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Subject: RIN 1219-AB34

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REFERRRING TO: CFR 30 Parts 18 and 75, RIN 1219-AB34

After reviewing the new proposals for design requirements for approval of high-voltage continuous mining machines operating in face areas of underground mines, there are several points that must be made. They are as follows:

1) Page 42817, col. 1: The No.16 AWG "stranded" ground check wire as described should be changed to: "special annular stranded with extensibility," to describe the only type of wire that will withstand the bending and flexing seen in the center interstice of a cable. Stranding of standard lay-up will not withstand the rigors of this central location. The standard stranded #10AWG Ground-Check wire in the outer interstice of a Type SHD-GC will withstand the rigors of flexing and bending because it is in a helix and, hence, is capable of excellent fatigue resistance as it moves in concert with the power conductors. The GC in the outer interstice is actually exposed to less mechanical stress due to its location in the helix. The center ground check wire has to have extensibility incorporated into the strand itself, much like a telephone handset cord. This is due to its axial location and no helix to absorb the flexing.

2) Page 42817, col. 1 and page 42822, Section 75.826: A new jacket compound has been developed for the mining industry, including underground coal. This new jacket material has a very high tensile strength and is extremely resistant to abrasion and tear. It is far superior to any rubber jacket compound available today. This material is Thermoplastic Polyurethane (TPU). TPU jacket physical properties are very nearly double that of rubber compounds in tensile strength and tear resistance. The abrasion resistance of TPU is five times that of most rubber jackets. This is shown in Table 1 below. A review of these properties shows that this new TPU material (non-black in color) should be added to RIN 1219-AB34 as an acceptable alternate jacketing compound. The compound is so rugged that it has only been extruded in a single-layer. The single layer is stronger than a two-layer rubber jacket. The problem with two-layer extrusions of Thermoplastic Polyurethane is that no adhesion can be developed between the layers as is found on the two-layer rubber jackets. Many and various adhesives have been tried on two-layers of TPU, but to no avail.

3) Page 42823, col. 2, Section 75.826: Cable handling issues documented here are subjected to individual mining practices. However, in this writer's opinion, there is no need to require and go to the extreme measures of High Voltage gloves to handle these cables. Cables for 2300 Volt Continuous Miners have been specially designed based upon the strengths of today's highly engineered insulations, jacket compounds, and special tapes. These same cables with two-layer rubber jackets and single-layer TPU jackets are routinely used at 4160 Volts.

Looking at the cable in detail, the following should be noted: Type SHD-GC cables are designed for the rugged use experienced in all types of mining. The Ethylene Propylene Rubber (EPR) insulation is specifically designed and practices. However, in this writer's opinion, there is no need to require and go to the extreme measures of High Voltage gloves to handle these cables. Cables for 2300 Volt Continuous Miners have been specially designed based upon the strengths of today's highly engineered insulations, jacket compounds, and special tapes. These same cables with two-layer rubber jackets and single-layer TPU jackets are routinely used at 4160 Volts.

Looking at the cable in detail, the following should be noted: Type SHD-GC cables are designed for the rugged use experienced in all types of mining. The Ethylene Propylene Rubber (EPR) insulation is specifically designed and compounded to meet the Insulated Cable Engineers Association requirements found in specification S-75-381. Most EPR insulations are rated and will withstand 550 Volts per mil (Vpm of insulation wall thickness) breakdown strength. The 5000 Volt cables being used have 110 mils (0.110 inch) of EPR over each power conductor. (See Table 2) These cables are energized at 2300 Volts. Dividing 2300V by 110 mils quotient is 20.9 Volts per mil electrical stress on the EPR insulation. Dividing 550Vpm by 20.9 Vpm yields a safety factor of 26.3. The insulation of this cable has 26.3 times the electrical strength that the insulation will ever experience on a 2300V Continuous Miner. Per the Insulated Cable Engineers Association, all 5000-volt SHD-GC cables are tested at 13kV AC before being shipped from the factory. This is at the rate of 118Vpm of insulation wall. Table 3, columns 4 and 5 show the ICEA physical requirements for EPR insulation and typical values for this material.

ICEA requires that 5000 Volt SHD-GC cables have a Strand Shield (SS) over the annealed copper power conductor. The strand shield encapsulates the power conductor in semi-conductive (semi-con) rubber, or with a semi-conductive tape. This semi-con material is used to equalize radial electrical stresses that the strand would place on the insulation if it were not covered with the semi-con layer. The SS "rounds-out" the strand so there are no "high points" which might electrically stresses the insulation unevenly. Table 2 shows the wall thickness of a typical extruded strand shield.

Over the EPR insulation in these 2300V Continuous Miner cables, a special Semi-conductive tape (SCT) is helically applied with a minimum 15% overlap. This tape is comprised of cloth having a semi-conductive rubber coating laminated into the fabric. The insulation surface has 100% coverage with this semi-con tape. If any sharp object penetrates the cable, passes through the tape, and into the power conductor, the tape plus the copper/fabric braid shield provide a well-defined path to ground. If the cable is crushed or pinched, the semi-conductive tape threads will be the first to make contact with the power conductor and provide an instantaneous path to the copper/textile braid shield.

Looking at the metallic shielding, one can see that the copper and textile braid shielding is substantial. This provides a copper coverage of 60% minimum. The copper component of the shield is comprised of 12 carriers (groups) of copper wires, each having 6 ends (individual wires). A typical copper/textile braid wire is comprised of #28AWG (0.0126 inch diameter) individual wires. With these wires, the total copper coverage of 60% is achieved per ICEA specification S-75-381.

The grounding conductors in 5kV SHD-GC cables are sized according to ICEA S-75-381. This requirement is in excess of that listed in 30CFR Part 75, paragraph 75.701-4, which states: "The cross-sectional area (size) of the grounding wire is at least one-half the cross-sectional are (size) of the power conductor where the power conductor used is No. 6 AWG or larger". Table 2 shows the actual percentage of grounding conductor cross-sectional area.

Table 1

Properties	TPU jackets	EHD rubber jackets, ICEA minimums	Typical EHD rubber jackets
Tensile strength, psi	5000	2400	2900
Elongation at rupture, %	500	300	500
Tensile strength at 200% elongation	1100	700	900
Tear strength, pounds per inch	120	40	55
Abrasion Index*	15	No requirement	70

*Material loss due to abrasion results in lower number indicating better abrasion resistance.

Table 2

Conductor size, AWG	ESS thickness	Insulation Wall	Ground size, AWG (2 per cable)	Total area of ground. (Ratio to power conductor)	Jacket Wall
1	0.015 inch	0.110 inch	5	79%	0.205 inch
1/0	0.015 inch	0.110 inch	4	79%	0.220 inch

The jacket itself provides excellent protection for the cable core. Jacket materials exceed ICEA S-75-381 specification in all categories. A typical material is Extra-Heavy-Duty (EHD) Chlorinated Polyethylene (CPE) Rubber. Jacket materials have been specially formulated and compounded to exceed the ICEA minimum physical values shown in Table 3, columns 2 and 3. These materials have very good tensile strength; tear resistance, and abrasion resistance. Rubber jackets on Type SHD-GC cables must applied in two layers with a bi-directional reinforcing twine in-between the layers per ICEA S-75-381. This twine aids in tear resistance of the rubber. The twine serves as a barrier to cuts, just the belting in automobile tires provides added cut and puncture resistance. The two jacket layers are vulcanized together with a cohesive bond. This bond, in and of itself, is another one of the important fundamentals, which make this cable rugged. Coloring the jackets makes the cables more visible and easy to identify. Colored jackets have the same physical properties as the black Type SHD-GC cable jackets. There is no loss of physical properties when using colored jackets. Lastly, the jacket wall thickness specified by ICEA S-75-381 is commonly met and usually exceeded by cable manufacturers. The wall itself is uniform and consistent . The surface of the cable jacket is smooth and dense. This is what gives the outer jacket good abrasion resistance.

In conclusion, the cable design, rubber materials, special shielding, and manufacturing processes make this cable capable of withstanding the extremely rigorous environment of mining. This, coupled with the extremely sensitive ground fault protection described throughout the document numbered RIN 1219-AB 34 indicate that mine operators should be allowed to handle the 2300Volt Continuous Miner cable without the use of High Voltage gloves or other special equipment, when desired.

Table 3

	ICEA Minimum Requirements		Typical Values	
ICEA S-75-381	EPR insulation	EHD rubber jackets	EPR insulation	EHD rubber jackets
Tensile strength, psi	1200	2400	1700	2900
Elongation at rupture, %	150	300	325	500
Tensile strength at 200% elongation	No requirement	700	No requirement	900
Tear strength, pounds per inch	No requirement	40	No requirement	55