WHAT MAKES PRYSMIAN CABLES DIFFERENT?

QUALITY SERVICE INSTALL ON PRYSMIAN PERFORMANCE TEST IN STALLATION SAFETY ECONOMIC ADVANTAG

PRYSMIAN PERFORMANCE TEST

Prysmian Group presents Prysmian Performance Test (PPT): the only comprehensive cable test system for safe, higher performance and lower total cost of ownership.

Although the cost of cable represents on average less than 1% of total cost of construction projects, choosing the right cable makes a significant difference. PPT results show that the Prysmian Group cable solutions, not only ensures you safer and higher performing applications but also allows you to work faster reducing the labour cost by up to 50%* and reducing the total cable cost by up to 12%*.

This is the Prysmian Group difference...

Prysmian Performance Test

prysmianperformanstesti.com

Prysmian Group

LINKING TO FUTURE

PRYSMIAN

Draka

*It is based on the reports by independent bodies.

INTRODUCTION

Prysmian Group, established in 1879, until today, initiated many "first" projects in its sector. Starting with worldwide special projects such as installing telegraph line to Red Sea in 1886, connecting Italy to United States with telegraph cables in 1925, connecting again Italy to Brazil with sub-sea telephone cables in 1950, Prysmian Turkey also completed the first production of 35 kV power cable, first 3600 pairs communication cable, first optical fibre cable and first safe cables against fire (Afumex®) in Turkey.

Prysmian Group, following the merger between Prysmian and Draka in 2011 and being the worldwide leading company in energy and telecom cables industry, having 17 R&D centers and 68 million Euro R&D budget in 2011 sustains its pioneer position on developing innovative products that are safe, high performance and economically advantageous. We are proud of realizing another first in Turkish cable market, "**Prysmian Performance Test**" that was created by our R&D center in Mudanya factory.

SECTOR AT A GLANCE

In today's industrialization and urbanization environment, energy consumption is increased by 92% in the last 10 years. A similar rise is also expected in the next period.

In recent years, multi-storey buildings are rapidly increased by 30% between 2007 and 2011. Besides, number of places where people are intense, such as shopping malls, hospitals, cinemas are increasing and therefore, it increases the risk of life and property safety in buildings.

When we look at the "statistics" that are related to fire, the biggest risk for human life and property, there were 26.444 fires in 2011 in Istanbul, and this number is increased by 32% compared to 2010. One of the biggest reasons of fires is the electrical installations and its component, the cables.

In the last 10 years, thanks to Turkey's impressive economic growth, while GDP per capita was 3.020 USD in 2001, in 2011 it increased approximately 3 times and became 10.444 USD. Moreover, labor costs (net minimum wage) are increased about 69% from 2002 until today. If every type of electrical wiring is forced to be installed by experts, while this obligation increases significantly the quality of electrical installation, it will also cause an unavoidable increase in total project cost.

AS PRYSMIAN GROUP

Being aware of the importance of cables used in projects and increasing responsibilities of electrical contractors, during the last 2 years we focused on safety and performance topics related with cables that are used in Turkish construction industry. We also worked on the economical advantages that could be obtained during the cable installation. Considering this information, we completed more than 2000 tests on different product groups and brands.

According to the test results, we identified that some cables do not meet the requirements of related standards in terms of measurement, performance and safety. We observed that substantial part of these cables were not designed according to the standards and some of them are below the required values specified in the standards in terms of physical characteristics. Additionally, there are big differences in terms of time saving on labor such as installation and strippability.

We as Prysmian Group, believe that we need to live in a safer and more effective world and feel responsible about presenting differentiated solutions.

These subjects are very important to us, therefore we decided to launch an initiative named "Attention! All Cables Are Not The Same...". There are 2 main focus points of this project: Raising the awareness that all cables are not the same and educating the stakeholders in the market that it is important to be careful while choosing the cable solution and brand, and select the safer, good performing and economically advantageous product. In order to support this initiative, we as Prysmian Group launched the "**Prysmian Performance Test (PPT)**", the only comprehensive

INTRODUCTION

test of the sector. PPT evaluates the cables in terms of "safety", "performance", "ease of use" and therefore economical advantages.

Although the cost of cable represents on average less than 1% of total cost of construction projects, choosing the right cable makes a significant difference. PPT results show that the Prysmian Group cable solutions, not only ensures you safer and higher performing applications but also allows you to work faster reducing the labour cost by up to 50%* and reducing the total cable cost by up to 12%*.

This is the Prysmian Group difference...

SAFETY

Throughout the lifecycle of the cables, they are required to ensure that the transmission function is associated with the quality of the materials used, the design and the production technologies. If a cable is not correctly selected or manufactured below the standards, it may lose its functionality in a short period of time can cause electrical leakage, even fire. Therefore, cables are the essential elements that increase the value and safety of the projects.

PERFORMANCE

Flame retardant cables keep the progress of the flame on cables at minimum. Low toxic gas emission and low smoke density, therefore increased visibility are very important in order to facilitate the evacuation process.

In addition, the functionality of the cables used in fire alarms, emergency exit lightings, ventilation fans, water pumps, fire systems or lift cables saves lives during fire.

According to researches, the main cause of the deaths in fire (70%) is smoke and gas emission of the burning materials. One of the best known examples of fatal effects of the spread of fire and smoke, resulting in the death of 17 people, is Dusseldorf Airport fire disaster in 1996. As a result of burning the cables installed in the trays, passengers were exposed to the deadly toxic smoke. Therefore, in order to ensure the safety of life and property in case of fire, high performance cables should be preferred.

ECONOMIC ADVANTAGE

Together with the conformity to construction standards and high performance in case of fire, ease of use is also important. During installation, cables can create efficiency in terms of labor force and time advantage. Ease of strippability, leaving less filling material on the cores and ease of pulling through the pipes increase the labor efficiency during cable installation.

*It is based on the reports by independent bodies.

PRYSMIAN PERFORMANCE TEST

		CABLE TYPE TEST MATRIX					
		NHXMH 052XZ1	N2XH [FE180]	YVV/ NVV	H05VV/ H05V2V2	H05V/H07V	H07Z1
A	**GEOMETRICAL TESTS**						
1	Conductor Examination	+	+	+	+	+	+
2	Insulation Wall Thickness	+	+	+	+	+	+
3	Sheath Thickness	+	+	+	+		
4	Outer Diameter	+	+	+	+	+	+
B	**ELECTRICAL TESTS**						
1	Measurement of Insulation Resistance at Ambient Temperature			+			
2	Insulation Resistance at Maximum Conductor Operating Temperature	+	+	+	+	+	+
3	Voltage Test (Core)		+	+			
4	Water Absorption Test for Insulation			+			
5	Surface Voltage	+	+				
6	D.C. Test for Long-Term Endurance to Voltage	+					
7	Voltage Test (Cable)	+				+	+
8	Lightning Impulse				+	+	+
9	Conductor Resistance	+	+	+	+	+	+
C	**MECHANICAL TESTS**						
1	Tensile Strength	+	+	+	+	+	+
2	Elongation at Break	+	+	+	+	+	+
3	Ageing						
	Ageing in Air Oven	+	+	+	+	+	+
	Ageing with Conductor			+		+	+
	Compatibility Test (Cable)	+	+	+	+	+	+
	Lost of Mass Test			+	+	+	+
4	Tests at High Temperature						
	Hot-Set Test	+	+				+
	Pressure Test at High Temperature	+	+	+	+	+	+
	Heat Shock Test			+	+	+	
	Shrinkage Test	+	+	+	+	+	
5	Tests at Low-Temperature						
	Cold Bend Test (Diameter < 12,5 mm)	+	+	+	+	+	+
	Cold Elongation Test (Diameter > 12.5 mm)	+	+	+	+	+	
	Cold Impact Test	+	+	+	+	+	+
D	**PERFORMANCE TESTS**						
1	Flame Propagation Test						
	For Single Cable	+	+	+	+	+	+
	For Bunched Cables						
	Cat. A F/R						
	Cat. A						
	Cat. B						
	Cat. C	+	+				+
	Cat. D						
2	Burning Droplet Test	+	+				+
3	Smoke Density	+	+				+
4	Tests for Gases Emitted During Burning						
	Acidic Gas Emittance	+	+			+	+
	Fluorine Amount						
	pH & Conductivity	+	+			+	+
5	Circuit Integrity Under Fire		[+]				
E	**FUNCTIONALITY TESTS**						
1	Strippability Test	+	+				
2	Slipperiness Test	+				+	+
3	Abrasion Test	+	+	+	+		
4	Shrinkage Test	+	+	+	+		
5	Cyclic Strength Test	+	+	+	+		

+ Test applied to the related cable.

A-GEOMETRICAL TESTS

A1 Conductor Examination

Conductor is the heart of a cable. Quality of the copper used in the conductor has a direct effect on the service life of the cable. The conductor structure should be tested using the following steps; number of wires in the conductor should be counted and the overall conductor diameter should be measured.

A2 Insulation Wall Thickness

Cable insulation wall thickness is, like the insulation resistance, a factor that affects the operation of the cable. Cables with insulation wall thickness lower than standard value would have a shorter lifetime.

Cross-sectional view of a cable.

3 samples are taken from cable ends and there must be at least 1 m distances between each ends. Each sample is cut vertically to the optical axis, and measured using a device such as a micrometer and profile projector. 6 measurements are done, starting from the point with the thinnest wall thickness. The average of all measurements, as well as the thinnest point should not be less than the value specified in the standard.

Cross-sectional view of insulation structure.

A3 Outer Sheath Thickness

3 samples are taken from cable ends and there must be at least 1 m distances between each ends. Each sample is cut vertically to the optical axis, and measured using a device such as a micrometer and profile projector. 6 measurements are made, starting from the point with the thinnest wall thickness. The average of all measurements, as well as the thinnest point should not be less than the value specified in the standard.

Cross-sectional view of a cable.

A4 Outer Diameter Measurement

For cables with outer diameter less than 25 mm, measurements are conducted using a device such as micrometer, profile projector, etc., in two perpendicular dimensions. Where the cable outer diameter exceeds 25 mm, the perimeter of the cable is measured with a measurement device and the outer diameter is calculated. As per the standard, samples up to 25 mm should be measured with 2 decimal digits, while samples greater than 25 mm should be measured with 1 decimal digit. The required values are defined in the standard related to each cable.

Geometrical measurements are done using a profile projector.

B-ELECTRICAL TESTS

B1 Insulation Resistance at Ambient Temperature

Before the test, the core is extracted from the ends, and the cable is immersed in water at ambient temperature for at least 1 hour. The D.C. testing voltage should be between 80 V and 500 V, and is applied to the cable for not less than 1 minute and more than 5 minutes, until a stable result is reached. Measurements should be done between each core and water.

B2 Insulation Resistance at Maximum Conductor Operating Temperature

Cores of the cable sample are immersed in water at a temperature range of ±2°C of the maximum operating temperature of the conductor, and measured using the same method as ambient temperature.

B3 Voltage Test (Core)

The cores of the cable sample should be immersed in water at ambient temperature at least 1 hour before the test. A voltage equal to 4 Uo, at the mains frequency, is continuously applied between the cores and the water for 4 hours.

B4 Water Absorption Test for Insulation

The cores are immersed in pre-heated water at the temperature specified in the standard. Cores which pass the 4 kV A.C. pre-voltage test will be kept in the water at the temperature specified in the standard. In accordance with the table provided in the standard, D.C. voltage is applied between the conductors and water.

B5 Surface Voltage

3 samples of 150 mm will be taken from the jacket, copper wire is wound around them, and conditioned in the oven. After conditioning of the samples in the oven, the resistance of the surface is measured using copper conductors after 1 minute.

B6 Test for Long-Term Endurance of the Insulation to D.C. Voltage

All jackets are stripped and the cores are immersed in water at 60°C. 220 V D.C. voltage is applied for 10 days. The test should not result in a short circuit in the insulation.

B7 Voltage Test (Cable)

Single-core cables are immersed in water at ambient temperature and test voltage is applied between the conductor and water for 5 minutes. In multicore cables, all cores but the one to be tested, as well as the metal components, if any, should be grounded. Then, the test voltage is applied between the conductor to be tested and water for 5 minutes.

B8 Lightning Impulse Test

Each core of the cable should endure 10 positive and 10 negative voltage impulses without any defect. After the impulse test, each core of the cable sample will be subjected to the power frequency voltage test for 15 minutes at ambient temperature.

B9 Conductor Resistance Measurement

Cables, conductors of which are to be measured, are placed in the testing room, such that they stay at the testing temperature for at least 12 hours. Then, the conductor resistance is measured using a microohmmeter, also calculating the temperature factor.

Extra Test: Sparking Voltage Test

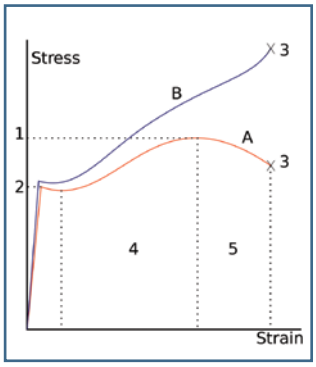
The test starts with the routine test voltage, and the voltage is increased in kV steps (max.10) until short circuit occurs. Electric field density should not be lower than the required values. This test is very important for the selection material.

Lightning impulse generator voltage divider.

C-MECHANICAL TESTS

C1/C2 Test for Tensile Strength and Elongation at Break

This test is very important for the determination of the mechanical endurance of insulation and jacket materials, as well as their behaviour under load. Tensile strength is calculated by dividing the maximum measured load by the cross sectional area, and denotes the load per unit area (N/mm^2). Elongation at Break is also determined with the same measurement, and calculated as a percentage (%) value that compares the pre and post-measurement lengths of the sample.



Tensile-Elongation graph.

C3 Ageing Tests

Aging test combinations are used to determine the specifications of the cable insulation and jacket materials after they were exposed to various conditions, and provides information on the cable life under the operating temperature.

Ageing in Air Oven

The samples are kept in the air oven for the ageing process, at a temperature specified in the standards. Tests are performed for tensile strength and elongation at break prior to and after ageing, and changes are observed.

Ovens used for aging tests.

Ageing in Air Oven with Conductor

This test is used, with temperature, to measure the effect on the core material of the conductor.

Compatibility Test (Ageing as a cable)

This ageing test is used to test the compatibility of all metal and non-metal material comprising a cable with each other, under the effect of temperature.

Loss of Mass Test

This test is used to determine the amount of softener in PVC material, that is lost due to heat (mg/cm2).

C4 Tests at High Temperature

Hot-Set Test

This test is used to determine the cross-linking specifications of the sample. Dumbbell-shaped samples are kept under a certain amount of load for 15 minutes at a temperature of 200°C, and then kept for additional 5 minutes without the load. The initial length, the length under load, and the length after the load is removed is measured, and the differences are calculated.

Pressure Test at High Temperature

This test is used to determine the change in the wall thickness of the cable jacket when exposed to external pressure. It simulates the crushing of the cable in various operating environments. As per the standard, the test is performed for 4 or 6 hours at a temperature of 80°C/90°C.

Heat Shock Test

This test is used to determine the durability of the cable when it is bended to a radius much less than its bending radius for 1 hour under a temperature of 150°C. It is important regarding the deformations at operating temperature.

Insulation Shrinkage Test

This test is performed to observe the shrinkage effect of temperature on the material. The test is performed for 4 hours at a temperature of 130°C. Shrinkage characteristics of the insulation material at cable connection points are very important.

C5 Tests at Low-Temperature

Cold Bend Test (Diameter < 12,5 mm)

This test is performed by winding the cable around mandrels prepared based on the diameter, at a temperature of -15°C.

Cold Elongation Test (Diameter > 12.5 mm)

This test is performed on the outer jacket material of the cable. The test utilizes the same method as the one used for the standard tensile strength and elongation at break. The only difference is that the test is performed in the test chamber under low temperatures.

Cold Impact Test

Weights, specified in the standard based on the outer diameter and outer jacket wall thickness of cables, are applied on the cable as impacts at a temperature of -15°C.

Materials specially developed by Prysmian Group are able to pass even the cold tests performed under temperatures below -15°C.

D - PERFORMANCE TESTS

D1 Fire Resistance Tests

Flame Propagation Test for Single Cable (IEC 60332-1-2)

This test is performed by the application of a flame, as specified in the standards, on a single cable sample. The resistance of a single cable, as well as the progress of the flame during the test are observed.

Flame Propagation Test for Bunched Cables (IEC 60332-1-24)

This test measures the fire resistance of cables installed side by side, as well as their effects on each other. This is an important test for cables used inside buildings. 3.5 meter long samples are harnessed and tied on a ladder inside a chamber, and exposed to flame for 20 or 40 minutes, using a method specified in the standard. The progress of the flame on the cables is observed throughout the test.

IEC 60332 - 3 Categories					
Category	A F/R	A	B	C	D
Plastic Volume (Lt/m cable)	7	7	3,5	1,5	0,5
Test Duration	40	40	40	20	20

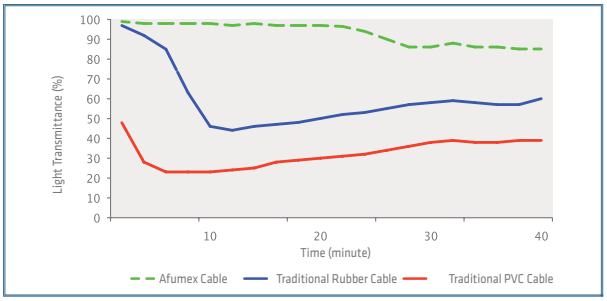
D2 Burning Droplet Test (IEC 60332-1-3)

While a cable burns, burning droplets of insulation, filler and jacket material fall and cause other objects in the vicinity to burn. The burning droplet test is performed to measure such effect.

An improper cable sample in burning droplet test.

D3 Smoke Density Test (IEC 61034-1/2)

The number of cables to be tested is determined based on the outer diameter of the cable. These cables are burnt in a closed cubical chamber with a volume of 27m³, using the fuel mixture specified in the standard. The light transmittance from a light source on one wall of the chamber to the receiver on the opposite wall, which is initially 100%, decreases during the test as the smoke caused by the burning cables spreads in the chamber. The light percentage reaching the receiver as of the end of the test is evaluated.



LSOH. Smoke density graphs for rubber and PVC.

In smoke density tests, fuel should be used as specified in the standards.

D4 Halogen Acid Gas Amount Test (IEC 60754-1/2)

This test is performed to measure the effects of the gases emitted by the burning cables on the surrounding environment. The burnt cable material is observed for pH and conductivity values. Emittance of acidic gases during burning results in fatal effects on people around, as well as malfunctioning of electronic equipment.

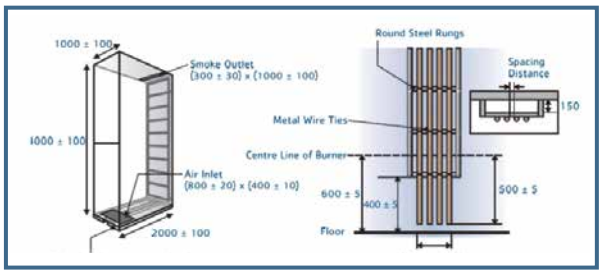
The halogen amount is measured by absorption of the burning gas into water.

D5 Circuit Integrity Under Fire

This test aims to measure how long cables maintain their current conductivity under a flame of at least 750°C. Such cables must be able to maintain circuit integrity for at least 3 hours.

D1 Flame Propagation Test for Bunched Cables (IEC 60332-3-24)

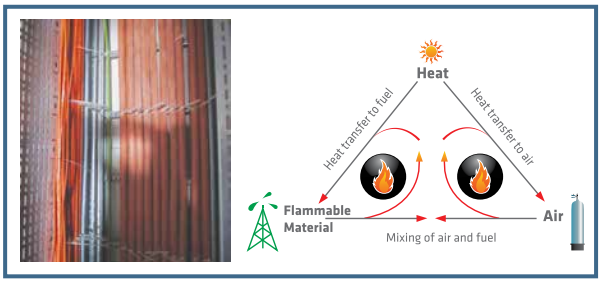
This is one of the most critical tests for cables used inside buildings. This test measures the fire resistance of cables installed side by side, as well as their effects on each other. Side-by-side cables may be less resistant to fire, compared to single cables. This may be caused by air gaps between cables, or a cable being affected by the burning cable.



Testing apparatus for the bunched cable flame propagation test.

Since cables are installed into a single tray especially in large buildings, fire on one floor may spread onto the other floors through such trays. Fire-resistant high-performance cables should be used in order to prevent fire spreading from one floor to another, or from one section to another on the same floor.

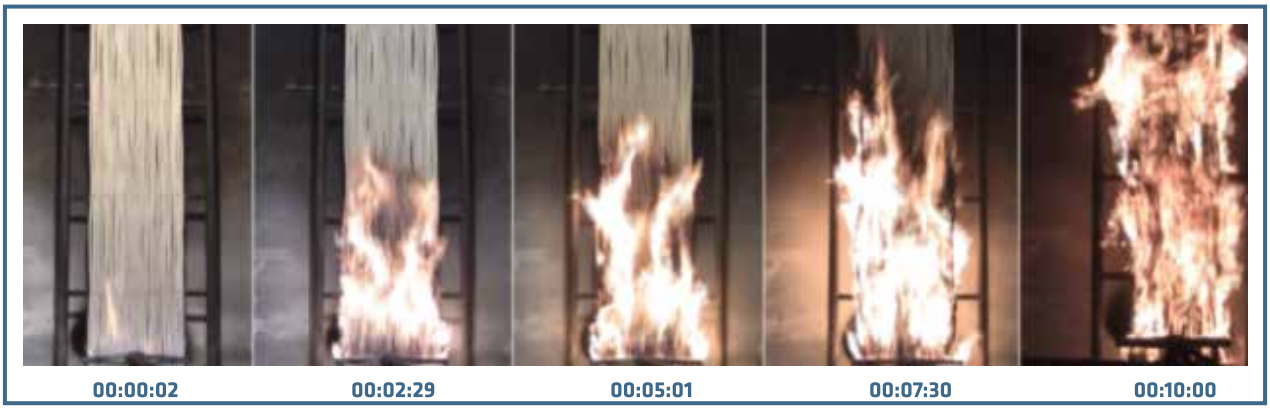
Cables are installed into a single tray in buildings.



Flame formation graph.

To perform the test, 3.5-meter-long samples are bunched and tied on a ladder inside a chamber, generally with a plastic volume 7 liters, and exposed to flame for 20 or 40 minutes, using a method specified in the standard. The cables should not carry the flames more than the level specified in the standard. AFUMEX® cables do not carry the flames in case of a fire incident, and do not cause the fire to spread.

Cable samples in the bunched cables flame propagation test.



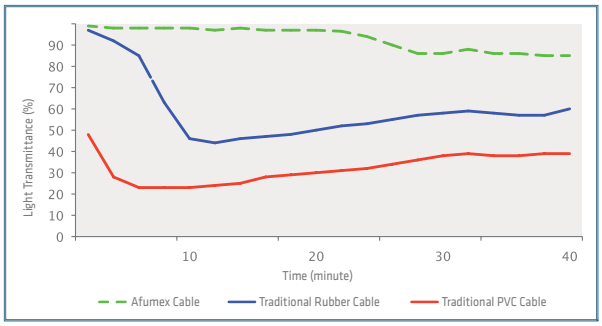
A failed cable sample.

D3 Smoke Density Test

Cables have a potential to cause heavy smoke while burning. This may be fatal, as it may reduce visible distance during evacuation, and cause poisoning. The test simulates the first 40 minutes, which is the most critical time for evacuation. AFUMEX® cables are the safest ones, thanks to their low smoke density while burning.

Smoke density test chamber.

The density of the smoke caused by the burning cable is evaluated. The number of cables to be burnt is determined based on the outer diameter of the cable, as specified in the relevant standard. These cables are burnt in a closed cubical chamber with a volume of 27m³, using a fuel mixture of 90% ethanol, 4% methanol and 6% water. A light source is located on one wall.

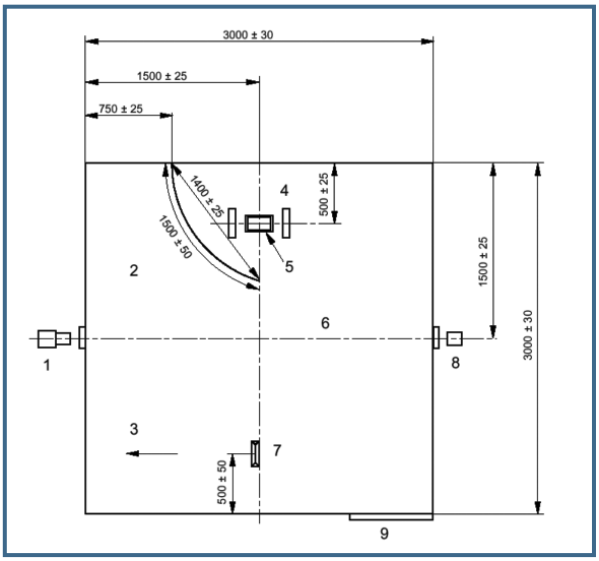


LSOH. Smoke density graphs for rubber and PVC.

The light transmittance from the light source to the receiver, which is initially 100%, decreases as the smoke caused by the burning cables spreads in the chamber. The fuel completely burns out during the 40-minute test.

A cable sample in the smoke density test.

The light level should not fall below 60%. In AFUMEX® cables, there is a reduction of 20% in the light measured by the receiver, while such reduction may rise up to 70% in standard PVC cables.



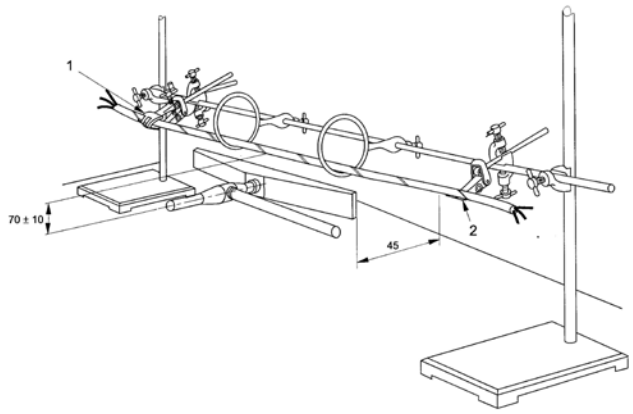
Smoke density test chamber, layout plan.

D5 Circuit Integrity Under Fire (IEC 60331-21)

In crowded buildings, it is of critical importance that systems such as fire warning alarms, emergency exit lighting, ventilation fans, fire extinguisher water pumps and fire elevators maintain their function in case of a fire incident. Cables used in such systems should be able to maintain their function even in case of a fire. In this way, smoke is prevented from spreading to other floors, sprinklers can activate in order to prevent spreading of fire, and alarm systems activate in order to alert necessary locations.

Tested cable should be able to maintain circuit integrity for at least 3 hours.

Cables used in similar systems are also subjected to test for burning under voltage. This test aims to measure how long cables maintain their circuit integrity under a flame of at least 750°C. A 1.2-meter sample is stripped 10 cm from both ends, and the nominal voltage is applied. Air and propane flow rates are set to achieve a flame of minimum 750°C, and the test is performed.



Testing apparatus.

During the test, the cable should be able to conduct electricity continiously for 3 hours under flames, and no short circuits should occur during cool-down period of 15 minutes.

This would provide enough time to enable people to escape from the building, and for firefighters to intervene.

AFUMEX® FE180 cables can successfully function for 3 hours in case of a fire incident, thanks to their special material.

A cable samples in the test for burning under voltage.

E-FUNCTIONALITY TESTS

E1 Strippability Test

During installation, cable jackets should be stripped in order to expose the core. Time loss may occur, especially in cases where filling material sticking on the core create difficulty in strippability. A cable that can easily be stripped can be installed more quickly. The test is performed using the strippability test load cells, which measures the strippability force.

A cable sample in the strippability test.

E2 Slipperiness Test

Building wire cables are pushed through ducts during installation. Cables that can move easily in the ducts provide ease in installation. Slipperiness test is performed to measure such effects.

A cable sample in the slipperiness test.

E3 Abrasion Test

The cable jacket may contact rough surfaces during installation, and be exposed to various mechanical effects. Abrasion test is performed to measure such effects. The test is performed by locating a V-shaped metal apparatus against the cable jacket at an angle of 90°. A certain amount of load is applied on the knife, several turns are made and the resistance of the jacket against abrasion is measured.

A cable sample in the abrasion test.

E4 Shrinkage Test

The cable jacket may shrink when exposed to high temperature. This would cause irreversible effects on the life cycle of the cable. Jacket shrinkage test aims to determine such effects.

E5 Cyclic Strength Test

A cable is exposed to the effects of low and high operating temperatures throughout its life cycle. Cyclic Strength Test is performed to measure such effects. (-15°C, +80°C) The cable is bent to its bending radius, and kept in a conditioning chamber. The conditioning chamber temperature reach the highest and lowest temperatures in a cyclic pattern, simulating the life cycle of the cable. The cracks and deteriorations on the cable are observed.

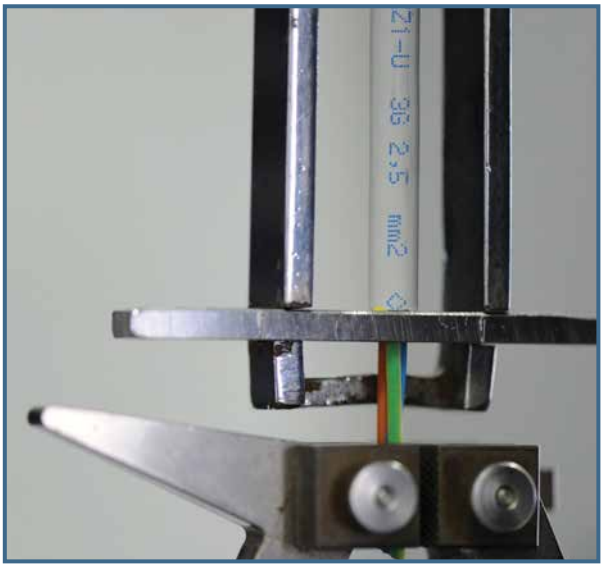
Cable samples in a cyclic strength test.

E1 Strippability Test

During installation, cable jackets should be stripped in order to expose the core. Time loss may occur, especially in cases where filling material sticking on the core create difficulty in strippability. A cable that can easily be stripped can be installed more quickly.

An operator stripes cables during installation.

The strippability test is performed to measure the strippability force. The method includes taking of 3 testing samples from different points of a 3 meters cable. A 50 mm long piece of jacket is stripped from one end of each sample.



A sample in the strippability test.

The exposed cores are passed through a ring and fitted to the pulling test device. One jaw of the device pulls the cores while the other jaw pulls the ring where the jacket is attached, and the strippability test is performed. The test measures the force, depending on the time necessary to strip the cable.

Prysmian (type NHXMH / 052XZ1) cables can be easily stripped even from 500 mm. This provides the end users easier use and quicker installation.

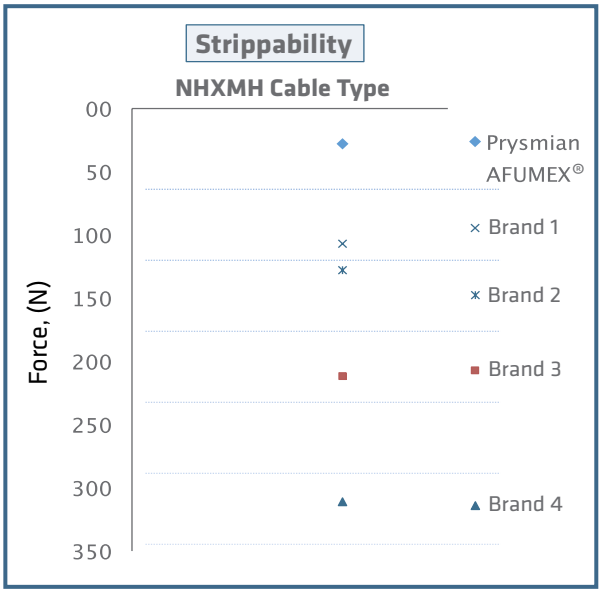


Table of comparison between samples taken from the market.

Easy stripping of cables saves time during installation.

E2 Slipperiness Test

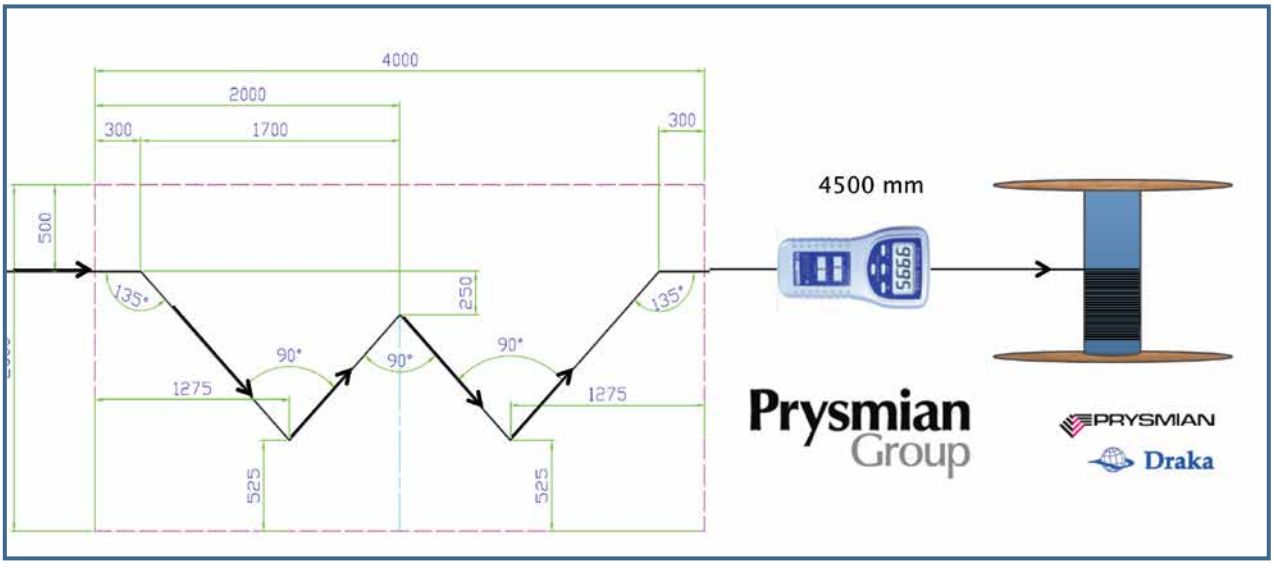
During installation of building wire cables, the cables are pushed through the trays. Products that can move easily in the ducts provide easy installation. Slipperiness test is performed to measure such effects.

Cables are installed by being pushed through the ducts.

The slipperiness test is a test developed by Prysmian, where the pulling force of a cable is measured within a testing apparatus having various W-shaped turning angles. The measured pulling force, which is quite high on the standard products, is significantly reduced in the special solutions developed by Prysmian.

Thus, end users are able to move the cable more easily through the ducts and provide economical advantage during installation.

Slippery cables can move through ducts even with small amount of force.



Slipperiness test simulation.

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