the o/a jacket no longer can protect the inner conductors mechanically or electrically from the surrounding elements.

Note: Not all PVC or LSZH compounds can be rated for oil resistance. Our EXZEL LSZH jacket compound is specifically formulated and tested to meet the UL requirements of Oil Res.-I-.

Pictured below are actual die-cut lab specimens of *EXZEL* vs. other competitive compounds after aging in hot oil for 96 hours at 100°C per UL Subject 13 Oil Res -I- requirements

- Sample (A): *EXZEL* compound showed no sign of damages and passed the UL Oil Res physical requirements.
- Sample (B): vendor (B) compound; physical damage was very obvious along with failing the UL Oil Res physical requirements
- Sample (C): vendor (C) compound; total compound break down after the Oil Res test

Samples (A)

Samples (B)

Samples (C)

EMI/RFI:

Our foil shield and braid combination of 100% Aluminum/Poly/Aluminum tape and 85% tinned copper braid coverage will ensure the highest protection against Electro Magnetic Interference (EMI) and Radio Frequency Interference (RFI) caused by close proximity of motors, generators, fluorescent lighting, power surges, two-way radios and wireless communications.

Surface Transfer Impedance (STI) and Electromagnetic Pulse (EMP) Shield Effectiveness:

Surface Transfer Impedance (STI) is used to evaluate the cable shield effectiveness and may also be used by both users and manufacturers to classify relative EMI/EMC performance of different shields.

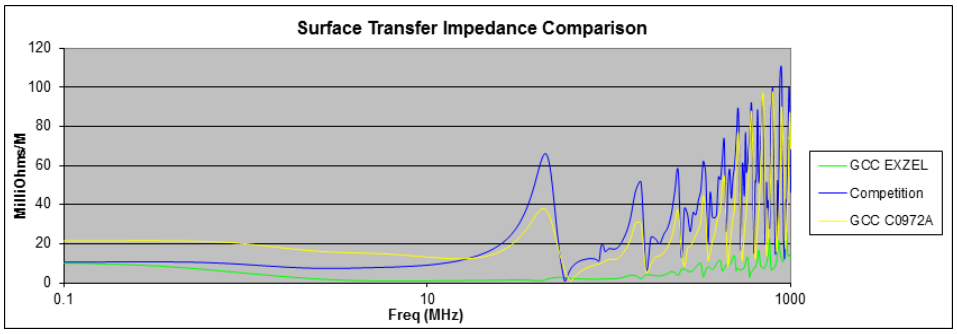
The lower the value of the surface transfer impedance, the more effective the cable shielding.

The higher the value of the Electromagnetic Pulse (EMP), the more effective the cable shielding.

In general, the EMP requirement is more stringent than the STI requirements therefore many cables that can meet the STI requirement may fail to meet the EMP requirement.

General Cable's *EXZEL* has an Electromagnetic Pulse (EMP) of 60.72 dB compared to 58.91 dB of the PVC competitive construction, so *EXZEL* passes the EMP requirement (60 dB min) specified in NAVSEA 6323050 while the PVC competitive construction failed to meet the requirement.

The chart below compares the Surface Transfer Impedances (STI) between *EXZEL* and two similar constructions. General Cable's *EXZEL* (STI) was superior to the competition (lower values).



Sunlight-Resistant: Jacket compound will not fade or deteriorate during its lifetime

Good Low Temperature properties (-40°C)

Save on installation and materials costs, as conduit and ducts are not required

Safety: Non-toxic under combustion or decomposition

Green: FR-LSZH meets LEED building certifications

Jacket Finish: Low friction reduces cable drag thru during installation

EU Directive 2002/95/EC (RoHS):

All materials used in the manufacture of *EXZEL* cables comply with the European Commission's Directive 2002/95/EC, which was adopted January 27, 2003 (as amended or supplemented), on the restriction of the use of certain hazardous substances in electrical and electronic equipment (also known as "RoHS"). On April 1, 2008, the EU Court of Justice decided that the exemption for DecaBDE will end as of June 30, 2008, effectively banning the use of DecaBDE in products sold into the EU after this date. General Cable does not use DecaBDE in our RoHS compliant cables; therefore, our cables are also compliant with this in addition to the RoHS directive.

REACH Regulation (EC 1907/2006):

All materials used in the manufacture of *EXZEL* cables do not contain any of the Annex XIV Candidate List chemicals published by the ECHA on January 13, 2010, at levels above the 0.1% threshold as defined by and measured in accordance with REACH. Thus, there are presently no disclosure obligations or restrictions on use with respect to these products under REACH.

California Proposition 65:

All materials used in the manufacture of *EXZEL* cables are in compliance with California Proposition 65.

LSZH VERSUS PVC

Cost: LSZH compounds are slightly higher in cost than some PVC compounds but it is the safety factors as they relate to humans and electronic equipment as well as friendliness to the environment that should be considered when it comes to cost.

Flexibility: There is a limited range of compound flexibility available for LSZH compounds versus PVC so it not recommended for robotic or continuous flex applications.

Flame Retardant: There is higher grade of flame-retardant PVC compounds available on the market like (Plenum PVC) because of the Halogen additive in PVC like Chlorine and Bromine that are not allowed in LSZH compounds.

FR-LSZH Cable being tested for Tray Cable Flame IEEE-383

CONCLUSION

When selecting or designing a cable for any application, the operating environments where the cable will be used, whether extreme or not, must be considered along with availability, performance, and price, among other things.

And when the safety of humans and the environment is a consideration, along with high-performance and capability, then General Cable's **Carol® Brand *EXZEL*™ LSZH Cables** are what you must specify.

LSZH NOTES OF INTEREST

- In February 2007, the Technical and Scientific Advisory Committee of the U.S. Green Building Council (USGBC) released its report on a PVC avoidance-related materials credit for the LEED Green Building Rating system. The report concluded that "no single material shows up as the best across all the human health and environmental impact categories, nor as the worst," but that the "risk of dioxin emissions puts PVC consistently among the worst materials for human health impacts."

- In November 1986, California approved "Proposition 65," a referendum initiative requiring a warning about exposures to toxic chemicals. This initiative becomes known as the Safe Drinking Water and Toxic Enforcement Act of 1986.

- In 2000, lawsuits were filed in San Francisco against representative defendant companies that manufacture or sell jacketed wire and cable products and products containing wire and cable, alleging violation of California's "Proposition 65."

- In 2003, Proposition 65 took effect with a list of 20 chemicals (including Vinyl Chloride) that are banned from use or disposal of in landfills.

- The State of California is currently considering a bill that would ban the use of PVC in consumer packaging due to the threats it poses to human and environmental health and its effect on the recycling stream. Specifically, the language of the bill analysis stipulates that the EPA has listed vinyl chloride a "constituent element" of PVC and as a carcinogen. It also further cites that there are concerns about the leaching of phthalates and lead from the PVC packaging.

- The Office of Technical Assistance's (OTA) – Branch of the Massachusetts Executive Office of Environmental Affairs), mission is to assist Massachusetts facilities with reducing their use of toxic chemicals and/or the generation of toxic manufacturing byproducts (including Chloride). For further information about this or other OTA materials, or about OTA's technical assistance services, go to their Web site at**:** http://www.mass.gov/envir/ota.

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