36th CSNI WGIAGE Meeting
08-12 April 2013

Relevant CSNI and CNRA Activities

Alejandro Huerta
Nuclear Safety Division, NEA

Upcoming CSNI, CNRA meetings

- CNRA meeting 3 - 4 June 2013
- CSNI meeting 6 - 7 June 2013
- NEA/CNRA/CSNI Joint Workshop on Challenges and Enhancements to DiD in light of the Fukushima Dai-ichi Accident
  - OECD Conference Centre, Paris, 5th June 2013

CSNI and CNRA meetings highlights

- CSNI 52nd Meeting (December 2012)
  - WG and TG activity reports
  - Roundtable Discussion on Fukushima Daiichi
  - Briefing on CNRA STG-FUKU current thinking and recommendations (including outstanding areas of possible CSNI involvement)
  - 3 new F-CAPS to be discussed
    - DiDELSYS 3, Hydrogen Generation Transport and Mitigation, SFP under Loss of Cooling Accidents
  - Discussion on DiD in preparation for June 2013 CNRA-CSNI workshop
  - Briefing by Japanese officials on R&D roadmap for medium to long term decommissioning program for Fukushima Daiichi NPS
  - Revisions to CSNI/CNRA JSP and CSNI OP

CSNI and CNRA meetings highlights

- CNRA 28th Meeting (December 2012)
  - WG and TG activity reports
  - Post-Fukushima activities
    - update from CRPPH
  - Proposals concerning the *Characteristics of an Effective Regulator*
  - Round table discussion of national reports
  - Use of CNRA Products – Canada and Spain
  - CNRA Bureau – Defence in Depth, IRSN Proposal for a Study on Economic Consequences of Severe Accidents
  - New Chair, Mr. Jean-Christophe Niel, ASN, France

Committee on the Safety of Nuclear Installations (CSNI)

CSNI Working Groups

- Working Group on Analysis and Management of Accidents (WGAMA)
- Working Group on Integrity and Ageing of Components and Structures (WGIAGE)
- Working Group on Fuel Safety (WGFS)
- Working Group on Risk Assessment (WGRISK)
- Working Group on Human and Organisational Factors (WGHOF)
- Working Group on Fuel Cycle Safety (WGFCS)

CSNI Activities on Safety Assessment and Research in Response to the Lessons from the Accident

- CSNI working closely with CNRA and CRPPH in Tri-Bureau co-ordination of NEA work in response to the accident.
- CSNI extended the scope of its Programme Review Group (PRG) to address cross-cutting activities related to the Fukushima Daiichi NPS accident.
- CSNI produced, at an early stage, a Concept Paper “Considerations and Approaches for Post Fukushima Daiichi Follow-Up Activities”.
- Received advice and requests from CNRA on new and existing tasks and actions
- Initiated new work to address identified Post Fukushima issues.
- Discussed approaches to meet safety research needs related to Fukushima and use of accident data to validate tools

CSNI Concept Paper

- CSNI at an early stage considered:
  - the high level technical and related issues that may need to be addressed in order to close current safety and/or knowledge gaps and identify technical priorities.
- This resulted in a CSNI concept paper “Considerations and Approaches for Post Fukushima Daiichi Follow-Up Activities”
  - this looked at external and internal hazards, plant robustness, safety management, emergency preparedness and safety research more generally.
  - it also noted that the occurrence of this accident signals that safety gaps still exist in current NPP technologies, in particular in their protection against certain hazards which are capable of leading to a severe accident – i.e. that focus should be given to strengthening and improving the implementation of the Defence in Depth concept.

Post Fukushima CSNI Work

Following the process established through the Tri-Bureau, the CSNI has undertaken eight (8) activities to address technical issues from the Fukushima Daiichi NPS accident:

- Technical Opinion Paper on Filtered Containment Venting (WGAMA)
  - Output: a comprehensive summary of the current status of the technology and venting strategies as well as developments required for possible improvements to filtration technologies

- Status Report on Hydrogen Generation, Transport and Management (WGAMA)
  - Output: a comprehensive summary of hydrogen risk management technology and strategies

Post Fukushima CSNI Work - 2

- Status Report on Spent Fuel Pool under Loss of Cooling Accident Conditions (WGAMA and WGFS)
  - Output: a summary of spent fuel pool accident phenomenology and mitigation measures, and a guide for further research activities
- Metallic Component Margins under High Seismic Loads (MECOS) (WGIAGE)
  - Output: a report documenting best practices for the analysis of ageing of passive metallic components (degradations, cracks or local thinning, reduced material properties, etc.) subjected to high seismic loads.
- Human Performance and Intervention under Extreme Conditions (WGHOF)
  - Output: a summary of HOF challenges during extreme events, good HOF practises and knowledge gaps, and proposed HOF principles for human performance and interventions under extreme conditions

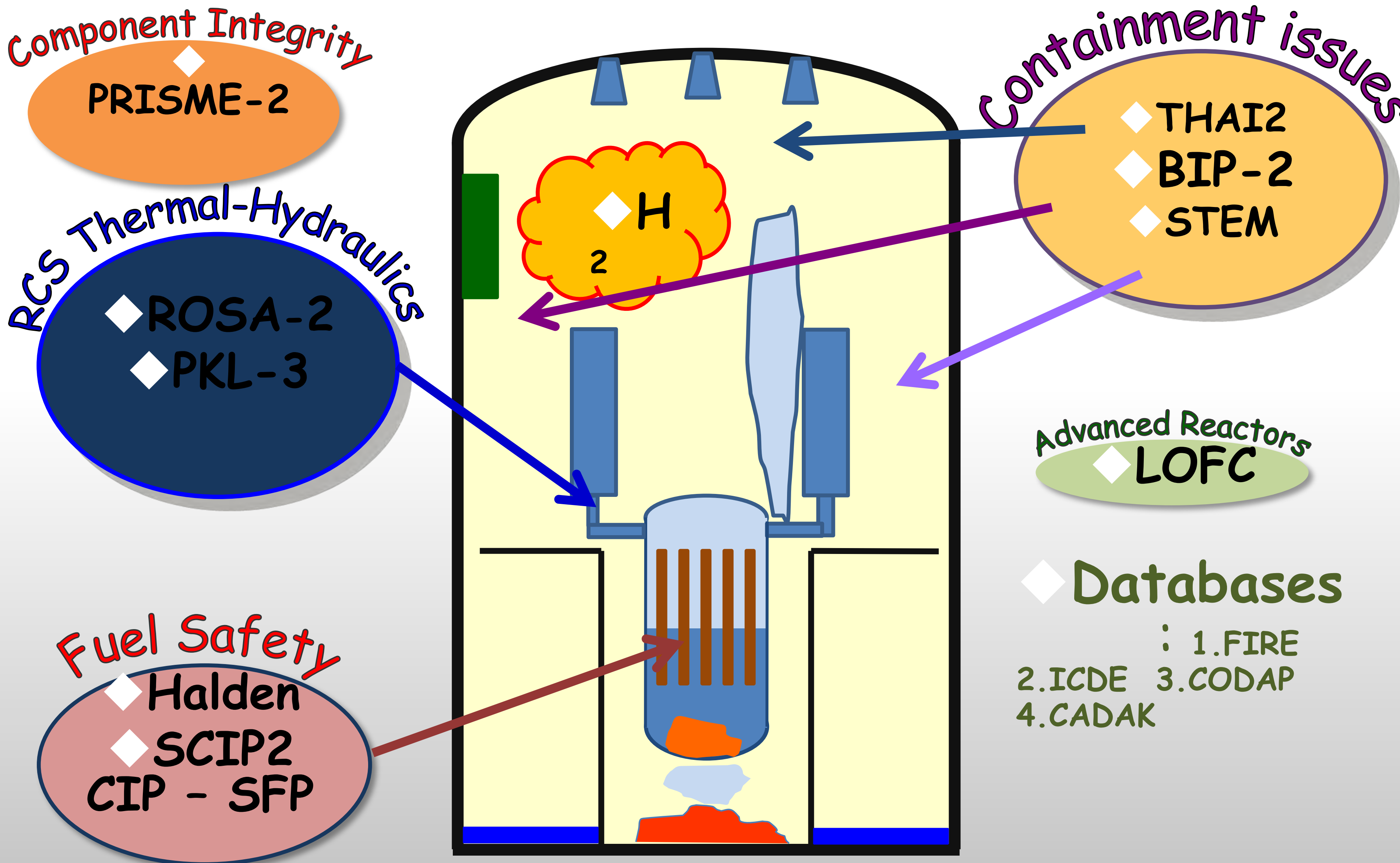
Post Fukushima CSNI Work - 3

- Workshop on Natural External Events including Earthquake (WGRISK)
  - Output: a report on commendable practices and experience gathered on PSA methodologies for natural external events.
- Workshop on the Robustness of Electrical Systems of NPPs in Light of the Fukushima Daiichi Accident (Task Group)
  - Output: a report describing the technical basis of the provisions already taken or planned in each country after the Fukushima accident, regarding the sources, the distribution systems and the loads.
- International benchmarking project of fast-running software tools for the estimation of fission product releases during accidents at nuclear power plants (WGAMA)
  - Output: a state-of-the-art report for simple tools to estimate fission product releases, including areas for improvement.

CSNI International Research Activities

- As illustrated on the next slide, there are 15 on-going joint research projects (experimental or database projects) that address, to varying degrees, issues from Fukushima, and that may gain insights as recovery and decommissioning activities proceed.

- In addition, the CSNI is considering to set up an expert group in severe accidents, materials, and other disciplines, to identify what data could be obtained from the decommissioning process in Fukushima that would be useful to validate/model codes/calculations in the future.


Component Integrity
PRISME-2
RCS Thermal-Hydraulics
ROSA-2
PKL-3
Fuel Safety
Halden
SCIP2
CIP - SFP
H
2
Containment issues
THAI2
BIP-2
STEM
Advanced Reactors
LOFC
Databases
: 1.FIRE
2.ICDE 3.CODAP
4.CADAK

New Joint International Research Projects

Since Fukushima there have been 3 new projects initiated that will also address, to varying degrees, lessons learned from Fukushima

- **ATLAS** - Advanced Thermal-hydraulic Test Loop for Accident Simulation
  - Output: investigation of design extension conditions to identify major thermal-hydraulic scenarios and provide guidance for accident management
- **HYMERES -** Hydrogen Mitigation Experiments for Reactor Safety
  - Output: improved understanding of the hydrogen risk phenomenology in containment that can enhance its modelling in support of nuclear power plant safety assessments
- **PKL phase 3** - PWR Transient Tests Under Postulated Accident Scenarios
  - Output: address current safety issues related to beyond design basis accidents with significant core heat-up, i.e. station blackout scenarios or loss of coolant accidents in connection with failure of safety systems. Demonstrate the efficiency of long term initiated AM measures.

New Joint International Research Projects

After Fukushima a new project was initiated following the proposal from Japan to improve severe accident codes and determine the evolution of the accident in the three units

- **BSAF -** Benchmark Study of the Accident at the Fukushima Daiichi Nuclear Power Station Project
  - Output: Phase I will be a full-scope Severe Accident analysis for the first ~6 days of accident events. Modelling results from phase one will inform decommissioning processes and measurements, which in turn provide data for further phases of modelling and for improving severe accident codes and analysis
  - Results will be useful for Japan to support planning of decommissioning activities and useful for other countries to improve the simulation of severe accident codes

Committee on Nuclear Regulatory Activities (CNRA)

Inspection Practices (WGIP)

- Current Tasks:
  - Inspection of Licensee’s Maintenance Programmes and Activities- Final report presented to CNRA for approval.
  - Inspection of Licensee’s Emergency Arrangements. Final report planned for June 2013.
  - 12th WGIP Workshop in April 2014 in Chattanooga, Tennessee, USA
    - Post-Fukushima Inspections; Event Response Inspections; Inspection of Outage Activities.
  - Developing new programme for coordination of NPP Observed/Witnessed Inspections. Two pilots to be conducted 2013. USA and Spain to host.

Operating Experience (WGOE)

- 12th WGOE meeting: November 2012 in Paris
- Event of Note: Reactor trip at Sizewell (UK) on 415V AC main uninterruptable power supply failure
  - Proposal for 2014 Workshop: Identifying, Defining, and Measuring the Effective Use of Operating Experience by Licensees and Regulators.
    - Possibly held in USA
- *Special Topical Discussion 13th Meeting* - **Spent Fuel Pool Events**
- *Pre-cursors to the Fukushima Accident* - Evaluation of Initiators and situations for new lessons post-Fukushima accident and improvements in implementing lessons learnt.

Regulation of New Reactors (WGRNR)

- Current Tasks:
  - Construction Experience Programme (ConEx)
    - Second synthesis report and other means for learning such as “Safety Cards” from new events and a table matching Construction Inspections and events lessons learned
  - Licensing Process and Structure of Regulatory Activities
  - Siting Issues related to post-Fukushima considerations
    - regulatory approaches used when regulating siting of a NPP; location of equipment on a site; and enhancements or changes to the regulatory approaches as a result of the Fukushima Accident
  - Workshop in Atlanta, Georgia, USA in October 2012
    - Lessons learned from siting, licensing and construction of new NPPs

Public Communication of NRO (WGPC)

- Current main Task:
  - Proceedings from the May 2012 CNRA Workshop "Crisis communication: facing the challenges
    - Conclusion prepared by WGPC –Planned for January 2013
  - International dimension of "crisis" communication
    - *Road Map extension to international Report*. **Report submitted to CNRA for approval.**
  - Stakeholder involvement in WGPC
    - One day session with journalists in future WGPC meetings
  - Task on Communication Plans for Regulators
    - Preliminary survey in autumn 2012
    - Full survey and Guidance document in 2013
- Continuous Task: « Flashnews » exchange network

Task Group on Nonconforming, Counterfeit, Fraudulent and Suspect Items(TG-NCFSI)

- **Report builds upon the work already done**
  - WGOE meetings: Issue of Generic Interest: Non-conformance (Spring 2010) and CFSI (Fall 2010)
- **Overview of report content**
  - Background of the issue
  - Causal factors and challenges faced
    - Root causes, latent causal factors, increased incidence in the supply chain, ageing and obsolescence, Adequacy of laws and regulatory framework, awareness of the issue and impact on safety, difficulties in detecting, safety culture in the supply chain
  - An Informed and Engaged Supply Chain
    - Education and training, knowledge management
  - Licensee processes and controls
    - Quality assurance program, procurement and supply chain management, post procurement,
  - Regulators' role
- Report was submitted to CNRA for approval in Dec 2012

Characteristics of an Effective Regulator

- Good body of work exists in previous NEA Regulatory Guidance booklets
- Includes:
  - Technical competence
  - Independence
  - Accountable
  - Transparency/Openness/Communication
  - Integrity
  - Predictable
- CNRA accepted the proposal to generate a green book on the topic.
- In addition CNRA accepted a proposal for Sweden to host a workshop on the topic.

Challenges and Enhancements to DiD in light of the Fukushima Dai-ichi Accident

- Session 1 – Background and objectives of the workshop with a key speech
- Session 2 – Concept of DiD
  - Concept and evolution
  - Influence of Fukushima en End Goal of DiD
  - Balance between prevention/mitigation
- Session 3 – DiD Focus on External Events
  - Impact of rare and extreme external phenomena
  - Approaches for rare and extreme external events

Task Group on Accident Management

- To review the regulatory framework for accident management following the Fukushima Daiichi NPP accident
- The TG will assess country needs and challenges in light of the accident from a regulatory point of view.
  - Enhancements of on-site accident management procedures
  - Decision-making and guiding principles in emergency situations.
  - Guidance for instrumentation, equipment and supplies for addressing long-term aspects of accident management.
  - Guidance and implementation when taking extreme measures for accident management

Task Group on Accident Management

- **1st Meeting 10 – 12 October 2012, OECD**
  - 10 countries participated in the meeting
  - Provided updates on country activities in the area of accident management
  - Draft Definition of Integrated Accident Management (IAM)
  - Four sub-groups will work to develop proposed report inputs

- **Coordination with the CSNI and CRPPH**

- **A final report is planned to be provide to CNRA in advance of its December 2014 meeting**

Thank You For Your Attention.

Questions?

CSNI – IAGE
Concrete sub-group meeting
8-9 April 2013

François Tarallo

IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Faire avancer la sûreté nucléaire

CONTENT

- Election of the Concrete Sub-group Chairman and Vice-Chair
- Status of the actions from last meeting
  - Improving Robustness Assessment Methodologies for Structures Impacted by Missiles (IRIS_2012)
  - Follow-up of IRIS activity
  - Study on Post-Tensioning Methodologies in Containment
- Status of actions proposed during last meeting
  - CAPS on Non-Destructive Evaluation of Thick Walled Concrete Structures
  - Probabilistic reliability methods
- New CAPS: Assessment of Structures subject to Concrete Pathologies (ASCET)
- Medium term strategy of the WGIAGE Concrete Sub-Group

Election of the Concrete Sub-group Chairman and Vice-Chair

As proposed by the Secretariat, election reaches a consensus on:

François Tarallo (IRSN, France) as Chair
Pekka Valikangas (STUK, Finland) as Vice-Chair

Improving Robustness Assessment Methodologies for Structures Impacted by Missiles (IRIS_2012)

Mr. Andrei Blahoianu (CNSC, Canada) presents the status of that activity.

The workshop, held in Ottawa, Canada, last October, gathered 26 teams from 10 countries and 1 International Organization. IAEA (Mr. Kenta Hibino) was present as member of the Organizing Committee. There were three days of good presentations and very interesting discussions, helped by the high level members of the Scientific Committee.

The Organizing Committee is encouraged to continue with OECD/NEA IRIS Research Program.

The proceedings and final report will be drafted by June. They should be approved during the December 2013 CSNI meeting.

Follow-up of IRIS activity

Mr. Blahoianu recalls that IRIS_2012 is the second phase of a 3-phase program.

The third phase will be dedicated to the study of induced vibrations.

Since the leaders of the 2 first phases (IRSN and CNSC) do not wish to keep that position, M. Blahoianu informs the group that EDF (Mr. Pierre Labbé) could take the lead of the third phase.
ENSI, STUK and IRSN say they are willing to support EDF in the organization of the 3rd phase.

Action Item: the chairman will contact Mr. Labbé to ask for confirmation.

Study on Post-Tensioning Methodologies in Containment

Mr. Etienne Gallitre (EDF, France) presents the status of that activity.

That study investigates the consequences of the type of tendon protection technology (greased or grouted) on design, construction and in-service inspection of the pre-stressing system.

During the intermediate expert meeting, held in November 2012 in Lyon, France, the summary of the future report was finalized, and the first contributions discussed. The progress of the report is roughly 70 %.

Final draft (July) will circulate in the task group.
The final meeting : December 2013, or next year. After the validation of the text within the task group, the draft will be sent for comments to all the concrete sub-group members, through the Secretary.

Publication of the report should be done by end of 2014.

CAPS on Non-Destructive Evaluation of Thick Walled Concrete Structures

The activity proposed by Dr. Ladislav Pecinka (NRI, Rez) during April 2012 meeting and approved by the CSNI committee in June 2012, is under way.

The corresponding workshop is postponed to mid-September 2013. The announcement will be distributed by the Secretariat.

Probabilistic reliability methods in structural analysis of nuclear buildings

During last year meeting GRS proposed an action related to probabilistic reliability methods in structural analysis of building probabilistic reliability methods in structural analysis of building structures of nuclear facilities that did not obtain a consensus.

It was agreed that GRS would re-think about the project and prepare a questionnaire to send to the members of concrete sub-group. The questionnaire has been distributed by e-mail on March 29th 2013.

By the date of the meeting, GRS had received only a few answers. It is decided that the members answer rapidly to GRS (with a copy to Mr. Huerta).

Then, GRS will assess the answers, draft a synthesis, and possibly define an activity to be discussed during 2014 meeting.

New CAPS: Assessment of Structures subject to Concrete Pathologies (ASCET)

Presentation by M. Andrei Blahoianu of a possible new CAPS.
Public acceptance of existing nuclear facilities depends on demonstrating adequate structural performance of these facilities during their entire lifetime.
Concrete pathologies have been detected in concrete nuclear facilities in several member countries.
Thus, it is worthwhile to carry out a research activity whose objective would be to form the foundation of general recommendations for ageing management of concrete nuclear facilities subject to different concrete pathologies. The main research axes are: material aspects, structural aspects and repair techniques, including testing and numerical simulation.
A Workshop could be conducted 18 months following agreement on the CAPS (tentatively October 2014), followed by a report.

The lead organisations in ASCET CAPS are CNSC and US NRC.
Supports expressed during the meeting : EDF (France), STUK (Finland), IRSN (France) and CSN (Spain).

Action Item: if that CAPS is endorsed by WGIAGE, CNSC sends within 2 weeks a mail to all members to ask firm participation to the task group.

Medium term strategy of the WGIAGE Concrete Sub-Group

Mr. Tarallo recalls the document “Medium-term strategies for the IAGE concrete working group”, edited in April 2006, notes the need of up-dating it.

It is asked to the participants to send their observations to the chair and the secretariat within 1 month. The chair will then propose an updated document for the validation of the members of the group.

18th IAGE-Metal Sub-Group meeting

Synthesis

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Presentation of Synthesis

- **Limited participation:**
  - Around 15 participants, from 10 different countries
  - mainly Regulators or Regulator Technical support organizations
- **New member: Poland regulator**
- **Diagnostic:**
  - 2 days too short to have technical presentations on on-going projects and definition of new proposal with a large scope
  - 2 days too short to be attractive for :
    - far away countries
    - Utility , Utility TSO or Research Organizations
  - "Forum" on Information exchanges between regulators ???

AEN NEA

Presentation of Synthesis

OECD

- 2.5.0 Reactor pressure vessel
  - 5.1 Final report on PROSIR – 1 : revision 6 available
  - 5.2 Discussion of potential future work on this topic: no new project
- 2.6.0 Fatigue
  - 6.1 Collection of fatigue tests on structures
    - Partially done
    - Japanese contribution planed (3 typical fatigue tests on structures)
    - EXCEL sheet + references before next June (CF)
  - 6.2 Next step on analysis of selected tests with different proposed rules (NUREG 6909…)
    - 2 USA tests / 2 French tests / 1 JRC test / 2 Japan tests
    - Report and conclusions before end of 2013 (CEA + CF)
  - 6.3 State of the art document on Environmental Fatigue
    - -1st draft for next summer
    - Review and complementary contributions before end of 2013
    - Final report before next meeting (CF)
  - 6.4 Status in each country: round table
    - Done
    - generally no Fen request before 40Y of operation (except SW-Fr with PSR)
  - 6.5 OECD-NEA Workshop : 3 days in Spain (or in France) around October 2013 or Spring 2014

Presentation of Synthesis

- ✓ 2.7.0 Benchmark on the analytical evaluation contribution for end 201 of the fracture mechanic parameters K / J (CEA)
  - 7.1 Existing results: K and J for cracked cylinders
  - 7.2 Next step and associated planning: elbows and welds : final for end 2014
  - 7.3 Up-to now 3 deliverables : PVP papers in 2010-2012-2013 : periodic update
- ✓ 2.8.0 Leak-before-break research in front of active degradation mechanism (USNRC)
  - 8.1 Questionnaire synthesis: many answers : different open points
  - 8.2 Deliverables: overview + recommended research activities
  - 8.3 USNRC propose cooperation on xLPR program
- ✓ 2.9.0 Hydro-proof pressure test (CSN)
  - 9.1 Last answer from EDF as soon as possible
  - 9.3 Updating of existing synthesis report before end of 2013
- ✓ 2.10.0 LTO research project – buried pipe ageing management (USNRC)
  - 10.1 Status in the main group (WGIAGE)
- ✓ 2.11.0 Operability / Functional capability (C. FAIDY)
  - 11.1 Status and round table review
    - Only 3 answers: Finland Sweden and France
  - 11.2 Deliverable and planning
    - Collection of different regulator positions
    - Before next meeting

Presentation of Synthesis

- 2.12 Round table on last year events in member countries regarding components failures or degradations connected to ageing (all)
  - 12.1 DOEL / TIHANGE RPV (TRACTEBEL)
  - 12.2 Other country status and consequences (all)

- 2.13.0 Cooperation with other international organizations (EC, IAEA, EPRI, others)
  - 13.1 EC activity (JRC)
  - 13.2 International Codes & Standards harmonization: MDEP – SDO Board – WNA-CORDEL (CF)

Presentation of Synthesis

☞ 3. New caps for 2013 – 2014 – 2015 …

- ✓ 3.1 MECOS – Large seismic load margins (propose by CF)
  - ➢ Building by Seismic Group and Mechanical components by Metal Group
  - ➢ Needs of New criteria / new methodology for high seismic loads ???
  - ➢ Effect of degradation and ageing on margins: lost of toughness, cracks, thinning
  - ➢ Few directions after 1st contact between Seismic and Metal Group:
    - Definition of high seismic level (Seismic Group)
    - Corresponding typical loads on the structure (Seismic Group)
    - Review of existing methods and associated criteria (Metal Group)
    - Review of existing tests on components and systems (Metal Group)
    - Define a possible "analytical benchmark" (Metal Group)
    - Prepare a dedicated Workshop or Summer School (Metal/ Seismic Group)
- ✓ 3.2 Other Post-FUKUSHIMA topic on metallic component integrity
  - ➢ Extreme load / beyond design analysis
  - ➢ Level E criteria….
  - ➢ Only one request:
    - severe accident for metallic components
    - Ask for clear requests concerning metallic component needs (loads, stress analysis, failure modes/degradation mechanism, material properties, criteria, connection to safety function…)

Report of Seismic Subgroup to Working Group IAGE

April 11 & 12, 2013

PARIS

Report of Seismic Subgroup - 1

- Logistics
  - Welcome & Self-Introduction
  - Adoption of Meeting
  - Approval of Previous Meeting Minutes
- Report on Nuclear Facilities that experienced an earthquake
- Report on Workshop on Deep Borehole & Data Analysis – CAPS
- Report on Seismic Input Definition & its Control Point - CAPS

Report of Seismic Subgroup - 2

- Report on Probabilistic Flooding Hazard
- International Workshop on PSA of External Hazards including Earthquakes with WGRISK in June 2013 at UJV(NRI) - CAPS
- Round Table Discussion
- Cooperation with International Organizations
- Subgroup Program of Work
  - Two CAPS
  - Mid-term Strategies for Subgroup
- Election of Subgroup Chairman & Vice-Chairman

Report of Seismic Subgroup - 3

- Report on Nuclear Facilities that Experienced an Earthquake
  - No new earthquakes in 2012
  - Iranian Earthquake at ~ 6 ½ within~30 km
    - No reported damage to facility
    - ~30 civilian casualities

Report of Seismic Subgroup - 4

- Second Workshop on Deep Borehole and Data Analysis
  - Installation Complete – some minor techical issues to data stream
  - Data Analysis Under Way – too early for significant oservations

Report of Seismic Subgroup - 6

- Probabilistic Flooding Hazards in & near Japan
  – Report by Prof (E) H. Shibata
  – Discussion of influence of bathymetric grid size and the overall importance for accurate bathymetric data

Report of Seismic Subgroup - 5

- Control PointDraft Report on Seismic Input Ground Motion Definition and its Control Point
  - Subgroup review of draft
    - 10 Member States contributed their deefinitions
    - Suggested inclusion of advantages & disadvantages of methodology
    - Update of draft expected this year

Report of Seismic Subgroup - 7

- Workshop on PSA of Natural External Hazards including Earthquakes (and Flooding)
  - To be convened at UJV (NRI) in mid-June 2013
  - ~20 Abstracts Received and Reviewed
  - Invitation to Subgroup Members to attend and participate in Panel Discussions

Report of Seismic Subgroup - 8

- Round Table Presentations and Discussions

Report of Seismic Subgroup - 9

- International Cooperation

Report of Seismic Subgroup – 10

- Seismic Subgroup Program of Work
  - Two new CAPS
    - Bayesian Ananlysis
    - CASH

Report of Seismic Subgroup - 11

- Election of Chairman And ViceChairman for Subgroup

Activities of the Seismic Behaviour of Structures and Components subgroup

OECD/NEA/CSNI/IAGE
annual meeting
Paris, 8-12 April 2013

CHANGER L'ÉNERGIE ENSEMBLE

On going activities

- **Nuclear Facilities that have experienced an earthquake**

  Database in cooperation with the IAEA

- **Seismic input definition and its control point**

Under Spanish regulator leadership. Inputs from Japan, USA, Canada, Finland, France, Germany, South Korea, The Netherlands, Spain, Sweeden and UK.

- **NEA/JNES WS on Earthquake measurements in deep wells**

Nov 2012 , Nigata Institute of Technology, Kashiwasaki
2nd WS on the subject79 participants, most from Japan

- **International WS on PSA on natural external hazards**

Prag, 17-20 June

- **Presentations by Japan**

Status of Methodology Development for Probabilistic Flooding and Tsunami Hazard Analysis

Mid-Term Strategy , New activities,

- Mid-Term Strategy

The current document was issued just before the Fukushima-Daïchi accident.
It should be updated accordingly, but the Fukushima effect should not drive the entire activity of the subgroup.
We should manage room for “business as usual” activities

A revised Mid-Term Strategy document to be drafted by the Chair and Vice-Chair (Jose Sanchez-Cabanero)

It is proposed that the subgroup issues a report on
« Lessons learnt from the Fukushima-Daïchi accident in terms of seismic risk for nuclear facilities »
3 year schedule

Mid-Term Strategy , New activities,

CAPS

➢ WS on lessons learnt from seismic response of Japanese NPPs to strong ground motions

The Tohoku Electric Power Company was approached. They are not ready to welcome such a WS in 2014

➢Benchmark on the seismic capacity of reinforced shear walls

- Quantify margins and describe seismic response of shear walls under high seismic loads
- Can be regarded as an F-CAPS

➢Benefit of Bayesian updating techniques for seismic hazard assessment

-Exchanges between seismologists and engineers. In line with conclusions and recommendations of the 2008 WS on "Recent developments in SHA and applications"

- Can be regarded as a "business as usual" activity.

Responses to Survey on Long-Term Operation

Robert L. Tregoning *

Sr. Technical Advisor for Materials Engineering

Nuclear Regulatory Commission

Office of Nuclear Regulatory Research

CSNI WGIAGE Annual Meeting

April 9 – 12, 2013

Paris, Fr

U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

** The views expressed herein are those of the author and do not represent official positions of the U.S. NRC.*

Introduction

- Twelve countries and JRC responded to the survey:
  - Belgium, Canada, Czech Republic, Finland, Germany, Japan, Netherlands, Slovakia, Slovenia, Sweden, Switzerland, USA

- Defining long-term operations (LTO) as greater than 40 years of operating life.

1. Is your country supporting LTO?
   - Most countries (10) supporting LTO
   - Belgium regulations have no limit but 2003 law limits to 40 years.
   - Germany has no LTO
   - Japan is currently reconsidering their original position to allow LTO.

2. Technical issues related to LTO (those most identified)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Concrete/Containment aging - 7 countries
- Fatigue – 6 countries
- RPV embrittlement - 6 countries
- Electrical/I&C – 6 countries
- Aging of CASS – 3 countries
- RPV internals – 3 countries

3. Regulatory issues related to LTO (those most identified)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Some countries didn't appear to understand question – clarify and resubmit?
- Implementation and effectiveness of aging management programs: Canada, Sweden, Switzerland, US
- Development of an aging management system/process – Finland
- Impact of aged components on safety analysis – Canada
- Development of an integrated aging management approach - Canada

4. Components/Systems that are difficult to inspect - examples

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Containment structure – 4 countries
  - Metal liner
  - Tendons/cables (grouted)
- CASS
- Cables in conduits with fire-proofing
- Buried piping
- Selected reactor vessel internal components
- Some dissimilar metal welds
- Several possibly unique components
  - CANDU Calandria assembly (Canada)
  - Reactor vessel safety injection nozzles (Slovenia)
  - Welded frame supporting reactor vessel (Netherlands)

5. Areas of related research - examples from each country

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Japan
  - Cable insulation degradation
  - SCC of stainless steels and nickel-base alloys
- Slovakia
  - Thermal ageing of nuclear power plant materials.
  - Monitoring flow accelerated corrosion using acoustic emission
- Canada
  - A roadmap to aging mechanisms and effects based on research and operational experience
  - Inspection and/or testing of bonded pre-stressing systems in the concrete containment
- Finland (addressed concrete only)
  - Material and component level failure analyses related to pre-stressing tendons, steel liners and fastening bolts
  - Service life management system

5. Areas of related research - examples from each country

- Belgium
  - Development of advanced methods for RPV embrittlement
  - Irradiation swelling of stainless steel PWR reactor internals (GONDOLE)
- Switzerland
  - NDE-techniques to detect corrosion damage in steel containment
  - Noble Metal Deposition Behavior in BWRs
- Sweden
  - Current and future moisture conditions in the concrete containment walls
  - Issues associated with aging of electrical and I&C equipment
- JRC
  - Irradiation of RPV materials with regard to late-blooming phases
  - Development of RI-ISI approaches (based on POD curves)

5. Areas of related research – examples from each country

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Slovenia (associated with LTO of Krško NPP)
  - Overview of regulatory requirements and practices from European countries and US
  - Development of procedure for supervision of ageing processes
- Germany
  - Fatigue testing under air and environmental conditions
  - Developing KTA 1403 “Ageing Management in Nuclear Power Plants”
- Czech Republic
  - Primary circuit environmental effects on degradation in VVER nuclear power plants
  - Aging of reactor internals
- US
  - Expanded materials degradation assessment – RPV, internals & piping, concrete/containment, electric and I&C
  - Aging of RPV internals

6. Ability to share results from research projects

- Generally able to share results
  - Information marked publicly available – 10 countries
    - Canada, Czech Republic, Finland, Germany, Japan, Sweden, Switzerland, Slovakia, Slovenia, US
  - Other information may require special permission (Finland)
  - Most countries cannot share proprietary or security-related information
- Belgium
  - Only publicly available publications related to the program on "Development of advanced methods for RPV embrittlement"
- Netherlands has no current or planned research in area to share
- JRC
  - Sharing of results on a case-by-case basis.
  - Most projects performed in collaboration with partner organizations and thus require agreement of the whole consortium for spreading results

7. Areas for conducting CSNI-sponsored research

- Question intended to identify possible topics for NEW research
- Several countries simply identified existing CSNI programs of interest (e.g., CODAP, CADAK, LBB)
- Several other countries did not answer question
- Most common and interesting responses
  - Environmental fatigue effects and prediction – 6 countries
  - Aging of concrete and/or containment structures – 4 countries
  - RPV embrittlement – 3 countries
  - Development of guidelines on aging management – Japan/Canada
  - On-line monitoring and evaluation - Germany
  - Safety and security of programmable digital control systems - Sweden
  - Development of advanced NDE techniques - Switzerland
  - Research on ex-plant materials/components - Japan

Responses to Survey on Buried Tanks and Piping

Robert L. Tregoning *
Sr. Technical Advisor for Materials Engineering

Nuclear Regulatory Commission
Office of Nuclear Regulatory Research

CSNI WGIAGE Annual Meeting
April 9 – 12, 2013
Paris, Fr

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

** The views expressed herein are those of the author and do not represent official positions of the U.S. NRC.*

Introduction

- Buried tanks and piping (BTP) survey intended as a potential LTO collaborative topic to explore
- Five countries and JRC responded to the survey:
  - Canada, Czech Republic, Slovakia, Switzerland, USA (partially complete)

1. Interest in developing database of tritium leaks in BTP
   - Canada and Czech Republic are interested
   - Switzerland and USA have little interest
   - JRC is interested, but will have little to contribute
2. (Regulatory) mechanism to track leakage events in BTP
   - No country has a simple means to get information directly and specifically on BTP leaks
   - Canada and Switzerland require reporting leakage in pressure boundary and/or safety components
   - US has access to industry's proprietary INPO database
   - Getting and sharing additional information may be difficult

3. Summary of most recent tritium leaks in BTP

- Canada
  - Would need to carry out a significant review of CNSC records
  - Not been a significant issue for CANDU plants to date
- Czech Republic
  - No tritium in BTP
- Slovakia
  - No tritium leaks in BTP within last 5 years
  - Only 2 leaks in ESW piping and 1 leak in fire water piping
- Switzerland
  - No tritium leaks in BTP within last 5 years
- JRC
  - 2010/2011 leak in reactor cooling water pipe for HFR
  - No radionuclide release
- US
  - Still developing response
  - Several leaks have been reported between 2009 – 2012
- With so few reported events, international trends (Question 4) are difficult to establish

5. Applicable codes and standards for inspection

- Canada
  - Provided a complete, thorough response related to applicable standards, inspection methods and frequency, acceptance criteria, and reporting requirements
  - Industry largely follows commercial standards as per government regulations
- Czech Republic
  - Provided a complete, thorough response related to applicable standards, inspection methods and frequency, acceptance criteria, and reporting requirements
  - Industry follows commercial standards which are not regulated by the government for BTP
- Slovakia
  - National law does not address BTP
- Switzerland
  - No specific codes and standards related to BTP inspection, but some regulations for safety-classified components applies
- US
  - ASME Section XI, IWA-5244 which requires periodic pressure or flow testing
  - Inspection methods include visual, system pressure tests, and unimpeded flow tests

6. Other applicable codes and standards

- Canada
  - Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products
- Czech Republic
  - No additional codes identified, but Czech industry developing a proposal for a BP program
- Slovakia
  - National law does not address BTP
- Switzerland
  - The Water Protection Ordinance defines additional inspection requirements
- US
  - Variety of standards and codes that address various BTP issues
  - Examples: ASME, NACE, ASTM, ACI, API, Pipeline Research Council

7. Regulatory responsibilities for BTP and leakage in BTP

U.S.NRC
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- Canada
  - Oversight of CSA B51 compliant systems (applies to Class 6 non nuclear piping)
  - Periodic inspection and review of pressure boundary degradation reports
- Czech Republic
  - Only for safety-related piping which includes essential service water
- Slovakia
  - No current regulatory responsibilities
- Switzerland
  - Only for safety-related nuclear SSCs which is only a limited number of BTP
- US
  - Regulatory authority for safety-related BTP
  - Require limits on radioactive effluent levels
  - Requirements for managing aging effects in systems/components important to safety under license renewal
  - Describe how contamination is limited for new plants

8. Regulations for BTP aging management and inspection

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Canada
  - General requirements for plant maintenance programs and inspection
  - Reporting of pressure boundary degradation issues
  - Separate aging management requirements
- Czech Republic
  - No current regulations in place
- Slovakia
  - No current regulations in place
- Switzerland
  - Requirements for safety-related nuclear SSCs (no BTP containing tritium)
  - Aging management regulations covers SCC of safety classes 1 to 3, and selected additional components defined by PSA
- US
  - Regulations invoke ASME Code (III and XI) for safety-related pressure-boundary BTP
  - Regulations limiting levels of radioactive effluents
  - Aging management program required for plants under license renewal

9. Other governing bodies with regulatory responsibilities

U.S.NRC
United States Nuclear Regulatory Commission
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- Canada
  - Authorized Inspection Agency (AIA) is authorized to register designs and procedures, perform inspections, and other functions/activities at power plants
  - All plants must have an AIA
- Czech Republic
  - Limited role of the State Labour Inspection Office (workers safety)
  - Limited role of the Ministry of the Environment (no tritium in BTP)
- Slovakia
  - No other governing bodies identified
- Switzerland
  - Pressure Vessel Institute (PVI) is a TSO for companies with water polluting liquids
  - PVI checks for compliance and performs inspections of BTP
- US
  - Department of Transportation regulates BTP with petroleum or hazardous chemicals outside the plant boundary
  - Environmental Protection Agency regulates tritium in drinking water for a leak that migrates outside the plant boundary and into drinking water

10. Roles and Responsibilities of different governing bodies

U.S.NRC
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- Canada
  - CNSC's role is nuclear safety
  - Provincial authorities are focused on conventional and worker safety
- Czech Republic
  - SONS's role is nuclear safety
  - State Labour Inspection Office's role is worker safety
- Slovakia
  - N/A
- Switzerland
  - ENSI's role is nuclear safety
  - PVI is responsible for safety of conventional pressure equipment and systems and tank inspections
- US
  - NRC does not share regulatory responsibility inside facility's boundaries with other organizations.

11. Research related to managing or detecting leakage in BTP

- Canada
  - None currently
- Czech Republic
  - None currently
  - Several studies on short and long-term degradation in BTP over the last 10 years
- Slovakia
  - Survey on evaluation of condition of ESW piping initiated in 2010.
  - Study on replacement and monitoring of condition (including detection of potential leakage) of buried piping (ESW, SW) is currently under development.
- Switzerland
  - None currently
- US
  - Research on detection and consequences of BTP degradation (NUREG/CR-6876)
  - Summary of activities used to manage contamination issues (NUREG/CR-7029)

12. Other industry commitments for BTP aging management/inspection

U.S.NRC
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- Canada
  - Participation in ASME Section XI Task Groups.
  - Developing a CSA Standard for periodic inspection of balance-of-plant piping
- Czech Republic
  - Plans to join EPRI's BP group to establish/follow good practices to manage degradation
- Slovakia
  - N/A
- Switzerland
  - No current commitments
- US
  - Develop and implement either a site-specific or company program for BTP
  - Expected actions with respect to discovery and reporting of groundwater contamination (including from BTP)
  - NEI 09-14, Revision 2, "Guidance for the Management of Underground Piping and Tank Integrity"
  - EPRI "Recommendations for an Effective Program to Control the Degradation of Buried and Underground Piping and Tanks"

13. Industry initiatives related to aging management or inspection and related research

U.S.NRC
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- Canada
  - CANDU Owners Group (COG) issued COG-09-4055 “NDE Methods for Buried Pipe: Review and Best-Practice Recommendations”.
  - Methods reviewed by EPRI are largely applicable to CANDU buried pipe
- Czech Republic
  - Industry is summarizing available codes and standards, including US ones, to create a proposal for a BP program
- Slovakia
  - Evaluating condition of all the relevant piping (started in 2011)
  - Summarizing operational events, failures, repair and replacement, evaluation of condition of piping and components with the determination of their reliability.
- Switzerland
  - No specific initiatives related to AMP or inspection of BTP.
- US
  - EPRI established Buried Piping Integrity Group for overseeing initiatives
  - Ongoing research includes
    - Development of risk-ranking software
    - Development and evaluation of remote inspection techniques
    - Design, maintenance, and evaluation of cathodic protection
    - Development of NDE

14. Technical issues related to BTP

- Canada
  - Develop a more structured monitoring and oversight process
- Czech Republic
  - Leakage is not a problem and is limited to some systems only
  - Most BPs in plants are encased in concrete and accessible by manholes
- JRC
  - Development of possible mitigation & repair strategies for BTP
  - Is BTP prone to specific types of corrosion?
- Slovakia
  - Current methods for condition monitoring are not sufficient
- Switzerland
  - MIC and pitting issues in some buried auxiliary cooling water systems
  - Inner coating of some pipes is degraded
- US
  - No issues with respect to safe operation
  - Current issues are directed toward reducing cost and improving reliability of inspection and repair activities

15. Activities addressing technical issues

- Canada
  - Developing standard for inspecting balance-of-plant pressure boundary components
- Czech Republic
  - No general activities
  - Addressing specific leakage issues at the Temelin and Dukovany plants
- JRC
  - No current activities
- Slovakia
  - Initiative on evaluation of condition of all the relevant piping
  - Participation on workshops on the relevant topic
  - Preparation of testing of new methods of BTP condition monitoring
- Switzerland
  - Initiated special maintenance measures in order to ensure integrity of non-safety relevant BTP.
- US
  - EPRI has produced several reports related to BTP and NDE of BTP
  - Additional information
    - http://pbadupws.nrc.gov/docs/ML1234/ML12345A254.pdf
    - http://pbadupws.nrc.gov/docs/ML1129/ML11297A002.pdf

16. Safety-related BTP without tritium

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- Canada
  - Some buried Emergency Core Cooling piping.
  - There may be other systems.
  - Not been a significant issue for CANDU plants to date.
- Czech Republic
  - There are such pipes in plants
- Slovakia
  - No such pipes exist
- Switzerland
  - Very limited number of buried safety-related pipes that do not contain tritium
- US
  - Some safety-related ASME Class 3 pipes
  - Direct inspection techniques
    - Internally delivered NDE platforms
  - Indirect inspection techniques
    - Guided wave UT
    - Electrochemical techniques

17. Indirect assessment techniques

- Canada
  - None currently required by regulation
- Czech Republic
  - Guided wave inspection is not used because most of the BP is in concrete.
  - Resistivity between soil and piping is measured on some systems
- Slovakia
  - None currently required by regulation
- Switzerland
  - No specific requirements for indirect assessment techniques
  - Inspection methods for safety-related SCC have to be qualified per regulations
- US
  - Pressure or flow tests as required by ASME Section XI and US regulations
  - Aging management programs for license renewal
    - Use of indirect techniques to identify critical locations for direct examinations
  - Underground Piping and Tanks Integrity Initiative
    - Use of indirect techniques to identify critical locations for direct examinations

18. Applications and requirements for cathodic protection (CP)

- Canada
  - CSA standard B51 refers to CSA Z662 for the requirement of buried piping CP and monitoring
- Czech Republic
  - Do not know definitively if CP is used, but if it is, it is very limited
  - No information on CP requirements
- Slovakia
  - CP on the Mochovce plant’s raw water inlet piping.
  - New requirements will be established after reconstructing the CP system
- Switzerland
  - No CP for BTP systems
- US
  - No requirement for use of CP
  - Aging management programs for license renewal
    - NACE Standard SP0169 addresses maintenance and survey requirements
  - Underground Piping and Tanks Integrity Initiative
    - NACE Standard SP0169 addresses maintenance and survey requirements

19. Potential regulatory gaps

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Canada
  - Limited oversight of inspection of balance-of-plant pressure boundary components
- Czech Republic
  - Not aware of any gaps
- Slovakia
  - Not aware of any gaps
- Switzerland
  - After final water treatment, discharge of lightly contaminated water is allowed
  - Potential leakage in a discharge pipe could lead to an unexpected enrichment of contamination close to the discharge pipe
  - Issue is under discussion within the regulatory body.
- US
  - Currently monitoring implementation of industry initiatives and not incorporating those requirements into regulations
  - Therefore, there are no current gaps

20. Plans to address potential regulatory gaps

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

- Canada
  - New CSA Standard governing inspection requirements for balance-of-plant pressure boundary components being developed will be incorporated into operating licenses.
- Czech Republic
  - Not aware of any gaps
- Slovakia
  - Unknown
- Switzerland
  - No actions planned at this time
- US
  - Conducting inspections to evaluate effectiveness and implementation of industry initiatives
  - If any issues arise, a regulatory response may be required

Proposal of New WGIAGE - Activities on Behaviour of Components and Structures under Severe Accident Loading (COSSAL)

Jürgen Sievers GRS

April 11 – 12, 2013

36th CSNI WGIAGE - Maingroup Meeting

OUTLINE

- Motivation for new WGIAGE - activities
- Objectives and working points
- Short-term actions and next steps

MOTIVATION FOR NEW WGIAGE - ACTIVITIES

- Activities on Nuclear Codes & Standards concerning response to severe accidents
  - Subitem component integrity: pressure boundary, containment

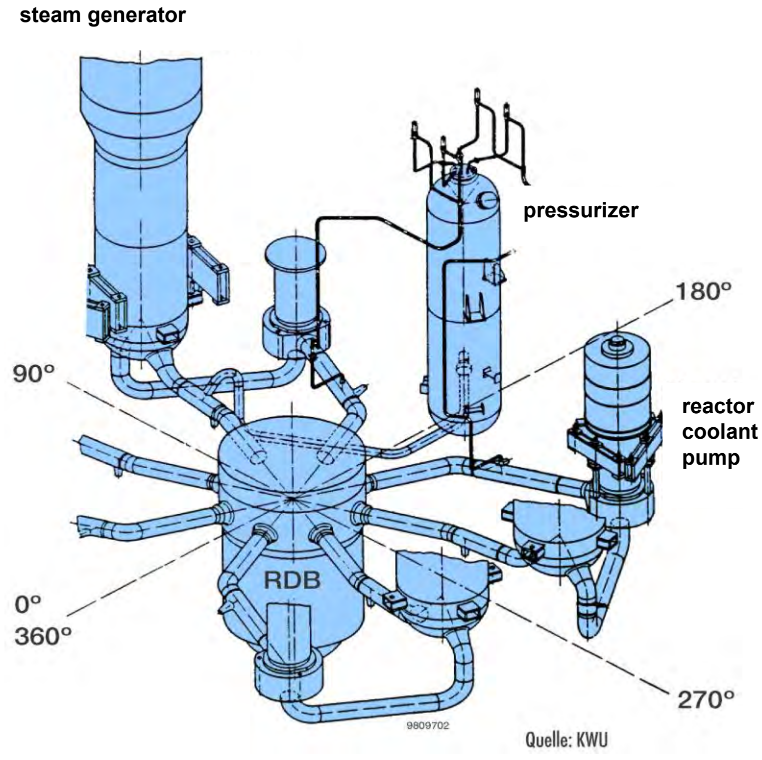
(ref.: ASME Response to March 11, 2011 Fukushima Events, ICONE-19, 2011)

- Thermal hydraulic activities on simulation of plant behaviour during severe accidents with core melt scenarios
  - Benchmark Study of the Accident at the Fukushima Daiichi NPS (BSAF)
  - ….

SAFETY RELEVANT ISSUE

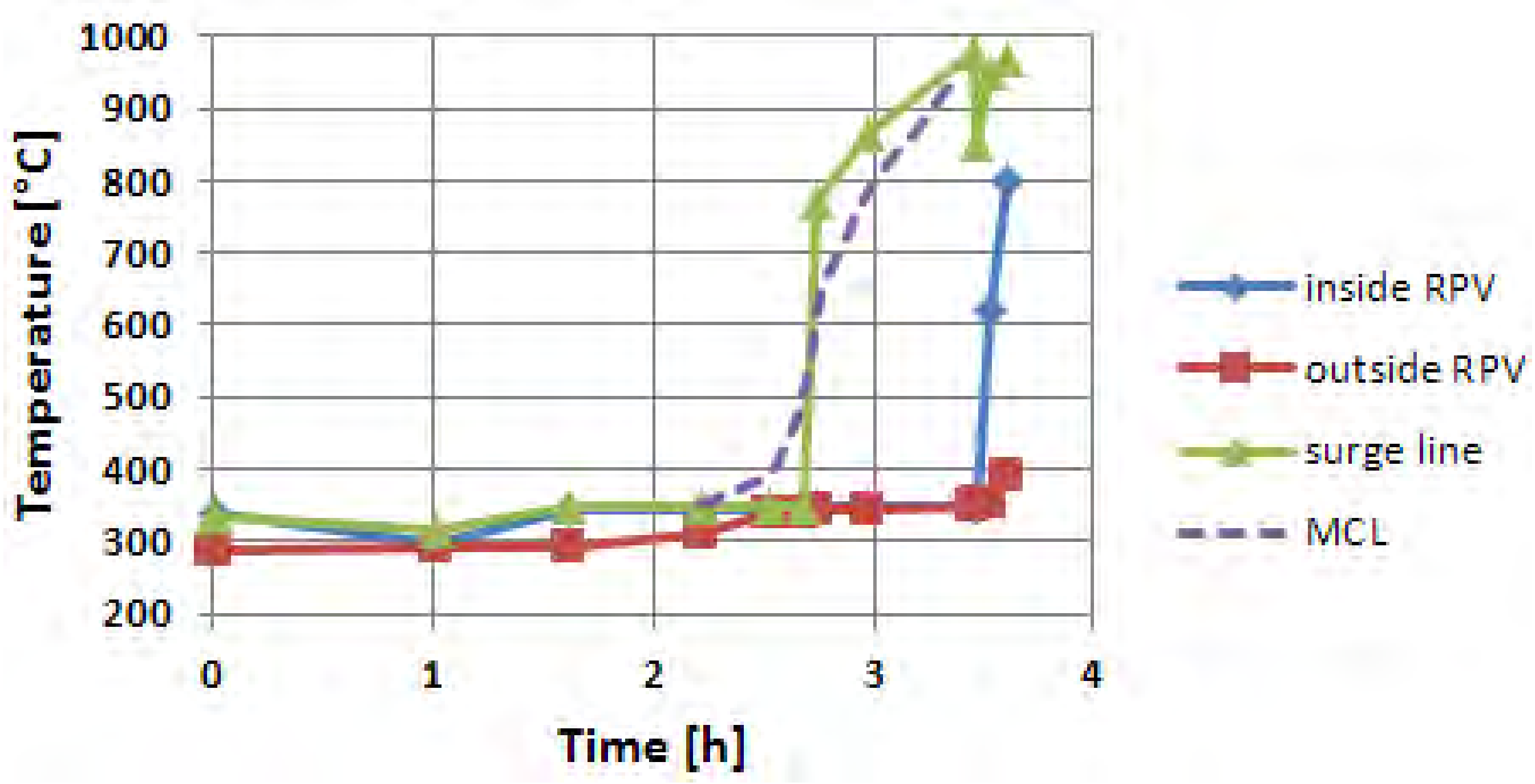
Which component of a primary circuit fails first during a severe accident scenario?

Primary circuit of German PWR



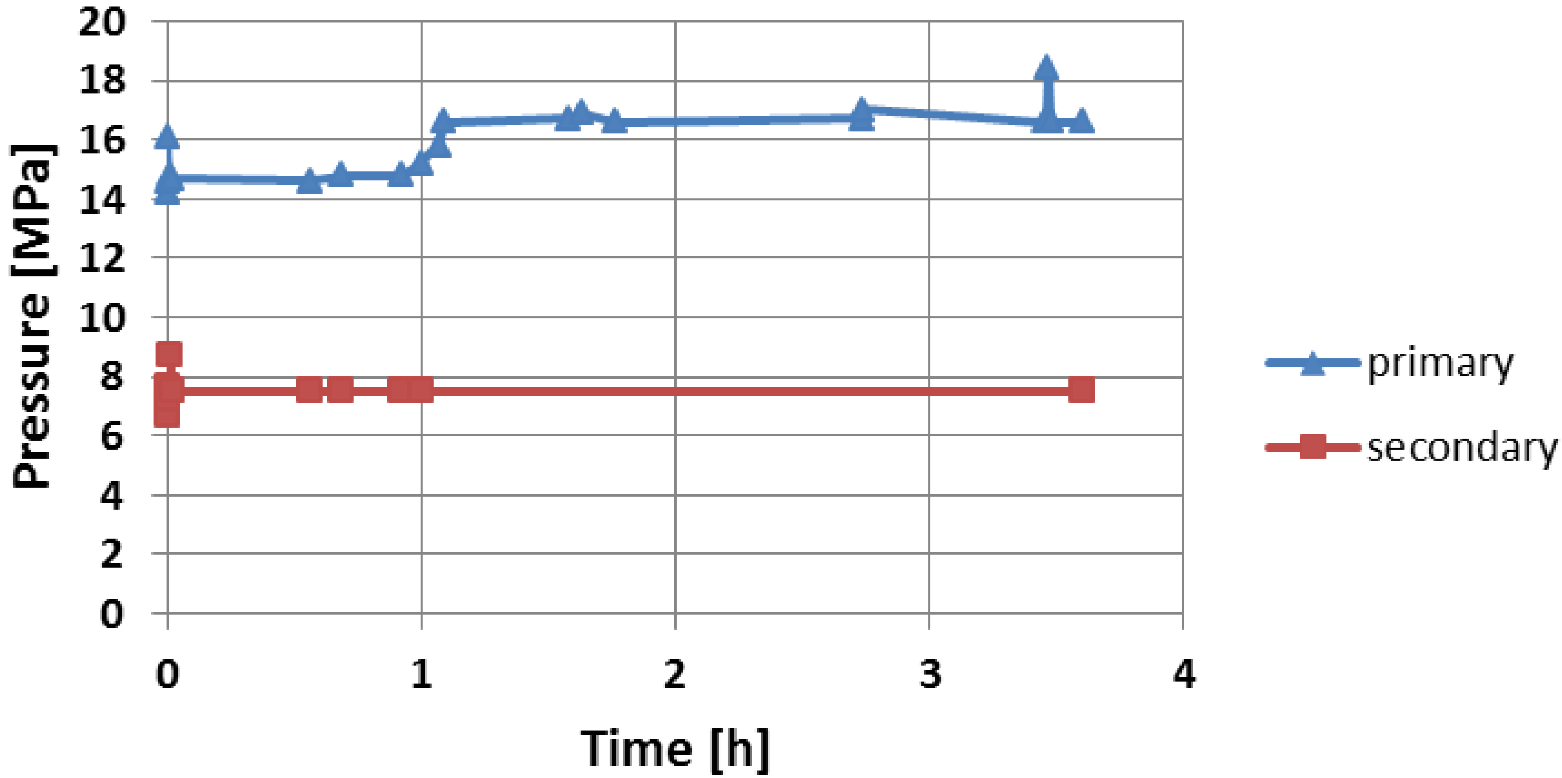
LOADING CONDITIONS DURING A CORE MELT SCENARIO

Load case “Total Station Blackout” calculated with MELCOR



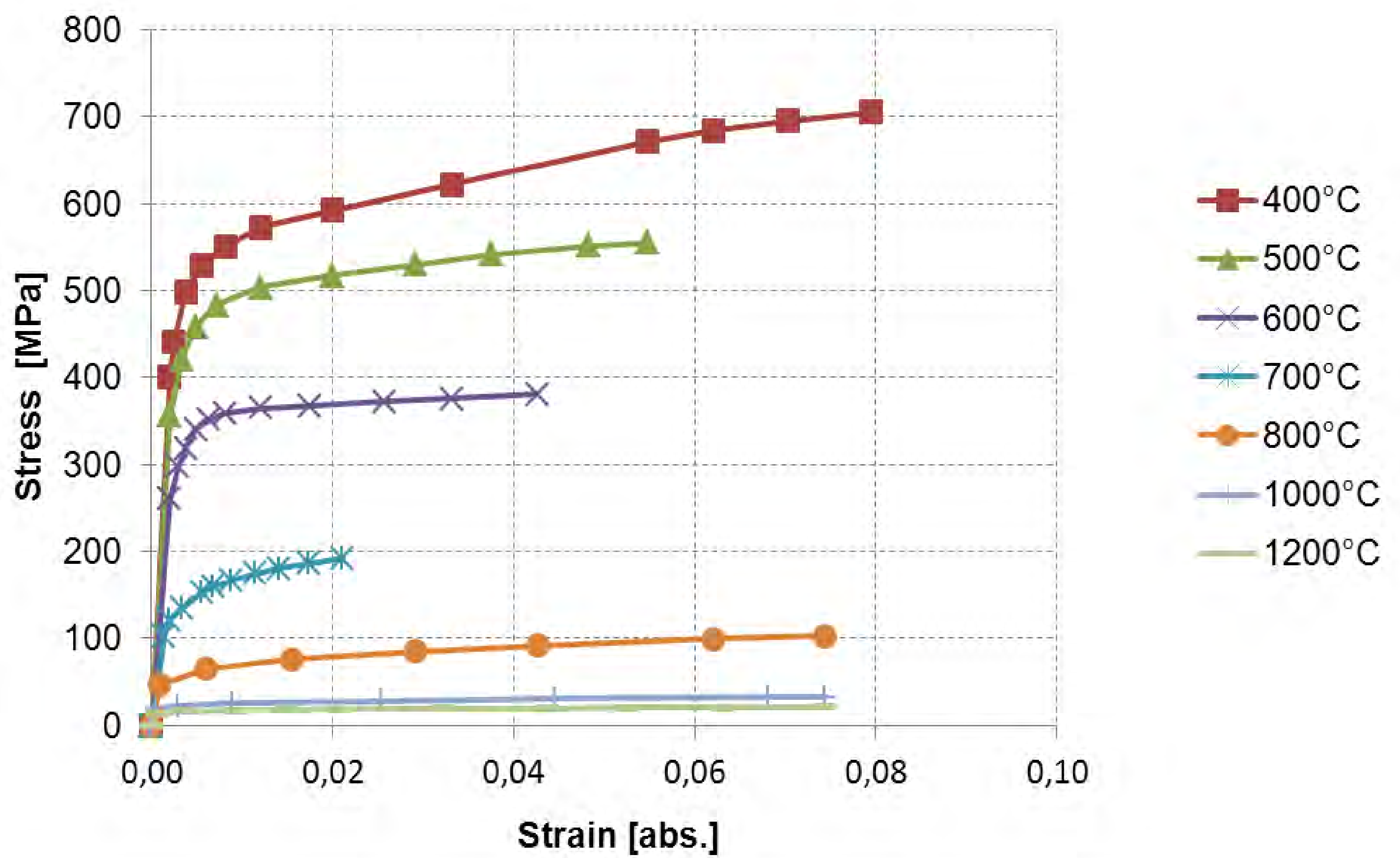
LOADING CONDITIONS DURING A CORE MELT SCENARIO

Load case “Total Station Blackout” calculated with MELCOR



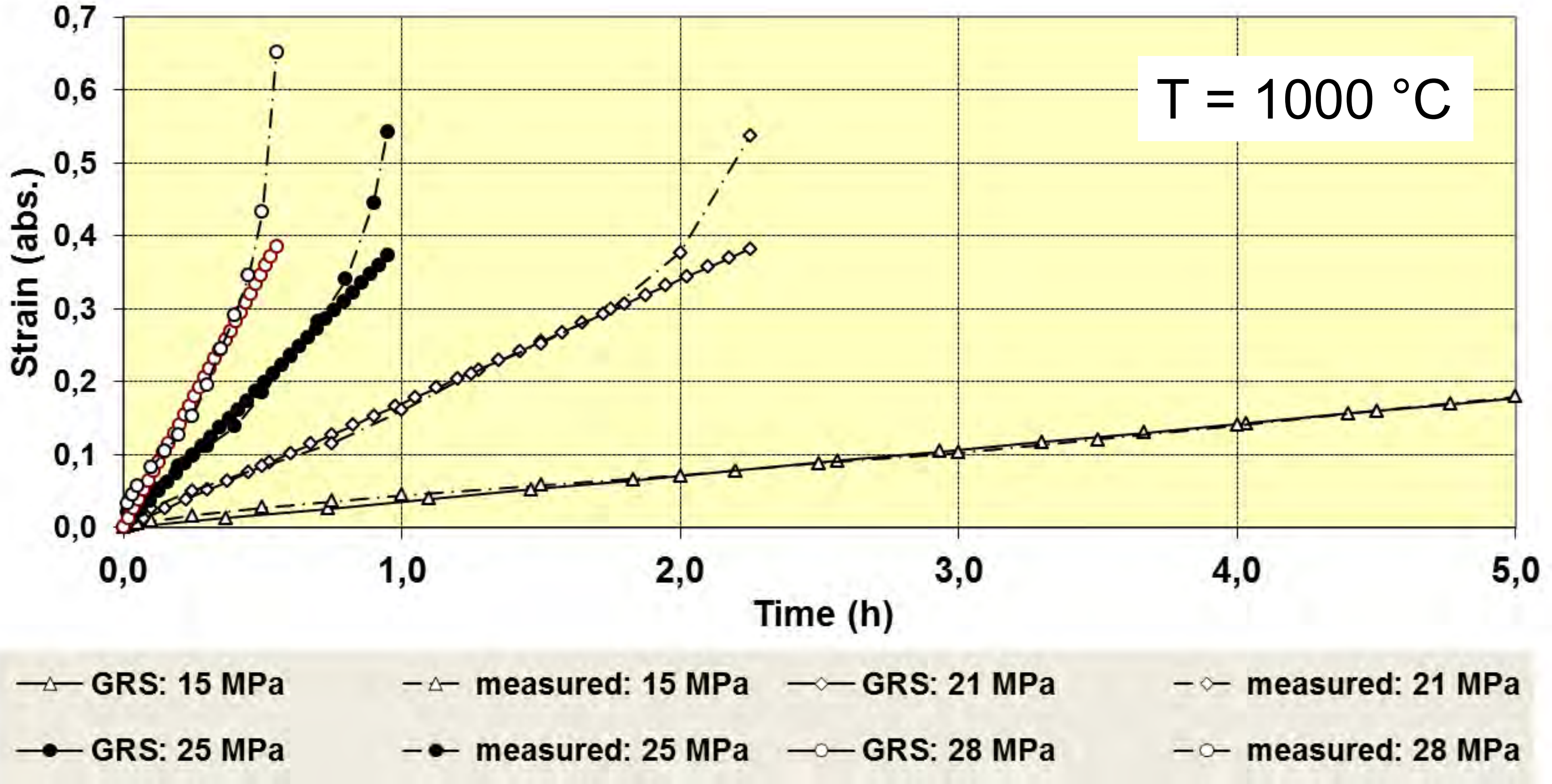
BASIS OF INTEGRITY ASSESSMENT

- Temperature dependent stress-strain curves



BASIS OF INTEGRITY ASSESSMENT

- Temperature and stress dependent creep curves



BASIS OF INTEGRITY ASSESSMENT

- Criteria for failure due to plastification
  e.g. Uniaxial Uniform Elongation / Stress triaxiality factor TF

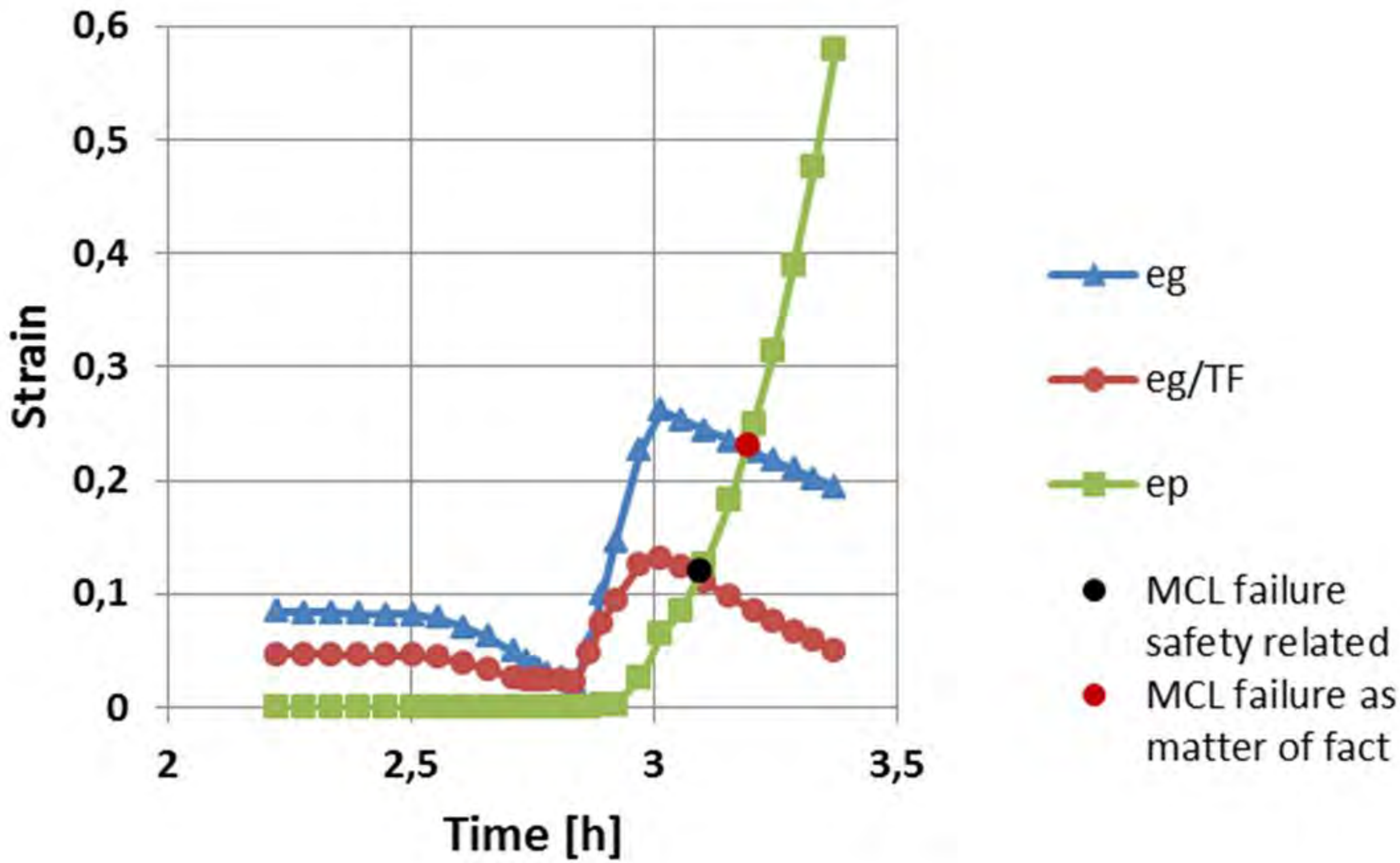
- Criteria for failure due to creep
  e.g. Uniaxial failure strain / Stress triaxiality factor TF

$$TF = \frac{\left|\sigma_1 + \sigma_2 + \sigma_3\right|}{\sigma_{effektiv}} \quad \text{due to Ju and Buttler (1984)}$$

- Assumptions concerning
  - safety related assessment of failure
  - assessment concerning failure as a matter of fact

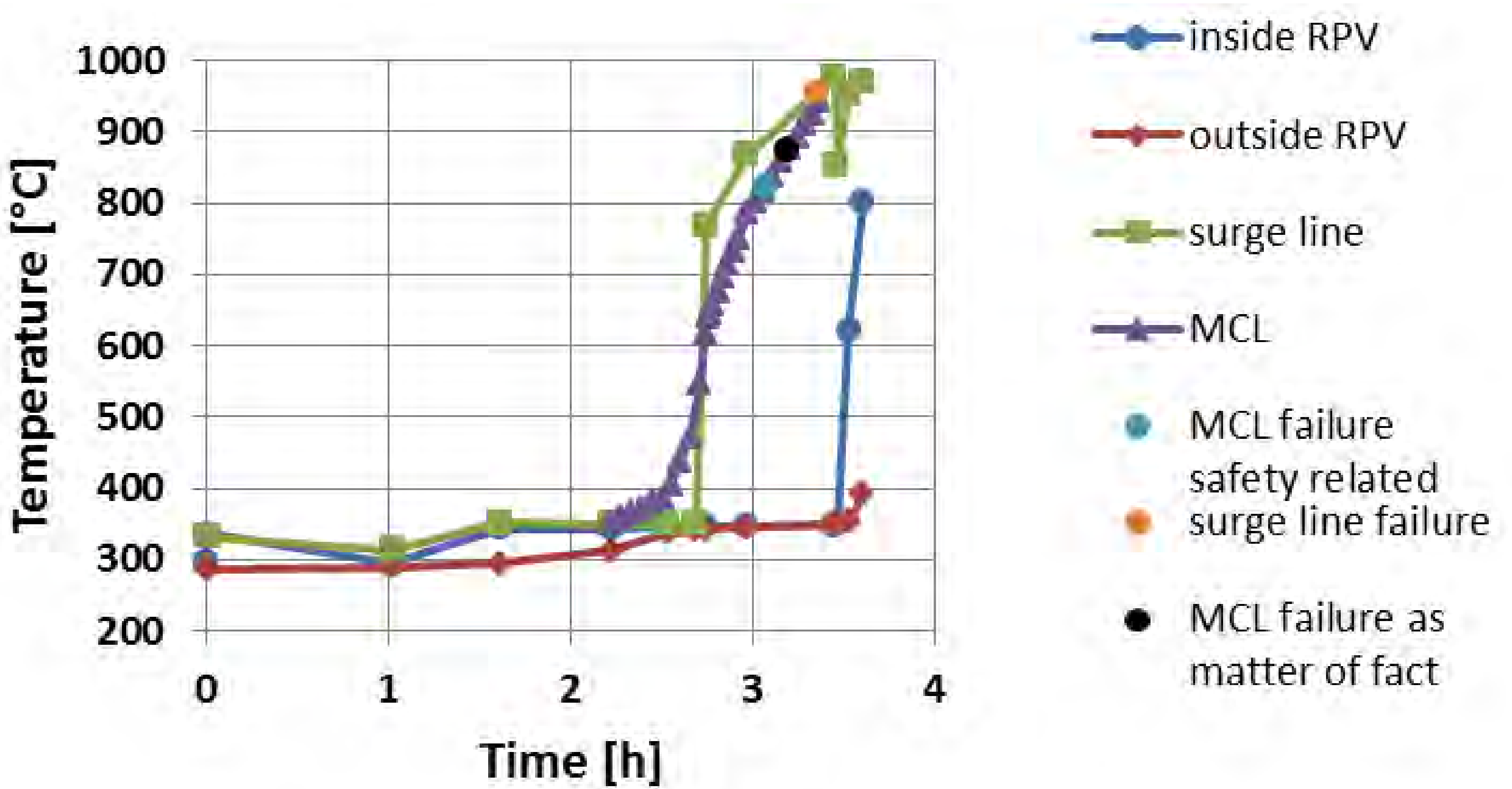
INTEGRITY ASSESSMENT OF MAIN COOLING LINE

Load case “Total Station Blackout” calculated with MELCOR

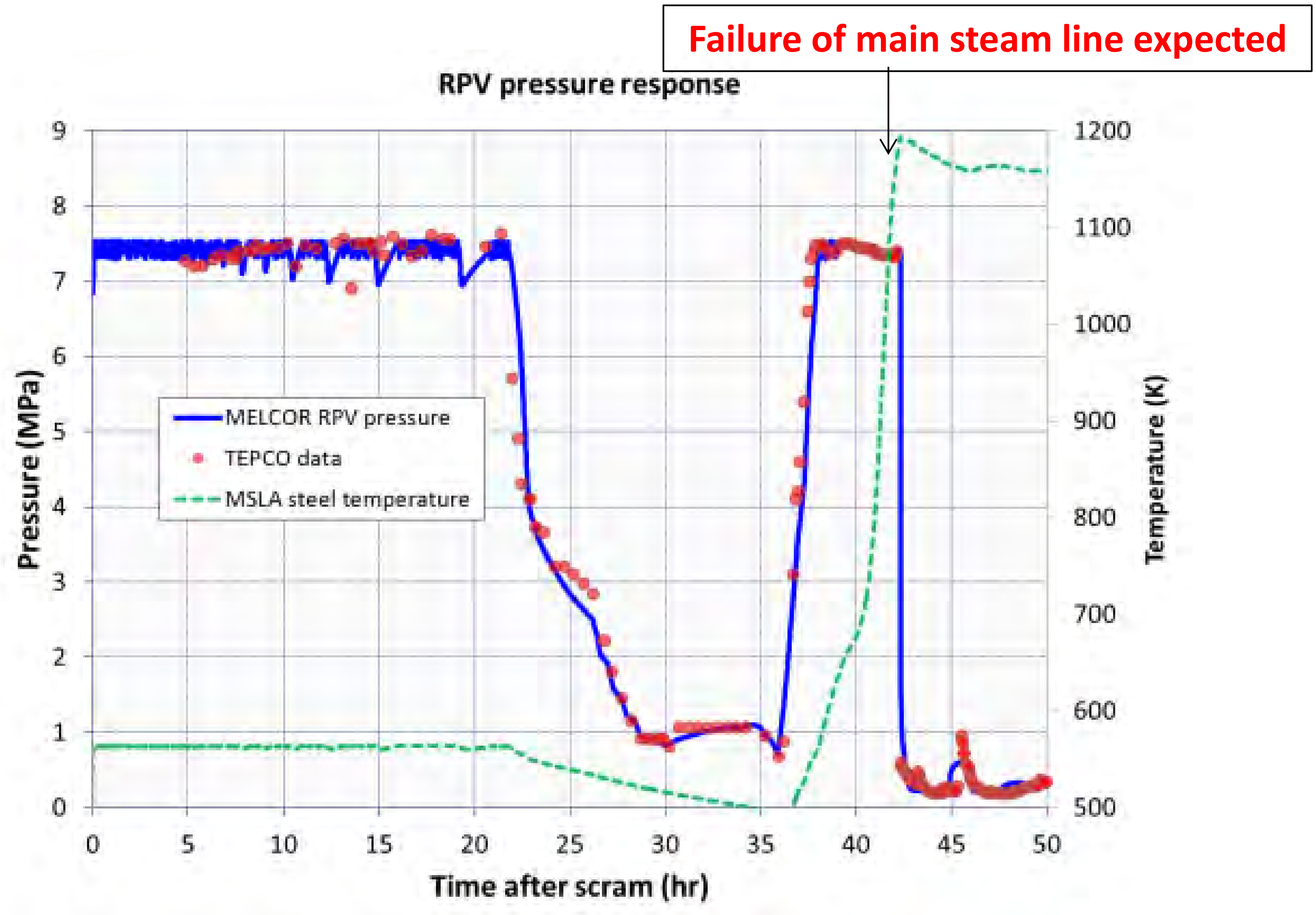


INTEGRITY ASSESSMENT OF MAIN COOLING LINE

Load case “Total Station Blackout” calculated with MELCOR



THERMAL HYDRAULIC INVESTIGATIONS ON FUKUSHIMA ACCIDENT



ref.: Randall Gauntt (SNL), DOE/NRC Analysis of Fukushima Accident Using MELCOR 2.1, NRC RIC, 2013

OBJECTIVES OF COSSAL*)

- Comparison of structure mechanical analysis methods for integrity assessment of components and structures under severe accident loading
  - Behaviour of metallic components loaded by core melt scenarios (Phase I)
  - Behaviour of steel and concrete containment structures loaded by hydrogen combustion (Phase II)
- Conclusions concerning influence factors on integrity assessment and quantification of safety margins

*) COSSAL - Components and Structures under Severe Accident Loading

WORKING POINTS OF COSSAL (PHASE I)

- Review of failure criteria for integrity assessment of RPV, piping and steam generator tubes loaded by core melt scenarios (status of validation)
- Benchmark activities concerning integrity assessment of
  - BWR main steam line and RPV type Fukushima Daiichi
  - PWR main cooling line, surge line, steam generator tube and RPV

  due to severe accident scenarios with core melting
  - Definition of geometry, material properties, loading conditions of scenarios
  - Integrity assessment of RPV, piping and steam generator tubes based on best estimate and simplified structure mechanics analysis methods
  - Quantification of safety margins
- Identification of relevant influence factors on integrity assessment and quantification of safety margins

SHORT-TERM ACTIONS

- Preparation of CAPS for metals group on COSSAL Phase I
- Call for participation within WGIAGE
- Contact with chair of the BSAF Management Board concerning data transfer on Fukushima related activities
- Contact with chairman of WGAMA concerning expert judgement on severe accident scenarios for PWR

NEXT STEP

- Proposal on the safety relevant issue:
  - What is the load carrying capacity of a steel or concrete containment during a severe accident scenario with postulated hydrogen combustion? (COSSAL Phase II - work for metals and concrete subgroups)

The 36 Meeting of the Integrity and Ageing of Components and Structures Working Group (WGIAGE)
The 18th WGIAGE Metal sub-group meeting
OECD Convention Center, Paris, France, 9-12 April 2013

Action items for specific nuclear facility of Fukushima-Daiichi NPS

April 2013

Masakuni Koyama

Japan Nuclear Energy Safety Organization (JNES)

Historical background

- 11 March 2011

  The grate east Japan earthquake hit Japan.

- 7 November 2012
  - Fukushima-Daiichi NPS was designated as specific nuclear facility.
  - Action items that the facility should implement were decided by Committee of Nuclear Regulation Agency (NRA)

- 7 December 2012

  NRA received the implementation plan prepared and submitted by Tokyo EPC.

- 21 December 2012

  The 1st meeting of Study Group of Monitoring and Evaluation of Specific Nuclear Facility (SG-MESNF)

- Until 29 March 2013
  - Seven meetings of the SG-MESNF were held.
  - Evaluate the implementation plan
  - Confirm current status for implementation plan

Action items for specific nuclear facility of Fukushima-Daiichi NPS

● Specific nuclear facility:

- Fukushima-Daiichi NPS designated in November 2012
- Action items that the facility should implement were decided by Committee of Nuclear Regulation Agency (NRA)

● Objectives of action items

- To reduce and optimize in whole risk of specific nuclear facility and to secure safety outside site, including completion of fuel removal as soon as possible,
- to conduct actions necessary to accomplish the objectives

● Action items: 8 categories

I. Whole schedule and risk evaluation
II. Design and facilities
III. Operation safety of specific nuclear facilities
IV. Physical protection of specific nuclear fuel material
V. Takeoff of fuel debris and decommission
VI. Consideration in preparing implementation plan
VII. Promotion of understanding for implementation plan
VIII. Receive of inspection for implementation plan

Action items for specific nuclear facilities of Fukushima-Daiichi NPS

I. Whole schedule and risk evaluation

- Prepare of whole schedule until decommissioning of reactor including process to decommissioning and removal and storage of fuel debris for unit 1 to unit 4
- Prepare of whole schedule for continuous maintaining reactor cold shutdown for unit 5 and 6
- In evaluating of risk for whole specific nuclear facilities and each facilities, to assess environmental effects on broad area outside site and to conduct reduction and optimization in risk enough to secure safety outside site

Action items for specific nuclear facilities of Fukushima-Daiichi NPS

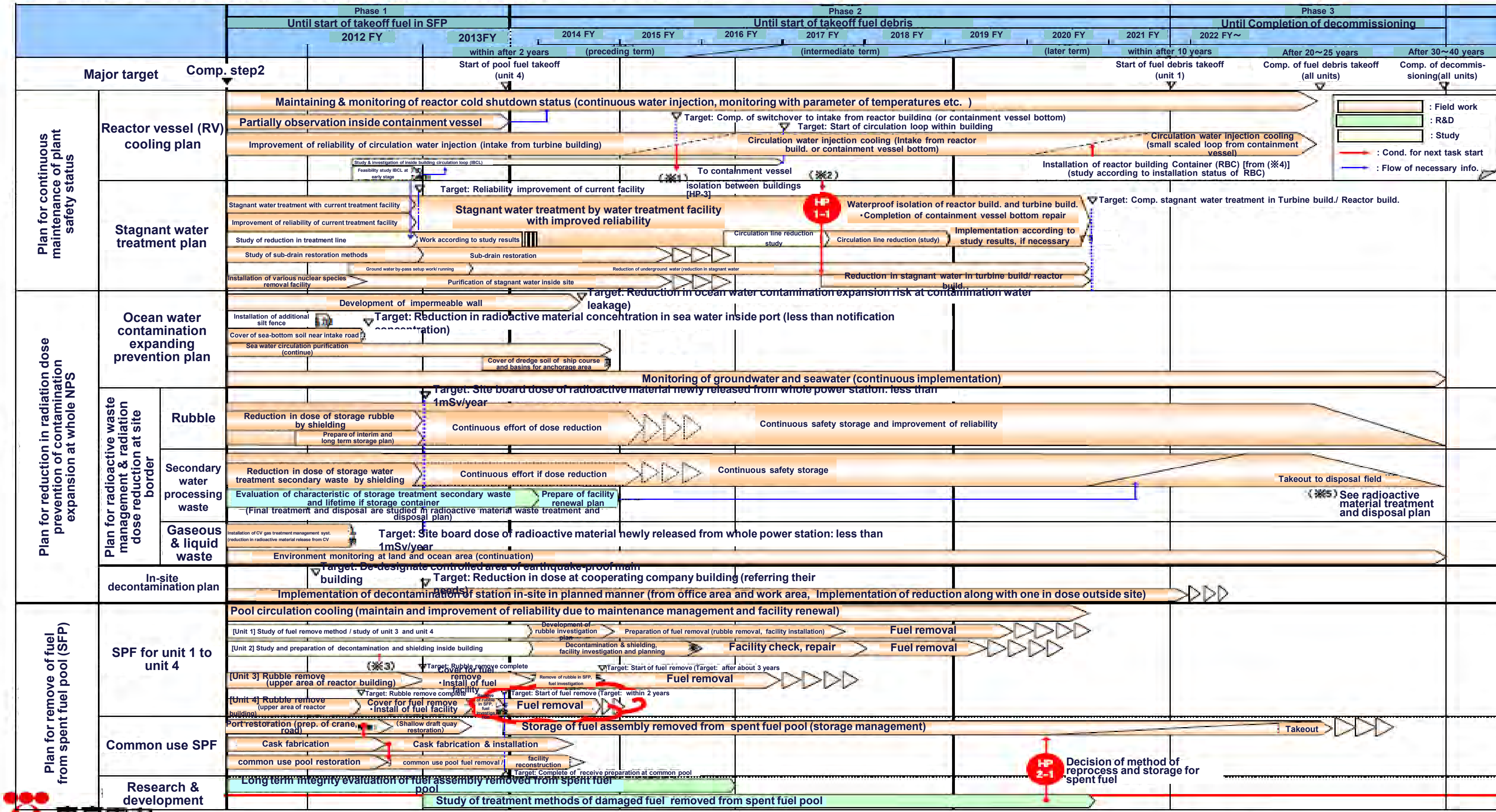
II. Design and facilities

1. Monitor of reactor
2. Removal of residual heat
3. Monitor of reactor containment facility atmosphere
4. Maintain of inert gas
5. Removal of fuel and its storage and management of in appropriate manners
6. Secure of electric power supply
7. Consideration of station blackout at design phase
8. Treatment, storage and management of solid radioactive waste
9. Treatment, storage and management of liquid radioactive waste
10. Management of gaseous radioactive waste
11. Radiation protection of site circumference due to radioactive material
12. Management of worker exposure dose
13. Emergency preparedness
14. Consideration at design stage
15. Others

Schedule of specific nuclear facility of Fukushima-Daiichi NPS (1/2)

Long term schedule for unit 1 to unit 4

Interim and long term roadmap until decommissioning for unit 1 to unit 4 of Fukusahima Daiichi NPS



Prepare from original material: The 1st meeting of SG-MESNF 資料2-1_福島第一原子力発電所 特定原子力施設に係る実施計画について (in Japanese)
http://www.nsr.go.jp/committee/yuushikisya/tokutei_kanshi/20121221.htm

Schedule of specific nuclear facility of Fukushima-Daiichi NPS (2/2)

Schedule for unit 5 and 6

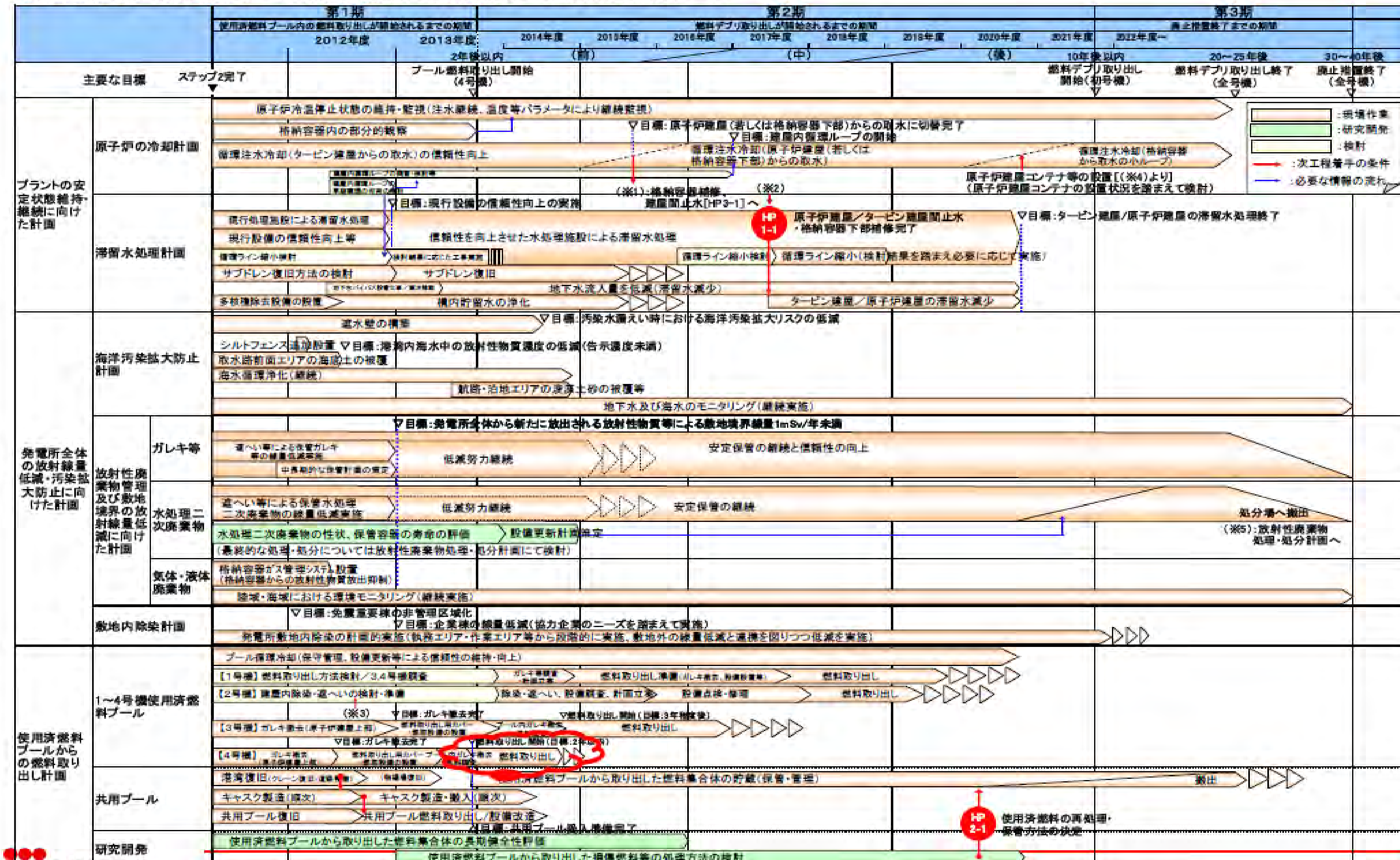
Intermediate term schedule of unit 5 and 6

		FY	2012		2013		2014		2015	2016
			1/2	2/2	1/2	2/2	1/2	2/2		
Plan for continuous maintenance of plant safety status	Cooling plan of reactor vessel and spent fuel pool	Maintenance and management of cold shutdown status								
	Stagnant water treatment plan	Improvement of stagnant water (SW) treatment, SW control and storage capability by current treatment facility								
Plan of fuel remove from unit 5 and 6	Unit 5	Restoration of fuel treatment facility and reactor building crane						Fuel (transfer ～ removal)		
	Unit 6	Restoration of fuel treatment facility and reactor building crane			Fuel (transfer ～ removal)					

* The intermediate schedule will be revised continuously according to field status.

1～4号機の全体工程

東京電力(株)福島第一原子力発電所1～4号機の廃止措置等に向けた中長期ロードマップの主要スケジュール



The 1st meeting of SG-MESNF 資料2-1_福島第一原子力発電所 特定原子力施設に係る実施計画について [PDF:16MB] 東京電力株式会社
http://www.nsr.go.jp/committee/yuushikisya/tokutei_kanshi/20121221.htm

5，６号機の全体工程

東京電力(株)福島第一原子力発電所5･6号機　中期スケジュール

		年度	2012 上期	2012 下期	2013 上期	2013 下期	2014 上期	2014 下期	2015	2016
プラントの安定状態維持・継続に向けた計画	原子炉及び使用済燃料プールの冷却計画		冷温停止状態の維持・管理 →							
	滞留水処理計画		現行処理設備による滞留水処理，滞留水抑制，貯留能力増強 →							
5･6号機からの燃料搬出計画	5号機		燃料交換機･原子炉建屋天井クレーン復旧 ／ 燃料（移動～搬出） →							
	6号機		燃料交換機･原子炉建屋天井クレーン復旧 ／ 燃料（移動～搬出） →							

＊本中期スケジュールについては，現場状況を踏まえて，継続的に見直していく。

東京電力

The 1st meeting of SG-MESNF 資料2-1_福島第一原子力発電所 特定原子力施設に係る実施計画について【PDF:1.6MB】
http://www.nsr.go.jp/committee/yuushikisya/tokutei_kanshi/20121221.htm

Aging Management and Long Term Operation in Canada - Regulatory Perspective

Andrei Blahoianu
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Canadian Nuclear Safety Commission

Presentation at WGIAGE annual meeting
Paris, April 08-12, 2013

Outline of Presentation

- Who we are
- Aging in CANDU
- Regulatory Framework
  - Aging Management RD/GD-334
  - Long Term Operation RD/GD-360
- Status of current life extension projects
- R&D supporting regulatory decisions on AM & LTO
- Cooperation
- Summary

Canadian Nuclear Safety Commission

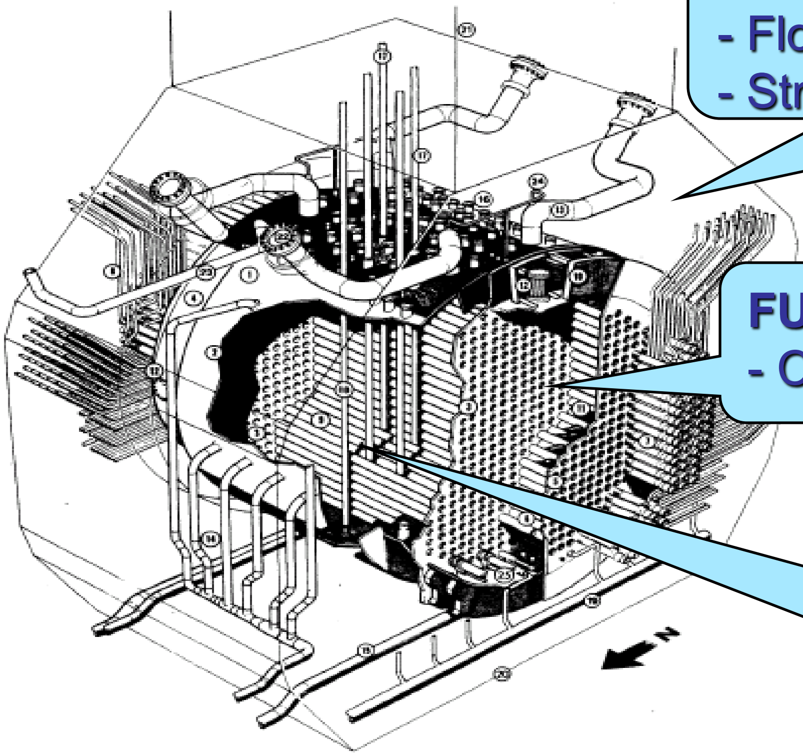
Regulates the use of nuclear energy and materials to protect the health, safety and security of Canadians and the environment; and to implement Canada's international commitments on the peaceful use of nuclear energy.

Over 65 years of nuclear safety!

CANDU Aging Issues

- CANDU pressure tubes, calandria tubes, and feeders can be replaced after about 25 years to address materials degradation effects.
- Materials’ degradation effects on other structures, systems and components (SSCs) can become of more concern for longer term operation.
- Refurbishment “outage” be seen as an opportunity to perform other major plant inspection, maintenance, replacement and safety upgrade activities that are not feasible during a normal maintenance outage

Examples of CANDU Aging Issues

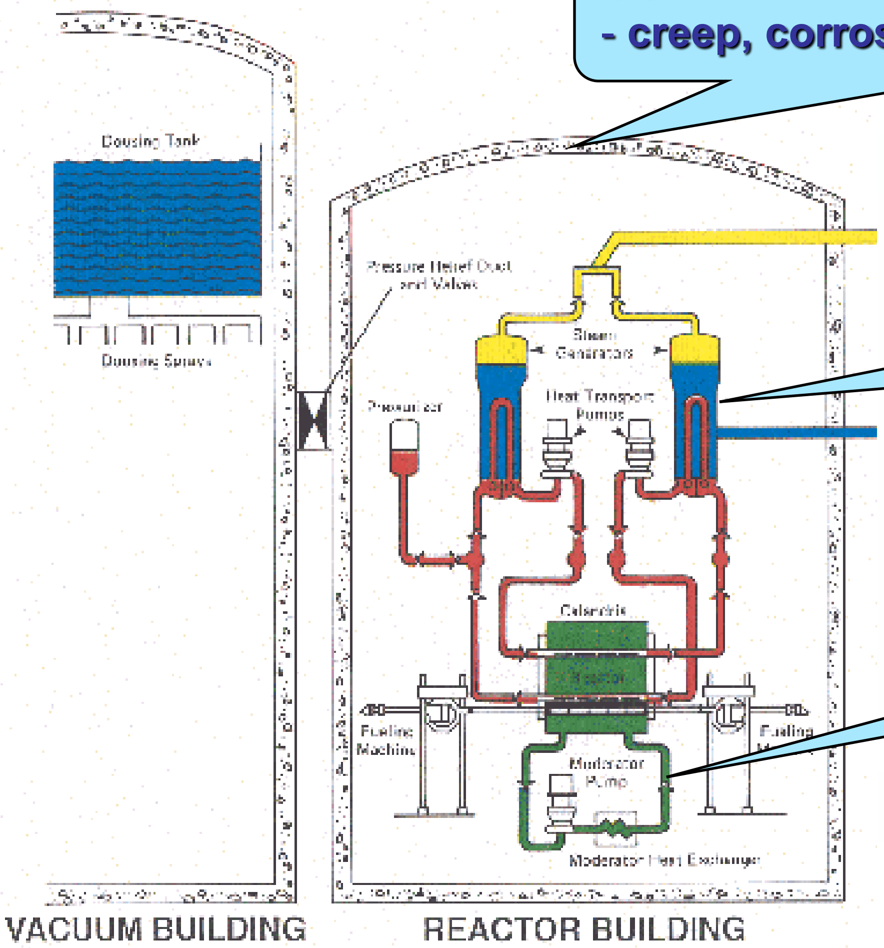


FEEDERS
- Flow Accelerated Corrosion (FAC)
- Stress Corrosion Cracking (SCC)

FUEL CHANNELS (PT/CT)
- Creep, DHC, property changes

REACTOR ASSEMBLY
-Corrosion, erosion, fatigue, creep, embrittlement

Examples of CANDU Aging Issues

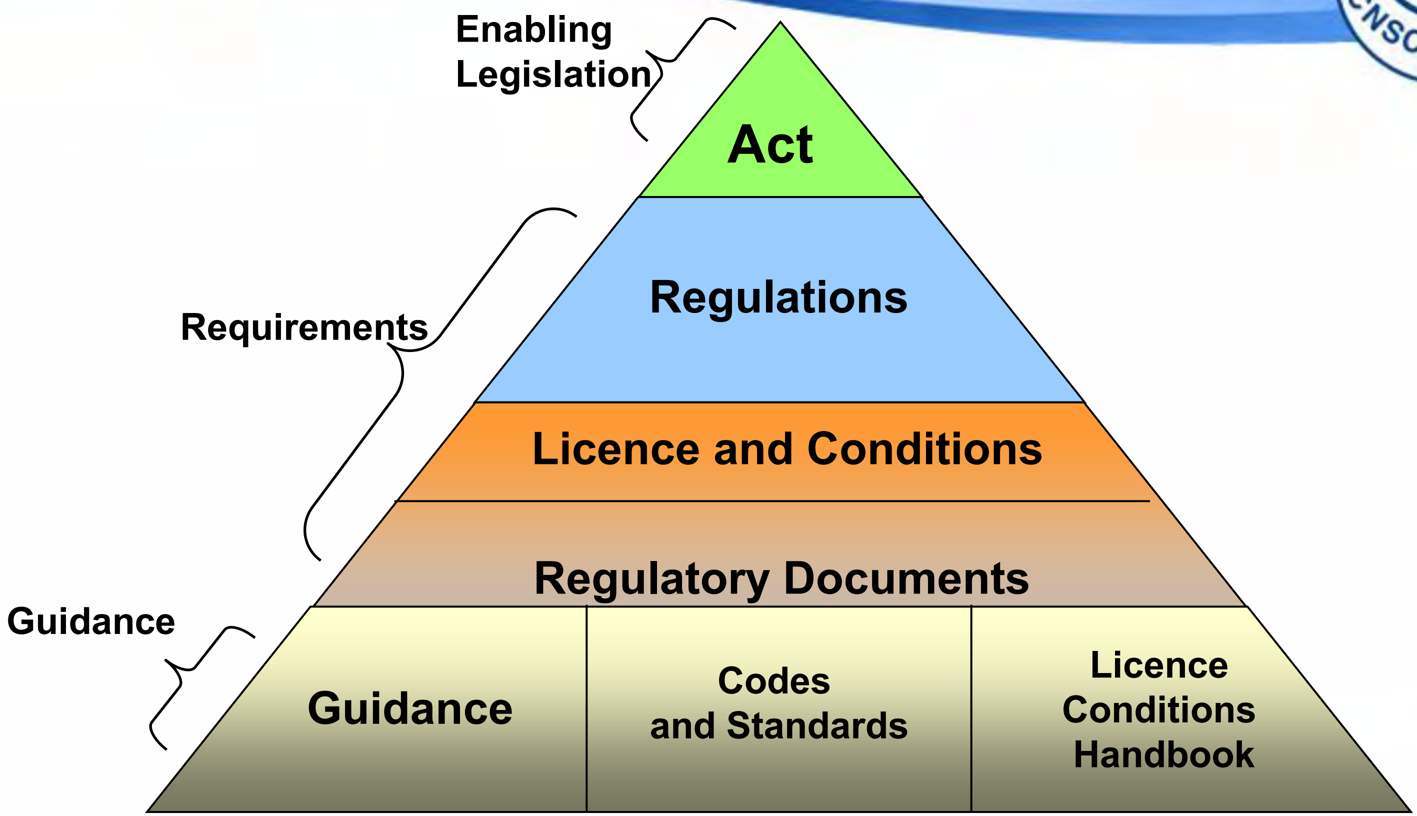


CONTAINMENT STRUCTURE
- creep, corrosion, stress relaxation

STEAM GENERATORS
- corrosion, erosion, wear

CABLES
- radiation, temperature embrittlement

Regulatory Oversight - CNSC Regulatory Framework



* Requirements if referred to in the licence

CNSC Regulatory framework for AM & LTO

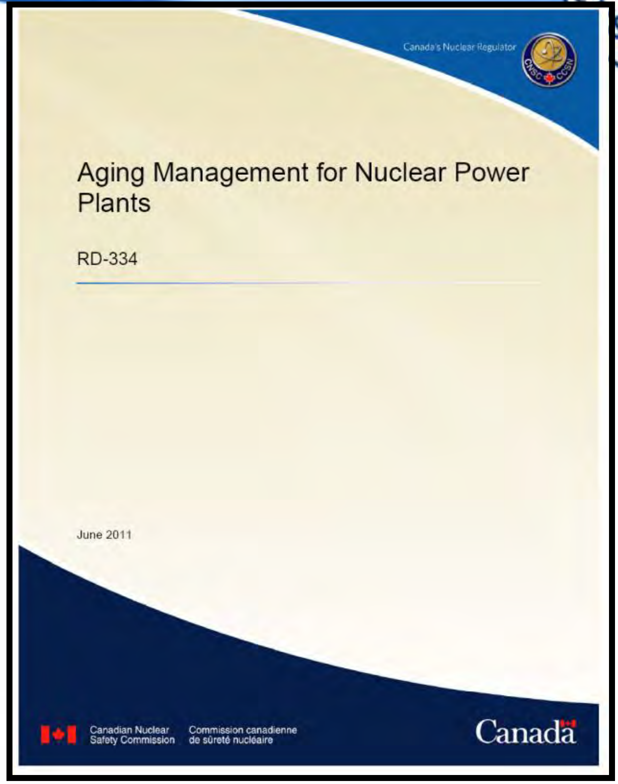
- CNSC adopted a comprehensive and systematic strategy to AM and LTO including:
  - ✓ Regulatory requirements and documents (RDs, GDs)
  - ✓ Adequate research
    - independent
    - joint with the industry
    - joint with international community
  - ✓ Implementation plans
  - ✓ Compliance verification

Regulatory Docs. relevant to AM and LTO

S-98	Reliability Programs for NPP
S-99	Reporting Requirements for NPP
S-210	Maintenance Programs for NPP
RD-337	Design of New NPP
RD/GD-360	Life Extension of NPP (Revision 2 under way)
RD/GD-334	Scheduled to be published in 1QT 2014 following a due process of internal review and public consultation and approval of the Commission.

RD-334: Aging Management for NPP

- Published by CNSC in June 2011
- Set outs the requirements of the CNSC with respect to the management of aging
- Requirements for proactive management of aging at each stage of a NPP's life cycle (design → decommissioning)
- Based on IAEA NS-G-2.12, *Aging Management for Nuclear Power Plants*, 2009


Canada's Nuclear Regulator

Aging Management for Nuclear Power Plants

RD-334

June 2011

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire
Canada

RD-334: Integrated (Plant Level) AMP Framework

1. Organizational arrangements;
2. Data collection and record keeping;
3. Screening and selection process;
4. Evaluations for aging management;
5. Condition Assessments;
6. SSC Specific AMPs;
7. Management of Obsolescence
8. Interfaces with Other Supporting Plant Programs;
9. Implementation of AMPs; and
10. Review and improvement of AMPs.

RD-334: Implementation Path Forward

- Publication of RD-334 (Complete - June 2011/available at www.nuclearsafety.ca)
- Implementation Workshop with industry (Complete - October 2011)
- Incorporate into NPP Licences and Handbooks (2012)
  - Licensees will be requested to submit compliance transition plan and schedule
- CNSC reviews and inspections of licensees programs and compliance with RD-334 (2012+)
- Currently transform in RD/GD-334 (1QT 2014)

Evolution of Approach to Life Extension: Development of RD/GD-360

- Decision to refurbish is an economic one, made by the operator based on business needs, strategy, cost, plant condition, etc.

- The approach to life extension of Nuclear Power Plants in Canada is based on one time application of an comprehensive Periodic Safety Review (PSR), called an *Integrated Safety Review (ISR)*
  - 2000 to 2006 : IAEA documents used to guide the reviews.
  - 2008 to present : Regulatory Document, RD-360 "*Life Extension of Nuclear Power Plants*" was enforced
  - A second version RD/GD-360 is under way

RD/GD-360: General Considerations

- Licensees are responsible for ensuring that their facilities and activities are operated in a manner that protects health, safety, security and the environment, while respecting Canada's international obligations.

- This responsibility includes making adequate provisions for managing the safe operation of the NPP as it approaches the end of its nominal design life, <u>including considerations for continued long-term operation of the facility, and for ending operation of the facility including the transition period from reactor unit shutdown and safe state of storage until decommissioning</u>.

- LTO implies 3 options:
  - continued operation; or
  - life extension; or
  - end of operation

RD/GD-360: General Considerations

- RD/GD-360 requires that the following be carried out:
  - Environmental Assessment (EA), where required,
  - Integrated Safety Review (ISR) to establish the scope of work required for life extension of a nuclear power plant, and
  - Review against modern standards, best practices, operating experience, research findings to re-baseline the safety case.
- Based on the results of the EA and ISR, licensees should establish:
  - an Integrated Implementation Plan (IIP) for the necessary plant refurbishment, safety upgrades and other compensatory measures, and
  - IIP does not have to fully <u>meet</u> modern standards but any gaps must be justified and agreed by regulator.

RD/GD-360: General Considerations (cont'd)

- Life Extension process involves replacement, maintenance, and/or modifications to major systems, structures and components (SSCs) to support safe operation
- Licensees should address modern high-level safety goals

RD/GD-360: Environmental Assessment

- An Environmental Assessment (EA) must be completed with a decision that the project will not likely cause significant adverse environmental effects
    - Mitigating measure may be required
- EAs can take nominally two years to complete
    - The EA studies are normally carried out by the licensee
    - 'Screening Report' on the EA is issued by the regulator for public input
- EA results are incorporated into the Integrated Improvement Plan (IIP) and are incorporated into the licence as part of the EA follow-up program

RD/GD-360: Integrated Safety Review

- The Integrated Safety Review (ISR) is a one-time comprehensive self-assessment carried out by the licensee, guided by:
  - IAEA Safety Guide, NS-G-2.10, “Periodic Safety Review (PSR) of Nuclear Power Plants”, 2003
- The ISR enables determination of ***reasonable and practical modifications*** that should be made to enhance the safety of the facility to a level approaching that of modern plants, and to allow for long-term operation
- Licensee shall prepare reports for each of the 14 CNSC Safety And Control Areas (SCA)

Safety Control Areas

- 1. Management System
- 2. Human Performance Management
- 3. Operating Performance
- 4. Safety Analysis
- 5. Physical Design
- 6. Fitness for Service
- 7. Radiation Protection
- 8. Conventional Healthy and Safety
- 9. Environmental Protection
- 10. Emergency Management and Fire Protection
- 11. Waste Management
- 12. Security
- 13. Safeguards
- 14. Packaging and Transport

RD/GD-360: Integrated Safety Review (cont'd)

- The objectives of the ISR are to determine:
  - the extent to which the plant conforms to modern standards and practices,
  - the extent to which the (updated) licensing basis will remain valid to the end of the proposed extended operating life,
  - the adequacy of the arrangements that are in place to maintain plant safety for long-term operation, and
  - the improvements to be implemented to resolve the safety issues that have been identified.

RD/GD-360: Integrated Implementation Plan

- The licensee incorporates the results of the EA and the ISR to develop the *Integrated Implementation Plan (IIP)*

- The licensee may proceed with the life extension activities upon acceptance of the plan by CNSC staff

- The licence is amended to include appropriate licence conditions that will need to be met for the return-to-service phase of the project

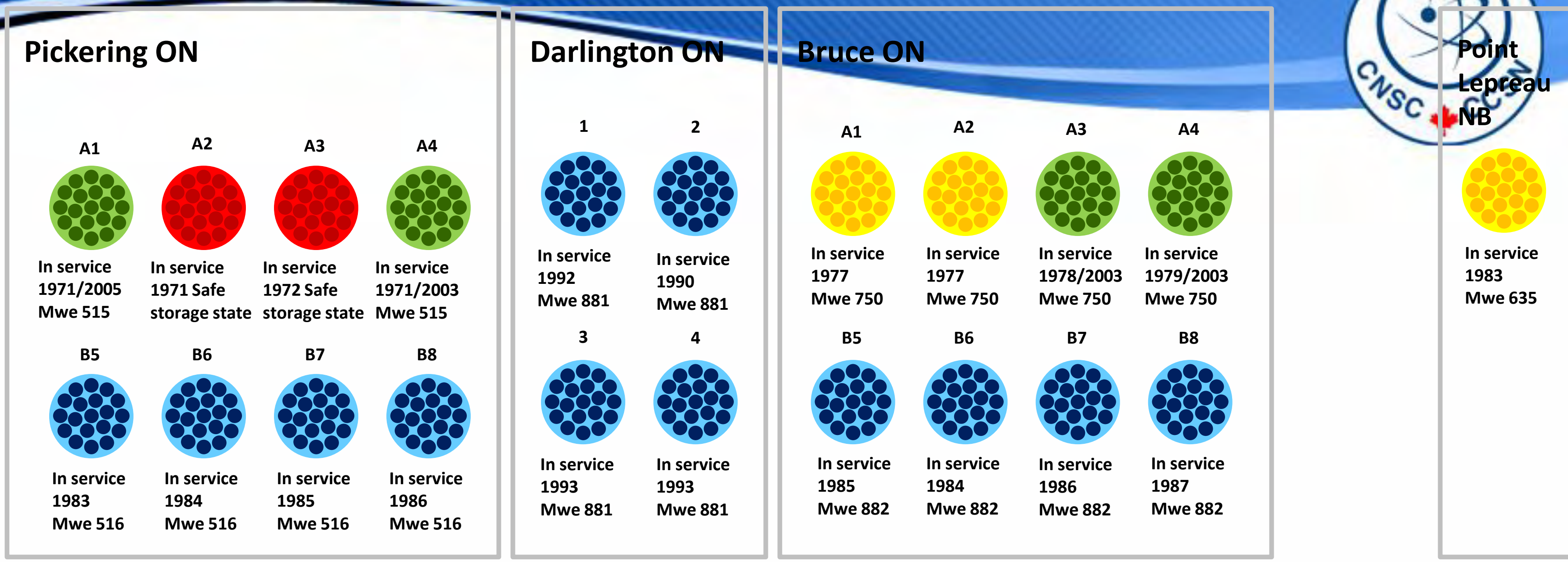
RD/GD-360: Project Execution

- Regulatory verification of project execution includes:
  - assessing licensee’s submissions (safety analyses, design packages, condition assessments, etc.),
  - audits and field inspections of procurement, construction commissioning and operations, and
  - reviewing Commissioning Completion Assurance reports

RD/GD-360: Return-to-Service

- Return-to-service is based on the licensee's ability to demonstrate that new and existing plant systems, structures and components conform to defined physical, functional, performance, safety, and control requirements
- The process of returning to service includes progressing to regulatory ***hold points***. These hold points are typically aligned with facility commissioning activities

Status of Current Life Extension Projects
Canada's Nuclear Energy Profile



Typical share of nuclear energy in total electricity generation

- Canada - 14.7%
- Quebec - 3%
- Ontario - 52%
- New Brunswick - 30%

Operable status (Average age – 25 Years)

- In service within design life
- In service / Returned to service
- Safe storage state
- In refurbishment

Status of Current Life Extension Projects

- The following projects are currently in progress
  - Pickering B: Integrated Safety Review completed (Pickering B will **not** be refurbished - end of commercial operation in 2020)
  - Bruce 1 & 2: restart scheduled for spring 2012
    Bruce 3 & 4 refurbishment still under consideration
  - Bruce B units: expected to go for refurbishment
  - Pt. Lepreau: restart scheduled for fall 2012
  - Darlington: basis for Integrated Safety Review submitted (refurbishment to start in 2016)

R&D supporting regulatory decisions on Fitness-for-Service (AM and LTO)

- International Steam Generator Tube Integrity Program ISG-TIP-4
- Probabilistic Assessment of Leak Rates through SG Tubes
- Loading of Steam Generator Tubes during Main Steam Line Break
- Irradiation Effects on Material Properties for 304L Stainless Steel Base Metal and Welds
- Component Operational Experience, Degradation and Ageing Programme (CODAP)-OECD/NEA
- Investigation of concrete AAR on existing nuclear structures
- ASCET (proposes CAPS in OECD-NEA/WGIAGE)

R&D supporting regulatory decisions on AM and LTO (cont.)

- Irradiation Effect on Pressure Tube Hydrides
- Investigation of Consequences of Concrete Alkali Aggregate Reaction on Existing Nuclear Structures - jointly with USNRC
- Ageing Management of Cables in Nuclear Generating Stations
- Cable Ageing Database and Knowledge Project (CODAK) OECD/NEA
- International Generic Ageing Lessons Learned (I-GALL) Database-CANDU Power Plants – IAEA

NOTE: New proposals for R&D must address to the extent possible the impact on operation of lessons learned from Fukushima event.

Co-operation

CNSC actively participates in national and international initiatives related to materials degradation

- IAEA
- OECD-NEA, mainly within WGIAGE
- Cooperation with nuclear regulatory agencies
- CANDU Owners Group (COG) – as observer

Summary

- **All licensees to have aging management programs in accordance with CNSC requirements, industry standards, and international best practices.**

- **CNSC recognizes activities to ensure continued plant safety as Canada's NPPs age and operators apply for LTO**
  - Revision 2 of Regulatory Document RD/GD-360 on LTO under way
  - New RD-334 on Aging Management: RD/GD-334 under way
  - Strengthen role of proactive aging management for Existing Plants and New Builds
  - National and International R&D programs
  - Sharing / exchange of OPEX with other regulators
  - Fukushima implications to be considered

Canada's nuclear power plants are safe

We Will Never Compromise Safety

Thank You

nuclearsafety.gc.ca

Canada

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

Trend and Direction of Nuclear Safety Countermeasures and Regulation in Canada and Expectations of International Cooperation after Fukushima

Andrei Blahoianu

Director, EDAD/DAA

Canadian Nuclear Safety Commission

Presentation at the WGIAGE annual meeting

Paris, April 08-12, 2013

Canada

Overview

- Who we are
- CANDU reactor safety features
- Canada’s Nuclear Energy Profile
- Fukushima Task Force/Recommendations/Action Plan
- Improvements to CNSC Regulatory Framework
- CNSC Review of new builds
- Fukushima-related improvements for New Builds
- Enhanced requirements on Long Term Operation
- Enhanced International Cooperation
- Trend and Direction in Industry Approach
- Changes to be incorporated into national/international standards
- Summary

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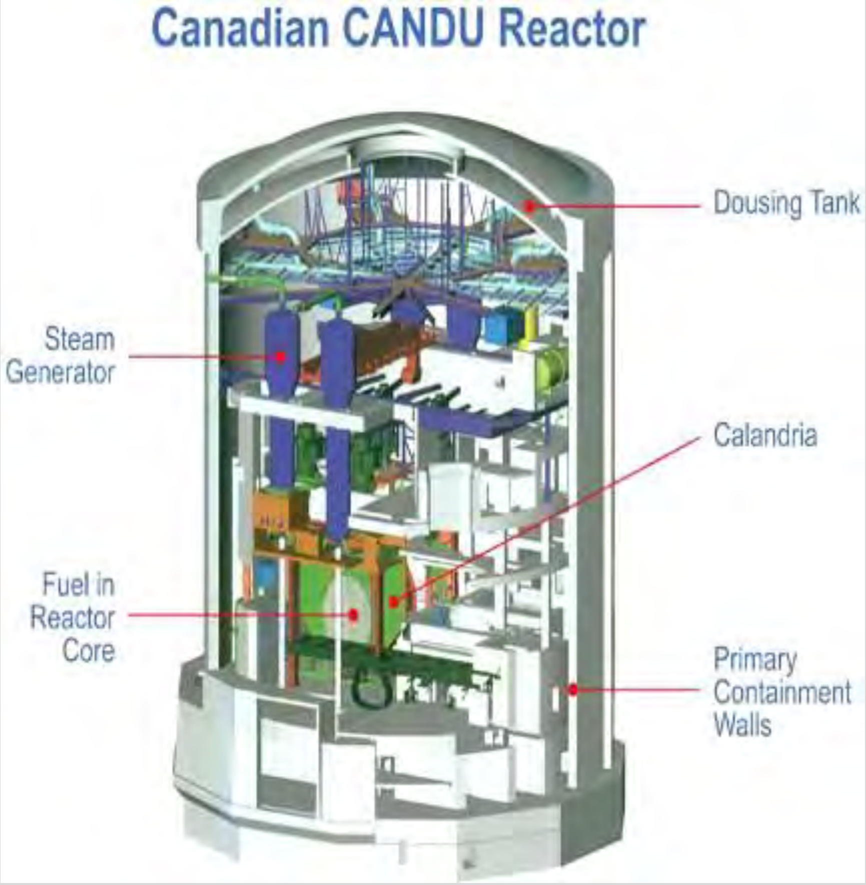
Over 65 years of nuclear safety!

CANDU reactor safety features

- Design philosophy
  - Two independent and diverse shutdown systems
  - Multiple barriers
  - Capability for cooling by natural buoyancy without external power supply
- Large containment
  - much larger than that in Fukushima Dai-ichi NPP
- Large inventory of water
  - Primary/Secondary coolant
  - Moderator coolant
- Many hours of passive cooling
  - Extended recovery time
- In-ground spent fuel pools
  - Seismically qualified
  - Diverse means of adding water
- CANDU pressure tubes, calandria tubes, and feeders can be replaced



Canada's Nuclear Energy Profile

Pickering ON

A1	In service 1971/2005 Mwe 515
A2	In service 1971 Safe storage state
A3	In service 1972 Safe storage state
A4	In service 1971/2003 Mwe 515
B5	In service 1983 Mwe 516
B6	In service 1984 Mwe 516
B7	In service 1985 Mwe 516
B8	In service 1986 Mwe 516

Darlington ON

1	In service 1992 Mwe 881
2	In service 1990 Mwe 881
3	In service 1993 Mwe 881
4	In service 1993 Mwe 881

Bruce ON

A1	In service 1977 Mwe 750
A2	In service 1977 Mwe 750
A3	In service 1978/2003 Mwe 750
A4	In service 1979/2003 Mwe 750
B5	In service 1985 Mwe 882
B6	In service 1984 Mwe 882
B7	In service 1986 Mwe 882
B8	In service 1987 Mwe 882

Gentilly QC

In service 1983 Mwe 635

- no refurb. ; end end of commercial life

Point Lepreau NB

In service 1983 Mwe 635

Typical share of nuclear energy in total electricity generation

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- Quebec - 3%
- Ontario - 52%
- New Brunswick - 30%

Operable status (Average age – 25 Years)

- In service within design life
- In service / Returned to service
- Safe storage state
- Refurbishment completed recently

CNSC Review of new builds (1/4)

CANDU Energy EC-6

Phase 3 Vendor Design Review starting very soon

Review is informed by OPEX from other CANDU countries (e.g. Fukushima lessons learned)

Westinghouse AP-1000

Phase 2 Vendor Design Review starting very soon (design meets Canadian design requirements?

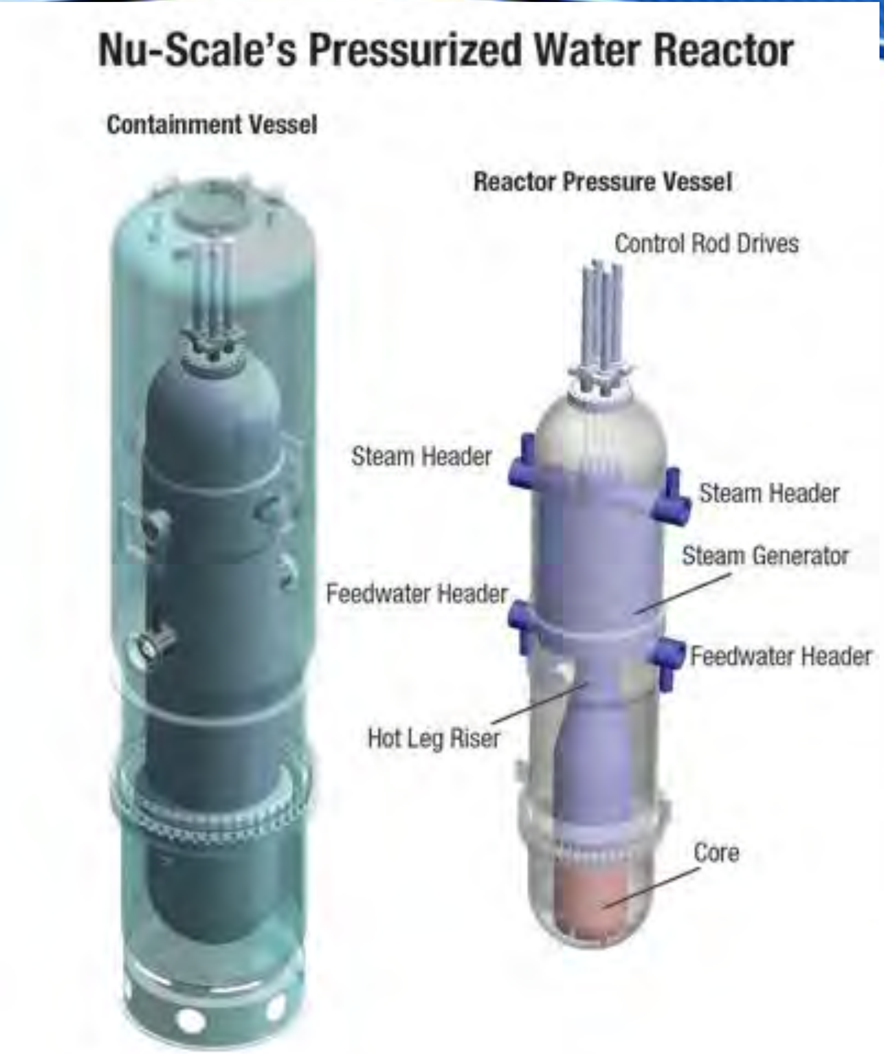
CNSC will realize design review efficiencies through interactions with other countries through OECD-NEA Multinational Design Evaluation Program (MDEP) AP-1000 Working Group

CNSC Review of new builds (2/4)

Phase 1 Vendor Design Review in progress (does vendor understand and will address Canadian requirements?)

ATMEA1 proposed the use of French codes and standards if the design will be used in a Canadian project – this is possible if vendor addresses any gaps / differences between French and Canadian codes and standards and meet the Canadian regulatory requirements (RD-337)

CNSC Review of new builds (3/4)



Small Reactor - Integrated PWR

- iPWR integrates reactor pressure vessel, reactor coolant system, steam generator and pressurizer into one pressure vessel.
- CNSC and USNRC are both reviewing the Generation mPower design and the NuScale design
- Both agencies are sharing information on technical requirements for this type of arrangement.

CNSC Review of new builds (4/4)

New developments on long term horizon– Smaller Factory Fuelled SMRs a.k.a "Nuclear Batteries" (approx. 2 to 25 MWe)

- Far north where fossil fuel delivery is becoming expensive and problematic
- **Initially:**
- Northern resource projects (mines)
- Critical military bases?
- **Eventually:**
- Villages and town that have no access to grid

E-DOC-4033152

CNSC Fukushima Task Force, Recommendations, and Action Plan (1/3)

CNSC Task Force

Established On April 20, 2011 to:

- review the capability of NPPs in Canada to withstand conditions similar to those that triggered the Fukushima accident
- examine the response and capability of NPPs to external events of higher magnitude than those have previously been considered.
- Short-term actions to confirm readiness of installed equipment
- Long-term measure to update safety case of nuclear power plants

CNSC Fukushima Task Force, Recommendations, and Action Plan (2/3)

<u>Task Force Report recommendations</u>

The report (in October 2011) made recommendations grouped into 4 areas:

1. Strengthening defence in depth
   - External events and beyond design basis accidents
   - Design and safety analysis
   - Severe accident management
2. Enhancing emergency preparedness
   - Off-site emergency response
   - Multiple jurisdictions
3. Improving regulatory framework and processes
   - Act, regulations and regulatory documents
   - Compliance and licensing processes
   - International cooperation
4. Enhancing international cooperation
   - CANDU owner countries
   - Other International regulators

CNSC Fukushima Task Force, Recommendations, and Action Plan (3/3)

<u>Action Plan on the Fukushima Task Force Recommendations</u>

- To address each recommendation in *Task Force Report*, the CNSC created the comprehensive <u>*CNSC Staff Action Plan on the CNSC Fukushima Task Force Recommendations*</u> (INFO-0828)
- *CNSC Staff Action Plan* describes specific actions to be implemented by licensees, CNSC staff, and affected federal and provincial authorities
- This action plan identified specific deliverables to be completed by the end of 2015

Improvements in CNSC Regulatory Framework (1/5)

<u>Overview of improvements in Regulatory Framework</u>

The CNSC Staff Fukushima <u>*Action Plan*</u> identifies the area of improving Regulatory Framework and Processes, including:

- Amendments to Regulations
- Developing new documents
- Updating key regulatory and guidance documents
- Introducing New Licence Conditions

Improvements in CNSC Regulatory Framework (2/5)

Amendments to Regulations

- Class I Facilities Regulations
  - to include explicit requirements for submission of off-site emergency plans with licence to construct or operate a nuclear power plant
- Radiation Protection Regulations
  - to define applicability of operational versus emergency dose limits during the post-emergency phases
  - to prescribe radiation protection criteria for workers who receive occupational exposures during emergency

Improvements to CNSC Regulatory Framework (3/5)

<u>Developing new documents</u>

- Emergency preparedness (replacing G-225 & RD-353)
- Accident management (incorporating G-306)
- Guidance Document GD-334 for Aging Management for NPP
  - RD-334 has been updated in June 2011
  - GD-334 will provide <u>practical guidance</u> as <u>how to meet the regulatory requirements</u> of RD-334
  - GD-334 will address lessons learned from Fukushima

Improvements in CNSC Regulatory Framework (4/5)

Updating key regulatory and guidance documents

- Site evaluation (RD-346)
- Environmental protection (S-296 & G-296)
- Safety analysis (S-294, RD-310, RD-308)
- Severe accident management (G-306)
- Design requirements for New NPPs (RD-337 rev. 2 & GD-337)

Improvements in CNSC Regulatory Framework (5/5)

Introducing New Licence Conditions

CNSC initiates proposal of new Licence Conditions to strengthen the oversight of existing programs and of programs being considered for new nuclear power plants

- Severe Accident Management (SAM) Program
- Accident Management Program
- Public Information Program

Fukushima-related improvements for New Builds (1/7)

Opportunity to Improve

- CNSC has established its modern requirements for design in RD-337 *"Design of New Nuclear Power Plants" (2008)*
- RD-337 contains requirements for many of the phenomena that occurred at Fukushima
  - Provisions for station blackout
  - Provisions to mitigate severe accidents
  - Provisions for hydrogen mitigation
  - Provisions for external events
  - Provisions for combined events
  - Provisions for fire protection
- The Task Force found that:
  - "…while recognising that the fundamental approach is sound, CNSC staff should **reconsider the detailed requirements for the design and analysis of new NPPs**"

Fukushima-related improvements for New Builds (2/7)

Approach to BDBA and Severe Accidents

- Complementary design features needed
  - to cope with events and conditions arising from Design Extension Conditions
- Severe accident phenomena are addressed in containment design
- Explicit requirements for system capable of monitoring core inventory in BDBA conditions
- Plant Design Envelope is extended:
  - to include Design Extension Conditions (DEC) in addition to existing *normal conditions*, *AOOs*, and *DBAs*

Fukushima-related improvements for New Builds (3/7)

Plant Design Envelope

Plant state	Plant Design Envelope				
				Beyond Design basis Accidents	
	NO	AOO	DBA	Design extension conditions (DECs)	Non-DECs
				Severe accidents	
Classification Frequency	1	1 to 10^{-2}	10^{-2} to 10^{-5}	$<10^{-5}$	
Public Radiological Acceptance Criteria	Effective dose limits as per the Radiation Protection Regulations	Dose acceptance criteria 0.5 mSv	Dose acceptance criteria 20 mSv	Safety goals (CDF $< 10^{-5}$, SRF $< 10^{-5}$, LRF $< 10^{-6}$) and deterministic requirements	
Structures, Systems, Components	Normal operation and control systems		Safety systems	Complementary design features	Any available SSCs
Safety Analysis	Deterministic safety analysis, probabilistic safety assessment and hazards analysis are performed				
Design Rules	Design basis Rules			Reasonable level of confidence	
Operator procedures	Operating manuals		Emergency operating procedures		Severe accident management guidelines
			Emergency management procedures		
Off-Site Response	None required		Graded response		Fully mobilised

Fukushima-related improvements for New Builds (4/7)

Approach to BDBA and Severe Accidents

- Emergency support systems shall provide continuity of the service until long term (normal or backup) service is re-established
  - Without the need for operator action to connect temporary on-site services for at least 8 hours
  - Without the need for off-site services and support for at least 72 hours
- The design of the emergency power supply (EPS) shall consider common-cause failure coincident with normal and standby power
  - EPS shall be physically separate and diverse from, and independent of, normal and standby power supplies

Fukushima-related improvements for New Builds (5/7)

Approach to Multi-units

Multi-unit challenges

- The events and consequences of an accident at one unit may affect the accident progression or hamper accident management activities at the neighbouring unit
- Available resources (personnel, equipment and fuel) would need to be shared among several units
- The multi-unit reactors in Canada share parts of containment

Multi-unit requirements

- Consider any challenges to a multi-unit site
- Specifically consider the risk associated with common-cause events affecting more than one unit at a time

Fukushima-related improvements for New Builds (6/7)

Changes under Consideration

- Common-cause failures
  - where physical separation by distance alone may not be sufficient for some common-cause failures (such as flooding), vertical separation or other protection shall be provided
- Safety analysis objectives
  - demonstrate that the design incorporates sufficient safety margins to cliff-edge effects

Fukushima-related improvements for New Builds (7/7)

Vendors of new NPP designs

Vendors of New NPP Designs are required to address new regulatory expectations stemming from the lessons learned from the Fukushima event, and to define potential EC6 Fukushima-related changes

Foe example, CANDU Energy submitted an interim report to the CNSC

- identified how the EC6 design aims to address the lessons learned from the Fukushima Event under Special Focus Topic of Extreme Severe Accidents
- indentified areas for further assessment

Enhanced Requirements on Long Term Operation (1/6)

- CNSC updated regulatory document RD/GD-360 for Long Term Operation of NPP (rev. 2 under review)
  - Reflect CNSC and industry cumulative experience from ongoing Long Term Operation
  - Include 3 options of Long Term Operation
    - Continued Operation
    - Life Extension (Refurbishment)
    - End of Commercial Operation

Enhanced Requirements on Long Term Operation (2/6)

- RD-360 requires a licensee to:
  - Conduct an Integrated Safety Review (ISR)
  - Establish an Integrated Implementation Plan (IIP) for the necessary plant refurbishment, safety upgrades and other compensatory measures
  - Develop and implement the Project Execution Plan (PEP)

Enhanced Requirements on Long Term Operation (3/6)

The ISR process is to determine:

- the extent to which the plant conforms to modern standards and practices
- the extent to which the (updated) licensing basis will remain valid to the end of the proposed extended operating life
- the adequacy of the arrangements that are in place to maintain plant safety for long-term operation
- the improvements to be implemented to resolve the safety issues that have been identified
- reasonable and practical modifications that should be made to enhance the safety of the facility for long-term operation

Enhanced Requirements on Long Term Operation (4/6)

- The IIP addresses the results of the ISR for the necessary plant refurbishment, safety upgrades and other compensatory measures by:
  - Listing the corrective actions and safety improvements to address the ISR findings
  - Specifying the schedule for implementing the corrective actions and safety improvements
  - IIP does not have to fully meet modern standards but any gaps must be justified and agreed by regulator
- The PEP establishes what needs to be done to achieve the IIP outcome

Enhanced Requirements on Long Term Operation (5/6)

- In accordance with the RD-360 requirements, licensees have to:
  - address modern high-level safety goals
  - review against modern standards, best practices, operating experience, research findings to re-baseline the safety case
  - identify any further gaps on the lessons learned from Fukushima accident
  - include assessments directly related to aging management
    - Actual Condition of SSC
    - Management of Aging

Enhanced Requirements on Long Term Operation (6/6)

- Assess current performance and condition of the SSC
  - identify any significant material degradation,
  - identify previously unidentified aging mechanisms or effects, and comparisons against predictions for the aging mechanisms
- Estimate future performance & residual service life
  - fatigue assessments, time limited aging analyses
- Recommend follow-up activities
  - inspections, refurbishment, repair, replacements
  - AMP Improvements
  - R&D

Enhanced International Cooperation (1/6)

- As per the lessons learned from Fukushima emergency, any domestic or international emergency involving CANDU reactors will require the CNSC to communicate with the international regulators regulating the CANDU reactors
- CNSC closely cooperates with regulatory bodies in countries with CANDU reactors
  - Take a leading role in support of CANDU regulators during a nuclear emergency
  - Review and update existing MOUs
  - CANDU Senior Regulators Meeting

Enhanced International Cooperation (2/6)

- The CNSC enhances cooperation with other nuclear regulators in addressing the lessons learned from the Fukushima accident and thus further strengthen the capability to respond efficiently to any nuclear emergency
  - Protocols and plans are in place to ensure that the CNSC will be in close communication with the IAEA for any domestic nuclear emergency
  - The United States and Canada have an arrangement in place specifically for nuclear emergencies
  - The CNSC has MoUs in place with most international stakeholders
    - Review and update existing MOUs
    - Bilateral Meetings
    - Exchange of nuclear regulatory and emergency preparedness expertise

Enhanced International Cooperation (3/6)

- CNSC strongly promotes IAEA and OECD-NEA initiatives of lessons learned from the Fukushima accident to achieves mutual understanding among regulatory bodies, technical support organizations, and nuclear industry
  - Convention on Nuclear Safety (2nd Extraordinary Meeting, Vienna, 27-31 August 2012)
  - Hosts the upcoming IAEA 3rd International Conference on Effective Nuclear Regulatory Systems (Ottawa, Canada, April 8-12, 2013)
- Canadian nuclear power industry is involved in various international working groups with a focus on nuclear safety, including the CANDU Owners Group and the World Association of Nuclear Operators

Enhanced International Cooperation (4/6)

- CNSC staff is been actively participating in international forums and learning from international experience, as well as contributing to the preparation of IAEA subject documents
  - IAEA International Seismic Safety Centre (ISSC) EBP
  - IAEA projects for Ageing Management, Long Term Operation, International Generic Ageing Lessons Learned (IGALL)
  - IAEA missions: Embalse (Argentina), Wolsong (South Korea)
  - International SG Tube Integrity Program (ISG TIP-4)
  - International Cooperative Group on Environmentally Assisted Cracking (EAC) of Water Reactor Materials

Enhanced International Cooperation (5/6)

- CNSC participates in various OECD-NEA working groups, and WGIAGE research activities. Lessons learned from Fukushima accident have been integrated with the WGs research activities
  - Workshop on Soil Structure Interaction knowledge and Its effect (hosted and chaired by CNSC, 2010)
  - IRIS_2012 workshop on simulations of structural impact (hosted and chaired by CNSC, Ottawa).
  - IRIS_2010 workshop on simulations of structural impact (Paris)
- CNSC participates in OECD-NEA
  - Pipe Failure Data Exchange Working Group (OPDE)
  - Component Operational Experience, Degradation and Ageing Programme (CODAP)

Enhanced International Cooperation (6/6)

- CNSC fully support the IRRS program and missions
- CNSC hosted an international team of experts for an IAEA Integrated Regulatory Review Service (IRRS) follow-up mission to Canada (Nov. 28 to Dec. 9, 2011)
  - The IRRS Report indicated that CNSC actions and responses to the nuclear accident were prompt, comprehensive and robust
  - The IRRS Team rated the CNSC response to the Fukushima accident as a good practice

Trend and Direction in Industry Approach (1/7)

- The *CNSC Fukushima Task Force Report* recommends
  - Strengthening each layer of defence built into the Canadian NPP design and licensing philosophy
  - Verifying effectiveness of existing plant design capabilities in beyond-design-basis accident conditions and supplement where appropriate
  - Conducting more comprehensive assessments of site-specific external hazards
- Accordingly, Canadian nuclear industry evaluated certain design enhancements for severe accident management wherever practicable
- Physical improvements to NPPs have commenced or have been planned

Trend and Direction in Industry Approach (2/7) - Strengthened Defence-in-Depth

Improved capability to withstand prolonged loss of heat sinks

- Existing Passive Heat Sinks
  - CANDU has large inventory of water many hours of passive cooling
  - No reactivity or structural concerns with rapid cool-down and depressurization
- Added Makeup Water Sources
  - Installing accessible connection points to steam generators, calandria vessel, and calandria vault
  - Temporary connections for services (electrical & water)
- Onsite and off-site emergency mitigating equipment (portable pumpers and diesel generators)
- Provision of back-up to primary/alternate emergency facilities

Trend and Direction in Industry Approach (3/7) - Strengthened Defence-in-Depth

Improved capability for power supply

Existing Electrical Systems

- CANDUs have good diversity and redundancy
  - standby and emergency power has many days supply of fuel

Added Power Sources

- Providing mobile Diesel Generators
  - stationed on-site or off-site
  - accessible connection points
  - adequate fuel
- Considering additional battery capacity or charging capability
  - may be limited to specific purposes, e.g. accident management related I&C, and critical loads/emergency response equipment
  - may add portable charging generators

Trend and Direction in Industry Approach (4/7) - Strengthened Defence-in-Depth

Added Safety Features for spent fuel

Existing Spent Fuel Cooling

- Slow heat-up
  - low heat load and large water inventory
- Pools are robust
  - pools are not in reactor building, in-ground and seismically qualified
  - steam can be vented
- No criticality issue

Added Safety Features

- Accessible pool makeup connections to increase make-up capabilities
- Provision of alternate sources of water inventory
- Better instrumentation – for monitoring water level

Trend and Direction in Industry Approach (5/7) - Strengthened Defence-in-Depth

<u>Improved containment performance</u>

Hydrogen Control

- Installing or evaluating Passive Autocatalytic Recombiners (PARs)
  - complementary to igniters
- Hydrogen concentration monitoring under consideration or already installed

Venting

- All CANDUs have filtered containment venting
  - In place and adequate for DBA –Design Basis Accident
  - Additional filtered system (i.e., Emergency Filtered Containment Venting) are being considered or already have been installed

Trend and Direction in Industry Approach (6/7)
- Enhanced Severe Accident Management

Severe Accident Management

Severe Accident Management Guidelines (SAMGs)

- Enhancements are being developed to address credible worst case scenario including multi-unit sites
- Readiness and adequacy
- Pre-planning and preparatory measures
- Roles and responsibilities of operations staff

Instrumentation

- Survivability of equipment and instrumentation in severe accident conditions
  - hardening of key I&C
  - additional instrumentation to support severe accident management

Trend and Direction in Industry Approach (7/7)
- Enhanced Emergency Preparedness

Emergency Preparedness

Emergency plans

- Ensure adequacy of on-site and off-site emergency measures
- Ensure emergency response organizations capability
  - responding effectively in severe event and/or multi-unit accident
- Conduct sufficiently challenging emergency exercises
- Include communication with off-site authorities

Emergency facilities and equipment

- Review and update

Changes to be Incorporated into national and international standards

Topics under consideration for CSA and ASME:

- Introduce design requirements including DEC
  - The design rules and practices against DEC do not necessarily need to incorporate the same degree of conservatism as applied to the design for design basis accidents
- Define complementary design features
  - When complementary design features are credited in a plant's safety case, there must be reasonable assurance that they will function as designed under the expected accident conditions
- Address possible cliff-edge effects
  - Very low-probability events irrespective of predicted frequencies of occurrence of the challenge
  - Natural phenomena that are unprecedented but conceivable at a given site

Summary

- The Fukushima Task Force review concludes that NPPs in Canada are safe and the risk posed to the health and safety of Canadians or to the environment is very low
- Lessons learned from Fukushima accident have been integrated with CNSC Regulatory Framework and international cooperation activities
- To address the lessons learned from Fukushima, additional safety improvements have been systematically identified, grouping into 4 areas:
  - Strengthening reactor defence-in-depth
  - Enhancing emergency response
  - Improving regulatory framework and licensing, and
  - Enhancing international co-operation
- These improvements, when completed by both the licensees and the CNSC, will render NPPs in Canada even safer

We Will Never Compromise Safety

nuclearsafety.gc.ca

Stress Corrosion Cracking of Alloy 690 TT in PWR primary water conditions CSN-ENSA-CIEMAT PROJECT

(Update of IAGE 2012 meeting)

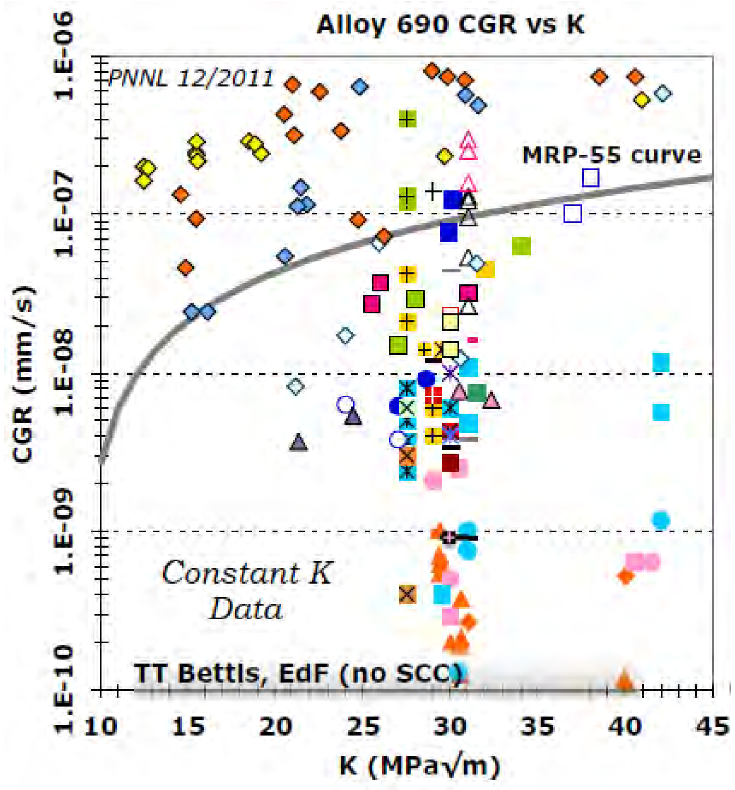
18th Metal Subgroup and 36th Main Group meetings, IAGE/CSNI/NEA

Paris 9-12, April 2013

Presented by: Carlos Castelao (CSN)
Prepared by: Lola Gómez-Briceño, Jesús Lapeña & Marisol García (CIEMAT)

Presented at the EPRI Alloy 690/52/152 PWSCC Research Collaboration Meeting 2012. Tampa, FL. November 2012

Background



Alloy 690 CGR, base metal, all conditions*

- ✓ For materials in as-supplied or as welded conditions, CGR are very low, structurally insignificant.
- ✓ For cold worked materials, CGR can be significantly higher.
- ✓ Variability observed in CGR test results can be consequence of several reasons, being relevant the level of the cold work and, possibly, plastic deformation.

*S. Bruemmer. Alloy 690/152/52 Research Collaboration Meeting, Tampa, FL. 2011

Background

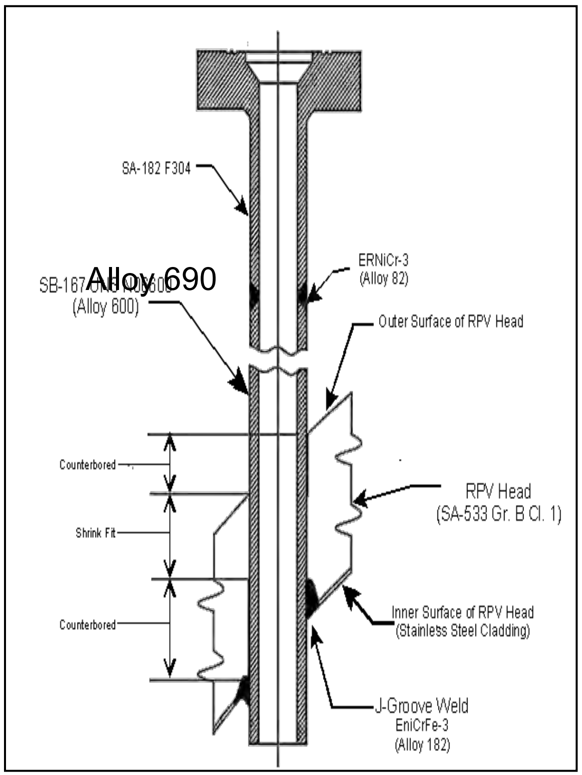
- ✓ Cold work and plastic deformation are consequence of the component fabrication process.
- ✓ Strain levels determination in Alloy 690 mockup samples by EBSD point out values around 15% in the Alloy 690 , within and close to the Alloy 690 HAZ. Higher strain levels can exist in the adjacent weld metal.
- ✓ Simulation of the areas of interest using cold worked materials by forging, rolling, tensile straining, etc…is not at straightforward task.
- ➢ The use of CGR specimens machined from a mock-up, well characterized regarding hardening and plastic strain levels, should be helpful to asses the behaviour of Alloy 690/ 52/152 in plants.

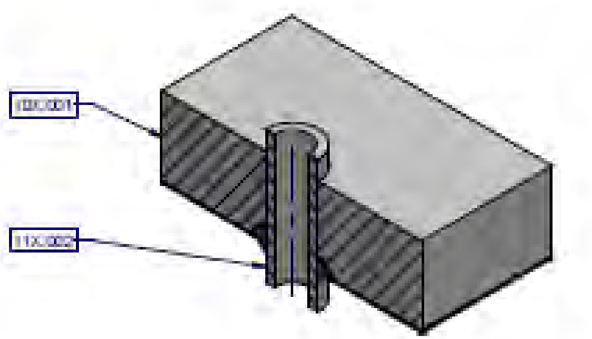
Objective and Scope

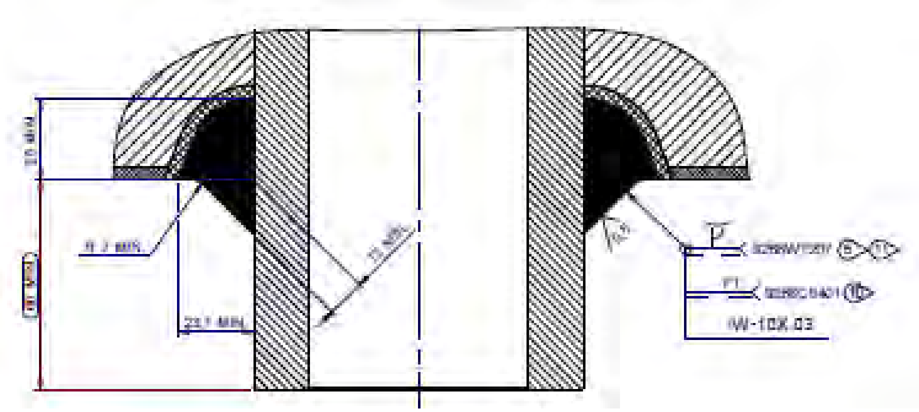
- ✓ The objective of this project is to obtain crack growth rate data on Alloy 690 TT base metal/HAZ/weld metal using specimens made from a CRDM.
- ✓ An exhaustive mock up characterization is planned.
  - ➢ Mechanical properties at room and high temperature of the CRDM 690 TT tube.
  - ➢ Microstructural characterization of Alloy 690 and weld metals.
  - ➢ Microchemistry of grain boundaries by Auger spectroscopy.
  - ➢ Determination of retained plastic deformation by EBSD.

CRDM mock-up

The CRDM mock-up has been fabricated by ENSA following the usual procedures used for the RPV head fabrication for the Spanish PWR NPP.





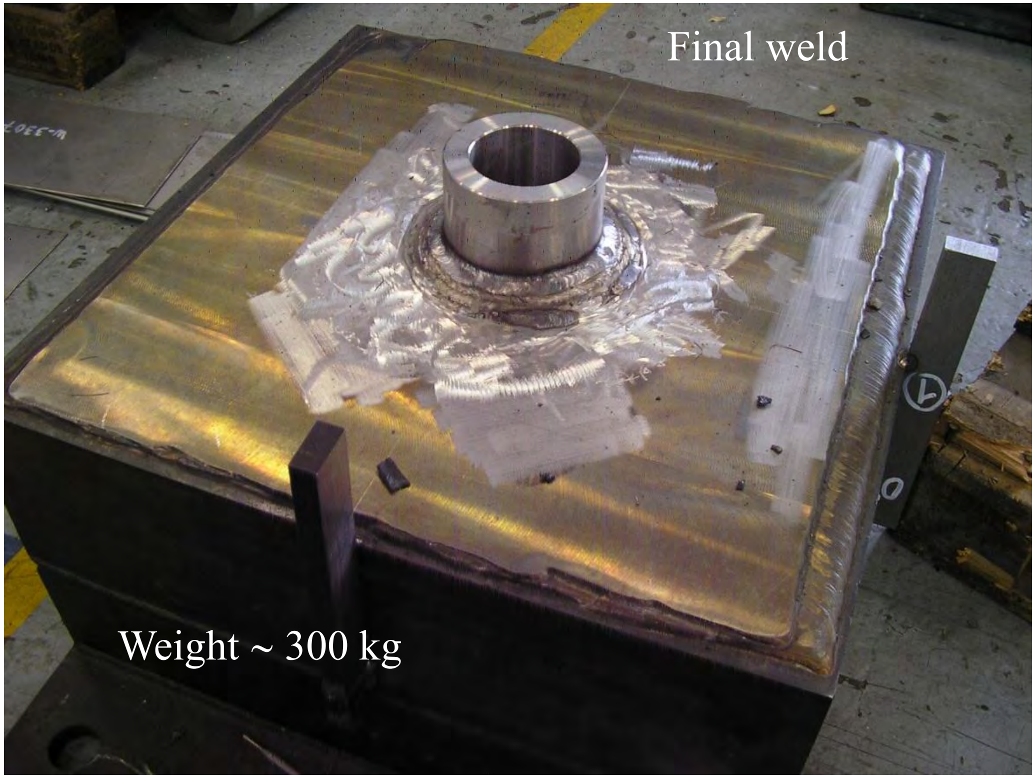


CRDM mock-up

The CRDM mock-up has been fabricated by ENSA following the usual procedures used for the RPV head fabrication for the Spanish PWR NPP.

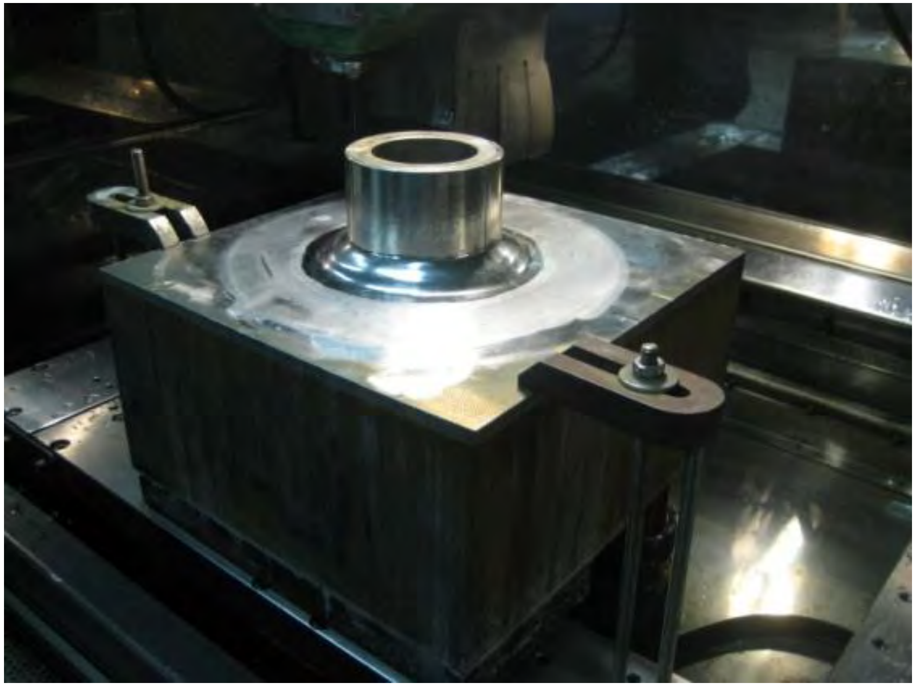
- ✓ Pressure vessel steel: SA-508 Class 3a. Heat S4781/S4782
- ✓ Dimensions of plate: 500x500x150 mm^3
- ✓ CRDM tube: Valinox Alloy 690TT, Heat RE 950
- ✓ Tube dimensions: 101.6 mm OD, 67.6 mm ID, 17 mm thickness
- ✓ Cladding of the SA-508
- ✓ Drilling of the SA-508 steel
- ✓ Machining and buttering of the well for the CRDM
- ✓ Mounting of the CRDM with interference
- ✓ Welding of the CRDM 52/152

Fabrication of the CRDM mock-up in ENSA



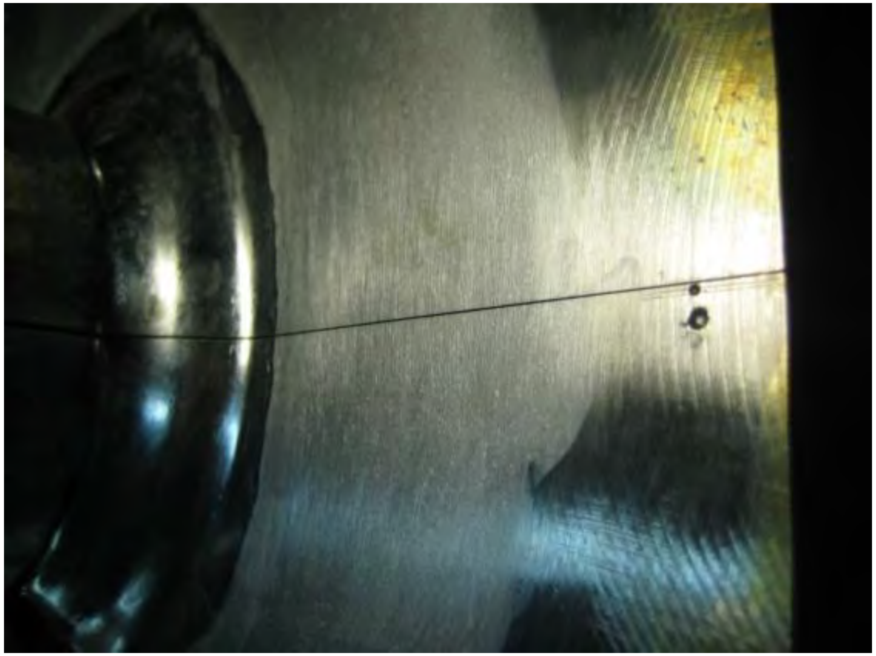
Fabrication of the CRDM mock-up in ENSA

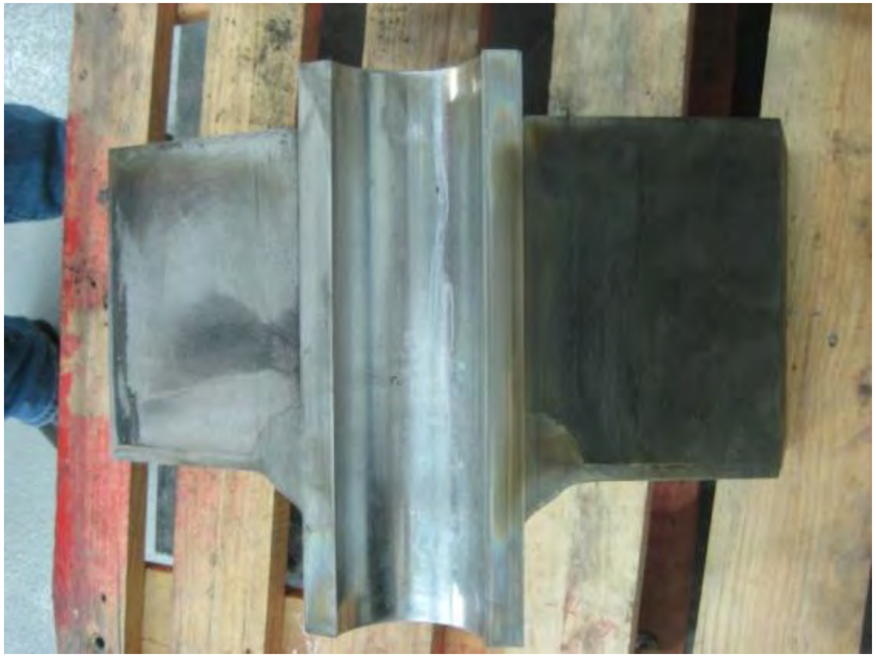
Cutting by EDM in Ciemat



Fabrication of the CRDM mock-up

Cutting by EDM in Ciemat

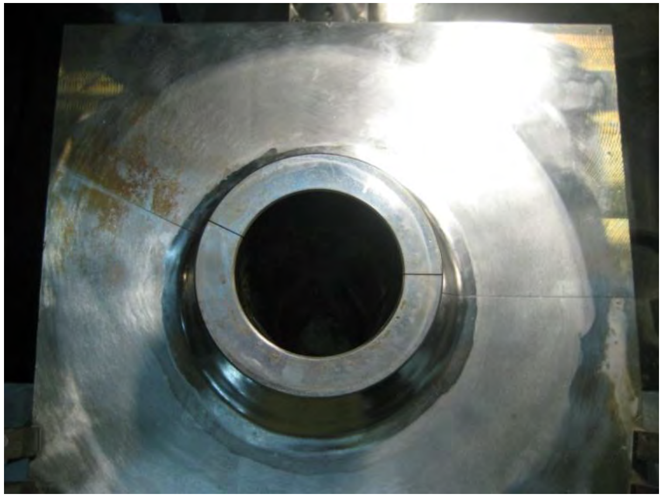


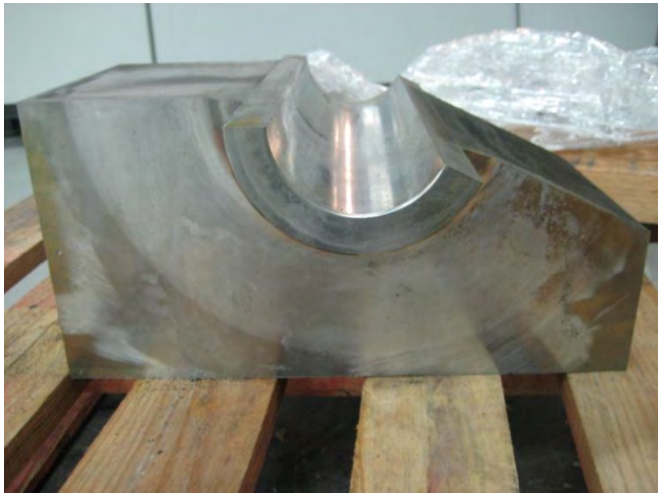


Fabrication of the CRDM mock-up

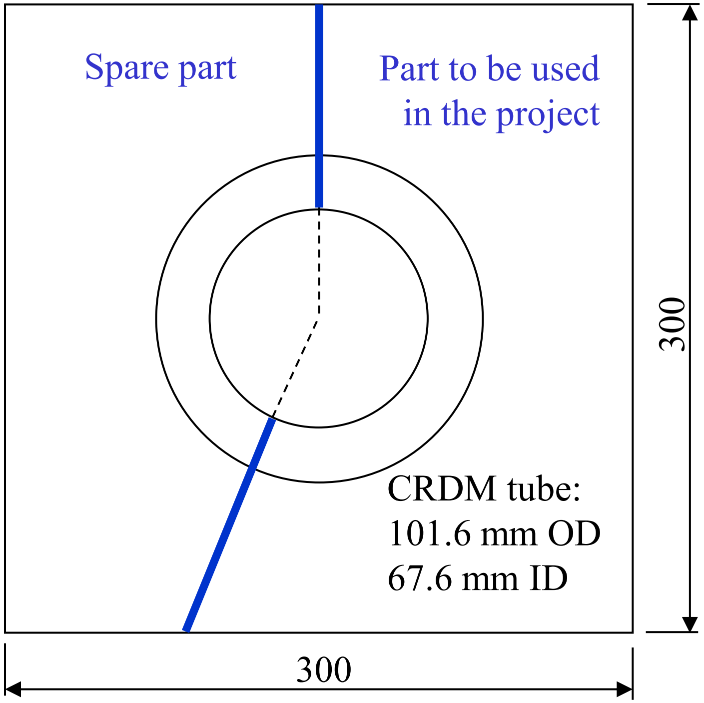
Cutting by EDM in Ciemat

Fabrication of the CRDM mock-up

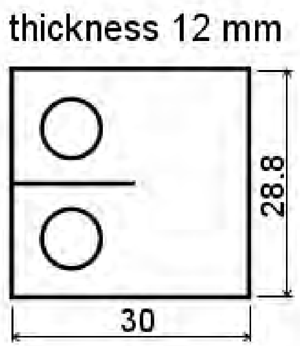


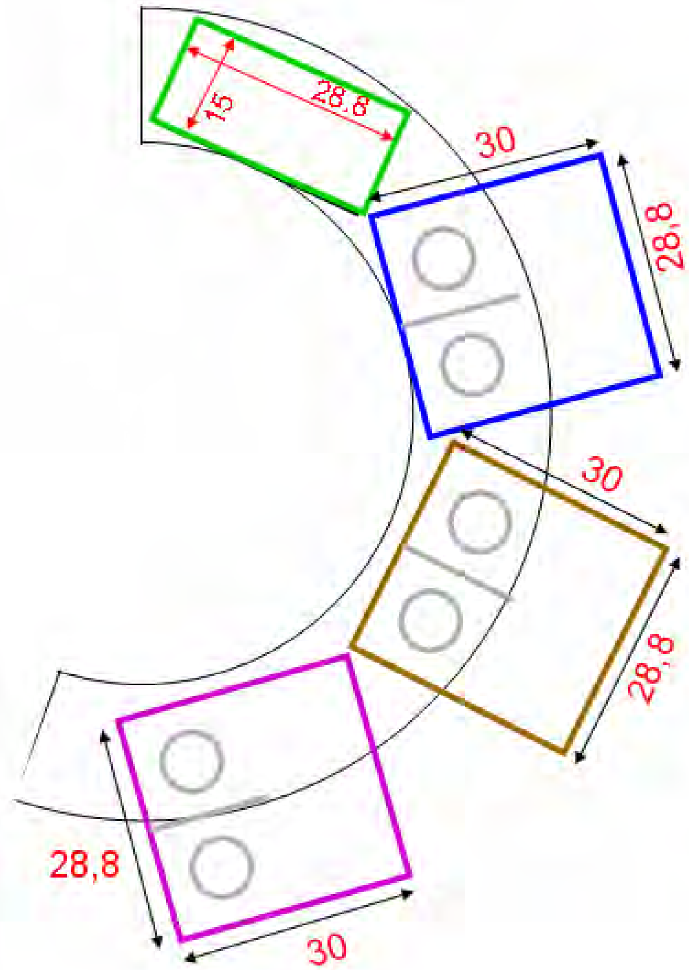


Cutting by EDM



Mechanizing of specimens



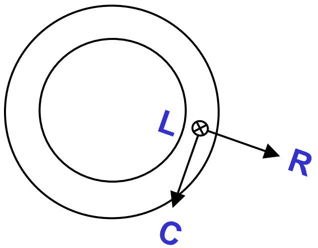


Machining of CT specimens

- From the welded area, eight (8) CT specimens, 12 mm thickness, will be machined according to ASTM E399 and E 813 with 5% side grooves:

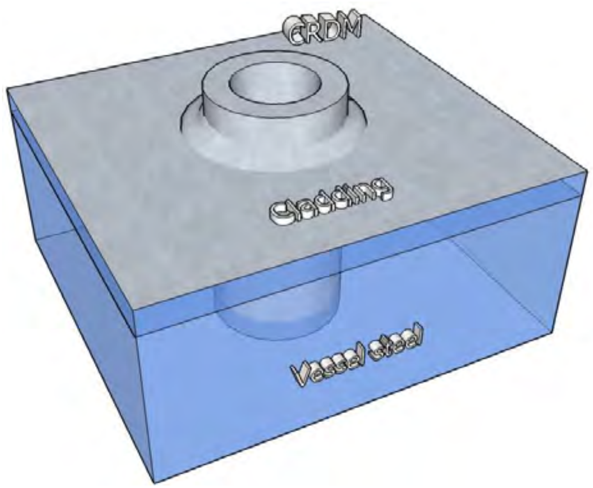
✓ Six (6) CT specimens with C-R orientation placed in the adequate mode to get crack propagation into

- Base metal
- HAZ
- Weld



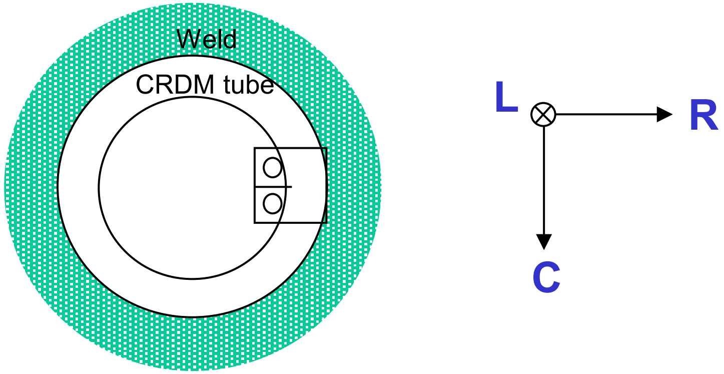
✓ Two (2) CT specimens with R-C orientation placed to get crack propagation

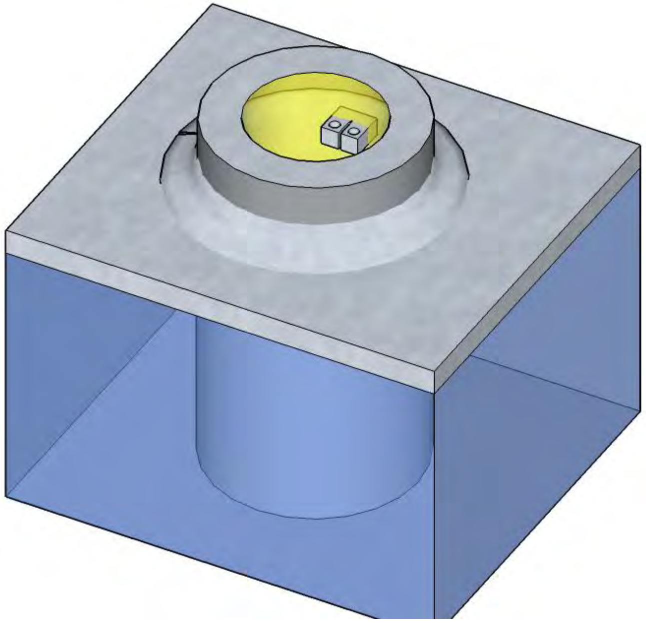
- Through the HAZ



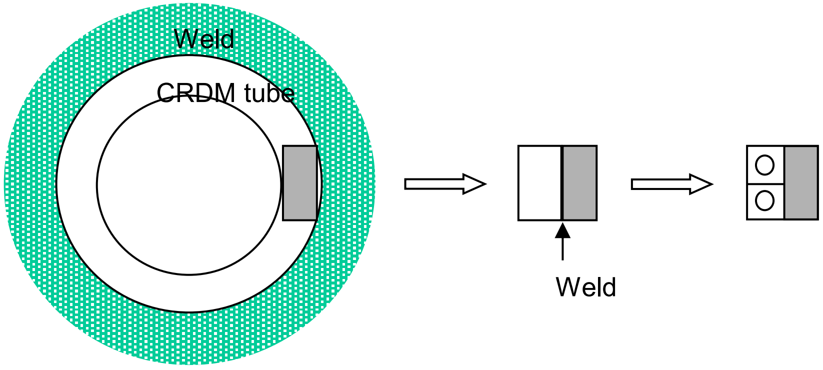
Machining of CT specimens

a) Two (2) CT specimens with orientation C-R. Crack propagation should be in the **BASE METAL** to simulate the axial cracks initiated in the ID of the CRDMs.



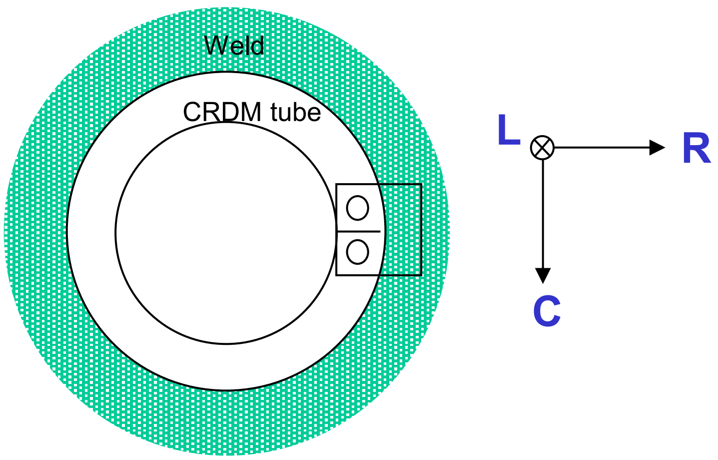


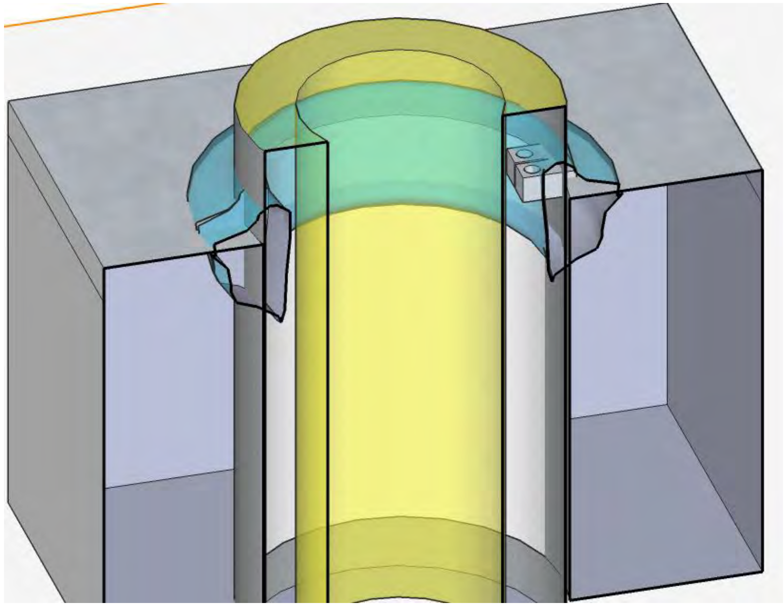
Electron beam welding



Machining of CT specimens

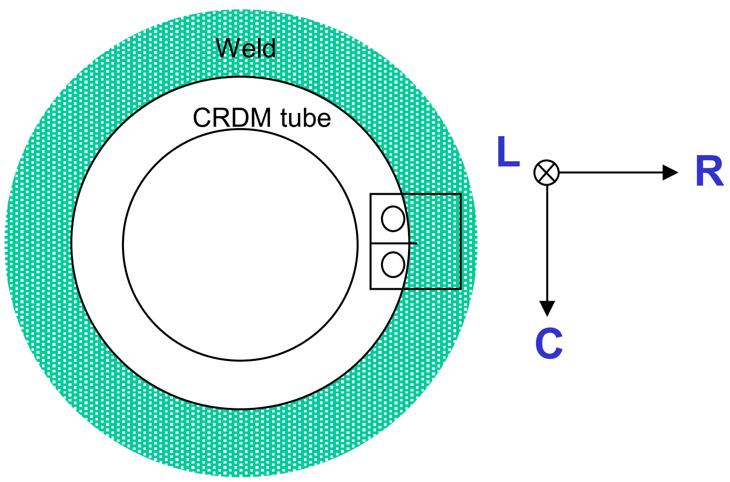
b) Two (2) CT specimens with orientation C-R. Crack propagation should be through the **HAZ** and into the weld.

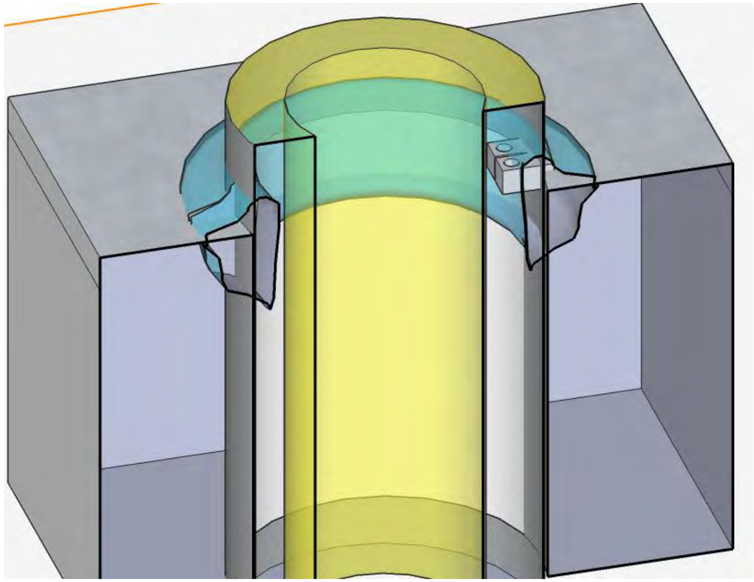




Machining of CT specimens

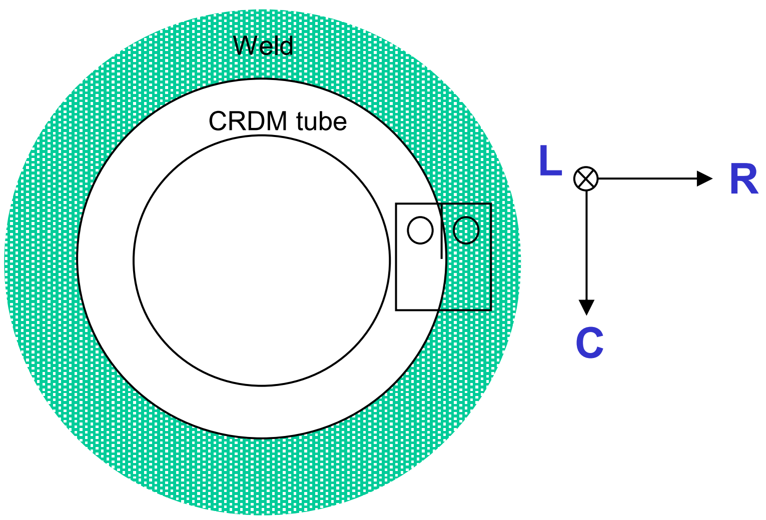
c) Two (2) CT specimens with orientation C-R. Crack propagation should be in the **WELD MATERIAL**

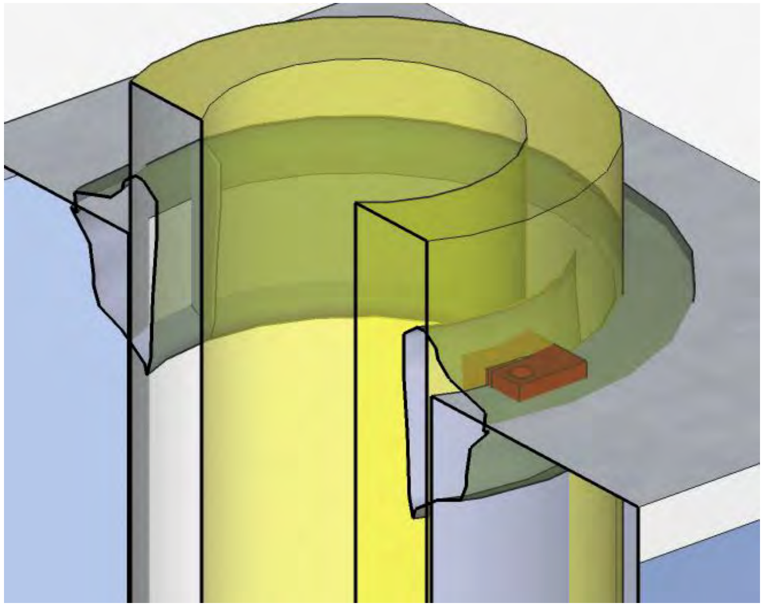




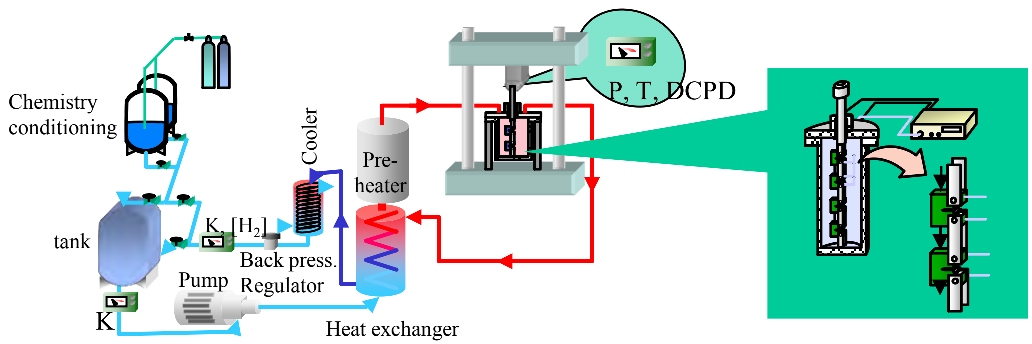
Machining of CT specimens

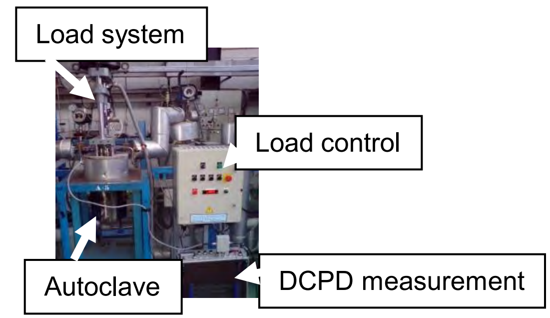
d) Two (2) CT specimens with orientation R-C. Crack propagation should be along the **HAZ**.





Crack Growth Rate tests: Experimental Facility





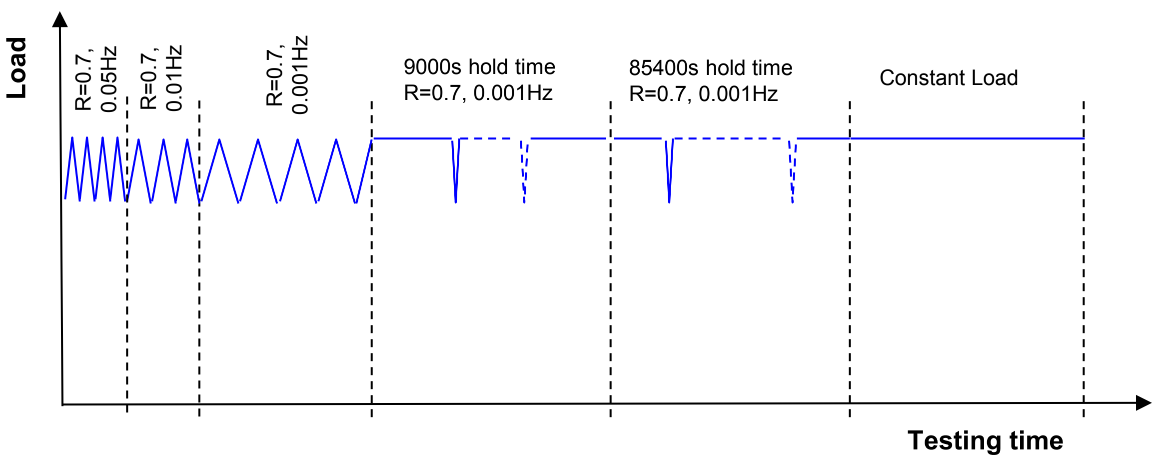
- ✓ Two CT specimens placed in chain shall be tested simultaneously in the same autoclave.
- ✓ Both CT specimens shall be instrumented with DCPD
- ✓ Two recirculating loops/autoclaves shall be used to carry out this project
- ✓ Experimental conditions: Primary water at 340ºC
  - 900 ppm B, 2.5 ppm Li, (pH 7.2 at 310ºC)
  - H_2 level needed to maintain $\Delta E = Ec_{Ni/NiO} - Ec_{Ni} = 32$ mV. This value corresponds to chemistry used in the Spanish PWR (35 cc H_2/kg H_2O and 325ºC).
- ✓ Test time for each CGR experiment is foreseen in around 5000 hours

Crack Growth Rate tests: Experimental Procedure

- ✓ Fatigue pre-cracking in air: R= 0.3 to 0.7 and 1-2 Hz.
- ✓ Specimens pre-oxidation 5-7 days in primary water at high T.
- ✓ Fatigue pre-cracking in high T water: R= 0.70 and frequency of 0.05 → 0.01 → 0.001Hz up to a crack propagation of 200 µm.
- ✓ SCC under constant load with periodical partial unloading.

  R= 0.7, 0.001Hz, 9000 s of hold time

  R= 0.7, 0.001Hz, 24 hours hold time
- ✓ Pure Constant load



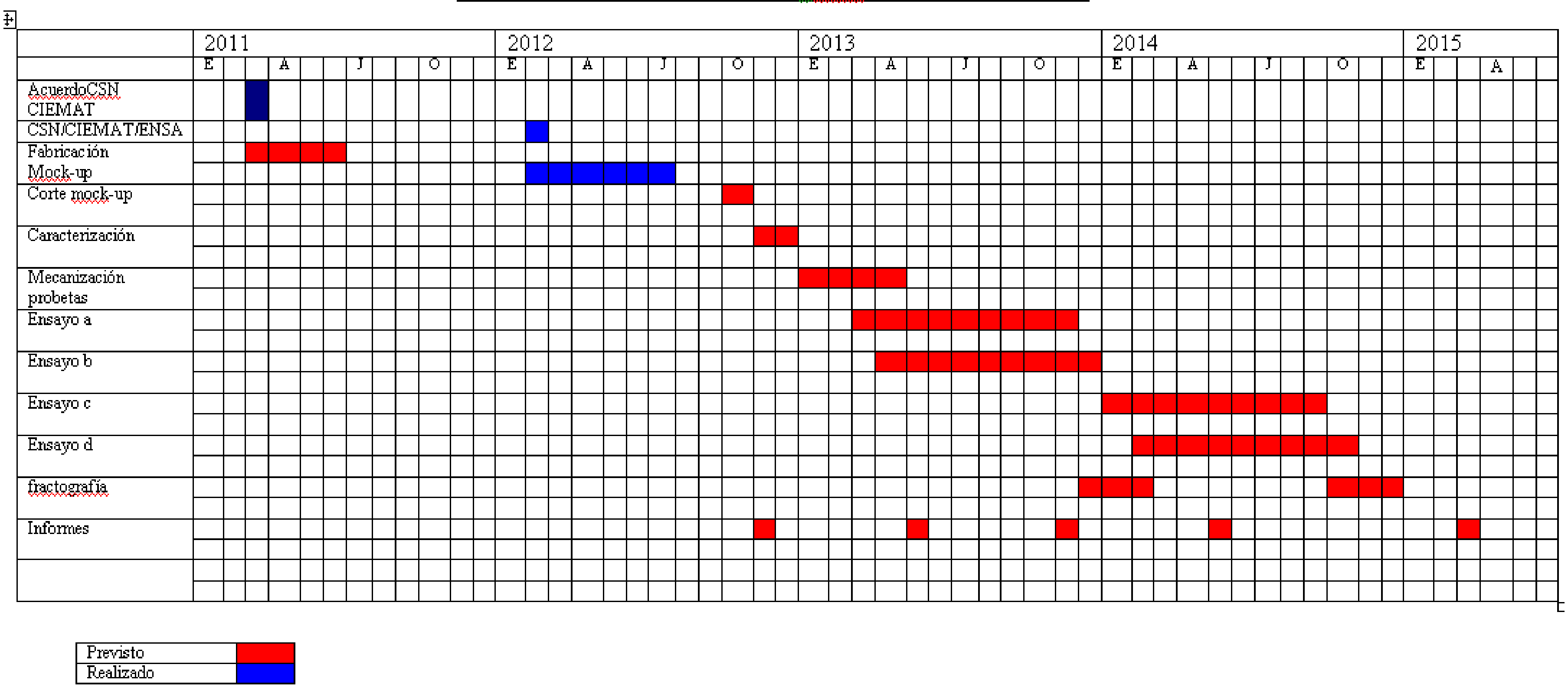
K_I =35 MPa $m^{1/2}$

Destructive examination and CGR determination

- ✓ After SCC testing, all samples will be opened by fatigue in air.
- ✓ Fracture surface shall be examined by SEM, and an appropriated number of measurements shall be taken across the CT specimen width to determine the average and maximum crack length.
- ✓ DCPD measurements will be corrected by fractography. Stress intensity factors shall also be corrected accordingly, taking into account the load applied and the actual crack size.

Cronograma

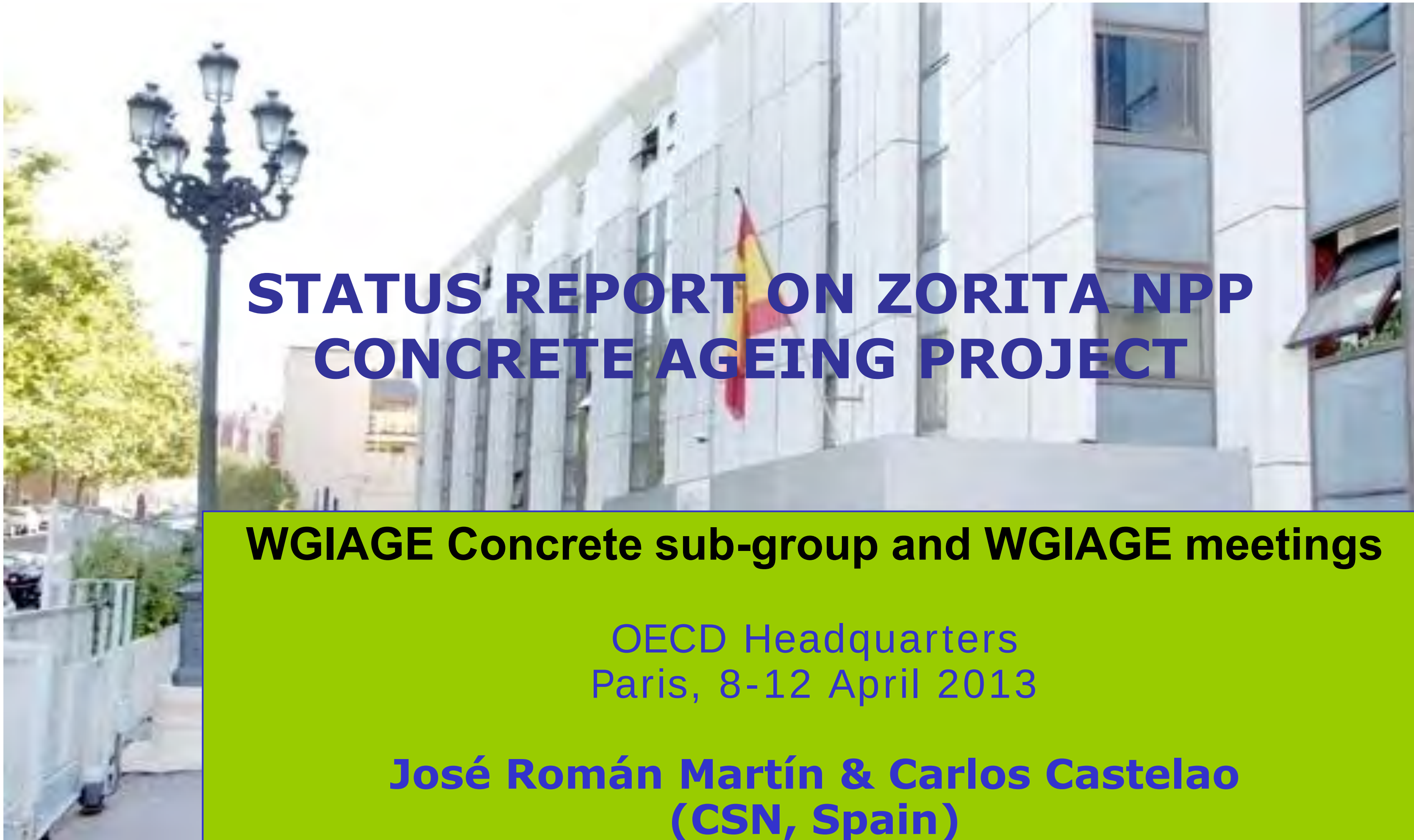
ACUERDO CSN-CIEMAT –ENSA (Alloy 690) 4 de octubre 2012



CSN-CIEMAT-ENSA are open to suggestions, contributions, collaborations, …

CONSEJO DE SEGURIDAD NUCLEAR

CEIDEN



STATUS REPORT ON ZORITA NPP CONCRETE AGEING PROJECT

WGIAGE Concrete sub-group and WGIAGE meetings

OECD Headquarters
Paris, 8-12 April 2013

José Román Martín & Carlos Castelao
(CSN, Spain)

CSN CONSEJO DE SEGURIDAD NUCLEAR

CONTENTS

CEIDEN

1.- BACKGROUND

- Zorita NPP consists of a PWR reactor, 1 loop, W design. 160 Mwe output.
- It was commissioned in 1968, and it operated until 2006.
- On february 2010, ENRESA took the responsibility for decommissioning the station.

José Cabrera NPP (Zorita)

1.- BACKGROUND (cont.)

- The Consejo de Seguridad Nuclear (CSN), Spanish regulator, is aware of the need of more research on the area of effects of high radiation (neutron+gamma) and temperature on concrete structures.

- Zorita's concrete structures could be of great value for this purpose, folllowing the steps of the ZIRP project about reactor vessel internals:

    - High neutron fluence in a commercial reactor

    - Synergy with the ZIRP project.

- CSN started in 2009 to meet with national organizations to check the feasibility of a project to obtain material from the Zorita concrete structures.

- In January 2010 the CEIDEN (Spanish Strategic Platform on Nuclear R&D) Working Group on Zorita Concrete was set up.

1.- BACKGROUND (cont.)

The project will be fund by the following partners:

- ENRESA (National Company of Nuclear Waste), in charge of the dismantling process of Zorita NPP
- ENDESA (utility)
- Gas Natural Fenosa (utility), licensee during operation of Zorita NPP
- IETCC (Instituto Eduardo Torroja de Ciencias de la Construcción), R&D lab.
- CSN (Consejo de Seguridad Nuclear, Spanish Regulator)

- IETCC is the lead laboratory and Gas Natural Fenosa provides technical support as licensee during operation.
- The project will be opened to other national or international organizations

CSN CONSEJO DE SEGURIDAD NUCLEAR

1.- BACKGROUND (cont.)

CEIDEN

Zorita NPP operating conditions:

- Inlet Coolant Temperature 282 ºC
- Core Average Temperature 293 ºC
- Core Exit Temperature 305 ºC
- Reactor Coolant System Pressure 140 kg/cm^2
- The plant was converted to up-flow 8 years before decommissioning
- 26,5 EFPY (Effective Full Power Years) of operation

CSN CONSEJO DE SEGURIDAD NUCLEAR

1.- BACKGROUND (cont.)

CEIDEN

Synergy with ZIRP (reactor vessel internals project)

- In ZIRP it was determine that the reactor vessel internals had an accumulated fluence of 58 dpa in some areas. No other commercial reactor has accumulated such fluence level, so far, at least under decommissioning stage.
- So, it is expected that some concrete areas surrounding the reactor vessel have also high values of neutron fluence and gamma radiation.
- This makes these structures of high value to perform tests to determine the irradiation effects.
- However, temperature is not so high, but enough to determine its effects on concrete properties.

2.- SCOPE

Steps followed:

- Bibliography review, GAP analysis, on the degradation of concrete structures on NPPs.

- As a consequence of the Gap Analysis, it was agreed that the effects of the following stressors on concrete will be studied:

  - High levels of neutron and gamma radiation

  - High temperature for long periods

  - Boric acid

  and

  - NDT on liner under concrete slab

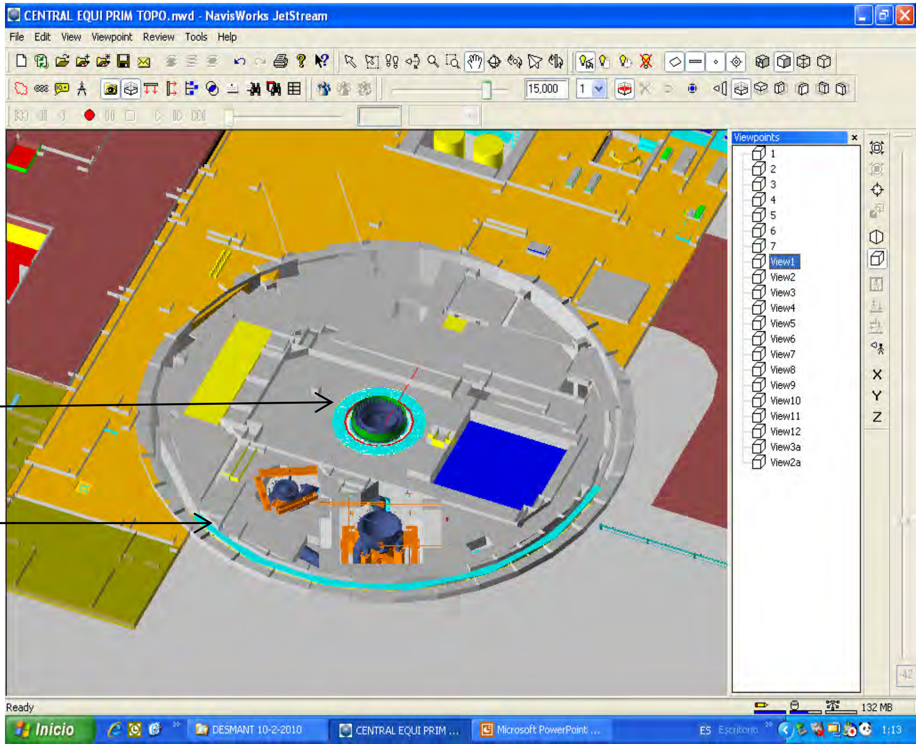
2.- SCOPE (cont.)

Structures to be considered:

- Biological shielding
- Spent fuel pool/transfer channel
- Containment building (as reference)
- Steel liner under concrete slab (NDT)

High-density concrete

Normal-density concrete



Biological shielding. Core samples

- The main purpose of the project is to test:
  - Areas of high irradiation
  - Areas of high temperature
  - Areas with a combination of high irradiation and temperature, if it is the case

- It is anticipated that these areas are:
  - Those of the biological shielding closer to the fuel elements (for irradiation), or
  - Those closer to the outcome branch of the reactor coolant system (for temperature),

  and have to be clearly identified.

- Some spare cores will also be drilled, to perform accelerated irradiation (EPRI's suggestion)

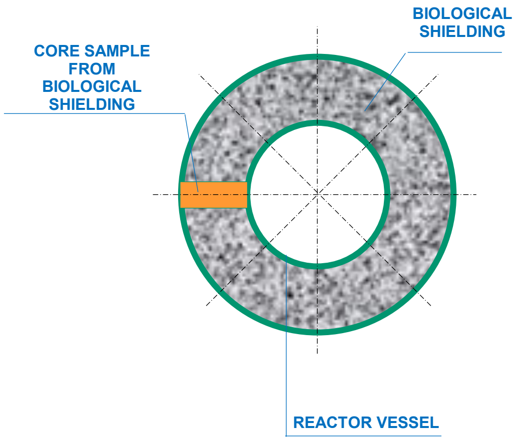
CSN CONSEJO DE SEGURIDAD NUCLEAR

2.- SCOPE (cont.)

CEIDEN

Biological shielding. Core samples (irradiation) identification:

- Symetry of the irradiation level around the fuel elements is 1/8
- This means that only 8 core samples with the maximum level of irradiation can be obtained
- For their identification, the same methodology of the ZIRP project will be used:



Neutron and Gamma sources calculation

➢ Compilation of 29 cicles of operation (38 Years – 26.36 EFPY):

Load patterns, cicle duration, power and burnup montly history, moderated high and low leaks configuration, upflow-downflow configuration of core bypass

2.- SCOPE (cont.)

Biological shielding. Core samples (irradiation) identification:

Neutron and Gamma sources calculation (cont.)

- Compilation of 594 fuel elements:

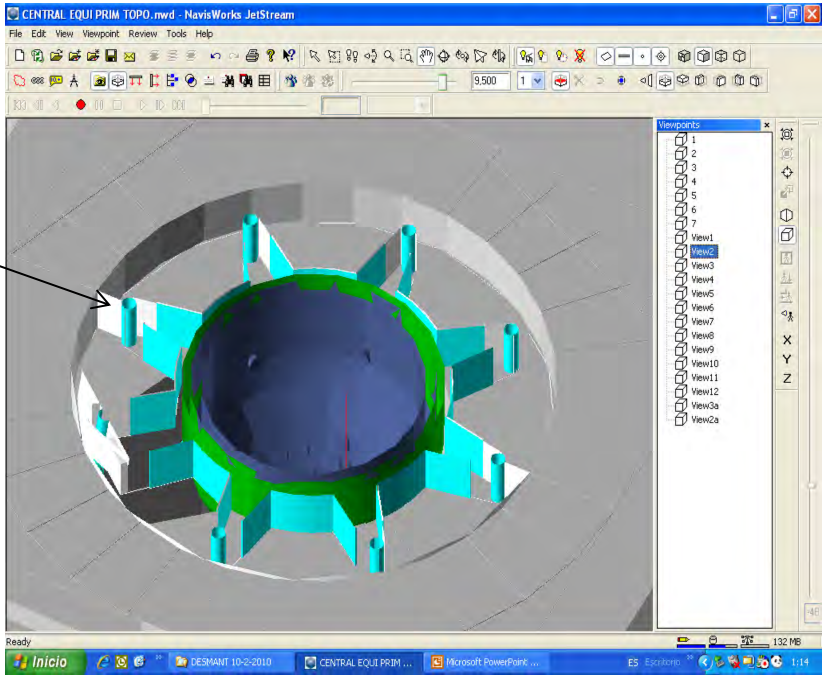
  Enrichment, operating cicles history, initial and final burnup for each operating cicle, HIPAR y LOLOPAR.fuel elements characteristics
- Reproduction of power and burnup history of 29 operating cicles. Representative state of each operating cicle
- Neutron sources (intensity and spectrum) of the 29 operating cicles
- Gamma sources (intensity and spectrum) of the 29 operating cicles
- Isotopic composition of fuel elements

▪ The output of these calculations will serve to identify the most irradiated areas of the biological shielding

Biological shielding. Core samples (irradiation) identification

- Also a rough estimation of fluence and gamma radiation will be obtained from the instrumentation wells and from operating experience.

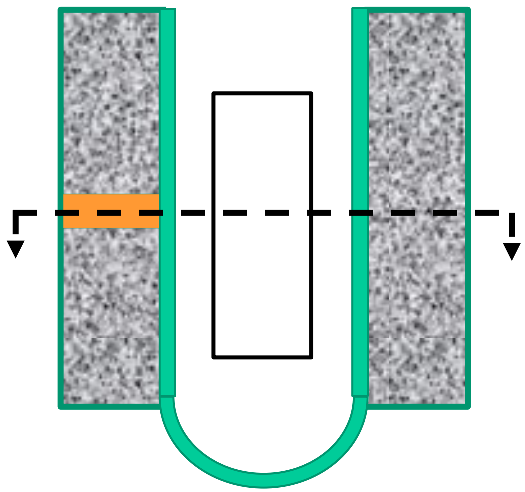
Instrumentation wells

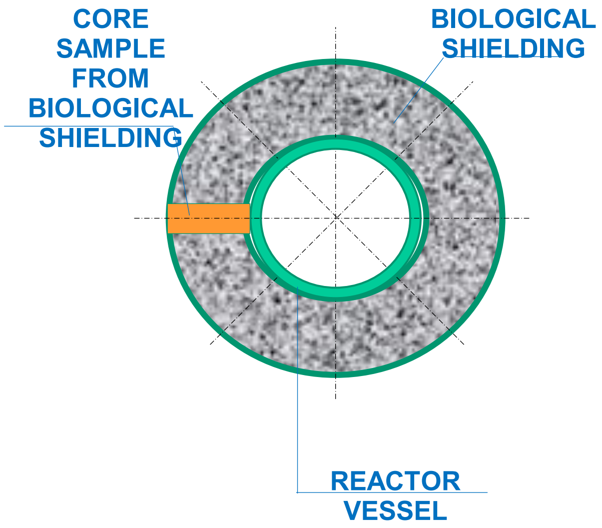


2.- SCOPE (cont.)

Biological shielding. Core samples (irradiation):

- The biological shielding will be drilled in-situ, in the identified locations, from reactor vessel side or from the opposite side, still to be decided

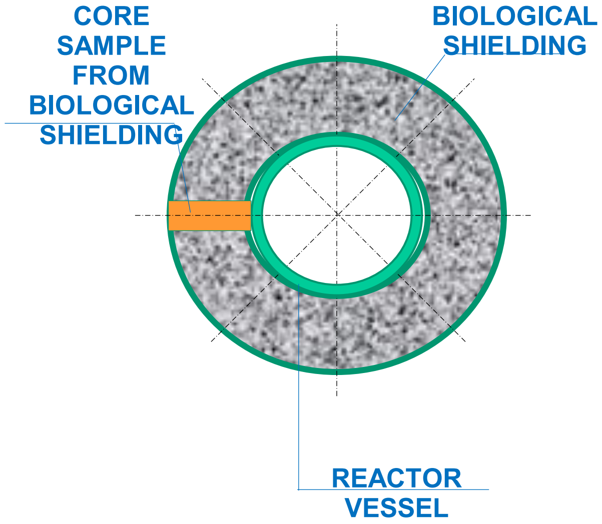


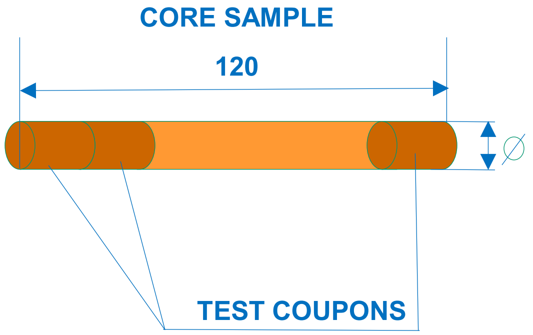


2.- SCOPE (cont.)

Test coupons (irradiation):

- From each core sample several test coupons will be obtained:
  - The closest to the reactor vessel
  - One from the opposite side
  - Some intermediate ones
- This approach will also allowed to determine the attenuation effects
- Dimensions of test coupons still to be decided





Biological shielding. Core samples (temperature):

- It is anticipated that these areas are those closer to the outcome branch of the reactor coolant system, in the biological shielding.
- This has to be confirmed through calculations, in the same way as for the irradiation, and through analysis of operating experience.
- The extraction process will be the same as for the previous core samples.
- Test coupons will be prepared from the core samples, as already explained.

Biological shielding. Core samples (irradiation+temperature)

- With the previous data on irradiation and temperature, decision will be taken on whether to drilled or not some other core samples with the "most representative" combination of both parameters.

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2.- SCOPE (cont.)

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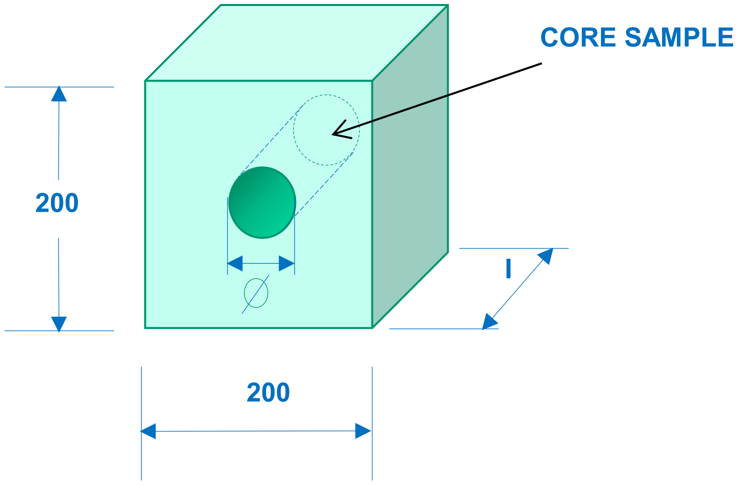
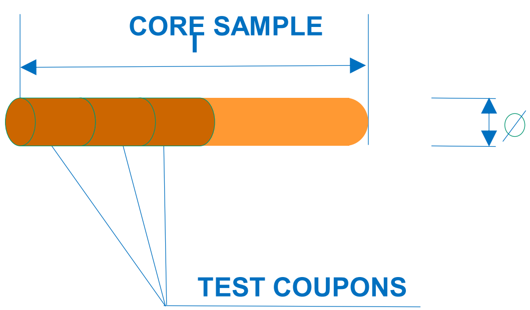
Spent fuel pool/transfer channel. Core samples (boric acid):

- The core samples of the spent fuel pool/transfer channel will be identified through analysis of operating experience:
    - Boric acid leaks during operation or refuelling outages
- Blocks of 2x2 meters will be cut
- As in the previous stage, core samples will be drilled from the blocks and from these cores tests coupons will be cut.





2.- SCOPE (cont.)

Containment. Core samples (reference):

- Some coupons will also be drilled from the containment, at different locations and heights, from the internal and external sides
- The results of these tests will be used as reference

NDT on liner under concrete slab

- Within the scope of the project it is also included the performance of NDT in some areas of the liner.
- IETCC will apply a specific technique to analyse the state of the liner in the selected areas.
- Destructive analysis of these areas will be then performed in order to verify the results obtained.

2.- SCOPE (cont.)

<u>What is not included?</u>

- The performance of any NDTs on thick concrete structures with the aim of their validation

CEIDEN is however open to any suggestion on this issue, as these structures could be very useful to validate NDT techniques.

3.- ON-GOING ACTIVITIES

Taking into account that it is expected that cores will be removed in year 2015, the following information is being collected:

- Drawings
- Concrete specifications (high and normal density),
- Operating experience, including Integrated Leak Rate Tests (ILRTs) performed
- Early tests on concrete, and
- Any other information that can be located.

- Also, chemical analysis on samples taking from some areas will be performed in order to characterize the concrete

Testing

- Test coupons coming from the biological shielding, the spent fuel pool/transfer channel and containment will be tested in IETCC research lab or in ENRESAS's facilities, in case they are contaminated.
- The envisaged tests to be carried out are those that the international community has already identified as neccesary to determine the temperature and radiation damage in concrete structures.
- This tests will include:
  - Mechanical
  - Microestructural
  - Others, still to be defined
- Two sets of tests have also been defined for characterization of concrete and liner corrosion

5.- STEPS TO FOLLOW

CEIDEN considers that after collecting the information of interest, at least the following protocols/procedures should be prepared and approved during year 2013:

- Fluence calculations (same methodology as in ZIRP)
- Temperature calculations (same as in ZIRP+operating experience)
- Identification of the exact locations of cores to be removed (synergy with ZIRP)
- Removal of cores
- Labelling of cores
- Storage
- Shipping to testing facility
- Testing performance
- Quality Assurance system of each organization will be followed

Deliverables. Reporting

- IETCC R&D lab will be in charge of compile, analyse and perform all neccesary work in order to draw conclusions on the effects of irradiation and temperature on concrete structures.
- Open literature will be taking into account.

7.- COLLABORATIVE PROJECT

Collaborative project

- The Spanish partners in this project wish to open it to other potential participants, at national and international level, once the agreement of the actual partners is in place.
- EPRI has already be in touch with the working group and will be contacted once the Spanish agreement be signed.
- NEA countries have also been informed through the Spanish delegate on the Subgroup on Concrete of the IAGE/CSNI working group.

8.- COMMITTEEs

Technical Committee (TC) members:

- Carmen Andrade (Chairperson), IETCC
- José Román Martín (Secretary), CSN
- Manuel Ordoñez, ENRESA
- Eduardo Serra, ENDESA
- Pedro Ortega, Gas Natural Fenosa
- Eduardo Más, CSN
- Carlos Castelao, CSN

Gas Natural Fenosa Engineering is supporting the TC work in recovering data and documentation from Zorita NPP.

- A Steering Committee with a representative from each participating organization is also in place.

Thanks for your attention

Developments in The Netherlands

OECD- NEA
WGIAGE main group;
9-12 April 2013

Wouter van Lonkhuyzen

Department of Nuclear Safety, Security and Safeguards (KFD)

Contents

Developments in Regulatory Framework (1/2)

- Safety requirements for new nuclear installations are developed
  - Initiatives for a new nuclear power plant are cancelled
  - Plans for building new research reactor (about 50 MW)
- Framework is aimed at nuclear power plants as well as research reactors (graded approach)
- Framework is aimed at new builds. Discussion on how to apply for existing installations is ongoing.
- Developments at IAEA and WENRA are followed and incorporated

Developments in Regulatory Framework (2/2)

<u>Beyond design</u>

- New builds:
  - New regulatory framework is aimed at new builds.
  - WENRA safety objectives are taken into account; e.g. extension safety demonstration, multiple failure conditions

- Existing power plants:
  - Discussion on how to apply new regulatory framework on new builds.
  - The Netherlands participates in the WENRA working groups in which reference levels for beyond design at existing power plants are formulated

Lessons Learned Fukushima

- As result of the stresstest at Borsele NPP a list of measures was compiled (for period 2012-2016), e.g.:
  - Seismic Margin Assessment
  - Study on seismic qualification fire fighting system and containment venting system
  - Study on airplane crashes
- The impacts of the closure of the German NPP's will be examined
  - KWU PWR NPP in The Netherlands
  - Use of knowledge
- Contacts with Switzerland and Spain because of same type of reactors
- National Action Plan update (ENSREG)

Margins in Seismic Analysis

Seismic Margin Assessment (SMA) NPP Borssele as result of Stress test and as part of periodic safety evaluation:

- Seismic hazard re-evaluation
- Plant walkdown

The analysis will be completed at the end of 2013. Measures will determined afterwards.

Human Environment and Transport Inspectorate
Ministry of Infrastructure and the Environment

Supervision on LTO and License Renewal Activities in The Netherlands

Dr. Lutz Lindhorst

Nuclear Safety Department (KFD)

The Netherlands

April 11, 2013

36th WGIAGE Main Group meeting

OECD, Paris

Nuclear Installations in The Netherlands

NPP KCB (EPZ)

CFPP CCB (EPZ)

source: ad.nl

source: milieuloket.nl

NPP Borssele (KCB): Background and History (not comprehensive)

- Siemens/KWU-type PWR, operated by EPZ

- 2 Loop, 449 MWel (485 MWel in 2006)

-1969 – 1973: construction

- 1973: first criticality

- "design assumption": 32 "Vollastjahre" (40 calendar years)

- (backfitting measures comp. to other Siemens/KWU-NPP)

- ***1994: government and parliament decided to close down the plant as of end of 2003***

- legal actions by (owners and) employees were taken in 2000

- court decision in 2002 ("Raad van State"): **operating term is confirmed as permanent**

- changes of government policy (around 2002) e.g. due to CO_2-goals (Kyoto)

→ ***government decided in 2006 that KCB may remain operational until end of 2033***

Borssele Covenant (June 2006) and LTO-project

- covenant = agreement between government and shareholders (Essent, DELTA)
- KCB may remain operational until end of 2033 **(60 years) under conditions, such as:**
  - stop of exploitation and start of decommissioning in end 2033
  - DELTA and Essent invest 250 Mio. EUR in fonds for renewable energy
  - EPZ has to show that KCB is within the 25% most safest (comparable, operational) NPP in EU, US and Canada → international benchmark commission
- revalidation of safety analyses (+analyses for SSC's with importance to safety)
- non-technical aspects of ageing, SALTO-mission, active components have to be addressed
- SAR has to be renewed <u>(that has an impact on the license !)</u>
- application for LTO-license was filed by licensee on September 12, 2012
- preliminary LTO-license granted on October 3, 2012 by the Ministry of Economic Affairs
- ***final LTO-license granted on March 18, 2013 by the Ministry of Economic Affairs***

Overview LTO-procedure licensee

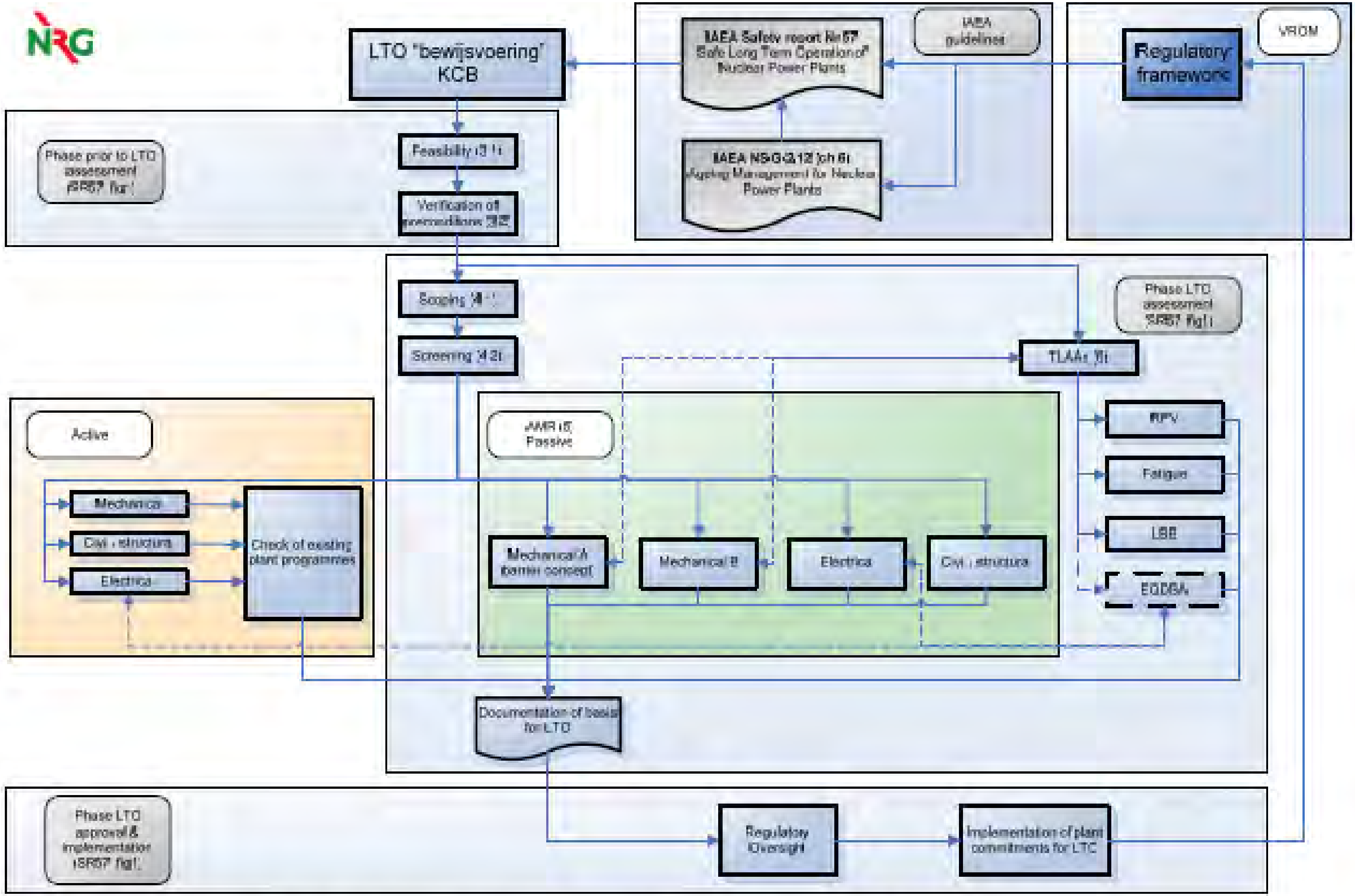


Figure 2 Overview of LTO "bewijsvoering" project (numbers as in SR57 [1])

source: NRG

Requirements from the final LTO-license (03-18-13) (examples)

“AMR” findings by authorities, supported by GRS and SALTO:

Ministerie van Economische Zaken

> Retouradres Postbus 20401 2500 EK Den Haag

N.V. Elektriciteits-Productiemaatschappij Zuid-Nederland EPZ
Postbus 130
4380 AC VLISSINGEN

Directoraat-generaal Energie, Telecom & Mededinging
Programmadirectie Nucleaire Installaties en Veiligheid

Bezoekadres
Bezuidenhoutseweg 73
2594 AC Den Haag

Postadres
Postbus 20401
2500 EK Den Haag

Factuuradres
Postbus 16180
2500 BD Den Haag

Overheidsidentificatienr
00000001003214369000

T 070 379 8911 (algemeen)
www.rijksoverheid.nl/ez

Ons kenmerk
DGETM-PDNIV / 13018780

Datum 18 maart 2013
Betreft Wijziging Kernenergiewetvergunning

Besluit

WIJZIGING VAN DE KERNENERGIEWET-VERGUNNING VERLEEND AAN DE N.V. ELEKTRICITEITS- PRODUKTIEMAATSCHAPPIJ ZUID-NEDERLAND (NV EPZ) TEN BEHOEVE VAN VERLENGING VAN DE ONTWERPBEDRIJFSDUUR KERNCENTRALE BORSSELE (Long Term Operation)

Verleend door:

DE MINISTER VAN ECONOMISCHE ZAKEN

- update Ageing Management (implementation plan n.l.t. 07-01-13)
- extra ISI (ASME vs. KTA) → 29 extra ISI
- repetition of UT–check on base metal of RPV rings (“Doel-3”)
- 2 new sets of irradiation specimens (RPV embritllement)
- FAMOS / load case catalogues (“Lastfallkatalog”)
- 5+3 locations (F/EF): finalizing of ageing calculations resp. add. measures/replacement
- implement findings of SALTO-mission (2012)
- overlap with ongoing 3rd Periodic Safety Review, e.g. safety factor 10 and 12 regarding non-technical aspects of ageing (organization, procedures, administration, personnel)
- renewal of SAR
- LBB, electronical equipment, active components
- implement lessons learned Fukushima / European Stresstest results
- international benchmark commission (first report in mid 2013 expected)

Useful links

Application, review by authorities and GRS, preliminary license, appeal procedure, final license can be found here:

http://www.rijksoverheid.nl/documenten-en-publicaties/vergunningen/2012/10/24/inspraak-verlenging-bedrijfsduur-kerncentrale-borssele.html

Special attention should be given to:

- conceptual document licensee:
  http://www.government.nl/documents-and-publications/reports/2012/09/09/conceptual-document-lto-bewijsvoering-kcb.html

- methodology report Ageing Management Review:
  http://www.government.nl/documents-and-publications/reports/2011/08/11/ageing-management-review-methodology-report.html

- LTO demonstration of fatigue TLAAs:
  http://www.government.nl/documents-and-publications/reports/2012/05/30/lto-demonstration-of-fatigue-tlaas.html

Useful links (continued)

- LBB reassessment:

  http://www.government.nl/documents-and-publications/reports/2009/11/26/review-time-dependency-break-preclusion-for-borssele-npp-to-2034-ref-9.html

- appeal procedure:

  http://www.rijksoverheid.nl/documenten-en-publicaties/publicaties/2013/03/20/zienswijzen-inspraak-verlenging-ontwerpbedrijfsduur-kerncentrale-borssele.html

- final license:

  http://www.rijksoverheid.nl/documenten-en-publicaties/vergunningen/2013/03/18/definitieve-beschikking-verlenging-ontwerpbedrijfsduur-kerncentrale-borssele.html