

OPEN JOINT-STOCK COMPANY

VNIIKP

**ALL-RUSSIA
RESEARCH, DESIGN AND TECHNOLOGY INSTITUTE OF CABLE INDUSTRY**

APPROVED:
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**Minutes No.1/3-01-09
Cable Sample Research
to Assess Quality of Screen Copper Wire
(Final)**

Agreement PO—138 dated November 03, 2008 with ABB Moskabel Ltd

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Confidential information

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1. Short description of research object

The Client (ABB Moskabel Ltd.) has submitted 40 pieces of cross-linked polyethylene insulated cable over 1 meter long each, labeled NEXANS 2XS(FL)2Y-1x1200/265-127/220(245). Each sample had a factory shipping seal at the end. The samples were selected at the Client's production facilities. The selection procedure was conducted with participation of K.B. Dolzhansky, VNIKP representative, a research assistant of High Pressure Cables, Insulating Systems Study and Troubleshooting Lab (No. 1/3).

The labels of the drums providing the samples are specified in Table 1 below. Table 1 contains the testing results of the 21st sample. The testing results of the other 19 samples are specified in Minutes No. 1/3-05-08 submitted to the Client earlier.

2. Research objectives

Research objectives are to assess the quality of screen copper wire.

3. Methods used

Visual microscopy in reflected light, digital photomicrograph.

4. Equipment used

Stereomicroscope equipped with microphoto device MBS-10 (LZOS, Russia); laboratory microscope LABOVAL 4 (Carlzeiss Jena, Германия); micrometer eyepiece МОВ 1-16x (ЛОМО, Russia); set of optical test-objects ОМР GOST 7513 (ЛОМО, Russia); digital mirror photographic camera Fuji FinePix S3Pro, software package for direct input of digital photos into computer Hyper Utility 2 (Fuji Foto Film Co, Ltd, Japan).

5. Findings

Some screen copper wires have numerous undulations, scorings and wire edges of different shapes and sizes. The number of such wires, and the maximum number of the traced defects specified in Table 1 for the 21st sample. Typical images of different-sized wire edges are presented in Fig. 1-4.

The table contains data concerning the wires with the defect size not less than 0.2 mm.

Table 2 contains data concerning maximum defect size in terms of the number of defected wires of all inspected samples in the amount of 40 items.

Sample testing results

Table 1

Item No.	Labeling	Number of defected wires	Maximum edge length, mm	Notes
1	2	3	4	5
1	36RU10	10	3.5	Dross on one of the wires
2	36RU14	7	0.5	
3	36RU17	8	0.75	
4	36RU19	11	1.25	
5	36RU23		0.5	
6	38RU02	4	0.2	
7	38RU03	7	0.25	
8	38RU06	4	1.0	
9	38RU12	1	0.2	
10	38RU13	6	1.5	
11	38RU18	4	1	
12	38RU19	10	1.75	
13	38RU22	6	1.75	
14	38RU24	6	1.0	
15	38RU25	2	0.25	
16	38RU26	6	2	
17	38RU27	3	1.5	
18	38RU29	15	2	
19	38RU30	9	1.75	
20	38RU31	16	1.75	
21	38RU32	7	2.5	

Number of wires and maximum sizes of the defects traced

Number of defected wires in the cable sample	Number of wire samples with defected wires	Maximum defect size, mcm
Up to 10 pieces	26 samples	3000
10-19 pieces	11 samples	3500
20 pieces and over	3 samples	2250

6. Conclusions and recommendations

6.1. Defects of copper wires traced in the submitted samples are identical with those traced previously in terms of their appearance and the nature of damages inflicted on the cable (See Minutes No. 01-08 to Agreement No. PO-226 dated June 01, 2008 and No. 1/3-05-08 (intermediate) to Agreement No. PO-138 dated November 03, 20008).

6.2. There is no interrelation between the number of defected wires and the maximum defect size. This fact proves high probability degree of maximum sized defects occurrence in each sample.

6.3. All investigated samples have wire defects, which testifies to the fact that the reason of these defects existed during the manufacturing period of the submitted samples.

6.4. In accordance with the Russian technical regulations for copper wire applied for manufacturing of high-voltage cable “no scratches, humps, undulations, hollows resulting in diameter limit deviation exceedance are allowed on the surface”. The limit deviation for the wires with the given diameter is 0.02 mm (Cl. 1.2.2 and Cl. 1.2.6 TR 16-705.492-2005).

In the course of the previous research (See Minutes No. 01-08 to Agreement No. PO-226 dated June 01, 2008) it was found out that such defects may result in damages of the outward electroconductive core screen. In Expert’s opinion, it produces negative impact upon electric strength of the insulating system and increases the probability of its breakdown on application of the nominal voltage.

6.5. In view of the above-mentioned facts the quality of the screen copper wires of all the samples is deemed unsatisfactory.

6.6. It is strongly suggested the cable with the above-mentioned defects is not used for operations.

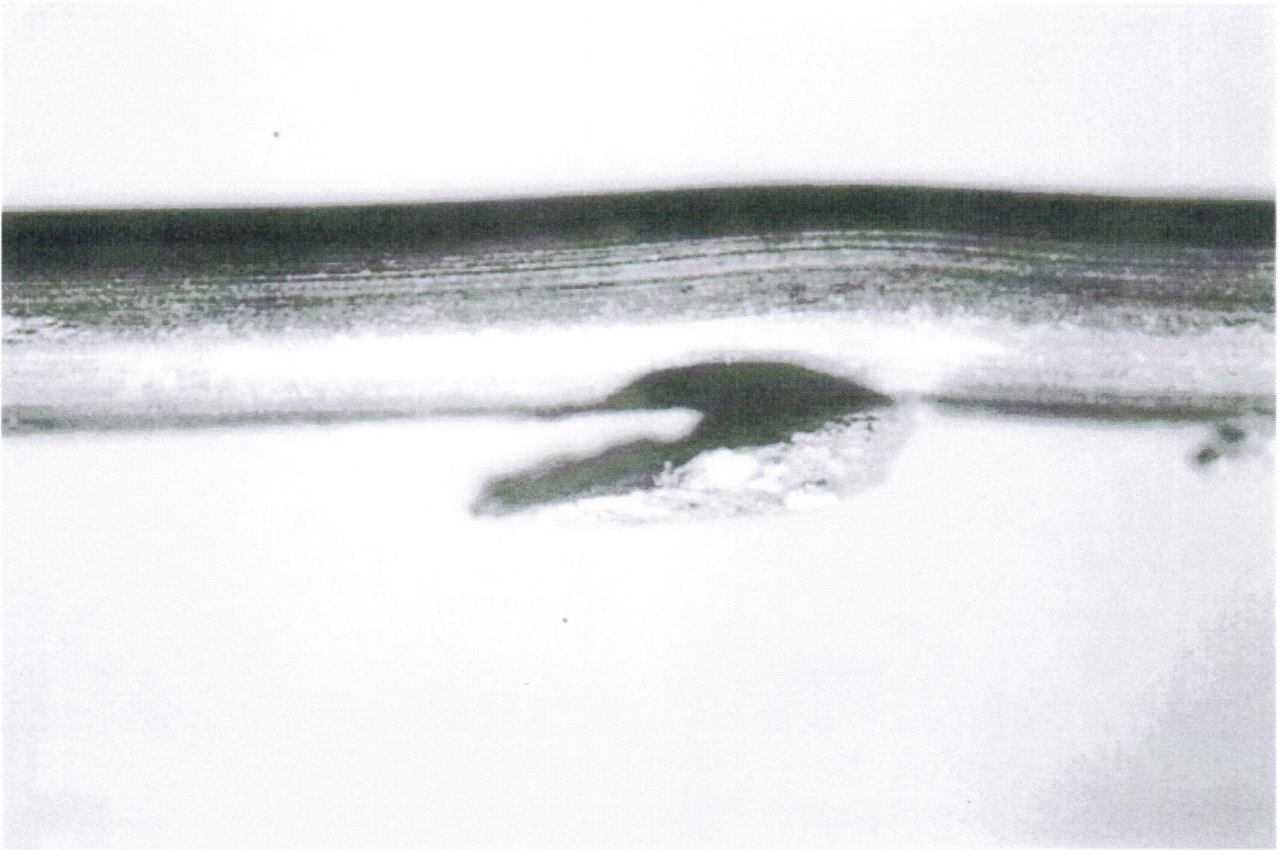


Fig.1.
Copper wire defects. Defect sizes are about 3.5 mm.



Fig.2.
Copper wire defects. Defect sizes are about 2.5 mm.

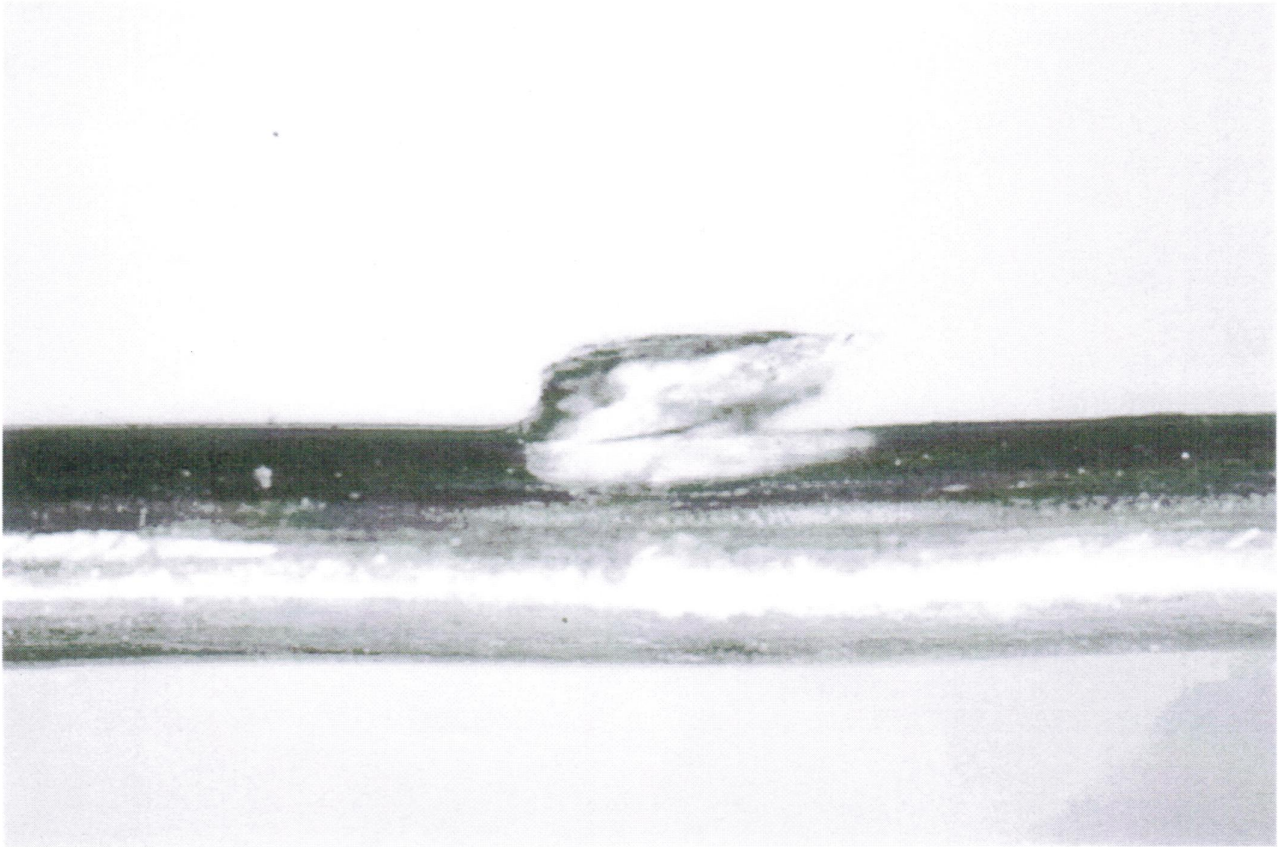


Fig. 3.
Copper wire defects. Defect sizes are about 2 mm.

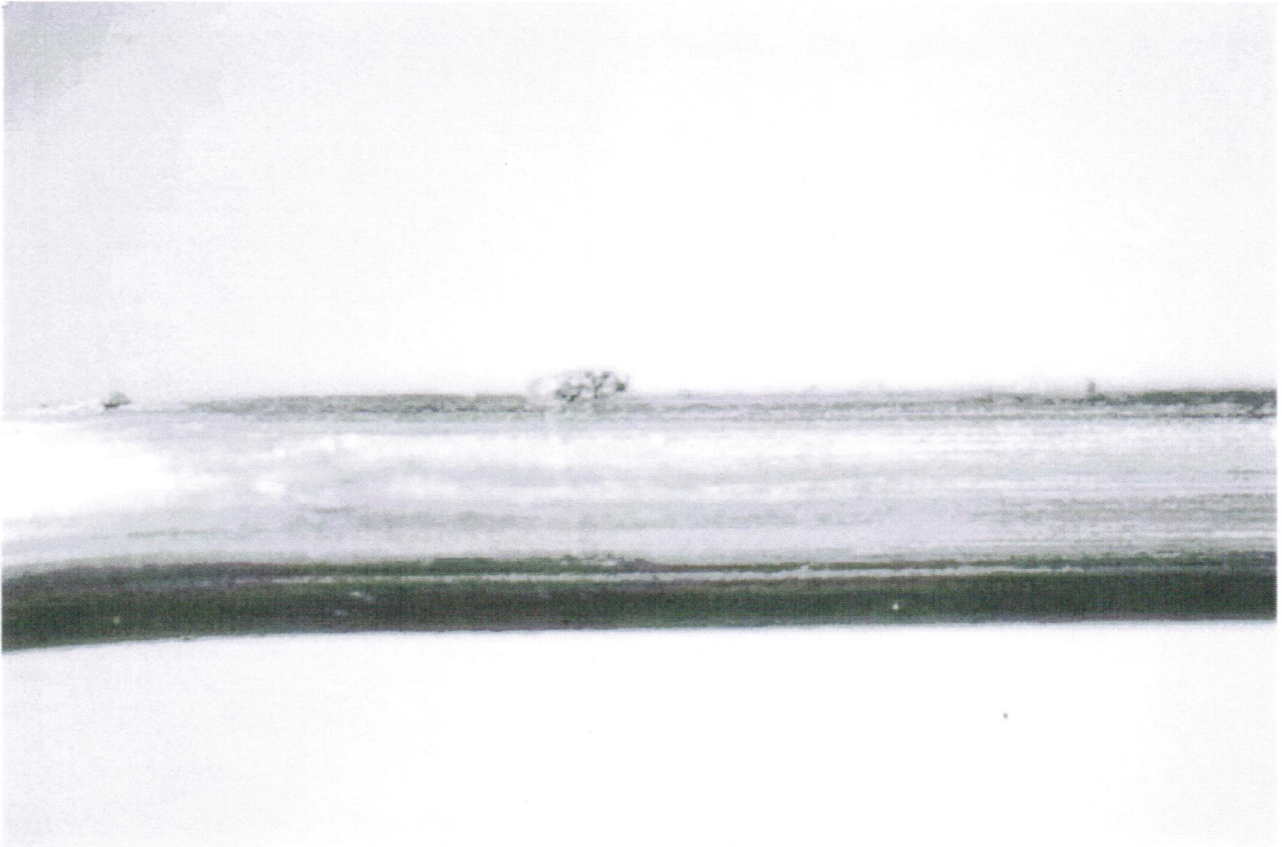


Fig. 4.
Copper wire defects. Defect height is about 0.2 mm