Cable qualification at NPPs: Certification and diagnostics

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FSUE “RISI” as the test centre for the State Corporation “Rosatom”

- Provides technical support to Rosenergoatom Concern OJSC
  - Diagnostics and state monitoring
    - Electric equipment (EE)
    - Power and instrumentation cables
  - Development and implementation of residual life management programs
  - EE and cable qualification tests for NPPs
Cable qualification at NPPs

- Assessment of cable technical state at NPPs is carried out on the basis of:
  - Results of typical certification tests
  - In-service technical diagnostics of representative cables

- The main technical document «Assessment of the technical condition and ageing management of cables in nuclear power stations»

ПО 1.2.1.02.999.0184-2013

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Rosenergoatom basic technical documents for cable residual life management (RLM)

- МР 1.2.1.13.1037-2015. “Diagnostics of technical state and residual life time of I&CS cables important for safety at NPPs
- МР 1.2.1.13.0018-2011. “Guidelines on diagnostics of defects in instrumentation cables at nuclear plants”
- ТПРГ 1.2.6.9.0072-2011. “Generic program for cable lines diagnostics at nuclear plants. Requirements and guidance on development and implementation”
- МР 1.2.02.0168-2013. “Diagnostics of technical state of power cables with impregnated paper insulation at nuclear plants”
- МР 1.2.1.13.1005-2015. “Overall diagnostics of technical state of power cables 6-10 kV with cross-linked polyethylene insulation”
Utilization of international experience

- IAEA-TECDOC-1188. Assessment and management of ageing of major nuclear power plant components important to safety: In-containment instrumentation and control cables, Volume 1-2, ISSN 1011-4289. – Vienna: IAEA, 2000
Implementation of measures on cables qualification

• Implementation of programs
  – diagnostic programs (a general program of the Concern and private NPP’s programs)
  – ageing management programs (AMP) of NPP’s elements
  – maintenance programs
• Doers
  – electrical and I&C workshops staff
  – technical support organizations’ staff
Main residual life characteristics of cables

- Service life (warranty, specified, certified, rated)
- (Technical) state indicators
- Initial and limiting values of the condition indicators
- Ageing curve (ageing model)
- Resistance to the design-basis external influencing factors (EIFs)

Cable RLM activities objective is to identify and periodically update the main residual life characteristics
Basic elements of cable RLM activities at NPPs

- Determination of cable resistance to design-basis external influencing factors (EIFs) and harsh environment conditions of operation ("hot spots")
- Identification of prevailing ageing mechanisms and effects
- Implementation of measures aimed at reduction of EIF strength
- Execution of diagnostics (monitoring) of technical state and regular assessment of residual life
- Development and implementation of new non-destructive methods for diagnostics (monitoring)
- Comparison of costs of cable removal from service with their replacement with costs of routine certification
- Well-timed replacement of cables with limiting state reached at power units
- etc.
Basic elements of cable RLM activities at NPPs (cont’d)

1. Cable ageing mechanism knowledge (the key to residual life management)
   - Insulating materials and their properties
   - Operating conditions
   - Main ageing mechanisms
   - Localization of operating “hot spots”
   - Specific condition indicators
   - Ageing impact on functional parameters
   - Operating experience
   - Results of scientific studies

2. Coordination of the activities as part of cable residual life management
   - Maintenance optimization
   - Operating experience transfer
   - Research & Development
   - Technical support
   - Requirements to reliable operation under impact of design-basis EIFs and “hot spot” operating conditions

3. In-service management of ageing mechanisms
   - Operating condition monitoring
     (temperature, radiation humidity, etc.)
   - Adjustments to compensate steam leaks, water leaks, etc.
   - Maintenance of ventilation, thermo-insulation, etc. systems
   - Reduction of operating “hot spots”

4. Cable state diagnostics and monitoring (detection and assessment of ageing effects)
   - Visual examination
   - Standard tests
   - ND diagnostics and state monitoring of representative cables
   - Assessments and comparison with certification test results

5. Operability maintaining
   - Cable certification in line with modern requirements
   - Alteration of cable routes
   - Searching and elimination of defects along routes
   - Replacement of aged cables
   - Witness cable laying

Tests

Planning

Mitigation of ageing effects

Preventing measures

Technical measures applied to cables

Determination of feasibility, term and conditions of further operation

Technical condition monitoring

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Cable qualification methodology for NPPs

• The main goal of qualification is to provide sound evidences of cable operability under impacts of external influencing factors (EIFs) in operation during a specified service life
  – First stage – performance of certification tests for new cable types on resistance to EIFs under both normal operation and design basis accident conditions, in order to define a certified service life
  – Second stage – ongoing qualification of cables in service at a nuclear power unit. The ongoing qualification goal is to extend the certified service life to a new time period, on the basis of operating experience analysis and conduction of periodical diagnostics (monitoring) of representative cables
• An alternative for the ongoing qualification would be:
  – cable replacement, or
  – repeated conduction of generic certification tests
Generic certification tests for defined operating conditions

• In course of typical qualification tests, cable degradation is artificially simulated:
  – for normal operating conditions (as per design) during the specified service life;
  – under impact of damaging factors for design basis accidents;
  – under impact of post-accident environment

• It is recommended to plan and perform the generic qualification tests for several time periods in parallel (e.g. for 25, 30, 35, 40 years)
Tests for resistance to design basis accidents

- under development of new elements
- under lifetime extension of nuclear units

<table>
<thead>
<tr>
<th>Accident parameter</th>
<th>HELB</th>
<th>LOCA</th>
<th>Loss of heat removal from a containment</th>
<th>Minor break</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature, °C</td>
<td>104</td>
<td>to 150</td>
<td>30 to 75</td>
<td>to 90</td>
</tr>
<tr>
<td>Pressure, kgf/cm²</td>
<td>1,2</td>
<td>to 5,0</td>
<td>от 0,05 до 0,12</td>
<td>to 0,17</td>
</tr>
<tr>
<td>Humidity, %</td>
<td>100</td>
<td>steam-air mixing</td>
<td>to 100</td>
<td>steam-air mixing</td>
</tr>
<tr>
<td>Activity, Bq/m³</td>
<td>-</td>
<td>to 9,3⋅10¹³</td>
<td>7,4⋅10⁷</td>
<td>to 5,5⋅10⁹</td>
</tr>
<tr>
<td>Absorbed dose rate, Gy/h</td>
<td>-</td>
<td>to 10³</td>
<td>to 1,0</td>
<td>to 1,0</td>
</tr>
<tr>
<td>Mode duration, h</td>
<td>to 1</td>
<td>to 10</td>
<td>to 15</td>
<td>to 15</td>
</tr>
<tr>
<td>Post-accident temperature, °C</td>
<td>15 – 50</td>
<td>20 – 60</td>
<td>20 to 60</td>
<td></td>
</tr>
<tr>
<td>Post-accident pressure, kgf/cm²</td>
<td>-</td>
<td>0,51 – 1,22</td>
<td>0,05 to 0,12</td>
<td></td>
</tr>
<tr>
<td>Post-accident conditions duration</td>
<td>-</td>
<td>to 30 days</td>
<td>to 15 hours</td>
<td>to 5 hours</td>
</tr>
<tr>
<td>Frequency of occurrence</td>
<td>once within a lifetime</td>
<td>once within a lifetime</td>
<td>once a year</td>
<td>twice a year</td>
</tr>
</tbody>
</table>

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## Traditional technical parameters of cables and associated acceptance criteria

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cable type</th>
<th>Acceptance criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameter</strong></td>
<td><strong>Cable type</strong></td>
<td><strong>Acceptance criteria</strong></td>
</tr>
<tr>
<td><strong>Ultimate elongation</strong></td>
<td>All types</td>
<td>Shall meet specification requirements &gt;50% of absolute value 1 &gt;50% of absolute value</td>
</tr>
<tr>
<td><strong>Flexural resilience test изгибе</strong></td>
<td>All types</td>
<td>No insulation cracks No insulation cracks No insulation cracks</td>
</tr>
<tr>
<td><strong>Dielectric strength test</strong></td>
<td>All types</td>
<td>Test passed successfully Test passed successfully Test passed successfully</td>
</tr>
<tr>
<td><strong>Insulation resistance</strong></td>
<td>All types</td>
<td>Shall meet specification requirements or design documentation Shall meet specification requirements reduced by an order of magnitude, or design documentation Shall meet specification requirements reduced by four orders of magnitude. The cable shall continue to perform its functions</td>
</tr>
<tr>
<td><strong>Electric capacity</strong></td>
<td>Communication cables</td>
<td>No changes No changes No changes</td>
</tr>
<tr>
<td><strong>Attenuation coefficient, Characteristic impedance, Interference elimination Signal propagation</strong></td>
<td>Coaxial</td>
<td>No changes associated with technical characteristics No changes associated with technical characteristics No changes associated with technical characteristics 2</td>
</tr>
<tr>
<td><strong>Another parameter</strong></td>
<td></td>
<td>Depends on specificity of the cable application (e.g. absence of liquid or steam in the cable during tests with design basis accident simulation)</td>
</tr>
<tr>
<td>Notes</td>
<td></td>
<td>1 For some cables, a value less than 50% of absolute length may be applied 2 Only those changes are acceptable which are provided for by the NPP design or a relevant standard, like attenuation coefficient increase due to temperature elevation.</td>
</tr>
</tbody>
</table>
# Certification test plan (minor leakage + LOCA)

<table>
<thead>
<tr>
<th>Order</th>
<th>Test stages</th>
<th>Thermal-induced ageing</th>
<th>Radiative-induced ageing</th>
<th>Measurements prior to steam test</th>
<th>“Small leak” mode (0.5-N cycles × 5 h) (115±2)°C; 0.170 MPa</th>
<th>“Large leak” mode (1 cycle × 24 h) (150±2)°C; 0.5 MPa</th>
<th>Measurements after steam test</th>
<th>Radiation-induced ageing</th>
<th>Holding in decontaminating solution 7 days under 60 °C and pressure 0.1 MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Holding in decontaminating solution 7 days under 60 °C and pressure 0.1 MPa</td>
</tr>
</tbody>
</table>

- **Operations**
  - **Equipment check**
  - **Visual examination**
  - **Insulation resistance measurement**
  - **EAB measurement**
  - **CI measurement**

**Stages of generic tests of in-containment cables and thermodynamic profiles of temperature and pressure in accident conditions, for VVER-1000 model 320 design (here \( N \) is a specified service life for cables, in years)**

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# Certification test plan (HELB)

<table>
<thead>
<tr>
<th>Order</th>
<th>Test stages</th>
<th>Thermal-induced ageing</th>
<th>Measurements before steam test</th>
<th>Measurements after steam test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>T, °C</td>
<td>P, MPa</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0,5 h</td>
</tr>
<tr>
<td>Operation</td>
<td>before</td>
<td>after</td>
<td>before</td>
<td>after</td>
</tr>
<tr>
<td>Equipment check</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual examination</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Insulation resistance measurement</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Functional test</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Measurement with intender (for cables)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EAB measurement (for cables)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HELB, 1 hour; (104 ± 2) °C; 0,12 MPa**
Tests for resistance to high-temperature air-steam mixing: cable samples from Balakovo and Kozloduy NPPs

РМ3 образца кабеля КВВГЭ 4×2.5 во время воздействия высокотемпературной парогазовой смеси. Образец изъят с первого блока после 25-летней эксплуатации

РМ3 образца кабеля КВВГЭнг 4×1,5 во время воздействия высокотемпературной парогазовой смеси. Образец был изъят с первого блока после 25-летней эксплуатации и дополнительно состарен на 10-летний дополнительный срок службы

РМ3 образца кабеля КУГВЭВнг 24×0,35 во время воздействия высокотемпературной парогазовой смеси. Образец изъят с первого блока после 25-летней эксплуатации

РМ3 образца кабеля КУГВЭЭнг 24×0,35 во время воздействия высокотемпературной парогазовой смеси. Образец был изъят с первого блока после 25-летней эксплуатации и дополнительно состарен на 10-летний дополнительный срок службы
Tests for resistance to high-temperature air-steam mixing: cable samples from Balakovo and Kozloduy NPPs (cont.)

R_{ИЗ} образца кабеля КПЭТИ 7Х2Х0,35 во время воздействия высокотемпературной парогазовой смеси. Образец изъят после 25-летней эксплуатации

R_{ИЗ} образца кабеля КПЭТИ 7Х2Х0,35 после предварительного старения на 10 лет эксплуатации. Образец изъят после 25-летней эксплуатации

R_{ИЗ} образца кабеля КПоБОВ14х2,5 во время воздействия высокотемпературной парогазовой смеси. Образец изъят после 18-летней эксплуатации с признаками предельного состояния по показателю ТНО
Operability assessment. Condition indicators
Selection of test parameters and specimens

- 3 to 5 specimens not longer than 3 m and additional short specimens for measurements of mechanical properties
- \[ t_{\text{test-1.}} = t_{\text{exp.}} \cdot \exp\left[\frac{E_a}{k} \cdot (1/T_{\text{test-1.}} - 1/T_{\text{exp.}})\right] \] – the thermal-induced ageing time (estimation as per Arrhenius law)
- Problems with determination of \( E_a \)
- \[ t_{\text{test-2.}} = \frac{D_{\text{exp.}} + D_{\text{accid-2}}}{P_{\text{test.}}} \] – the radiation-induced ageing time, \( P \leq 500 \text{ Gy/h} \) (\( P \leq 100 \text{ Gy/h} \) in case of existence of a synergetic effect)
Conservatism and uncertainties in generic tests

• In the accelerated tests it is impossible to apply an ageing mechanism in full scale due to high intensity of the influencing factors
• The main cause of the conservatism introduced is application of the Arrhenius model
• Simulation of multifactor ageing in the accelerated tests (separate / simultaneous impact / sequence of impacts)
• Addressing other EIFs, including the ones not included in the design basis
• Errors of EIF strength simulation associated with the testing equipment. Typical tolerances are:
  ▪ maximum temperature:  +8 °C
  ▪ maximum pressure:  ±10% of sensor readings
  ▪ absorbed dose:  ±15% of dosimeter readings
  ▪ power source voltage:  ±10% of voltage readings
Principal RLM activities for cables in service

• Cable service condition monitoring
• Identification of representative cables and identification of cable routes in harsh operating environment (“hot spots”)
  ❑ The cables which are comprehensively characterize the ageing of cables of a certain type, with the same conditions of their installation, the same external factors influencing over all parts of cable routes, and the same operating modes
• Diagnostics (monitoring) of conditions of the representative cables on the basis of condition indicators, including specimens of witness cables
• Implementation of measures aimed at reduction of EIF strength
• Cable repairing and replacement as per schedule

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Assessment of current certified status of cables

- The EQ1 cables are those with certified service life $T_{eq}$ not less than the additional operating life $T_{newpr}$ for the power unit plus residual operating life as per design $T_{respr}$: $T_{eq} \geq T_{newpr} + T_{respr}$

- The EQ2 cables are those with $T_{eq}$ less than $T_{newpr} + T_{respr}$, but not less than the current operating life $T_{cur}$ for the power unit

- The EQ3 cables are those with $T_{eq} \leq T_{cur}$

- The EQ4 cables are those with unconfirmed certification status

  - Cables can be transferred to another class (e.g. from EQ4 to EQ1 class) provided that positive results are obtained in generic certification tests or their certified status is confirmed by documents
Technical examination of cable routes

- Visual and tactile examination
- Thermovision monitoring
- Questioning the personnel
- Review of operating documentation

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Temperature and radiation monitoring

- were used: 1) assembly of 2 thermoluminescent dosimeter; 2) analysis of data from standard sensors
- actual radiation level did not exceed design basis level
Non-destructive diagnostic methods

• Can be arbitrarily divided onto two groups
  – The methods allowing to evaluate the extent of insulation ageing due to their high sensitivity (*determination of antioxidant and stabilizer concentrations, measurements of recovery voltage, isothermal relaxation current, \( \text{tg}\delta \) in the range 0.001 to 1000 Hz, …)
  – The methods which does not provide a high sensitivity to ageing, but allow to locate (preliminary determine the location) the defects already developed along the cable routes (*time-based reflectometry, partial discharge reflectometry, bridge methods*, …)
## Methods of diagnostics

<table>
<thead>
<tr>
<th>Method</th>
<th>Condition monitoring and service life determination</th>
<th>Defects localization over the route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultimate elongation measuring for cable insulation materials</td>
<td>Yes, main destructive method</td>
<td>No</td>
</tr>
<tr>
<td>Measurement of insulation resistance $R_{in}$ and absorbing properties $K_a$ and $PI$</td>
<td>Yes, low sensitivity</td>
<td>No</td>
</tr>
<tr>
<td>Detection of gel fraction</td>
<td>Yes, ageing monitoring through counting the number of joinings</td>
<td>No</td>
</tr>
<tr>
<td>Density measurement</td>
<td>Yes, ageing monitoring by density value</td>
<td>No</td>
</tr>
<tr>
<td>Nuclear magnetic resonance (NMR)</td>
<td>Yes, ageing monitoring by NMR relaxation time length</td>
<td>No</td>
</tr>
<tr>
<td>OTO determining by DSC (differential scanning calorimetry)</td>
<td>Yes, by OTO (onset temperature of oxidation)</td>
<td>No</td>
</tr>
<tr>
<td>Determining of induction time (IT) by DSC method</td>
<td>Yes, by induction time</td>
<td>No</td>
</tr>
<tr>
<td>Measuring by cable indenter</td>
<td>Yes, by stiffness ratio</td>
<td>No</td>
</tr>
<tr>
<td>IR Fourier spectroscopy of insulation micro-samples</td>
<td>Yes, by characteristic absorption bands</td>
<td>No</td>
</tr>
<tr>
<td>Measuring of specific heat of fusion by DSC method for micro-samples of $\geq 4$ mg mass</td>
<td>Yes, for PTFE insulation</td>
<td>No</td>
</tr>
<tr>
<td>Thermal gravimetric analysis (TGA)</td>
<td>Yes, by mass loss</td>
<td>No</td>
</tr>
<tr>
<td>Frequency dielectric spectroscopy (FDS)</td>
<td>Yes, by dielectric losses in wide frequency range</td>
<td>No</td>
</tr>
<tr>
<td>Measuring of recovered (return) voltage in power cables</td>
<td>Yes, by recovered voltage parameters</td>
<td>No</td>
</tr>
<tr>
<td>Method of isometric relaxation current measurement (IRC-analysis), i.e. discharge current measurement method</td>
<td>Yes, by relaxation curve parameters</td>
<td>No</td>
</tr>
</tbody>
</table>
## Methods of diagnostics (cont’d)

<table>
<thead>
<tr>
<th>Method</th>
<th>Condition monitoring and service life determination</th>
<th>Defects localization over the route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional method of partial discharges (PD) recording</td>
<td>Yes, by PD parameters in power cable insulation</td>
<td>No</td>
</tr>
<tr>
<td>Method of PD recording at damping oscillating voltage (OWTS-method)</td>
<td>Yes, by PD parameters in power cable insulation</td>
<td>Yes</td>
</tr>
<tr>
<td>Reflectometry (time-based, time-based with reference voltage source, wavelet)</td>
<td>Yes, low sensitivity to insulation ageing</td>
<td>Yes</td>
</tr>
<tr>
<td>Bridge methods</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Topographic methods (induction, capacity, potential methods)</td>
<td>No</td>
<td>Yes, precise positioning</td>
</tr>
<tr>
<td>Thermovision monitoring</td>
<td>No</td>
<td>Yes, depending on availability of visual access to route</td>
</tr>
<tr>
<td>Frequency reflectometry. Resonance alternating method of standing waves (LIRA - Line Resonance Analysis)</td>
<td>Yes, sensitivity is better than for time-based reflectrometry</td>
<td>Yes</td>
</tr>
<tr>
<td>Joint (simultaneous) time-and-frequency reflectometry</td>
<td>Yes, sensitivity is better than for time-based reflectrometry</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Traditional methods of electrical insulation ageing estimation. Measurement by cable indenter

\[ \tau_{\text{service life}} = \tau_0 \cdot \frac{M_{\text{Pr}} - M(\delta)^{0.95}}{M(\delta)^{0.95} - M_0} \]

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Traditional methods of electrical insulation ageing estimation. Differential scanning calorimetry

- Polyolefine insulation materials (polyethylene, etc.)
  - Measurement of onset temperature of oxidation (OITP) for micro-samples
  - Measurement of induction time (OIT)

\[
\tau_{OITP} = \tau_{test} \cdot \frac{OITP_{test} - OITP_{lim}}{OITP_{ini} - OITP_{test}} \cdot \frac{OITP_{ini} + 273}{OITP_{lim} + 273}
\]

\[
\tau(T, \gamma) = a \cdot \exp\left(\frac{E_a}{RT}\right) \cdot \exp(-k \cdot D)
\]
Traditional methods of electrical insulation ageing estimation. IR-Fourier spectroscopy

IR-Fourier spectroscopy is a traditional method for estimation of polymer insulation materials ageing rate

\[ C = C_0 \exp\left[-(k^*_i + k_i P^n) t\right] \]

\[ TG5\% = TG5\%(0) \cdot \left(1 - r \cdot P^n \cdot t\right) \]
Places of taking microsamples of cable coats and insulation

СПОВр: 163-170
Каналы ЦИИСРК

Отметка 38.1, РО - ГО

A.I. Kononenko, FSUE “RISI”
MP 1.2.02.0168-2013. “Diagnostics of technical state of power cables with impregnated paper insulation at nuclear plants”

- $R_{\text{ins}}$ 1 min per 1 km, $K_a$, PI
- Restored voltage (LIRV, PIRV)
- OWTS method
- frequency-dielectric spectroscopy
- thermal imaging monitoring
MP 1.2.02.0168-2013. “Diagnostics of technical state of power cables with impregnated paper insulation at nuclear plants”

Time reflectometry and PD distribution on a cable line length

PD attenuation because of carbonazation of paper insulation and conduction increasing (especially at cable bend points)
MP 1.2.1.13.1005-2015. “Overall diagnostics of technical state of power cables 6-10 kV with cross-linked polyethylene insulation”

- Insulation ageing
  - insulation ageing diagnostic by measurements of isothermal current of relaxation
- Damages during mounting and couplings installation
  - OWTS-method

\[ I_{relax} = I_0 + \sum_{i=1}^{3} a_i e^{-\frac{t}{\tau_i}} \]
MP 1.2.1.13.1005-2015. “Integrated diagnostics of technical state of power cables 6-10 kV with cross-linked polyethylene insulation”
Frequent resonance reflectometry (LIRA method)

- The method was established under Halden Reactor Project OECD and developed by Wirescan AS.
- LIRA (frequency analysis of lines): computer-based frequency resonance reflectometer identifies properties of progressive and ultimate defects in cable lines by characteristics of standing waves generated in the range of 25kHz to 100 MHz with step from 5 kHz to 25 kHz.
- Localization of defects in cable lines with accuracy 0.3% of the cable length.
- Sensibility to capacitive defects 5 pF/m.
Frequent resonance reflectometry (LIRA method)

- Registration of «skinned over» defects in PE insulation of power cables
- Registration of defects in I&C low-voltage cables (cable fault at 400 V)
- It is difficult to interpret a type of defects
- Discontinuities of cable lines give the response that is comparable to the insulation defects
- It is impossible to develop our own diagnostic method since the device is patented
Informational support to technical diagnostics conduction

- Informational support to diagnostics (monitoring) of cables technical condition means a documented certification of the reference cables with computerized cable log keeping, i.e. database for the cables service parameters and residual life characteristics that are to be estimated as part of regular cable inspection.
Development and introduction of programmes for the cable residual life management

Standard forms for:
- RLM activities
- Diagnostics procedure
# RLM activities and procedure for cables diagnostics

<table>
<thead>
<tr>
<th>Harsh service condition sections of cable routes, and external influencing factors</th>
<th>List of cable types in “hot spots”</th>
<th>Methods of diagnostics (monitoring) of technical condition</th>
<th>Technical documents regulating diagnostics (monitoring) of condition</th>
<th>Measures to reduce EIF impacts on ageing rate</th>
<th>References to documents</th>
<th>Terms of completion (regularity of action)</th>
<th>Responsible persons</th>
<th>Remarks</th>
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<tbody>
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</table>

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<tr>
<th>Reference cable in “hot spot” with its identifier or local point of micro-sampling and measurements</th>
<th>Type of insulation/internal layer/outer jacket</th>
<th>Mechanisms of cable insulation materials ageing</th>
<th>Prevailing mechanism of material ageing</th>
<th>Determining indicators of component material condition</th>
<th>Criteria for insulation material condition assessment</th>
<th>Actual values of determining indicators of cable insulation materials condition by monitoring results</th>
<th>Recommended additional monitoring of technical condition</th>
<th>Terms of completion</th>
<th>Responsible persons</th>
<th>Reference to document regulating diagnostics (monitoring) conduction</th>
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A.I. Kononenko, FSUE “RISI”
Thank you for your attention!