

## Rolling Stock Cable

This catalog covers rolling stock for underground, mass transit lines and tramlines as well as diesel and regional trains. The increasing need to reduce both volume and weight has lead to the development of miniaturized cables, as well as high temperature cables with enhanced performance. This leads to highly stressed materials being used in the harsh environment of rolling stock. Caledonian & Addison provides a full range of products from Medium Voltage to Instrumentation cables, and from Standard Wall, Medium Wall to Thin Wall designs. The materials used have been specially developed to improve mechanical and thermal properties, fire performance and extended life using advanced technologies, such as electron beam irradiation and silan.

New challenges in the rolling stock industry must be met due to long-awaited equipment upgrades, booming freight traffic and high-speed train projects, and the growing need for conventional subways, fully-automated metros, and light-rail suburban vehicles worldwide.

Caledonian & Addison manufactures a complete range of rolling stock cables and components, meeting national and international standards, We supply wide range of rolling stock cables from 300V to 6kV in diameter of 0.5mm sq to 400mm sq covering diverse railway standards. All cables meet strict technical requirements in terms of electrical safety, fire-performance (low-smoke and toxicity, continuous operation in the event of fire).

As an OEM, Caledonian rolling stock cables provides our railway customers with future headroom by meeting the following European Norms (EN) and international standards :

- EN 50264 European railway standard
- EN 50306 European railway standard
- BS 6853 British railway standard
- DIN 5510-2 German railway standard
- NF F 16 101 French railway standard
- UIC (International Union of Railways) 895

This catalog covers rolling stock for underground, mass transit lines and tramlines as well as diesel and regional trains. The increasing need to reduce both volume and weight has lead to the development of miniaturized cables, as well as high temperature cables with enhanced performance. This leads to highly stressed materials being used in the harsh environment of rolling stock. Caledonian provides a full range of products from Medium Voltage to Instrumentation cables, and from Standard Wall, Medium Wall to Thin Wall designs. The materials used have been specially developed to improve mechanical and thermal properties, fire performance and extended life using advanced technologies, such as electron beam irradiation and silan.

## CENELEC Standard

According to CENELEC Standards, railway rolling stock are designed to meet the following critical requirements:

- 1) 2 levels of low temperature: -25°C and -40° C resistant
- 2) 2 levels of fluids resistance: oil resistant, or extra oil and fuel resistant
- 3) 3 levels of hazard: HL1. HL2-HL3. HL4

Low temperature, oil resistant	(-25° C, IRM 902)	A	B	C
Extra low temperature, oil resistant	(-40° C, IRM 902)	D	E	F
Low temperature, extra oil and fuel resistant	(-25° C, IRM 902. IRM 903)	G	H	J
Extra low temperature, extra oil and fuel resistant	(-40° C, IRM 902. IRM 903)	K	L	M
Extra low temperature, no oil and fuel resistant	(-40° C)	O	O	O

Caledonian Rolling Stock cables, branded as FIREROL, are mainly classified as follows:

### EN 50264

Caledonian standard wall and medium wall rolling stock cables conform to EN 50264 for use in power cars, diesel-electric locomotives, electric and diesel multiple units EMU / DMU, high-capacity rails, mono rail and light rail vehicles, sleeping cars and passenger coaches. FIREROL are very flexible cables.

#### Application:

Strictly halogen free, these wires combine the advantages of small size, lightweight, high chemical resistance, high mechanical properties. They are recommended for installation in railway vehicles (locomotives, trains, trolleybuses...).

A 120°C conductor temperature is allowed for a 20000 hours cumulative working time.

The external sheath is oil and diesel oil resistant, ozone and UV resistant

#### Conductors:

Flexible stranded tinned copper class 5 according to IEC 60228 with optional separator tape. Conductors temperature +90°/105° C

#### Standard:

EN 50264-1: General requirements applicable to cables, including detailed requirement for the insulating and sheathing materials

**Standard Wall rolling stock cables having special fire performance**

EN50264-2 = pr EN50264-2-1	Standard wall single core cables with crosslinked elastomeric insulation 0.6/1kV Unscreened, unsheathed 1mm <sup>2</sup> -400mm <sup>2</sup> FRL-SW-1SU 1.8/3kV Unscreened, unsheathed 1mm <sup>2</sup> -400mm <sup>2</sup> FRL-SW-3SU 1.8/3kV Unscreened, sheathed 1mmsq-400mm <sup>2</sup> FRL-SW-3S 3.6/6kV Unscreened, sheathed 1mmsq-400mm <sup>2</sup> FRL-SW-6S
EN50264-3 = pr EN50264-2-2	Standard wall multi-core cables with crosslinked elastomeric insulation 300/500V Unscreened or screened 1/1.5/2.5 mm <sup>2</sup> ( 2-40 Cores) FRL-SW-05M / FRL-SW-05M-OS 0.6/1kV Unscreened or screened 1 mmsq-50 mm <sup>2</sup> ( 2.3.4 cores) FRL-SW-1M / FRL-SW-1M-OS
Insulation compounds:	Crosslinked halogen free rubber EI 101 (for A, B, C), EI 102 (for D, E, F), EI 103 (for G, H, J), EI 104 (for K, L, M) and EI 105 (for O, EPDM compound)
Sheathing compounds:	Special crosslinked halogen free black rubber type: EM 101 (for A, B, C), EM 102 (for D, E, F), EM 103 (for G, H, J), EM 104 (for K, L, M)

**Medium Wall rolling stock cables having special fire performance**

pr EN50264-3-1:	Medium wall single core cable with crosslinked elastomeric insulation with reduced dimensions 0.6/1kV Unscreened, unsheathed 1mm <sup>2</sup> -400mm <sup>2</sup> FRL-MW-1SU 1.8/3kV Unscreened, unsheathed 1mm <sup>2</sup> -400mm <sup>2</sup> FRL-MW-3SU 1.8/3kV Unscreened, sheathed 1mm <sup>2</sup> -400mm <sup>2</sup> FRL-MW-3S 3.6/6kV Unscreened, sheathed 1mm <sup>2</sup> -400mm <sup>2</sup> FRL-MW-6S
pr EN50264-3-2:	Medium wall multi-core cables with crosslinked elastomeric insulation with reduced dimensions 300/500V Unscreened or screened 1/1.5/2.5 mm <sup>2</sup> ( 2-40 Cores) FRL-MW-05M / FRL-SW-05M-OS 0.6/1kV Unscreened or screened 1 mm <sup>2</sup> -50 mm <sup>2</sup> ( 2.3.4 cores ) FRL-MW-1M / FRL-SW-1M-OS
Insulation compounds:	Crosslinked halogen free black rubber EI 106 (for A, B, C), EI 107 (for D, E, F), EI 108 (for G, H, J), EI 109 (for K, L, M) and EI 110 (for O, EPDM compound)
Sheathing compounds:	Special crosslinked halogen free rubber type: EM 101 (for A, B, C), EM 102 (for D, E, F), EM 103 (for G, H, J), EM 104 (for K, L, M)

**EN 50306**

Caledonian thin wall rolling stock cables conform to EN 50306 are resistant to chemicals, acids, oils, fuels and UV light. Anti-termite cables and anti-rodent cables can also be offered upon customer request.

**Application:**

Strictly halogen free, these wires combine the advantages of small size, lightweight, high chemical resistance, high mechanical properties. They are recommended for installation in railway vehicles (locomotives, trains, trolleybusses...).

A 120°C conductor temperature is allowed for a 20000 hours cumulative working time.

The external sheath is oil and diesel oil resistant, ozone and UV resistant

**Conductors:**

Flexible stranded tinned copper class 5 according to IEC 60228 with optional separator tape. Conductors temperature +90°/105° C or +105°/125° C

**Insulation:** Crosslinked halogen free polyethylene or polymer

**Sheathing:** Cables sheathed with special S1 and S2 compounds (described in EN 50306-1) or EN 50264 sheathing compounds (EM 101. EM 102. EM 103 and EM 104)

**Standard:**

EN 50306-1: General requirements applicable to cables, including detailed requirement for the insulating and sheathing materials

<b>Thin Wall rolling stock cables having special fire performance</b> EN 50306-2:	Thin wall single core cables 300/500V Unscreened 0.5mm <sup>2</sup> -2.5 mm <sup>2</sup> FRL-TW-05SU
EN 50306-3:	Thin wall single core and multi core cables (pairs, triads, and quads) screened 300/500V Screened 0.5mm <sup>2</sup> -2.5 mm <sup>2</sup> ( 1-4 Cores ) FRL-TW-05S-OS or FRL-TW-05M-OS
EN 50306-4:	Thin wall multi-core and multi pair cables Unscreened, sheathed for either exposed or protected wiring 0.5mm <sup>2</sup> -2.5mm <sup>2</sup> (2-48 Cores) FRL-TW-05M-SW, FRL-TW-05M-ESW Screened, sheathed for either exposed or protected wiring 0.5mm <sup>2</sup> -2.5mm <sup>2</sup> (2-8 Cores) FRL-TW-05M-SW-OS, FRL-TW-05M-ESW-OS Screened, sheathed for either exposed or protected wiring 0.5mm <sup>2</sup> -1.5mm <sup>2</sup> (2-7 Pairs/Cores) FRL-TW-05MP-SW-IOS, FRL-TW-05MP-ESW-IOS

**EN 50382**

Caledonian High Temperature cable is characterized by its lightweight and small size which provide high flexibility and easy handling required for high-speed train cable applications. High temperature cables implies higher current capacity for the same cross-section. The higher the continuous temperature load, the longer the life time of the cable at a given working temperature. Caledonian High Temperature cable allow greater safety margins and higher current capacity, with the following features:

- Low weight cable
- Low size cable
- Thin wall cable
- Wide operating temperature range (+125°C down to -60°C)
- Low smoke density (>90% light transmission)
- Short circuit cable and Earth fault-proof cables (>250°C)

**Conductors:**

For 120°C class : Flexible stranded tinned copper

For 150°C class : Flexible plain annealed copper

Class 5 (or class 6 on request) according to IEC 60228 with optional separator tape

**Braiding:**

Optional textile braid (for reinforced versions)

**Insulation:** Type EI 111 or EI 112 (if sheathed) cross-linked halogen free silicone rubber

**Sheathing:** Low temperature, oil resistant, ozone and UV resistant

For 120°C class : special cross-linked black rubber type EM106 according to EN 50382-1

For 150°C class : special cross-linked black silicone rubber type EM 107 according to EN 50382-1

**Minimum bending radius:**

Dynamic use : 5 to 8 x outer diameter

Static use : 4 x outer diameter

**Standard:**

EN 50382-1: General requirements applicable to cables, including detailed requirement for the insulating and sheathing materials

**High temperature rolling stock cables having special fire performance**

EN 50382-2	Single core, silicon rubber insulated cables for +120° C and +150° C 1.8/3 kV unscreened, unsheathed with or without textile braid 1.5mm <sup>2</sup> -400mm <sup>2</sup> FRL-HT-3SU 1.8/3 kV unscreened, sheathed with or without textile braid 1.5mm <sup>2</sup> -400mm <sup>2</sup> FRL-TW-3S 3.6/6 kV unscreened, unsheathed with or without textile braid 2.5mm <sup>2</sup> -400mm <sup>2</sup> FRL-TW-6SU 3.6/6 kV unscreened, sheathed with or without textile braid 2.5mm <sup>2</sup> -400mm <sup>2</sup> FRL-TW-6S
------------	--

**Cable design in accordance with EN 50264 & EN 50306****Cable Make Up****Conductors**

Tinned fine copper strands according to VDE 0295 / IEC 60228. class 5 are generally used for railway cables. For nominal cross section of over 50mm sq, 0.41mm strand wire will be used instead of 0.51mm as stipulated in IEC 60228. The IEC 60228 Class 5 enhances flexibility and the ease of handling, thus lengthening the product life of the cable. These class 5 class conductors are extremely flexible, and easy-to-install in the compact rolling stock environment.

**Insulation and outer sheath**

Crosslinked polyolefine copolymer or EPR will generally be used for insulation whereas electron-beam cross-linked elastomer is employed for sheathing. Cross-linked elastomer compounds offer very good durability that can resist heat, oil, vibration, chemical aggression, etc

**Electrical Characteristics****Nominal voltage**

Nominal voltage of a cable refers to the reference voltage for which the cable is intended to be used. In EN 50264. applicable to power cables, different voltage ranges ranging from 0.6/1 kV, 1.8/3 kV to 3.6/6 kV are defined. For each of these voltage ranges, specific insulation thickness requirements are also stipulated in this standard. The operating voltage should not exceed the corresponding maximum nominal voltage allowed.

**Current Carrying Capacity**

Current carrying capacity is defined as the amperage a conductor can carry before melting either the conductor or the insulation. There are many factors which will limit the amount of current that can be passed through a wire. These major determining factors are:

**Conductor Size:**

The larger the circular mil area, the greater the current carrying capacity. The amount of heat generated should never exceed the

maximum temperature rating of the insulation

**Ambient temperature:**

The higher the ambient temperature, the less heat required to reach the maximum temperature rating of the insulation.

**Conductor Number:**

Heat dissipation is lessened as the number of individually insulated conductors, bundled together, is increased

**Installation Conductors:**

Restricting the heat dissipation by installing the conductors in conduit, duct, trays or raceways lessens the current carrying capacity. This restriction can be alleviated somewhat by using proper ventilation methods, forced air cooling, etc.

According to EN 50343. "Railway applications - Rolling stock – Rules for installation of cabling" current carrying capacity are based on maximum conductor temperatures of 90°C and 150°C defined in 3 b. The ambient temperature is 45°C. The following table shows the current carrying capacities for a cable installed in mid air.

**Current carrying capacity for cables in accordance with EN 50264**

Nominal cross section of copper conductor mm <sup>2</sup>	Current carrying capacity Conductor temp. 90 °C (max) Ambient temp. 45 °C I [A]	Current carrying capacity Conductor temp. 150 °C (max) Ambient temp. 45 °C I [A]
0.5	14	-
0.75	16	-
1	20	-
1.5	25	-
2.5	33	46
4	46	64
6	60	84
10	85	119
16	110	154
25	150	211
35	190	267
50	240	337
70	300	422
95	360	506
120	425	598
150	490	689
185	560	788
240	675	950
300	775	1091
400	950	1337

**Ambient temperature**

External conditions such as ambient temperature and bundling must be taken into account when

determining actual current carrying capacity. The following tables show the corresponding k1 modification factors depending on an ambient temperature differing from 45 °C. Current carrying capacity decreases or increases depending on these factors

**Maximum conductor temperature 90°C**

Temperature °C	10	20	30	40	45	50	60	70
k1	1.33	1.25	1.15	1.05	1	0.94	0.82	0.66

**Maximum conductor temperature 150°C**

Temperature °C	- 50	- 30	- 10	10	30	45	60	80	100	120
k1	1.38	1.3	1.23	1.15	1.06	1	0.92	0.81	0.69	0.53

**Physical Characteristics**

**Temperatures and overload temperatures**

EN 50264 defines two overload categories for cables at 90°C and 150°C : 160°C/50 h for 90°C and 250°C /50 h for 150°C. This means that for a period of less than or equal to 50 hours, increased conductor temperatures can be withstood, while the operability of the cables remains unimpaired. This has the advantage that short-time temperature increases can be identified and more serious damage such as fires can be prevented.

**Environmental conditions**

Cables are suitable for fixed installation in rail vehicles up to - 40°C and are resistant to oil according to EN 50305. EN 60811-2-1. UIC 895 and resistant to fuel according to EN 50305. EN 60811-2-1. UIC 895.

**Fire Performance**

EN 50264 and EN 50306 only describe cables and wires made from halogen free materials that minimise the risk of damage to persons and property. These materials refer to hazard levels 1 – 4 as defined in EN 45545-1( fire protection on railway vehicles). These levels

define the degree of possibility of personal injury as the result of a fire. Amongst other things, they also form the basis of the requirements for materials used in rail vehicles.

**Halogen Free**

The test is for determination of the amount of halogen acid gas, other than the hydrofluoric acid evolved during combustion of compound. When tested in accordance with IEC 60754-1. the hydrochloric acid yield should be less than 0.5% (5mg/g) for LSOH compound.

**Corrosivity**

Corrosive gases produced in case of fire cause damage to vehicles and facilities and therefore should be avoided. According to EN 50267-2-2. a material is not corrosive if its combustion gases meet the stipulated target values for conductivity ( $\leq 10 \text{ } \mu\text{s/mm}$ ) and pH value ( $\geq 4.3$ ).

This is equivalent to IEC 61034

**Toxicity**

In accordance with EN 50305- 9.2. or NFC-20454 a toxicity index (ITC) is calculated following analysis and titration of combustion gases. The aforementioned hazard levels require that certain toxicity indices are not exceeded.

The toxicity indices for power cables listed in the following table are derived from EN 50264.

HL	ITC
HL 1	not specified
HL 2 / HL 3	5 (max)
HL 4	3 (max)

The required toxicity indices for cables and wires, depending on hazard level, in accordance with EN 50306 (thin wall) are displayed in the following table:

HL	ITC	
	Insulation and sheath S1	EM101-104 and sheath S2
HL 1	not stipulated	not stipulated
HL 2 / HL 3	10 (max)	5 (max)
HL 4	6 (max)	3 (max)

**Toxic Fumes**

Naval standard NES713 burns a set amount of material and analyses the gases given off. The volume of each gas is multiplied by the toxicity index for each gas. The toxicity index for each gas are added together to give an overall toxicity index for the material. LFH materials should have a toxicity index maximum of 10.

**Flame Retardance**

In accordance with EN 50265- 2-1 or IEC 60332-1. testing is carried out for a single insulated wire or cable. The specimen is deemed to have passed this test, if after burning has ceased, the charred or affected position does not reach within 50mm of the lower edge of the top clamp.

In accordance EN 50266-2-4. EN 50305 9.1 and IEC 60332-3. testing is carried out for bunched cables. A gas burner flame is applied to the bottom of a vertically arranged conductor bundle in a test furnace. Following completion of the flame test, the specimen consisting of 3.5m, is deemed to have met the requirements, if after burning has ceased, the extent of charred or affected portion does not reach a height exceeding 2.5m above the bottom edge of the burner

**Smoke Density**

For smoke density testing, the cube test is employed according to EN 50268-2-1 or IEC 61034. The 3 metre cube test measures the generation of smoke from electric cables during fire. A light beam emitted from a window is projected across the enclosure of to a photo cell connected to a recorder at the opposite window.

The recorder is adjusted to register from 0% for complete obscuration to 100% luminous transmission. A 1 metre cable sample is placed in the centre of the enclosure and then subjected to fire. The minimum light transmission of the smoke is then measured.

The following table shows the minimum percentages of light transmission depending on hazard level:

HL	Light transmission
HL 1	not specified
HL 2 / HL 3	60 %
HL 4	70 %

**BS 6853.**

In 1999. BS 6853 was introduced in UK and whose highest categories are probably the most demanding in the world. BS 6853 covers both smoke emission testing and flammability testing. BS 6853 also introduced the concept of an R-Index, which is a single number quantification of the toxic gas risk associated with candidate composite materials for use in railway rolling stock. The R-Indices are split into the following categories:

- Category 1a Trains which predominantly use tunnels R < 1.0
- Category 1b Trains which use tunnels, but infrequently R < 1.6
- Category 2 Trains which run, predominantly, overground R < 3.6

The R-Index is generated by analysing eight gases of combustion, for which critical concentrations have been established by NIOSH/OSHA and reported as IDLH, (Immediately Dangerous to Life and Health), values.

Toxicity is the most important factor to address during the cable design. Toxicity limit for the UK and France are identical because both require the same test method for elastomers (NF X 70-100). The only difference is that the U.K.'s specification requires an addendum for nitrous oxides. Toxicity limits for French and the U.K. standards are developed from the IDLH values published in the National Institute for Occupational Safety and Health (NIOSH) Guide. IDLH, or Immediately Dangerous to Life or Health, values are calculated based on levels of gas in a particular atmosphere for 30 min that would pose an immediate risk. The U.K.'s BS 6853 specification is the most stringent, closely followed by the French, and finally the U.S. It's important to note that Germany does not have a toxicity requirement.

#### R Index

#### IDLH Values

Gases	U.K.(mg/m <sup>3</sup> ) BS 6853	French (mg/m <sup>3</sup> ) NF X 70-100	U.S. (ppm) SMP 800C
CO	1.400	1.750	3.500
CO <sub>2</sub>	73.000	90.000	90.000
HCl	76	150	500
HBr	101	170	100
HCN	56	55	100
HF	25	17	100
NO/NO <sub>2</sub>	38		100
SO <sub>2</sub>	270	260	100

#### NFF 16-101/2

In France the French Railway's standard NFF 16-101/2 combines reaction to fire, (M rating), with smoke and toxicity, (F rating), to provide a true FST evaluation of the fire safe properties of a composite material.

As with the UK BS 6853 standard, the M/F rating required in NFF 16-101 is dependent on

the type of rolling stock, the extent to which it uses tunnels and the position and orientation of the composite part in the vehicle.

#### Test methods

The standard comprises the following test methods:

Flammability

NF-EN 60695-2 Glowing Wire at 850+/-15C and 960+/-15C

NF-EN ISO 4589-2 Oxygen index determination

Smoke Density

NFX 10-702 Smoke density determination

Toxicity

NFX 70-100 Pyrolysis and combustion gas analysis

#### M rating

M rating refers for the fire resistance classification of the materials to be used in the transportation industry

This classification rates the material in five categories

M0: incombustible

M1: non flammable

M2: burns with difficulty

M4: easily inflammable

M5: very easily inflammable

#### I/F rating

I/F rating refers to ignition resistance and fume classification of non metallic electrical components used in the underground transportation industry.

#### Test description

##### 1. Ignition

The ignition characteristics is determined by a combination of glow wire test (GWT) and oxygen index.

The material under test is categorized in the following tables:

Class	Oxygen Index	Glow Wire
I0	>70	No ignition at 960C
I1	>45	No ignition at 960C
I2	>32	No ignition at 850C
I3	>28	Ignition does not persist at 850C after glow wire is withdrawn
I4	>20	
NC	<70	

(Not classified)

##### 2. Fume composition

The parameters tested are fume opacity and analysis of pyrolysis as well as combustion gases.

All 3 parameters are used to calculate the smoke index ( SI) which in turns determines the fume class

F as follows:

F Class	S.I Values
F0	≤ 5
F1	≤20
F2	≤40
F3	≤80
F4	≤120
F5	>120

**Classification**

Each material will receive I/F rating, the smaller the number the better. Unfortunately, good I and good F are difficult to achieve: low I values frequently means addition of fire retardant packages which in turns leads to high F values.

Consequently, 4 overall I/F performance classes are defined as follows:

	I0	I1	I2	I3	I4	I5
F0	IV	IV	IV	II	I	I
F1	IV	IV	IV	II	I	I
F2	IV	IV	III	II	I	I
F3	IV	III	III	I	I	I
F4	IV	III	I	I	I	I
F5	IV	I	I	I	I	I

- I Performance class 1. least demanding
- II Performance class 2
- III Performance class 3
- IV Performance class 4. most demanding

**DIN 5510**

In Germany, the fire standards requirements in railways are defined by the DIN 5510. which does not include any measurement of toxic gases but focuses only on reaction to fire and smoke produced in a fire scenario.

According to DIN5510. the test samples, vertically arranged in the test chimney, are stressed by a special bunsen burner for 3 minutes. The combustibility, smoke release and dripping behaviour are then assessed.

The extent of destroyed surface area is decisive of the fire performance rating. The following are the fire performance classification:

Class		
B1	Easily ignitable	Damaged area 90%-100%
B2	Combustible	Damaged area 76%-90%
B3	Difficult to ignite	Damaged area <75%
B4	Incombustible	No damage

The rating with respect to burning dripping are also observed in the chimney test. Differentiation between the classes is based on visual observation by T1 burning dripping to T4 no visible deformation/ no softening.

The smoke release during the chimney test will be done by the reduced transmission value. Two classes, SR1 10% min and SR2 < 50% min are used.

**EN 45545**

En 45545 is a common new EU standard is to replace the existing national regulations for fire safety in trains and track-guided vehicles. This new standard constitutes a harmonising of the existing national standards based on the highest common denominator – and will therefore represent a stiffening of the fire safety regulations applied in the individual countries.

The new standard divides railway vehicles into four operation categories. As seen below, it particularly targets safety in connection with tunnels and bridges:

Category	Services	Infrastructure
1	Mainline, regional, urban and suburban	Operation not determined by underground sections, tunnels and/or elevated structures
2	Urban and suburban	Operation determined by underground sections, tunnels and/or elevated structures with walkways or other means for safe side evacuation from the vehicles
3	Mainline and regional	Operation determined by underground sections, tunnels and/or elevated structures with walkways or other means for safe side evacuation from the vehicles
4	Mainline, regional, urban and suburban	Mainline, regional, urban and suburban operation determined by underground sections, tunnels and/or elevated structures without any means for safe side evacuation from the vehicles

The standard also establishes four hazard levels that determine the requirements for protection against fire and smoke formation. Most new railway vehicles will be designed to hazard level 3. but some vehicles, for example for light rail systems, will have to conform to hazard level 4.:

Category	Design category			
	Standard vehicles	Automatic vehicles	Double-decked vehicles	Sleeping cars
1	HL 2	HL 2	HL 2	HL 2
2	HL 2	HL 3	HL 3	N/A
3	HL 3	HL 4	HL 3	HL 4
4	HL 4	HL 4	HL 4	HL 4

HL 1 Long distance train

HL2 Regional train without tunnel

HL3 High speed trains  
 City and regional trains  
 Trams with party going through tunnels.

HL4 Metro  
 Night train with sleeping coaches

## Ordering Code

### FRL-A-BC-D-E-F-G

#### A- Wall Type

- SW- Standard Wall
- MW- Medium Wall
- TW- Thin Wall
- HT- High Temperature

#### B- Voltage Type

- 05-300/500V
- 06-0.6/1KV
- 3-1.8/3KV
- 6-3.6/6KV

#### C- Core Type

- S- Single Core
- M-Multi Core
- MP-Multi Pair

#### D-Insulation or Sheath Type

- U-Unsheathed
- SW-Standard Wall Sheath
- ESW-Exposed Standard Wall Sheath
- RI-Reinforced Insulation

#### E- Screen Type

- OS-Overall Screen
- IOS-Individual & Overall Screen

#### F-Number of Cores and Pairs

- 10C- 10 Cores

#### G- Cross Section Areas

- 1.5- 1.5mm<sup>2</sup>

## Test Method

### EN 50305

#### Test Methods

Special test are stipulated in EN 50305 for each European railway rolling stock. Below is the test method for the rolling stock cables to En 50264 and EN 50306 and EN 50382 :

For Standard Wall and Medium Wall cables according to EN 50264	
<b>Ageing test at: +120° C</b>	
<b>Fluid Resistance:</b>	IRM 902 for mineral oil resistance
	IRM 903 for fuel resistance
	N oxalic acid
	N sodium hydroxide
<b>Test at low temperature:</b>	-25° C or -40° C
<b>Fire Propagation:</b>	Single core test EN 50265-2-1 (IEC 60332-1)
	Bundle core test EN 50266-2-4 (IEC 60332-3C) + EN 50305
<b>Toxicity Test:</b>	Toxicity EN 50305
<b>Smoke Density Test:</b>	Low smoke EN 50268-2 (IEC 61034)
<b>Halogen Test:</b>	acid and toxic gases EN 50267-2-1/8-2-2 (IEC 60754-1&2)
<b>Electrical Test:</b>	Dielectric test and direct current stability test at +85° C
For Thin Wall cables according to EN 50306	
Standard Wall tests plus	
<b>Long Term Ageing Test:</b>	(20.000 h at +125° C) EN 50305
<b>Notch Propagation Test:</b>	EN 50305
<b>Abrasion Test:</b>	EN 50305
For High Temperature cables according to EN 50382	
Standard Wall tests plus	
<b>Ageing Test</b>	for silicon insulation at +200° C and long term sheath ageing test (20.000 h at +140° C)

