Analysis of determination of fire resistance limits of cable lines

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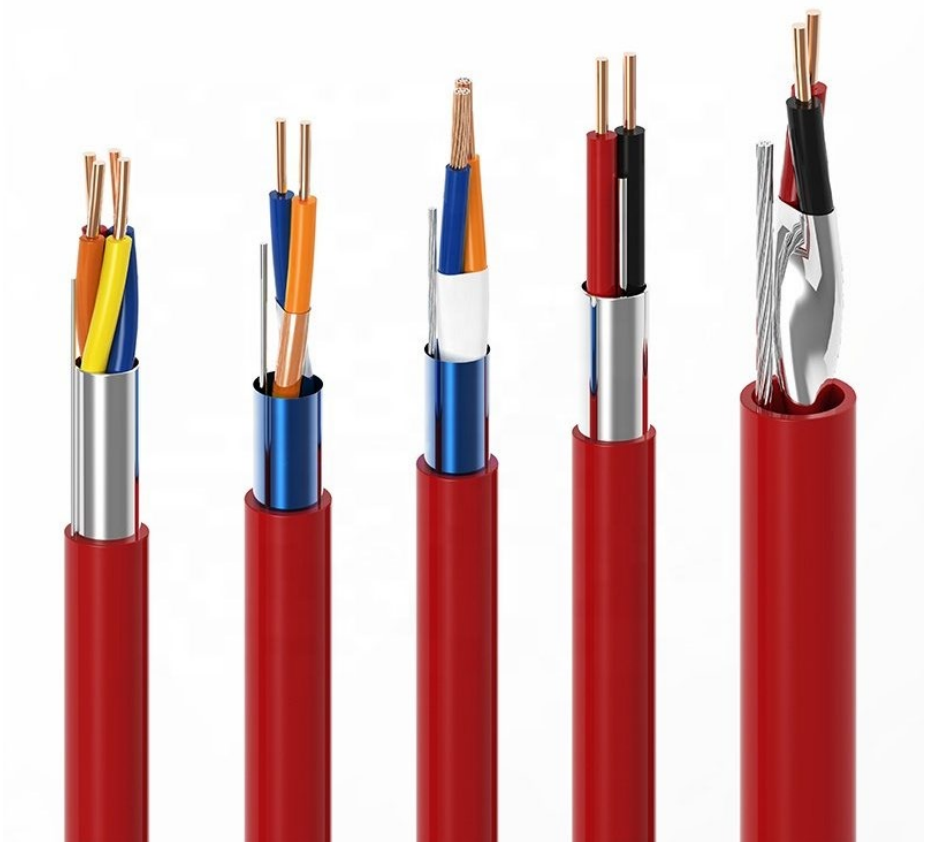
$147.5 billion — the total amount of damages caused to Ukraine's infrastructure due to the war, as of April 2023

The damages inflicted upon the education sector have increased by **$9.1 billion**, with educational institutions continuing to suffer from damages and destruction caused by the war. As of April 2023, the total number of damaged or destroyed educational facilities has reached **3,200**, including over **1,500** secondary schools, almost **1,000** kindergartens, and **538** higher education institutions.

Damages caused by damage to the energy infrastructure have also increased by **$200 million**, with the total damages now amounting to **$8.3 billion**.

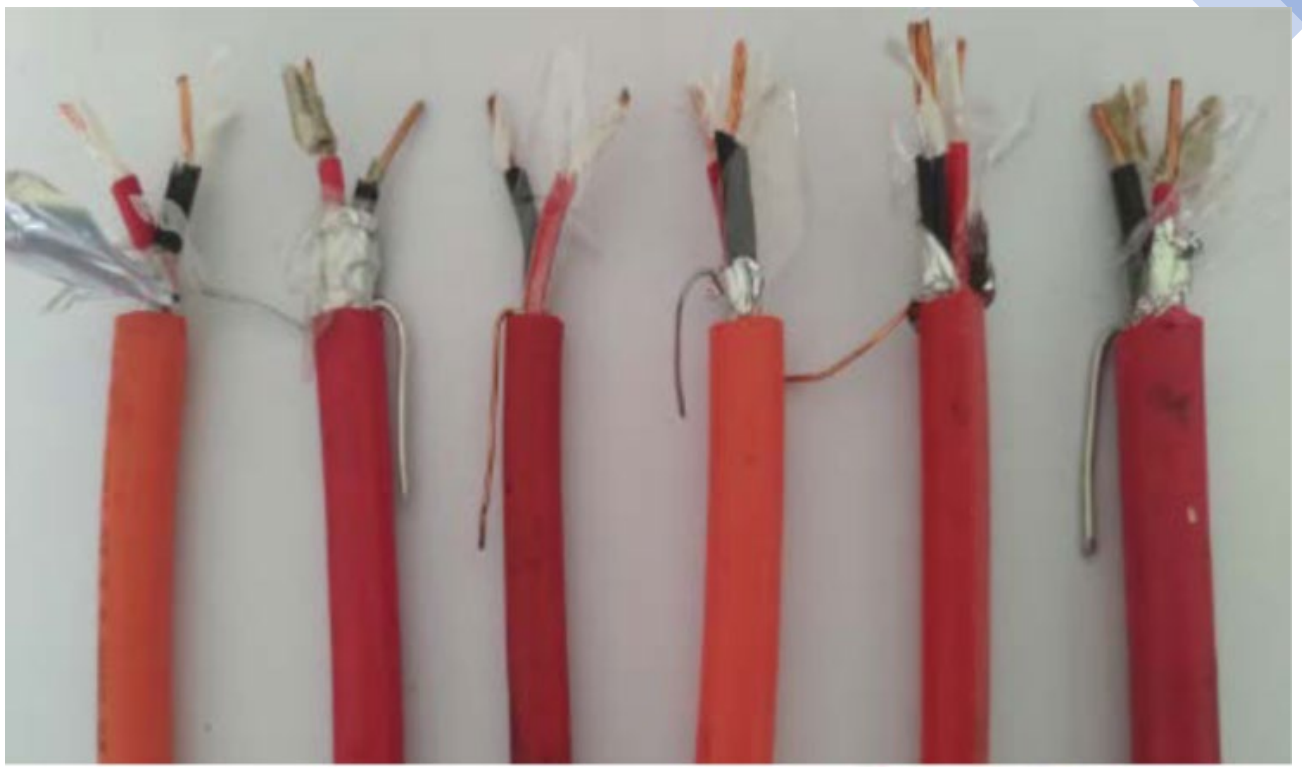
Property type	Damage, $ billion
Housing	54,4
Infrastructure	36,2
Assets of enterprises, industry	11,4
Education	9,1
Agriculture and land resources	8,9
Energy	8,3
Forests	4,5
Transport	3,1
Healthcare	2,7
Utilities	2,7
Trade	2,6
Culture, sport, tourism	2,2
Administrative buildings	0,5
Electronic communications	0,6
Social sphere	0,2
Financial sector	0,0
Demining	
Total	**147,5**

The purpose of the study is to analyze the limits of fire resistance of cable lines and establish their class according to the classification by fire resistance and temperature mode

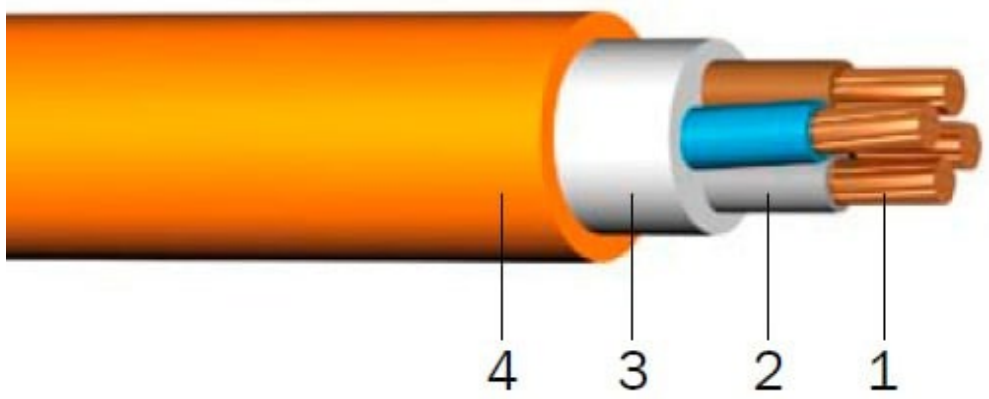


There are several types of fire alarm cables:

Unshielded Non-Plenum (UNP) Cable
Shielded Non-Plenum (SNP) Cable
Unshielded Plenum (UP) Cable
Shielded Plenum (SP) Cable
Fiber Optic Cable



Fire-Resistant cables with mica/glass tape construction



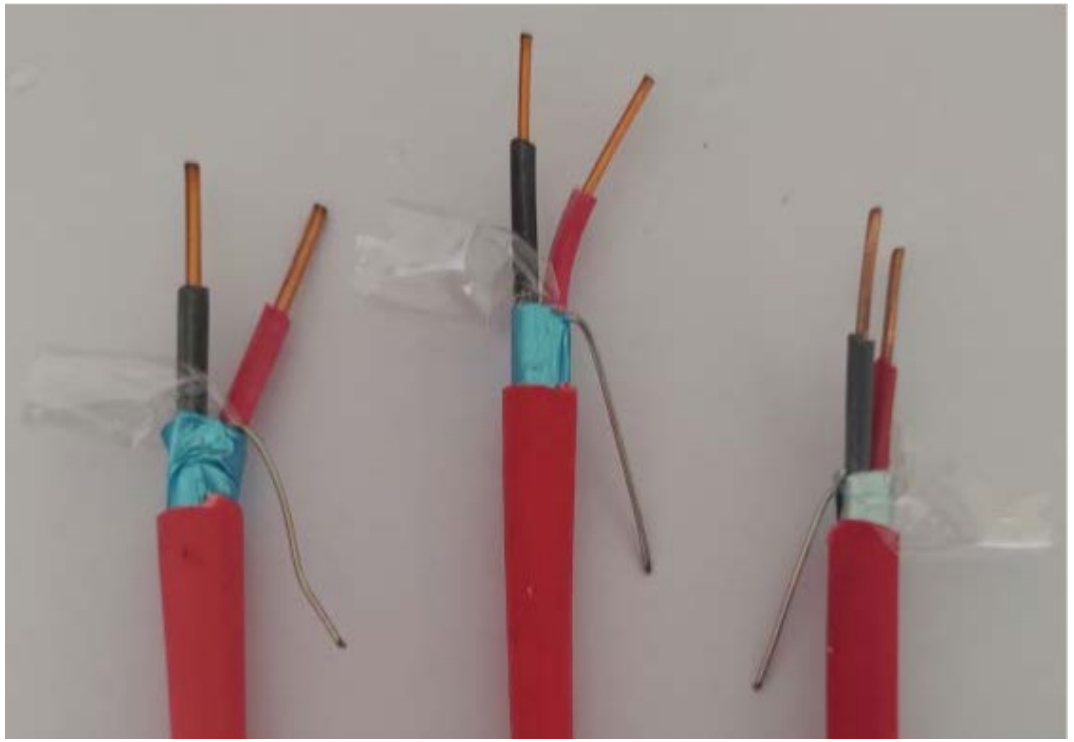
Cable design (N)HXH FE180/E30

1 - Copper conductor

2 - Silicone rubber insulation that ceramizes during fire.

3 - Halogen-free filling.

4 - Sheath made of a polymer composition that does not contain halogens.

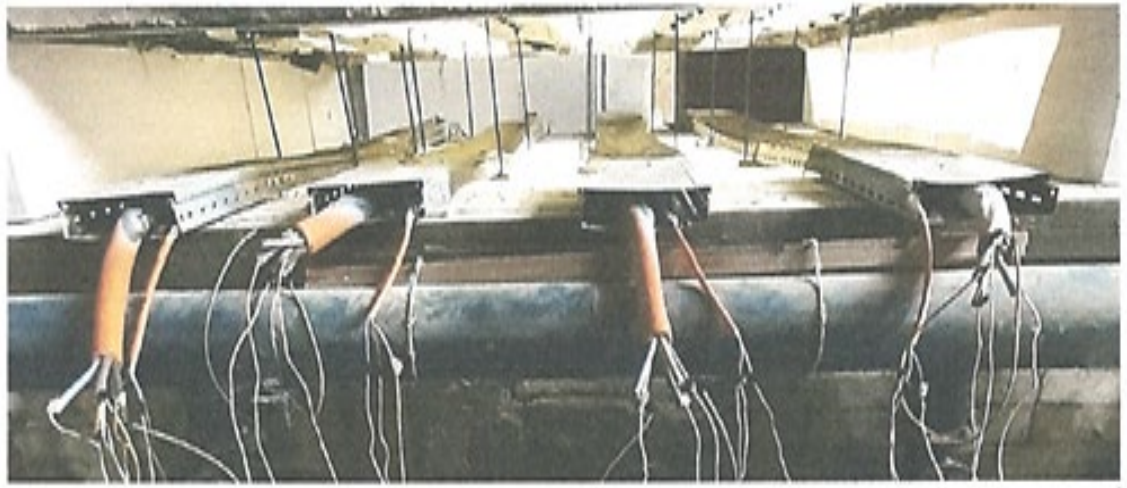


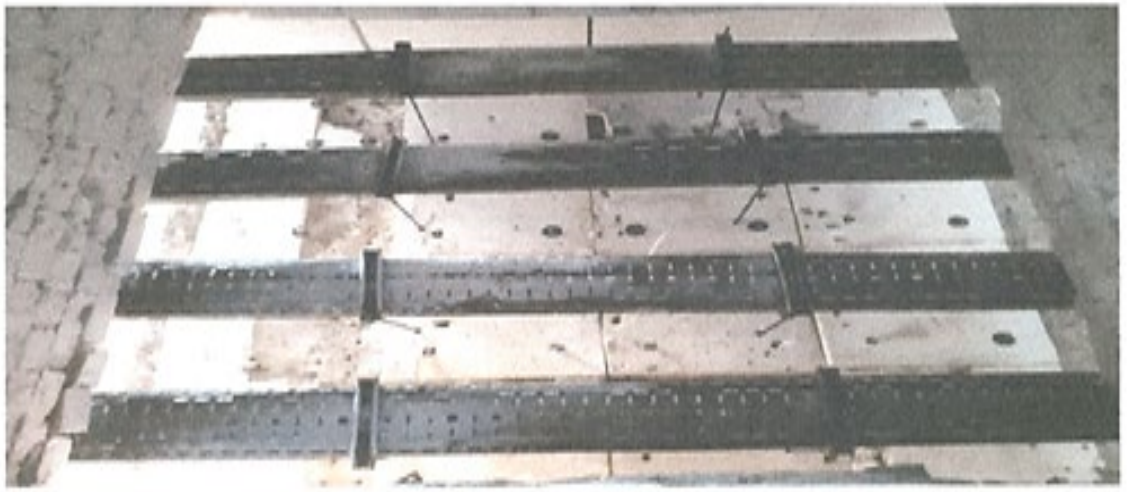
The construction of fire-resistant cables with silicone insulation

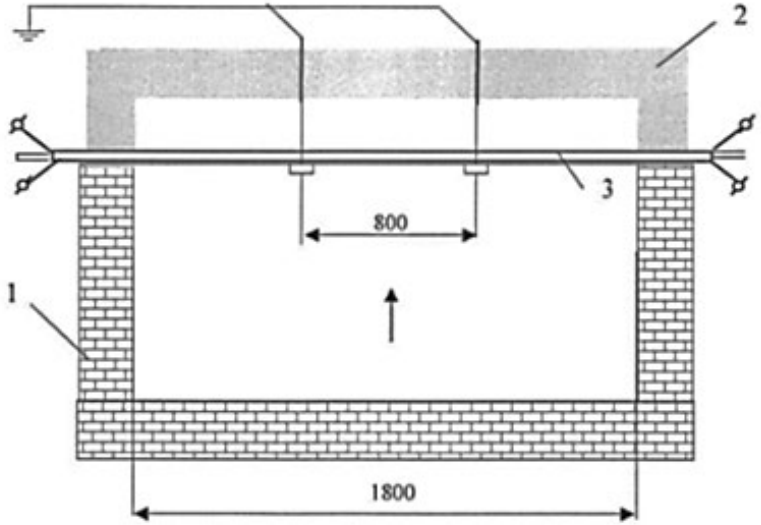
Test method standards for fire resistance tests on fire resistant cables

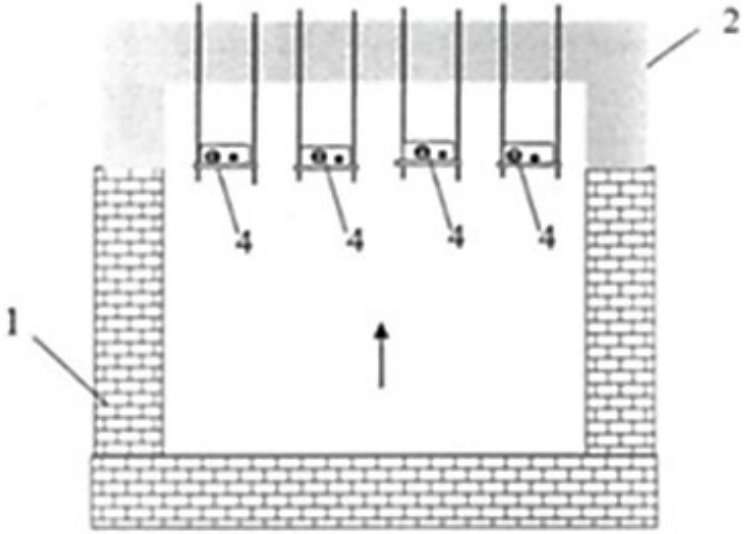
No	Name of the standard	Duration of the test
1.	IEC 60331-11-1999 & IEC 60331-21-1999 – Fire Alone at 750 °C, rated voltage up to 0.6/1 kV	90 minutes
2.	BS 6387-2013Category C – Resistance to fire alone test at 950 °C	180 minutes
3.	BS 6387-2013Category W – Resistance to Fire with Water at flame temperature of 650 °C	15 min – flame 15 min – flame and water
4.	BS 6387-2013Category Z – Resistance to fire with mechanical shock at 950 °C	15 min – flame and impact for every 30 secs
5.	IEC 60331-1 -2018 – Fire with shock at 830 °C for rated voltage of upto 0.6 / 1 kV & diameter exceeding 20 mm	30 min, 60 min, 90 min or 120 min- Impact of 20 secs at 5 min intervals
6.	IEC 60331-2 -2018 – Fire with shock at 830 °C for rated voltage of up to 0.6/1 kV & diameter not exceeding 20 mm	30 min, 60 min, 90 min or 120 min-flame, Impact of 20 secs at 5 min intervals
7.	IEC 60331-3 -2018 – Fire with shock at 830 °C for voltage up to 0.6/1 kV tested in a metal enclosure	30 min, 60 min, 90 min or 120 min- flame, Impact of 20 secs at 5 min intervals
8.	BS 8491-2008 – Assessment of fire integrity of large diameter power cables of safety systems – Fire, Water & Mechanical shock	30 min, 60 minor 120 min-flame, Impact of 20 secs at 10 minutes intervals, 5 mins before the end of the test, at least 5 bursts of water application of 5 secs at 60 secs intervals
9.	IS 17505 (Part-1)-2021Category F – Resistance to fire alone test at 950 °C	180 minutes
10.	IS 17505 (Part-1)-2021Category W – Resistance to Fire with Water at 650 °C	15 min – flame At least 5 bursts of water of 5 s duration at 60 seconds intervals
11.	IS 17505 (Part-1)-2021Category S – Flame and Shock application at 950 °C	15 min –flame Impact for 20 secs at 5 min intervals
12.	IS 17505 (Part-1)-2021Category F-30 F-60 F-120 Flame, Shock, and water jet application at 830 °C	30 mins, 60 mins, 120 mins – flame, the impact of 20 secs at 5 min intervals. 5 mins before the end of the test, at least 5 bursts of water application of 5 secs at 60 secs intervals
13.	BS EN 50200: 2015Annex E 30 minutes – Flame, Shock, and water jet application at 830°C	30 mins-flame, Impact every 5 minutes throughout the test, water spray for the final 15 minutes of the test
14.	BS EN 50200: 2015 PH 30 PH 60 PH 120 Flame and mechanical shock	30 mins, 60 mins, 120 mins - Flame, Impact at 5 every mins interval

THE MEASURING OF THE FIRE RESISTANCE LIMIT



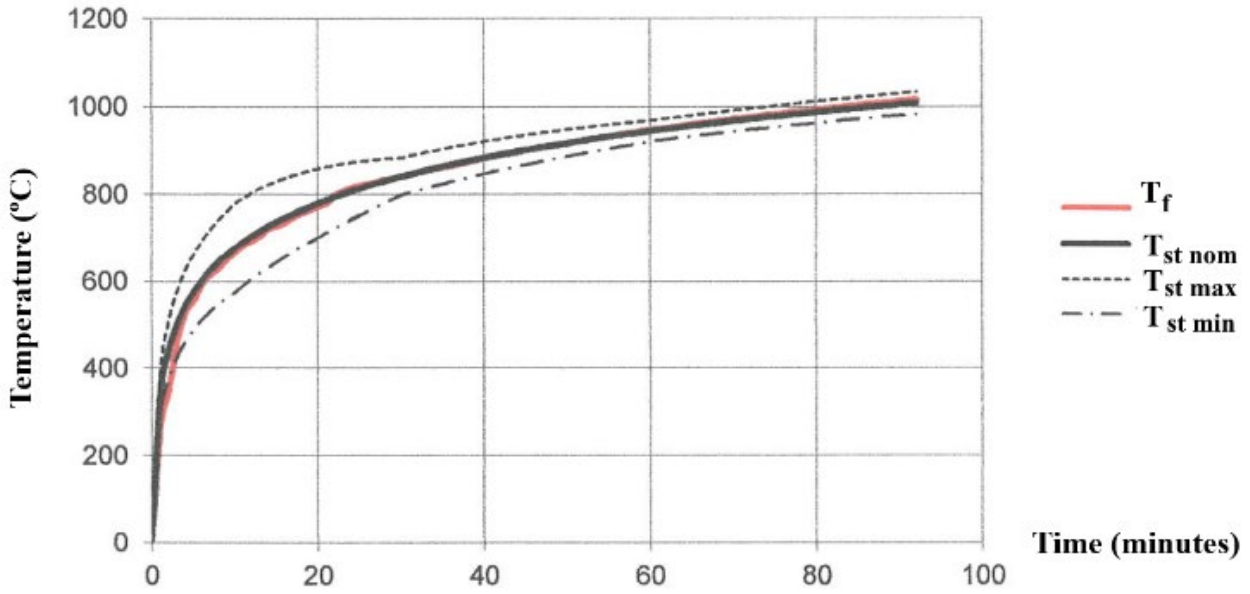






Layout of cable lines samples : 1 – furnace, 2 – furnace cover, 3 – trays, 4 – cable samples

THE MEASURING RESULTS



The test results showed that the cable line made of (N)HXH FE180/E30 3×1.5 cable laid in metal perforated cable trays has a fire resistance limit of at least 32 minutes. This corresponds to the fire resistance class P30

$$t_{fr} = t_{mes} - \Delta t,$$

where

t_{fr} is the limit of fire resistance, min;

t_{mes} is the smallest value of the time from the beginning of the test to reaching the limit state of fire resistance, which is determined by the results of two samples, min;

Δt – test error, min

$$\Delta t = (0{,}015 t_{mes} + 3)(A_s - A_f)/(A_s - A_{min})$$

where

A_s, A_f, A_{min} are integral values (areas under the curves) of the standard temperature, the average temperature in the furnace, and the minimum permissible temperature in the furnace, respectively, ºC×min.

If $A_f > A_s$, then $\Delta t = 0$

THANK YOU FOR YOUR ATTENTION!