SCAP

OECD-NEA SCC and Cable Ageing Project

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Materials degradation has been experienced worldwide since the inception of nuclear power plant operation.

Material degradation is expected to continue as plants age and operating license are extended.

Unanticipated and unmanaged structural degradation could result in significant loss of safety margins, economic losses and undermine public confidence.

Resource burden on both regulators and operators.

**Importance of proactive efforts**

Two subjects identified as the focus of the project:

- Stress Corrosion Cracking
- Degradation of cable insulation
SCAP Objectives

1. Establish a complete *database* with regard to major ageing phenomena for SCC and degradation of cable insulation through collective efforts by OECD/NEA members,

2. Establish a *knowledge-base* by compiling and evaluating collected data and information systematically, with regard to major ageing phenomena for SCC and degradation of cable insulation, and

3. Perform an *assessment* of the data and identify the basis for *commendable practices* which would help regulators and operators to enhance ageing management
### SCAP member countries

<table>
<thead>
<tr>
<th></th>
<th>Management Board</th>
<th>SCC WG</th>
<th>Cable WG</th>
</tr>
</thead>
<tbody>
<tr>
<td>BELGIUM</td>
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<td>NORWAY</td>
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<td>SLOVAK Rep</td>
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<td>SWEDEN</td>
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<tr>
<td>USA</td>
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</tr>
</tbody>
</table>

- 14 countries are joining the project
- The IAEA and the EC are participating as observer
### SCAP SCC working group (List of organization)

<table>
<thead>
<tr>
<th>Country</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>BELGIUM</td>
<td>SCK-CEN (Belgian Nuclear Research Centre)</td>
</tr>
<tr>
<td>CANADA</td>
<td>CNSC (Canadian Nuclear Safety Commission)</td>
</tr>
<tr>
<td>CZECH REP.</td>
<td>NRI Rez plc (Nuclear Research Institute)</td>
</tr>
<tr>
<td>FINLAND</td>
<td>VTT (Valtion Teknillinen Tutkimuskeskus)</td>
</tr>
<tr>
<td>FRANCE</td>
<td>IRSN (Institut de Radioprotection et de Surete Nucleaire)</td>
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<tr>
<td></td>
<td>ASN Directorate for Nuclear Pressure Vessels (DEP)</td>
</tr>
<tr>
<td>GERMANY</td>
<td>GRS mbH</td>
</tr>
<tr>
<td></td>
<td>AREVA NP GmbH / NTM-G</td>
</tr>
<tr>
<td>KOREA</td>
<td>KINS (Korea Institute of Nuclear Safety)</td>
</tr>
<tr>
<td></td>
<td>Materials Engineering Department</td>
</tr>
<tr>
<td></td>
<td>Mechanical Engineering Department</td>
</tr>
<tr>
<td>JAPAN</td>
<td>Tohoku University</td>
</tr>
<tr>
<td></td>
<td>METI/NISA (Ministry of Economy, Trade and Industry, Nuclear and Industrial Safety Agency)</td>
</tr>
<tr>
<td></td>
<td>JAEA (Japan Atomic Energy Agency)</td>
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<tr>
<td></td>
<td>JNES (Japan Nuclear Energy Safety Organization)</td>
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<tr>
<td></td>
<td>NEL (Nuclear Engineering, Ltd.)</td>
</tr>
<tr>
<td>MEXICO</td>
<td>National Commission on Nuclear Safety and Safeguards</td>
</tr>
<tr>
<td>SLOVAK REP.</td>
<td>VUJE Inc.</td>
</tr>
<tr>
<td>SPAIN</td>
<td>CSN (Consejo de Seguridad Nuclear)</td>
</tr>
<tr>
<td>SWEDEN</td>
<td>Swedish Nuclear Power Inspectorate (SKI)</td>
</tr>
<tr>
<td>USA</td>
<td>U.S NRC (Nuclear Regulatory Commission)</td>
</tr>
<tr>
<td>Country</td>
<td>Organisation</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------------------------------------------------------------------------</td>
</tr>
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<td>LABORELEC</td>
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<td>NORWAY</td>
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<td>USA</td>
<td>U.S NRC (Nuclear Regulatory Commission)</td>
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</table>
*The project is being financed through a Japanese voluntary contribution*
### SCAP (Project) Schedule

<table>
<thead>
<tr>
<th>MB</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
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<tr>
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<td><strong>2nd MB (May)</strong></td>
<td><strong>3rd MB (June)</strong></td>
<td><strong>4th MB</strong></td>
<td><strong>5th MB</strong></td>
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</tr>
<tr>
<td>SCC WG</td>
<td>1st WG (Oct)</td>
<td>2nd WG (Jan)</td>
<td>3rd WG (May)</td>
<td>(2-3 times a year)</td>
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</tr>
<tr>
<td>Cable WG</td>
<td>1st WG (Sep)</td>
<td>2nd WG (Mar)</td>
<td>3rd WG (Sep)</td>
<td>(2-3 times a year)</td>
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</table>

- **Database, Knowledge base definition and collection of data**
- **Populating data**
- **Assessment of data**
- **Development of commendable practices**
Scope of the SCC Event Database

- The SCC event database addresses passive components degradation or failure attributed to stress corrosion cracking (SCC) occurring at NPP in participating countries.

- The scope of the database includes class 1 & 2 pressure boundary components*, reactor pressure vessel internals and other components with significant operational impact, excluding steam generator tubing.

- The following mechanisms are considered in the database:
  - External chloride SCC
  - Irradiated assisted SCC
  - Inter-granular SCC in austenitic stainless steel and nickel-based material
  - Primary water SCC and trans-granular SCC

*Class 1 and 2 pressure boundary components are defined by the American Society of Mechanical Engineers (ASME) as follows: class 1 includes all reactor coolant pressure boundary (RCPB) components; class 2 generally includes systems or portions of systems important to safety that are designed for post-accident containment and removal of heat and fission products.
SCC Working Group

SCC Event Database structure

- SCAP SCC is a relational database in Microsoft® Access.
- The data entry is managed via input forms, tables, roll down menus and database relationships.
- Database searches and applications are performed through user-defined queries that utilize the tables and built-in data relationships.
- The data entry forms are organized to capture essential passive component failure information together with supporting information.
SCC Working Group

SCC Event Database structure (The four data entry forms) [1/3]

<1. Failure Data Input>

- Information such as plant name and plant operational state at time of discovery the event.
- Type of event with options such as thought-wall crack with active leakage, part through-wall crack and different types of leaks.
- Information on collateral damage to operational events involving active leakage is included. Corrective actions taken at the plant are included.
- A detailed description of plant conditions prior to the event and the plant response and method of detection is recorded.
- All relevant information that characterizes the degraded component is included.
SCC database (Input format)

SCAP-SCC 2007:1 - Form 1

Event Narrative

The Electric Power Company has been under periodic inspection since 2000, when work was done to the visual inspection of piping nozzle stubs. Locations in total were identified near the base of a piping nozzle stub that was subject to the controlled drain leak rate.

The leak rate was analyzed and was confirmed to be a crack in the primary coolant. Inspections of this piping nozzle stub further revealed that the cracker was identified only after the drain. It was confirmed that the crack material was attributed to leakage from this piping nozzle stub. The crack was located on the primary side of the pipe to measure temperature.
SCC Working Group

SCC Event Database structure  (The four data entry forms) [2/3]

<2. Flaw Characterization>

• Description in free-format of the flaw. For through-wall flaws information about size (equivalent diameter), for part through-wall flaws information on flaw depth, length and orientation is included.

<3. ISI History>

• Recording ISI programme weaknesses, information about ISI of the affected component or ISI history such as time of most recent inspection is recorded.
SCC Working Group

SCC Event Database structure (The four data entry forms) [2/2]

<4. Root Cause Information >

• This form consists of fields to describe the age of the component (in-service life time), location of failure, the method of detection and the apparent cause in terms of the different SCC mechanism along with fields describing contributing factors.

(e.g. Alloying elements, Mechanical properties, pH (For PWR), Conductivity, Surface finish, Chemical history, Repair weld, Crack morphology, SCC mechanism, Specific regulatory actions, boric acid, contamination from inside or outside due to chlorides, sulphides)

• A free format field is provided to describe the root cause analysis.
## SCC Event Database Field Definitions (Example of form 4)

<table>
<thead>
<tr>
<th>Field name</th>
<th>Type</th>
<th>Description</th>
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<tbody>
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<td></td>
<td>- Stainless Steel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Ni-based Alloy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- SS/Carbon Steel (stainless steel clad carbon steel)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Carbon Steel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Low Alloy Steel</td>
</tr>
<tr>
<td>CHEMISTRY HISTORY</td>
<td>Text</td>
<td>Narrative description (can include references)</td>
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<td>SCC mechanism</td>
<td>Text</td>
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<td>- ECSCC - External Chloride SCC</td>
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<td></td>
<td></td>
<td>- IASCC - Irradiation Assisted SCC</td>
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<tr>
<td></td>
<td></td>
<td>- IGSCC - Austenitic Stainless Steel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- IGSCC - Nickel based material</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- PWSCC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- SICC (Strain-rate induced SCC)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- TGSCC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Corrosion Fatigue</td>
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## Programme of Work for 2007/2008
### SCC Working Group

<table>
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<th>Year</th>
<th>2006</th>
<th>2007</th>
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<td><strong>SCC WG</strong></td>
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<tr>
<td>1st WG</td>
<td>5–6 Oct</td>
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<td>2nd WG</td>
<td>24–25 Jan</td>
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<tr>
<td>3rd WG</td>
<td>10–11 May</td>
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<tr>
<td>4th WG</td>
<td>28–29 Nov</td>
<td></td>
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</table>

### Event Database
- Definition of scope
- Finalize event database format
- Finalize Coding guidelines and Quality Assurance Plan
- Finalize a glossary of terms including Coding guidelines
- Populating event data
- Analysis phase

### Knowledge Base (KB)
- Development of requirements and definition of range of application
- Defining the topics and format
Cable Working Group

Scope of the Cable Database

- The Cable database covers the following
  - Safety related cables that support the ECCS,
  - Cables important to safety i.e., other cables desirable to prevent or mitigate design bases events,
  - Cables important to plant operation i.e., cables that could fail and cause a plant trip or reduction in plant power.
- Cables with voltage ratings up to 15 kV AC and 500 DC, including Instrumentation & Control cables.
- Cables Types: Coaxial, Triaxial, Fiber optic and hybrid.
- Insulation Types: XLPE, SiR, PVC, EPDM, EPR, CSPE, EVA and other
- Conductor Material: copper, copper-tin, aluminum, glass, PMMA and other
- Connector and assembly are out of scope
Cable Working Group

Cable Database structure

- The Cable database is a relational database, operating on MySQL software chosen by the Clearinghouse.
- The data entry to the database is managed via tables, and roll down menus.
- Database searches and applications are performed through user-defined queries that utilize the tables and built-in data relationship.
- The 9 database screens are defined.

Table 1. Technical data of cable
Table 2. Cable maintenance data
Table 3. Data for the cable failure events
Table 4. Cable environmental qualification code data
Table 5. Plant and cable environmental condition
Table 6. Mitigation of cable-installed environment
Table 7. Cable replacement
Table 8. Regulatory information for cable
Table 9. Cable condition monitoring
Table 1. Technical data of cable

- Specification of insulation material, conductor size, rated voltage, cable type and manufacturer.
- Description of the operating environmental condition, design pressure, temperature, humidity, codes and standards for qualification.

Table 2. Cable maintenance data / Condition monitoring

- Cable inspection and in-service condition monitoring methods, cable sampling and cable repairing information.

Table 3. Data for the cable failure events

- Information on real cable failure events. A narrative description of the event, root causes, and the countermeasures.
Cable Working Group

Cable Database structure (The 9 data entry forms) [2/3]

Table 4. Cable environmental qualification data
- Describes the summary main results of the qualification tests and the full test report when available

Table 5. Plant and cable environmental condition
- Selected areas of the plant monitored for temperature, radiation etc.,

Table 6. Mitigation of cable-installed environment
- Information regarding mitigation methods to reduce the severity of the cable environment.
Cable Working Group

Cable Database structure (The 9 data entry forms) [3/3]

Table 7. Cable replacement

- Describes the reasons for cable replacement: Degradation, Failed, Modification, End of qualified life and Others with a pull down menu.

Table 8. Regulatory information for cable

- Regulatory requirements for cable ageing management, regulatory guides and results of previous safety evaluations. Industry standards for meeting the regulatory requirements.

Table 9. Cable condition monitoring

- A description of the condition monitoring method, the principle of monitoring and a description of the monitoring technique.
- Aging indicators, such as elongation at break and the monitoring data, along with its acceptance criteria is also recorded.
Cable database (*Input format *)

*These figures are from trial cable database and will be improved by the Clearing House.
### Cable Database Field Definitions (Example of Table 2)

<table>
<thead>
<tr>
<th>Field name</th>
<th>Type</th>
<th>Description</th>
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<tbody>
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<td>Text</td>
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<td>Text</td>
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<td>Elongation at break</td>
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<tr>
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<td></td>
<td>Indentor</td>
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<td>Insulation resistance</td>
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<td>LIRA</td>
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<td>Oxidation induction temperature</td>
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<td>Oxidation induction time</td>
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<td>- Instrumentation</td>
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<td>- Coaxial or triaxial</td>
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<td>- Fiber optic</td>
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<td>- Hybrid</td>
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<tr>
<td>Regulatory code/Industry standard</td>
<td>Text</td>
<td>Description of the name and summary of regulatory code or industry standard applied to the cable inspection or condition monitoring</td>
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<tr>
<td>1st WG (17–18 Sep)</td>
<td>2nd WG (1–2 May)</td>
<td>3rd WG (12–13 Sep)</td>
</tr>
</tbody>
</table>

**Database**
- Definition of scope
- Finalize event database format
- Finalize Coding guidelines
- Finalize Quality Assurance Plan
- Populating data (Technical data [Table 1] and other data)

**Knowledge Base (KB)**
- Development of requirements and definition of range of application
**Coding guidelines and Quality Assurance programme**

**Coding Guidelines**
- Database user instructions
- Working with the database (Practical information)
- Database field categories (Data entry form (table))
- Data entry (Form [SCC], Table [Cable])
- Appendix (Database field definitions & Supporting tables, Definition of roll-down menu)

**Quality Assurance Program (QAP)**
- Define technical requirements and steps to ensure objectives of project are accomplished in timely manner
- Define roles & responsibilities of project participants – instill shared responsibility and develop communications protocols
- Define the programmatic steps/procedures to control quality – Database & Knowledge base considerations
- Process for continuous improvement
- Define steps for protection of restricted and confidential data
Future steps and intended outcomes

The project is currently in the development phase.
- Defining and refining the database format
- Defining database access policy
- Developing database interface
- Populating data (Some preliminary data have already been provided by the member countries)

<Next steps>
- Define a topics on Knowledge base
- Assessment of data and development of commendable practices (2008-2009)
- Workshop

<Intended outcomes>
Project’s outcomes will be used by the NEA member countries to:
- Evaluate how operating experience and state-of-the-art technology are incorporated into plant operating practices;
- Support regulatory authorities’ reviews of ageing management programmes.