



ÚJV Řež, a. s.

# Long term operation activities for VVER new builds

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Operated NPP reliability can be generally lost by two phenomena:

- Material ageing

*Can be solved by proper design and good quality AM (Ageing Management) program based on AM review results*

- Incorrect design change

*Can be solved by good quality CM (Configuration Management) and Design Change process based on DB Documents*

## ■ AM should cover all stages of NPP life (Proactive strategy)

- Design
  - Proper design
- Fabrication and construction
  - Production specific data
- Commissioning
  - Measurement of virgin state
- Operation (Long Term Operation)
  - Operational programs
- Decommissioning

Common Ageing management strategy

Comprehensive and proactive Ageing management strategy

- **To support CEZ (Czech electricity producer) during tender on new NPP ÚJV identified potential material and ageing management gaps of new VVER units.**
  - Material Management Matrix (MMM) format developed by EPRI and applied for western NPP designs was used
  - Experience with ageing of VVER-1000 units were used
  - Also the list of questions (41) for discussion with the supplier was prepared.
  - Specific SW tool for development of Ageing management matrixes for new units was developed
- **Main benefits of this work:**
  - Development of proactive ageing management strategy just before the operation
  - Gathering of all necessary ageing management related information from early stage of unit life
  - Potential modification of critical locations before operation
- **Now ÚJV experts work in cooperation with EPRI on Material Degradation Matrix (MDM) for VVER NPPs**

## Specific SW tool for ageing management in design phase contains:

- a. Ageing management matrixes for main components and their critical locations
- b. Evidence of another AM important information
  - Material data
  - Operational conditions
- c. Expert assessment of material risks from the point of view:
  - Likelihood of degradation
  - Consequence of degradation
  - Probability of detection of degradation
- d. Evidence of gaps and oportunities

# SW tool for ageing management in design phase



frm\_mainMMM

## MMM - Materials Management Matrix

MMM TABLE:

Project	Major Assembly	Assembly	Sequential Component
EPR	Steam Gen. Tubes & Internals	Tube Bundle Support Assembly	Tube Support Plates
EPR	Steam Gen. Tubes & Internals	Tube Bundle Support Assembly	Anti-Vibration Bars
EPR	Steam Gen. Tubes & Internals	Axial Economizer	Double Wrapper
EPR	Steam Gen. Tubes & Internals	Axial Economizer	Divider Plate
EPR	Steam Gen. Tubes & Internals	Moisture Separators	Primary Moisture Separators (swirl vanes, piping, supports)
EPR	Steam Gen. Tubes & Internals	Moisture Separators	Dryer (frames, banks, channels, supports)
EPR	Steam Gen. Tubes & Internals	Feedwater Distribution	Thermal Sleeve
EPR	Steam Gen. Tubes & Internals	Feedwater Distribution	Piping, Fittings, Deflector Plates, & Supports

Záznam: 334 z 359 Bez filtru Vyhledávání

Risk and Materials | Design | Operation

Expert Assessment

Relative Risk	High
RPN	1,39
LOD	1,2
COD	0,81
POD	1,44

Materials

Material Class: CS

Material Grade: (SA-516 Gr. 60)

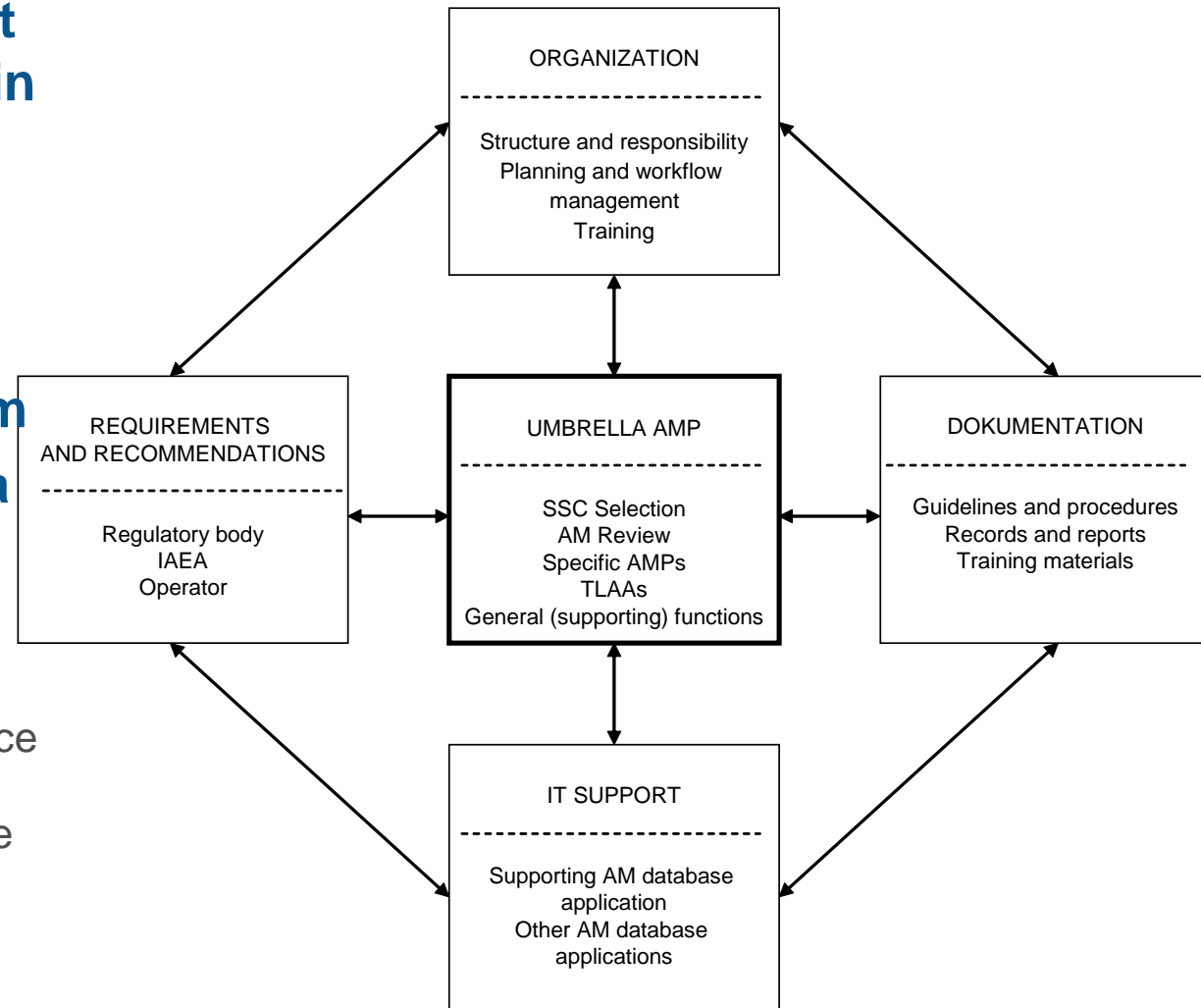
Degradation Mechanism

Name	Explanation
C&W: Pit	Corrosion & Wear - Pit Pitting
C&W: Wstg	Corrosion & Wear - Wstg Wastage
RiFR: Env	Reduction in Fracture Resistance - Env Environmentally Based
*	

# PLIM or Umbrella AM Program development



- The most important requirement of the future operator is to obtain all information to be able to define and perform necessary programs.
- It can be solved by early implementation of PLIM program
- ÚJV has great experience with a new program design and implementation that covers:
  - Aging management approach,
  - Maintenance (Condition and Performance monitoring) approach and
  - Run to failure approach (or maintenance when it is effective)
- Design is based on analysis using ageing management process elements.



- **The best way is to do the AM review that start already in design phase**
- **For SSC with relevant ageing degradation impact an adequate set of Monitoring measures, Parameters to be monitored and their acceptance criteria and corresponding AM programs or TLAA are stated and written to the last three columns of the AM Matrix.**
- **Minimum table proposed for EUR revision D.**
























SSC (mechanical, civil, and electrical)	Functions important for safety or production reliability	Relevant ageing mechanism / ageing effect	Parameters to be monitored and their acceptance criteria	Measures (diagnostics, in-service inspection, maintenance, ..., TLAA)
...	...	...	...	...



## Example from AM review done by ÚJV for SG of South Ukraine NPP unit 1

SSC (mechanical, civil, I&C and electrical)	Functions important for safety or production reliability	Relevant ageing mechanism / ageing effect	AM program or TLAA (maintenance, in-service inspection, ...)	Parameters to be monitored and their acceptance criteria	Corrective or mitigation actions
<i>SG heat exchange tubes</i>	<i>Integrity</i>	<i>Crevice corrosion</i>	<i>In-Service Inspection – Eddy Current Test (ISI – ECT)</i>	<i>crack depth (length) / comparison with maximum allowable crack</i>	<i>Plugging</i>
		<i>Crevice corrosion</i>	<i>Hide-Out-Return evaluation</i>	<i>high-temperature pH(T) / pH(T) &gt; neutral pH(T)</i>	<i>microdosing of sodium or lithium hydroxide</i>
		<i>SCC / axial cracks</i>	<i>Hide-Out-Return evaluation</i>	<i>high-temperature pH(T) / pH(T) &gt; neutral pH(T)</i>	<i>microdosing of sodium or lithium hydroxide</i>
		<i>SCC / axial cracks</i>	<i>ISI - ECT</i>	<i>crack depth (length) / comparison with maximum allowable crack</i>	<i>Plugging</i>
		<i>Loss of function by synergic effect of different degradation mechanisms</i>	<i>Secondary circuit chemistry management</i>	<i>media conductivities, anion and cation concentrations / monitored chemical parameter is out of defined range for predefined importance level</i>	<i>identify root cause and correct it in term state for particular importance level</i>

- For effective performance of all above activities convenient supporting database application linked to already existing NPP information sources were developed.
- Database application called INFOZ can be used for efficient AM review
  - Quality evaluation of:
    - Understanding of ageing,
    - Ageing monitoring,
    - Ageing mitigation,
  - Quality evaluation of AM programs by assessment of effective AM program attributes
  - TLAA evaluation

	Část zařízení (subkomponenta)
	Posouzení informací o stárnutí zařízení
	Shrnutí stavu porozumění stárnutí zařízení
	Posouzení stavu hodnocení stárnutí zařízení
	Posouzení zmírňování stárnutí zařízení
	Hodnocení stárnutí zařízení a doporučení
	Funkce zařízení
	Návrhové specifikace
	Použitá projektová dokumentace
	Materiály a výrobní technologie
	Doprava, sklad, montáž
	Předprovozní kontroly a zkoušky
	Provozní kontroly
	Zprávy dle - Směrnice ČEZ
	Provozní měření
	Odchytky provozních režimů
	Kontrolní výpočet, funkční spolehlivost
	Výpočet odezvy, hodnocení životnosti
	TLAA
	Opatření vyplývající z programu řízeného stárnutí
	Kvalifikace
	Údržba
	Hodnotící ukazatele údržby

## List of forms used for gathering of the inputs and Evaluation in supporting application

- **Essential data**
  - Structure or Component Basic Data
  - Technical Specification of SC
  - Structure or component functions
- **Design data**
  - Used design documentation
  - Materials and production technology
  - Design specification
  - Design calculation, prove of functional reliability
- **Fabrication, construction and commissioning data**
  - Transport, storage, assembly
  - Pre-service inspections and tests
- **Maintenance, surveillance and In-service inspection**
  - In-service inspections
  - In-service measurements
  - Maintenance
  - Maintenance evaluation indicators
- **AM calculations, assessment and mitigation**
  - Equipment Qualification and Pipe Break Evaluation
  - Calculation of response and evaluation of SC lifetime
  - The mitigating measures resulting from the AM
- **AM review**
  - Assessment of existing information applicable to understanding of the SC aging
  - Summary of the current state of SC understanding of ageing
  - AM monitoring (assessment) status evaluation
  - Current AM mitigation evaluation
  - Final estimation of the results of the evaluation and determination of recommendations
- **TLAA and AM programs**
  - TLAA evaluation
  - Evaluation of AM programs

- **Already in pre-operational phase of NPP life it is worth to implement particular AMPs and start to gather necessary data for their future operation.**
- **Generic attributes of an effective ageing management program (according to IAEA NS-G-2.12) can be used as an outline of AMPs:**
  1. Scope of the AMP based on understanding ageing,
  2. Preventive actions to minimize/ control ageing degradation,
  3. Detection of ageing effects (principles, methods),
  4. Monitoring and trending of ageing effects (techniques),
  5. Acceptance criteria, ...

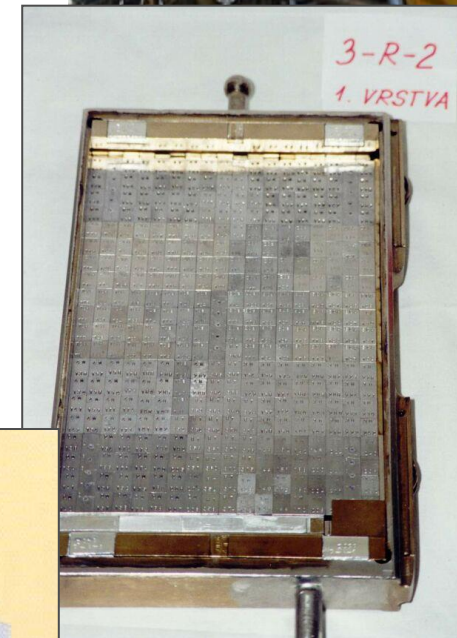
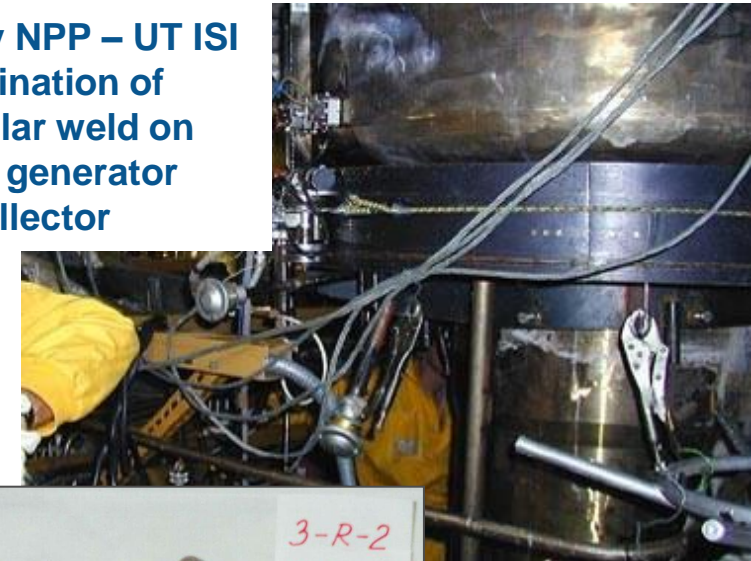
# Examples of AMPs



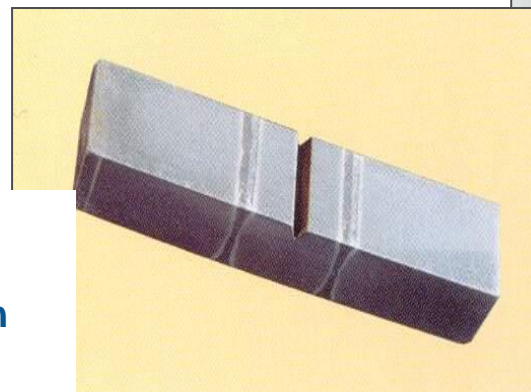
## ÚJV experience with review, design and realization of major AM programs

- RPV surveillance specimen program
- ISI
  - Risk informed methodology, Qualified methods
- Low cycle fatigue monitoring program
- Secondary Chemistry and Plugged Tubes Database
  - Information sharing between „western“ VVERs Dukovany, Paks, Temelin, Loviisa, Bohunice, Mochovce, Zaporozhie
- Secondary circuit flaw accelerated corrosion (FAC) evaluation
  - EPRI - CHECWORKS
- Chemical regimes management for nuclear and conventional power plants (MULTEQ)
- Mechanical components failure root cause determination
- Valves functional qualification
- ...

Dukovany NPP – UT ISI examination of dissimilar weld on steam generator collector



RPV material test specimen welded by electron beam



- **For Czech and Ukraine NPPs ÚJV developed different AMPs supporting database applications**
- **On the basis of that experience the effective generalised solution was developed that enable:**
  - to define any kind of AMPs
  - to address arbitrary level of system, structure or component (three levels of decomposition is sufficient - for example Pipelines, Pipelines segments and Components)
  - to make available specific monitoring activity support in form of specific protocols, evaluation tools (analysis) based on defined monitoring methodology and monitored type of SSC.

# Supporting Database Application Development



Database entrance Pipelines

Address: 2YA.187.33.81.00.000.Weld No.1

Pipelines Segments Components

Components Definition

Component ID	Description	Type	Material	Start of ope	Inner diame	Outer diame
Weld No.1	Weld to pressurizer (PRZ)	Homogenous weld	EA-400/10T	5.1.1985	346	426
Line pos.1		Bend	10GN2MFA + 08	5.1.1985	346	426
Weld No.8	Temperature measurem	Heterogenous weld	EA-400/10T	5.1.1985	19	40
Weld No.6	Temperature measurem	Heterogenous weld	EA-400/10T	5.1.1985	19	40
Weld No.2		Homogenous weld	EA-400/10T	5.1.1985	346	426
Line pos.2		Weldment	10GN2MFA + 08	5.1.1985	346	426
Weld No.3		Heterogenous weld	EA-400/10T	5.1.1985	346	426
Line pos.8		Pipeline	08CH18N10T	5.1.1985	346	426
Weld No.4		Heterogenous weld	EA-400/10T	5.1.1985	346	426
Line pos.3		Weldment	10GN2MFA + 08	5.1.1985	346	426
Weld No.10	Temperature measurem	Heterogenous weld	EA-400/10T	5.1.1985	19	40
Weld No.5	Weld to primary loop T-	Homogenous weld	EA-400/10T	5.1.1985	346	426

Picture of the selected segment

Database entrance Programmes AM Programme (Measure)

Programme name ISI Programme

AM Programme specification

SSC ID	SSC Description	Monitoring Methodolo	Volume	Monitoring cycle
2YA.187.33.81.00.000.Weld No.1	Weld to pressurizer (PRZ)	Visual Inspection	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.1	Weld to pressurizer (PRZ)	Penetration Test	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.1	Weld to pressurizer (PRZ)	Ultrasonic Inspection		
2YA.187.33.81.00.000.Weld No.8	Temperature measuremen	Visual Inspection	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.8	Temperature measuremen	Penetration Test	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.6	Temperature measuremen	Visual Inspection	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.6	Temperature measuremen	Penetration Test	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.2		Visual Inspection	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.2		Penetration Test	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.3		Visual Inspection	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.3		Penetration Test	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.4		Visual Inspection	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.4		Penetration Test	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.10	Temperature measuremen	Visual Inspection	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.10	Temperature measuremen	Penetration Test	100%	1 per 4 years
2YA.187.33.81.00.000.Weld No.5	Weld to primary loop T-join	Visual Inspection	100%	1 per 4 years

Select Address

Protocols Analysis

Protocol ID: 003

■ For Czech and Ukraine NPPs UJV developed different supporting database applicatins for:

- PLIM program
- AM review
- LTO Technical-economical study
- Different AM programs
  - Cables
  - Pipelines
  - ...

- **Effective NPP operation (or LTO) is influenced from the earlier stages of its life.**
- **In the design phase it is useful to optimize design features using tools as MMM and AM Review.**
- **These activities will enable to propose and implement PLIM program based on Proactive AM approach for all NPP life stages.**





**Thank you for your attention**

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**IAEA –Ageing Management for Nuclear Power Plants, Safety Guide NS-G-2.12, Vienna 2009:**

***Managing ageing of nuclear power plants means ensuring the availability of required safety functions throughout the plant service life, with account taken of changes which occur with time and use. This requires addressing both physical ageing of structures, systems and components, resulting in degradation of their performance characteristics, and obsolescence of SSCs, i.e. their becoming out of date in comparison with current knowledge, standards and regulations, and technology.***

***Ageing management of SSCs important to safety should be implemented proactively (with foresight and anticipation) throughout the plant's lifetime, i.e. in design, fabrication and construction, commissioning, operation (including long term operation and extended shutdown) and decommissioning.***

**Broadly accepted PLIM definition designed by EPRI is included in OECD document:**

**NEA – Status report on nuclear power plant life management, NEA/SEN/NDC(2000)6, May 2000**

***Nuclear power plant life management is defined as an integration of ageing management and economic planning to:***

- a) optimize the operation, maintenance, and service life of the system structure and components,***
- b) maintain an acceptable level of performance and safety and***
- c) maximize return on investment over the service life of the plant.***