IAEA-EBP-LTO-05
05-05-04

EXTRABUDGETARY PROGRAMME ON SAFETY ASPECTS OF LONG TERM OPERATION OF WATER MODERATED REACTORS

MINUTES OF THE PROGRAMME'S WORKING GROUP 2 FIRST MEETING

4-6 February 2004
IAEA, Vienna, Austria

INTERNATIONAL ATOMIC ENERGY AGENCY

1. INTRODUCTION

The number of Member States giving high priority to extending the operation of nuclear power plants beyond their initial license is increasing. Decisions on long term operation (LTO) involve the consideration of a number of factors. While many of these decisions concern economic viability, all are grounded in the premise of maintaining plant safety. The IAEA recognized this new industry initiative; therefore, in the 1990's, it developed comprehensive generic guidance on how to manage the safety aspects of physical ageing. It was recognized, however, that internationally agreed-upon, comprehensive guidance was needed to assist regulators and operators in dealing with the unique challenges associated with the LTO issue.

In response, the IAEA initiated this Extrabudgetary Programme (Programme) on 'Safety aspects of long term operation of water moderated reactors' (original title was 'Safety aspects of long term operation of pressurized water reactors'). The Programme's objective is to establish recommendations on the scope and content of activities to ensure safe long term operation of water moderated reactors. The Programme should assist regulators and operators of water moderated reactors, and, in particular WWERs, in ensuring that the required safety level of their plants is maintained during long term operation, should provide generic tools to support the identification of safety criteria and practices at the national level applicable to LTO, and should provide a forum in which MS can freely exchange information.

The Programme activities are guided by the Programme Steering Committee (SC), follow the overall SC Programme Workplan and SC Terms of Reference, [1], and are implemented in 4 Working Groups (WG). The WGs focus on:

- general LTO framework (WG 1);
- mechanical components and materials (WG 2);
- electrical components and I&C (WG 3);
- structures and structural components (WG 4).

Further detailed information on the Programme could be found at: http://www-ns.iaea.org/nusafe/s_projects/salto_int.htm .

The 1st meeting of WG 2 was held at IAEA in Vienna, 4-6 February 2004. The purpose of the 1st meeting of WG 2 was to review and finalize the respective parts of the draft Workplan [2], and the draft Standard Review Process [3] and to initiate the WG 1 activities.

This report provides the minutes for the initial meeting of Working Group 2. The Agenda for the Meeting is provided in Appendix I. The list of participants is provided in Appendix II.

2. MEETING SUMMARY

The meeting was opened by Radim Havel, the Programme Scientific Secretary, who outlined the objectives of the IAEA Extrabudgetary Programme "Safety Aspects of Long Term Operation of Pressurized Water Reactors". Vladimir Piminov, the WG 2 Chairman, discussed the objectives of the first working group meeting, reviewed the meeting agenda and initiated discussion of national approaches to long term operation.

2.1. NATIONAL PRESENTATIONS

The meeting continued by presentation of national approaches on general framework on long term operation. The summaries of the national presentations are provided next, the complete presentation handouts are provided in Appendix III.

Bulgaria

Kozloduy NPP operated six nuclear power units, total power 3760MW. Kozloduy NPP generated about 45% of the total electricity production in the country last decade. Based on the decision of the Government of Bulgaria KNPP Units 1 and 2 were shutdown at the end of 2002.

General:

1. Definitions of the Plant Life Operation, Long Term Operation and strategic long-term tools.
2. The safety improvement activities at KNPP "Complex Modernization Programme" for units 1-4, PGR`97 and main achievements. Long-term operation license for units 3 and 4 according to the newly established Safe Use of Nuclear Energy Act has been obtained.
3. Evaluation of Rest and Residual Life Time (RLT) of Kozloduy NPP units 3 and 4. Primary goals, phases, steps and the results of those activities.
4. Generating an Ageing Management Programme (AMP) that permits detection, evaluation and mitigation of the relevant ageing degradation and identification of the plant locations where they are likely to occur.

Summary: With the Modernization Programmes of Units 3,4 and 5,6 and the Rest Life Time Analysis for Units 3 and 4, KNPP has already undertaken activities towards Long Term Operation.

Czech Republic

1. Applicable laws and regulatory requirements; approaches, processes and practices

Original Soviet/Russian rules do not contain any reference to component/plant lifetime assessment and LTO. Design lifetime is given in , the design documentation as recommendations from component manufacturers. Czech laws and rules as well as SONS documents and regulations do not contain any reference to the definition of design lifetime, thus also no comments on long term operation beyond design lifetime. SONS gives a conditional authorization for further plant operation on the basis of periodic operational safety reports and approval after each year periodic inspection and maintenance results. There are several recommended documents to be used for lifetime assessments. Plants in operation have been designed in accordance with former Soviet/Russian rules and codes requirements. For replacements it is possible to use original codes or Czech ASI Code. Time limited ageing analysis should be part of the periodic safety reports of components.

2. Available research results.

Results of research and development are very useful for explanation of ageing mechanism effects and their possible mitigation and avoidance. There is a number of PHARE projects as well as national projects on component integrity assessment, environmental and NDE qualifications. There are also the IAEA programmes with significant contribution.

3. Outstanding technical and programmatic issues

The IAEA RER Project on the Design Basis Management is important for stressing the need for accurate knowledge of " Know Why". Guideline for the Design Basis Documents Collation and Maintenance was developed and is actively used. Extension of this programme with project strategy " To develop well-managed, understood and preserved safety, design and operational margins" is proposed as one of key elements for successful LTO programme.

4. In-service inspection of WWER components, significant tool for the LTO management.

Several key components, such as the RPV, SG, Pressurizer and piping components were described from the NDE Qualification point of view. It was stressed that PHARE projects and the ENIQ Methodology were key contributors to the success of this activity.

5. New R&D Project funded by Ministry of Industry and CEZ Utility

Principal goals of this project are to prepare methodology and tools for the comprehensive remaining lifetime assessment based on the SONS Degree Requirements on selected SSCs, to prepare effective remaining lifetime assessment for the particular SSC in case of immediate need and to organize methodology, tools and conditions for LTO with required justification.

6. Additional Questions

Classification of the SSCs meeting the LTO review requirements
Aging management for passive components
Aging management for active components
Processes for incorporating plant operating experience
Research programmes and other programmes related to the aging mgm.

Finland

The Loviisa Nuclear Power Plant owned by Fortum consists of two VVER-440 units from the late 1970s and the early '80s. According to the present assumption the economical lifetime of the Loviisa NPP is expected to be at least 50 years. For the next operating license renewal in 2007 a thorough safety review is required, which also includes assessment of ageing. In the presentation approaches applied at the Loviisa nuclear power plant for long-term operation were reviewed. Various activities have been or are being carried out to minimize and control ageing of systems, structures and components (SSCs) in order to achieve desired plant service life while maintaining required safety and reliability. The presentation focused on the main mechanical components, their known or possible ageing phenomena as well as their ageing management activities. In addition, the specific procedures adapted at the Loviisa nuclear power plant for an effective plant life management (PLIM) were described. The critical SSCs have been identified and classification of SSCs has been performed. An approach for critical component life management has been formulated and implementation of this approach for steam generators is underway.

Hungary

In 2001, NPP Paks has launched a project for the preparation of LTO. A detailed study based on the plant status assessment and a business analysis showed the interest for an extension of the operational lifetime by 20 years beyond the design lifetime (30 years). The license renewal process will be a two-step process, because of the peculiar regulatory framework in Hungary. In 2007, the NPP Paks has to get a licence in principle for the extended operation and in 2012 the operation licence has to be renewed. The basic task of the project for the preparation of LR are the integrated plant assessment and review of time limited ageing (Time Limited Ageing Assessments, review of the ageing management programmes and time limited EQ) mainly focused on the long lived passive SSCs. This possible because the function of the active safety related SSCs would be evaluated and controlled through adequate performance criteria after each maintenance period (maintenance rule). The updated FSAR has also an essential role in the definition of the scope and content of the LR process. The PSR will be focused on the process with long time constant: feedback of experience, changes in the regulation, new scientific results, new information on hazards, new safety analyses methods and tools, and last but not least the ageing of the plant with emphasis on the comparison with the forecast made in the LR application report.

Russian Federation
The approach to LTO consists of:

1. Development of regulatory basis.
2. Upgrading of the NPP unit.
3. Analysis of the unit compliance with the requirements of valid safety regulatory documents.
4. In depth safety assessment of the NPP unit.
5. Substantiation of residual life of non-replaceable components of NPP.
6. Elaboration and implementation of plant aging management programmes.

Existing regulatory documents are adequate for ensuring the safe operation of the NPP units during the period of extended operation. Russia has positive experience in extending NPP operational life beyond design lifetime (Novovoronezh 3 and 4, Kola 1).

Sweden
Evaluation of nuclear power plant structures, systems and components (SSC) should not be limited to only what is needed to fulfill the deterministic Safety Analysis Report (SAR). Also safety in depth should be considered. This would include SSC contributing to the core damage frequency. In Sweden both deterministic and probabilistic methods should be used since they complement each other.

In Sweden it is stipulated by the regulator that a new integrated safety analysis and assessment of a power unit shall be made at least once every ten years. The analysis should take into account (among others) the aging phenomena detected at the unit and elsewhere in the world and analyze/predict what has been done and what must be done. The analysis and assessment should be made so that the plant could safely operate until the next periodic assessment i.e. at least 10 years. Evaluation is made in the perspective of the power plant operating for 60 years.

In service inspections (ISI) are governed by regulations stipulated by SKI (regulatory body)[1]. Basically the approach is risk oriented consisting of a consequence index and a material index. The combination will give the volume where A is 100%. A include the RPV and large diameters pipe which are part of the RCPB connected under the core. The interval between inspections is determined by the detection limit size and the time it takes to critical crack based on accepted crack growth rates and considering all possible loads. The negative effects of these rules are unexpected high cost in qualification of personnel, methods and equipment and to provide test blocks for the qualification. The rules also increased the radiation exposure to the personnel since ISI will be more concentrated to the RPV and items close to the RPV. This has driven the utilities to replace more SCC Particular difficult issues are the presence of geometric obstacles at HAZ, dissimilar welds etc.

Active SSC must be tested (performance verification) so that all requirements are met at least to the next time a test will be performed. It is important to have implemented test criteria in according to the analysis made in the SAR taking into account the possible degradation to the next test and that the test might be performed in another way than is actual during the event it

[1] Currently SKIFS 2000:2

shall handle. Particularly important is to ensure the overlapping since all tests in some way on active SSC are divided into several different tests.

Trending is performed to find the end of life of active/passive SSC and is depending of good track records on test results and preventive/corrective maintenance performed.

A short summary of the modernization and reconditioning of the Oskarshamn 1 power plant was given. During the last 10 years Oskarshamn 1 has been off-line for 5 of those years. First reconditioning and later modernization. The reconditioning was mostly due to full filling new requirements from the regulator particularly concerning ISI but also aging of electrical and I&C equipment, difficulties in ISI of certain important welds etc. The modernization was to meet new rules and regulations that are required today for building a new power plant. Even though Oskarshamn Unit 1 is the oldest plant in many respects it is the most modern.

Ukraine

Design lifetime of the Ukrainian NPPs is 30 years. This period will have expired in 2010 for some of the Ukrainian plants. The Ageing Management Programme and the regulatory document "General provisions of NPP unit operation continuation during beyond design time" are under development at the moment. It is scheduled that they will be issued in 2004.
Currently the programmes of technical evaluation for thermal mechanical equipment are being developed.
The purposes of these programmes are the following:

1. To determine the equipment that could operate beyond design lifetime; to determine the frequency of maintenance of the equipment; determine the frequency for such equipment maintenance, monitoring/inspection methods means for such equipment.

2. To determine the equipment subject to replacement.

The results of these assessment activities will be included into the SAR.
It is expected that preparation of the report to be completed for 2 years before expiring of the unit design lifetime.
Current challenges: LTO of the passive irreplaceable components or the difficult replaceable components such as RPV, SG.

USA

Nuclear power plant licenses were originally issued for 40 years and are allowed to be renewed for an additional 20 years. A 40 year term was selected upon the basis of economic and antitrust considerations, not technical limitations. However, once the license term was selected, individual plants may have been engineered for an expected 40 year life.

The US NRC license renewal process establishes the technical and administrative requirements for renewal of operation power plant licenses. The US NRC regulation of the extended period of operation for a renewed license has three major considerations or assumptions. These are:

- Existing regulatory process is adequate for ensuring safety of operating plants
- Current licensing basis (CLB) is adequate and carries forward into the period of extended operation
- Issues relevant to the current operation of plants will be addressed by the regulatory process, which will carry forward into the period of extended operation.

The process used in the U.S. to review license renewal applications contains two major parts. One review considers the environmental issues of 10 CFR Part 51 and the other considers the safety issues of 10 CFR Part 54. When addressing the safety issues of 10 CFR Part 54, a license renewal application must provide the NRC with a technical evaluation that demonstrates that the applicant has identified aspects of plant aging and has implemented (or will implement) programmes that will adequately manage aging degradation for the period of extended operation. The NRC reviews the application and verifies the safety evaluations through on-site audits and inspections.

The U.S. NRC has established a license renewal review process that is documented in the following three publications – Generic Aging Lessons Learned Report (GALL), Regulatory Guide 1.188 and the Standard Review Plan (SRP). These documents are available to the public and currently include resolution of public comments. The license renewal review focuses on passive, long-lived structures and components of the plant that are subject to the effect of ageing. The license renewal rule requires an applicant, in part, to:

1. perform a scoping review to identify the structures, systems, and components within the scope of license renewal based on criteria delineated in the rule and
2. perform an integrated plant assessment to identify the structures, systems and components that are subject to ageing management, to justify the methodology used, and to demonstrate that analyses that are based on the current operating term have been evaluated and shown to be valid for the period of extended operation.
3. demonstrate that time-limited ageing analysis used for current operation have been evaluated and are valid for the period of extended operation

When the US NRC also performs plant specific reviews of the environmental impacts of license renewal in accordance with the U.S. National Environmental Policy Act and the requirements of 10 CFR Part 51, a public meeting is held near the nuclear power plant seeking renewal to identify any environmental issues specific to the plant seeking license renewal.

European Commission
C. Rieg (EC/JRC) gave a presentation about the EC contribution to Nuclear Safety and Nuclear Power. General figures of the Institute for Energy are given as an introduction to its activities in the sector of material science and component assessment. SAFELIFE is the current integrated approach to R&D activities on critical components of ageing NPPs. It integrates networking (AMES, ENIQ, NESC, NET, AMALIA & SENUF), contributions to R&D actions, particular support towards the acceding Countries & maintenance and development of the JRC research capabilities & R&D tools. Additional support is provided to the CEECs within the TACIS/ PHARE Nuclear Safety Programmes. In this frame JRC provides for technical project management assistance and performs specific projects (dissemination / RPV embrittlement). Details on the activities on Classification and Qualification of components, ISI and NDE techniques (e.g. ENIQ, Risk-informed ISI, direct support by methodology implementation and equipment supply), Maintenance (SENUF, direct support by TACIS/PHARE projects) and ageing management (e.g. RPV, RPV internals, piping, NDE) show that the main focus of the supporting activities is in line with the industrial needs.

2.2 DISCUSSION OF THE WORKPLAN FOR AND SRP

The working group members discussed both the Workplan and SRP. Changes to the Workplan were recorded in the document as the WG members reached a consensus on each issue. The latest revision of the work plan is documented in IAEA-EBP-LTO-02. The major changes to document are provided below.

Specific Review Comments to Workplan for WG2; IAEA-EBP-LTO-02

1. Under the Section 3. Scope WG2 members agreed to use the standard IAEA definitions of fundamental safety functions.
2. Under the Section 3. Scope it WG2 members agreed to the following revision concerning structures.
   - support structures for piping, vessels and equipment including snubbers and viscoelastic dampers
3. Under the Section 5. Milestones and Deliverables WG2 members agreed to the following schedule for milestones.

Task 1. Collect Information on Mechanical Component and Material Issues

1. Complete Draft of Standard Review Process – *February 13,2004*
2. Finalize and submit to Steering Committee Standard Review Process for Working Group 2 – March 2004
3. Complete information collection
   - Draft report by June 15, 2004
   - Final Report by July 31, 2004

Task 2. Assess and Analyze Member State Information

1. Complete initial outline of Task 2 report and initial analysis of information collected from Task 1. September 15,2004.
2. Identify and discuss needed additional information at a review meeting - October 11, 2004. This will serve as the second meeting of Working Group2.
3. Complete draft report that outlines common practices and differences among national requirements, processes and practices relating to long term operation – January 2005
4. Finalize the draft report prepared in item 2 – March 23-25, 2005. This will also serve as the third meeting of Working Group 2. The finalzed report will be submitted by April 7th, 2005 which will incorporate comments from the meeting in March.

Task 3. Complete Final Working Group Report to Steering Committee

1. Complete draft report from Working Group 2 – September 2005
2. Discuss and resolve SC comments – October 2005
3. Finalize report that identifies safety criteria and practices for mechanical components and material issues among MS – April 2006
4. Provide WG 2 input to the SC final report in co-ordination with the other WGs – July 2006

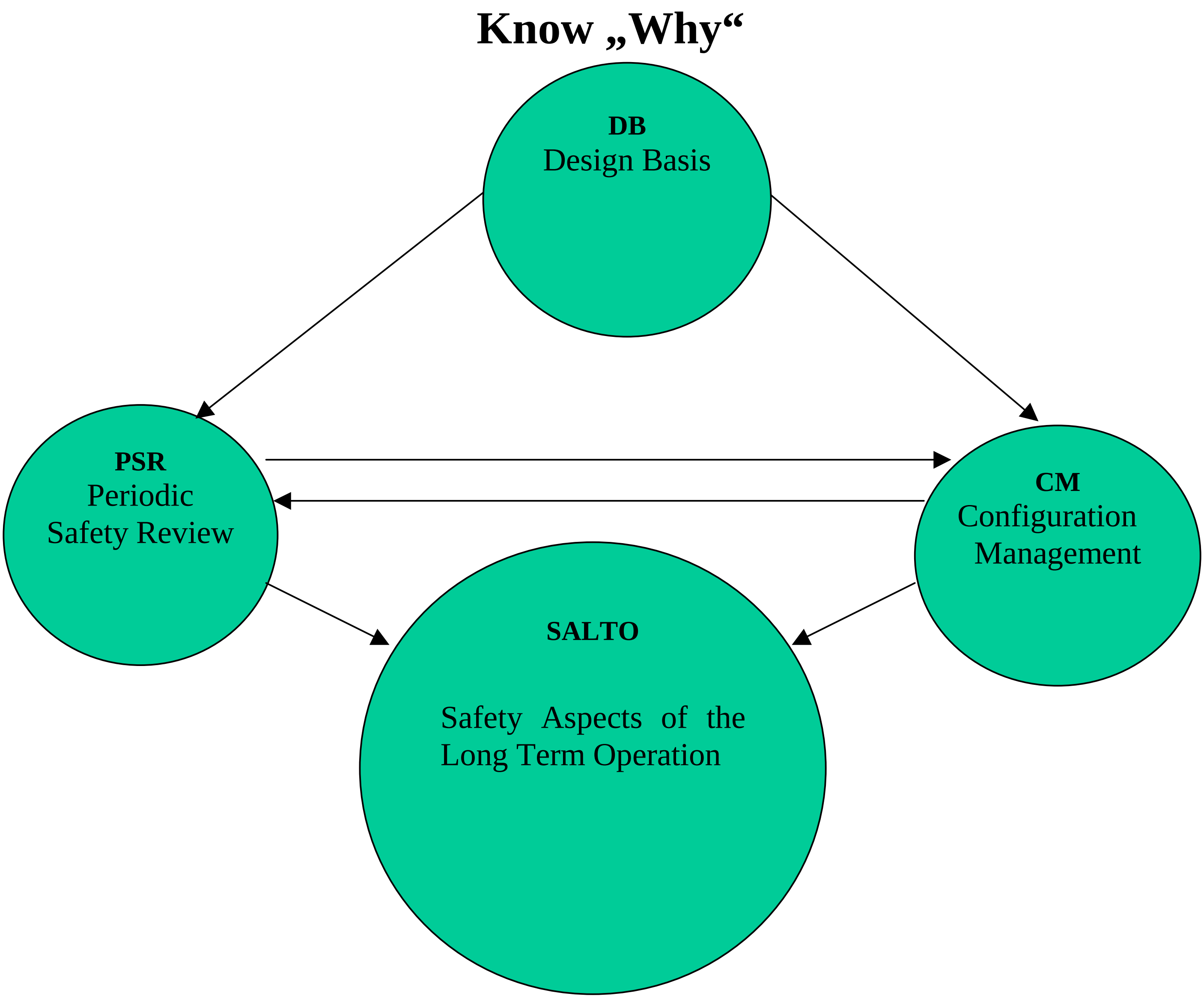
Specific review comments to Standard Review Process: IAEA-EBP-LTO-03

1. Under Section 3.0 – Scope of Reviews; it was agreed that a third paragraph should be added to acknowledge the relationship of the elements Design Basis Management, Periodic Safety Review (or Current Licensing Basis), Configuration Management and Long Term Operation. The third paragraph is drafted as follows.

   The steering committee also recognized the essential role of two other processes – the Design Basis Management and Configuration Management. The interaction of Design Basis Management, Periodic Safety Review (or Current Licensing Basis), Configuration

Management and Long Term Operation are shown in the figure below with a brief explanation.

Periodic Safety Review (PSR) and Configuration Management (CM) are completely complementary programmes. In order to conduct a successful PSR (tool for LTO) the plant must be able to retrieve design, operating and safety information that is accurate and reflects the actual configuration. It is the CM programme's goal to ensure that the infrastructure to make that happen is in place. CM is an integrated programme (total site) to collect and manage plant configuration information from conceptual design through its operating lifetime, including all changes made.



2. The second paragraph under section 4.2 was revised to add several topics. The revised paragraph is provided below.

   Working Group 2 will require information that describes the following topical areas to complete its objectives.

   – *The process used in developing the scope of systems, structures and components (SSCs) that are subject to the long term operation (LTO) review.*

- *Design basis information verified by configuration management (The intent is not to collect Design Basis information but rather to verify that the Design Basis is properly controlled through Configuration Management)*
- *In-service inspection and surveillance practices for passive and active components, including any augmented inspection programmes that address issues such as erosion/corrosion, augmented inspection of steam generator tubing or augmented inspection for specific degradation mechanisms such as intergranular stress corrosion cracking, thermal fatigue due to stratification, etc.*
- *Condition monitoring or surveillance to mitigate degradation mechanisms*
- *Maintenance practices for active components*
- *Applicable Aging Effects on Structure and Component Intended Function(s)*
- *Aging Management programmes*
- *Plant-specific safety analyses which may have been based on an explicitly assumed plant life or operating period, number of cycles, cumulative load, etc. (for example, aspects of the reactor vessel design may assume a 40 year life or a limit on neutron fluence on the vessel wall)*
- *Information from applicable research projects*
- *Operational experience*

3. Table II in section 4.2 was revised to delete the following items.
    - Electrical One-Line or Schematic Drawings
    - Emergency Operating Procedures

4. There was considerable discussion concerning the safety factors that WG2 should address. The revised set of safety factors that WG2 agreed upon is provided in the latest revision of Standard Review Process: IAEA-EBP-LTO-03

3. ACTION ITEMS

1. Mr. Taylor agreed to develop and distribute a draft of the meeting by February 10, 2004.
2. Mr. Taylor agreed to develop and distribute a draft national report that may be used as a template by March 30, 2004.
3. Mr. Havel agreed to revised the Work Plan of Working group 2 to reflect IAEA definitions of reactor coolant pressure boundary integrity and safe shutdown, see item 1 under Specific Review Comments to Work Plan for WG2; IAEA-EBP-LTO-02
4. Mr. Taylor agreed to complete the distribution of the draft meet6ing minutes by February 13, 2004 and Working Group members agree to complete review and comments by February 20, 2004.

4. REFERENCES

[1] Minutes of the Programme's 1st Steering Committee Meeting, IAEA-EBP-LTO-01, Vienna, 2003 (internal EBP report).

[2] Minutes of the Programme's Planning Meeting, IAEA-EBP-LTO-02, Vienna, 2004 (internal EBP report).

[3] Standard review processIAEA-EBP-LTO-03 Vienna, 2004 (internal EBP report).

APPENDIX I.
PROVISIONAL AGENDA

Wednesday, 4 February 2004		
09:00	Opening, Meeting objective	R.Havel
09:15	EBP SALTOPWR WG 2-Workplan, SRP	V.Piminov, T.Taylor
10:30	*Coffee break*	
	National presentations	
11:00	Bulgaria	T. Ribarska
11:45	Czech Republic	J. Zdarek
12:30	*Lunch break*	
14:00	Finland	R.Korhonen
14:45	Hungary	S.Ratkai
15:30	*Coffee break*	
16:00	Russian Federation	V.Vasiliev
16:45	Sweden	F.Barnekow
17:30	*Adjourn*	
18:00	*Wine & Cheese Reception*	*VIC Restaurant*
Thursday, 5 February 2004		
9:00	Ukraine	S.Kostenko/ Z.Gubenko
9:45	USA	T.Taylor
10:30	*Coffee break*	
11:00	EC/JRC	C-Y.Rieg
11:45	Discussion on national approaches	V.Piminov, T.Taylor
12:30	*Lunch break*	
14:00	Review & finalize WG 2 Workplan	V.Piminov, T.Taylor
15:30	*Coffee break*	
16:00	Review & finalize WG 2 Workplan cont'd	V.Piminov, T.Taylor
17:00	Review & finalize WG 2 SRP	V.Piminov, T.Taylor
17:30	*Adjourn*	
Friday, 6 February 2004		
09:00	Review & finalize WG 2 SRP cont'd	V.Piminov, T.Taylor
10:30	*Coffee break*	
11:00	Review & finalize WG 2 SRP cont'd	V.Piminov, T.Taylor
12:00	Final discussion	V.Piminov, T.Taylor
13:00	*Adjourn*	

APPENDIX II.
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APPENDIX III.
PRESENTATIONS' HANDOUTS

IAEA EBP
on
SAFETY ASPECTS OF LONG TERM OPERATION OF PRESSURIZED WATER REACTORS

1st Meeting of Working Group 2

IAEA, Vienna, 4-6 February 2004
Radim Havel

EBP BACKGROUND

- Scoping meeting – March 2003 (RF, SWE, USA)
- 1st SC meeting – May 2003 (BUL, CR, FI, H, RF, SR, SP, SWE, UKR, USA, EC) + (F, UK); IAEA-EBP-LTO-01; EBP overall Workplan incl. Objective, exp. outcome, and approach (SC+4WGs)
- Planning meeting – August 2003 (WG chairs + secs + SC chair); IAEA-EBP-LTO-02; WG 1-4 draft Workplans, initiated SRP development
- EBP: May 2003 – November 2006; RB 2007 onwards

EBP OBJECTIVE

- SC: IAEA-EBP-LTO-01
- Assist PWR operators and regulators:
  - to ensure the required safety level is maintained during long term operation
  - to provide generic tools to support the identification of safety criteria and practices applicable to long term operation at national level
- Develop an internationally agreed common framework to support safe long term operation including related processes and practices
- SC nominated WG chairpersons/secretaries

WGs OBJECTIVE

- 4 areas:
  - General LTO framework,
  - Mechanical components and materials,
  - Electrical components and I&C,
  - Structures and structural components
- Tasks:
  - Compile/collect info (national summary reports)
  - Review and compare info
  - Reconcile info
  - Formulate final reports
- Standard review process (uniformity and compatibility, PSR index)
- Homework assignments (meetings…co-ordination)

1st WG 2 MEETING OBJECTIVE

- Finalize Workplan incl. schedule (mtgs., outcomes, plan WG meetings to facilitate scheduling SCMs, etc.)
- Finalize SRP (WG 2 part)
- Initiate collection of information, etc.
- Homework assignments (whole EBP)
- Future meetings-where&when
- Deadlines
  - next SC meeting: 16-18 March 2004
  - final WG 2 drafts (Workplan+SRP): 1 March 2004 (WG1: 13-15 Jan; WG3: 10-12 Feb; WG4: 3-5 Mar)
- Meeting minutes
- Vladimir to ‘sell’ WG results (LTO-02, 03, and 05)

3 March 2004 5

WG-2

Mechanical Components and Materials

Proposals on accomplishment of Task 1 and Task 2 (to discuss with WG members)

1. **Each participating country/WG member shall prepare "National Report"** *(as an separate document, not MS PowerPoint presentation!)* containing the information on Task 1.
2. The drafts of "National Reports" will be considered and discussed during the 2d and 3d Information Collection Meetings

Proposals on accomplishment of Task 1 and Task 2 (to discuss with WG members) (2)

3. Content of **"National Reports"** shall be:
   - uniform for all countries
   - consistent to SRP
   - precisely defined (this meeting, E-mail / may be corrected after consideration of first drafts)
   - Provide similar level of details
4. Report of WG-2 on Task 2 will consist of:

- Integrated/Analytical Report *(will be drafted by WG Chairman/Secretary with the use of WG members' findings related to common elements/differences in national approaches/practices)*
- Attachment – all "National Reports"

Proposals on Content of "National report" (first draft to initiate discussion) (1)

1. Introduction/Background
   - National strategy relating to LTO of PWRs
   - Purpose and content of the document
2. Regulatory basis for LTO of mechanical components
   - National regulations relevant to LTO of mechanical components (reference, status, short description)
   - The process used in developing the scope of systems, structures and components (SSCs) that are subject to the long term operation (LTO) review
   - ???

Proposals on Content of "National report" (first draft to initiate discussion) (2)

3. Ageing Management for Passive Components
   - ISI (regulatory requirements, practices, any augmented programmes relating to LTO)
   - AMP (regulations and practices)
   - Surveillance programmes
4. Ageing Management for Active Components
   - Maintenance Programmes
   - Any augmented requirements/activities relating to LTO

Proposals on Content of "National report" (first draft to initiate discussion) (3)

5. Applicable Ageing Effects on Structure and Component Intended Function(s)
   - RPV
   - Reactor internals
   - Steam Generator
   - Pressurizer
   - Primary circuit pipelines
   - Steam lines
   - Diesel Generator
   - ….
   - ….

Proposals on Content of "National report" (first draft to initiate discussion) (4)

6. Research programmes and other programmes under development that are relevant to aging management issues
   - Short description and purposes
   - Results achieved/expected
7. Any additional information concerning LTO of mechanical components (optional)
8. Opened issues/problems

WG-2 Workplan

Mechanical Components and Materials

Working Group 2 Objective

- The objective of Working Group 2 on Mechanical Components and Materials is to develop tools to support the identification of safety criteria and practices for the area of Mechanical Components and Material associated with the Long Term Operation (LTO) of pressurized water reactors (PWRs and WWER). Providing such tools will assist regulators and operators of NPPs in ensuring that the required safety level of their plants is maintained during LTO.

Systems, Structures, and Components (SSC) relevant to LTO : (1)

All safety-related systems, structures, and components that are important to the following functions:

- The integrity of the reactor coolant pressure boundary;
- The capability to shut down the reactor and maintain it in a safe shut down condition; and
- The capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposure.

Systems, Structures, and Components (SSC) relevant to LTO : (2)

All nonsafety-related systems, structures, and components whose failure could prevent the satisfactory accomplishment of, or initiate challenges to any of the safety functions defined above.

<u>Systems, Structures, and Components (SSC) relevant to LTO :</u> (3)

SSC that are important to ensure a specific functional purpose that may be essential to safe LTO of the plant, such as:

- **fire protection,**
- **environmental qualification,**
- **pressurized thermal shock,**
- **anticipated transients without scram,**
- **severe accident management,**
- **station blackout**

Specific items for WG-2 activities:

- Piping
- Pumps, both the active portion and the passive vessel
- Valves, both the active portion and the passive vessel
- Vessels
- Vessel Internals
- Emergency Diesels
- Attachments, such as integrally welded supports, that may affect the integrity of a pressure boundary
- Heat Exchangers

Tasks

- **Task 1**
- **Collect information on existing research, regulatory and operational approaches, programs, and practices related to Mechanical Components essential to safe LTO of PWRs.**

- **Task 2**
- **Review and compare existing regulatory and operational approaches and practices to identify common elements.**

- **Task 3**
- **Develop recommendations and guidelines for inclusion in the draft report to the Steering Committee (SC)**

Task 1: Collect Member State Information

Milestones

1. Complete Draft of Standard Review Process
2. Finalize & Submit to Steering Committee Standard Review Process for Working Group 2
3. Complete Information Collection Meetings

Deliverables

1. Report outlining the Standard Review Process Developed for Working Group 2
2. Report(s) for each of the information Collection Meetings

Task 2: Assess Member State Information

Milestones

1. Complete Initial Analysis of Information and identify needed additional information
2. Submit in writing a final request for information needed to complete assessment of the technical basis
3. Complete Draft Report
4. Finalize Report for member states requirements, processes and practices relating to long term operation

Deliverables

1. Report that describes for member states requirements, processes and practices relating to long term operation

Task 3: Complete Final WG-2 Report to S C

Milestones

1. Complete Draft Report from Working Group 2
2. Resolve Steering Committee Comments
3. Finalize Report

Deliverables

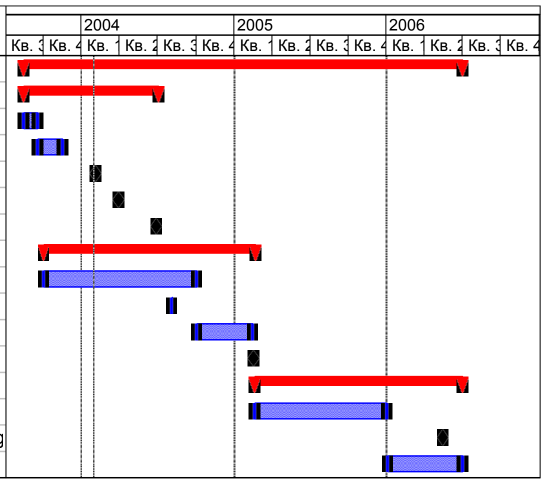
1. Final Report

Content of WG-2 Final Report

- Summary of the applicable laws, regulatory requirements and operational approaches to regulating and managing the LTO of the member states' pressurized water reactors.
- Definition of the differences between the applicable laws, regulatory requirements and operational approaches among the member states participating in the Programme
- Identification of potential safety issues where additional regulatory and/or operational development may be needed. This section of the report will also identify any critical safety issues that need to be resolved.
- Recommendations from the working group for resolving the most critical safety issues.

WG-2 Time Schedule (current)

Ид.	Task Name
1	**WG 2 Mechanical/Materials**
2	**Task 1**
3	Draft St.Rev.Proc.
4	Final St.Rev.Proc.
5	Kick-off&D.coll.Mtg.-US
6	Data coll. Mtg. EUR
7	Data coll. Mtg. Rus
8	**Task 2**
9	Init.anal.of info
10	Final req.for info.
11	Draft Rpt.-Req.
12	Final Rpt.-Req.
13	**Task 3**
14	WG draft Rpt
15	Resolve SC comments Mtg
16	WG final Rpt



Anticipated Meetings for Working Group 2

Task 1.0

- Kick-off and Data collection meeting (Vienna, IAEA) 4-6/02/04
- Data collection meeting in Europe (????) 30/03/04
- Data collection meeting in Russia (Gidropress) 30/06/04

Task 2.0

- Meeting in Vienna (Finalize Report) 15/02/05

Task 3.0

- Meeting in Vienna (Resolve Comments of SC) 15/05/06

IAEA-EBP-LTO-03

Draft 08-01-04

EXTRABUDGETARY PROGRAMME ON SAFETY ASPECTS OF LONG TERM OPERATION OF PRESSURIZED WATER REACTORS

STANDARD REVIEW PROCESS

INTERNATIONAL ATOMIC ENERGY AGENCY

The objectives of this SRP are:

- ensure a well defined, uniformly structured and comprehensive approach to the collection of information and review processes;
- facilitate communication among the Programme participants;
- define a scope of activities that clearly identifies the specific elements of LTO that this Programme addresses

The use of the SRP will assist in achieving the overall Programme objectives :

- Collect available information on the existing approaches to research and development and operational and regulatory aspects related to LTO.
- Review and compare existing regulatory approaches and practices to identify common elements, and reconcile differences in safety criteria. Obtain consensus on the main elements of a common framework in connection with LTO.
- Review and compare the existing operator approaches and practices to identify common and most efficient elements. Identify important outstanding issues to be resolved. Develop corresponding guidelines to assist operators to develop and improve their program and practices needed to support safe LTO.

WG-2. REQUIRED INFORMATION (1)

- The process used in developing the scope of systems, structures and components (SSCs) that are subject to the long term operation (LTO) review.
- In-service inspection practices for passive components, including any augmented inspection programs that address issues such as erosion/corrosion, augmented inspection of steam generator tubing or augmented inspection for specific degradation mechanisms such as intergranular stress corrosion cracking.

WG-2. REQUIRED INFORMATION (2)

- Applicable Aging Effects on Structure and Component Intended Function(s).
- Aging Management programs.
- Plant-specific safety analyses which may have been based on an explicitly assumed plant life or operating period, number of cycles, cumulative load, etc.

SAMPLE LISTING OF WG 2 POTENTIAL INFORMATION SOURCES (To be discussed) (1)

- Requirements for Periodic Safety Review or Safety Evaluation Report Aging Management programs.
- Verified Databases of Operational Experience (a database that is subject to administrative controls to assure and maintain the integrity of the stored data or information).
- Updated Final Safety Analysis Reports (UFSAR) .
- Piping and Instrument Diagrams (P&IDs).
- Electrical One-Line or Schematic Drawings ????
- Operations and Training Handbooks.
- Design Basis Documents and Design Drawings.
- General Arrangement or Structural Outline Drawings.

SAMPLE LISTING OF WG 2 POTENTIAL INFORMATION SOURCES (To Be Discussed) (2)

- Quality Assurance Plan or Program.
- National In-service Inspection codes.
- Design Basis Event Evaluations ????
- Emergency Operating Procedures. ????
- . Correspondence with the regulator.
- System Interaction Commitments.
- Technical Specifications.
- Regulatory Compliance Reports (including Safety Evaluation Reports).

INFORMATION REPORT OUTLINE (WG-2 Part only)

3.0 WORKING GROUP 2

3.1 The process used in developing the scope of systems, structures and components (SSCs) that are within the long term operation (LTO) review.

3.2 In-service inspection practices for passive components

3.2.1 Augmented inspection programs that address issues such as erosion/corrosion,

3.2.2 augmented inspection of steam generator tubing or

3.2.3 augmented inspection for specific degradation mechanisms such as Intergranular stress corrosion cracking

3.3 Maintenance Codes or Practices for Active Components .

3.4 Equipment Qualification Practices

3.5 Applicable Aging Effects on Structure and Component Intended Function(s)

3.6 Aging Management programs

3.7 Plant-specific safety analyses which may have been based on an explicitly assumed plant life or operating period

3.8 Compilation of a list of reference documents

IAEA EBP on Safety Aspects of Long Term Operation of Pressurized Water Reactors

KNPP APPROACH

T. Ribarska
Maintenance Division, KNPP

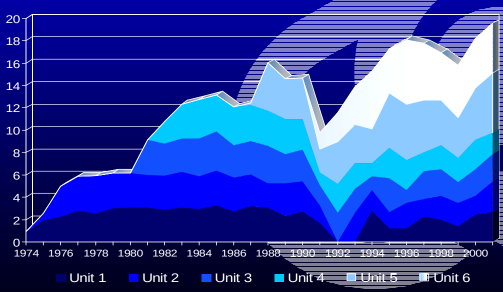
First Meeting of WG 2, Vienna 04 – 06 February 2004

KOZLODUY NPP
CONSTRUCTION AND COMMISSIONING

- 6 Units of total capacity of 3760 MW constructed and commissioned by stages
- 1970 - 1975: Units 1 & 2 of 440 MW each
  Pressurized Water Reactors, standard first generation Soviet design
- 1973 - 1982: Units 3 & 4 of 440 MW each
  Pressurized Water Reactors, enhanced first generation Soviet design
- 1982 - 1991: Units 5 & 6 of 1000 MW each
  Pressurized Water Reactors, standard second generation Soviet design

KOZLODUY NPP
ELECTRICITY GENERATION

- 1974 - 2003
  - 371.9 GWh gross electricity production
  - 344.4 GWh supplied to the grid

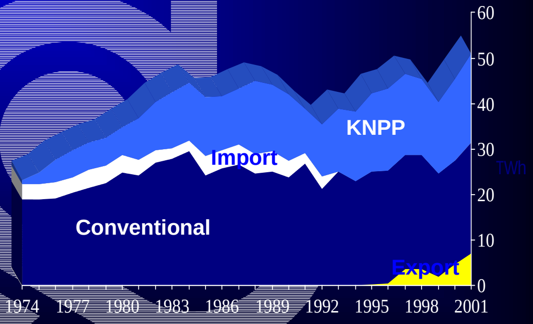


- 2002
  - Output 20.222 GWh
  - Units 1 to 4 producing half of the electricity
- 2003
  - Output 17.278 GWh

KOZLODUY NPP

IMPORTANCE FOR BULGARIA

- Last decade
  - 44% to 46% of the overall annual electricity production in Bulgaria



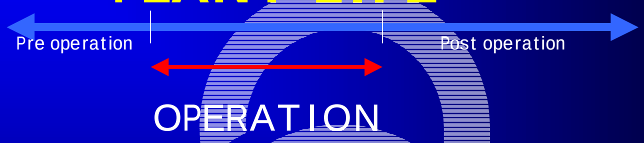
KOZLODUY NPP

THE ADEQUATE SUPPLY OF ENERGY IS ESSENTIAL FOR THE ECONOMIC DEVELOPMENT OF A COUNTRY

THE TASK OF PROVIDING COST EFFECTIVE, SAFE AND RELIABLE ENERGY WITH DUE CONCERN FOR SAFEGUARDING THE ENVIRONMENT IS BECOMING AN ESSENTIAL POLITICAL, ECONOMIC AND SOCIAL REQUIREMENT

KOZLODUY NPP

PLANT LIFE



- PLANT LIFE INCLUDES PRE- AND POST- OPERATION ACTIVITIES AND COVERS THE CHOICE OF PLANT, ARRANGING FINANCE, OBTAINING NECESSARY PERMISSIONS, ORDERING COMPONENTS, CONSTRUCTION, COMMISSIONING, OPERATION, PREPARATION FOR SHUTDOWN, DECOMMISSIOMING AND RETURNING THE SITE TO A 'GREEN' FIELD.
- PLANT LIFE REFERS TO THE PERIOD WHEN FINANCIAL CHARGES ARE MADE AGAINST THE PLANT

KOZLODUY NPP

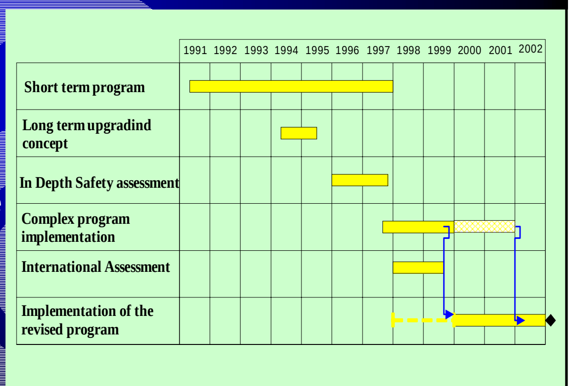
- **Life Plant Operation** is the period when electricity is made and sold and the NPP is making money to cover the initial costs and to make provision for the whole of the NPP Life cycle.
- It is **NOT** a defined period but it will determine the total electricity generated by the NPP, thus its revenue. Some countries have no specific regulations covering operating lifetimes. The plant can continue to operate if the plant is safe.

KOZLODUY NPP

- Long term operation is:
  - The most significant tendency of the present-day development of nuclear power
  - The most effective course of putting up funds for the preservation of generating supplies
- Strategic long term ”tools”are, such as:
  - Safety upgrade
  - Life management of critical systems

KOZLODUY NPP

- Since the early nineties, all units at Kozloduy NPP have been under continuous upgrading. For Units 1-4, initially the so-called short term upgrading programme has been implemented in the period 1992-1997. Extensive upgrading programmes were developed both for units 1-4 and for units 5-6 during the second half of nineties and are now under implementation.



KOZLODUY NPP

- The extensive improvement programme for Kozloduy units of 440 MW, referred to as PRG'97, has been developed using modern Western and IAEA standards and taking into account international findings and recommendations as well as Bulgarian own experience and analysis.
- The spectrum of upgrading measures covers the whole range of safety concerns for pressurized water reactors required by the current safety standards and international safety practice.
- The modernization has resolved all IAEA safety issues [IAEA-TECDOC-640], the requirements of the Complex Program for Modernization, as well as the IAEA and WENRA missions' requirements.

KOZLODUY NPP

- Main achievements:
  - The main safety goals of PRG'97 are accomplished;
  - All safety issues, identified by IAEA are resolved;
  - Units SAR is fully updated in line with the current requirements finalizing the process of units Periodic Safety Review;
  - The new safety case (V-209M) is comparable to V-213 model;
  - RLT Management program for the next 15 years has been developed;
  - Long term operational license for units 3 and 4 according to the newly established **Safe Use of Nuclear Energy Act (SUNEA)** has been obtained.

KOZLODUY NPP

- Evaluation of **Rest Life Time (RLT)** of Kozloduy NPP units 3 & 4 was executed by a Consortium between Framatome ANP GmbH, Germany and Atomstroyexport, Russia.
- The primary goals of this project was to perform an independent evaluation of the residual service life of structures, systems and components subject to acceptance by international experts, to identify the need for future investigations/calculations in certain cases, and to find solutions for improvements that achieve a consensus of safety and economy.
- The RLT Contract, which has been part of the comprehensive modernization program for Kozloduy NPP Units 3 and 4 comprised three phases:

KOZLODUY NPP

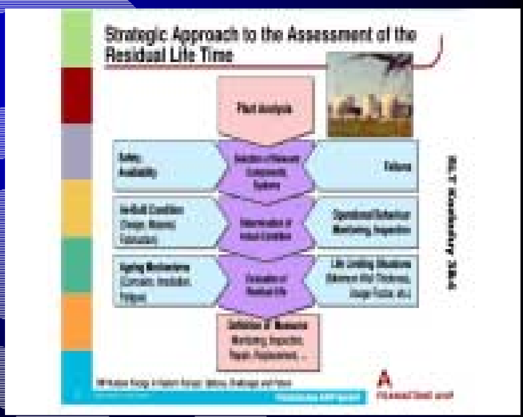
- The **First Phase** was the evaluation of the residual service life of representative (safety- and availability-relevant) components and systems of the two plants using state-of-the-art techniques.
  - The first step defined a list of structures, systems and components considered sensitive to aging degradation. The selection followed the classification of plant components elaborated by the IAEA, as well as the involved companies' experience;
  - Step 2 was to obtain knowledge on the actual condition of structures, systems and components by comprehensive review of existing information related to understanding of component aging, using all data available (from manufacturing, pre-/in-service inspection, walk downs, environmental conditions, operational data, failure and maintenance records, R&D, world-wide experience, etc.).
  - The third step defined the potential aging mechanisms, considering general knowledge and plant-specific information.

KOZLODUY NPP

- Step 4 considered the effects of the relevant life-limiting aging mechanisms. Evident proof had been provided that no life-limiting situation is reached under normal operational or transient conditions during the foreseen service life.
- The fifth step determined the residual service life of the structures, systems and components for the leading aging mechanism by appropriate algorithms e.g. stress and fatigue analysis and fracture mechanics analysis or alternatively engineering judgment. By evaluation of the results of all structures, systems and components the residual service life of the plant has been estimated, also considering economic and safety aspects.
- In the final step measures were defined where necessary to enable the structures, systems and components to achieve the remaining or - if intended - a prolonged service life.

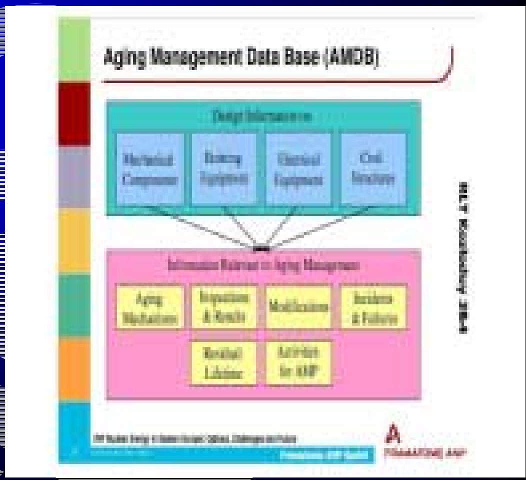
KOZLODUY NPP

- The result of these activities has been utilized for
  - review and integration of preventive maintenance activities,
  - measures for plant improvement in terms of safety and availability, and
  - further targeted in-service inspection and in-service monitoring tailored to the specific needs of the plant.



KOZLODUY NPP

- The Second Phase elaborated a computerized system structured for handling all relevant component or system data, from plant erection, involving relevant data gathered during plant operation and in-service inspection and replacement activities as well.



KOZLODUY NPP

- The Final Phase consisted of generating an aging management program that permits detection, evaluation and mitigation of the relevant aging degradation mechanisms and identification of plant locations where they are likely to occur.
- An effective aging management program (AMP) is dedicated to all structures, systems and components relevant to safety and critical for the residual service life. It is part of the maintenance program of specific plant units.

KOZLODUY NPP

- The continuous feedback of experience is essential to ensure on-going improvement in the understanding of the aging degradation and in the effectiveness of the AMP.
- This collection of activities is summarized for each structures, systems and components and referred to as Aging Management Program. By continuous (re-)evaluation and consideration of the results from the activities (e.g. in case of new R&D-results, new experiences gained conceptual changes) as well as by update of the AMP, the cycle of aging and plant life management is brought to a closed loop.
- The concept and strategy of such an AMP is consistent with current IAEA proposed practice and methodology .

KOZLODUY NPP

- As a conclusion of the RLT project it was stated, that there are **no general problems that might effect the plant operation till the expected 30 years of operation .**
- **Moreover, for the biggest part of the most-important components it was found out that they could operate significantly longer – for 35 or 40 years without major interventions.**

KOZLODUY NPP 1990 – 2003

- During the last decade Kozloduy NPP invested estimable efforts and financial funds in safety upgrades and operational safety culture enhancement. The safety level achieved complies with the internationally accepted requirements.
- This resulted in the provision of the operation licence for Unit 3&4 for the next 8/10 years, i.e. until its end of design life time.
- Further extension will depend on the successful implementation of RTL and AMP on our units.
- In fulfillment of Bulgaria international political commitments, the safe decommissioning of Units 1 and 2 started at the end 2002. The significant negative social, economical and environmental impact of the early closure should be addressed adequately

AGEING AND AGEING MGM. OF MECHANICAL COMPONENTS AND MATERIAL ESSENTIAL TO LTO OF PWR

MS: CZECH REPUBLIC

WG Member: ZDAREK JIRI, PhD

Nuclear Research Institute Rez near Prague (e-mail: zda@ujv.cz)

Representing: Regulatory Body (SUJB, Czech Republic)

Electric Utility (CEZ, Czech Republic)

TSO

SCOPE

1. APPLICABLE LAWS AND REGULATORY REQUIREMENTS; APPROACHES, PROCESSES AND PRACTICES
2. RESEARCH
3. OUTSTANDING TECHNICAL AND PROGRAMMATIC ISSUES
4. OPERATIONAL EXPERIENCE

RELATED TO:

AGEING AND AGEING MGM. OF MECHANICAL COMPONENTS AND MATERIALS

ESSENTIAL TO LTO OF PWR

1. APPLICABLE LAWS AND REGULATORY REQUIREMENTS; APPROACHES, PROCESSES AND PRACTICES

LAWS AND REGULATIONS-1

- ORIGINAL SOVIET/RUSSIAN RULES DO NOT CONTAIN ANY REFERENCE TO COMPONENT/PLANT LIFETIME ASSESSMENT AND, OF COURSE, FOR ANY LONG TERM OPERATION/PLEX
- LONG TERM OPERATION CAN BE UNDERSTOOD AS OPERATION BEYOND DESIGN LIFETIME
- DESIGN LIFETIME IS GIVEN IN THE DESIGN DOCUMENTATION AS RECOMMENDATIONS FROM COMPONENT MANUFACTURERS
- THUS, DESIGN LIFETIME IS MOSTLY NOT CALCULATED, BUT ONLY ASSESSED ON THE EXPERIENCE WITH SIMILAR TYPE COMPONENTS – IF CALCULATED, THEN ON THE BASIS OF DESIGN OPERATIONAL REGIMES AND CODE MATERIAL PROPERTIES

LAWS AND REGULATIONS-2

- ACTUAL RESIDUAL LIFETIME IS PERIODICALLY CHECKED/ EVALUATED IN PERIODIC REPORTS WHERE TRENDS OF THE COMPONENT LIFETIME USAGE SHOULD BE DOCUMENTED – REAL OPERATIONAL REGIMES, THEIR NUMBER AND POSTERIORITY AND OPERATION CONDITIONS SHOULD BE WELL INCLUDED ON THE BASIS OF SURVEILLANCE. THIS REPORTS ARE REGURALLY SUBMITED TO REGULATORY BODY
- CZECH LAWS AND RULES AS WELL AS SONS DOCUMENTS AND REGULATIONS DO NOT CONTAIN ANY CONCRETE REFERENCE TO THE DEFINITION OF DESIGN LIFETIME, THUS ALSO NO COMMENTS ON LONG TERM OPERATION/BEYOND DESIGN LIFETIME
- UNDER THE CURRENT PROCEDURE, THE LIVING OPERATIONAL SAFETY REPORT IS MAINTAINED. SONS GIVES A CONDITIONAL AUTHORIZATION FOR FURTHER PLANT OPERATION ON THE BASIS OF PERIODIC OPERATIONAL SAFETY REPORTS (EACH 10 YEARS) WITH ITS APPROVAL AFTER EACH YEAR´S PERIODIC INSPECTION AND MAINTENANCE RESULTS

LAWS AND REGULATIONS-3

- THUS, LTO COULD BE CONSIDERED ON THE BASIS OF RESULTS/ TRENDS FROM PERIODIC OPERATIONAL SAFETY REPORTS
- THE COMPREHENSIVE SAFETY ASSESSMENT INCLUDING AGEING IMPACT IS REQUSETED BY SONS (SEE LETTER FROM 1996)
- RULES FOR LTO APPROVAL SHOULD BE PREPARED AND CREATED BY THE SONS ON THE BASIS OF PLANT DEMANDS
- DESIGN COMPONENT/PLANT LIFETIME IS NOT A CONSTANT AS APPROVAL BY THE SONS IS GIVEN PERIODICALLY ON THE BASIS OF RESULTS FROM PERIODIC OPERATIONAL SAFETY REPORTS
- LIFETIME OF COMPONENTS SHOULD BE DETERMINED/ EVALUATED IN ACCORDANCE WITH „ASI“ DOCUMENTS (SECTION IV), VERLIFE „UNIFIED PROCEDURE FOR ASSESSMENT OF LIFETIME OF COMPONENTS AND PIPING IN WWER PLANTS DURING OPERATION“ AND SONS „REQUIREMENTS AND RULES FOR WWER RPVs AND INTERNALS LIFETIME EVALUATION DURING OPERATION“

CURRENT DESIGN CODES-1

- DESIGN CODES FOR WWER COMPONENTS IN CZECH REPUBLIC:
  - PLANTS IN OPERATION HAVE BEEN DESIGNED IN ACCORDANCE WITH FORMER SOVIET/RUSSIAN RULES/CODES/REQUIREMENTS
  - COMPONENTS WERE MANUFACTURED IN ACCORDANCE WITH THESE CODES/RULES FROM MATERIALS ALLOWED BY THESE CODES
  - EXCHANGE AND REPAIR COULD BE PERFORMED BY COMPONENTS MANUFACTURED IN ACCORDANCE WITH THESE RULES WITHOUT SPECIAL SONS APPROVAL
  - ANY EXCHANGE OF COMPONENTS MANUFACTURED ABROAD BY OTHER MANUFACTURERS AND/OR FROM OTHER MATERIALS (E.G. IMPORTED FROM OUTSIDE WWER COUNTRIES) SHOULD BE PERFORMED IN ACCORDANCE WITH „ASI“ NORMATIVE DOCUMENTATION (SECTIONS I AND II)

CURRENT DESIGN CODES-2

- NEWLY DESIGNED COMPONENTS FOR REPAIR/EXCHANGE SHOULD HAVE TO BE DESIGNED AND MANUFACTURED AGAIN IN ACCORDANCE WITH „ASI“ DOCUMENTATION (SECTIONS I, II AND III)
- ORIGINAL SOVIET/RUSSIAN DESIGN CODES AND RULES DO NOT CONTAIN REQUIREMENTS FOR SOME SPECIFIC PROPERTIES/OPERATIONAL CONDITIONS LIKE EQUIPMENT QUALIFICATION FOR HARSH CONDITIONS DURING LOCA AND OTHER LEAKAGE EVENTS
- SUCH RULES AND REQUIREMENTS (E.G. LBB, EQUIPMENT QUALIFICATION ETC.) HAVE TO BE PREPARED BY THE SONS FOR THEIR APPLICATION TO PLANTS/COMPONENTS

TIME LIMITED AGEING ANALYSIS-1

- ANALYSIS OF AGEING MECHANISMS SHOULD BE A PART OF PERIODIC SAFETY REPORTS OF COMPONENTS
- ANALYSIS OF AGEING MECHANISMS AND THEIR EFFECTS ON COMPONENT LIFETIME AND BEHAVIOUR IS A PART OF PLIM/AMP OF EVERY PLANT
- TIME LIMITED AGEING MECHANISMS ARE OF THE MAIN CONCERN IN PLIM/AMP OF THE PLANTS
- AMP HAS BEEN PREPARED FOR EACH PLANT AND IS NOW UNDER RE-CONSIDERATION WITH THE EXTENSION OF NUMBER OF KEY COMPONENTS TO BE CONTROLLED AND MANAGED – THIS REVISION IS BASED ON A NEW ANALYSIS OF AGEING MECHANISMS BASED ON AN OPERATIONAL EXPERIENCE, RESULTS FROM COMPONENTS SURVEILLANCE, IN-SERVICE INSPECTION AND MAINTENANCE AS WELL AS ON GENERIC RESULTS FROM SIMILAR PLANTS/COMPONENTS OPERATION

TIME LIMITED AGEING ANALYSIS-2

- POTENTIAL MITIGATION/MAINTENANCE/REPAIR/EXCHANGE ACTIONS RESULT FROM THE ANALYSIS TO ASSURE REQUIRED LIFETIME
- SUCH ACTIONS ARE BASED ON RESULTS FROM DAMAGED COMPONENTS – THEIR LIMITED AGEING MECHANISM SHOULD BE EITHER AVOIDED OR SUPRESSED AS MUCH AS POSSIBLE

2. RESEARCH

AVAILABLE RESEARCH RESULTS-1

LTO SHALL BE BASED ON:

- OPERATIONAL RESULTS AND EXPERIENCE
- RESULTS FROM SURVEILLANCE, INSPECTIONS AND MAINTENANCE
- CALCULATIONS OF OPERATIONAL REGIMES
- TREND CURVES OF MAIN AGEING MECHANISM EFFECTS IN KEY COMPONENTS

RESULTS FROM RESEARCH AND DEVELOPMENT PROGRAMMES ARE ALSO VERY USEFUL FOR EXPLANATION OF AGEING MECHANISM EFFECTS, THEIR POSSIBLE MITIGATIONS AND AVOIDANCE

FOR THIS PURPOSE, RESULTS FROM THE FOLLOWING PROGRAMMES CAN BE USED AND APPLIED FOR LTO ANALYSIS AND PROPOSALS:

- SURVEILLANCE PROGRAMMES INCLUDING SUPPLEMENTARY SURVEILLANCE PROGRAMME
- QUALIFICATION PROGRAMMES FOR NEW MATERIALS

AVAILABLE RESEARCH RESULTS-2

- PHARE PROJECTS ON RPV INTEGRITY
- PHARE PROJECT ON RPV REPAIR AND NEW WELDING MATERIALS
- PHARE PROJECTS ON REACTOR INTERNALS CHARACTERISATION
- PHARE PROJECTS ON NDE QUALIFICATION
- PHARE PROJECTS ON LBB APPLICATION
- NATIONAL PROJECTS ON COMPONENTS INTEGRITY ASSESSMENT, EQUIPMENT QUALIFICATION ETC.

AVAILABLE RESEARCH RESULTS-3

- VERLIFE „UNIFIED PROCEDURE FOR LIFETIME ASSESSMENT…“
- CALCULATIONS OF PTS REGIMES INCLUDING PROPOSALS FOR MITIGATION ACTIONS
- CALCULATIONS OF STRESS AND TEMPERATURE CONDITIONS ON KEY COMPONENTS
- SURVEILLANCE MEASUREMENTS OF OPERATIONAL CONDITIONS OF KEY COMPONENTS INCLUDING THERMAL STRATIFICATION, VIBRATIONS, FLOW ASSISTED EROSION ETC.

AVAILABLE RESEARCH RESULTS-4

- IAEA CRP ON „MASTER CURVE“ APPLICATIONS TO SURVEILLANCE PROGRAMMES
- IAEA CRP ON EALUATION OF IAEA DATABASE ON WWER RPV SURVEILLANCE DATA
- IAEA CRP ON RADIATION DAMAGE, ANNEALING AND RE-EMBRITTLEMENT OF WWER-440 WELD

3. OUTSTANDING TECHNICAL AND PROGRAMMATIC ISSUES

IAEA RER DESIGN BASIS MANAGEMENT

- GUIDELINE FOR DESIGN BASIS DOCUMENTS (DBD) COLLATION AND MAINTENANCE
- PILOT DBD FOR LP ECCS (WWER-440 AND 1000 TYPE)
- REVIEW AND VERIFICATION PROCESS

DESIGN BASIS

- THE IMPORTANCE OF HAVING ACCURATE KNOWLEDGE („KNOW WHY“) OF THE DESIGN BASIS AND DEEP TECHNICAL AWARENESS OF THE OPERATIONAL FUNCTIONALITY OF THE PLANT HAS BEEN COMING MORE IN FOCUS
- IT HAS BEEN RECOGNISED THAT THE CAPABILITY TO RESPOND TO ANY QUESTION REGARDING OF THE ORIGINAL DESIGN INTENTIONS AND COMPREHENSIVELY TO CLARIFY ANY FUNCTION OF THE PLANT DESIGN HAS TO BE ESTABLISHED AND MAINTAINED DURING THE WHOLE PLANT LIFETIME

IAEA RER PROPOSAL

ESTABLISHING AND MAINTAINING DESIGN BASIS REQUIREMENTS IN AN ON-GOING CONFIGURATION MANAGEMENT PROGRAM FOR NPP OPERATIONS AND MAINTENANCE.

PROJECT STRATEGY:

TO DEVELOP WELL-MANAGED, UNDERSTOOD AND PRESERVED SAFETY, DESIGN AND OPERATIONAL MARGINS.

PROJECT DESIGN ELEMENTS:

1. PROCESSES USED TO CHANGE OR VALIDATE THE DESIGN BASIS ARE RIGOROUS AND EFFECTIVELY IMPLEMENTED
2. LICENSING AND DESIGN REQUIREMENTS ARE WELL DEFINED, DOCUMENTED, CONTROLLED, AND RETRIEVABLE
3. PLANT EQUIPMENT CONFIGURATION AND PERFORMACE ARE CONSISTENT WITH DESIGN AND LICENSING REQUIREMENTS
4. ROLES AND RESPONSIBILITIES FOR ESTABLISHING AND MAINTAINING LICENSING AND DESIGN BASES ARE UNDERSTOOD AND APPLIED CONSISTENTLY
5. ULITITY LEADERSHIP ESTABLISHES A CULTURE THAT THOUGHTFULLY MANAGES SAFETY, DESIGN & OPERATIONAL MARGINS
6. CONDUCT OF DAY-TO-DAY OPERATIONS AND MAINTENENCE ACTIVITIES REFLECT CONSIDERATION OF LICENSING AND DESIGN BASIS, AS WELL AS OPERATIONAL, SATETY AND DESIGN MARGINS
7. DEVELOPMENT OF ASSESSMENT AND PERFORMANCE INDICATOR TOOLS TO ASSIST NPP MANAGEMENT WITH ON-GOING PROGRAMME MONITORING

4. IN-SERVICE INSPECTION OF WWER TYPE RPVs - A TOOL FOR LTO MANAGEMENT

IN-SERVICE INSPECTIONS OF WWER TYPE RPVs - A TOOL FOR RPV LTO MANAGEMENT

1. WWER TYPE RPV CIRCUMFERENTIAL BUTT WELDS – MECHANISED UT INSPECTIONS FROM INNER AND OUTER SURFACE
   - PERFORMED WITH PULSE ECHO TECHNIQUES ONLY TILL 2002 WITH VERY GOOD DETECTION, BUT LIMITED (HEIGHT) SIZING CAPABILITIES
   - SINCE 2003 USED QUALIFIED INSPECTIONS (PULSE ECHO + TOFD FOR CORE REGION BUTT WELDS) WITH SUBSTANTIALLY IMPROVED SIZING CAPABILITIES ENABLING TO DECREASE THE DESIGN SIZE DEFECT FOR PTS CALCULATIONS FROM 1/4 TO 1/10 OF RPV WALL THICKNESS
   - UT QUALIFICATION OF OTHER THAN CORE REGION BUTT WELDS CONTINUED IN 2003-2004

IN-SERVICE INSPECTIONS OF WWER TYPE RPVs CONTINUATION

2. OTHER WWER TYPE RPV QUALIFICATIONS CONTINUED IN 2004:
   - WWER TYPE RPV NOZZLE INNER RADII – MECHANISED UT INSPECTIONS FROM INNER/OUTER SURFACE – PULSE ECHO (TOFD) TECHNIQUES IN MAXIMUM SCOPE
   - WWER 440 RPV SAFE-END DISSIMILAR WELD – MECHANISED UT INSPECTION FROM INNER/OUTER SURFACE – PULSE ECHO (TOFD) TECHNIQUES IN MAXIMUM SCOPE
3. WWER TYPE RPV HEAD – NO QUALIFICATIONS PERFORMED NOR PLANNED FOR 2004-2005 (RPV HEAD PENETRATIONS, ETC.)

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5. IN-SERVICE INSPECTION OF WWER TYPE SGs

- A TOOL FOR LTO MANAGEMENT

IN-SERVICE INSPECTIONS OF WWER TYPE SGs - A TOOL FOR LTO MANAGEMENT

1. WWER 440 TYPE SG COLLECTOR THREAD HOLES - MECHANISED ET INSPECTION – THREADS AND THREAD HOLE LOWER PART AND BOTTOM INNER SURFACE
   - PERFORMED WITH NON-QUALIFIED TECHNIQUES TILL 2003 ESPECIALLY FOR THREADS WITH LIMITED DETECTION CAPABILITIES FOR THREAD HOLE LOWER PART AND BOTTOM INNER SURFACE
   - SINCE 2003 QUALIFIED ET INSPECTIONS USED FOR BOTH THREADS AND THREAD HOLE LOWER PART INCLUDING BOTTOM INNER SURFACE WITH SUBSTANTIALLY IMPROVED CAPABILITIES
2. VVER 440 SG COLLECTOR DISSIMILAR WELD – MECHANISED UT INSPECTION FROM OUTER SURFACE (PARTIALLY QUALIFIED IN PHARE 1.02/94, QUALIFICATION CONTINUATION PLANNED IN 2004-2005)

IN-SERVICE INSPECTIONS OF WWER TYPE SGs CONTINUATION

3. WWER TYPE SG TUBES – INNER SURFACE
   - ET NON-QUALIFIED OR PARTIALLY QUALIFIED INSPECTIONS PERFORMED TILL 2003 WITH LIMITED DETECTION AND SIZING CAPABILITIES
   - ET QUALIFICATION (FOR CIRCUMFERENTIAL ODSCC AND PITTING IN FREE SPAN/BENDS AND WEAR) COMPLETED WITH PRACTICAL TRIALS AT THE END OF 2003
   - SINCE 2003/2004 ONLY QUALIFIED ET INSPECTIONS WITH IMPROVED DETECTION AND SIZING CAPABILITIES PERFORMED

IN-SERVICE INSPECTIONS OF OTHER WWER TYPE COMPONENTS (CONTINUATION)

4. OTHER WWER TYPE INSPECTION AREAS WHERE UT QUALIFICATION IS COMPLETED OR CONTINUED

   - WWER 440 PRESSURISER DISSIMILAR WELD – MECHANISED UT INSPECTION FROM OUTER SURFACE – PULSE ECHO TECHNIQUE (NO INSPECTIONS UP TO NOW)
   - VVER 1000 ECCS DISSIMILAR WELDS – MECHANISED UT INSPECTION FROM OUTER SURFACE – PULSE ECHO TECHNIQUE (NO INSPECTIONS UP TO NOW)
   - WWER 1000 PRIMARY PIPING CIRCUMFERENTIAL WELDS OF 850 MM DIAMETER – MECHANISED UT INSPECTION FROM OUTER SURFACE – PULSE ECHO TECHNIQUE

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NEW R & D PROJECT FUNDED BY MINISTRY OF INDUSTRY AND ČEZ UTILITY

„METHODOLOGY AND TOOLS FOR LTO PROCESS“

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GOALS

1. PREPARE METHODOLOGY AND TOOLS FOR COMPREHENSIVE REMAINING LIFETIME ASSESSMENT BASED ON SUJB DEGREE REQUIREMENTS ON SELECTED SSCs AT REQUIRED TIME PERIOD
2. PREPARE EFFECTIVE REMAINING LIFETIME ASSESSMENT FOR THE PARTICULAR SSC IN CASE OF IMMEDIATE NEED
3. ORGANISE METHODOLOGY, TOOLS AND CONDITIONS FOR LTO WITH REQUIRED JUSTIFICATION

IAEA – EBP – SALTO – PWR – WG 2

4 – 6 February 2004
IAEA, Vienna, Austria

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COMMENT

A. PRESENT CONCERN: IDENTIFY INFORMATION FOR NEAR TERM INVENTORY WHICH WILL FULLY SERVE TO MEET DESCRIBED GOALS
B. DEFINITION OF „REPRESENTATIVE TYPE“ SSCs SERVING AS REPRESENTATIVE FOR SELECTED SSCs
C. DEVELOPMENT OF GENERAL MODEL FOR LTO MGM OF SSCs AND RELATION TO MAINTENANCE AND CHANGE PROCESS FULLY IN LINE WITH DB AND CM PROJECTS

IAEA – EBP – SALTO – PWR – WG 2

4 – 6 February 2004
IAEA, Vienna, Austria

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4. OPERATIONAL EXPERIENCE

- ALL MOST SIGNIFICANT COMPONENTS AND INFORMATION NEEDED FOR THE LTO PROCESS ARE ALLREADY IMPLACE OR UNDER SIGNIFICANT STAGE OF DEVELOPMENT
- WE WILL NOW CONCENTRATE ON ANALYSING AND DEVELOPING COMPREHENSIVE CONFIGURATION MANAGEMENT (CM) PROGRAM WHICH MOST DIRECTLY SUPPORT THE LTO.

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EXPECTED BENEFITS:

- MORE RELIABLE/CREDIBLE PLANT CONFIGURATION INFORMATION
- IMPROVED ABILITY TO IDENTIFY/MAINTAIN DESIGN BASIS INFORMATION
- REDUCE THE IMPACT OF AN „AGING WORKFORCE“ (MORE DANGEROUS THAN „AGING STEEL“)
- REDUCED MAINTENANCE WORK AND REWORK
- SINGLE SOURCE OF CONTROLLED INFORMATION
- FEWER NONCONFORMING REPORTS AND AUDIT REPORTS
- IMPROVED PLANT OPERATIONS
- ENHANCED TRAINING
- SATISFY REGULATORY REQUIREMENTS

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CLASSIFICATION OF THE SSCS MEETING THE LTO REVIEW REQUIREMENTS

- Classification based on existing Regulations for Safety Classes
- Classification developed for the EQ programme
- Classification for the PSR
- All above will be evaluated for the LTO Review Requirements

AGING MANAGEMENT FOR PASSIVE COMPONENTS

- Review of existing ISI, specifically ENIQ based Qualification Process for remaining critical components was presented

AGING MANAGEMENT FOR ACTIVE COMPONENTS (MAINTENANCE PROGRAMME)

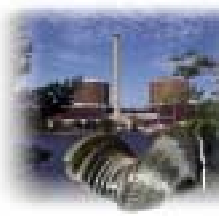
- Actuator and Valve diagnostics programme is prepared and under evaluation
- Other components (e.g. pumps) are under regular maintenance programme

PROCESS FOR INCORPORATING PLANT OPERATING EXPERIENCE (LOAD HISTORY)

- Pressure and temperature logs are evaluated regularly
- Thermal stratification programme is evaluated carefully
- Fatigue usage monitoring is in place

RESEARCH PROGRAMMES AND OTHER PROGRAMMES RELATED TO THE AGING MGM.

- This subject was covered during presentation



Loviisa NPP approaches to long-term operation

Ritva Korhonen, Fortum Nuclear Services Ltd

IAEA-EBP-LTO
1st Meeting of WG2 on Mechanical Components and Materials
Vienna, February 4 - 6, 2004

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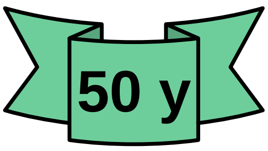
Loviisa NPP approaches to long-term operation

- **Main objective: safe and cost-effective operation**
  - Identification and management of the threaths
  - Planned long-term operation
  - Optimal utilization of limited resources
- **Lifetime goal:**



- **Loviisa plant long-term operation**
  - Approaches to plant life management
  - Examples of approaches to component life management

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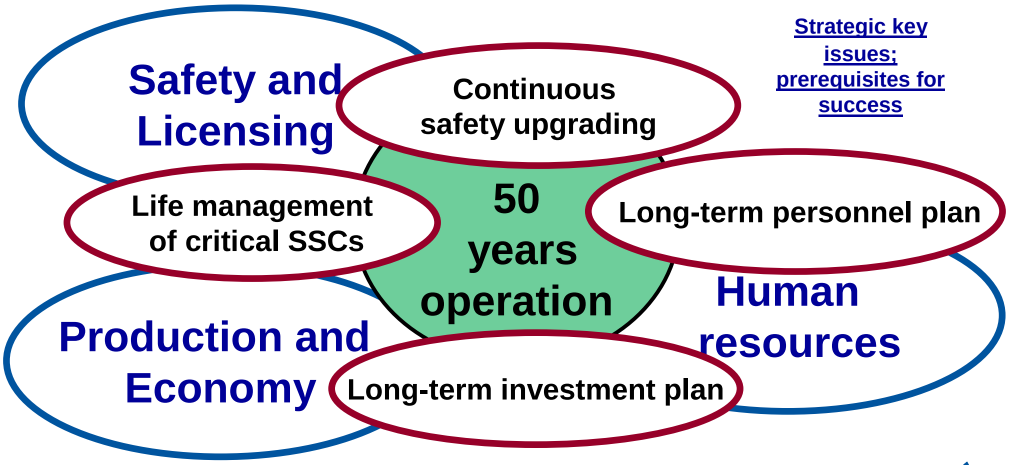
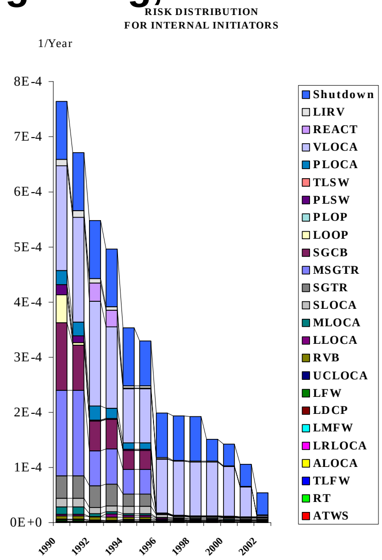
Loviisa NPP, strategic key issues and tools for long-term operation



Loviisa NPP approaches to long-term operation

- Continuous improvement of safety
- Modernization activities since 1990
- Long-term investment plan for years 2000-2015
- Implementation of plant life management as part of the plant organization's activities
  - Implementation of the PLIM programme is an important element of operating license renewal
  - Ensures safe and cost-effective plant operation
  - → activities for critical component ageing and life management
  - All maintenance and inspection activities should support PLIM

Safety upgrading, CDF development



Upgrading and modifications since 1990

Main condenser renewals 1989 - 1990
Coating of the HP-turbine casings 1990 - 1994

Replacement of HP- pre-heaters 1991- 1994
LOCA actuator replacements 1988 - 1991

Main gate valve repairs 1992 - 1996
New SG blowdown system 1992 - 1994

PRISE modifications 1996:
Additional emergency water tank
Additional pressurizer spray
New pressurizer safety valves
Automated isolation of steam generators
N16 detection in main steam lines

Severe accident management 2000-2003
Renewal of LP ECC pumps 2000-2002

SG primary collector modifications 1998 - 2004

Large secondary side piping renewals 1994 - 2000
Moisture separators for HP-LP steam lines 1992 - 2000
New SG FW manifolds 1994 - 2002

New secondary water chemistry,
New sump strainers 1994

Power upgrading 109% (turbines, generators, transformers) 1996 - 2002.
A new backup diesel driven sprinkler system 1996

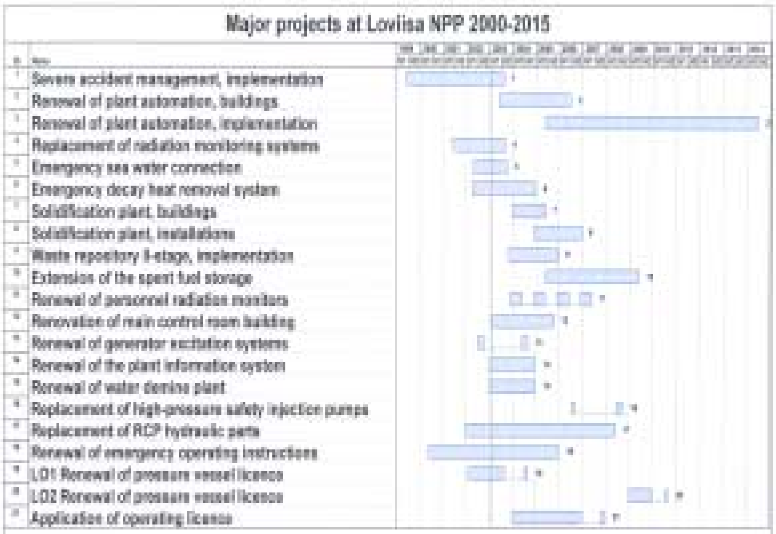
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003

Improved boron dilution control 1992-1998

Outage safety valves, RPV annealing 1996

RCP seal water improvements, New fire alarm system 1999 - 2001

Long-term investment plan until 2015



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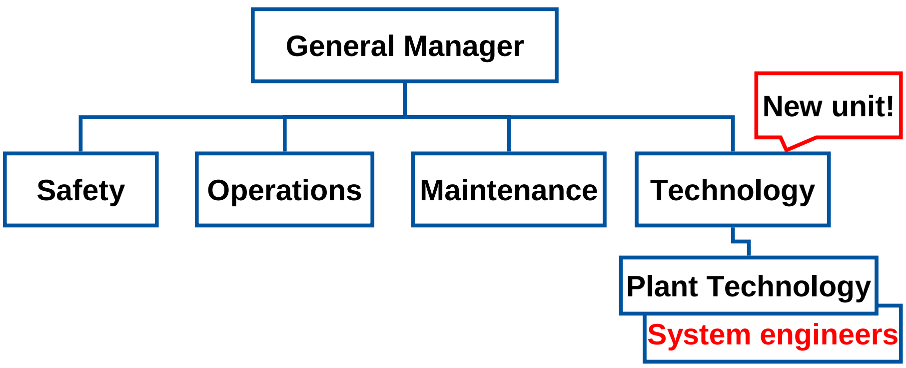
Implementation of Loviisa plant life management

New plant organization since 1.1.2002



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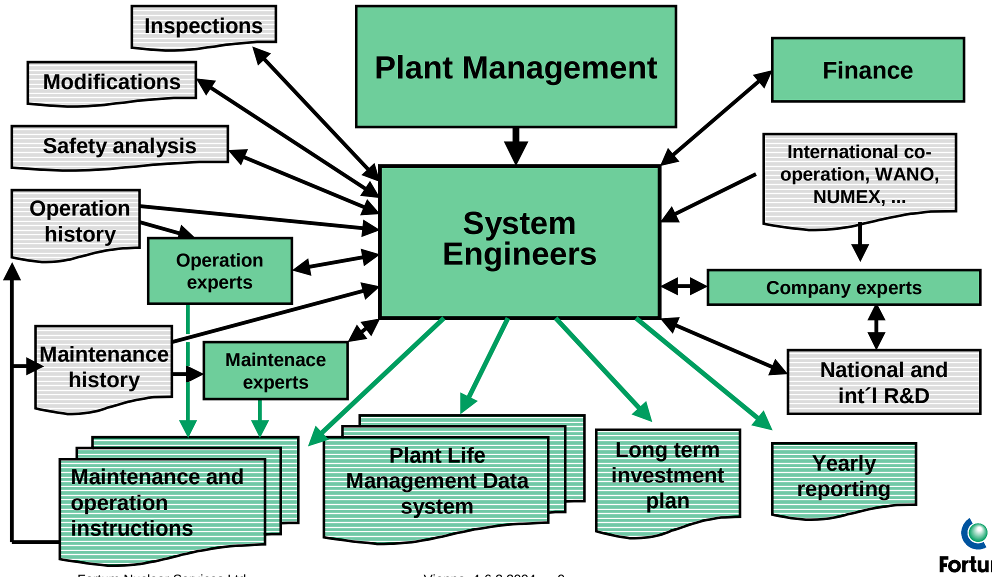
Implementation of Loviisa plant life management

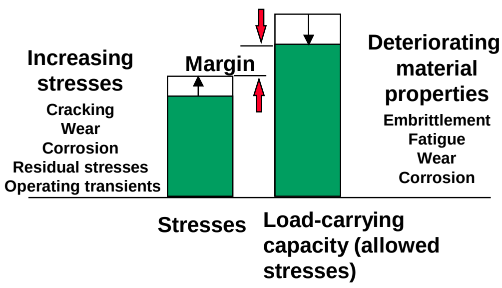


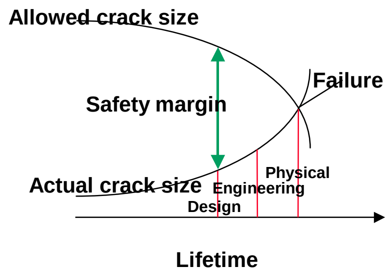
Long-term operation of the plant, general PLIM approach

The approach to plant life management consists of:

- **Identification of critical systems, structures and components (SSCs)**
- **Classification of the identified SSCs**
- **Identification of loadings and ageing mechanisms**
- **Method development for the lifetime prediction**
- **Identification and implementation of applicable ageing countermeasures**

Long-term operation of components





Component reliability

Component ageing and life

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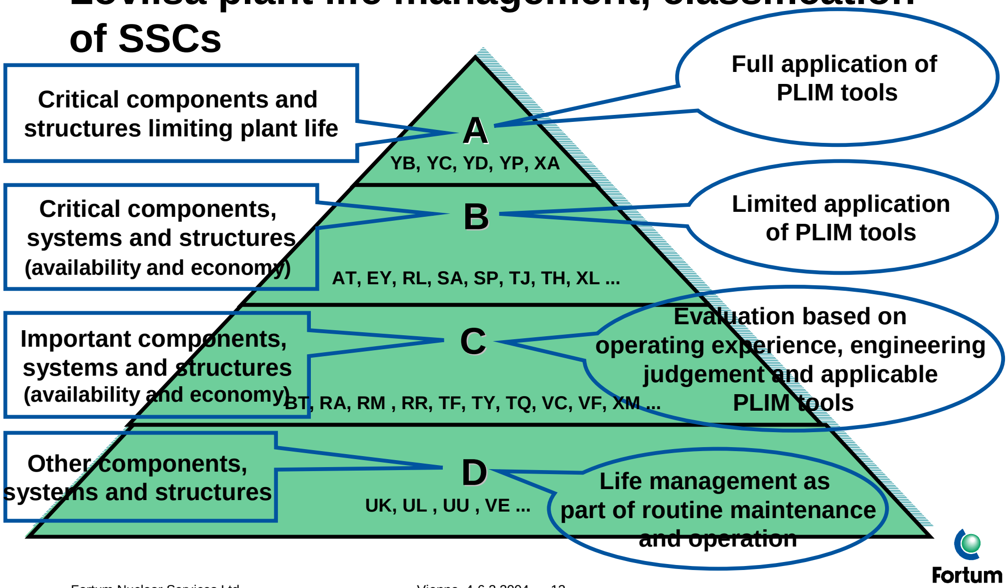
Loviisa plant life management, classification of SSCs



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Loviisa NPP's PLIM approach, classification of SSCs

<u>Class A</u>: Reactor pressure vessel, steam generator, pressurizer, main coolant pump, containment structures

<u>Class B</u>: E.g. primary circuit, high and low pressure safety injection systems, feedwater system, condencers, turbine, generators, diesels, ice condenser system, ...

<u>Class C</u>: E.g. nuclear intermediate cooling, sprinkler, drainage and vents, main steam line, main condensate, residual heat removal, circulating and service water systems, ice condenser cooling system, ...

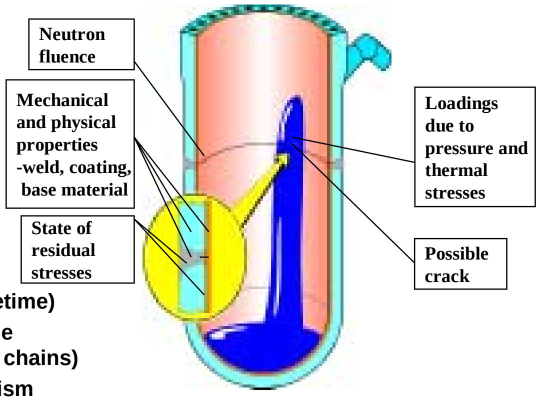
<u>Class D</u>: E.g. condenser purification system, auxiliary boiler plant, drinking water supply, sewerage, ...

Loviisa approaches to long-term operation of critical components, (class A)

Reactor pressure vessel

- Simple component, the critical area identified
- Main ageing mechanism radiation embrittlement
- Definition of loadings complicated
- Complicated analyses - continuous method development
- Inspections: visual, UT
- Research: RPV embrittlement management (licensing, 50 years lifetime)
  - re-embrittlement behaviour of the annealed weld (e.g. surveillance chains)
  - radiation embrittlement mechanism
  - methods for PTS analyses
  - qualification of NDT methods

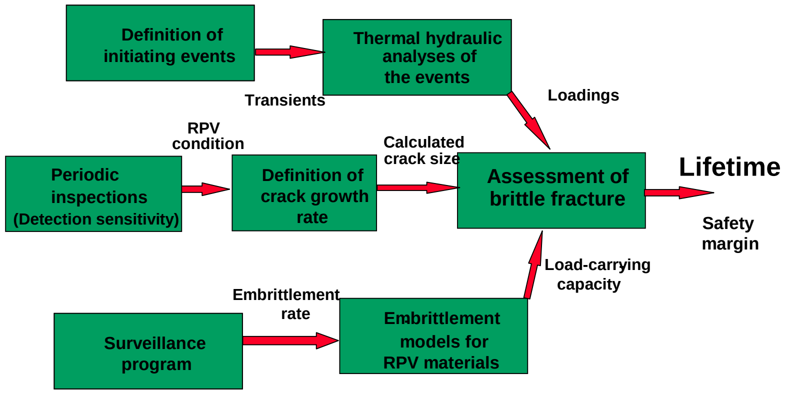
Lifetime management



Loviisa approaches to long-term operation of critical components, (class A)

Reactor pressure vessel safety analyses

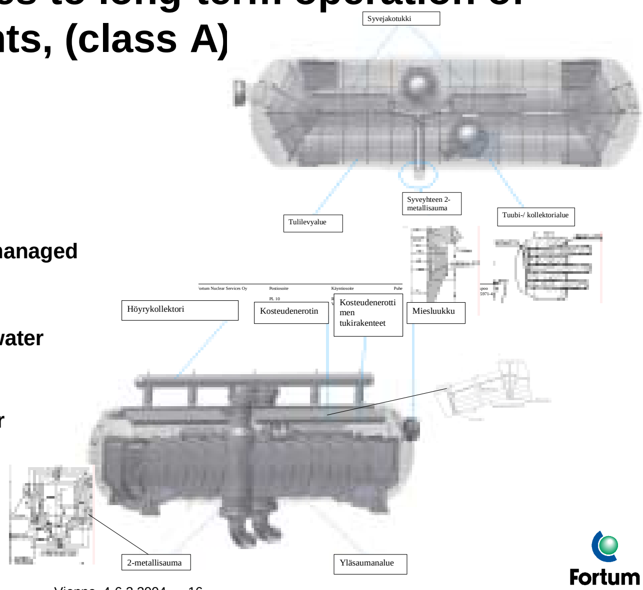
Pressurized thermal shocks (PTS)



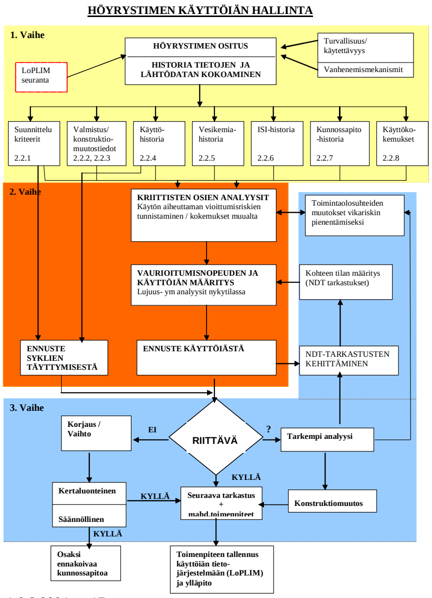
Loviisa approaches to long-term operation of critical components, (class A)

Steam generators

- Complicated component
- Several critical areas
- Several possible ageing mechanisms
- Large amount of data to be managed
- Data collection, analysis and management key issues
- Inspections: visual, UT, ET, water chemistry monitoring
- Research: methods for life management, effects of water chemistry, collector sealings
- Model for critical SSCs' life management



Loviisa approaches to long-term operation of critical components, (class A)



Approach for steam generator life management

- 1. stage: Identification of critical areas and data collection
- 2. stage: Initial analyses, assessment of ageing and lifetime prediction of critical areas
- 3. stage: Ageing countermeasures

Loviisa approaches to long-term operation of critical components, (class A)

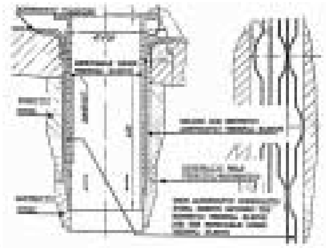
Pressurizer

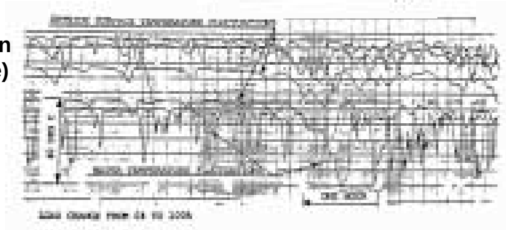
- Connections between austenitic piping and the pressurizer critical areas
- Inspections: visual, UT, monitoring of temperature, strain, pressure
- Research: thermal fatigue

Loviisa approaches to long-term operation of critical components, (class A)

Lower nozzle of the pressurizer

- Water temperature fluctuates significantly with state of loading (startup / spraying / warm-up / water level adjustment)
- Geometrical discontinuity
- Material discontinuity
- Inspection difficult
- Important to detect crack initiation and propagation (-> large leakage)





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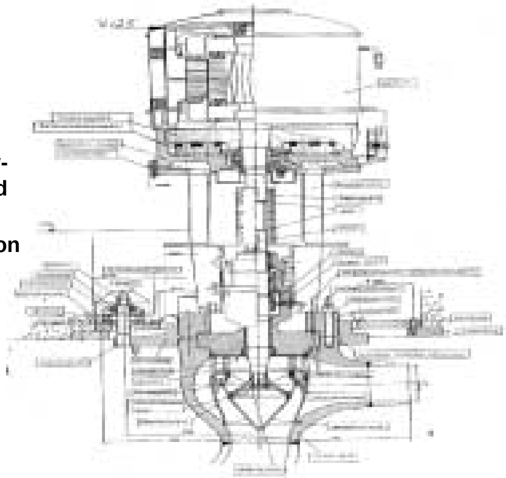
Loviisa approaches to long-term operation of critical components, (class A)

Main coolant pump

- Unique component
- Ageing mechanisms: corrosion fatigue possibly assisted with thermal fatigue, fatigue due to flow-induced vibration possibly assisted with thermal loads
- Inspections: visual, ET, UT, vibration monitoring
- Research: fatigue due to complicated loadings



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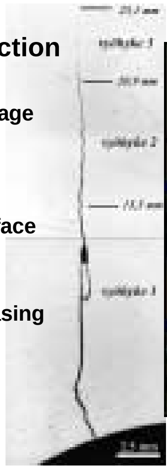
Loviisa approaches to long-term operation of critical components, (class A)

Degradation of pump suction stools

- Probable locations of damage known
- Actual stresses partly unknown
- Cracks opening to the surface (PT), branching of cracks
- New construction
- Refurbishment of pump casing and seals
- Elimination of vibrations

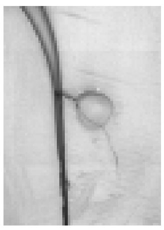


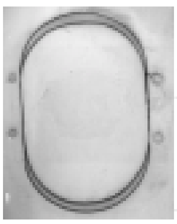
Fortum

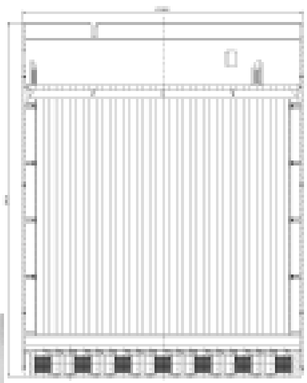
Loviisa approaches to long-term operation of critical components, (class B)

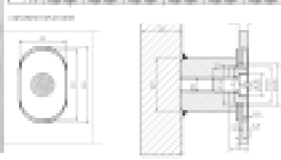
Reactor internals

- Embrittlement, (IASCC)
- Cracking of the radiation shielding plate and shielding plate attachment screws of core basket
- Inspections: visual
- Research: international IASCC programs, definition of internals' stresses during DBA and definition of allowed crack sizes of their critical areas









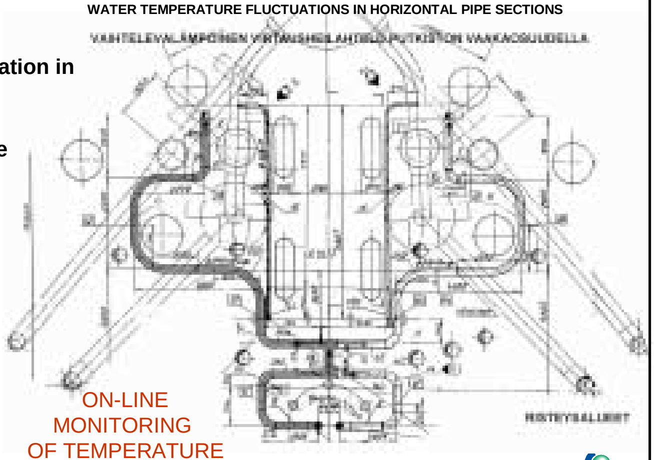
Fortum

Loviisa approaches to long-term operation of critical components, (class B)

Pressurizer surge line

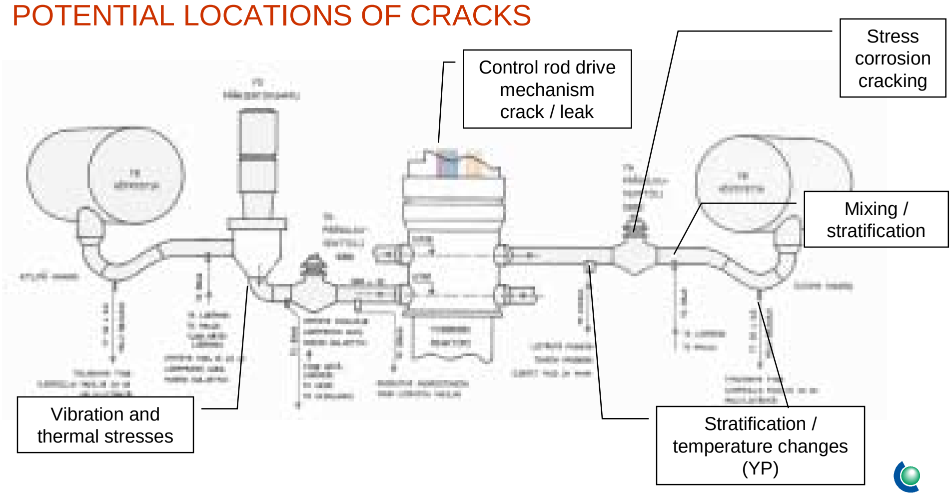
- Ageing mechanism: stratification in horizontal pipe
- Inspections: monitoring of temperature, strain, pressure
- Research: thermal fatigue

WATER TEMPERATURE FLUCTUATIONS IN HORIZONTAL PIPE SECTIONS



Loviisa approaches to long-term operation of critical components, (class A, B and C)

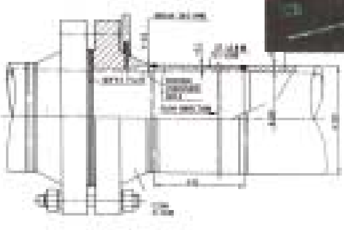
POTENTIAL LOCATIONS OF CRACKS



Loviisa approaches to long-term operation of critical components, (class B)

Secondary piping (feed water system)

- Two feed water line breaks
- Known ageing mechanism, large amount of possible erosion corrosion sites
- Extensive inspection programme
- Large amount of inspection data, requirements for data management
- Weak point analysis with computer program (erosion corrosion rate)
- Replacement of large portions of piping
- Change of water chemistry
- Power upgrading



Break in the flow control orifice of the feed water line

Loviisa approaches to long-term operation of components, other important issues to PLIM

- Obsolescence of automation -> modernization of instrumentation and control systems
- Gentle loading of components (transients, water chemistry)
- Maintenance strategy:
  - Assessment of component condition from reliability records, tests, inspections and condition monitoring
  - Active exchange of information
  - Redefinition of service and overhaul intervals
  - Repair or replacement of components before failure

Loviisa approaches to long-term operation of components, summary

Major challenges for near future

- Reliable and competitive production
- Extensive life management programs for critical SSCs
- Balanced investment plan for 50 years operation
- Implementation of major projects in normal outages
- Personnel generation exchange
- Preparedness for operating license application

Loviisa approaches to long-term operation of components, summary

Successful life management demands:

- Controlled plant operation and maintenance
- Proper timing of modernizations
- Continuous monitoring and upgrading of environment and component state
- Management of identified ageing effects
- Co-operation between experts of different fields
- Efficient use of limited resources
- Taking into account life management and its requirements in the whole plant operation

LONG TERM OPERATION AT PAKS NPP

PROJECT TASKS TO OBTAIN THE LICENCE IN PRINCIPLE

Sándor RÁTKAI PAKS NPP

CONTENT (ABOUT)

- Some basic information about Paks NPP
- The image of Paks NPP
- Legal frameworks, regulations
- Conception of Long Term Operation (LTO)
- License renewal at PAKS NPP
- Project plan (in technical sense, schedule)
  - Time Limited Ageing Assessments (TLAA)
  - Ageing management + ISI program review

CONTENT (ABOUT NOT!)

- Long term operation:
  - – environmental aspects
  - – human resources, plant staff ageing
  - – knowledge management
  - – political and social aspects

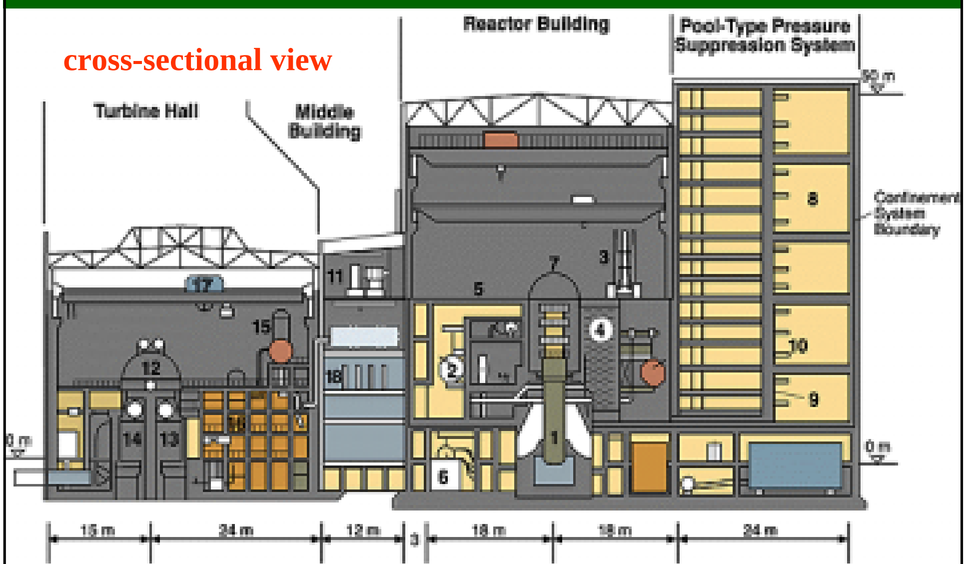
SOME BASIC INFORMATION ABOUT PAKS NPP

BASIC TECHNICAL DATA

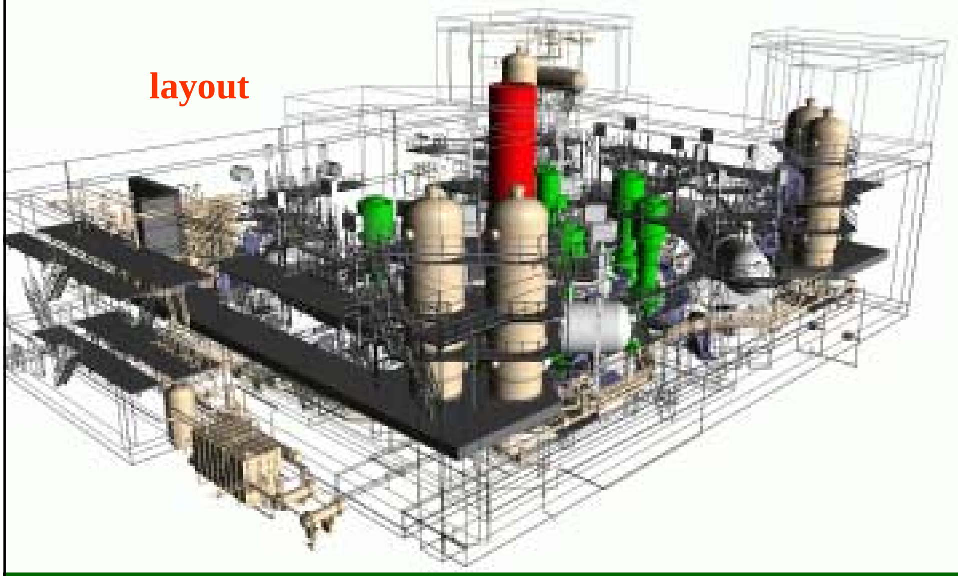
No. of Units	4
Type:	pressurized (light) water cooled, water moderated, reactor WWER-440, second generation V-213
No. of loops	6
Thermal power	1375 MW
No of turbines	2
Electrical power of the generators	2 x 230 MW
Electrical power	470 MW
Primary pressure	12,4 MPa
Pressure before the turbines	4,46 MPa
Average temperature of the coolant	282 °C
Dimensions of the core (hight/diameter)	2,5/2,88 m
Fuel	42 t Uranium oxide

BASIC TECHNICAL DATA

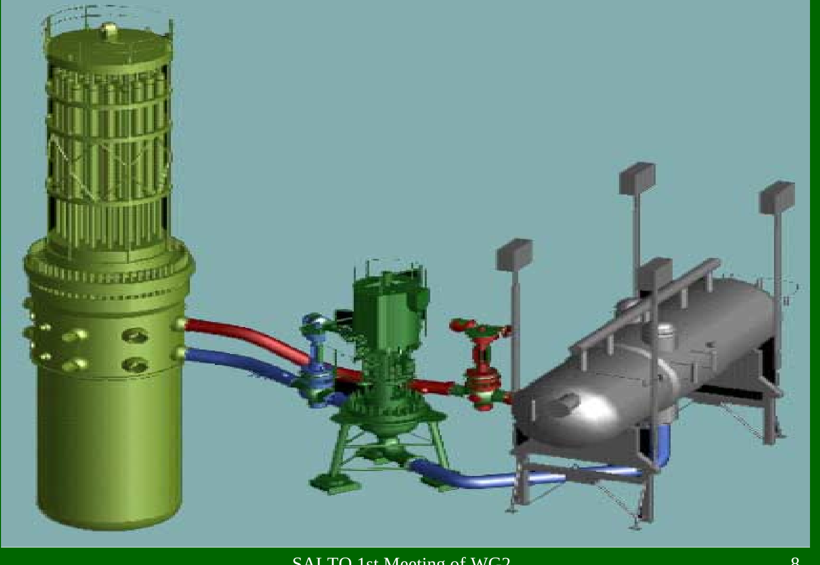
cross-sectional view



BASIC TECHNICAL DATA

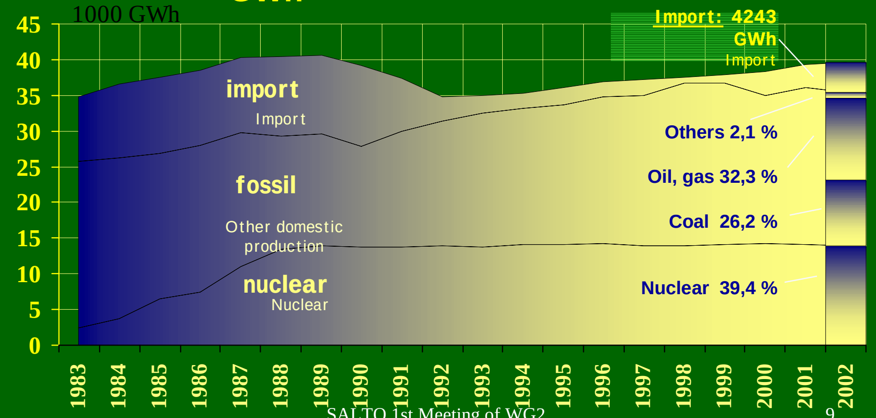


BASIC TECHNICAL DATA



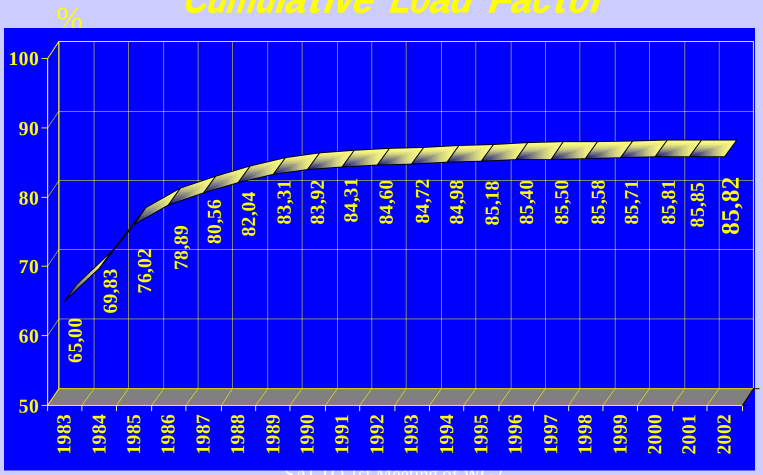
ROLE of Paks NPP

Domestic production: 35377 GWh



Operational experience

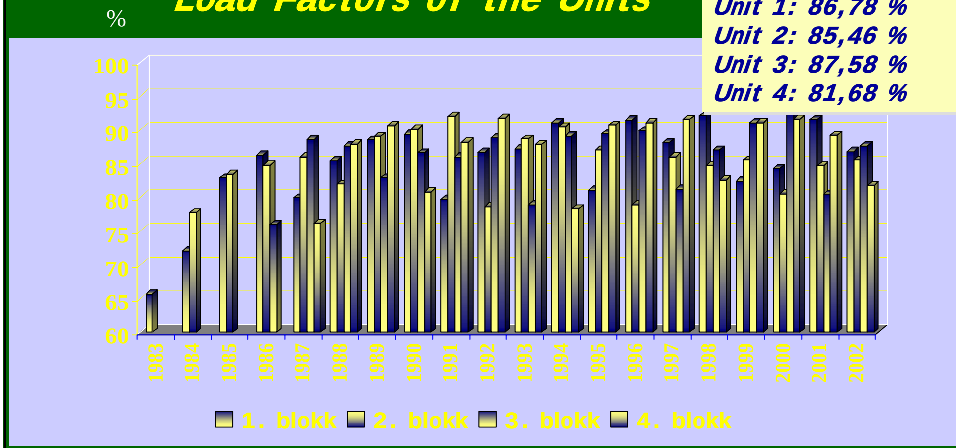
Cumulative Load Factor



Operational experience

Load Factors of the Units

2002
Unit 1: 86,78 %
Unit 2: 85,46 %
Unit 3: 87,58 %
Unit 4: 81,68 %



Unit 1 Unit 2 Unit 3 Unit 4

THE IMAGE of PAKS NPP

STRATEGIC OBJECTIVES OF PAKS NPP

- ***BASIC GOAL*: MAINTAIN THE SAFETY LEVEL ACCORDING TO THE INTERNATIONAL REQUIREMENTS**
- **EXTENSION of OPERATIONAL LIFETIME :**

  ORIGINAL DESIGN LIFETIME + 20 YEARS = 50 YEARS OF OPERATION
- POWER UPRATING UP TO 500 MW

  (8% OF REACTOR THERMAL POWER)

LEGAL FRAMEWORKS, REGULATIONS

GENERAL LEGAL FRAME

- Act on Nuclear Energy, 1996, NUCLEAR SAFETY REGULATIONS, 1997
- Act on the Environment, water usage
- Act on Electric Energy (new, market liberalisation beginning from 2003)

THE HUNGARIAN NUCLEAR REGULATION FOR LTO

- **GOV. DECREE 108/1997, NUCLEAR SAFETY REGULATION:**
  - **LICENSE RENEWAL:** THE DESIGN LIFE TIME IS 30 YEARS; IT CAN BE EXTENDED, THE LICENSEE HAS TO SUBMIT TO THE AUTHORITY THE APPLICATION FOR THE LIFE TIME EXTENSION 5 YEARS BEFORE DESIGN LIFE TIME EXPIRES (Unit No 1, 2007),

    TWO STEP PROCESS!: PRINCIPAL APPROVAL in 2007, LICENSE RENEWAL in 2012
  - THE SYSTEM OF **PERIODICAL SAFETY ASSESSMENT** EXISTS (next in 2008), PSR AS SELF ASSESSMENT AND REPORTING OBLIGATION
  - **ANNUAL UPDATING OF THE FINAL SAFETY REPORT** EXISTS (FSR ACCORDING TO REG. GUIDE 1.70, A PROJECT FOR DESIGN BASIS RECONSTRUCTION AND REG.GUIDE 1.70 COMPLIANCE IS GOING ON, 2004)

REGULATORY GUIDELINES

1. Licence Renewal
   - 4.15 - License-Renewal program during operation of NPPs
   - 1.28 - Content of License Renewal application report
2. Preconditions to obtain the licence renewal in-principle
   (four leg philosophy of the Hungarian Regulation – absolutely necessary condition)

2.1. Ageing Management

- 3.13 - Ageing Management Considerations during Design of NPPs
- 4.12 - Ageing Management during Operation of NPPs
- 2.15 - QA in Ageing Management Program
- 1.26 - Regulatory control of AM Program
- 1.26.S1 - Scope of SSCs in AM Program
- (no) - PTS guide (new)

2.2. Design Basis Reconstruction

- No guides were issued
- The necessary requirements were declared in the QA-Manual for FSAR elaboration

2.3.Maintenance Rule

- 4.18 - Guides for Maintenance Program of NPPs
- 1.27 - Regulatory Monitoring of the Effectiveness of the Maintenance Program

2.4.Environmental Qualification

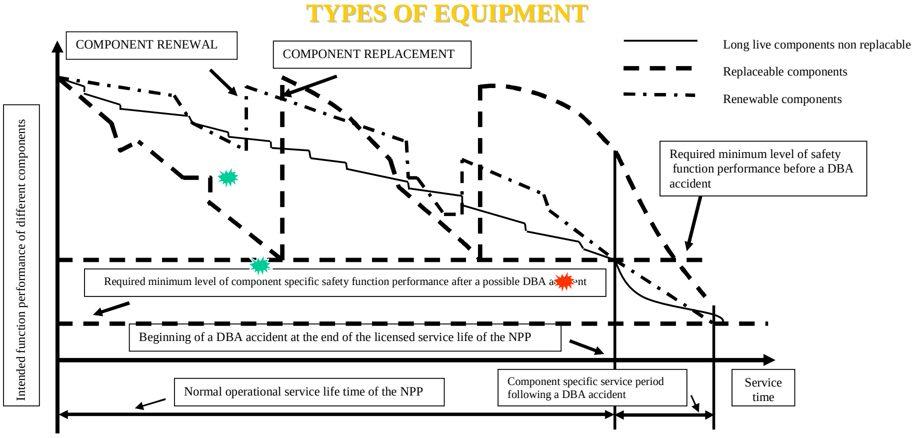
- 3.15 - E-Q requirements during design of NPPs
- 3.15.S1 - Standards for E-Q
- 4.13 - E-Q and its preservation during operation of NPPs
- 1.27 - Regulatory Control of E-Q and its preservation

MAIN SOURCES of the LR BACKGROUND DOCUMENTS

- **AGING MANAGEMENT**
  - IAEA AM GUIDELINES, TECHDOCS
  - VVER AMP REPORTS
  - NPAR REPORTS
  - OECD AMP REPORTS
  - GALL REPORT
  - ACI, ASME, IEEE CODES
- **LICENCE RENEWAL**
  - NRC LR RULE
  - LR APPLICATIONS
  - NEI 95-10
  - USNRC LR STANDART REVIEW PLAN
- **MAINTENANCE RULE**
  - 10CFR50.65
  - NUMARC 93-01
  - NRC INSPECTION REPORTS
  - NUREG 1648
- **TLAA -FATIGUE**
  - PARTLY AVAILABLE ORIGINAL DESIGN CALCULATION
  - PNAE
  - ASME III
  - NPAR REPORTS
  - NUREGS
- **TLAA RPV-PTS**
  - IAEA WWER-PTS GUIDE
  - ASME XI
  - EU VERLIFE
  - LOVIISA PTS PRACTICE
- **I&C EQ IN HARSH ENVIRONMENT**
  - IEEE EQ CODES
  - IAEA CABLE AMP GUIDELINE
  - OECD CABLE AMP REPORT
  - LOVIISA PRACTICE
  - VERSAFE REPORT

CONCEPTION of Long Term Operation (LTO)

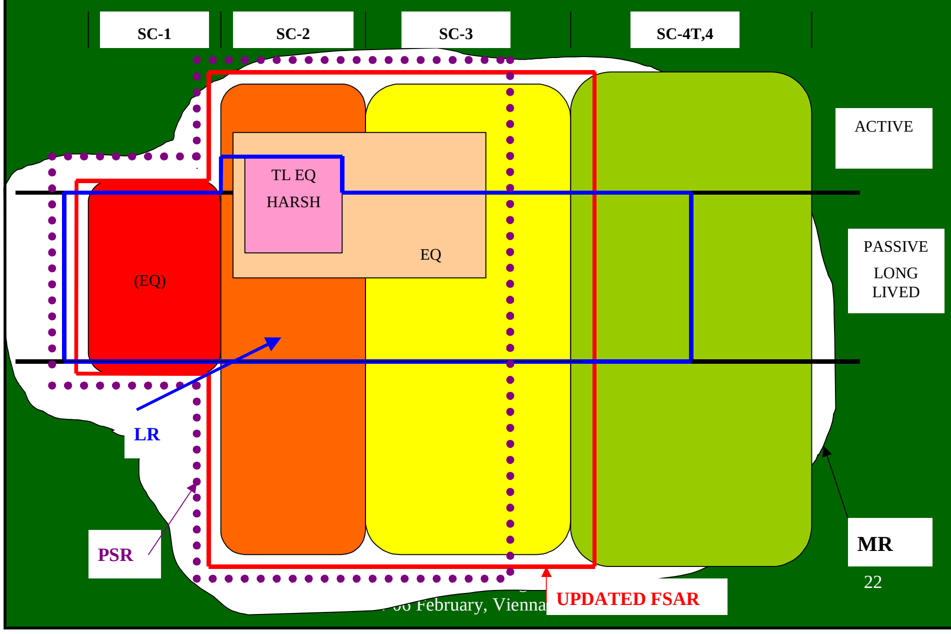
RELATIONSHIP OF THE SAFE LICENSABLE SERVICE LIFE OF THE NUCLEAR POWER PLANT – AND THE AGING PROCESS OF DIFFERENT TYPES OF EQUIPMENT



THREE MODELS FOR REGULATION OF LONG TERM OPERATION

- The concept of the periodic safety review
- The plant life management
- The concept of License Renewal

SCOPE OF THE FSAR, PSR, LR and MR

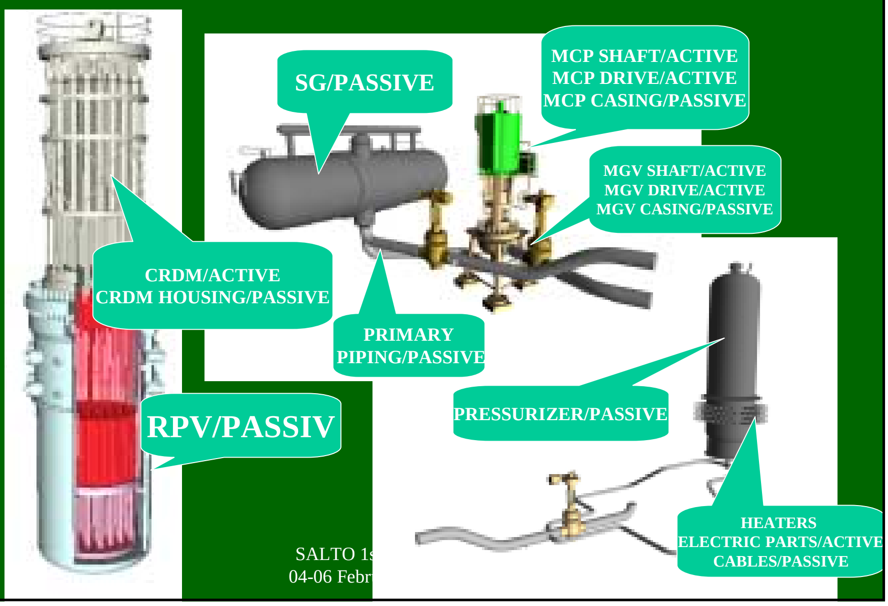


PASSIVE/ACTIVE SCC

- **Passive components:**
  – That perform an intended function without moving parts or without a change in configuration or properties
- **Active components:**
  – That perform an intended function with moving parts or with a change in configuration or properties

- **Examples of passive intended functions**
  – Pressure-retaining boundary
  – Filtration
  – Structural support
  – Provide electrical connections to specified sections of an electrical circuit to deliver voltage, current, or signals
  – Heat transfer
  – Fire barrier
- **Examples of active intended functions**
  – Valve opening/closing
  – CRDM inserting
  – Flow pumping
  – Temperature measuring

TYPICAL MAIN PASSIVE/ACTIVE VVER 440/213 COMPONENTS



The License Renewal concept of LTO HUNGARIAN APPROACH

- The concept of Licence Renewal (LR) is usually followed by the countries where the operational licence is granted for a fixed time span limited either by the design lifetime or other considerations.
- This concept is based on the correlation between the continuous control of the CLB and the control of those aspects of the plant safety, which are depending on the unavoidable ageing of safety related SSCs.
- In these regulatory systems the CLBs are maintained and they are documented in the (annually updated, living) Final Safety Analysis Report (FSAR).
- In addition to this, the efficiency of the maintenance system is controlled with some performance criteria for the active safety related SSCs.
- The LR process itself is focused on the ageing management of long-lived passive SSCs, on the review of the validity of the time limited ageing analyses and environmental qualification of long live harsh environment SSCs.

CONDITION OF LTO – MAINTAIN CRL

DESIGN LIFETIME (30 years)

Safe operation
Condition monitoring:
•inspections and tests,
•ISI
Condition maintaning:
•maintenance, upgrading
•refurbishment
EQ (**finalisation**)

+

PLEX (+20 years)

•TLAA
Time limited EQ
Development of ageing management program

Ageing management
Environmental qualification
Monitoring the effectiveness of maintenance
Development of FSR

LICENSE RENEWAL AT PAKS NPP

(project plan in technical sense, schedule)

FEASIBILITY OF LICENSE RENEWAL

- 1995-1999, PERIODIC SAFETY REVIEW OF ALL UNITS, AGEING ASSESSMENTS, START OF AGEING MANAGEMENT ACTIVITIES
- 2000, FEASIBILITY STUDY AND BUSINESS PLAN FOR LR

FINDINGS OF PLANT ASSESSMENT

1. Reactor Pressure Vessel

DOMINATING AGEING MECHNANISM: EMBRITTLEMENT

- UNITS 3-4, 50 YEARS WITHOUT EXTRA MEASURES
- UNIT 2, FOR 50 YEARS HEATING OF THE ECC TANKS MIGHT BE REQUIRED
- UNIT 1, FOR OVER 40 YEARS ANNEALING MIGHT BE REQUIRED + THE HEATING OF THE ECC TANKS

2. Steam Generator

DOMINATING AGEING MECHNANISM: LOCAL CORROSION OF THE HEAT EXCHANGING TUBES FROM THE SECONDARY SIDE

50 YEARS FEASIBLE WITHOUT SG REPLACEMENTS

AGEING MANAGEMENT: condenser replacement, high pH water chemistry to save SG

PLANS, SCHEDULES

- 2001: PREPARATORY PROJECT LAUNCHED
- 2002: final business decision of the owner, development of the detailed project plan
- 2002: development of detailed Regulatory Requirements
  2002-2007: preparation of LR, development of the life time management programme, preparation of the documents for licensing, partial implementation of measures, environmental protection licensing
- 2007(2006): application for in-principle approval of extended operation
- (2008: PSR)
- 2012: approval and license for 50 years

TIME SCHEDULE IS DRIVEN BY REGULATORY PROCESS

REVIEW OF THE PROJECT TASKS

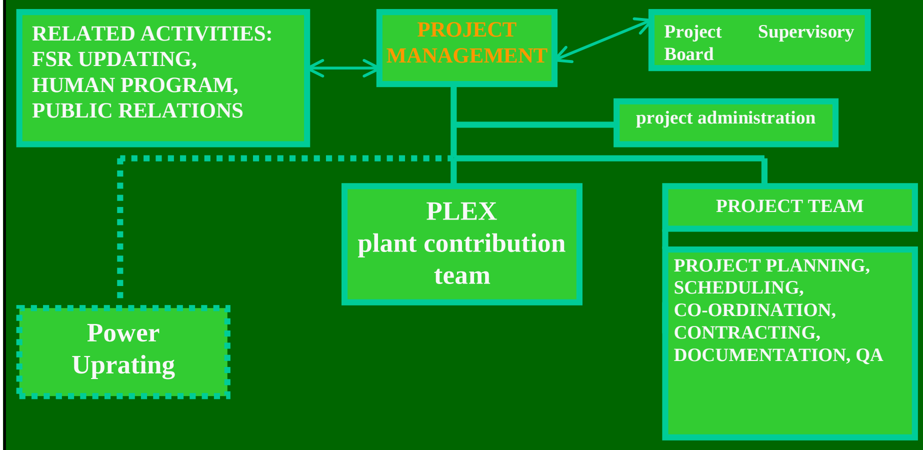
No.	Tasks of the project
1.	Determination of the scope of the license renewal and methodology
2.	Overall review of the current ageing management practise
3.	Solving the currently known unresolved issues (from feasibility study)
4.	Time Limited Ageing Assessment (TLAA)
5.	Other TLAA tasks
6.	Currently known ageing management measures
7.	Introduction of the new maintenance rules: evaluation, methodological task, development of programs
8.	Finalisation of the programs for equipment qualification + methodology development
9.	Condition maintaining activities (making reconstruction plans)
10.	Elaboration of the measures derived from the comprehensive review of the current ageing management programs
11.	Activities to obtain the nuclear safety licence-in-principle
12.	PR activities
13.	Implementation of the reconstruction and investment plan
14.	Finalisation of the EQ (deficiencies)
15.	Fulfilment of the new maintenance rules (effectiveness)

WHO AND HOW SUPPORTS THE PROJECT TECHNICAL WORK?

International co-operations:
- IAEA expert missions, EU frameworks (VERLIFE, VERSAFE), NRC (not directly?)
- FORTUM? (independent review)

Domestic support:
- Expert team(s) at Paks NPP
- Scientific committees at the fields below:
  - reactor pressure retaining parts+internals
  - other pressure retaining safety components (SC-1, SC-2)
  - civil structures
  - erosion/corrosion
  - ISI + inspection qualification
- TSO (VEIKI)

PROJECT ORGANIZATION



TIME LIMITED AGEING ASSESMENTS (TLAA)

MAJOR TIME LIMITED AGEING ASSESSMENTS

FATIGUE CALCULATIONS:

- PARTIAL RE-DESIGN IS NEEDED FOR THE MAIN SAFETY RELATED COMPONENTS
- ASME III METHODOLOGY
- RUSSIAN MATERIAL DATA

PTS CALCULATIONS:

- RE-DESIGN IS NEEDED
- METHODOLOGY IS BASED ON THE INTERNATIONAL PRACTICE (IAEA,VERLIFE,ASME,PNAE)
- POSTULATED DEFECT INITIATION/ARREST,WPS,RESIDUAL STRESSES,CLADDING
- EOL FLUENS CALCULATIONS TO BE VALIDATED BY DOSIMETRY (SURVEILLANCE,CAVITY)

TIME LIMITED AGEING ASSESSMENTS (FATIQUE)

- Review of the load cycles and the required number of cycles assuming 60 (50+10) year operating time.
- Determine the “re-design“ load curves, which represent uniform conservatism for fatigue calculations of equipment with safety class 1-2
- Perform fatigue analysis (+in limited scope redesign) of the equipment with safety class 1-2 for 60-year operating time.
- Review of the current cycle monitoring activities, the monitored CUF affecting parameters, the required additional measurements relating to the completeness of monitoring

TIME LIMITED AGEING ASSESSMENT
(PTS)

- Complete the list of initial PTS events, which have to be analysed (Screening criteria is: 10^{-5}/year)
- Conduct the thermal hydraulic analysis of PTS events with frequency of more than 10^{-5}/year
- Determination of maximal acceptable transition temperature of the critical reactor vessel components with stress and fracture mechanical analyses.
- Estimation of the RPVs fast neutron fluence taking into 3D behaviour of neutron flux. Harmonisation the calculation of the fluent and dosimetry measurements.

TIME LIMITED AGEING ASSESSMENT
(PTS cont.)

- Evaluation of embrittlement properties of the critical locations of the reactor vessel. Preliminary estimation of the above features for the extended lifetime considering the power uprating option.
- Determination of the licensable lifetime of the reactor vessels (taking into account the effect of heating up the EEC system, annealing, shielding,LLC etc.)
- Evaluation of the experiences connected to annealing, elaboration of the required activities

OTHER TYPICAL TLAA TASKS

- Check on (In the frame of FSAR updating)the existence of other TLAAs + extension of that beyond 30 years
- Evaluation the stability of detected indications (crack propagation calculations)
- Identification of sensitive SC 1-2 components from point of view thermal stratification + introduction “sampling type” monitoring system + evaluating the critical equipment against fatigue
- Analysis of the thermal embrittlement degradation mechanism of steam generator and pressurizers housing (p-T curves; 22K)

AGEING MANAGEMENT PROGRAM

CONTENT AGING MANAGEMENT REVIEW

- (a) Programe policy, organization and resources.
- (b) A documented method and criteria for identifying SSCs covered by the
- ageing management programe.
- (c) A list of SSCs covered by the ageing management programe and
- records that provide information in support of the management of ageing.
- (d) Evaluation and documentation of potential ageing degradation that may
- affect the safety functions of SSCs.
- (e) The extent of understanding of dominant ageing mechanisms of SSCs
- (f) The availability of data for assessing ageing degradation, including
- baseline, operating and maintenance history.
- (g) The effectiveness of operational and maintenance programmes in
- managing aging of replaceable components.
- (h) The programe for timely detection and mitigation of ageing
- mechanisms and/or ageing effects.
- (i) Acceptance criteria and required safety margins for SSCs.
- (j) Awareness of physical condition of SSCs, including actual safety margins,
- and any features that would limit service life.

These issues are identical those of belonging to LR concept LTO, but we should concentrate efforts only on the long live passive SSCs

PRACTICAL STEPS FOR AGEING MANAGEMENT

- Identification the scope of the ageing management
- Definition of dominant ageing mechanism and stressors
- Identification of sensitive locations
- Characterisation of dominant ageing mechanism (calculations and analyses)
- Determination of monitoring parameters
  - installed technological measurements
  - installation of new measurements (example:surge line)
  - review of ISI operation and ISI plans
- Development of data base for ageing monitoring
- Data acquisition
- Fill the monitoring system
- Analyse, feed back (maintenance, operation, conditions keeping

LIST OF COMPONENTS
NEEDS AGEING MONITORING

- REACTOR PRESSURE VESSEL
- REACTOR VESSEL INTERNALS
- REACTOR VESSEL SUPPORTS
- CONTROL ROD DRIVE MECHANISM
- REACTOR COOLING SYSTEM
- PIPING CONNECTED TO RCS
- STEAM GENERATOR
- MAIN CIRCULATING PUMP
- PRESSURIZER
- MAIN GATE VALVE
- HYDROACCUMULATOR
- HIGH SAFETY SIGNIFICANCE PUMPS, VALVES AND CONNECTING PIPING
- EMERGENCY DIESELGENERATOR
- CABLES
- CONTAINMENT STRUCTURE
- CONTAINMENT PENETRATIONS (MECHANICAL AND ELECTRICAL)
- CONTAINMENT ISOLATION VALVES
- CONTAINMENT LINERS
- FEED WATER PIPING, PUMPS,VALVES

- IN THE NEAR FUTURE ADDITIONAL COMPONENTS WILL BE ANALISED !
  - SAFETY RELATED HEAT EXCHANGERS
  - PIPING SUPPORTS
  - SPENT FUEL POOLS
  - CONTAINMENT VENTILLATION SYSTEM

TYPICAL CONTENT OF THE AMP REVIEW REPORTS
ASSESSMENT OF THE AGING PROCESSES IN THE DESIGN

1. IDENTIFY AGING RELATED OPERATIONAL PROCESSES AND ENVIRONMENTAL CONDITIONS
   - 1.1. OPERATIONAL PARAMETERS OF THE SYSTEMS
   - 1.2. NORMAL OPERATIONAL CYCLES.
   - 1.3. SPECIAL OPERATIONAL MODES
   - 1.4. WATER QUALITY NORMS - CORROSION - STRESSORS
   - 1.5. ENVIRONMENTAL DATA AND PROVISIONS
   - 1.6. EQUIPMENT QUALIFICATION PROVISION
2. COMPONENT DESIGN
   - 2.1. LOCATIONS OF STRESS CONCENTRATION
   - 2.2. LOCATIONS SUSCEPTIBLE TO CORROSION
   - 2.3. POSSIBLE STRESSORS AND LOCATIONS OF OTHER AGING MECHANISMS
   - 2.4. THE INSERVICE INSPECTION CONDITIONS
   - 2.5. MONITORING CONDITIONS
   - 2.6. MAINTENANCE, REPLACEMENT, RENEWAL CONDITIONS
3. APPLIED MATERIALS
   - 3.1. STRENGTH AND CORROSION RESISTANCE CHARACTERISTICS
   - 3.2. LONG TERM STABILITY OF MATERIAL CHARACTERISTIC
   - 3.3. DAMAGE PROPAGATION RESISTANCE
   - 3.4. COMPATIBILITY OF THE MATERIALS
   - 3.5. NPP EXPERIENCE OF THE APPLIED MATERIALS
4. ANALYSIS OF THE AGING PROCESSES OF THE SYSTEM COMPONENTS
   - 4.1. IDENTIFY POSSIBLE DEGRADATION MECHANISMS
   - 4.2. DESCRIBE THE DEGRADATION PROCESS
   - 4.3. IDENTIFY DEGRADATION LOCATIONS
   - 4.4. ESTIMATE THE EXPECTED IMPACT OF THE AGING PROCESSES- RESIDUAL LIFE
   - 4.5. SENSITIVITY ANALYSIS OF THE AGING PROCESSES- MITIGATION POSSIBILITIES
5. DESIGN SPECIFICATION OF THE AGING MANAGEMENT
   - 5.1. OPERABILITY SPECIFICATION
   - 5.2. MAINTENANCE MODE SPECIFICATION
   - 5.3. PERIODIC MATERIAL INSPECTION AND FUNCTIONAL TESTING SPECIFICATION
   - 5.4. MONITORING
   - 5.5. QUANTITATIVE CHARACTERISTICS OF THE POSSIBLE AGING PROCESSES - CRITERIAL VALUES

TYPICAL CONTENT OF THE AMP REVIEW REPORTS: AGING MANAGEMENT DURING THE OPERATION

1. AGING MANAGEMENT PROGRAM
   - 1.1. DEFINITION OF THE EXTENT
   - 1.2. ORGANIZATIONAL BACKGROUND
   - 1.3. SYSTEM OF THE PROCEDURES AND REGULATIONS RELATED TO THE AGING MANAGEMENT OF SSC
2. OPERATIONAL AGING MANAGEMENT PROCESS
   - 2.1. DATA COLLECTION AND RECORD KEEPING OF AGING RELATED CHARACTERISTICS
   - 2.2. RECORD KEEPING ABOUT THE OPERATIONAL INSPECTIONS, FAILURES, MALFUNCTIONS E.T.C.
   - 2.3. OPERATION OF THE MONITORING SYSTEMS
3. AGING MANAGEMENT IN THE MAINTENANCE PROCESS
   - 3.1. PREDICTIVE MAINTENANCE PROGRAMS
   - 3.2. MAINTENANCE AND REPAIR INSTRUCTION MANUALS
   - 3.3. RECORD KEEPING OF THE RESULTS OF ROOT CAUSE ANALYSIS OF THE FAILURES
   - 3.4. RECORD KEEPING ABOUT THE SPARE PART RESERVING
4. ANALYSIS OF THE AGING PROCESSES OF THE SYSTEM COMPONENTS
   - 4.1. IDENTIFY POSSIBLE DEGRADATION MECHANISMS
   - 4.2. DESCRIBE THE DEGRADATION PROCESS
   - 4.3. IDENTIFY DEGRADATION LOCATIONS
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   - 5.4. MONITORING
   - 5.5. QUANTITATIVE CHARACTERISTICS OF THE POSSIBLE AGING PROCESSES - CRITERIAL VALUES

REVIEW ON THE CURRENT ISI PROGRAM

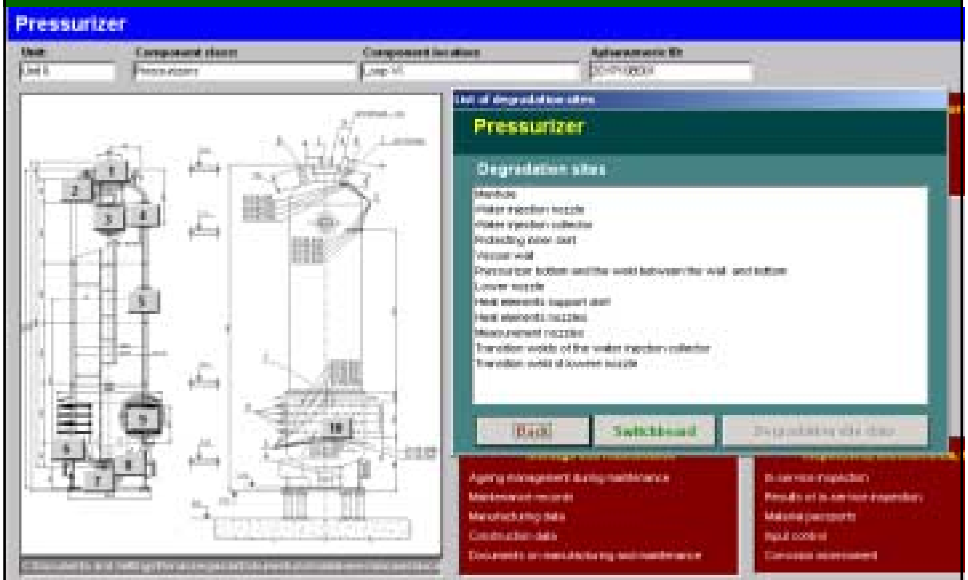
GOALS:

- **supporting the LR activities**
- **introduction of widely accepted ISI methodology**
- **maintaining the current outage period**

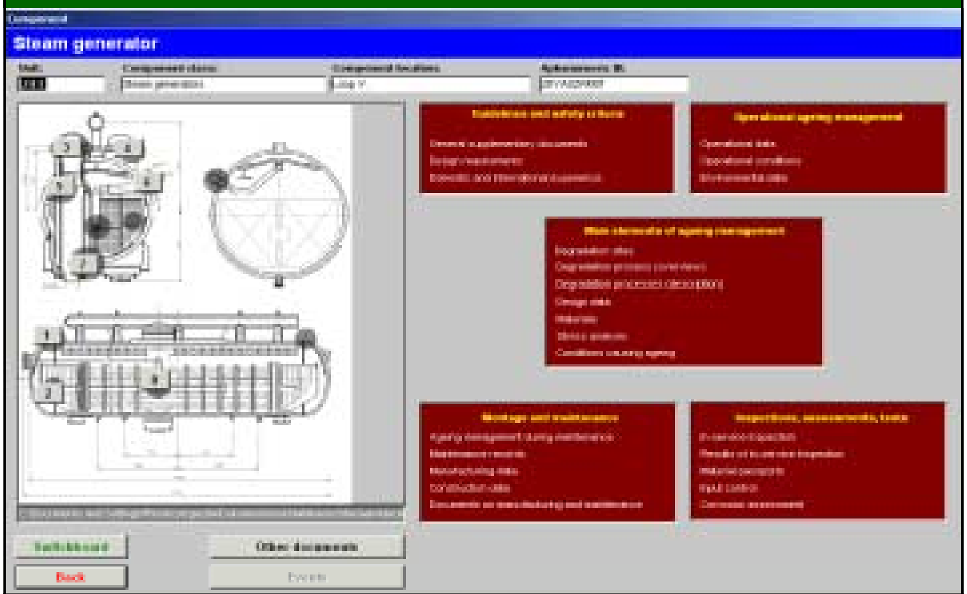
NEW FEATURES:

- **Adopting the ASME XI code requirements**
- **Inspection qualifications**
- **Changing the inspection interval (4⇔8 years)**
- **Introducing risk based approaches (not accepted yet)**

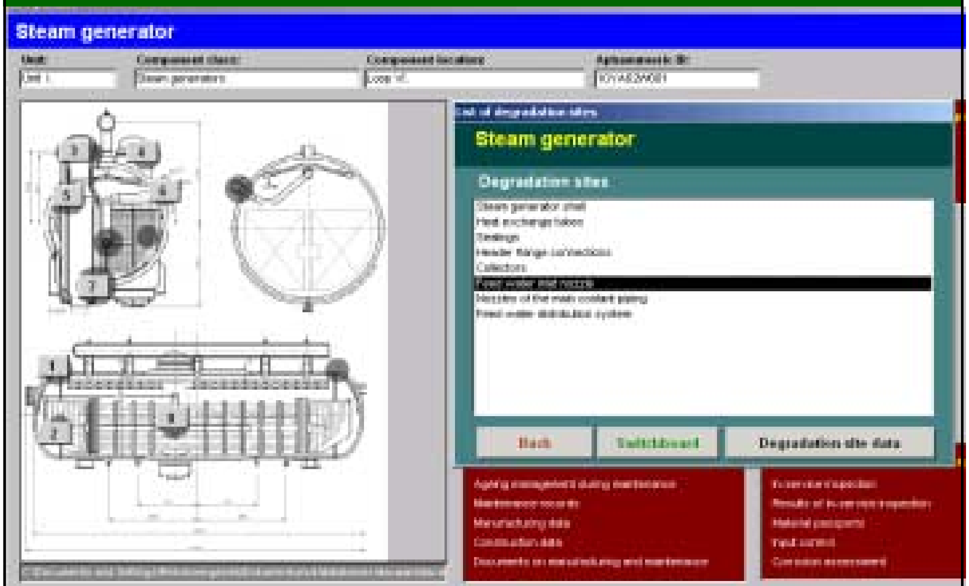
CRITICAL COMPONENTS OF THE PRESSURIZER



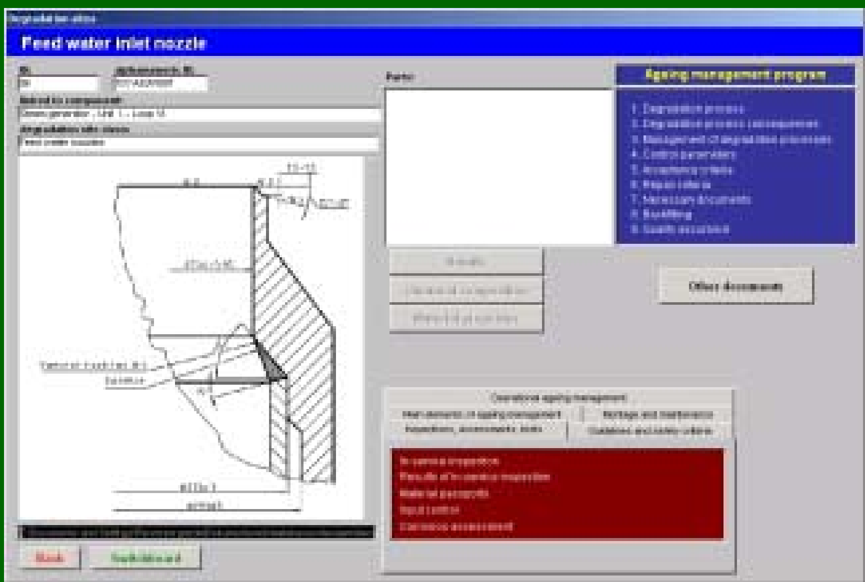
Data recovery on component/critical component level



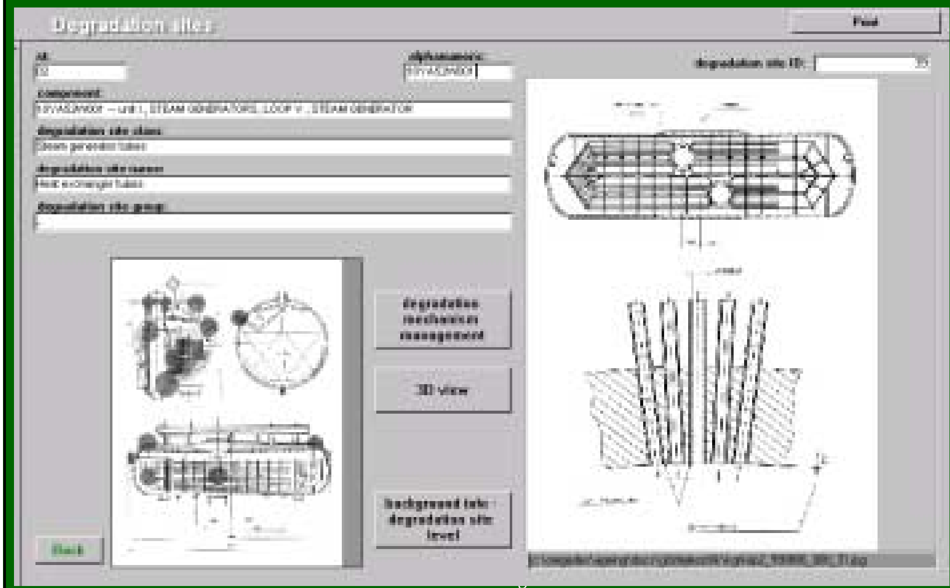
PAKS NPP AGING MANAGEMENT PC DATABASE: CRITICAL COMPONENTS OF THE STEAM GENERATOR



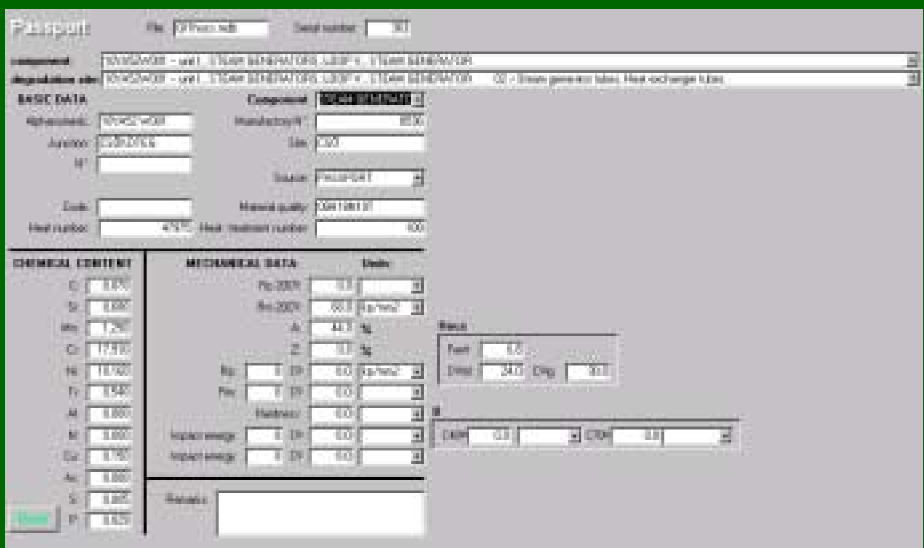
PAKS NPP AGING MANAGEMENT PC DATABASE: 2. CRITICAL COMPONENT - MAIN FEED WATER NOZZLE



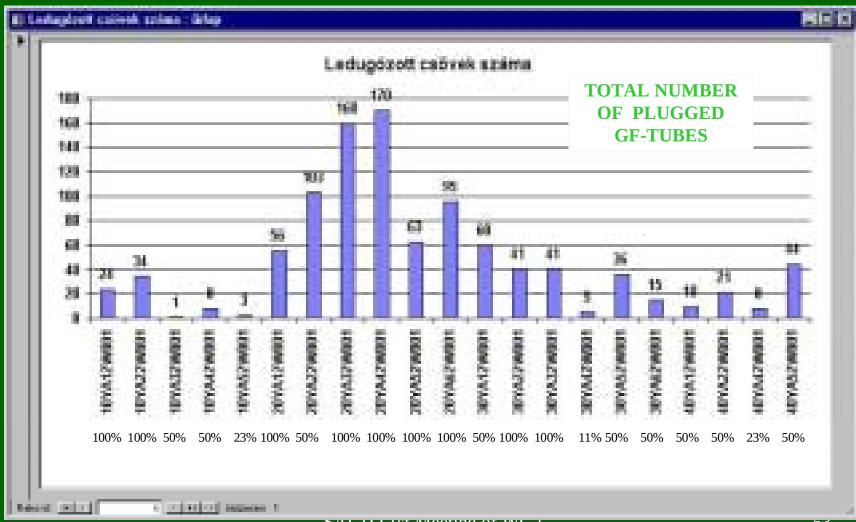
AGEING MONITORING SYSTEM



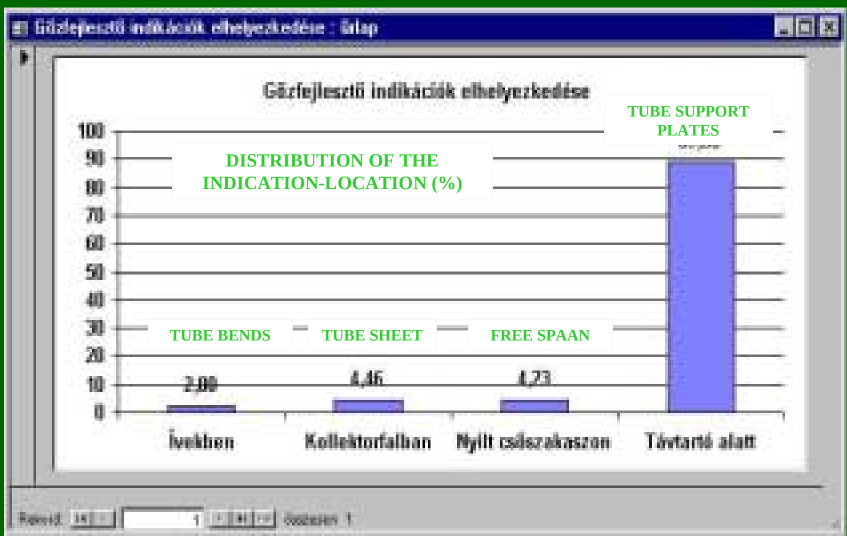
AGEING MONITORING SYSTEM



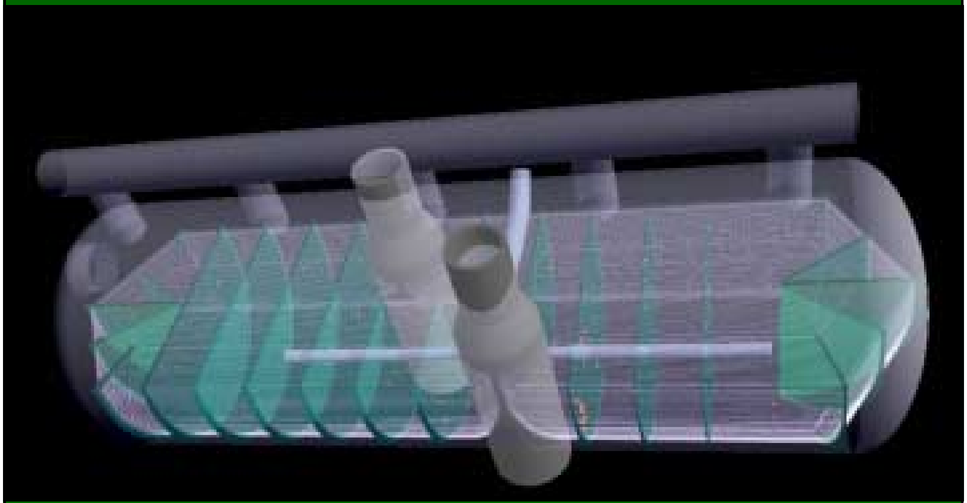
PLUGGED TUBES IN THE STEAM GENERATOR



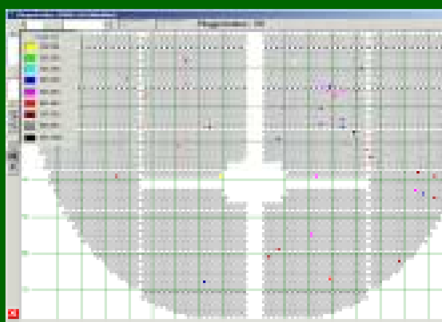
INDICATIONS IN THE STEAM GENERATOR HEAT EXCHANGE TUBES

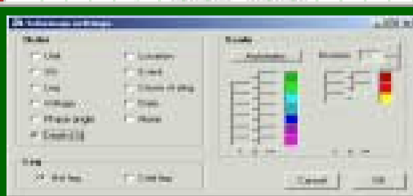


PLUGGED TUBES IN THE STEAM GENERATOR

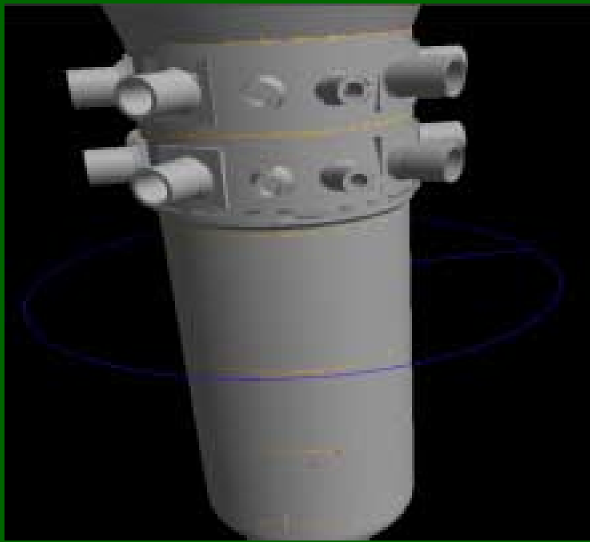


RECOVERY OF SG TUBE DEGRADATION DATA



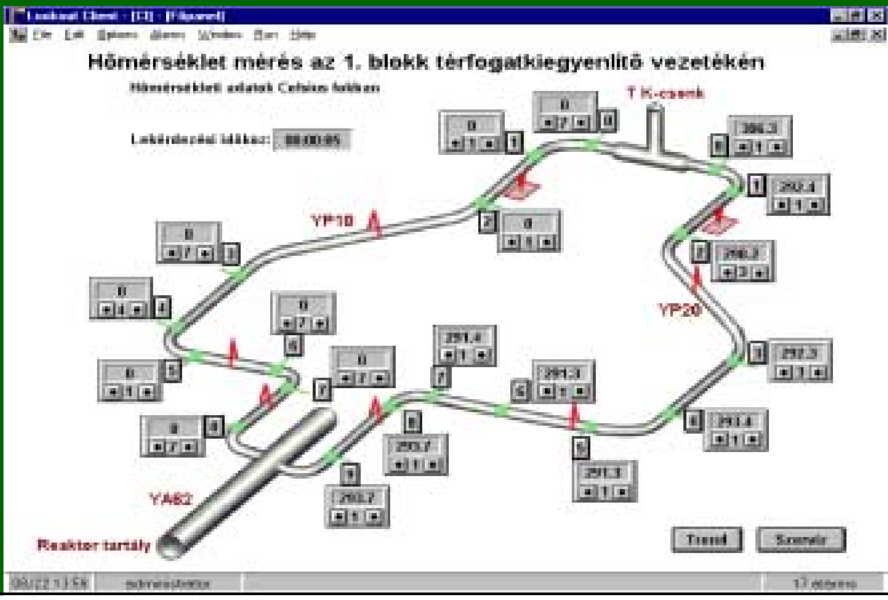


DETECTED INDICATIONS IN THE REACTOR PRESSURE VESSEL

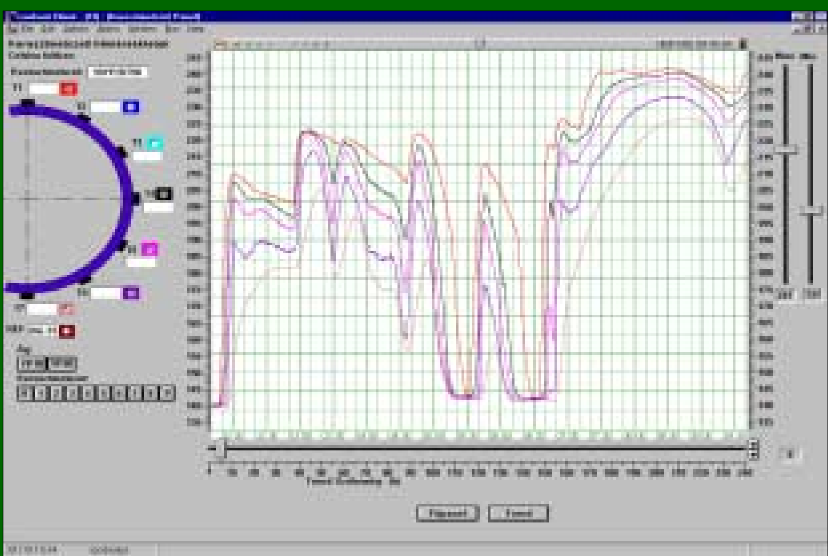


DETECTED INDICATIONS IN THE REACTOR PRESSURE VESSEL (ZOOM)

THERMAL STRATIFICATION MONITORING ON THE PRESSURIZER SURGE LINE



MEASURED TEMPERATURES



SUMMARY

– The recent practice of maintenance, upgrading and replacements ensures the good condition of the plant. The license renewal for 20 years is feasible.

– The use of international best practice and the international acceptance is a very important success condition.

– The licence renewal project ensures the condition of LTO (future of nuclear power generation in Hungary.)

International Atomic Energy Agency

WWR LTO in Russia

Meeting of the Working Group 2 on MCM/LTO
Vienna, Austria, 4-6 February, 2004.

1

International Atomic Energy Agency

WWR LTO in Russia

Meeting of the Working Group 2 on MCM/LTO
Vienna, Austria, 4-6 February, 2004.

2

NPP with WWER-440 reactors

N º	Country	NPP	Unit	Reactor plant type	Installed capacity MW (e)	Date of commissioning
1	Russia	**Kola**	1	V-230	440	06.73
2	Russia	**Kola**	2	V-230	440	12.74
3	Russia	**Kola**	3	V-213	440	03.81
4	Russia	**Kola**	4	V-213	440	10.84
5	Russia	**Novovoronezh**	3	V-179	417	12.71
6	Russia	**Novovoronezh**	4	V-179	417	12.72
7	Armenia	**Armenian**	2	V-270	440	01.80
8	Bulgaria	**Kozloduy**	1	V-230	440	06.74
9	Bulgaria	**Kozloduy**	2	V-230	440	08.75
10	Bulgaria	**Kozloduy**	3	V-230	440	12.80
11	Bulgaria	**Kozloduy**	4	V-230	440	05.82
12	Hungary	**Paks**	1	V-213	440	12.82
13	Hungary	**Paks**	2	V-213	440	09.84
14	Hungary	**Paks**	3	V-213	440	09.86
15	Hungary	**Paks**	4	V-213	440	08.87

3

NPP with WWER-440 reactors

N º	Country	NPP	Unit	Reactor plant type	Installed capacity MW (e)	Date of commissioning
16	Slovakia	**Bohunice**	1	V-230	440	03.79
17	Slovakia	**Bohunice**	2	V-230	440	06.80
18	Slovakia	**Bohunice**	3	V-213	440	09.84
19	Slovakia	**Bohunice**	4	V-213	440	08.85
20	Slovakia	**Mochovce**	1	V-213	440	07.98
21	Slovakia	**Mochovce**	2	V-213	440	12.99
22	Ukraine	**Rovno**	1	V-213	402	12.80
23	Ukraine	**Rovno**	2	V-213	416	12.81
24	Finland	**Loviisa**	1	V-213	440	11.77
25	Finland	**Loviisa**	2	V-213	440	11.80
26	Chechia	**Dukovany**	1	V-213	440	02.85
27	Chechia	**Dukovany**	2	V-213	440	02.86
28	Chechia	**Dukovany**	3	V-213	440	11.86
29	Chechia	**Dukovany**	4	V-213	440	06.87

4

NPP with WWER-1000 reactors

N º	Country	NPP	Unit	Reactor plant type	Installed capacity MW (e)	Date of commissioning
1	Russia	**Balakovo**	1	V-320	1000	12.85
2	Russia	**Balakovo**	2	V-320	1000	09.87
3	Russia	**Balakovo**	3	V-320	1000	12.88
4	Russia	**Balakovo**	4	V-320	1000	03.93
5	Russia	**Balakovo**	5	V-320	1000	-
6	Russia	**Kalinin**	1	V-338	1000	05.84
7	Russia	**Kalinin**	2	V-338	1000	12.86
8	Russia	**Kalinin**	3	V-320	1000	-
9	Russia	**Novovoronezh**	5	V-187	1000	05.80
10	Russia	**Rostov**	1	V-320	1000	12.01
11	Russia	**Rostov**	2	V-320	1000	-
12	Ukraine	**Zaporozhe**	1	V-320	1000	12.84
13	Ukraine	**Zaporozhe**	2	V-320	1000	10.85
14	Ukraine	**Zaporozhe**	3	V-320	1000	12.86
15	Ukraine	**Zaporozhe**	4	V-320	1000	12.87
16	Ukraine	**Zaporozhe**	5	V-320	1000	08.89
17	Ukraine	**Zaporozhe**	6	V-320	1000	10.95

5

NPP with WWER-1000 reactors

N º	Country	NPP	Unit	Reactor plant type	Installed capacity MW (e)	Date of commissioning
18	Ukraine	**Rovno**	3	V-320	1000	10.86
19	Ukraine	**Rovno**	4	V-320	1000	-
20	Ukraine	**Khmelnitski**	1	V-320	1000	11.87
21	Ukraine	**Khmelnitski**	2	V-320	1000	-
22	Ukraine	**South Ukraine**	1	V-302	1000	12.82
23	Ukraine	**South Ukraine**	2	V-338	1000	01.85
24	Ukraine	**South Ukraine**	3	V-320	1000	09.89
25	Bulgaria	**Kozloduy**	5	V-320	1000	11.87
26	Bulgaria	**Kozloduy**	6	V-320	1000	05.91
27	Chechia	**Temelin**	1	V-320	1000	12.00
28	Chechia	**Temelin**	2	V-320	1000	04.03

6

Major lines of the activities in lifetime extension of NPP unit

- Comprehensive examination of the NPP unit
- Modernization of the NPP unit in order to enhance its safety
- Justification of residual lifetime of non-replaceable and non-repairable components of the NPP unit
- In-depth Safety Assessment of the NPP unit

→ **Obtaining a long-term license for operation beyond of the design operating life**

7

Basic trends of safety improvement

Basic technical measures:

- extending the spectrum of design basis accidents;
- ensuring the primary circuit integrity;
- improving reliability of components and systems important to safety;
- reducing probability of initiating events occurrence;
- improving structural reliability of safety systems;
- improving leak-tightness and integrity of the sealed zone;
- management of beyond design basis accidents;
- improving operation culture.

8

Basic measures on safety improvement

- implementation of "leak-before-break" concept (up-to-date system of diagnostics and non-destructive testing);
- solution of a problem of the RPV brittle strength (annealing, installing dummies, templets);
- replacement of safety valves of PRZ PORV and SG PORV;
- installing MSIV;
- safety systems upgrading (system of reliable power supply to the consumers of the first and second groups, safety boron injection and sprinkling systems, service water system);
- upgrading the 4th physical barrier (implementation of jet-eddy condenser; improving leak-tightness of sealed confinement);
- replacement of reactor control, monitoring and protection technical equipment (NFME, PPPE, APC, PG, ICIS);
- measures on management of beyond design basis accidents (mobile diesel-generator plant, additional emergency SG makeup).

9

Results of implementation of basic measures on safety improvement

Units 3, 4 of NV NPP and Units 1,2 of Kola NPP were brought to the acceptable safety level considering the requirements of up-to-date standards for assurance of the following principles:

- **redundancy;**
- **independence;**
- **single failure;**
- **protection against common cause failure**

10

Extension of operating life

Regulatory basis:

- Principal possibility of NPP Unit operating life extension is defined in OPB-88/97 (item 5.1.14);
- Requirements for extension of operating life of RP equipment and pipelines are defined in i. 2.1. 11 of "Rules..." PNAE G-7-008-89;
- Federal regulations "Basic requirements for NPP Unit operating life extension" NP-017-2000
- "Standard program of comprehensive examination of NPP Unit during operating life extension" RD EO 0283-01
- "Regulations on management of service life characteristics of NPP Unit components" RD EO 0281-01
- Quality assurance program for activities on operating life extension of NPP Units of the first generation (standard), RD EO 0291-01

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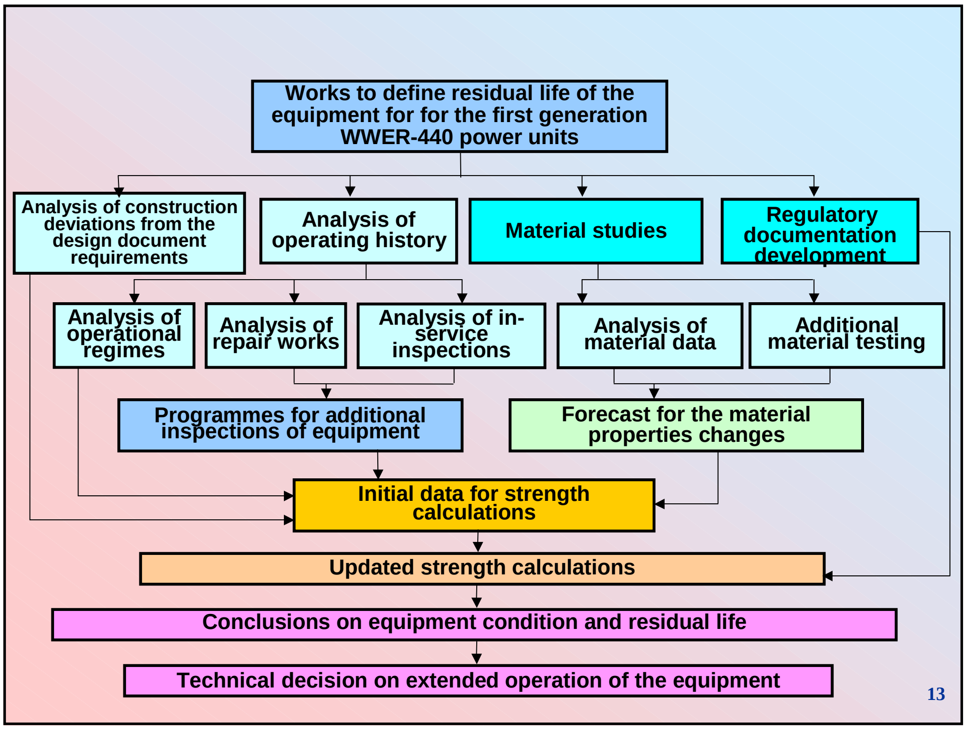
Extension of operating life

Basic measures according to NP-017-2000

- performing the comprehensive examination;
- developing the program of Unit preparation for operating life extension;
- preparing Unit to operation within the period of extended operating period, including justification of safety and residual life of components, replacement of equipment with the expired service life and modernization or reconstruction of Unit, if required;
- carrying out the required tests.

12



Extension of operating life

The following should be determined as a result of comprehensive examination:

- **technical condition of the equipment important to safety;**
- **equipment with the expired service life;**
- **equipment which service life can be extended;**
- **irreplaceable equipment and preliminary assessment of its residual life.**

14

Extension of operating life

Analysis of RP equipment operation history:

- ❑ specifying the list of operating conditions;
- ❑ determination of actual number of cycles of operating conditions;
- ❑ forecast of the number of cycles of operating conditions for the service life to be extended;
- ❑ determination of equipment technical state:
    - ❑ analysis of deviations from the design during manufacture and mounting of equipment;
    - ❑ analysis of in-service inspection results;
    - ❑ analysis of repair work results.

15

In necessary case extra inspection have been made according to special programmes. For example RPV, internals, MCL inspections:

Television inspection results of the RPV internals. Photo of the core barrel bottom

16

Extension of operating life

Provision of material properties

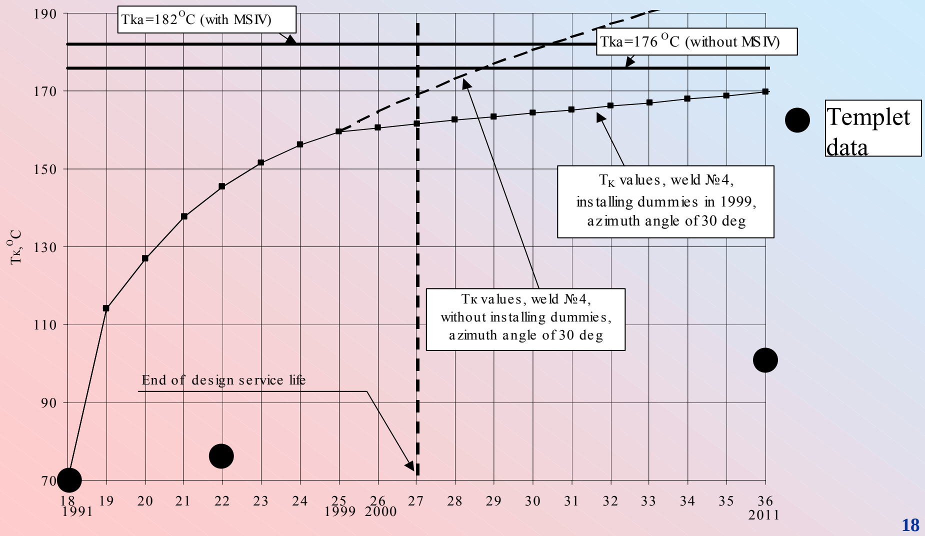
Objective – justification of guaranteed values of physical-mechanical properties of RP equipment materials for the extended service life with regard for their degradation from the effect of operational factors

The work was performed by specialists from:

- **CNII KM “Prometei”;**
- **IRTM RRC “Kurchatov Institute”;**
- **VNIIAES;**
- **OKB “Gidropress”.**

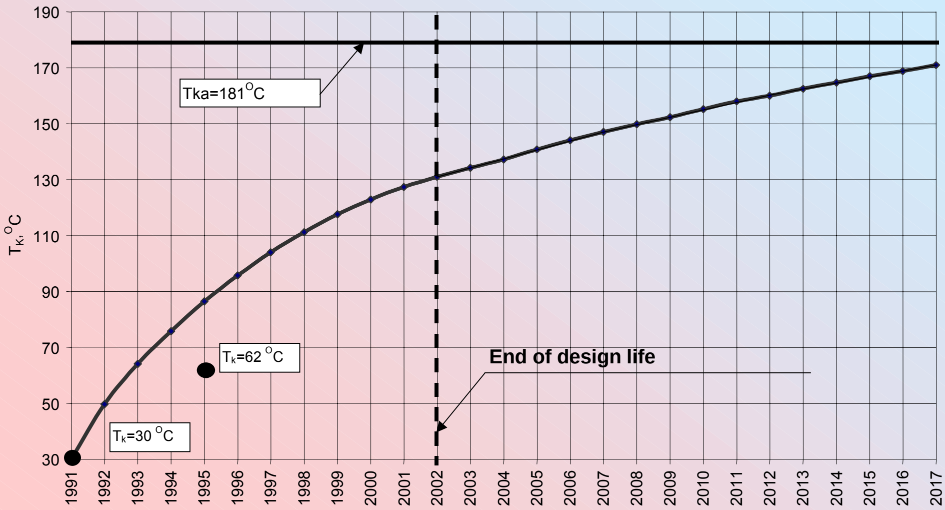
Reactor Pressure Vessel of NV NPP Unit 3

Calculations of brittle fracture with and without dummies



Reactor Pressure Vessel of NV NPP Unit 4

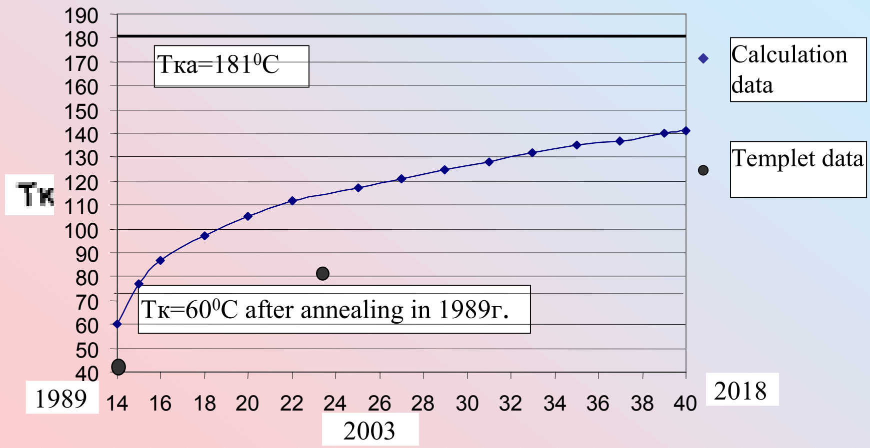
Calculations of brittle fracture



19

Reactor Pressure Vessel of Kola NPP Unit 1

Calculations of brittle fracture



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Calculational justification of RP equipment service life for NV NPP, Unit 3

Nine technical solutions were prepared on RP equipment service life extension

To justify technical solutions 35 strength calculations have been performed

Nine technical decision on extended operation have been made for RP equipment

Extension for 15 years in addition to the design service life is justified

With performance of additional measures

1. RPV
2. Internals
3. Top head unit
4. Steam generator
5. MCL

Without additional measures

1. Pressurizer
2. Relief tank
3. PRZ system lines
4. Annular tank

21

Calculational justification of RP equipment service life for NV NPP, Unit 3

Further operation of reactor pressure vessel is allowed for the period of 15 years in addition to the design life providing the following measures:

It is planned to cut out templets (boat samples) from RPV in 2005 and in 2011.

Assessment of technical state and specifying the RPV residual life will be made by years 2007 and 2012 with regard for results of study of templets cut out in 2005 and in 2011, respectively

Methods and technical equipment will be developed for inspection of weld No. 10 before preventive maintenance of 2003 according to i. 4.3 of “Program of work on justification of a possibility to extend the service life of WWER-440 RPV for NV NPP, Units 3 & 4”

22

Result of the work

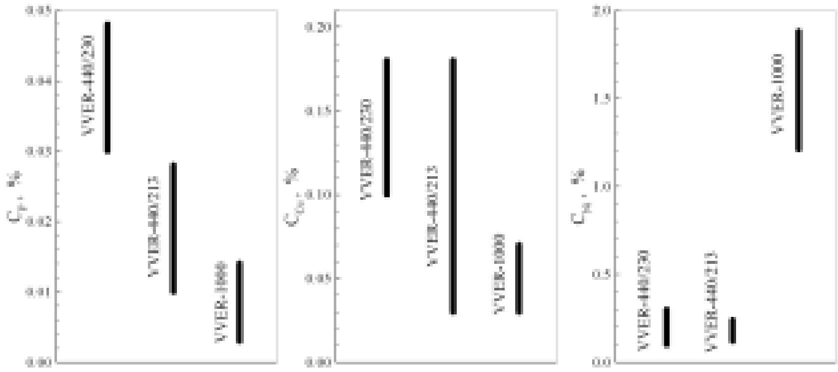
Regulatory body of Russia has granted licenses for operation of NV NPP, Units 3, 4, and of Kola NPP, Unit 1, beyond of the design operating life

23

Three generation of VVER type units are in operation

•VVER-440/230 •VVER-440/213 •VVER-1000

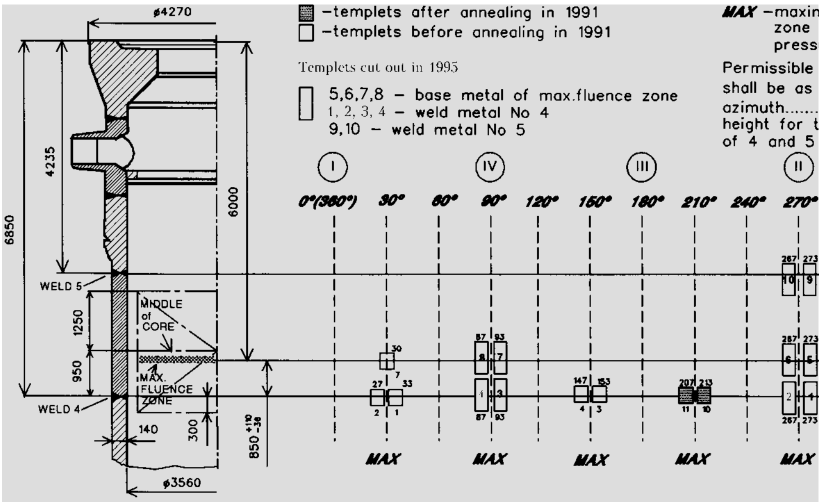
Basic difference in VVER RPV steels is the difference in P, Cu and Ni contents



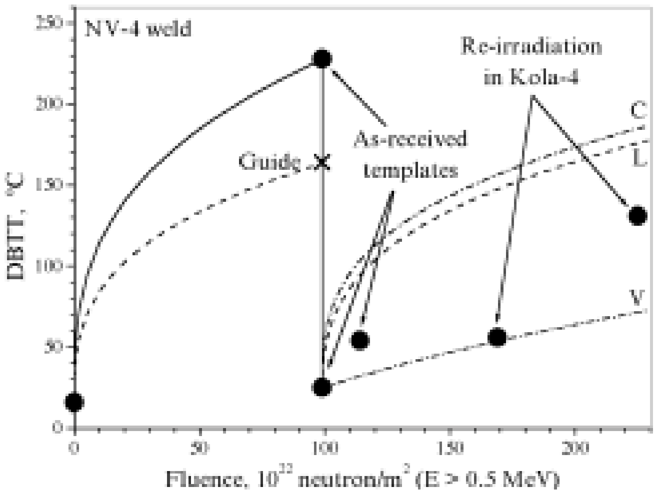
The problems of the lifetime of VVER-440/230 RPVs

- **Features**
- **absence of surveillance programs**
- **absence of archive metal**
  - **All VVER-440/230 RPVs were annealed because of extremely high rates of radiation embrittlement of the core welds**
  - **Re-irradiation embrittlement kinetics determines RPV steels lifetime**
- **Activities**
  - → **taking templates**
  - → **templates irradiation in surveillance channels of VVER-440/213 RPVs**
  - → **special research programs for data base development**
  - → **development of new model of re-irradiation embrittlement**

Scheme of templets cutting out from Novovoronezh-4 RPV



Novovoronezh-4 template test results



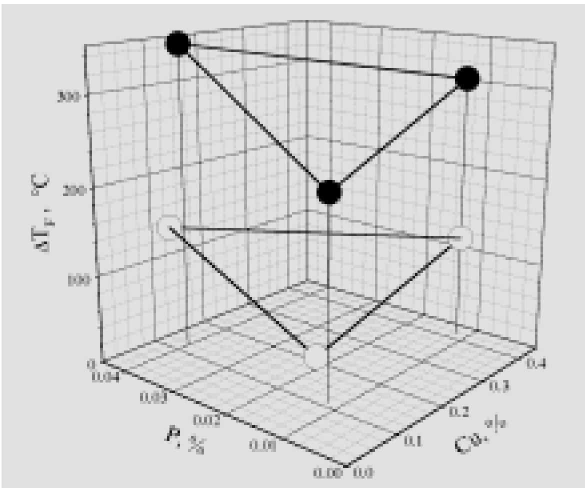
The basic problems for VVER-440/213 RPV steels

- Development of standard reference dependencies and determination of the core weld lifetime
- Data on fracture toughness are highly restricted

The activities necessary

- Processing of surveillance specimens test results
  - →determination of irradiation conditions using advanced techniques
  - →determination of radiation embrittlement parameters
- Study of the effects of P, Cu and other factors on radiation embrittlement
- Development of trend curves
- Surveillance specimens reconstitution for fracture toughness tests

Nickel accelerated radiation embrittlement



High Ni

Low Ni

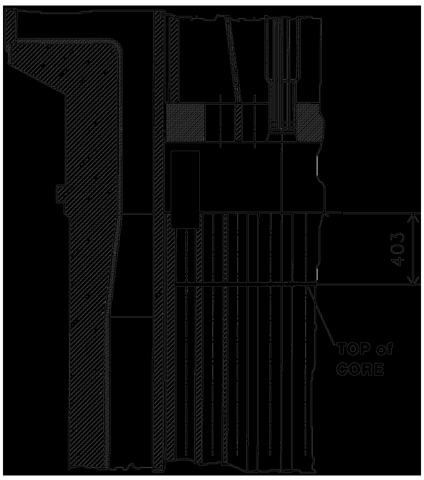
Fluence of 90×10^{22} m^{-2}

The basic problems of the lifetime of VVER-1000 RPVs

- **High nickel contents (1.5-1.9 wt.%) at 80% core welds of operating VVER-1000 units**
  - **⇒High rates of radiation embrittlement of the core welds.**
- **Accelerated irradiation databases were used for the trend curves development**
  - **⇒The trend curves are unreliable and unconservative**
  - **⇒The nickel effect was not taken into account**
- **Data on fracture toughness are highly restricted**
- **Leading factor for the available research programs results ranges from 30 to 1000**
- **VVER-1000 surveillance programs:**
  - **Leading factor: 1 - 6;**
  - **Overheating: < 10 °C**

  ⇒ Surveillance programs data are the most representative for VVER-1000 RPV steels
- **Shortcomings of VVER-1000 surveillance programs**

Scheme of surveillance assembles location in reactor



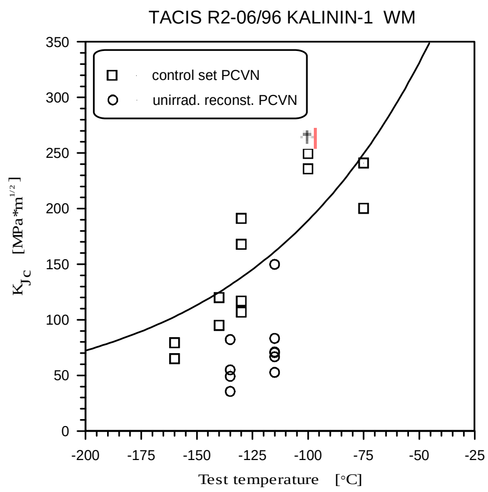
Assembles are in position with high flux gradient

Shortcomings of VVER-1000 surveillance programs:

- **Neutron fluence calculations are accentuated by complicated iron – water environment**
- **High flux gradient through surveillance capsules**
  → ***number of specimens irradiated in comparable conditions ranges from 6 to 8.***

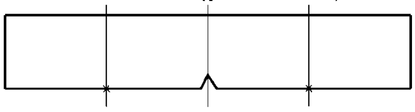
⇒ **Radiation embrittlement parameters cannot be determined with the requirement accuracy**

Additional disadvantage of VVER-1000 surveillance programs: quality of fatigue cracks at three point bend specimens is insufficient



Reconstitution technique effectiveness

Positions on standard surveillance specimens, where ^{54}Mn gamma activities were measured (positions 1/4, 1/2 and 3/4).

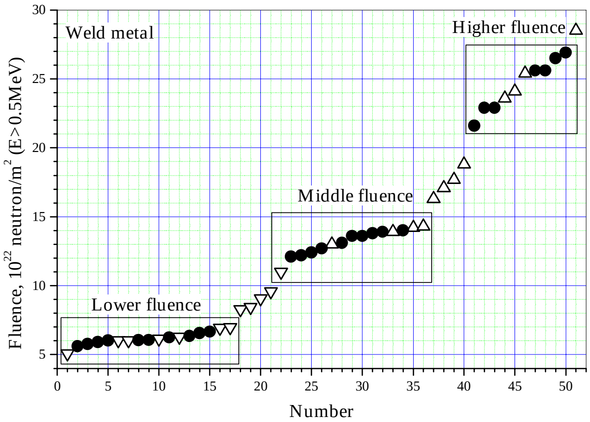


- **The jointed data set enables to choose groups of specimens for impact bend tests to construct transition curves in compliance with requirements of the Russian Standard both to the number of experimental points on one curve (not less than 12) and to the radiation homogeneity (difference in fluence values not more than 15%) and also pick out groups of specimens with close fluence values for construction of fracture toughness temperature dependencies.**

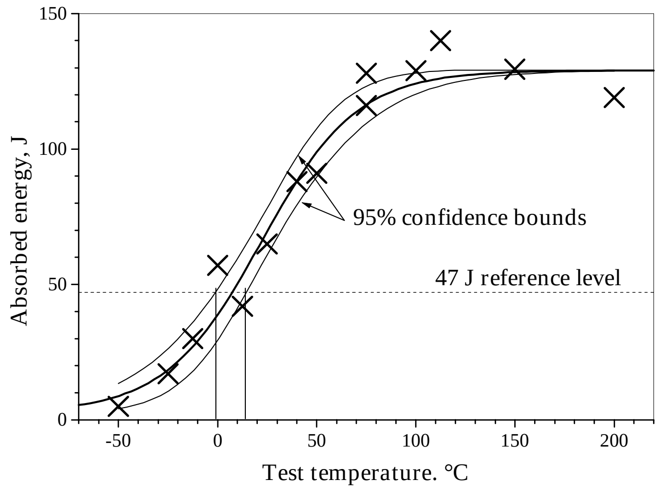
⇒ **All the shortcomings of VVER-1000 surveillance programs can be emended and surveillance programs data are the most representative for VVER-1000 RPV steels**

Weld metal surveillance specimens of Kalinin-1 RPV

∇ - standard specimens of upper row;
Δ - standard specimens of lower row; ● - reconstituted specimens.



Transition curve for standard and reconstituted specimens of weld metal of Kalinin-1 RPV with mean fluence of 13.2x10²² neutron/m². The error of DBTT evaluation with probability of 95% is not exceed ±7°C



The activities necessary

- Study of <u>the third surveillance sets</u> (some specimens of the third surveillance sets provide the designed end-of-life fluence)
- Surveillance specimens reconstitution for impact bend tests
- Surveillance specimens reconstitution for fracture toughness tests
- Processing of surveillance specimens test results
  - →determination of irradiation conditions using advanced techniques
  - →determination of radiation embrittlement parameters
  - →development of surveillance specimens data base
- Study of the effect of nickel and other factors on radiation embrittlement
- Development of trend curves

Swedish approaches to long term operation

Fredrik Barnekow

1st meeting of WG2 on Mechanical Components and Materials. Wien, February 4-6, 3004

2004-03-03

Classifying mechanical components for LTO

- SSC which are are needed in the analysis of the plant events in the SAR
- SSC which have a great influence on the PSA result (safety in-depth)
- Non-SSC which could jeopardize the SSC

2004-03-03

Aging management for passive components

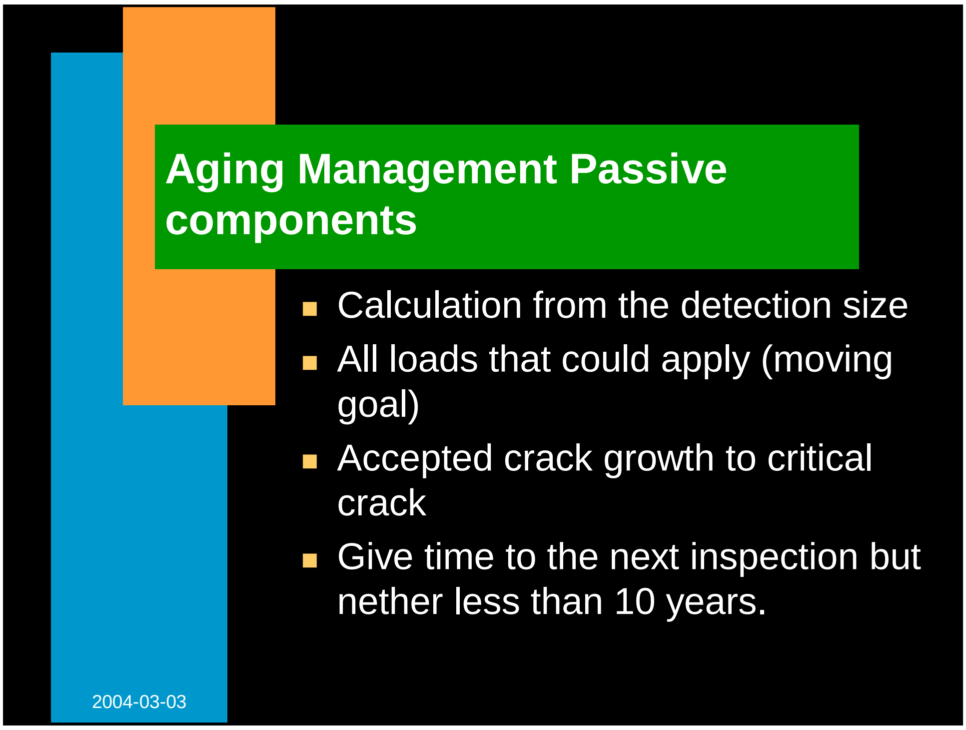
- Index of consequence and materials is used
- Small pipe size, top or bottom break or automatic isolation valves decrease the consequence
- Materials index made up on thermal mixing, erosion/corrosion, IGSCC, IASCC, thermal fatigue, vibrations

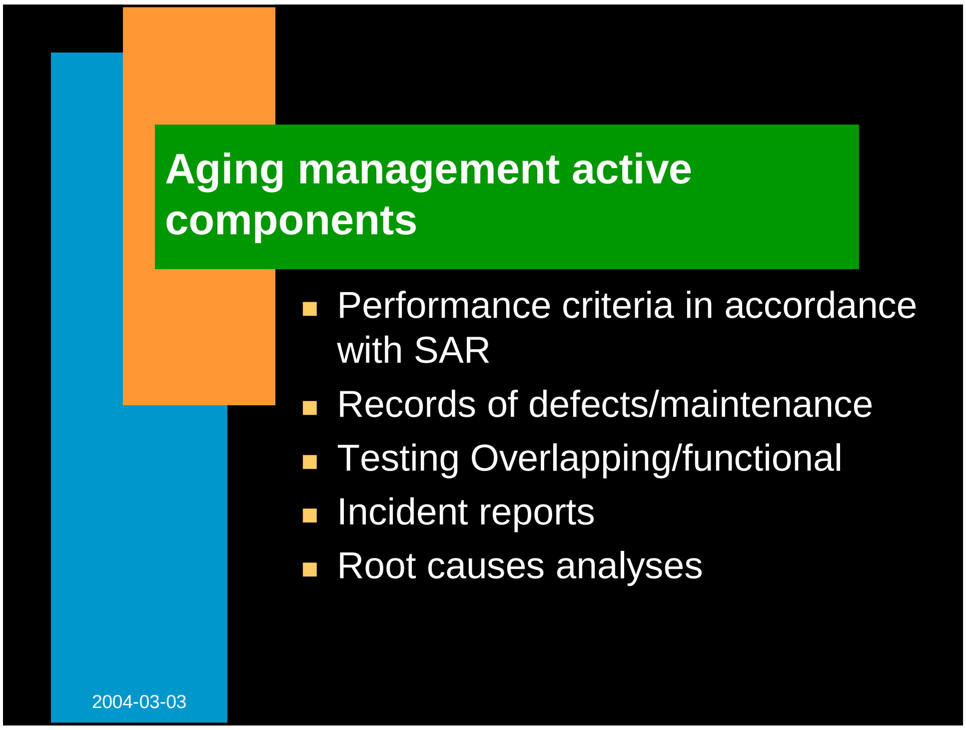
2004-03-03

Aging Management Passive components

- Qualified inspection methods required.
- What are we looking for?
- Test blocks
- Possible detection size
- Qualification of methods, techniques, procedure and personnel together

2004-03-03


Aging Management Passive components
Calculation from the detection size
All loads that could apply (moving goal)
Accepted crack growth to critical crack
Give time to the next inspection but nether less than 10 years.
2004-03-03


Aging management active components
Performance criteria in accordance with SAR
Records of defects/maintenance
Testing Overlapping/functional
Incident reports
Root causes analyses
2004-03-03

Aging active components

- Reporting transients versus budget
- Replacement of organic materials and refurbishing etc according to equipment qualification life time
- Monitoring actual environment
- Condition testing, signature etc

2004-03-03

Results Oskarshamn 1

- Inspections/ Replaced all the RPV internals.
- All containment isolation valves (including MSIVs). Added isolation valves
- All electrical equipment in the containment incl penetrations
- All stainless steel piping in the containment, nozzles in piping,

2004-03-03

Oskarshamn 1

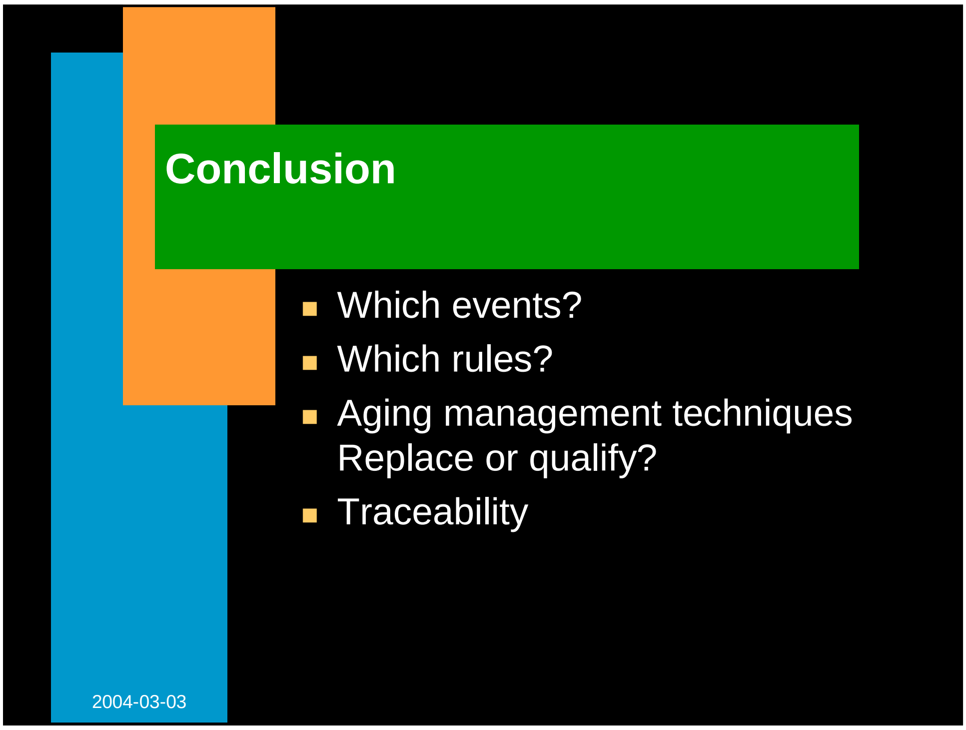
- New RHR, qualification of aux. condenser
- Diversified SRV-system
- Diversified I&C from sensor to RPS

2004-03-03

Oskarshamn 1

- New turbine
- New electrical and I&C equipment for SSC
- Four electrical trains physically and functional separated (two new dieseltraines)
- New events to be handled, earthquake, outside flooding, hails, storms , scram on second scram,

2004-03-03


Conclusion
Which events?
Which rules?
Aging management techniques Replace or qualify?
Traceability
2004-03-03

IAEA SALTO PWR EBP
FIRST MEETING OF THE WORKING GROUP 2 ON
MECHANICAL COMPONENTS AND MATERIALS,
IAEA HEADQUARTERS, VIENNA , 4-6 FEBRUARY 2004

APPROACHES ON LONG TERM OPERATION OF MECHANICAL COMPONENTS AND MATERIALS AT UKRAINIAN NPPs

Sergiy Kostenko,
State Nuclear Regulatory Committee of Ukraine

Zoya Gubenko,
NAEC "Energoatom"

NORMATIVE BASIS ON LONG TIME OPERATION

… The continuation of operation of NPP units over design term is priority … (Decree of Ministry of Ukraine № 1553 from 12.10.2000);

The Solution concerning NPP extension of units operation over design term should be accepted only on the basis of safety review results(OPBU);

Plant design should foresee inspection of serviceable of systems and components with the object of long time operation or replacement of equipment (OPBU);

" Lifetime of the equipment and pipelines should be extended … on the basis of technical solution … The acts of a metal condition examination should be enclosed to Technical solution and if it is necessary strength calculations confirming of lifetime extension possibility should be enclosed too " (PNAE G-7-008-89).

2

NORMATIVE BASIS ON NPP LIFETIE PHASE

#	NPP Lifetime phase		SNRCU Normative documents	UTILITY Normative documents
1	2		3	4
1	Design		"General regulations on safety providing of NPPs" NP 306.1.02/1.034-2000 or OPBU	Norms and rules concerning designing NPPs and its elements
2	Construction			Norms and rules for structure and safety operation of equipment, pipelines, systems and elements of NPPs "Ageing Management Program" (under design)
3	Commissioning			
4	Operation	Operation during design Lifetime		
		Operation over design Lifetime	"General provisions on safety providing of NPPs after design Lifetime" (under design)	"Provision on order of life time extension of equipment of safety significant systems" "Ageing Management Program" (under design)
5	Decommissioning		"General regulations on safety providing of NPPs and research nuclear reactors during decommissioning ", NP 306.2.02/1.004-98	Absent

3

GENERAL PROVISION TO LONG TERM OPERATION OF EQUIPMENT OF SAFETY SIGNIFICANT SYSTEMS

Provision are extended for equipment of 2 and 3 class (on OPBU determination) safety significant systems (SSS)
Procedure for long term operation (LTO) of safety significant systems equipment (SSSE) includes the following stages:

- **developing of the SSSE List classified on the principle of the same type;**
- **developing of the Schedule for SSSE long time operation ;**
- **performing of the measures on LTO in accordance with Program on survey work of technical status of equipment;**
- **developing of Conclusion and Solution on LTO**

SSSE list should consist:

- **name of equipment;**
- **type of equipment;**
- **classification symbol in accordance with OPBU or PNAE G-7-008-89;**
- **the date of Commissioning;**
- **reliability index value adjusted by standard;**
- **information concerning to long time operation measures has been performed before;**
- **operational characteristics of the processing environment;**
- **number of operating time cycle.**

4

REQUIREMENTS TO CONTENT OF PROGRAM ON SURVEY WORK OF TECHNICAL STATUS OF EQUIPMENT

- .Checking of the technical documentation status
- .Checking of the operation conditions and routine maintenance
- .List, scope and examination procedure for technical status evaluation of the equipment
- .Operating reliability analysis
- .Criteria for LTO ability
- .Requirements to drawing up of results of performing works
- .Conclusion and Solution on possibility to LTO

5

REQUIREMENTS IN FORCE TO LONG TERM OPERATION OF PIPELINES

Long term operation of pipelines should be verify by the positive results of :

- **In-service inspection performed usually per 4 year**
- **Measuring of mechanical properties of metal in 100 thousand hours in operation;**

In-service inspection are performed in accordance with Typical instruction by the following kind of non-destructive testing :

- **Visual and instrumentation;**
- **Radiographic;**
- **Ultrasonic;**
- **Magnetic;**
- **Eddy current;**
- **Penetration**

Measuring of mechanical properties in 100 thousand hours in operation are performed in accordance with Typical program and included:

- **measuring of strength and plastic properties of metal;**
- **mainly using two kind of non-destructive testing as follows: kinetic hardness method and micro sample method**

6

REQUIREMENTS IN FORCE TO LONG TERM OPERATION OF MOVING PARTS OF VALVES

Over assigned resource operation may be permitted on base of performing thorough repairs that provide replacement or complete restoration;

Thorough repairs usually are performed per 4 year and include the following works:

- **the complete dismantling;**
- **performing of visual and instrumentation testing to define deterioration of parts of valve;**
- **performing of another non-destructive testing to detect defects;**
- **mechanical properties examination of metal (in case of need) by destructive testing;**
- **replacement or repair of failed parts or surfaces;**
- **assembling and adjustment;**
- **testing of various kinds**

7

LIVING PROBLEMS RELEVANT TO LTO

Reactor Pressure Vessel (RPV):

- **integrity and residual life of RPV is evaluated on results of surveillance specimens testing exceptionally;**
- **for fluence measurement opposite RPV active zone is used calculated-experimental method developed by Nuclear Research Institute (Kiev);**
- **IAEA guidance on Thermo Shock calculations is not used;**
- **taking in account the poor reliability of surveillance specimens testing results and missing of the data of nickel impact it is impossible to calculate residual life of RPV to day.**

Steam Generator (SG):

- **methods on LTO of SG are missing;**
- **heat exchange tubes plugging criteria is various for different Units and varies 60-85%;**
- **heat exchange tubes plugging criteria is established on the base of Utility proposition and it is not enough valid;**
- **in accordance with Regulatory Body requirements number of plugging tubes in one SG should not exceed 12% of total quantity, otherwise SG must be replaced.**

8

U. S. License Renewal Process

Developed by P.T. Kuo
Presented to Working Group 2 –
Safety Aspects of Long Term Operation
February 5, 2004
by

Tom Taylor,
Pacific Northwest National Laboratory

Battelle

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

Presentation Outline

- Background and overview
- License Renewal Rule (Rule)
- Guidance Documents
  - Generic Aging Lessons Learned (GALL) Report
  - Standard Review Plan for License Renewal (SRP-LR)
  - Regulatory Guide 1.188
  - NEI 95-10
  - Interim Staff Guidance
- Summary

What is License Renewal?

- Atomic Energy Act of 1954
  - 40-year license to operate
  - Allows for renewal
- License Renewal Rule allows new license to be issued to operate for up to 20 years beyond the current term
- Application submittal requirements
  - Not earlier than 20 years before expiration of current license
  - Not later than 5 years before expiration of current license for timely renewal provisions

Significant Basis of Life Extension

- Existing regulatory process is adequate for ensuring safety of operating plants
- Current licensing basis (CLB) is adequate and carries forward into the period of extended operation
- Issues relevant to the current operation of plants will be addressed by the regulatory process, which will carry forward into the period of extended operation.

License Renewal Regulations

- Safety Review of Renewal Application
  - Safety Evaluation
  - Hearing Opportunity
  - Advisory Committee on Reactor Safeguards (ACRS) review
  - Inspection Verification
  - Commission approval
- Environmental Impacts of Renewal Application
  - National Environmental Policy Act (NEPA)

Principles of License Renewal

- The regulatory process is adequate to ensure that the licensing bases of all currently operating plants provide and maintain an acceptable level of safety, with the possible exception of the detrimental effects of aging.
- Plant-specific licensing basis must be maintained during the renewal term in the same manner and to the same extent as during the original licensing term.

Scope of the License Renewal Rule

- Safety-related systems, structures and components relied upon to:
  - Maintain integrity of the reactor coolant pressure boundary
  - Ensure capability to shut down and maintain a safe shutdown condition
  - Prevent or mitigate offsite exposures comparable to 10 CFR part 100 offsite dose analyses for siting
- Nonsafety-related systems, structures and components whose failure could prevent safety-related function as outlined above

Scope of the License Renewal Rule

- Systems, structures and components relied upon for compliance with regulations:
  - Fire protection (10 CFR 50.48)
  - Environmental Qualification (10 CFR 50.49)
  - Pressurized thermal shock (10 CFR 50.61)
  - Anticipated transients without SCRAM (10 CFR 50.62)
  - Station blackout (10 CFR 50.63)

Integrated Plant Assessment (IPA)

- Identify and list structures and components subject to an aging management review (AMR)
- Describe/justify methods to identify structures and components subject to an AMR from those systems, structures, and components within the scope of the rule
- Demonstrate effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the CLB for the period of extended operation

Time-limited Aging Analyses (TLAAs)

- Definition
  - Involve systems, structures and components within the scope of the rule (not limited to passive and long-lived),
  - Consider the effects of aging,
  - Involve time-limited assumptions defined in the current operating term,
  - Determined by licensee to be relevant in safety determination,
  - Involve conclusions related to performance of intended functions, and
  - Contained or incorporated by reference in CLB

TLAAs (continued)

- Applicants are required to provide a list of TLAAs in the LRA
- The TLAAs demonstrate that
  - Analyses remain valid for the period of extended operation,
  - Analyses have been projected to the end of the period of extended operation, or
  - Effects of aging on the intended functions will be managed during the period of extended operation

Other Requirements of the License Renewal Rule

- Final Safety Analysis Report (FSAR) Supplement
  - Summary description of the programs and activities for managing the effects of aging and evaluation of TLAAs
- Technical Specification Changes
  - Changes and their justification necessary for managing the effects of aging during the period of extended operation

Standards for Issuance of Renewed License

- Actions have been or will be taken to
  - Manage the effects of aging during the period of extended operation on the functionality of structures and components
  - Evaluate TLAAs that required review
- Reasonable assurance that activities authorized by the renewed license will continue to be conducted in accordance with the CLB

GALL Report

- Catalog of generic aging management evaluations
  - Builds on previous aging studies
  - Reviews aging effects
  - Identifies relevant aging programs
  - Evaluates program attributes to manage aging effects
- Evaluation Conclusion
  - Program is adequate and no further evaluation is needed, or
  - Program should be augmented or new program considered

GALL Report (continued)

- Table of Contents
  - Chapter I Application of ASME Code
  - Chapter II Containment Structures
  - Chapter III Structures and Component Supports
  - Chapter IV Reactor Vessel, Internals, and Reactor Coolant System
  - Chapter V Engineered Safety Features
  - Chapter VI Electrical Components
  - Chapter VII Auxiliary Systems
  - Chapter VIII Steam and Power Conversion System
  - Chapter IX Not Used
  - Chapter X Time-Limited Aging Analyses
  - Chapter XI Aging Management Programs
  - Appendix Quality Assurance for Aging Management Programs

Standard Review Plan (SRP-LR)

- Guidance is consistent with NUREG-0800 Format
- Includes guidance for the following review sections
  - Areas of Review
  - Acceptance Criteria
  - Review Procedures
  - Evaluation Findings
  - Implementation
  - References

SRP-LR (continued)

- Provides staff guidance in reviewing license renewal applications
- References GALL report for generic aging evaluations
- Focuses on areas where programs should be augmented
- Incorporates lessons learned from initial license renewal reviews

Program Attributes (SRP-LR, Section A.1)

- Scope of program
- Preventive actions
- Parameters monitored or inspected
- Detection of aging effects
- Monitoring and trending

Program Attributes (continued)

- Acceptance criteria
- Corrective actions
- Confirmation process
- Administrative controls
- Operating experience

Regulatory Guide 1.118 & NEI 95-10

- RG 1.188 endorses NEI 95-10, Revision 3, “Industry Guideline for Implementing the Requirements of 10 CFR Part 54 - The License Renewal Rule”
- NEI 95-10 provides guidance to applicants in preparing their license renewal applications
  - Standard format of license renewal application
  - Active/passive component determination table (Appendix B to 95-10)
  - Consistency with other license renewal guidance documents

Interim Staff Guidance (ISG)

- Provides guidance on generic, technical issues that emerge between revisions of the license renewal guidance documents
- Contain guidance that current or future applicants need to address
- May have to be addressed by licensees with renewed license
- Currently:
  - 5 ISGs approved
  - 15 (roughly) ISGs in review
- Approved ISGs are available on the NRC web site

ISG Process

- Provides a structured approach to developing interim staff guidance
- Allows for stakeholder input
- Addresses implementation for future and current applicants
- Addresses FSAR update for newly identified information for plants with renewed licenses

Summary

- License renewal is a proven option for meeting power demands while maintaining public health and safety
- Stable and predictable
- Allows for public scrutiny and participation
- Meets agency goals of
  - Maintaining public health and safety
  - Enhancing public confidence
  - Increasing effectiveness and efficiency
  - Reducing unnecessary regulatory burden

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EC Contribution
to Nuclear Safety & Nuclear Power

by
Mr. Claude RIEG (EC/JRC-IE)

IAEA Extrabudgetary Programme on Safety Aspects of Long Term Operation of Pressurised Water Reactors	***Mechanical Components and Materials WG2***

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Summary

- *About the EC/JRC-IE*
- *Activities in the "sector"*
- *Component classification & qualification*
- *ISI and NDE techniques*
- *Maintenance*
- *Ageing*

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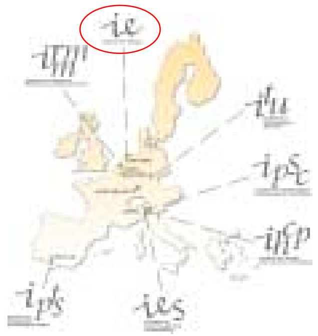
About EC/JRC-IE

- *IE is one of the 7 Institutes of the JRC, located in Petten (NL)*



Nuclear Energy
HFR
Nuclear safety in the enlarged EU
New nuclear energy systems
Support to TACIS & PHARE

Non-Nuclear Energy
Energy from waste and biomass
Waste incineration
Alternative fuel storage and distribution
Fuel cell performance

Sustainable Energy Technologies Reference and Information System (SETRIS)

- The Institute for Energy provides scientific and technical support for the conception, development, implementation and monitoring of community policies related to ENERGY
- Special emphasis is given on the security of energy supply and sustainable and safe energy production

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About EC/JRC-IE (Cont^d)

HFR and Reactor Applications
- Fuel & Material irradiation
- New systems
- Materials ageing
- Medical applications
- Neutron methods

Technical & Scientific Support for TACIS & PHARE (TSSTP)
- Design safety
- On-site assistance
- Regulatory authorities and TSOs
- Industrial radioactive waste manag^nt and decommissioning
- Dissemination of projects results

✓ **Assistance to PM cycle (AIDCO / ELARG)**
✓ **Performance of Projects (DIS./RPV)**

Nuclear Safety
- Structural integrity
- Inspection management
- Accident analysis
- PSA / risk assessment
- Computational fluid dynamics
- Advanced reactor concepts
- Data management & dissemination

SAFELIFE
An Integrated JRC-IE Approach to Plant Life Management

Perfect
IP & NoE

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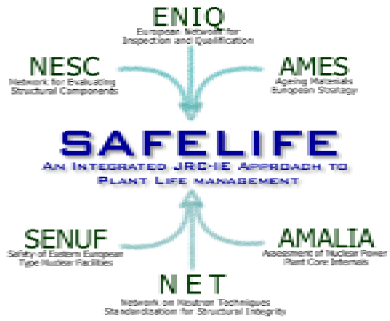
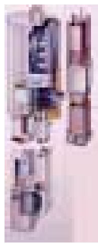
Activities in the sector

- *SAFELIFE focuses on PLIM & includes:*
  - ***Networks**, used to bring together the key players in technical fields, to establish consensus R&D issues and promote best practices*
  - ***Contributions to related Share-Cost R&D Actions (Integrated Projects and/or Networks of Excellence)***
  - ***Promoting actions to ensure for best integration of Acceding Countries (Training & Collaboration)***
  - ***Maintain and Develop the JRC research capabilities & R&D tools (HFR-LYRA, Neutron diffraction & radiography, TEM, SANS)***





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Activities in the sector (Cont[d])

EURATOM
TREN – RTD
FWP 5 & 6

- *SAFELIFE - Focus (2004 -) & SCAs/IP-NoE*

RPV
Piping Systems
Internals
Weldments

→ **Integrity assessment**
Fracture mechanics
Residual stresses
Thermal fatigue
(Re)-Embrittlement & ageing
In-service inspection
Maintenance

NDE methods for monitoring degradation →
Risk management for PLIM →
Safety culture management for PLIM →
Others →

- ✓ COBRA (VVER 440 RPV Surveillance temperature & Dosimetry (in-situ)
- ✓ GRETE (Round-Robin of NDT for ageing monitoring)
- ✓ ATHENA (PLIM/PLEX, VVER 440 RPV embrittlement & re-embrittlement, PRIMAVERA)
- ✓ PISA (Phosphorus role on embrittlement)
- ✓ FRAME (Fracture toughness trend curve validation)
- ✓ REDOS (Reactor dosimetry optimisation)
- ✓ THERFAT (Thermal fatigue assessment)
- ✓ SMILE (Warm-Prestressing effect)
- ✓ FITNET (Neutron techniques for microstructures examination)
- ✓ INTERWELD (Irradiation effects on Stainless Steel HAZ)
- ✓ ADIMEW (Integrity assessment of dissimilar welds)
- ✓ ENPOWER (Optimisation of weld repairs)
- ✓ SPIQNAR (Signal Processing & Improved Qualification)
- ✓ NURBIM (Risk-based [Informed] Inspection Methodology)
- ✓ VOCALIST (Constraint-based structural integrity methodology)
- ✓ **PERFECT** (Irradiation damage modeling / microstructure > integrity)

➢ **Integrated approach to R&D activities on critical issues for PLIM of ageing NPPs (both western and Russian-type)**

➢ **European best-practices and guidelines for deterministic and risk- informed structural integrity assessment of key components**

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Activities in the sector (Cont^{d})

RELEX
AIDCO – ELARG
(1991 -)

JRC – Scientific & Technical Support:
- ✓ Project selection
- ✓ Project Description
- ✓ Specifications (Service & Supply)
- ✓ Tender evaluations
- ✓ Project Management
- ✓ Project Results evaluation & dissemination

- *TACIS / PHARE Nuclear Safety Programmes*

TACIS (2004-06)
- ➢ Enhancing the Safety Culture, both at Regulator & Operator level
- ➢ Addressing Issues related to nuclear waste and spent fuel, including North-West Russia
- ➢ Contribution to relevant EU-supported international initiatives (Chernobyl Shelter Fund, MoU with Ukraine, NDEP Fund, Medzamor)
- ➢ Addressing Safeguards and Off-site Emergency Preparedness issues

- ➢ On-Site Assistance: Contribution to implementation of upgrading / modernisation measures, including licensing
- ➢ Design Safety: Comprehensive Assessment of physical phenomena of structures, systems & components of VVER & RBMK Reactors, PLIM, SR upgrading
- ➢ OSEP: Emergency Crisis Centres Upgrading, including Radiological & Meteorological Monitoring and Data exchange
- ➢ Waste Management & Safeguards: Long-term waste strategies & repositories, decommissioning, NUMAC
- ➢ Regulatory Authorities & TSO: Implementation of the legal and procedural Basis, documentation building & trainig

PHARE (2003)
- ➢ Enhancing the Regulatory Authority Effectiveness
- ➢ Increasing Radiation Protection
- ➢ Improvement of Radioactive Waste Management
- ➢ Heightening On & Off-Site Emergency Preparedness

- RPV embrittlement
- Primary circuit integrity (LBB)
- NDE / ISI
- QA & Component certification
- Maintenance
- RLT assessment

- Reactor core safety analysis
- Accident analysis & management
- Operating procedures & Personnel training

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Component Classification & Qualification

- *TACIS / PHARE*

- ➢ Updated Functional & Seismic Classification of Safety Related Components (mechanical & electrical)
- ➢ Re-assessment of Seismic Loading
- ➢ Ad'hoc ageing effects during operation
- ➢ Re-assessment of accidental environment conditions (pressure, temperature, radiation)

- ✓ Re-assessment of accident environmental conditions within the "confined zones" (VVER 440) and containment (VVER 1000), including benchmarking of containment codes (CONTAIN, COCOSYS, WAVCO, MARCH)
- ✓ Reassessment of seismic spectra for component qualification purposes
- ✓ Ad'hoc "Bubble Condenser" qualification tests (EREC)
- ✓ Accident analysis and containment codes upgrading (heat transfer, condensation and hydrogen behaviour models)
- ✓ Elaboration of appropriate qualification programmes for operating NPPs, including:
  - Random on-site leak tests for piping sections,
  - Random laboratory tests on typical (removed) sensors,
  - Systematic laboratory tests on representative spare parts for instrumentation & power cables'
  - ad'hoc replacement with qualified new components

- ✓ Functional tests of main Safety related Equipment (SG Safety Valves)

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ISI and NDE techniques

- *ENIQ*

Harmonisation of Codes & Standards at European Level in the Field of Inspection & Qualification

✓ Coordinate expertise & resources for assessment of NDT systems
✓ Develop Qualification schemes
✓ Promote the use of technical justifications

✓ Study Risk-Informed concepts & consequences on inspection qualification
✓ Establish a EU framework on Risk-Informed Inspection & Harmonise the national positions

European Approach / Methodology

- General principals agreed with NRWG (1996)
- Guidelines for VVER NPP operating Countries in agreement with the IAEA (1999)
- All EU & many of the CEECs are using the European Methodology (various extend)
- Used in the non-nuclear field (CEN TC 138 WG9 & EPERC TTF3)

Pilot Studies Concept (Stainless Steel / Carbon Steel / Cladding)

ENDEF

- Strategic Plan for the implementation of ISI Qualification Systems in the CEECs (relevance & consistency of technical assistance projects)
- Draft Guidelines for detailed project proposals to improve ISI in VVER & RBMK units

Test Pieces Database

- Common database on existing test pieces
- Facilitate the Qualification Trials by facilitating access of ENIQ/IAEA members to a common set of test pieces

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ISI and NDE techniques (Cont[d])

- *ENIQ / SCAs*

ENIQ / TG4 (Risk)

✓ Set-up in 1996
✓ Explore the way from standard ISI (including implicit risk evaluations) towards a structured risk-informed ISI, including SRM, expert elicitation, virtual risk appreciation)

SPIQNAR

- Improve the performance of US inspection (detection & sizing) in austenitic stainless steel components
- Improve confidence in the qualification procedures

✓ 13 partners (UK, F, E, B, S, D, JRC & CZ) sharing numerous tests pieces, various transducers & substantial tests results
✓ Signal processing methods assessment
✓ Proposals for improved inspection practices for IGSCC cracks detection & sizing

NURBIM

- Develop a Risk-based (informed) methodology in order to optimise inspection & maintenance regarding safety and economics
- Promote Best Practices and an Integrated Approach for inspection and assessment of NPP components

✓ 12 partners (UK, F, D, S, F, E, JRC & CZ)
✓ Potential damage mechanisms, Validation of Structural Reliability Models & associated software, Integration of qualitative & quantitative analysis, interface between probability of failure and consequences, acceptance criteria & cost-benefit assessment, Inspection capability and qualification, Case study (Oskarshamm) & Handbook of best practices

- Draft European Best Practices (2004)
- Structural integrity reliability models
- PROSIR benchmark & PROSAC implementation

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ISI and NDE techniques (Cont^d)

- *TACIS / PHARE*

Main Areas of Activities

- Comparisons of methodologies (East / West)
- Definition and delivery of Qualification blocs / samples and contribution to ISI systems qualification
- Development of automated inspection systems for circular piping welds
- Evaluation of ISI effectiveness / reliability
- Definition of training requirements
- Contribution to the creation of national NDE centres for training, qualification and certification
- Elaboration of improved ISI programmes
- Preparation of technical specifications for ISI equipment and tools
- Procurement of ISI equipment and tools

Main Components

- ✓ VVER 440/213: RPV, Pressuriser (junction to MCL, surge line & nozzle/nozzle dissimilar weld), SG (transition weld, feed-water nozzle transition weld), MCP (inlet circumferential weld, outlet circumferential weld & longitudinal weld in the outlet elbow) & MCL circumferential welds
- ✓ VVER 1000: RPV (core shells, threaded holes), MCL circumferential welds & SG (collector ligaments & tube bundles)
- ✓ RBMK: Fuel Channels & Primary circuit

Main Non Destructive Techniques

- Surface (Visual, Camera, Eddy Current)
- Trough Thickness (Ultrasonic, Radiographic)

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Maintenance

- *SENUF*

✓ New "Forum" promoting *Safety of Eastern European Type Nuclear Facilities* by providing communication between Eastern European Nuclear Operators in Candidate Countries themselves and relations with Major Western European Nuclear Operators

✓ Main objective :Promote safety upgrading by technical exchange between operators

✓ Area of interest: Operational safety (Maintenance is selected as a prime topic)

✓ Working Group on NPP maintenance established (Collaboration Agreement signed by 9 institutes)

Task 1: Advanced strategies to optimise NPP maintenance (Status Report)

- To collect and analyse existing optimisation strategies (e.g. condition based, reliability centred, risk-informed maintenance)
- To identify differences and commonalities in the Western and Eastern European practice

- *Maintenance management*
- *Types of maintenance*
- *Maintenance optimization*
- *Intolerance of equipment problems*
- *Long range focus*
- *Maintenance personnel knowledge and skills*
- *Efficient and effective work management system*
- *Maintenance procedures*
- *Maintenance facilities, tools, equipment*
- *Procurement of parts, materials and services*
- *Maintenance history*
- *Area for improvement*

Task 2: Advanced and special tools, equipment, materials and processes (Database)

- Existence, parameters, experiences, contact person concerning the tools…

Anticipated Reports:

- NPP maintenance in CIS and CEEC (Evaluation report)
- Life management of VVER NPPs (Status report)

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Maintenance (Cont[d])

- *TACIS / PHARE*

43 (+ 2) Projects

Countries
- Armenia (1)
- Czech Republic (3)
- Hungary (1)
- Kazakhstan (1)
- Lithuania (1)
- Russian Federation (23 +2)
- Ukraine (13)

Major Topical Issues
- Maintenance management (organisation, optimisation, …)
- Maintenance personnel training
- Condition monitoring, Diagnostics
- Repair technologies
- Special maintenance tools
- Maintenance information and management system

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Ageing

- *SAFELIFE*

RPV
- VVER 440 (high P%): Re-embrittlement studies & experiments (Contribution to PRIMAVERA)
- VVER 1000 (High Ni-Mn%): Tailored materials characterisation (as received / after irradiation)
- Recommended procedure for assessment of shallow defects
- Report of 2nd ENIQ pilot study (cladding)

Piping
- Thermal Fatigue: Crack initiation & propagation data evaluation, Plasticity model assessment, Progress report on the Harmonised European Assessment Procedure
- Dissimilar welds: ISI round robin results, Integrity Assessment Report, Status report on advances crack modelling techniques under mixed mode loading, including residual stresses evaluation aspects

RPV internals
- Start-up of the new high pressure / high temperature water chemistry loop (IGSCC)
- Evaluation of the potential experimental capabilities including validation of fracture toughness measurements (Cv / mini Cv / 3-point bend)
- Industrial needs for IASCC

Non Destructive Investigations
- Material damage and stress field evaluation by Non Destructive Methods
- Validation of portable experimental methods (round robins) for various techniques & development of physical (damage) / analytical (stress field) models
- New facilities (SANS / Neutron Radiographie)

New Methodologies and expertise for material characterisation
- Dynamic Toughness Testing
- TEM

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Ageing (Cont^{d})

- *TACIS / PHARE*

RPV

- VVER 440/240: Direct Characterisation – Annealing Embrittlement & Re-embrittlement experiments (KZD / NVZ)
- VVER 440/213: Toughness reference curves
- VVER 1000: Nickel effect – Dosimetry benchamarking – Surveillance Programme (SS) Assessment
- VVER 1000 & 440/213: RPV integrity re-assessment including SS results upgrading (RF+U)

Piping (LBB)

- VVER 440/240: Feasibility studies (KZD / NVZ) & Detailed assessment for Medzamor
- VVER 1000: Detailed assessment including material characterisation on mock-ups and preparation of a reference methodology

RPV internals

- Preliminary Safety assessment of aged RPV internals
- Material characterisation and contribution to the understanding of IASCC phenomena

Other aspects

- Cable Ageing: Activation energy characterisation & prediction models
- Lifetime assessment: General approaches on secondary systems (NVZ)