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**TESTING AND MEASURING EQUIPMENT/ALLOWED SUBCONTRACTING**  
**Power cables with extruded insulation and their accessories for rated voltages from 1kV**  
**(Um=1,2kV) up to 30kV (Um=36kV)**  
**Part 1: Cables for rated voltages of 1kV (Um=1,2kV) and 3kV (Um=3,6kV)**  
**IEC 60502-1 2.Edition (2004-04)**

R=Required by Lab

S=May be subcontracted

Clause	Measurement/testing	Testing / measuring equipment / material needed	Subcontracting
16	Sample tests		
16.4	Conductor examination	Vernier caliper or micrometer caliper	R
16.5	Measurement of thickness of insulation and of non-metallic sheaths(including extruded separation sheaths, but excluding inner extruded coverings)	Measuring microscope or profile projector of at least 10 x magnification.	R
16.6	Measurement of thickness of lead sheath		
16.6.1	Strip method	Micrometer with a plane faces of 4mm to 8mm diameter and an accuracy $\pm 0,01$ mm.	R
16.6.2	Ring method	Micrometer having either one flat nose and one ball nose, or one flat nose and a flat rectangular nose 0,8mm wide and 2,4mm long with an	R



		accuracy $\pm 0,01$ mm.	
16.7	Measurement of armour wires and tapes		
16.7.1	Measurement on wires	Micrometer having two flat noses to an accuracy of $\pm 0,01$ mm.	R
16.7.2	Measurement on tapes	Micrometer having two flat noses of approximately 5mm in diameter to an accuracy of $\pm 0,01$ mm.	R
16.8	Measurement of external diameter	Micrometer, profile projector, measuring tape, a direct reading diameter tape or similar apparatus.	R
16.9	Hot set test for EPR, HEPR and XLPE insulations and elastomeric sheaths	Oven with natural air flow or air flow by pressure, airflow rate: 8 ~ 20 completed air changes per hour; grips, weights, system for measurement of the elongation.	R
17	Type tests, electrical		
17.1	Insulation resistance measurement at ambient temperature	Water tank; thermometer; insulation resistance tester with DC source between 80 V and 500 V.	R
17.2	Insulation resistance measurement at maximum conductor temperature	Heated water tank, thermometer; insulation resistance tester with DC source between 80 V and 500 V.	R
17.3	Voltage test for 4h	High voltage power supply (AC 7200V); water tank.	R



17.4	Impulse test for cables of rated voltage 1,8/3(3,6)kV	Current heating system; thermocouple; impulse voltage generator (peak value 40 kV).	R
18	Type tests, non-electrical		
18.1	Measurement of thickness of insulation	Measuring microscope or profile projector of at least 10 x magnification.	R
18.2	Measurement of thickness of non-metallic sheaths (including extruded separation sheaths, but excluding inner coverings)	Measuring microscope or profile projector of at least 10 x magnification.	R
18.3	Test for determining the mechanical properties of insulation before and after ageing	Tensile machine and system for measurement of the elongation; equipment for punching dumb-bell test pieces and equipment for cutting or grinding the insulation to obtain 2 parallel surfaces; Optical measuring instrument / dial gauge; Oven with natural air flow or air flow by pressure, airflow rate: 8 ~ 20 completed air changes per hour.	R
18.4	Test for determining the mechanical properties of non-metallic sheaths before and after ageing	Tensile machine and system for measurement of the elongation; equipment for punching dumb-bell test pieces and equipment for cutting or grinding the insulation to obtain 2 parallel surfaces; Optical measuring instrument / dial gauge; Oven with natural air flow or air flow by pressure, airflow rate: 8 ~ 20 completed air changes per hour.	R
18.5	Additional ageing test on pieces of completed cables	Tensile machine and system for measurement of the elongation; equipment for punching dumb-bell test pieces and equipment for cutting or grinding the insulation to obtain 2 parallel surfaces; Optical	R



		measuring instrument / dial gauge; Oven with natural air flow or air flow by pressure, airflow rate: 8 ~ 20 completed air changes per hour.	
18.6	Loss of mass test on PVC sheath of type ST2	Oven with natural air flow or air flow by pressure, airflow rate: 8 ~ 20 completed air changes per hour; analytical balance with a sensitivity of 0,1mg; punching dies for dumb-bell test pieces; desiccator with silica gel or similar material.	R
18.7	Pressure test at high temperature on insulation and non-metallic sheaths	Indentation device consists of a rectangular blade with an edge $0,7 \pm 0,01$ mm wide, loads (weights) and supports; air oven; microscope or profile projector with two decimal places.	R
18.8	Test on PVC insulation and sheaths and halogen free sheaths at low temperatures		
	Bending test at low temperature	Suitable low temperature cabinet; cold bend test apparatus consisting essentially of a revolving mandrel and guiding devices for the test pieces; mandrels with different diameters.	R
	Elongation test at low temperature	Tensile machine with a cooling device or tensile machine installed in a cooling chamber; system for measurement of the elongation; equipment for cutting or grinding the sample and equipment for punching dumb-bell test pieces.	R
	Impact test at low temperature	Impact test apparatus; pad of sponge rubber about 40mm; suitable low temperature cabinet; hammers; caliper for measurement of the height of fall hammer.	R



18.9	Test for resistance of PVC insulation and sheaths to cracking (heat shock test)	Mandrel with different diameters; air oven	R
18.10	Ozone resistance test for EPR and HEPR insulations	Device for generating a controlled amount of ozone; a means for circulating ozonized air under controlled conditions of humidity and temperature through a chamber containing the test pieces to be tested; a means for determination of ozone concentration; suitable device for the clamping and elongation of test pieces; cylindrical mandrels consisting of wood or metal; desiccator filled with silica gel or equivalent material; accurate laboratory balance reading to 0,1mg.	S
18.11	Hot set test for EPR, HEPR and XLPE insulations and elastomeric sheaths	Oven with natural air flow or air flow by pressure, airflow rate: 8 ~ 20 completed air changes per hour; grips, weights; system for measurement of the elongation.	R
18.12	Oil immersion test for elastomeric sheaths	Tensile machine and system for measurement of the elongation; equipment for punching dumb-bell test pieces equipment for cutting or grinding the insulation to obtain 2 parallel surfaces; Oil no. 2 (IRM 902); heated oil bath.	R
18.13	Water absorption test on insulation	<p><b>a) Electrical test:</b> AC and d.c. voltage sources; voltmeter; water bath with heating equipment.</p> <p><b>b) Gravimetric water absorption test:</b> filter paper; air oven or low-pressure oven; a desiccator filled with silica gel or equivalent material; analytical balance with a sensitivity of 0,1mg; test mandrel with different diameter; glass vessel; preboiled distilled or deionized water; vacuum (residual pressure close to 1 mbar); glass tube with condenser or beaker covered with glass lid.</p>	R



18.14	Fire tests		
18.14.1	Flame spread test on single cables	Propane gas burner: 1 kW pre-mixed flame including system of confirmation of test flame;3-sided metallic screen 1200 mm high, 300 mm wide and 450 mm deep with open front and closed top and bottom; suitable timer; vernier caliper with an accuracy of 1mm;propane gas with prescribed purity.	R
18.14.2	Flame spread test on bunched cables	Vertical test chamber with width 1000mm,depth 2000mm height 4000mm; ladder; smoke cleaning attachment; one ribbon-type propane gas burner fitted with an accurate means of controlling the fuel and air input flow rates; suitable timer; graduate metal scale for measurement of the burning length.	S
18.14.3	Smoke emission test	Test enclosure with inside dimension of 3000mm and constructed of a suitable material fixed on to a steel angle frame and one side shall have a door with a glass inspection window and the other two opposite sides shall have transparent sealed windows; photometric system ( light source: halogen lamp with a tungsten filament with a clear quartz bulb; and receiver); standard fire source: 1,00litre± 0,01litre of alcohol; metal tray with bottom base 210mmx110mm,top base 240mmx140mm,height 80mm,thickness 1,0mm; draught screen; table-type fan with flow from 7 to 15m <sup>3</sup> /min;suitable timer.	S
18.14.4	Acid gas emission test	Tube furnace; fireproof tube made of silica; suitable thermocouple for temperature's control; combustion boats; two wash bottles containing at least 220ml of 0.1M sodium hydroxide for absorption of the gases ; air supply system; synthetic air or compressed air or ambient air.	S

18.14.5	pH and conductivity test	Tube furnace; fireproof tube made of silica; suitable thermocouple for temperature's control; combustion boats; two wash bottles containing distilled or demineralized water; air supply system; synthetic air or compressed air or ambient air; measuring instruments (analytical balance of an accuracy of $\pm 0,1$ mg; pH meter to an accuracy of $\pm 0.02$ , equipped with a suitable pH electrode; conductivity measuring device with a range of $10^{-2}$ $\mu$ s/mm and a suitable electrode; timer)	S
18.14.6	Fluorine content test	Oxygen flask; pipettes; volumetric flasks; fluoride ion electrode with suitable millivolt (method A); visible spectrophotometer ( method B); Reagents: a) Method A: electrode filling solution – buffer solution as recommended by electrode manufacturer. b) Method B: alizarin fluorine blue reagent – dissolve 2,5 g alizarin fluorine blue complex in 15ml 2–propanol plus 35 ml water. Filter before use. c) Standard fluoride solution prepared from sodium fluoride. d) Dodecanol. e) 0,5 M sodium hydroxide solution.	S
18.14.7	Toxicity test	under consideration	
18.15	Measurement of carbon black content of black PE oversheaths	Device consists of furnace, combustion boat about 75mm long, hard glass/silica / porcelain combustion tube with bore approximately 30mm and length $400 \pm 50$ mm, stopper carrying a thermometer and tube; desiccator; analytical balance with a sensitivity of 0,1mg; Nitrogen; air or oxygen. Thermogravimetric analysis as an alternative test method.	S



18.16	Shrinkage test for XLPE insulation	Vernier caliper; air oven; support or talc bath.	R
18.17	Special bending test	Test cylinder with different diameter; air oven; AC voltage source (3.5kV).	R
18.18	Determination of hardness of HEPR insulation	Test instrument for measuring hardness; Groove or metal jig; V-blocks.	R
18.19	Determination of the elastic modulus of HEPR insulation	Tensile machine; equipment for punching dumb-bell test pieces and equipment for cutting or grinding the insulation to obtain 2 parallel surfaces; optical measuring instrument / dial gauge.	R
18.20	Shrinkage test for PE oversheaths	Vernier caliper; air oven; support or talc bath.	R
18.21	Additional mechanical tests on halogen free oversheaths	Under consideration	R
18.22	Water absorption test for halogen free oversheaths	Filter paper; air oven or low-pressure oven; a desiccator filled with silica gel or equivalent material; analytical balance with a sensitivity of 0,1mg; test mandrel with different diameter; glass vessel; preboiled distilled or deionized water; vacuum (residual pressure close to 1 mbar); glass tube with condenser or beaker covered with glass lid.	R

Note: The presence of equipment alone does not indicate a satisfactory situation. Assessors must evaluate the equipment design, calibration, uncertainty and documentation to ensure compliance with the directions of the standard. The requirements of ISO/IEC 17025 regarding validation are applicable, as the tests of this standard are not standardised tests.