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PERCENT INSULATION LEVEL

For medium voltage cables, insulation levels greater than 100% are intended to provide an additional safety factor for the un-faulted phase conductors in the event of a fault on one phase in a three phase system.

Power cable voltage ratings are based on a grounded WYE system. Here the insulation thickness is based on the cable voltage rating divided by 1.732. Thus for a 15kV rated cable, the thickness is designed for 15/1.732 = 8.66kV. This is known as the 100% insulation level (formerly referred to as a "Grounded" system). If a fault exists for less than 1 minute, then the 100% insulation level is suitable.

The 133% insulation level was designed for use on systems where voltage from the neutral point varies from 15kV/1.732, depending on load balance. This was formerly referred to as "Ungrounded". The basis for the term ungrounded is that each cable is capacitively coupled to ground via a high-reactance path. It does not mean that no grounds are connected to the cables shield. If the fault exists for more than 1 minute, but less than 1 hour, then the 133% insulation level is required by industry standards.

A 173% insulation level is used when a phase to ground fault, depending on the system, appears as full phase-to-phase voltage across the insulation for more than 1 hour.

The table below demonstrates various expected voltages for various insulation levels.

Cable Rated V	Corresponding N - G Voltage for Insulation Level of		
(N-N)(KV)	100%	133%	173%
5	2.4	3.2	4.16
8	4.6	6.2	8.0
15	8.7	12	15
25	15	19	25
35	20	27	35
46	27	35	46

Insulation thickness' for medium voltage cables can be obtained from ICEA standards. It is our industry convention to name cables using the phase to phase voltage. When referencing industry tables, please keep this convention in mind.

The table for shielded solid dielectric cables is listed below.

NOMINAL INSULATION THICKNESS				
Rated Circuit Voltage, Phase-to-Phase Voltage	**Conductor Size, (AWG or kcmil)**	**Nominal Insulation Thickness (mils)**		
		100 Percent Level	**133 Percent Level**	**173 Percent Level**
2001 - 5000	8 - 1000 1001 - 3000	90 140	115 140	140 140
5001 - 8000	6 - 1000 1001 - 3000	115 175	140 175	175 220
8001 - 15000	2 - 1000 1001 - 3000	175 220	220 220	260 260
15001 - 25000	1 - 3000	260	320	420
25001 - 28000	1 - 3000	280	345	445
28001 - 35000	1/0 - 3000	345	420	580
35001 - 46000	4/0 - 3000	445	580	750

For paper insulated cables (PILC), instead of a table, the following methodology from AEIC CS1 is used.

For a shielded 15kV, 133% insulation level, multiply the voltage rating by 1.33

15 x 1.33 = 20kV

Then from Table I of AEIC select the corresponding wall thickness for a 20kV rated cable, namely 200 mils (for 1/0 to 1000mcm). This cable would have a dual rating:

15kV - 133% • 20kV - 100%

Non-Shielded Cables Rated 0 - 2400 volts

The NEC does not provide voltage level categories for non-shielded cables rated 0-2.4kV. The insulation thickness' as prescribed by the NEC and UL are based on mechanical requirements and are over-insulated for the voltages involved. Note that ICEA does provide these insulation levels for non-NEC applications.

Overall, insulation level for shielded medium voltage cables are based on the operating parameters of the system. The choice of 100, 133 or 173% is based on duration of the fault interrupting device. Guidelines for the appropriate level can be found in standards like:

The NEC • IEEE Red Book • ICEA • AEIC

Many medium voltage end users prefer 133% insulation level for additional security and for an additional safety factor to address the rigors of cable in installation and splicing/terminating.

Non-shielded cables are over insulated and as such do not follow the insulation level convention.

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