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# MDEP Conference on New Reactor Design Activities

Multinational Design Evaluation Programme (MDEP) Conference Proceedings

Paris, France
10-11 September 2009

AEN NEA

NUCLEAR ENERGY AGENCY

**Nuclear Regulation**

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## Conference Proceedings
## Paris, France
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NUCLEAR ENERGY AGENCY
Organisation for Economic Co-Operation and Development

## ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of 33 democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Commission takes part in the work of the OECD.

OECD Publishing disseminates widely the results of the Organisation's statistics gathering and research on economic, social and environmental issues, as well as the conventions, guidelines and standards agreed by its members.



## NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1st February 1958 under the name of the OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full member. NEA membership today consists of 28 OECD member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, Norway, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Commission also takes part in the work of the Agency.

The mission of the NEA is:

- to assist its member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information.

The NEA Data Bank provides nuclear data and computer program services for participating countries. In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

## Foreword

The MDEP is a unique ten-nation initiative being undertaken by national regulatory authorities from Canada, China, Finland, France, Japan, Republic of Korea, the Russian Federation, South Africa, the United Kingdom, and the United States with the purposes of co-operating on safety design reviews of new reactors and indentifying opportunities to harmonise and converge on safety licensing review practices and requirements. The OECD Nuclear Energy Agency has been chosen to provide the technical secretariat support. The International Atomic Energy Agency participates in many of the MDEP activities.

Started in 2007 with co-operation on various pilot project issues, the MDEP's expected outcomes are: (1) improved effectiveness and efficiency of regulatory safety design reviews, (2) increased quality of safety assessments, and (3) and identified areas for the convergence of regulatory requirements and practices. Making each regulator stronger in its ability to make sovereign safety decisions is a key objective that cuts across all MDEP activities.

In 2008, the top regulators from each national authority met as the MDEP Policy Group and adopted the present structure and programme of work for the MDEP, including the pursuit of co-operation on specific safety design reviews and pursuing closer co-ordination on harmonisation and convergence issues such as digital instrumentation and control, mechanical codes and standards, and vendor inspections. The MDEP is currently a long-term programme that focuses in near term and interim results to share within MDEP and with other stakeholders.

With effective communications in mind, the MDEP Policy Group directed the NEA to co-ordinate the Conference on New Reactor Design Activities with the purpose of communicating to a wide spectrum of stakeholders worldwide as to the program of work and accomplishments of the MDEP, and soliciting feedback and input from these stakeholders regarding recommendations on how to co-operate more efficiently on new reactor design reviews and to encourage standardisation and harmonisation on regulatory requirements and practices. Another key aspect of this Conference was to allow the various industry stakeholders to share their activities on new reactor designs and standardisation efforts. These stakeholders included non-MDEP regulators, vendors, licensees, reactor applicants, industry organisations, standards development organisations, etc. The Conference was held on 10–11 September 2009 at OECD Headquarters in Paris. These Conference Proceedings contain the details of the various sessions and the topics discussed as well as specific presentations given by panel members

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* See Appendix A for additional contributions.

∗ See Appendix A for additional contributions.

∗ See Appendix A for additional contributions.

## Session 1

## Welcome and opening

## Session 1 summary

Mr. Luis Echávarri, Director-General of the Organisation for Economic Co-operation and Development's (OECD) Nuclear Energy Agency (NEA), opened the first Multinational Design Evaluation Programme (MDEP) Conference on New Reactor Design Activities by welcoming all attendees to the OECD Headquarters in Paris. Over 170 guests representing 23 countries and 11 international organisations attended the Conference. Mr. Echavarri stressed the important role that regulators play in ensuring the safety of new nuclear operating plants.

Mr. Andre-Claude Lacoste, President of the French nuclear safety authority and Chair of MDEP's Policy Group, also welcomed the attendees and provided information about MDEP stating that the purpose of the Programme is to increase the effectiveness and efficiency of new reactor design safety reviews, to make these reviews more safety-focused, and to encourage harmonisation and convergence of regulatory requirements and practices. He further detailed the work of each of the issue and design-specific working groups. Mr. Lacoste highlighted that the goal of this Conference was to share information about MDEP activities and achievements with important stakeholders and to solicit feedback from them.

This session concluded with brief remarks by MDEP Policy Group members from Canada, China, Finland, France, Japan, the Russian Federation, South Africa, the UK and the US.

**Welcome and introductory remarks**

*Luis Echávarri*
Director-General, OECD Nuclear Energy Agency

Good morning everyone. I would like to welcome you in the name of the OECD Nuclear Energy Agency (NEA) to the first Multinational Design Evaluation Programme (MDEP) Conference on New Reactor Design Activities and to the OECDs Headquarters. At this event, at which there are more than 170 attendees representing 23 countries and 10 international organisations, we will be discussing between regulatory authorities and the industry, the joint efforts of regulators from various countries to ensure that the new reactor designs, so important for the future of nuclear power, are safe, secure, and environmentally friendly.

I would like to commend you for taking time out of your very busy schedules to discuss the ongoing activities and accomplishments of the MDEP and the international initiatives that the industry and other stakeholders are undertaking to increase the focus on safety in new reactor designs. I would like to welcome and thank Mr. André-Claude Lacoste, President of the French Nuclear Safety Authority and Chairman of the MDEP Policy Group, for his efforts on this important multinational initiative. He has provided excellent guidance and forethought to the MDEP organisation by bringing his expertise to the table. hanks also to the Policy Group for placing its trust in the NEA who is proud of performing the technical secretariat duties for the MDEP, through its experienced staff and because of our well established communications lines with the other Committees and Programmes of the NEA, such as the Committee for Nuclear Regulatory Activities (CNRA), the Committee for the Safety of Nuclear Installations (CSNI), and the Generation IV International Forum (GIF). Co-ordination of MDEP efforts with these groups as well as with the IAEA that takes part in MDEP, other international groups, and industry representatives, is one of the most important goals of the MDEP. This Programme was initiated by the member countries to address near term needs to co-operate on new reactor designs and it is meant to complement the work that others are doing to ensure the safety of new nuclear power generating facilities through standardisation of designs and regulatory requirements and practices.

A number of you may be unfamiliar with the OECD and NEA so let me briefly explain their roles. The OECD brings together the governments of countries committed to democracy and the market economy from around the world. Under the OECD umbrella, the 30 member countries work together to support sustainable economic growth, to raise the living standards in their countries and to assist the economic development of other countries. The organisation provides a setting where governments compare policy experiences, seek answers to common problems, identify good practices and co-ordinate domestic and international policies. The topic, which is gathering us here today, fits very well with the aim of the Organisation.

The Nuclear Energy Agency, a member of the OECD family, has 28 of the 30 OECD members. Our mission, in line with the overall aim of the OECD, is to assist our member countries in maintaining and further developing through international co-operation, the scientific, technological and legal bases for a safe, environmentally friendly and economic use of nuclear energy for peaceful purposes. Our members include very advanced nuclear countries and represent 85% of the world's nuclear capacity. In addition, we have a well established and formal relationship with the Russian Federation. Last October, the NEA celebrated its 50$^{th}$ anniversary of providing quality service to its member countries in supporting the safe use of nuclear power. With the efforts that are ongoing now as part of the MDEP with respect to new reactors, nuclear power will be in a better position to remain a key part of the energy mix for many decades to come and, as such, the NEA looks forward to continuing its value-adding work in this field.

Speaking of the future, I hope that some of you are familiar with the Nuclear Energy Outlook (NEO) produced by the NEA in 2008 on the occasion of our 50th anniversary. The NEO addresses, among other things, how nuclear energy can play a pivotal role in minimising the negative consequences of the world's growing energy demand. The NEO is considered by many to be *the* reference for looking at the future of nuclear power around the world, as well as for analysing the challenges ahead and the role of governments to cope with these challenges. In addition to the English and French versions, a complete Japanese version was produced with the financial support of the Japanese government. The Executive Summary itself was issued in ten languages. We are hoping to update this document periodically to reflect the ever-evolving challenges for the future.

With regard to important challenges, the NEA is helping to address some of the most important societal issues facing the world today. One such issue is for example ensuring the safe supply of medical radioisotopes. With the assistance of the government of Canada and the French Nuclear Safety Authority, the NEA quickly organised a workshop to bring together some of the key players in the production, supply, and distribution chains of these important radioisotopes. The result was a fuller understanding of the challenges ahead and recommendations to try to ensure the continued availability of medical radioisotopes. I mention this issue because it emphasises the importance of the work we do. The NEA sees the work with MDEP to have very significant influence, to ensure that the construction and operation of NEW nuclear reactors is safe, secure, and environmentally friendly, and you all play an important part in this work.

It is also with the spirit of addressing new challenges that the NEA welcomes performing the technical secretariat functions for the MDEP. We were involved in the very initial discussions of this unique multinational initiative with the US Nuclear Regulatory Commission and the French nuclear safety authority in 2005 and we are happy to see that the Programme has been converted to a long term project that focuses on interim results so that we can facilitate the co-operation on new reactor design reviews, exploring opportunities to converge on regulatory requirements and practices, and co-ordinating vendor inspections.

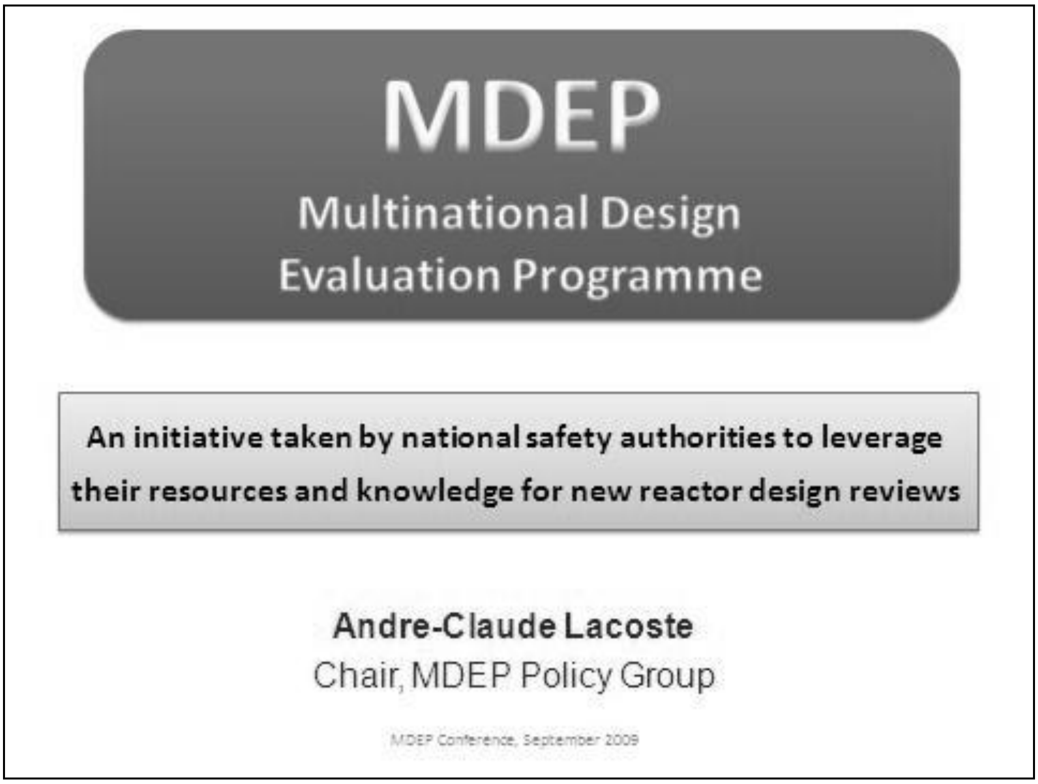
So, with such a lofty goal as helping to ensure the safety of the new reactor fleet worldwide, I encourage you to get the most out of this conference, to provide frank and constructive comments and let others benefit from your experience. Take a look at the subjects that we will be discussing in each of the six Sessions. Today we have the status of the work and accomplishments of the MDEP. As you will hear, this is a unique multinational initiative that looks to leverage the expertise of the involved regulators to co-operate on new reactor design reviews as well as to work towards harmonisation and standardisation of regulatory requirements and practices. We invite your perspectives on this programme and how we may be able to better achieve results. The conduct of this conference is a result of the MDEP Policy Group wanting to solicit input from industry stakeholders and to more fully communicate the work of MDEP to the entire spectrum of stakeholders. The work to date already includes input from industry standards development organisations such as IEC, AFCEN, ASME, JSME and KEPIC, and some vendors and licensees worldwide. Tomorrow, the industry will share with us the efforts that they are undertaking to encourage standardisation also. The benefits of standardisation and harmonisation in both reactor designs and regulatory requirements and practices will allow all stakeholders (whether they be vendors, licensees, or regulators) to focus their limited resources on those issues that are the most safety significant. You will certainly hear more about that throughout the next two days.

To wrap up, I would again like to thank you for attending this event and I look forward to productive interactions with and among you. Thank you again to the MDEP Policy Group members who are here today; it is with your dedication and devotion to this initiative and that of your staff that will undoubtedly ensure its success. And as a final note, the NEA staff is here to assist you in any way possible. If you have a need, they are here to help. You can spot the NEA staff by their OECD badges. Again, welcome and please enjoy the NEA/MDEP Conference on New Reactor Design Activities.

It is now my pleasure to introduce the the MDEP Policy Group Chair, Mr. André-Claude Lacoste.

**Introductory remarks and overview of MDEP**

*André-Claude Lacoste, Chairman, ASN*
*MDEP Policy Group (PG) Chair*



## Membership

- **Current members:** Canada, China, Finland, France, Japan, Korea, Russian Federation, South Africa, the United Kingdom and the United States.
- **The IAEA takes part in the work of MDEP**



## Expected Outcomes

**Setting up an enhanced co-operation among regulators :**

- To improve the effectiveness and efficiency of regulatory design reviews
- To raise the safety assessment quality and the safety level
- To facilitate convergence of regulatory requirements


Background
• Initially proposed in 2005
• A one-year pilot project conducted in 2006 - 2007 to assess the feasibility of the programme
→ Focused on Severe Accidents, Digital Instrumentation and Controls and Emergency Core Cooling Systems
• Initial two-year programme approved in 2007
• Specific recommendations and structure identified and approved in 2008
• Converted into long-term programme in 2009
MDEP Conference, September 2009
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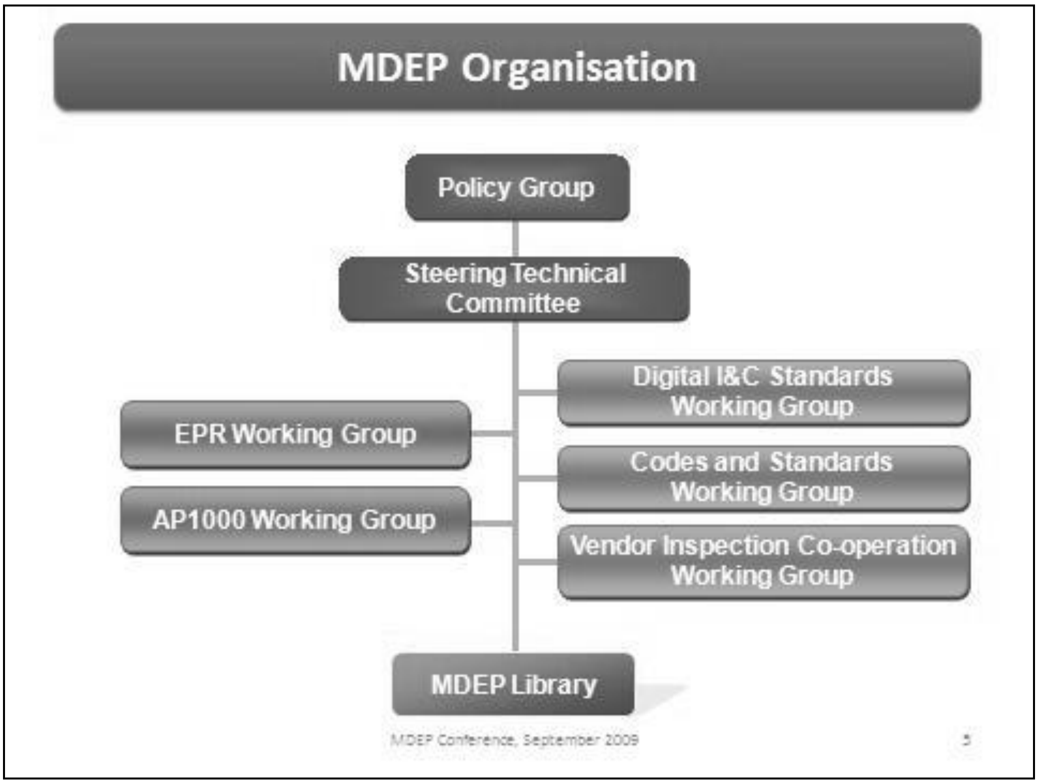
MDEP Organisation
Policy Group
Steering Technical Committee
Digital I&C Standards Working Group
EPR Working Group
Codes and Standards Working Group
AP1000 Working Group
Vendor Inspection Co-operation Working Group
MDEP Library
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## Vendor Inspection Co-operation Working Group

Goal : to benefit from other regulators' inspections of vendors to support new reactor reviews, vendor inspections and manufacturing oversight

**Comparison of regulator practices**

- Quality Assurance Requirements Comparison Table ongoing

**Several trial joint inspections carried out in 2007 and 2008**

- Sharing of vendor inspections results
- Production of a Joint Inspection Protocol Document

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## Codes & Standards Working Group

Goal: to achieve convergence of regulatory requirements and practices related to nuclear component design

**Identification of similarities and differences among codes and standards**

- Work with standard development organisations to compare pressure vessel codes
- Understanding the technical and regulatory basis for differences identified

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## Digital Instrumentation and Controls Working Group

**Goal: to achieve convergence of regulatory requirements and practices related to digital I&C standards for reactor safety systems**

**Identification of main differences among codes and standards**

- Defense-in-depth and diversity
- Data communications

**Identification and proposition of convergence**

- Software common cause failure
- Software tools



## EPR Design Specific Working Group

**Goal: to share and co-operate on specific design evaluations and construction oversight**

**Members : Finland, France, US, UK, China and Canada**

**General exchange on project status, review and construction**

**Co-operation on design reviews :**

- Digital I & C
- Probabilistic Safety Assessment
- Containment and Accident Analysis
- Severe Accidents


AP1000 Design Specific Working Group
Goal: to share and cooperate on specific design evaluations and construction oversight
Members : China, US, UK, Canada (Observer)
General exchange on project status, review and construction
Co-operation on design reviews :
• Squib Valves
• Civil and Structural Engineering / Shield Building
• Control Rod Drive Mechanisms
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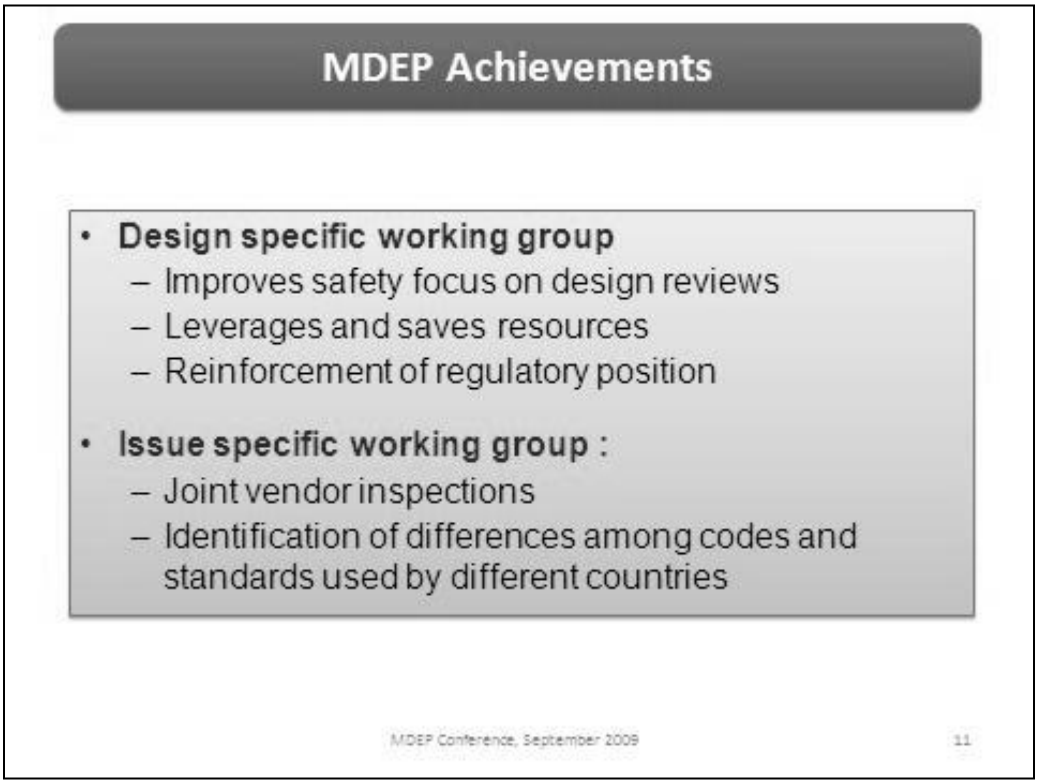
MDEP Achievements
• Design specific working group
– Improves safety focus on design reviews
– Leverages and saves resources
– Reinforcement of regulatory position
• Issue specific working group :
– Joint vendor inspections
– Identification of differences among codes and standards used by different countries
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## Next steps

- Keep regulatory bodies, vendors and operators informed about MDEP activities, progress, and results;
- Developing an international vendor inspection programme;
- Recommendations to standards development organisations regarding possible convergence and harmonisation.

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## Personal Views and Expectations

1. MDEP is a key programme for new build activities
2. MDEP is a mid- and long-term programme, but short-term concrete results are necessary
3. To be efficient, MDEP needs to concentrate on a limited number of pertinent topics
4. Each working group needs to have an **action plan** :

   → Final and interim objectives, clear schedule and periodic reports
5. Convergence of regulatory practices will finally lead to convergence of regulatory requirements

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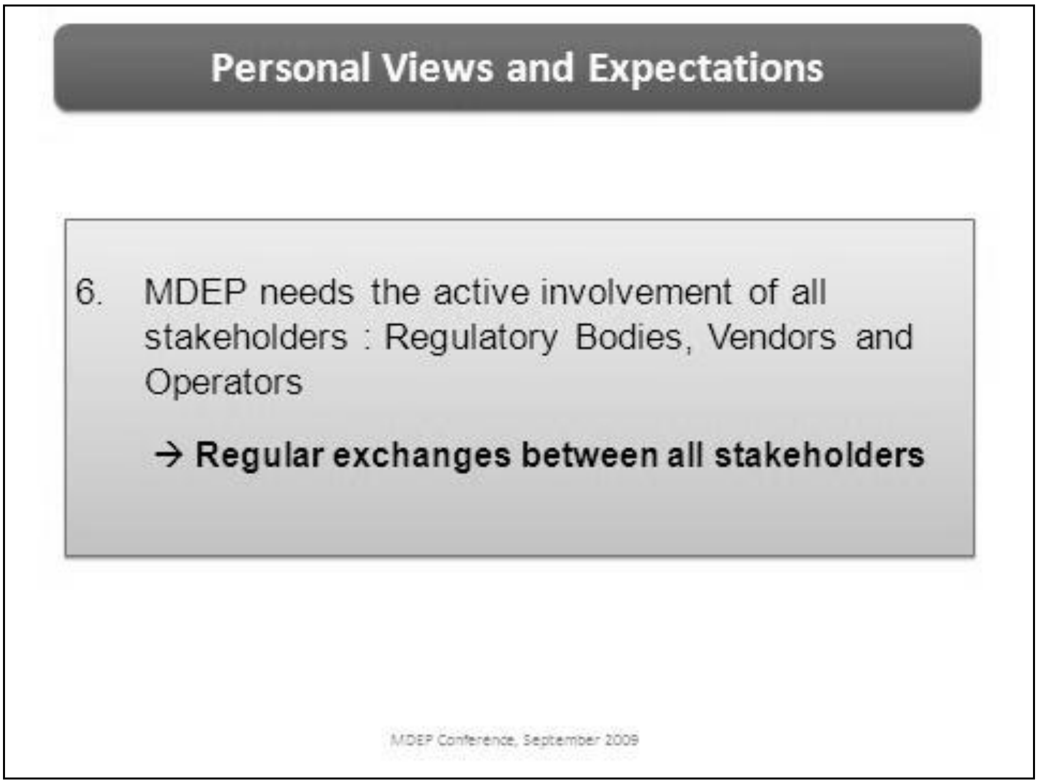
Personal Views and Expectations
6. MDEP needs the active involvement of all stakeholders : Regulatory Bodies, Vendors and Operators
→ Regular exchanges between all stakeholders
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## Session 2

## MDEP activities and accomplishments on design-specific working groups

## Session 2 summary

The following participants made remarks and/or gave presentations on the status of the design-specific working groups:

- Terry Jamieson, Canadian Nuclear Safety Council (CNSC), Vice-President, and Chair of Session 2, Part 1
- Petteri Tiippana, Finnish Radiation and Nuclear Safety Authority (STUK) and Chair of the EPRWG
- Eileen McKenna, US Nuclear Regulatory Commission (NRC) and Chair of the AP1000WG

The following participants took part in the panel session on design-specific activities:

- Jukka Laaksonen, STUK, Director-General, MDEP Policy Group Member, and Chair of the Session 2, Part 2, Panel
- Gary Holahan, NRC, Deputy Director of the Office of New Reactors and Chair of the MDEP Steering Technical Committee (STC)
- Guillaume Wack, French Nuclear Safety Authority (ASN), Director Nuclear Power Plants Department, and Member of the STC
- Francois Bouteille, AREVA, Senior Vice-President of Safety and Licensing and Licensing Manager for Olkiluoto 3 Project
- Ed Cummins, Westinghouse, Vice-President of Regulatory Affairs and Standardisation
- Juoni Silvennoinen, Teollisuuden Voima, Ltd. (TVO), Project Director for Olkiluoto 3
- Christopher Bakken, EDF Energy UK, Director of Nuclear New Build Operations, Safety and Licensing

After the presentations by the chairs of the EPR Working Group (EPRWG) and AP1000 Working Group (AP1000WG), the panel session was conducted to discuss the activities that are going on pursuant to MDEP's work on design-specific issues. Members of the panel included those from the regulators participating in MDEP as well as representatives from the companies who have designed and are licensing reactors in several MDEP countries. The panel chair, Jukka Laaksonen, provided brief introductory remarks and invited each panel member to say a few words about their views on MDEP design-specific activities. Each panel member discussed the role that their respective organisations are playing in the licensing and construction of new reactors around the world. Some common themes emerged in these comments and in the questions and answers that followed.

The industry representatives emphasised that they are embracing standardisation to address new reactor issues and they would hope and recommend that the regulators do also. Both Westinghouse and AREVA described their efforts in maintaining a standard design as much as possible to increase efficiency in the licensing, construction, and operation of new nuclear power plants worldwide. Some differences in designs may be driven by differing regulatory requirements or practices or perceptions of regulation requirements and practices by the licensees. AREVA cited differences in the Digital Instrumentation and Control (DI&C) design among the various EPRs due to differing levels of experience of use and safety review of DI&C systems in the different countries. Westinghouse noted that some of the regulators were not in complete alignment on the basis of the shield building especially in the area of designing and evaluating the civil structures to withstand a specific design basis threat.

The vendors and licensees stated that the emphasis on standardisation should help the safety focus of design reviews by leveraging resources. In addition, they expressed a desire for the regulator to take credit for thorough design reviews carried out in other countries by competent regulators, where the designs are the same. Moreover, they underscored the goal of regulators, which is to co-operate on vendor inspections and in doing so insure that a sufficient supply of safe components are available for the new reactor fleet.

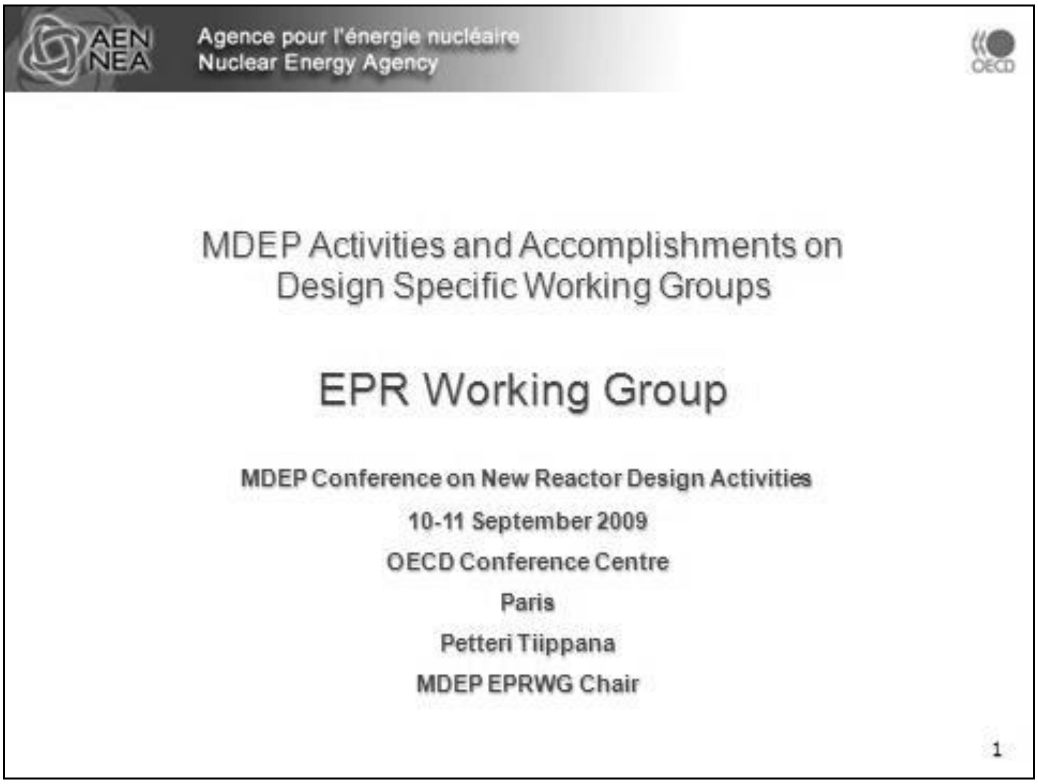
The MDEP representatives on the panel agreed that they do value standardisation for safety reasons and that as part of the design-specific working groups, the MDEP participants share documents and evaluations to help leverage resources and make licensing design reviews more safety focused. They noted that the Vendor Inspection Co-operation Working Group (VICWG) – an issue-specific MDEP working group – is addressing the issue of inspection of nuclear components and that VICWG work will be discussed in session 3.

Some of the vendor representatives encouraged closer interactions with the reactor designers to ensure sufficient and appropriate input to inform the safety reviews. Other representatives from international organisation stated that it would be helpful to stakeholders if MDEP could document where issues have been resolved in safety design reviews.

Comments from the audience were equally as important and included the following: the industry requested more interactions with reactor vendors to further discuss standardisation and safety; comments were made that it would be useful if MDEP regulators, involved in the design-specific working groups, could produce documents when design safety issues are resolved for a particular design; a non-MDEP regulator stated that documentation about design safety reviews could even be useful and applicable to reactors already in operation. In response to a question from the audience regarding MDEP's added value, the MDEP regulator representatives stated that co-operation on the design-specific topics was very useful to countries that have smaller regulatory staffs as these co-operative efforts helped to leverage vital and competent resources in performing the safety reviews.

**EPRWG**

*Petteri Tiippana, Chair, EPRWG, STUK*



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## General Objectives and Activities

**Objectives**

The Multinational Design Evaluation Program (MDEP) is a multinational initiative to develop innovative approaches to leverage the resources and knowledge of mature, experienced national regulatory authorities who will be tasked with the regulatory design review of new reactor plant designs.

**Activities:**

- Enhancing multilateral co-operation within existing regulatory framework.
- Increasing multinational convergence of codes, standards, and safety goals by establishing Reference Regulatory Practices
- Implementing MDEP products and regulatory practices to facilitate licensing reviews of new reactors, including those being developed by the Generation IV International Forum.

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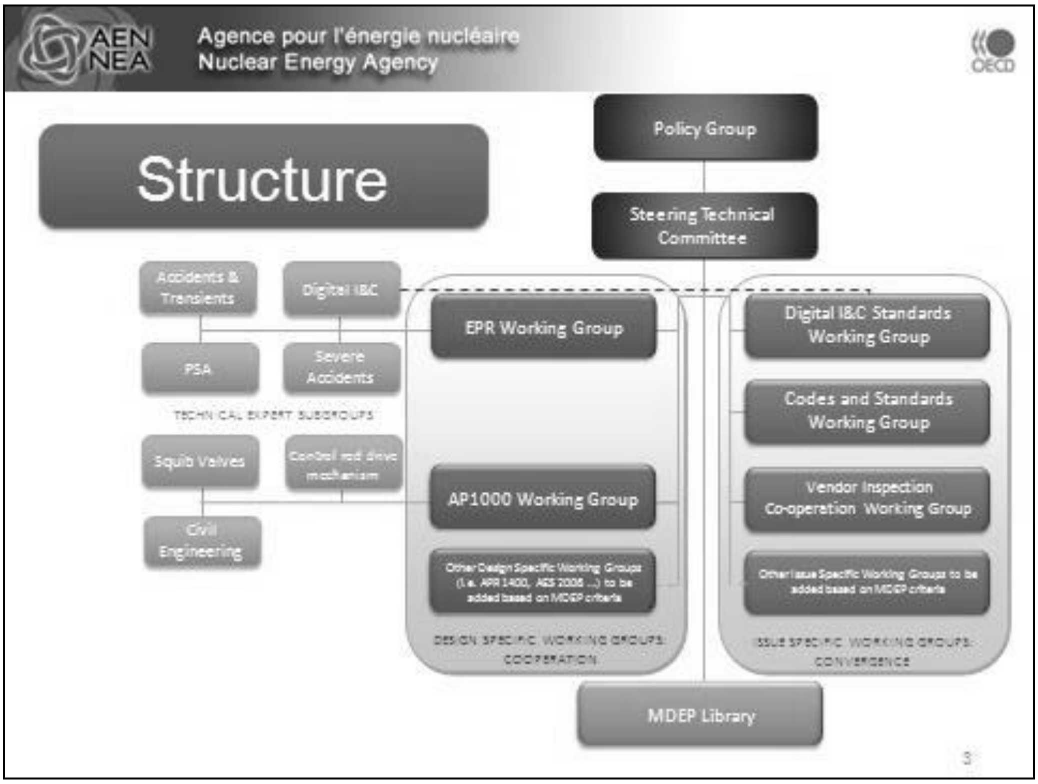

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## EPR Working Group - Goals

- Goal of the MDEP EPRWG is to share information and experience on design reviews and construction oversight in order to
  - leverage the technical evaluations completed by each of the participating regulators
  - leverage the resources and knowledge of the national regulatory authorities
  - develop consistency between regulators and/or to understand differences
  - develop joint assessment on specific subjects
- Make safety assessments more robust and increase the safety level of EPR

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## EPR Working Group - General

- Members of EPR WG are regulators from:
  - Canada,
  - China,
  - Finland (chair),
  - France (co-chair),
  - United Kingdom,
  - United States
- Countries where EPR is being licensed or constructed
- Group has been meeting regularly since early 2008


Source: Areva 1st half results presentation 31.8.2009

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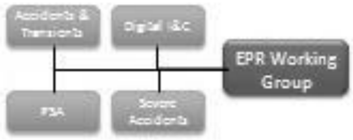
## EPR Working Group - Activities

- General meetings on the status of each EPR project
  - discussions on the status of design review, construction
  - goal to identify new items for in depth discussions in the group
- Specific task groups for
  - instrumentation and control
  - probabilistic risk assessment
  - accidents and transients
  - severe accidents
- Issue specific meetings, teleconferences/net meetings and email exchanges on specific topics

Source: TVO, Hannu Huovila

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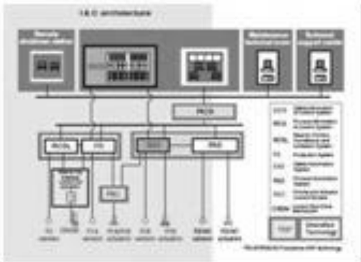
## EPR Working Group - Instrumentation and Control

- I&C architecture
  - defence levels - independence, diversification, separation
  - requirement specifications for the I&C
- Specific design topics
  - priority actuation modules, operating interfaces, "black boxes"
- Information Security
  - mechanisms and processes in the I&C design to ensure information security
- Software verification and validation
- Testing of the I&C



Source: Areva EPR Brochure March 2005

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## EPR Working Group - PSA

- PSA analyses and modeling
  - requirements,
  - main results and risk profiles - differences identified, causes studied
- Co-operation with other task groups
  - Insights from Level 2 reviews
  - Modeling of I&C
- Internal and External events
  - Layout and Fire protection
- Design difference between EPRs
  - causes for differences
  - risk significance and modeling

Source: Clipart

Source: Areva EPR Brochure March 2005

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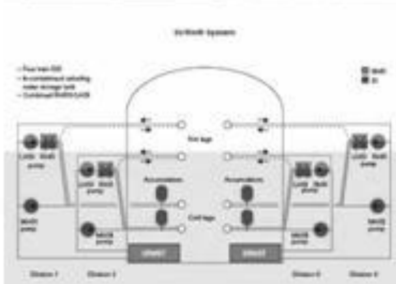
## EPR Working Group - Accidents and Transients

- Containment issues
  - long-term mass and energy release to containment
  - two room concept and mixing
  - leak tightness of containment
- Methodologies for accident and transient analyses
- LOCA issues
  - sump design and tests,
  - debris and downstream effects
  - NPSH for emergency core cooling systems
- Criticality safety
  - management of boron dilution
  - criticality control during outages



Source: Areva EPR Brochure March 2005

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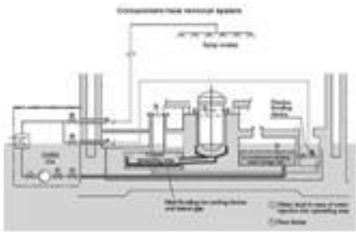
## EPR Working Group - Severe Accidents

- Hydrogen management in two room concept
  - several analyses made by different codes and models (independent from vendor's codes and models) - good compatibility, good reliability
- Cooling of the molten core
  - design of the cooling system
  - structure of the spreading area
- Severe accident instrumentation
  - Scope and qualification
- Operating strategies for severe accidents



Source: Areva EPR Brochure March 2005

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## EPR Working Group - Specific topics

- Discussed
  - Safety classification and related QA requirements
  - Fire protection requirements, analyses and design issues
- Need to be discussed
  - Radiation Protection
  - Grouted tendons
  - Operational safety issues
  - Human factors engineering

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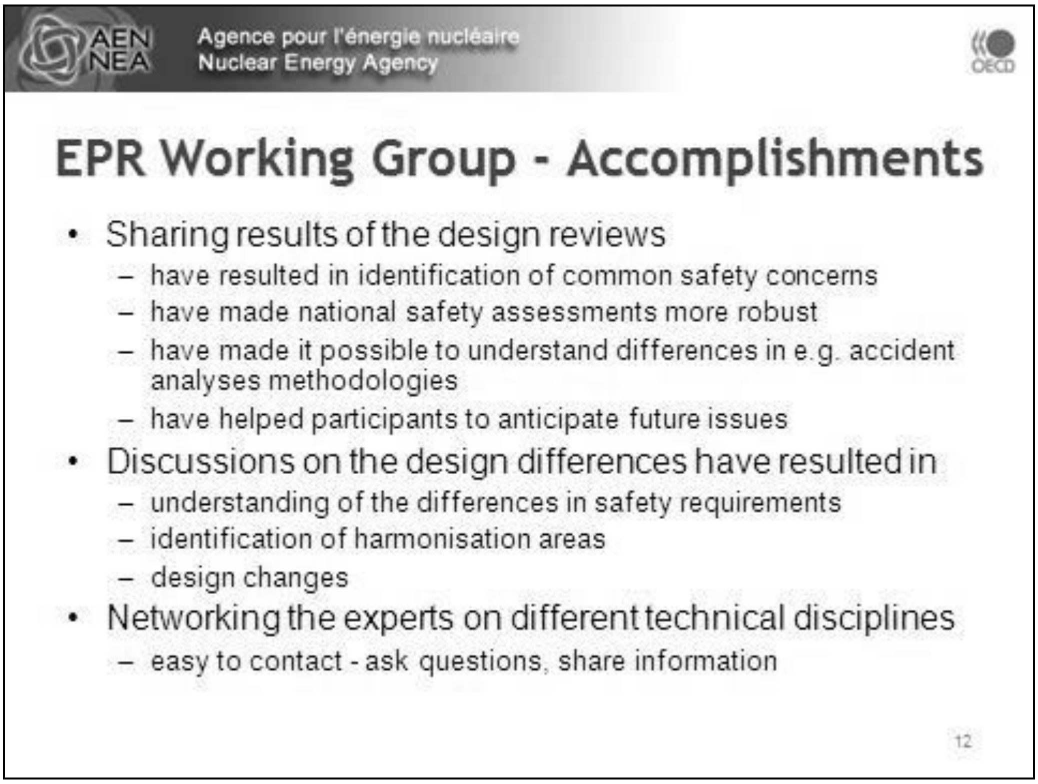
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EPR Working Group - Accomplishments
• Sharing results of the design reviews
– have resulted in identification of common safety concerns
– have made national safety assessments more robust
– have made it possible to understand differences in e.g. accident analyses methodologies
– have helped participants to anticipate future issues
• Discussions on the design differences have resulted in
– understanding of the differences in safety requirements
– identification of harmonisation areas
– design changes
• Networking the experts on different technical disciplines
– easy to contact - ask questions, share information
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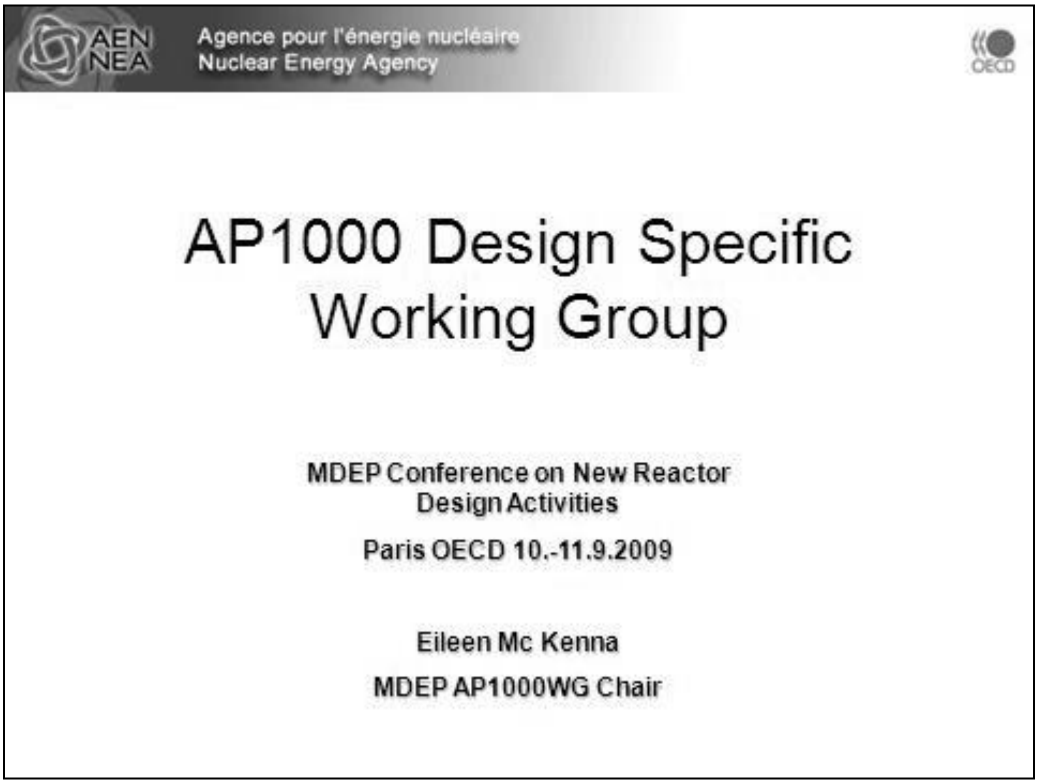
**AP1000WG**

*Eileen Mckenna, Chair, AP1000WG, US NRC*



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## First Meeting

- Initial meeting in February 2009 in China;
- Participants were Canada, China, United Kingdom, United States;
- Three subgroups proposed (civil engineering, squib valves, CRDMS);
- Plan for second meeting fall 2009.

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## Current Status

- Country representatives to each subgroup identified;
- US and UK representatives observed Westinghouse design review meeting on squib valve design/testing;
- Two subgroups will meet in September
- Tentative meeting of civil engineering subgroup later this year.

**Session 2 (cont.)**

**Design-specific activities panel**

*(Panel member contributions can be found in Appendix A on page 185.)*

## Session 3

## MDEP activities and accomplishments on issue-specific working groups

## Session 3 summary

The following participants made remarks and/or gave presentations on the status of the issue-specific working groups:

- Nicolay Kutin, Russian Federation Nuclear Safety Authority, Rostechnadzor, Chairman and MDEP Policy Group member and Chair of Session 3, Part 1
- Pascal Regnier, French Institute of Radiation and Nuclear Safety (IRSN), Instrumentation and Controls Expert and member of the DICWG
- Ahmed Ibrahim, CNSC, Engineering Design Assessment Division, and Chair of the CSWG
- Sébastien Limousin, ASN, Director, Nuclear Pressure Equipment Department, and Chair of the VICWG

The following participants took part in the panel session on issue-specific activities:

- Bill Borchardt, NRC, Executive Director for Operations
- Guy Clapisson, South African National Nuclear Regulator (NNR), Chief Executive Officer (acting) and PG and STC member
- Bryan Erler, American Society of Mechanical Engineers (ASME) Nuclear Codes and Standards, Vice-President
- Cécile Laugier, French Association for the Design, Construction, and Operating Supervision of the equipment for Electro-Nuclear boilers (AFCEN), President
- Tsuyoshi Nakamura, Japan Steel Works (JSW), General Manager
- Sang Jin Kim, Doosan Heavy Industries (DHI), Nuclear Power Plant Quality Control, Vice-President

After the presentations given by the chairs of the Digital Instrumentation and Control Working Group (DICWG), Codes and Standards Working Group (CSWG), and Vendor Inspection Co-operation Working Group (VICWG), the panel session was conducted to discuss the activities that are going on pursuant to MDEP work on issue-specific topics. Members of the panel included those from the regulators' participation in MDEP as well as representatives from mechanical codes Standards Development Organisations (SDOS such as ASME and AFCEN) and nuclear power plant component manufacturers (JSW and DHI). The panel chair, Bill Borchardt, provided brief introductory remarks and invited each panel member to say a few words about their views on MDEP issue-specific activities. Each panel member discussed the role that their respective organisations play in standards development and component manufacturing in support of licensing and constructing new reactors around the world. The ASME and AFCEN representatives gave a brief description of their organisations' role in the code comparison project, which the CSWG is dealing with. Some common themes emerged in these comments and in the questions and answers that followed. The representatives from the SDOs stressed the importance of close communication between industry, SDOs, and regulatory bodies regarding standardisation efforts and that harmonisation and standardisation must have a clear safety, economic, and business benefit to truly be feasible. The component manufacturers stressed that harmonisation of requirements, including the quality assurance criteria area as well as mechanical codes, would be very beneficial in manufacturing high quality and safe products for new reactors.

**Digital Instrumentation and Control**

*Mr. Regnier, Member of DICWG, IRSN*

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# Overview of DICWG

- Currently Active Members
  - Canada, Finland, France, Japan, Republic of Korea, Russian Federation, United Kingdom, and the United States
  - Chair: US
- Participation of representatives from
  - IAEA
  - IEC
  - IEEE
- NEA providing technical secretariat support

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3 MDEP Conference – September 2009

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# Key Objectives

- Evaluate the similarities and differences in standards and regulatory practices
- Develop common regulatory practices and move toward harmonization
- Influence convergence of standards
- Share knowledge and insights
- Increase regulatory cooperation
- Cooperate with design-specific working groups

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# Accomplishments

- Developed
  - Program plan
  - Communication plan
  - Problem-solving model
- Held four successful meetings
- Identified priority issues
- Developed and reviewed comparison of standards
- Engaged designers/vendors for input
- Engaged IEC and IEEE for participation
- Drafted letters to IEC and IEEE suggesting convergence
- Made a substantial progress in developing common regulatory positions
- Made MDEP library operational for the working group

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## Quick Inquiries

- A structured model to promote information sharing among DICWG members
- Efficient method for sharing of expert knowledge, regulatory documents, operating experience and lessons learned
- Members benefited

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## Common Regulatory Practices

- Under development
  - Software common cause failure (US)
  - Software tools (UK)
  - Software Verification and Validation (Japan)
- Planned
  - Complex Electronics (France)
  - Data Communications (Korea)
  - Common position on key principles for digital I&C Systems in Nuclear Power Plants (US)
  - ... (TBD)
- To promote convergence/harmonization of standards and regulatory practices

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## Challenges

- Differences in regulatory practices, standards, regulations, reactor designs, and experience
  - Takes time to understand each other
- Convergence of high-level topics
  - Classification schemes

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## Path Forward

- Continued timely sharing of information and cooperation among members
- Continued development of common regulatory practices
- Continued influence and promotion of convergence and harmonization of standards
- Continued engagement with stakeholders

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Long-Term Vision
• Common regulatory practices completed/updated for key digital I&C issues
– Lessons from design-specific working groups captured
– Endorsed by Steering Technical Committee
– Approved by the Policy Group
• Progress made toward harmonization/convergence of standards
• More efficient and effective safety decision making and licensing process for new reactor I&C design
• Increased stakeholder confidence
10
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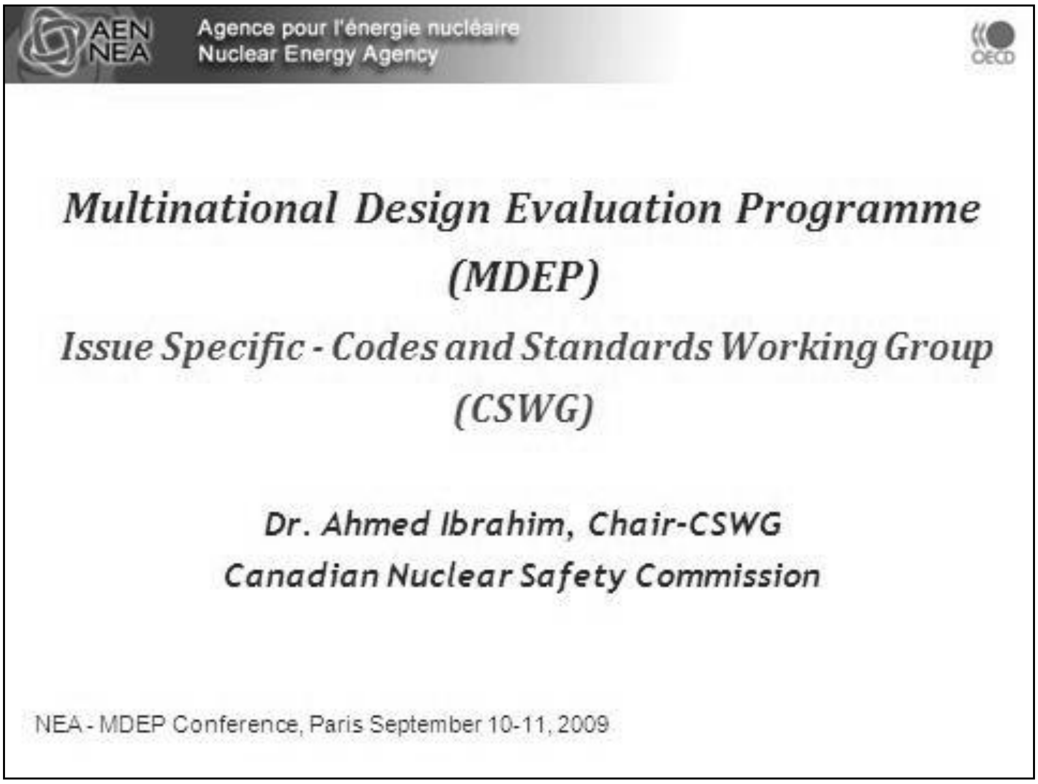
**Codes and Standards**

*Mr. Ibrahim, Chair, CSWG, CNSC*



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## *Contents*

- *Members of the Code and Standard Working Group (CSWG)*
- *CSWG: Work Scope, Schedule, and Code Effective Dates*
- *Codes Comparison Work Plan*
- *Status/Achievement of Codes Comparison*
- *Conclusion*

2

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## *Members of the CSWG*

- CSWG member states are: Canada, China, Finland, France, Japan, Korea, Russian Federation, South Africa, the United Kingdom and the United States.
- The OECD Nuclear Energy Agency (NEA) is the technical secretariat and IAEA takes part in the CSWG meetings.
- In addition, the Code Development Organizations (SDOs) are invited to attend the WG meetings.

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## Codes and Standards Working Group (CSWG) - 1

♦ **Scope**

- **The codes and standards to be used are the pressure boundary component design codes developed by: ASME (United States), AFCEN (France), JSME (Japan), KEA (Korea), CSA (Canada) and the Russian Norms and Rules (Russian Federation)**

- **The CSWG will:**

  - evaluate the code differences in component design codes used in member countries (based on inputs identified by the Standards Development Organizations - SDOs) & identify the most beneficial areas for convergence (or harmonization) of codes

  - examine potential paths for reconciliation of the code differences

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## Codes and Standards Working Group (CSWG) - 2

♦ ***Schedule***

| | |
|---|---|
| *- 2008:* | *Initial Code Comparison Work (Phase 1; Class 1 - Vessels)*<br>*SDOs presented their work progress on October 2008* |
| *- 2009/2010:* | *Continue comparison work / Identification of differences/ Examination of potential convergence/Harmonization & Initiate Phase 2 (Class 1 – piping, pumps, and valves)* |
| *- Beyond 2010:* | *The MDEP Program extended from a 2 yrs programme to a long-term programme that focuses on interim results. The 5- year planning period may be used* |

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## Codes and Standards Working Group (CSWG)-3

- **CODE Effective Dates**

**The specific pressure boundary codes and standards to be utilised in the comparisons by the SDOs are:**

- ASME B&PV Code, 2007;
- AFCEN RCC-M, 2007;
- JSME S NC I, 2008; and
- KEA KEPIC, 2007.

- Incorporation of the Russian Norms and Rules and the Canadian Codes comparisons will also be initiated as soon as feasible

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## Codes Comparison Work Plan - 1

- **SDOs Plan for 2008-2009/2010:**

**The SDOs started the comparison between the design codes by:**

- Developing of a spreadsheet to compare the requirements of the codes
- Evaluating significant differences in technical and administrative requirements – (Recently the SDOs decided not to perform this activity)
- Comparing other codes against ASME Code starting with Class 1 vessels, addressing: scope, classification, responsibilities, material, design, fabrication, examination, pressure testing, overpressure protection, and administrative requirements – Phase 1
- Start Phase 2 comparison work for class 1 piping, pumps and valves

## Codes Comparison Work Plan - 2

- CSWG Plan for 2008-2009:

**The WG will review the SDOs code comparison results and:**

- Provide an assessment of the identified differences (through correspondence and joint meetings between the CSWG and the SDOs).
  (Based on the recent SDOs decision not to evaluate the significance, the CSWG will discuss the impact on the schedule during the WG next meeting, November 2009)
- Documenting the findings, into a retrievable database (within the MDEP-Library)
- Providing recommendations for the most beneficial areas for convergence (harmonization) of codes and reconciliation of code differences

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## Codes Comparison Work Plan - 3

- CSWG Plan for 2009-2010:

**The specific actions to be completed based on the SDOs progress:**

- Further developing the code comparison table by the SDOs to include Class 1: piping, valves, and pumps; (It is expected to start before the end of 2009)
- Continuation of discussions on potential areas of code Harmonization
- Include the comparisons of the Russian Norms and rules and the Canadian Codes
- Developing of harmonization approach(*) for pressure boundary design codes
- Developing of a process to communicate and interact with the SDOs on their respective future new code requirements, to enhance harmonization

**The plan will be adjusted based on the results by end of 2009**

(*) Discussion on harmonization started during the CSWG July 2009 meeting

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## Status/Achievement of Codes Comparison

- **Status of Phase 1 Comparison, Class 1-Vessels, against ASME Code requirements, as of July 2009**

- Korea (KEPIC) Code

Korea completed Phase 1 of the Code-comparison activity, October 2008. The technical requirements of the KEPIC and the ASME Codes are identical

- Japan (JSME) Code

A comparison of the rules on material, design, fabrication, examination, testing, and over pressure protection of Class 1 Vessel in JSME and ASME codes is completed. Design and construction requirements are almost identical. Differences were identified

- France (RCCM) Code

The comparison between rules on design, material, fabrication, welding, NDE, hydro test, over pressure protection in RCCM and ASME was completed in the scope of Class 1 components. Differences were identified. (full comparison , August 26, 2009)

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## Conclusions

1. The result from the SDOs code comparison to-date showed differences exist in the Class 1 vessels design requirements
2. As such, code conversion is NOT Possible.
3. Harmonization of the technical requirements of design codes and standards is feasible.
4. Not all technical requirements can be harmonized.
5. Model for harmonization has been recently initiated by the CSWG, will be further discussed in next working group meetings.

**Vendor Inspection Co-operation**

*Sébastien Limousin, Chair, VICWG, ASN*

# Vendor Inspection Co-operation Working Group

Sébastien LIMOUSIN, Chairman

MDEP Conference

10 September 2009

## The working group

- Most nuclear safety authorities carry out inspections at vendor facilities (at their main offices or at manufacturing shops)
- So far these inspections have not been coordinated and have a different scope
    - Vendors are subject to multiple inspections and audits
    - Regulators are not using the results of inspections performed by others

## Content

- Presentation of the working group
- Program plan: a three step approach
- First step: achievements
- Second step: plans
- Conclusion

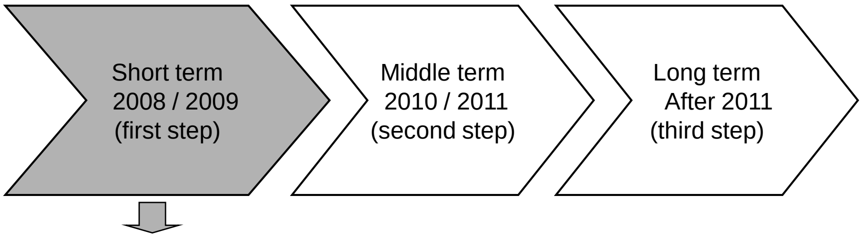
## The working group

- To address this issue, a working group was created in 2008.
- Long term objective: to establish a common framework and to organize multinational inspections
- 10 countries are participating
- Scope: so far limited to pressure boundary components but will be expanded

## Objective

- To reach the long term objective, a three step program plan has been established

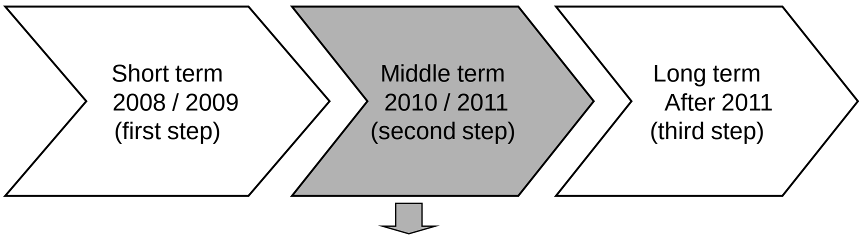
# Three step program




**First step : identifying commonality and differences in the regulatory practices**

- Witnessed inspections
- Surveys among MDEP regulators

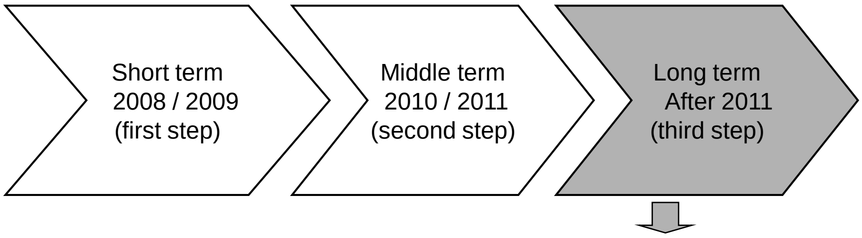
# Three step program




**Second step : using the results of inspections performed by others**

- joint inspections
- bilateral agreements

## Three step program




**Third step : establishing a common framework**

- international inspections

## First step Achievement: witnessed inspections

- <u>Witnessed inspection</u>: an inspection conducted by a regulator and observed by one or several other regulators
- 4 witnessed inspections organized in 2008 and 6 in 2009
- The inspections were organized in 5 countries and involved 7 regulatory bodies

## First step Achievement: witnessed inspections

- Witnessed inspection: an inspection conducted by a regulator and observed by one or several other regulators
- 4 witnessed inspections organized in 2008 and 6 in 2009
- The inspections were organized in 5 countries and involved 7 regulatory bodies

## First step Achievement: survey results

Regulators carry out different types of inspections:

- Inspections aimed at checking that the licensees are performing appropriate surveillance of vendors
- QA audits
- Sample technical inspections performed on individual components with hold points and notification points

## First step Achievement: survey results

- A survey on QA requirements was conducted (comparison with 10 CFR 50 Appendix B)
- This survey showed that QA requirements are very similar in MDEP countries

## First step Achievement: conclusion

- MDEP regulatory bodies have deepened their knowledge of other countries' practices
- QA inspections and audits are a good area of cooperation
- Bilateral agreements could be established for technical inspections
- Long lead items will be a key issue

## Second step (2010 / 2011)

- Objective: use the results of inspections performed by other regulators
- Program plan:
  - QA inspections and audits
  - Bilateral agreements (could be addressed outside MDEP)
  - Long lead items

## Second step (2010 / 2011)

- Objective: use the results of inspections performed by other regulators
- Program plan:
  - QA inspections and audits
  - Bilateral agreements (could be addressed outside MDEP)
  - Long lead items

## Second step (2010 / 2011)
QA audits

- Improve the knowledge of QA requirement of participating countries
- Organize *joint inspections* (inspections or audits conducted by a regulator with the participation of other regulators on the inspection team)
- 2 or 3 joint inspections (QA inspections or audits) to be organized
- May require international training of inspectors

## Second step (2010 / 2011)

- Long lead items have to be manufactured well in advance
- The final project or the country of destination may not be known
- A key issue: the surveillance performed by the licensee
- The Working Group is meeting the industry on October to address these issues

# Conclusion

- Benefits for safety:
  - Use of other regulators' best practices
  - Shared inspection results
  - Improved efficiency and effectiveness of vendor inspection programs by building on other regulators' work

- Benefits for the industry:
  - Convergence of regulatory requirements
  - Less frequent but more comprehensive inspections

## Session 3 (cont.)

## Issue-specific activities panel

*(Panel member contributions can be found in Appendix A on page 199.)*

# Session 4

## Industry initiatives on new reactor designs

## Session 4 summary

The following persons made remarks and presentations on the status of the issue-specific working groups on Digital Instrumentation and Control (DICWG), Codes and Standards (CSWG), and Vendor Inspection Co-operation (VICWG):

- Michael Micklinghoff, E.ON Kernkraft, Vice-President and, WNA/CORDEL, Chairman, and Chair of Session 4, Part 1
- Takuya Hattori, President, Japan Atomic Industrial Forum, Inc., *(presentation given by Masashi Yokota of JAIF)*
- Bernard Fourest, EURELECTRIC, Senior Safety Advisor
- Christian Raetzke, E.ON Kernkraft, Vice-President, International Regulatory Affairs, WNA/CORDEL representative
- Vladimir Asmolov, JSC "Concern ENERGOATOM", First Deputy Director General
- Alex Tsela, PBMR Company, General Manager of Nuclear Safety, Licensing and SHEQ

Included in the session's presentations was information on the history of nuclear power in Japan and the situation of new reactor plants there, as well as details of the new VVER reactor design in Russia. PBMR design activities were also discussed in this session.

The EURELECTRIC representative presented information on standardisation efforts by his organisation and its members and the European Nuclear Installations Safety Standards (ENISS) Initiative. ENISS was created to establish a common licensee view to WENRA.

The World Nuclear Association (WNA) Co-operation in Reactor Design Evaluation and Licensing (CORDEL) working group representative provided a presentation about standardisation. CORDEL's agenda is for international standardisation of reactor designs and addressed industry and the regulator's roles. A highlight of the presentation is the identification that due to national regulatory differences, licensing of standardised design across a range of countries is very difficult. On the regulatory side, WNA/CORDEL's presentation proposed three main targets including (1) design approvals with international impact, (2) harmonisation of safety requirements, and (3) alignment in licensing procedures. CORDEL proposed a three-step integrated process to address these challenges: Step 1, sharing design assessments; Step 2, accept another regulator's design approval; Step 3, issue international design certification.

This proposal was seen as very interesting and elicited much feedback in this and the following session. MDEP regulator representatives cautioned that, as indicated in WNA/CORDEL's presentation, each national regulatory authority has its sovereign responsibility to assess the safety of reactor designs that are licensed, constructed, and operated within its own borders and pursuing an international design certification may challenge those sovereign authorities. Furthermore, MDEP regulators cautioned that the licensing of nuclear power plants is as much a political process as it is a technical process and established regulatory procedures have developed over time due to national and international experiences with nuclear power. Also, MDEP is already doing some of the tasks indentified in Step 1 of WNA/CORDEL's proposal and perhaps in Step 2. It was agreed that this proposal needs further discussion in other fora and perhaps should be modified to reflect the political nature of licensing new nuclear power plants.

The following persons took part in the Panel Session on Industry Initiatives on New Reactor Design Activities following the presentations:

- Paul Rorive, FORATOM, President and Chair of session 4, part 2
- Mike Weightman, HM Chief Inspector, UK Nuclear Installations Inspectorate, and MDEP PG member
- Wei Jiang, China's National Nuclear Safety Authority (NNSA), Deputy Director-General, Department of Nuclear Safety Management and STC member
- Jerald Head, GE-Hitachi, Vice-President, Regulatory Affairs
- Kiyoshi Yamauchi, Mitsubishi Heavy Industries, Nuclear Energy Systems, Executive Officer and Senior Vice-President
- Bernard Salha, EDF, Director of the Nuclear Engineering Division
- Robert Goodman, Ontario Power Generation, Director of Engineering for the Darlington New Nuclear Project

**Japanese Nuclear Industry representative**

*Mr. Hattori, President, Japan Atomic Industrial Forum, Inc.*
*(presentation given by Mr. Yokota of JAIF)*

## MDEP ?

D'ou venons-nous ? Que Sommes-nous ? Qu allons-nous ?
by Paul Gauguin(1848~1903)

Where Do MDEP Come From ?
What Are MDEP ?
Where Are MDEP Going ?

2

## Look back to the past Experience in Japan

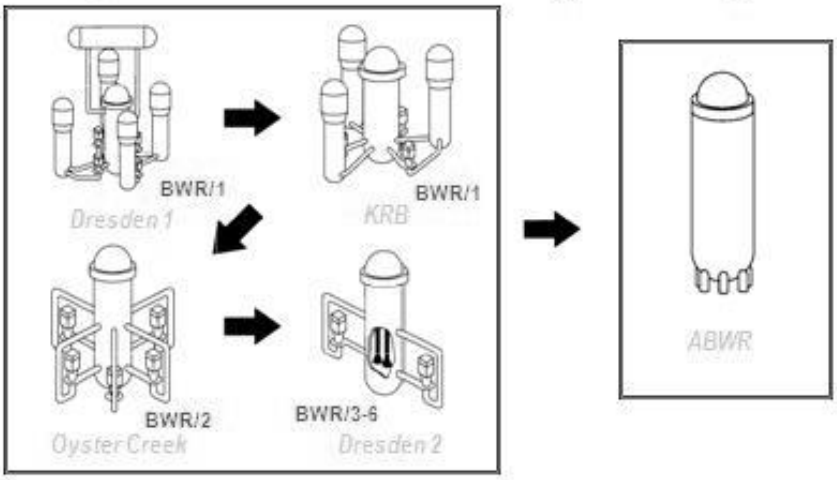
### Nuclear Development Program in Japan

* Introduction the Nuclear Tech. from UK & USA
* Accumulation of Const. & O&M Experience
* Improvement of Sys. & Component based on the Feedback of Const. and O&M experience
* Improvement & Standardization Program
* Development of advanced Rx (ABWR & APWR)

3

## Evolution of BWR Technology

**"Simplification" is the Key Concept**

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## Improvement and Standardization Program in Japan (1)

- **Improvement and Standardization Program in Japan**
  - * **Phase I (1975~1977)**
  - * **Phase II (1978~1980)**
  - * **Phase III (1981~1985)**
- **ABWR & APWR is the final outcome of the Phase III**

5

## Improvement and Standardization Program in Japan (2)

### Objectives of the Program

* Enhance Safety
* Improve Operability
* Improve Maintainability
* Reduce Radiation Exposure
* Improve Availability Factor
* Improve Constructability

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## Improvement and Standardization Program in Japan (3)

- **Application of State of the Art Technology**
  * Advanced I&C (Digital Control Sys.)
  * Latest Analytical Design Method (FEM)
  * Simulation Technique
  * PSA Methodology
  * Advanced Manufacturing Method (ex. Welding and Forging)
  * Advanced Construction Method
- **The Basic Policy is "Test before Use"**
  * Qualification Test program by Full Size Mockup

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LIGHTS ON
JAIF
Improvement and Standardization Program in Japan (4)
Feedback from Const. and O & M experience
Lessons Learned from Accidents
* Fire Protection····BF
* Human Factor ····TMI
* Man Machine Interface ····TMI
* Emergency Preparedness ····TMI
* Severe Accident····TMI/Chernobyl
* Safety Culture ····Chernobyl
Adoption of latest Knowledge and Data Set
8


LIGHTS ON
JAIF
Improvement of Management Sys.
While the Improvement and Standardization Program executed, management sys. have been continuously improved to enhance operational safety, quality and reliability.
* Enhancement of QMS
* Improvement of Emergency Preparedness
* Improvement of Human Performance
* Adoption of the Third Party's Review
(WANO peer review, IAEA OSART etc.)
* Enhancement of Knowledge Management Sys.
9

## Where are we standing now ?

- Safety, Quality and Reliability have been reaching nearly to the acceptable level.
- What's next ?

→ Realization of the Nuclear Renaissance !

- How can we cooperate internationally to realize the Nuclear Renaissance ?

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## Nuclear Renaissance

- MDEP Activity could be the strong leverage for realization of the Nuclear Renaissance.
- What and How ?

→ Can we learn and share any lessons from the past experience ?
( e.g. ABWR development )

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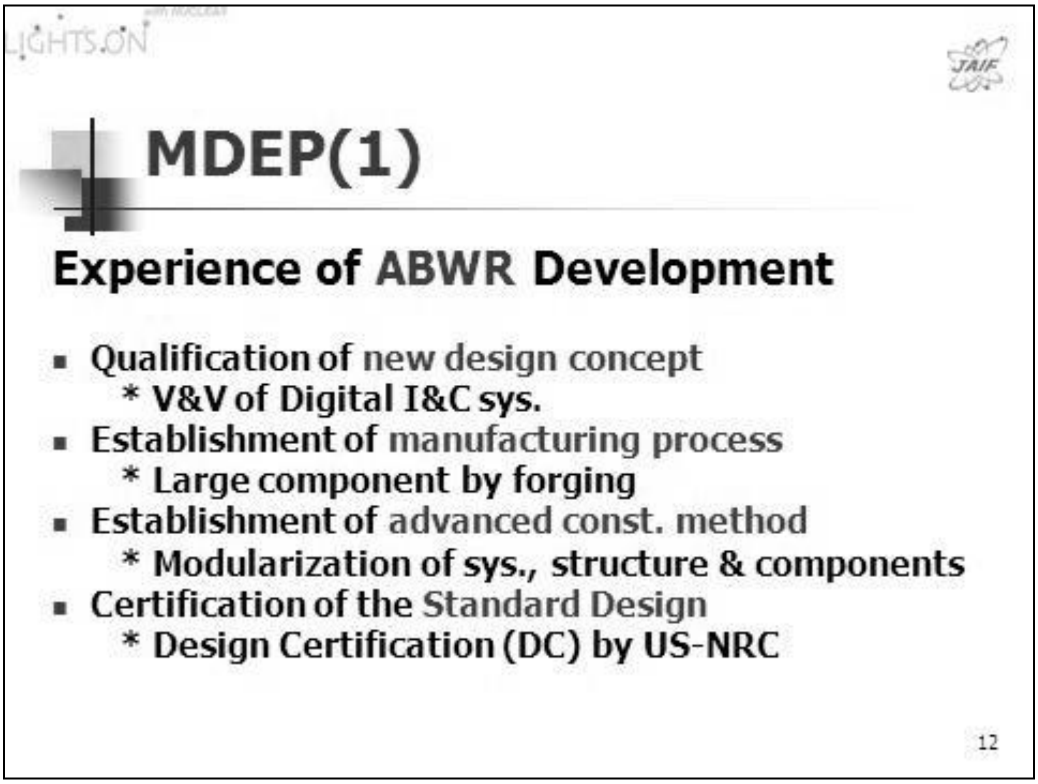
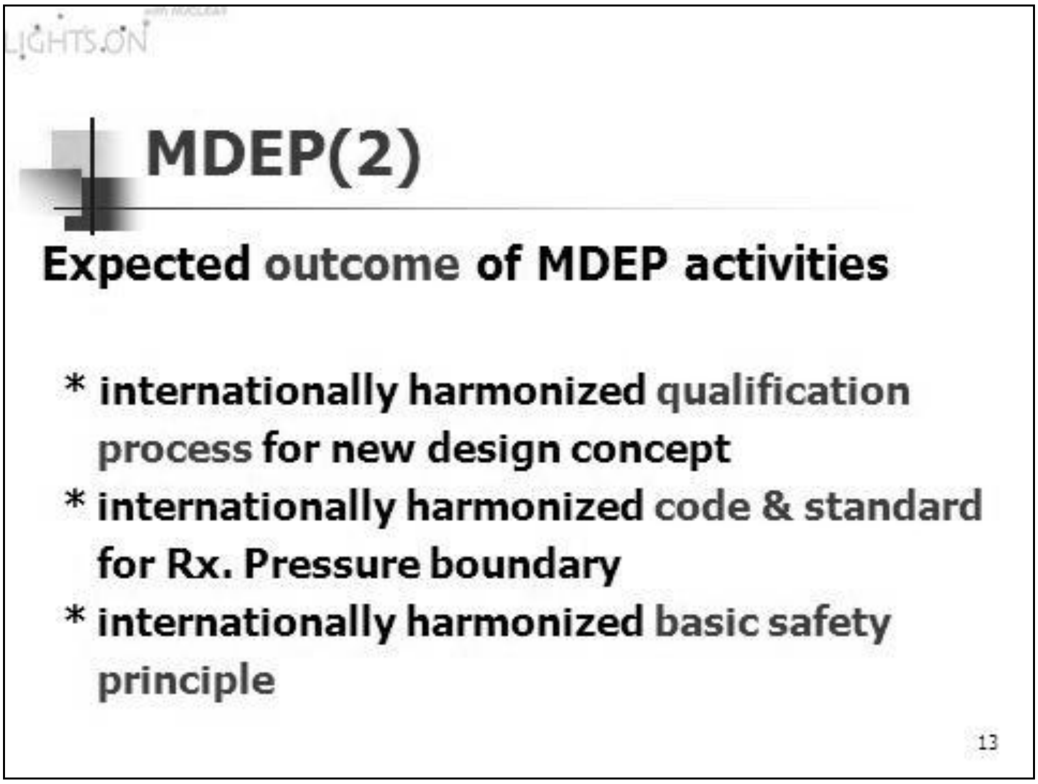

LIGHTS ON
JAIF
MDEP(1)
Experience of ABWR Development
▪ Qualification of new design concept
* V&V of Digital I&C sys.
▪ Establishment of manufacturing process
* Large component by forging
▪ Establishment of advanced const. method
* Modularization of sys., structure & components
▪ Certification of the Standard Design
* Design Certification (DC) by US-NRC
12


LIGHTS ON
MDEP(2)
Expected outcome of MDEP activities
* internationally harmonized qualification process for new design concept
* internationally harmonized code & standard for Rx. Pressure boundary
* internationally harmonized basic safety principle
13

LIGHTS ON

JAIF

## MDEP(3)

**Expected benefits for the Industry from MDEP activities**

* minimize Licensing Risk
* safety, quality and economy level could be improved
* improve the confidence of general public

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## Summary

- First priority is "Make the Nuclear Renaissance happen in timely manner".
  So, MDEP should be practical in terms of scope and coverage.
- In order to contribute to the Nuclear Renaissance, Japanese Industry is prepared to cooperate together with the MDEP activities.

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**European Utility Network representative**

*Mr. Fourest, Senior Safety Advisor, EURELECTRIC*

## Introduction (1/2)

From a utility perspective, standardisation of reactor designs provides:

- Economic benefits by reduction of construction and operational costs
- More certainty in licensing process and therefore reduction of financial risks
- But also safety benefits with allowing larger and more efficient feedback in construction and operation of fleets of similar designs



## Introduction (2/2)

- In the early nineties several european utilities got together to prepare specifications for the next genration of NPPs to be built in Europe:
  European Utilities Requirements (EUR)
- In 2005, as a counterpart of WENRA initiative to define safety Reference Levels for existing nuclear facilities, European nuclear utilities established ENISS inside FORATOM:

European Nuclear Installation Safety Standards

UNION OF THE ELECTRICITY INDUSTRY
eurelectric

## The EUR project initial objectives (1991)

- Light water reactor plants only
- Reduced licensing risks
  - Quite high safety objectives: common rules valid for a long enough time and in a wide enough area
  - Improved acceptance by the public and the administrations
  - Safety harmonisation : within Europe and, as far as possible, with USA
- Increased LWR plant competitiveness
  - allowing the development of standard designs usable throughout a wide area
  - promoting cost-effective design features
  - establishing conditions for a fair competition between the vendors
- Open electricity market
  - Harmonised design requirements

MDEP Conference Paris 10-11 September 2009

## EUR today: a mature cooperative organisation of European utilities

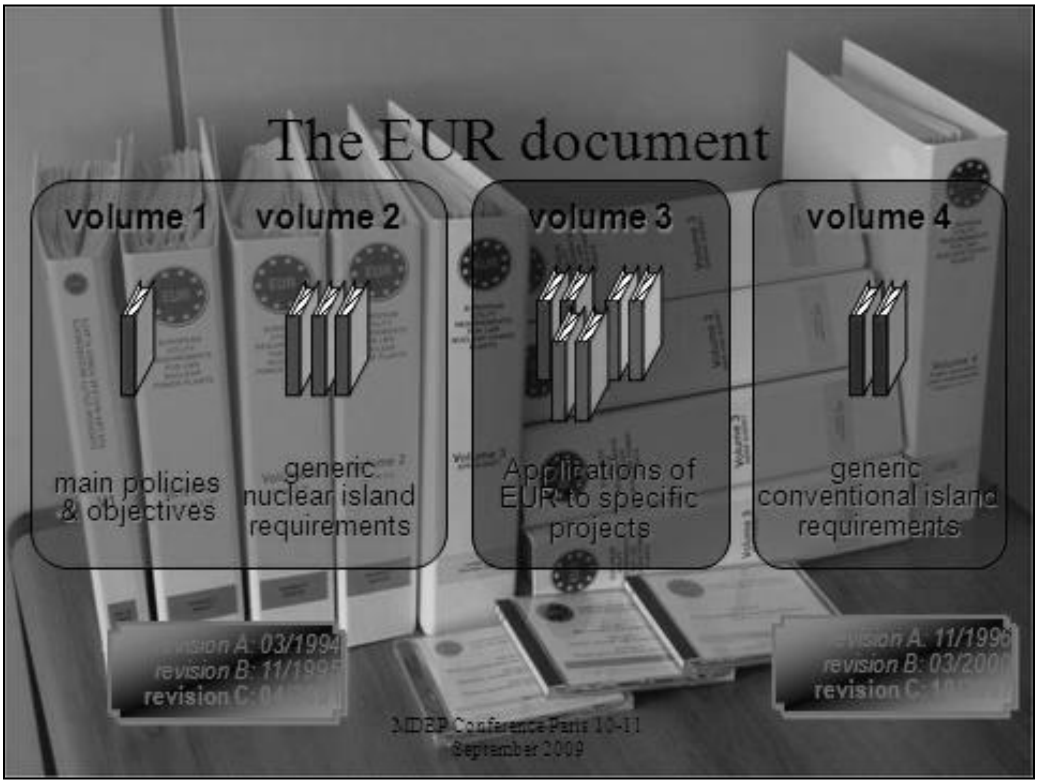
- working together since 1992
- committed to keep the nuclear option open
- sharing specification and development works for Gen 3 LWR plants
- involving most of the major European electricity producers.
- operating a very large nuclear fleet: more than 130 LWRs + others
- in competition with each other

MDEP Conference Paris 10-11 September 2009

## EUR: a hub to harmonise European utilities views & requirements and to make Gen 3 a reality in Europe

- a utility network to share experience in plant specification (including conventional part and grid interface), design evaluation, licensing …
- a common bridge with external stakeholders
  - the vendors
  - the regulators: safety (WENRA), HV grid, …
  - the EUR counterparts outside Europe: EPRI, Asian utilities, …
  - the international organisations: IAEA, OECD, EU, WNA…
  - the education and training organizations and networks: ENEN, WNU,…

MDEP Conference Paris 10-11 September 2009



## EUR volume 3: analyses of compliance of the selected LWR projects vs. the EUR generic requirements

- analyses at detail level
  - each of the 4000 requirements (shall, should, may) of the EUR volumes 1 & 2 is analysed by EUR utilities' engineers from information supplied by the vendors.
  - standard scale of compliance for all the projects
  - rationales & references
  - cross-checking between the different assessments
  - several man•years for each project
- the detailed analyses are not published
- only the main deviations are highlighted in the published part as well as the main "compliance with objectives".

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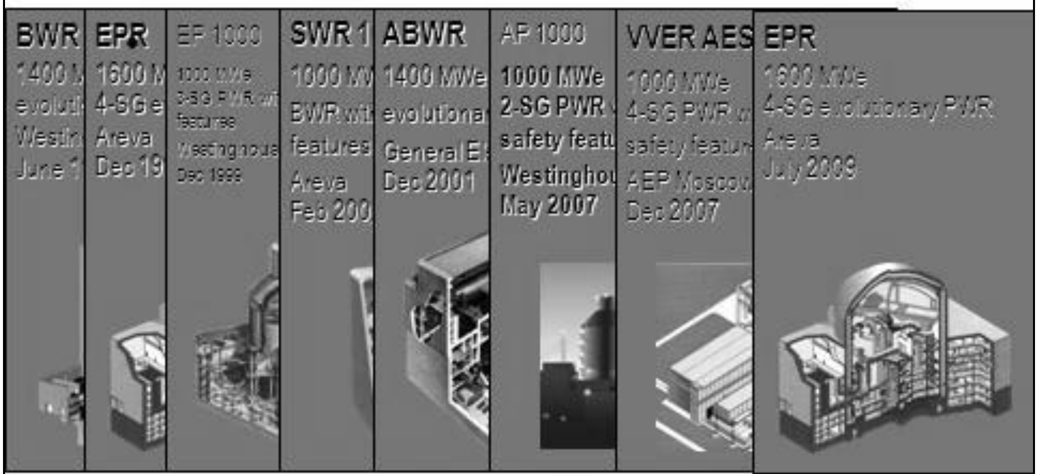
## EUR volume 3

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## The TRENDS

- The EUR document is more and more used as a specification for Gen 3 reactor bids
- The EUR document is being maintained and improved
  - Revision B of the EPR just completed
  - Preliminary works on MHI's APWR evaluation
  - Other Gen 3 LWR projects?
- The EUR organisation keeps enlarging
  - EnergoAtom (Ukraine), CEZ (Czech Republic) have been welcomed into the EUR organisation
  - ENEL and Endesa have re-entered the organisation
  - MVM (Hungary) associate member

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## ENISS :European Nuclear Installations Safety Standards Initiative

Objectives

- To establish a common licensee view with respect to the "WENRA RLs"
- To present the industry position in discussions with WENRA
- To support an exchange of information about the interaction of license holders with their national regulators, in order to achieve a harmonised set of new regulations.
- To create an information platform for the European nuclear license holders with respect to new national and international regulatory activities
- To strengthen the influence in the revision work of the IAEA Safety Standards
- To cooperate with the European Institutions on regulatory issues in the area of nuclear safety, radiation protection, waste management and decommissioning
- To collaborate with international associations dealing with regulatory issues

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## ENISS – Membership

All ENISS Members are representing licensees

- Belgium (Tractebel, Electrabel)
- Finland (Fortum, TVO)
- Germany (EON, RWE)
- Italy (SOGIN/ENEL)
- Spain (UNESA)
- The Netherlands (EPZ)
- France (EdF, AREVA NC)
- Sweden (EON-Se, Vattenfall AB)
- Switzerland (Swiss Nuclear)
- Czech Republic (CEZ)
- Hungary ( Paks NPP)
- Slovakia (Slovenske Elektrarne, JAVYS*)
- Romania (Nuclearelectra)
- Bulgaria (Kozloduy NPP)
- United Kingdom (BE)
- Slovenia (Krško NPP)
- Lithuania (Ignalina NPP*)

*involved only in waste & decommissioning activities

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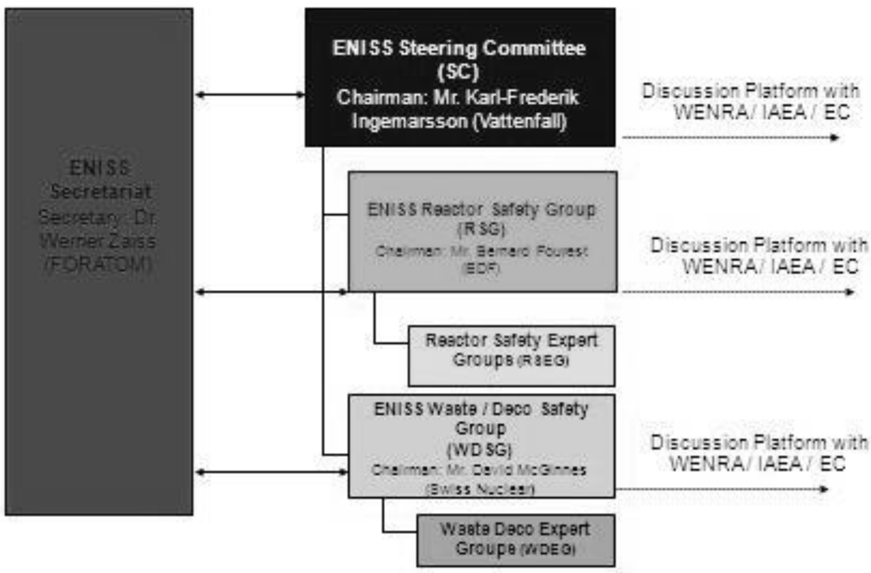
## ENISS - Organisation

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## Interaction with WENRA

In January 2006, WENRA published three Harmonisation Reports:

- Harmonisation of Reactor Safety in WENRA Countries
- Waste and Spent Fuel Storage Safety Reference Levels Report for Nuclear Facilities
- Decommissioning Safety Reference Level Report for Nuclear Facilities

Comments and suggestions by stakeholders were asked for end of May 2006

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## WENRA – ENISS Interaction – Reactor Safety

A constructive dialog between WENRA and ENISS on its comments

- Several meetings on 2006/2007
- Several sets of comments from ENISS
- Explanatory notes prepared by WENRA (on PSA) and by ENISS (on fire protection)
- Proposed Interpretations of some RLs by ENISS agreed by WENRA

WENRA published a new set of RLs on January 2008

Futur interactions expected on Safety Objectives for GEN 3 being prepared by WENRA on 2010

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## WENRA-ENISS Interactions: Waste/Spent Fuel Storage and Decommissioning:

–First Drafts issued in January 2006, but without benchmarks

–ENISS provided comprehensive comments

–Consultation and discussion between ENISS and WENRA WDWG

–Version 2.0 both to be issued end of 2009

Stakeholders are invited to provide comments

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## ENISS Participation in the Revision of the IAEA Safety Standards

▪WENRA's Policy Statement: Influence the Revision of the IAEA Safety Standards as appropriate

▪Strengthening the influence of European nuclear licensees on IAEA Regulatory Work with regard to nuclear facilities

▪FORATOM/ENISS acting as a non-governmental organisation representing the European nuclear power plant licensees

▪IAEA/ENISS Meeting to launch a cooperation agreement (8 February 2007)

▪ENISS assistance in IAEA Drafting Groups, observer status in IAEA Safety Standard Committees (NUSSC, WASSC…)

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## ENISS involvement in IAEA Standard activities

**Areas to be covered**

(Priority on Requirements)

- NPP Design
- NPP Operation
- Management Systems
- Waste Management / Treatment
- Decommissioning
- Radiation Protection (with respect to nuclear safety)

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## EU Nuclear Safety Directive

- In the framework of the European Nuclear Energy Forum, ENISS suggested contents elements of this Directive: should be based on IAEA safety fundamentals, but no technical content
- Interactions with European Parliament
- Interactions with ENSREG

EU Nuclear Safety Directive approved by the Counsel on June 2009

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UNION OF THE ELECTRICITY INDUSTRY
eurelectric

## Conclusions

- With the EUR initiative, European nuclear utilities were the first to work towards standardisation of reactor designs at the international level.
- EUR requirements are being used by utilities in Europe and elsewhere as a basis for specifiyng new reactors.
- Some level of safety harmonisation is one of the precondition to standardisation.
- European nuclear utilities welcome WENRA initiative to establish Reference Levels for existing plants. It creates ENISS to interact with it, and this already provided concrete and positive results.
- ENISS and EUR will join their efforts to interact with WENRA on new reactor safety objectives.
- MDEP is an other steps towards standardisation and the nuclear industry is eager to support this effort.

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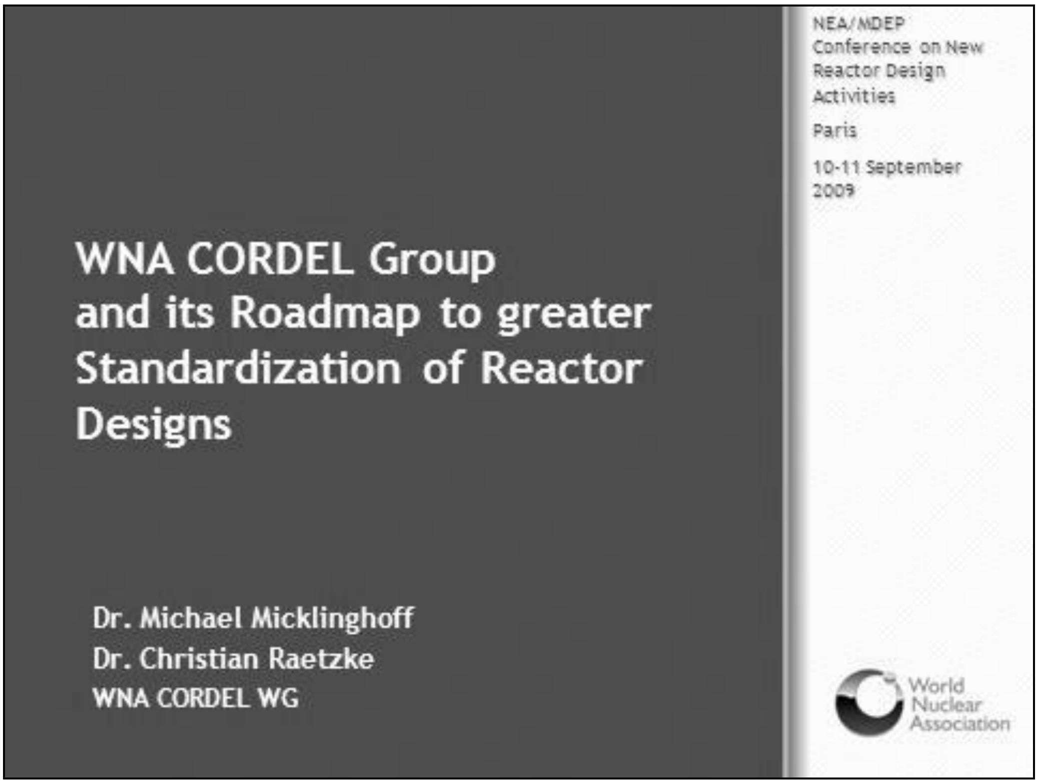
**WNA/CORDEL representative**

*Micahel Micklinghoff, Chairman, CORDEL Group,*
*Vice-President, E.ON Kernkraft GmbH*



2

## WNA CORDEL Working Group

Cooperation in Reactor Design Evaluation and Licensing (CORDEL)

Founded in January 2007

Membership:

Includes all major vendors and many utilities interested in new build.

**Chairman:** Michael Micklinghoff (E.ON)

**Vice Chairman:** Francois Bouteille (AREVA NP)

**Companies:** AREVA NP, Atkins, Atomstroyexport, British Energy, EDF, ENDESA, ENEL, NNEGC Energoatom, E.ON, EXCEL Nuclear Services, GE-Hitachi, Hitachi-GE Nuclear, KHNP, Mitsubishi Heavy Industries, NOK, OPG, Rosenergoatom, RWE Power, TEPCo, TVO, Westinghouse, also FORATOM/ENISS, EUR, EPRI, ISO

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## CORDEL's agenda: International standardization of reactor designs

- International standardization means that each vendor's design can be built by a vendor, and ordered by a utility, in every country without obligatory adaptation to specific national regulations
- Standardization will
  - help deliver large-scale worldwide new build of nuclear power plants
  - bring benefits for safety

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## Standardization and safety

- Fleets of standardized designs offer a broad basis for construction and operation experience feedback
- Design improvements could be implemented across the fleet
- Risk of a design shortcoming affecting the whole fleet (large scale shutdown) is small due to high probability of early detection of design flaws

**Standardized advanced plants will bring additional safety layers for design, construction, operation and decommissioning**

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## Standardization: Industry's role

- Industry's commitment to standardization - definition of utilities' requirements for new reactors (EUR, URD)
- Industry should work together towards common industrial nuclear Codes & Standards, i.e. mechanical codes, I&C.
- Vendors should share existing licence application documents with applicants and regulators
- Owners' Groups to be strengthened in order to facilitate the exchange of operation experience and of design improvements within the fleets and across the fleets
- Operators and vendors to jointly tackle the issue of a Design Authority to maintain design knowledge across the whole life cycle of a nuclear power plant

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## Existing regulatory/legal situation

- Each reactor project needs a licence issued in a specific procedure after full assessment by the competent regulatory body
- Licence is issued according to special national licensing procedures, which vary considerably
- Licence is based on national safety requirements, which are similar in high-level goals, but vary considerably in details

► **This makes licensing of standardized designs across a range of countries extremely difficult**

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## Role of Regulators and Governments

- Standardization as such must be delivered by industry…
- …but industry needs to be enabled to do so by starting new approaches within national and international regulatory frameworks
- Three main targets to tackle the situation presented in the previous slide:
  - **design approvals with international impact**
  - **harmonization of safety requirements**
  - **alignment in licensing procedures**

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## Potential regulatory hurdles on the way to standardization

- Sovereignty of each country's regulator has to be respected
- Regulators are bound by law to apply their national safety requirements and licensing procedures
- Regulators need to build up knowledge of the design

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## The CORDEL integrated approach: 3 steps towards standardization

CORDEL proposes **3 subsequent steps to overcome these hurdles and to** achieve full international **standardization** of reactor designs

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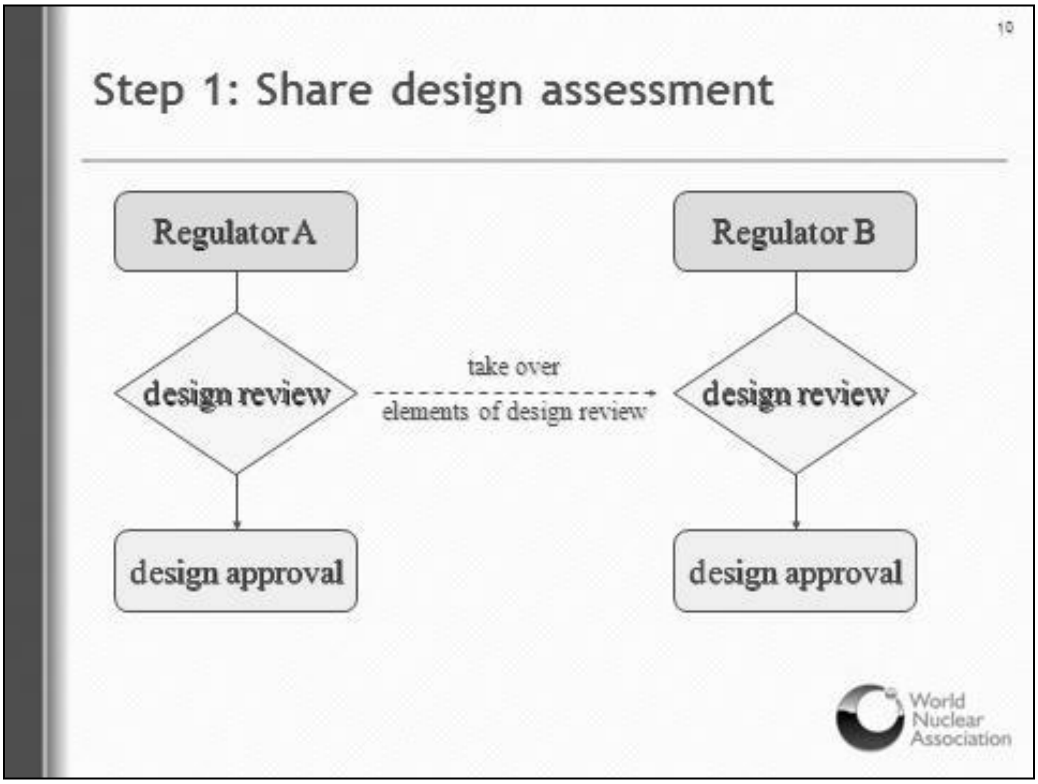
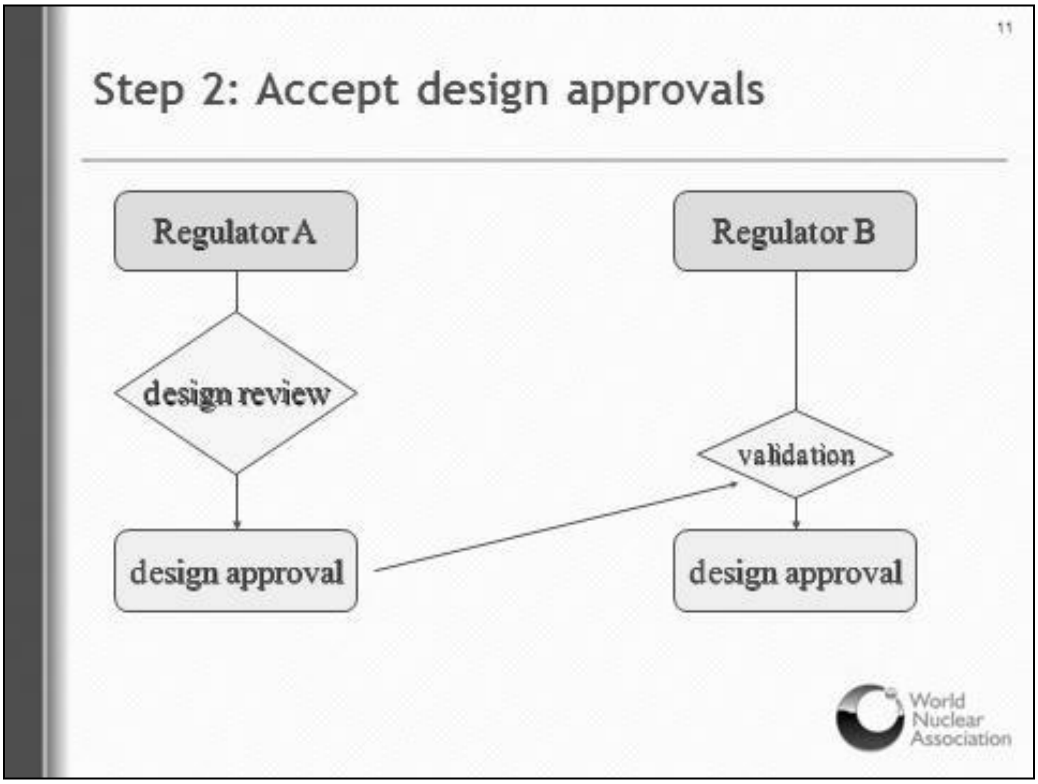
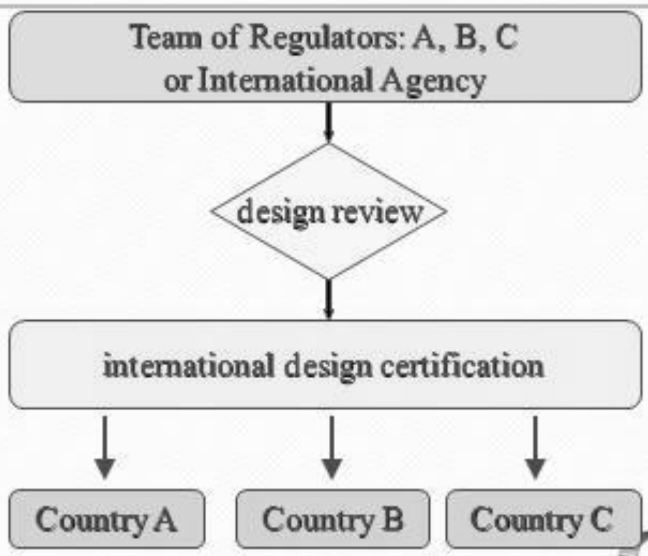

10
Step 1: Share design assessment
Regulator A
Regulator B
design review
take over
elements of design review
design review
design approval
design approval
World
Nuclear
Association


11
Step 2: Accept design approvals
Regulator A
Regulator B
design review
validation
design approval
design approval
World
Nuclear
Association

## Step 3: Issue international design certification




## Step 1: Mutual acceptance of design reviews and assessments

- For demonstration of safety, the regulators could make use of:
  - Assessment work done by their peers, e.g. by reusing calculations or modelling of event sequences
  - Assessments done by industry (EUR, US URD)
- This would reduce the strain on regulators' resources
- This would be done within existing legal framework and existing responsibilities of regulators
- MDEP development towards shared assessment work is highly appreciated

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## Step 2: Mutual acceptance of design approvals (1)

Mutual acceptance of design approvals – a facilitated takeover of a foreign design approval

- not "automatic" but through a "validation" procedure. There are models for this, e. g. transport casks for radioactive waste.
- Focus for national regulator would be on "local" site-specific and operator-specific issues
- Adaptation of national legislation may in some countries be necessary to permit taking over foreign design approvals

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## Step 2: Mutual acceptance of design approvals (2)

Example: Italy's new Act on Energy Companies, Act no. 99 of 23 July 2009, Art. 25, 2 i):

> [Government is empowered to issue] a provision that **licences** relating to technical requirements and specifications for reactor designs which have been licenced in the past 10 years by the competent authorities in member states of OECD-NEA, or in states linked to Italy by bilateral agreements … in the nuclear sector, **will be considered to be valid in Italy after approval by the Nuclear Safety Agency**

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## Step 2: Mutual acceptance of design approvals (3)

- Licensing processes and documents should be aligned so that the design acceptance of one country would fit into the licensing sequence of another country
- Contents of supporting documents should be harmonized (e.g. US Design Control Document and UK Pre-construction Safety Report)
- Strong alignment of safety requirements is necessary. Two possible ways:
  - harmonization of national regulations to jointly agreed or international standards (see WENRA)
  - acceptance of foreign regulations on a case-to-case basis

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## Step 3: International Design Certification

- International Design Certification - issued by a team of all concerned regulators (MDEP?) or by an international organisation
- National regulator assesses applicability to local circumstances, and supervises construction, commissioning and operation
- International Design Certification is owned by the vendor and is valid for entire design life
- Vendor is responsible for maintaining design authority, operator is "intelligent customer" (it wouldn't make sense to maintain 20 design authorities for one design.....)

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## Standardization: Role of WNA CORDEL

**Industry is prepared to provide CORDEL with resources**

- to promote standardization of designs
- to support regulators
- to encourage production of international codes and standards by international standards organizations and
- to make further steps towards strengthening best practice sharing and experience feedback mechanisms (via owners' groups)

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## Standardization: Role of MDEP

**CORDEL proposes giving MDEP an enhanced role:**

- MDEP's role should be strengthened in order to strive with new impetus towards joint design reviews and multinational design approvals
- MDEP should become international institution backed by inter-governmental agreements crafted under the auspices of IAEA or OECD-NEA
- MDEP needs its own workforce
- MDEP should work on comprehensive design reviews and, as a product of this work, make proposals for harmonization of safety standards to its member states

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## Standardization: Role of governments and IAEA

- A facilitated take over of Design Approvals by foreign regulators and an international harmonization of regulations may in the long run require
  - some changes in national legislation
  - creation of inter-governmental agreements
- This new framework would be beneficial for all - for established nuclear countries and for emerging nuclear countries or those with a small nuclear program
- IAEA is the most appropriate platform to coordinate inter-governmental initiatives

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## CONCLUSIONS (1)

**WNA CORDEL Group proposes 3 subsequent steps** to achieve full international **standardization** of reactor designs:

1. Acceptance of design reviews done by foreign regulators
2. **Acceptance of design approval** by a foreign regulator
3. Issuance of **internationally valid design certification**

In parallel and to enable this, national licensing procedures and safety requirements have to be harmonized.

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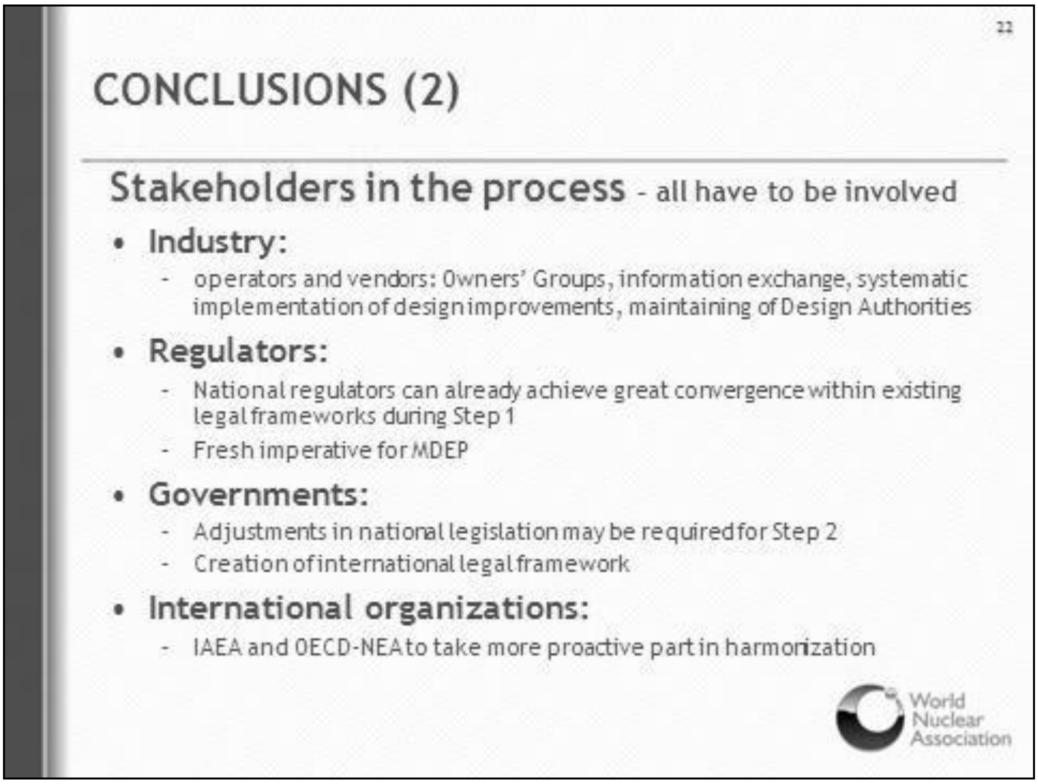
22
CONCLUSIONS (2)
Stakeholders in the process - all have to be involved
• Industry:
- operators and vendors: Owners' Groups, information exchange, systematic implementation of design improvements, maintaining of Design Authorities
• Regulators:
- National regulators can already achieve great convergence within existing legal frameworks during Step 1
- Fresh imperative for MDEP
• Governments:
- Adjustments in national legislation may be required for Step 2
- Creation of international legal framework
• International organizations:
- IAEA and OECD-NEA to take more proactive part in harmonization
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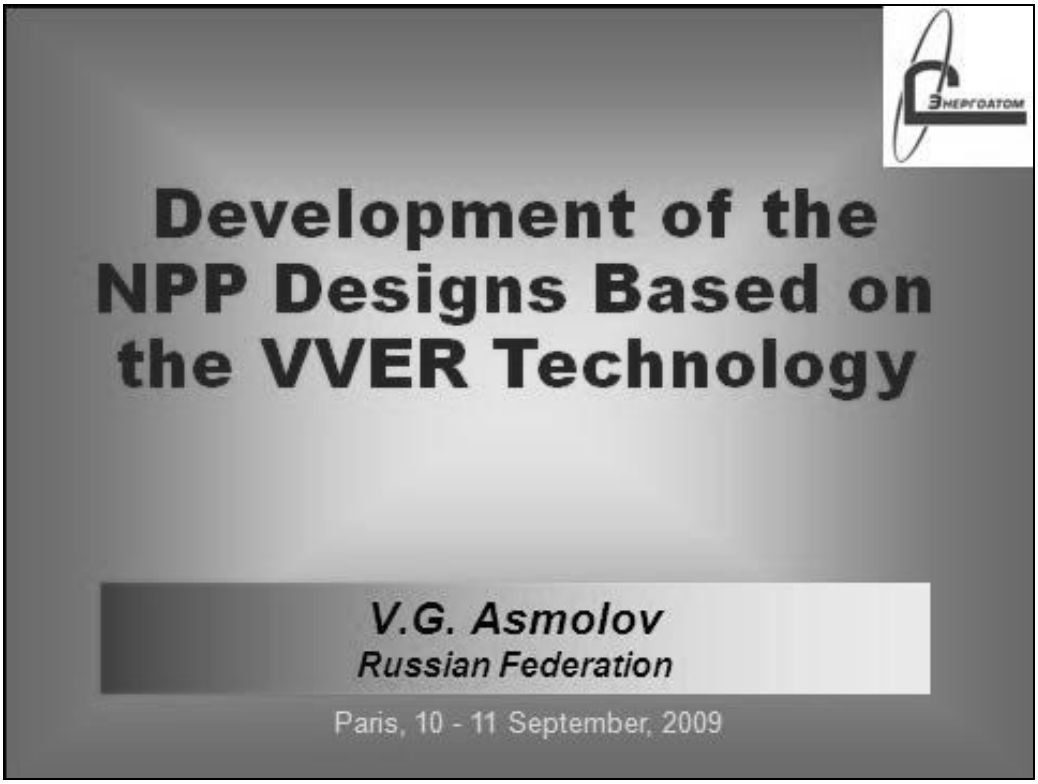
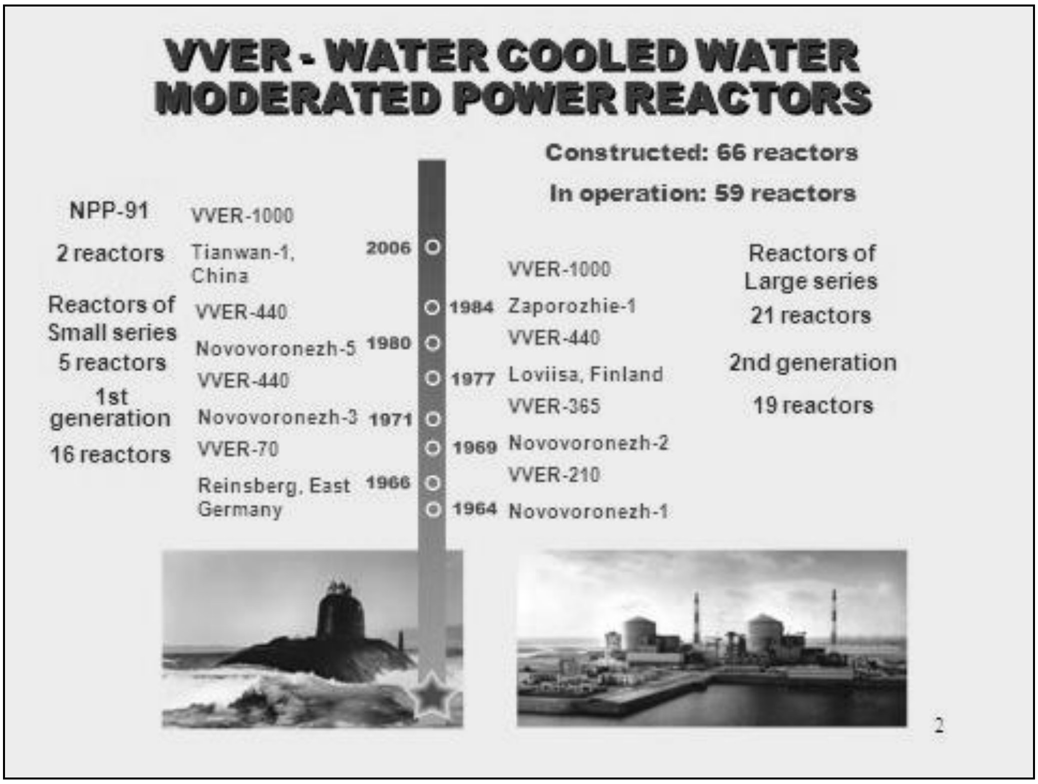
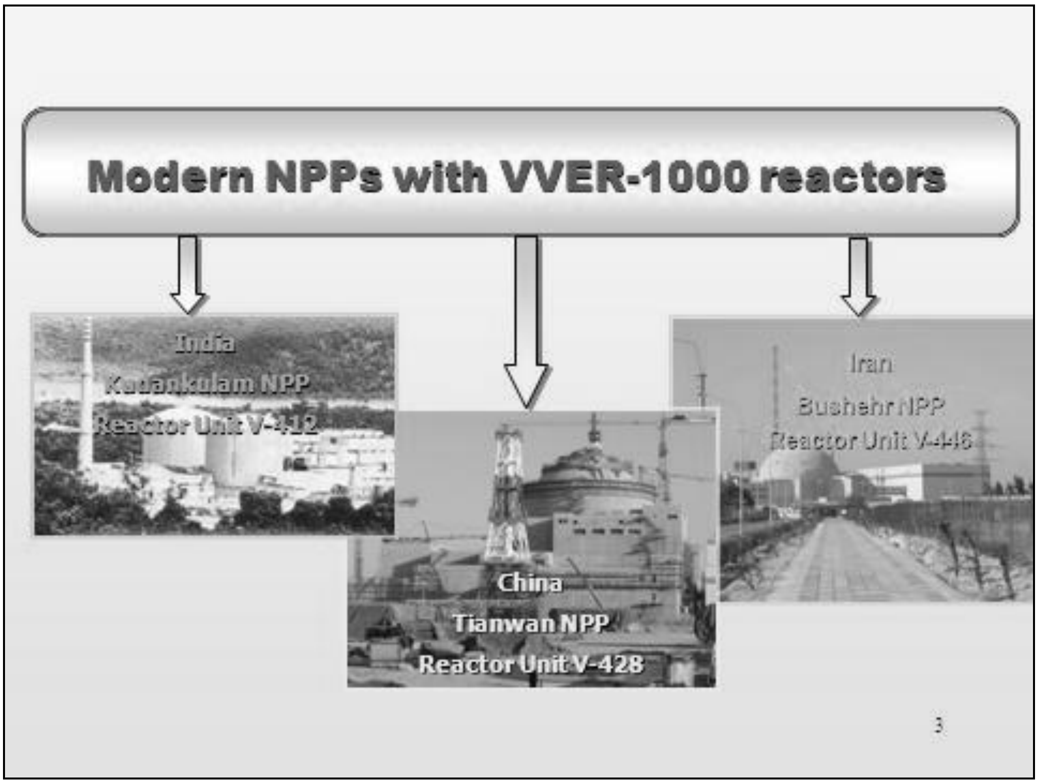
**Representatives from other national nuclear power industries**

*Vladimir Asmolov, ROSATOM, Energoatom*




VVER - WATER COOLED WATER MODERATED POWER REACTORS
Constructed: 66 reactors
In operation: 59 reactors
NPP-91
2 reactors
VVER-1000
Tianwan-1, China
2006
Reactors of Small series
5 reactors
1st generation
16 reactors
VVER-440
Novovoronezh-5
1980
VVER-440
Novovoronezh-3
1971
VVER-70
Reinsberg, East Germany
1966
VVER-1000
1984 Zaporozhie-1
VVER-440
1977 Loviisa, Finland
VVER-365
1969 Novovoronezh-2
VVER-210
1964 Novovoronezh-1
Reactors of Large series
21 reactors
2nd generation
19 reactors
2


Modern NPPs with VVER-1000 reactors
India
Kudankulam NPP
Reactor Unit V-412
China
Tianwan NPP
Reactor Unit V-428
Iran
Bushehr NPP
Reactor Unit V-446
3

## Main goals of the NPP-2006 Project

- NPP-2006 nominal electric power - to be at least 1200 MW (gross);
- Design service life of the NPP main equipment – 60 years;
- Availability factor – 92%;
- Load factor – 90%;
- Duration of the overhaul life – not less than 8 years;
- Fuel cycle length – up to 24 months;
- Requirements for load follow characteristics –according to EUR;
- Feed water inventory - to be sufficient for decay heat removal within 24 hours;
- Total frequency of the core degradation – less than $10^{-6}$ per reactor-year

4

## Achieved goals of the NPP-2006 Project

- **Thermal power has been increased up to 3200 MW and Efficiency factor (gross) of a power unit has reached 36.2%, due to:**
  - *Removal of excessive conservatism;*
  - *Improvement of steam turbine thermal circuit;*
  - *Improvement of steam parameters at the steam generator outlets;*
  - *Decrease of pressure losses in steam lines.*
- **Economic efficiency has been improved through:**
  - *Optimization of passive and active safety systems;*
  - *Unification of the applicable equipment;*
  - *Decrease of materials consumption;*
  - *Shortening of construction phase duration.*


## Main parameters of the Reactor Unit

| Parameter | NPPs with VVER-1000 | NPP-2006 |
|---|---|---|
| The reactor nominal thermal power, MW | 3000 | 3200 |
| Load factor | 0.80 | 0.92 |
| Coolant pressure at the reactor outlet, MPa | 15.7 | 16.2 |
| Coolant temperature at the reactor inlet, °C | 290.0 | 298.6 |
| Coolant temperature at the reactor outlet, °C | 319.6 | 329.7 |
| Maximum linear heat flux, W/cm | 448 | 420 |
| Pressure at the outlet of the SG steam header, MPa | 6.27 | 7.0 |
| Mass flow rate in the core, kg/(m²-s) | 3850 | 3930 |
| Minimum DNB ratio | 1.30 | 1.38 |
| Maximum level of fuel burnup, MW-day/kgU(FA) | 55.0 | 59.7 |
| Averaged level of fuel burnup, MW-day/kgU(FA) | 49 | 55 |
| Period between reloadings, months | 12 | 12/18 |

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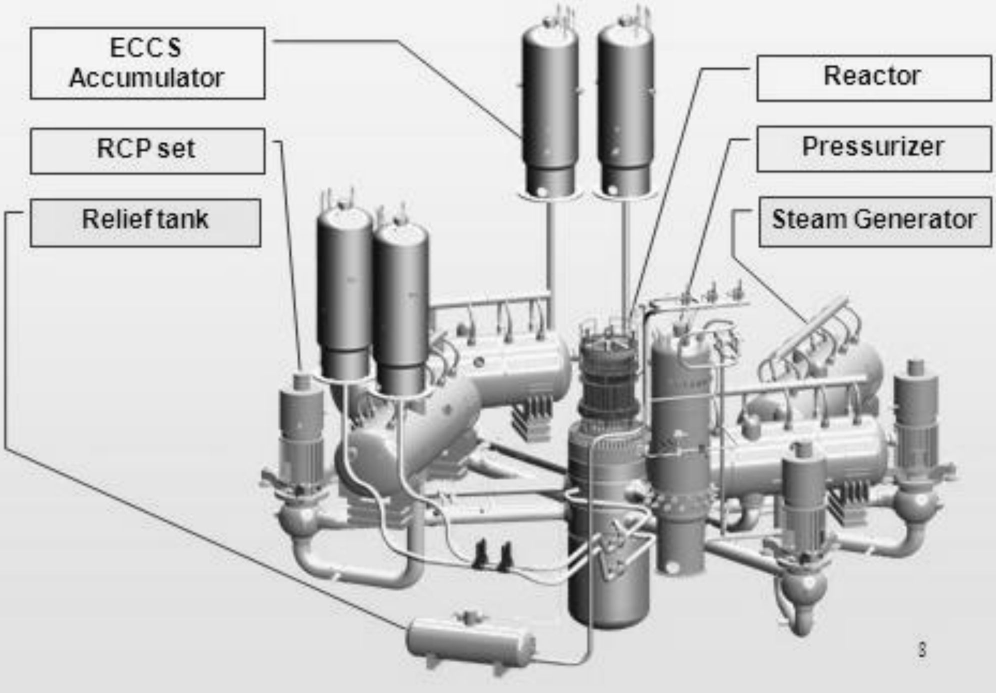
## Basic pattern of the NPP-2006 Reactor Unit




## Design solutions for the basic equipment of NPP-2006 reactor units

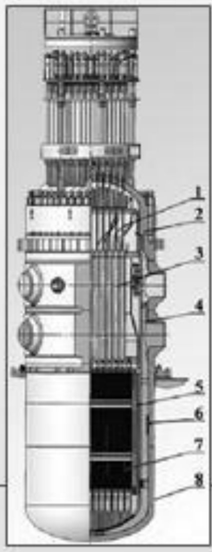
9

## Reactor unit

### Basic design distinctions:

- RPV inner diameter is extended by 100 mm as compared to the VVER-1000 RPV;
- Core baffle height is increased by 200 mm;
- The guiding frame for the CPS control rods in the protective tube unit is extended

| Условные обозначения<br>Symbols | |
|---|---|
| Сборка внутриреакторных детекторов<br>In-core instrumentation detectors | 1 |
| Блок верхний<br>Upper unit | 2 |
| Блок защитных труб<br>Protective tube unit | 3 |
| Шахта внутрикорпусная<br>Core barrel | 4 |
| Выгородка<br>Core baffle | 5 |
| Образцы-свидетели<br>Surveillance specimens | 6 |
| Зона активная<br>Core | 7 |
| Корпус ядерного реактора<br>Nuclear reactor vessel | 8 |

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## Reactor pressure vessel

| Parameter | Value | |
|---|---|---|
| | NPP-2006 | NPP with VVER-1000 |
| Length, mm | 11185 | 10897 |
| Internal diameter, mm | 4250 | 4150 |
| Wall thickness in the core region, mm | 197.5 | 192.5 |
| Mass, t | 330 | 320 |

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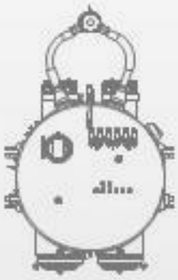
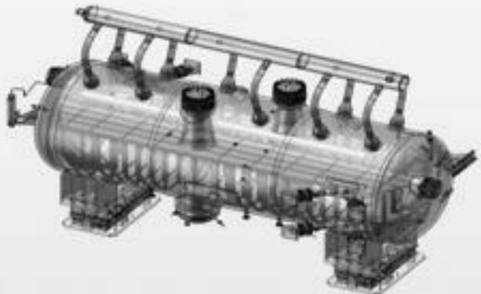
## Steam Generator





| Parameter | NPP with VVER-1000 | NPP-2006 SG of PGV-1000MKP - type |
|---|---|---|
| Inner diameter of the steam generator vessel, m | 4.0 | 4.2 |
| Tube bundle arrangement | staggered order | corridor-type |
| Steam pressure , MPa | 6.3 | 7.0 |

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## Steam Generator

- the secondary side water inventory is increased from 52 up to 63 $m^3$;
- rare corridor-type arrangement of tubes is used in the tube bundle;
- the flow rate in the tube bundle is increased;
- the opportunity of intertube space clogging with the separated sludge is reduced;
- easy access is provided into intertube space for inspection;
- the space under the tube bundle is enlarged to facilitate sludge removal

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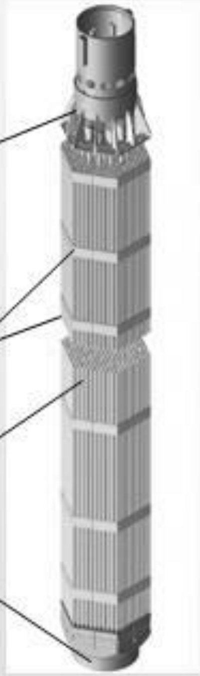
# Fuel assembly

Fuel mass has been increased by 18% due to the elongation of the fuel column by 200 mm and to the changing of the fuel pellet sizes

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# Safety systems

Comparison of Tianwan NPP and NPP-2006 designs

| | Tianwan NPP | NPP-2006 |
|---|---|---|
| ECCS active part | Separated four-channel systems of high and low pressure with a channel redundancy of 4 x 100 % each | Separated four-channel systems of high and low pressure with a channel redundancy of 4 x 100 % each |
| Emergency boron injection system | Four-channel system with a channel redundancy of 4 x 50 % | Four-channel system with a channel redundancy of 4 x 50 % |
| Emergency feed water system | Four-channel system with redundancy of 4 x 100 % with emergency feed water tanks | Four-channel system with redundancy of 4 x 100 % with emergency feed water tanks |
| Passive heat removal system (PHRS) | Not available | Available |
| Containment passive heat removal system (CPHRS) | Not available | Available |
| Core catcher | Available | Available |

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## Passive heat removal systems (PHRSs) in the NPP-2006 design

- **SG passive heat removal system (SGPHRS):**
  - prevention of core melting in case of a BDBA
  - mitigation of radiological consequences of accidents with leakage from primary into secondary loop
- **Containment passive heat removal system (CPHRS):**
  - long-term heat removal from the containment in case of any BDBA

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## Core melt retention system (core catcher)

- Location under the reactor lower head
- Protection from thermal & mechanical impacts of the corium
- Provision for heat removal from the corium
- Provision for the corium subcriticality
- Reduction of gas release into the containment
- Provision for exothermal reactions

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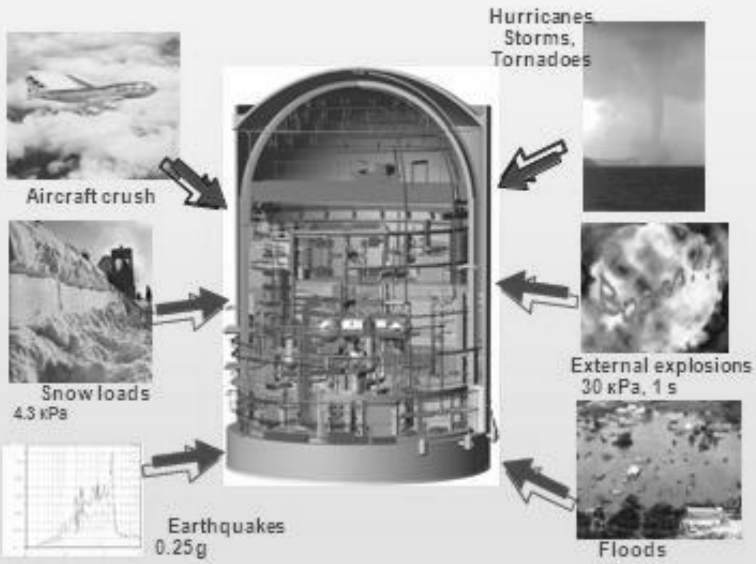
## Protection from external impacts in the NPP-2006 design

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## Expert reviews in the course of development and implementation of the NPP-2006 design

- **The utility's peer review as part of the acceptance procedure :**
  - departments of the Design Engineering branch;
  - departments of the Production & Operations branch.
- **Governmental authorities reviews:**
  - «Glavgosexpertiza» – design documentation and the site investigation results;
  - Rostechnadzor – licensing.

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## Near-term prospects of the VVER technology development (NPP-2006M)

- Employment of MOX fuel
- Introduction of a renovated vessel steel with increased radiation resistance

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## Long-term prospects of the VVER technology development

- More efficient use of uranium and plutonium
- Increasing thermodynamic efficiency
- Reduction of investment risks

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## Goal features of an innovative NPP unit based on the traditional VVER technology

- Fuel utilization - operation with breeding ratio (BR) ~ 0.8 – 0.9 and natural uranium consumption 130 – 135 t/GW (e) per year
- Thermodynamic efficiency - improvement of the efficiency coefficient by optimization of the steam generator design and by the maximum possible increase of steam parameters
- Investment payback – shortening of the construction period down to 3.5 – 4 years due to the industrial modular fabrication

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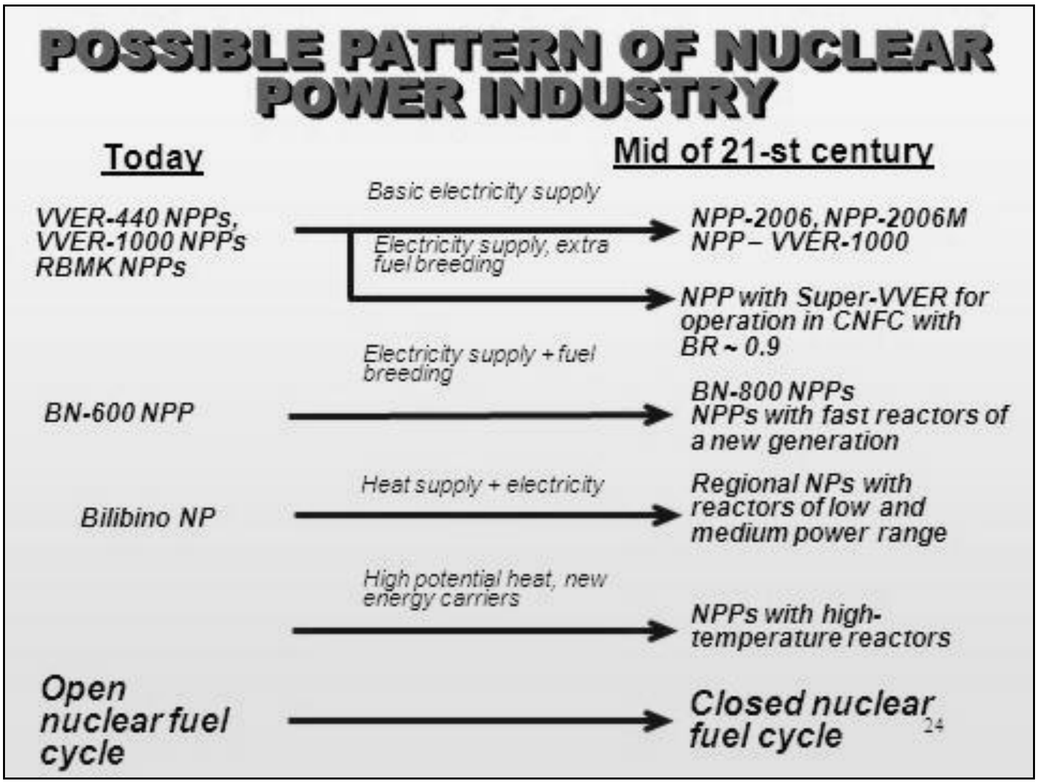
## Fields of R&D towards innovative design of the vessel-type water-cooled reactors

(options of NPPs with SUPER-VVER)

- Cooling with water of subcritical parameters, with the capability for neutron spectrum control
- Cooling with boiling water of subcritical parameters
- Cooling with supercritical pressure water in variable neutron spectrum:
  - in direct-flow one-loop reactor unit
  - in two-loop reactor unit
- Steam cooling in subcritical and supercritical pressure ranges of the fast neutron spectrum

23


POSSIBLE PATTERN OF NUCLEAR POWER INDUSTRY
Today
Mid of 21-st century
Basic electricity supply
VVER-440 NPPs, VVER-1000 NPPs RBMK NPPs
NPP-2006, NPP-2006M NPP – VVER-1000
Electricity supply, extra fuel breeding
NPP with Super-VVER for operation in CNFC with BR ~ 0.9
Electricity supply + fuel breeding
BN-600 NPP
BN-800 NPPs NPPs with fast reactors of a new generation
Heat supply + electricity
Bilibino NP
Regional NPs with reactors of low and medium power range
High potential heat, new energy carriers
NPPs with high-temperature reactors
Open nuclear fuel cycle
Closed nuclear fuel cycle
24

**Representatives from other national nuclear power industries**

*Alex Tsela*
*General Manager of Nuclear Safety, Licensing & SHEQ, PBMR Company*

## PRESENTATION

- Context: South Africa and PBMR
- Design Activities
- International Collaborations
- Cooperation with MDEP

P B M R

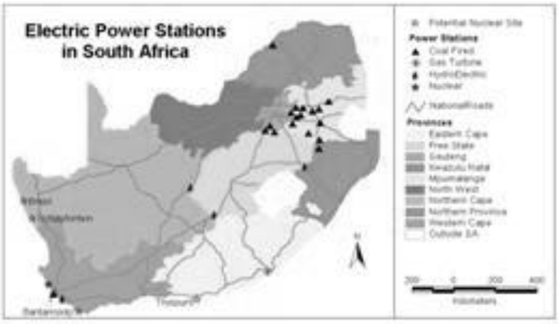
# The historical SA Nuclear Industry & SA's nuclear capability

P B M R



Page 3

South Africa is committed to promoting sustainable development of human kind through implementing relevant policies & effectual measures




P B M R

## Development of strategic competence 1969 - 1989

Uranium Enrichment

Fuel fabrication

Weapons programme

P B M R

## Two PWR Reactors at Koeberg, Cape Town

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## VAALPUTS
## Waste Disposal Site – Northern Cape

P B M R

VAALPUTS
Waste Disposal Site – Northern Cape

PBMR Pty, Ltd

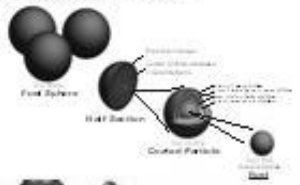
## Current PBMR Investors & Corporate Governance

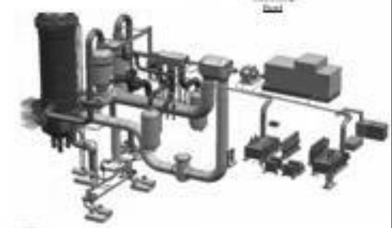
- SA Government (grant)
- IDC
- Eskom
- Westinghouse
- Operate under a Co-operation agreement (shareholders agreement to be signed)
- PBMR Board and sub-committees maintain Corporate Governance

IDC
Your partner in development finance
Eskom
Westinghouse
PBMR

## PBMR DESIGN PRODUCTS

- Pebble Bed Fuel
- Pebble Bed Fuel Plant
- 400 MWt DPP reactor design, direct Brayton Cycle:
  - **Selection of Brayton Cycle** that favours high ROT, high RIT and high system pressure (for high power density)
- Small DPP reactor design, steam cycle :
  - Optimised for process heat, electricity or both





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P B M R

## DESIGN PROGRESS(1/2)

*POWER PLANT :*

- The conceptual design of the direct cycle power plant has been completed.
- Significant progress on equipment design, including:-
  - Conceptual design of all subsystems and equipment
  - Detail design of key equipment to the stage where procurement of long lead items could be initiated
- Design verification in progress.
- Analysis progressing for the completion of the Safety Case (SAR).

*FUEL:*

- Advance Fuel Design quality and safety specifications aligned with NNR regulations (LD-1096, RD-0034) to relate performance of the PBMR advance fuel to reference fuel (German fuel).
- PBMR Advance Fuel manufactured in the Fuel Development Laboratories (FDL) was transported on $6^{th}$ September 2009 from RSA to INM (Russia) for testing.



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## DESIGN PROGRESS(2/2)

***FUEL PLANT:***

- A conceptual design based on the Hobeg plant has been completed.
- A basic design has been completed to a point where the following has been completed:
  - Process Flow and Piping and Instrumentation design to the point of completion of Hazop, Safety Assessment, Safety Instrumented Level analysis,
  - Establishment of design principles and approaches,
  - Completion of external hazard analysis including seismic, and
  - Completion of fire hazard assessment.

***MANUFACTURING:***

- Manufacturing and receiving inspection was successfully completed on the Top Plate Outer and the Top Flange Shell for the Core Barrel Assembly.
- Receiving inspection including additional Non Destructive Examinations were completed on half shell plates for the Reactor Pressure Vessel.
- Welding and NDE activities were completed on long welds joining 2 off half shell plates.

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## CURRENT DESIGN ACTIVITIES(1/2)

***POWER PLANT:***

- Recent market surveys have shown a **huge interest for PBMRs in the high-temperature process heat** or cogeneration applications (Coal-to-Liquid, Oil Sands).
- PBMR consequently decided to change its product focus to a **plant that will generate steam** for process heat applications or electricity generation or both (cogeneration).
- Established a Design Baseline from the HTR-Modul design (Reactor with indirect steam cycle power conversion).
- Updating the design to comply with modern regulatory and customer requirements.
- Identified the critical design trade-offs and issues that need to be addressed.

***FUEL:***

- Establishment of the PBMR Fuel Design Authority.
- Progressing with improving the fuel design regarding control mechanism for transport of fission products in normal and accident conditions.



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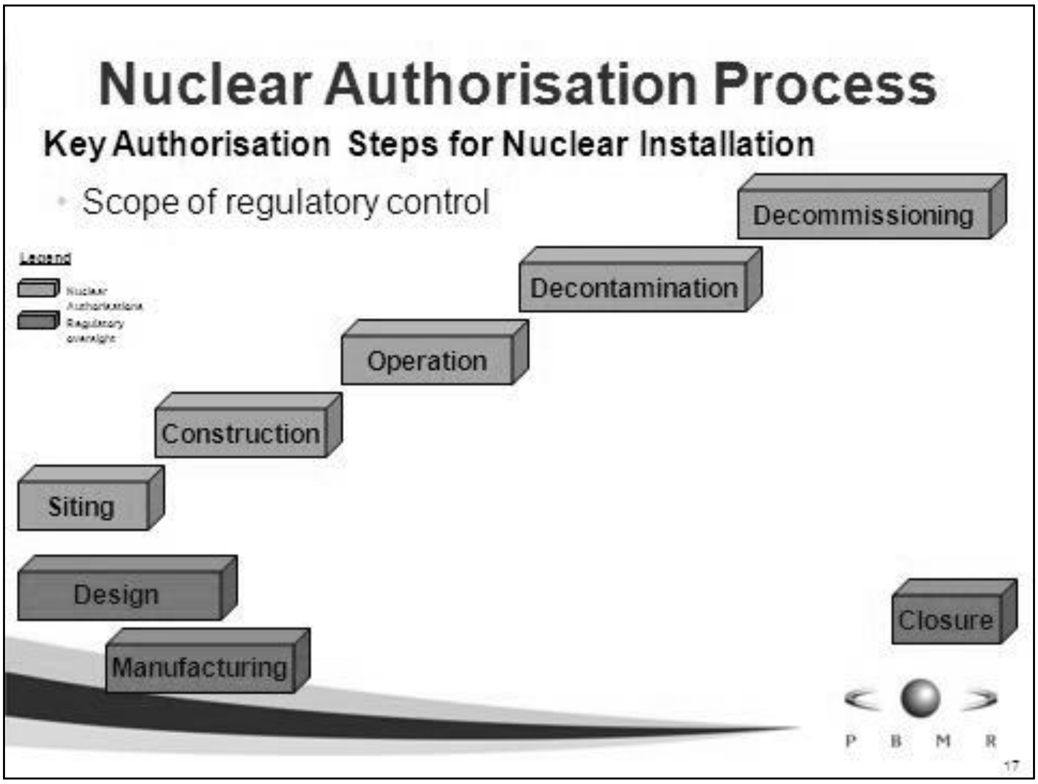
DESIGN REVIEWS
P B M R


Nuclear Authorisation Process
Key Authorisation Steps for Nuclear Installation
Scope of regulatory control
Legend
Nuclear Authorisations
Regulatory oversight
Decommissioning
Decontamination
Operation
Construction
Siting
Design
Manufacturing
Closure
P B M R
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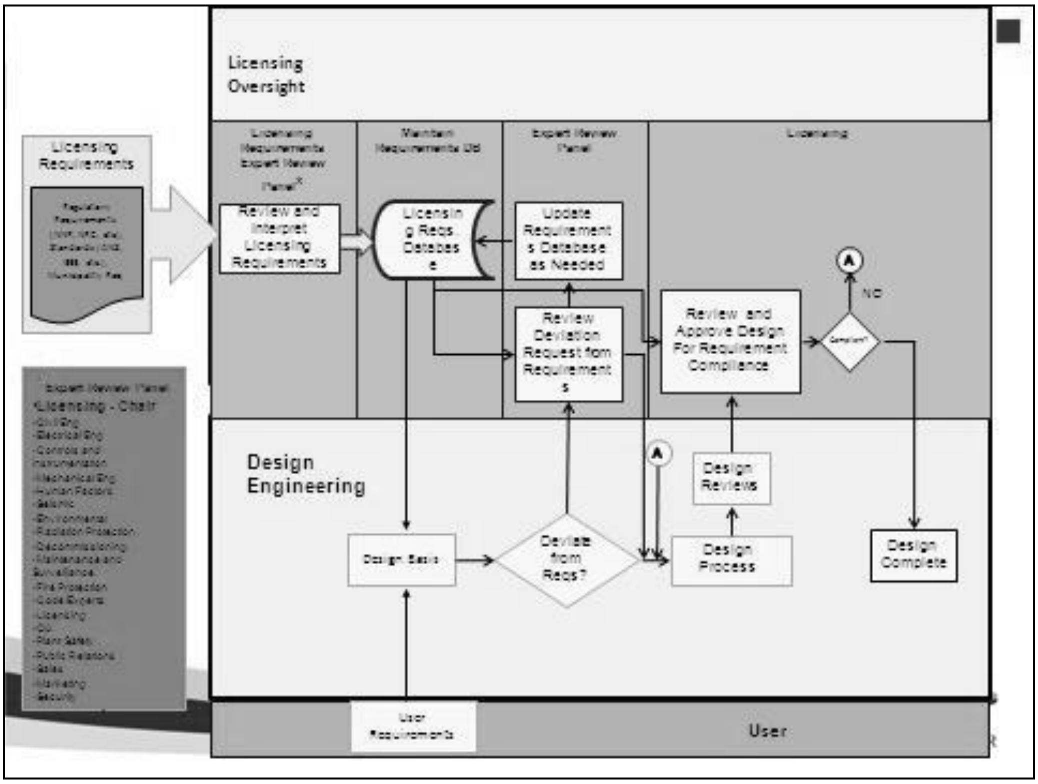


# DESIGN REVIEW ACTIVITIES

- Two types of reviews are performed:
  - Independent review of individual design deliverables for accuracy and completeness
  - Design reviews to determine design maturity
- Design reviews are planned at different Plant / SSC levels and are executed in accordance with a controlling procedure.
- Design reviews may cover a specific topic (e.g. Human Factors) or may cover the total design at a defined point in the project phase (e.g. End-of-Phase Review)
- Typical End-of-Phase design reviews include:
  - System Requirements Review (Is the requirement set complete?)
  - System Design Review (Is the system design appropriate?)
  - Critical Design Review (Is the design ready for manufacturing and procurement?)

  *Note: Risk identification and mitigation is an integral part of the design review*
- Design review requirements are placed on suppliers and attended by PBMR in accordance with applicable QA requirements.

## INTERNATIONAL COLLABORATIONS(1/2)

***DIGITAL INSTRUMENTATION CONTROL:***

- Design review of DPP400 (Direct Brayton Cycle) Thermo-hydraulic Control philosophy and algorithms at Westinghouse, Mannheim in October 2008.
- PBMR Employees representing South Africa on technical subcommittee 45A 'Instrumentation and control of nuclear facilities'.
- PBMR Employees have in the past participated in IAEA activities such as digital I&C licensing workshops, and classification of I&C functions.
- PBMR I&C engineers apply requirements / guidance from publications from the following organizations:
  - IAEA's (e.g. NS-G 1.3 'Instrumentation and Control Systems Important to Safety in NPPs')
  - IEC (e.g. IEC 61513 'NPPs – I&C important to safety – General requirements for systems')
  - US NRC (e.g. Regulator Guides and Interim Staff Guides)

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## INTERNATIONAL COLLABORATIONS(2/2)

**VENDOR INSPECTIONS COOPERATION:**

- None

***CODES AND STANDARDS:***

- PBMR Employees (x3) serve as volunteer members of the following ASME Boiler & Pressure Vessel Code Committees
  - Standards Committee Section III – Nuclear Facility Components (member)
  - Standards Committee Section XI – Nuclear In-service Inspection (member)
  - Sub-group on Graphite Core Components Section III (member)
  - Working Group HTGR Section III – Rules for Construction of HTGR (Chair)
  - Special Working Group HTGR Section XI – Rules for In-service Inspection of HTGR (Chair)
  - Sub-group Strategy and Management Section III (member).

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## BENEFIT FROM MDEP(1/3)

***DIGITAL INSTRUMENTATION CONTROL:***

- International peer review of Plant thermo-hydraulic control.
- Share in international experience in plant thermo-hydraulic control.
- Endorsement of a suite of codes, standards, principles and concepts applicable to I&C by regulators in various countries where PBMR may want to sell plants without having to significantly change the I&C design to meet local requirements.
- Harmonization between major I&C design standards (e.g. IEC and IEEE), such that a single I&C design can conform to both suites of standards.
- Lowered I&C project risk as result of:
  - 'up front' understanding of regulatory requirements; and
  - available and documented I&C safety principles and concepts.

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## BENEFIT FROM MDEP(2/3)

***VENDOR INSPECTIONS COOPERATION:***

- Cost savings benefit where Inspectors from other countries can represent PBMR in certain vendor inspection activities where PBMR cannot.
- Should any collaborations be formed bilateral information exchange arrangements between the Regulators would be a benefit.
- Regulators would have the advantage of the knowledge of their own country legislation to ensure that other Regulators understand them hence resulting in good knowledge of codes and standards.
- Collaborations might result in the use of common procedures by the different countries, where applicable.

***CODES AND STANDARDS:***

- Endorsement of a chosen suite of codes by regulators in various countries where PBMR may want to sell plants without having to change the design to meet local requirements
- A convergence in regulatory practices would ease the obtaining of a license in countries where PBMR may want to sell plants without having to change the design to meet local requirements.
- Enhanced regulatory cooperation could lead to a situation whereby a code, standard and/or code case accepted by one regulatory body could be more easily accepted by other regulatory bodies. This would avoid the duplication of effort in terms of a once-off presentation to one of the regulatory bodies.

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## Helium Test Facility

The HTF at Pelindaba tests the helium blower, valves, heaters, coolers, recuperator and other components at pressures up to 95 bar and 1200 degrees C.

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## Helium Test Facility: Pelindaba

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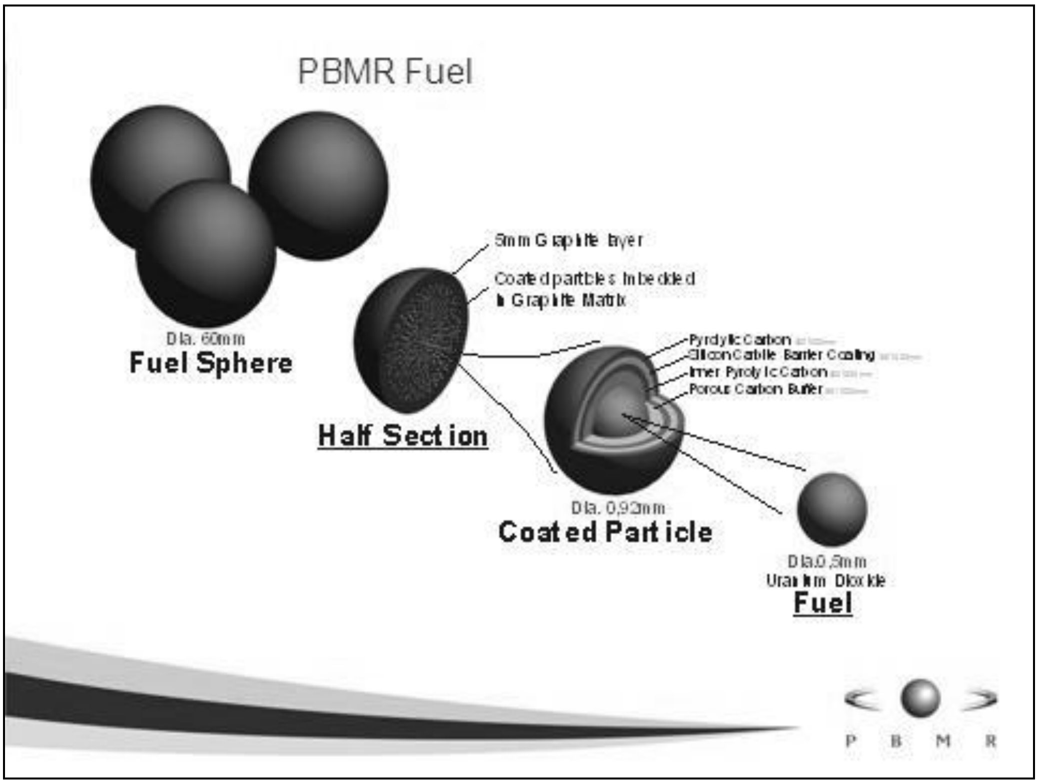
Test facilities at the North-West University
High Temperature Test Unit
High Pressure Test Unit
Pebble Bed Micro Model


Fuel Fabrication at Pelindaba


PBMR Fuel
Dia. 60mm
Fuel Sphere
5mm Graphite layer
Coated particles imbedded
in Graphite Matrix
Half Section
Pyrolytic Carbon
Silicon Carbide Barrier Coating
Inner Pyrolytic Carbon
Porous Carbon Buffer
Dia. 0,92mm
Coated Particle
Dia.0,5mm
Uranium Dioxide
Fuel
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**Session 4 (cont.)**

**Industry initiatives panel**

*(Panel member contributions can be found in Appendix A on page 229.)*

## Session 5

## Other international initiatives related to new reactor designs

**Session 5 summary**

The following persons made remarks and presentations on international initiatives related to new reactor designs:

- Koichiro Nakamura, Deputy Director-General, NISA, Japan and chair of Session 5
- Philippe Jamet, IAEA, Director, Nuclear Installation Safety
- Mike Weightman, NEA/CNRA Chair, HM Chief Inspector, UK Nuclear Installations Inspectorate, and MDEP PG member
- Dana Drábová, WENRA Chair, Chairman State Office for Nuclear Safety in Czech Republic
- Richard Meserve, INSAG Chair and President of the Carnegie Institution

The purpose of this session was to provide information about other regulatory activities that are taking place in other fora and how they can contribute to increased standardisation of designs, requirements, and standards. The topics focused on design activities and accomplishments, and views on recommendations to achieve positive results of co-operation with MDEP.

Jamet addressed relevant activities being undertaken by the International Atomic Energy Agency (IAEA) that support standardisation of regulatory approaches as well as design review activities for new reactors. More specifically, the IAEA provides safety standards at a high level as well as general safety requirements and specific safety requirements pertaining to new reactor activities. The safety standards represent international consensus on best international practices to achieve a high level of safety.

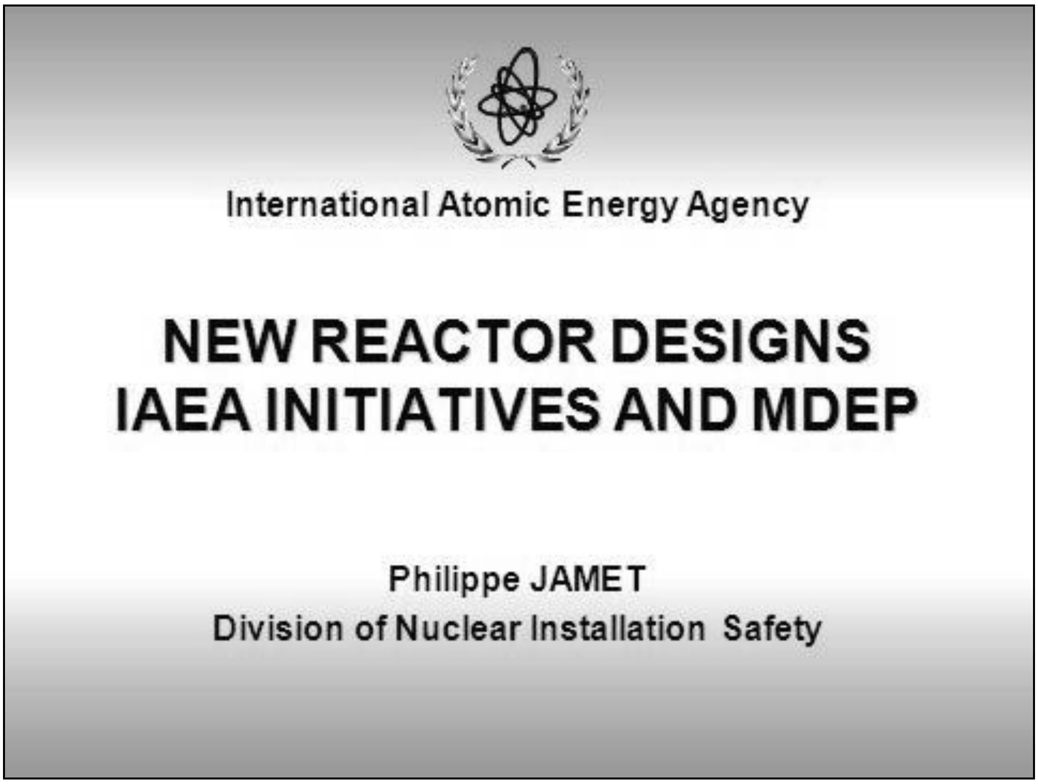
Weightman addressed relevant activities being undertaked by the Committee on Nuclear Regulatory Activities' (CNRA) Working Group for the Regulation of New Reactors (WGRNR). WGRNR is responsible under the CNRA for the programme of work dealing with regulatory activities in the primary programme areas of siting, licensing and oversight for new commercial nuclear reactors. WGRNR also serves as the focal point of communications between CNRA and MDEP to ensure effective use of resources and to preclude unnecessary redundancy in workloads.

Drábová addressed the activities of the Western European Nuclear Regulators Association which includes 17 European countries (and five European observers). With respect to work relevant to new reactor design activities, WENRA's structure includes the Reactor Harmonisation Working Group (RHWG), which has as its aim the harmonisation of safety approaches to continuously improve nuclear safety. WENRA is working on the formulation of safety objectives for new reactors and plans to maintain close contact with MDEP (in which there are several WENRA members).

Richard Meserve addressed the activities of INSAG with regard to MDEP and the global nuclear safety regime. He reiterated the importance of regulators and other stakeholders to uphold the safety standards that have been established and to continue to share information to enhance the safety regime. He acknowledged that MDEP is an important vehicle for sharing safety insights; the MDEP serves to advance international harmonisation; and the MDEP nurtures co-ordination among regulators in assuring compliance with standards for internationally sourced parts and components.

**IAEA representative**

*Philippe Jamet, Director, Nuclear Installation Safety*



## New Reactor Designs
## IAEA Initiatives and MDEP

- IAEA Safety Standards and Services
- Recent IAEA initiatives related to new reactor designs
- Relation between IAEA initiatives and MDEP
- Conclusions

2 International Atomic Energy Agency

## IAEA Statute (Article III.A.6)

- "To establish or adopt… [in consultation with…] standards of safety for the protection of health and minimization of danger to life and property"
- "…and to provide for the application of these standards"

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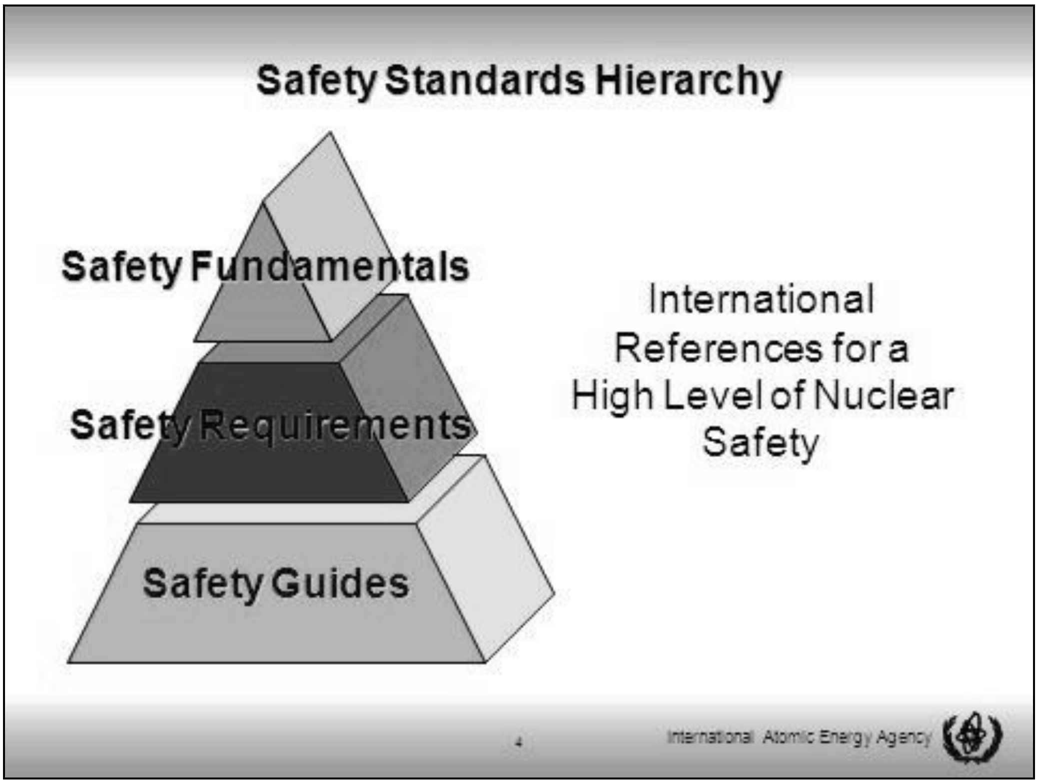
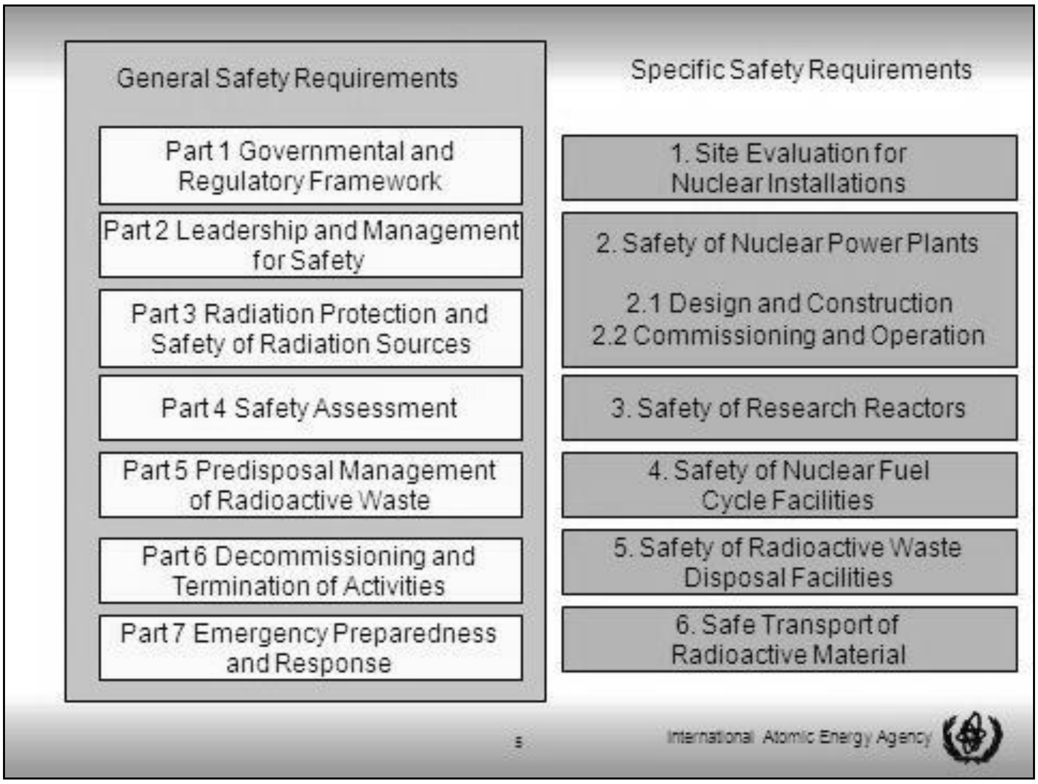

Safety Standards Hierarchy
Safety Fundamentals
Safety Requirements
Safety Guides
International References for a High Level of Nuclear Safety
4
International Atomic Energy Agency


General Safety Requirements
Part 1 Governmental and Regulatory Framework
Part 2 Leadership and Management for Safety
Part 3 Radiation Protection and Safety of Radiation Sources
Part 4 Safety Assessment
Part 5 Predisposal Management of Radioactive Waste
Part 6 Decommissioning and Termination of Activities
Part 7 Emergency Preparedness and Response
Specific Safety Requirements
1. Site Evaluation for Nuclear Installations
2. Safety of Nuclear Power Plants
2.1 Design and Construction
2.2 Commissioning and Operation
3. Safety of Research Reactors
4. Safety of Nuclear Fuel Cycle Facilities
5. Safety of Radioactive Waste Disposal Facilities
6. Safe Transport of Radioactive Material
5
International Atomic Energy Agency

## Development of Safety Standards

- Development process involving:
  - International Commission
  - International Technical Committees
  - Consultation of IAEA Member States
  - Recognized experts
- Member States approve standards through the Board of Governors or the Director General of the IAEA

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## Status of Safety Standards

**Safety Standards represent international consensus on best international practices to achieve a high level of safety**

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## Utilization by Member States

- Formally adopted (i.e. China, Netherlands)
- Direct use of standards to establish regulation (i.e. Canada, Czech Republic, Germany, India, Korea, Russian Federation)
- Used as reference for review of national standards and situations (by all States, also by Industry)
- Used by International Organizations (European Safety Directive, WENRA)



## IAEA Safety Review Services

- Regulatory Framework and Activities
  IRRS – Integrated Regulatory Review Service
- Operational Safety
  OSART – Operational Safety Review Team
  SEDO – Safety Evaluation of Fuel Cycle Facilities During Operation
  SCART – Safety Culture Assessment Review Team
- Research Reactors
  INSARR – Integrated Safety Assessment of Research Reactors
- Engineering and Technical Safety

## IAEA Initiatives related to new reactor designs

### Generic Reactor Safety Review

- Asses compliance of the design with relevant safety standards
- All stages of the design

  (From first conceptual documentation to Safety Analysis Report)

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## Relevant Safety Standards For Generic Reactor Safety Reviews (GRSR)

Safety Fundamentals (SF-1)

Safety Assessment Requirements (GS-R-4)

Requirements for the Design of NPPs (NS-R-1)

Safety Standards against which the review will be conducted

Guides for the Design

Guides for Assessment

Supporting Safety Guides

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## Approach for GRSR

### Reviews of reactor safety documentation by international experts

- **Completeness**
  Gaps with respect to the Safety Standards Requirements?
  Evidence that substantiates the safety claims and arguments?
- **Comprehensiveness**
  All features of installation?
  All modes of operation?
  Entire lifetime?



## GRSR already performed

| Reactor | Document | Counterpart | Member State |
|---|---|---|---|
| ACR 1000 | Safety case submitted for UK Bid | NII | UK |
| AP 1000 | Safety case submitted for UK Bid<br>Safety and Environmental Report | NII<br>Westinghouse | UK<br>US |
| APR 1400 | Safety and Environmental Report | KHNP | KOREA |
| ATMEA 1 | Conceptual Design Safety File | ATMEA | FRANCE |
| EPR | Safety case submitted for UK BID | NII | UK |
| ESBWR | Safety case submitted for UK BID | NII | UK |

## Experience from GRSR

- Can be applied to mature designs as well as to concepts
- Support Member States in evaluation of new reactor safety
- Contribute to form a basis for harmonization of safety approaches
- Valuable feedback for Standards interpretation, clarification and future update
- Show potential for early evaluation of innovative reactors

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## Support provided by GRSR to Member States

Provide valuable input for individual evaluation or the national licensing process

**BUT**

Does not constitute any form of licensing or design certification

- No evaluation of the implementation of the requirements
- No evaluation of the correctness of technical claims

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## Participation of IAEA to MDEP

IAEA takes active part in the work of MDEP in order to:

- Ensure effective communication and alignment with activities in similar areas
- Provide viewpoints from the IAEA Safety Standards which provide a general level of harmonization
- Enhance further the safety standards based on feedback from its use in MDEP

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## Safety Standards as one of the basis of MDEP

With respect to harmonization, MDEP pilot project concluded that:

"In many aspects there is already a significant degree of harmonization at a general level in the form of the IAEA safety standards: further harmonization will be assisted by building on these internationally agreed documents."

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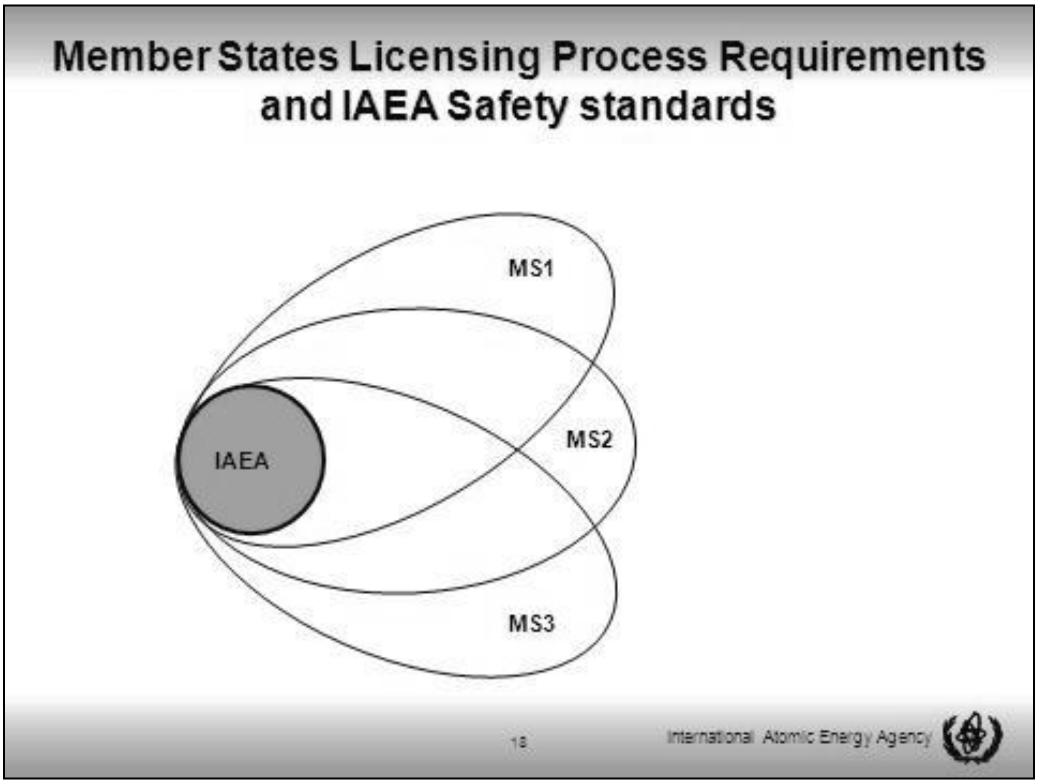
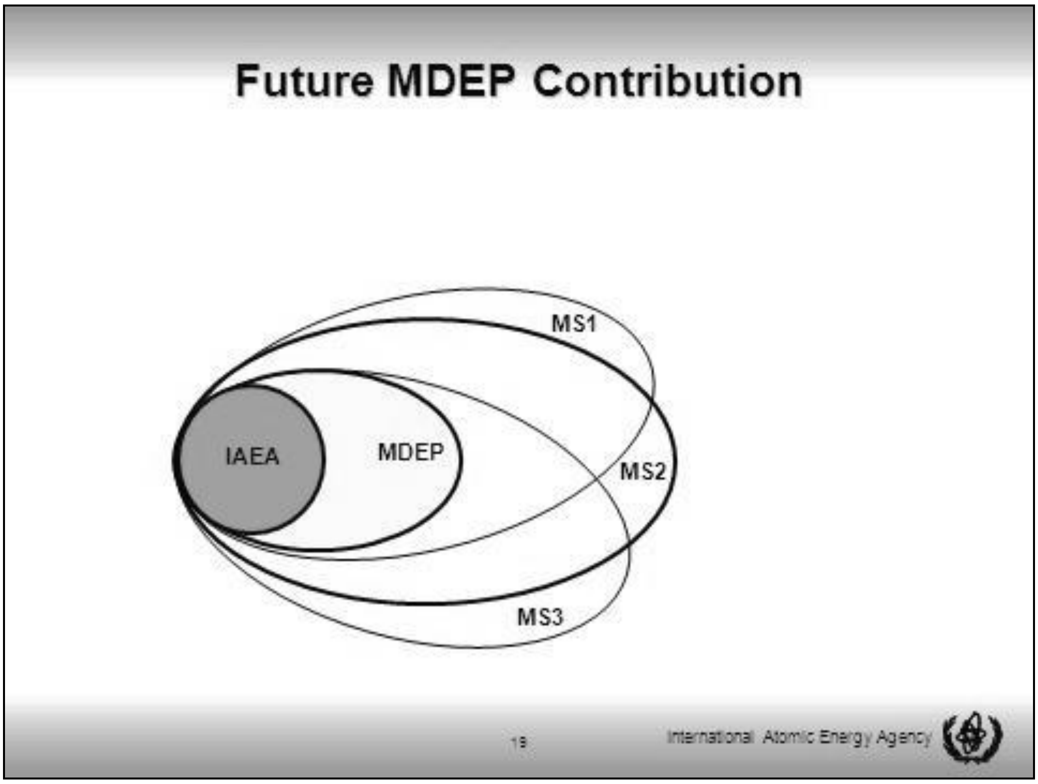

Member States Licensing Process Requirements and IAEA Safety standards
MS1
IAEA
MS2
MS3
18
International Atomic Energy Agency


Future MDEP Contribution
MS1
IAEA
MDEP
MS2
MS3
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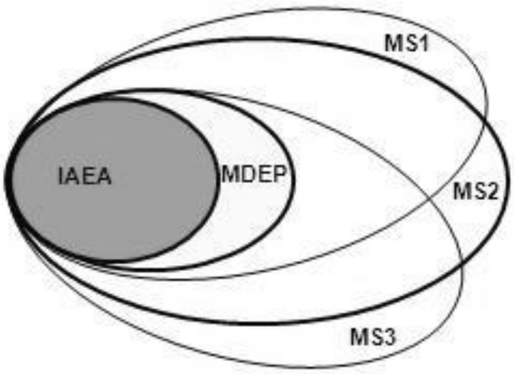
## Future MDEP Contribution to IAEA Safety standards

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## CONCLUSIONS

- IAEA is successfully performing safety reviews of new reactor designs using the current Safety Standards
- IAEA is participating actively in MDEP
- Current Safety Standards are a first basis for harmonization
- The results of MDEP should be used as a basis to further extend the IAEA Safety Standards

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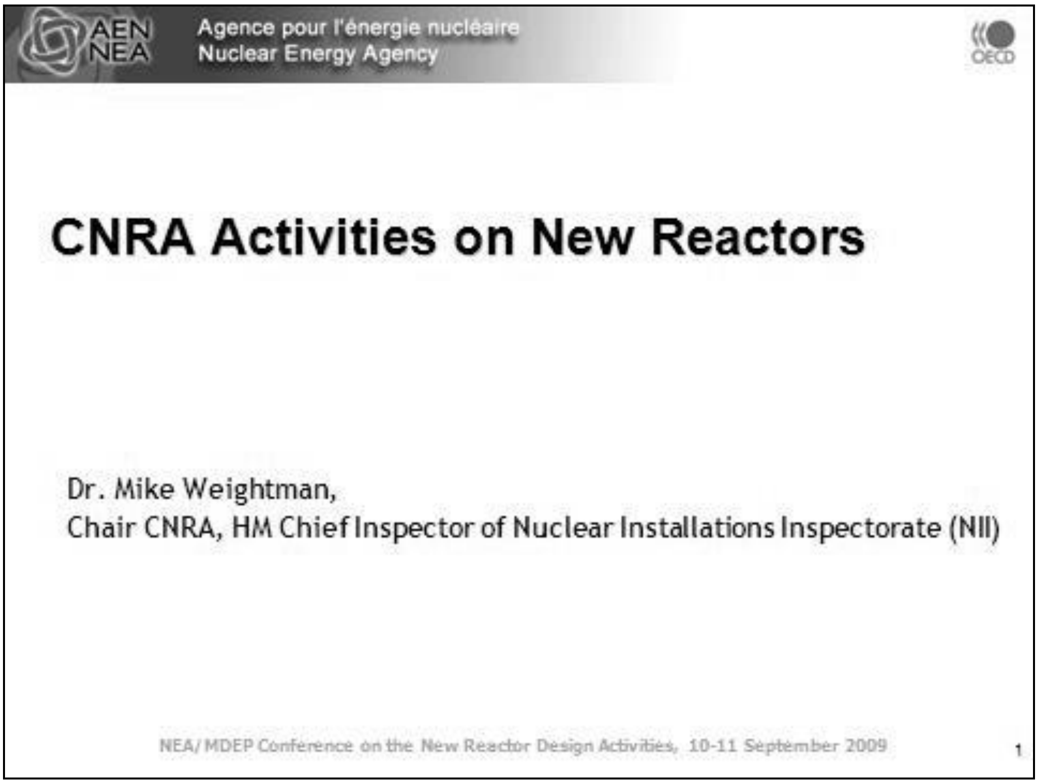
**NEA/CNRA representative**

*Mike Weightman, HM Chief Inspector,*
*Nuclear Installations Inspectorate (NII)*
*Chair, CNRA*



AEN NEA Agence pour l'énergie nucléaire Nuclear Energy Agency OECD

## Contents

- NEA Committee on the Nuclear Regulatory Activities
- WGRNR Mandate and Membership
- Programme of Work (PoW)
  - Construction Experience Database/Assessment
  - Survey on the Regulation of Site Selection and Preparation
  - Develop Report on Licensing Process and Structure of Regulatory Activities
- Expected Use of WGRNR Results and Products

NEA/MDEP Conference on the New Reactor Design Activities, 10-11 September 2009 2

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## *Committee on Nuclear Regulatory Activities (CNRA)*

- One the 7 NEA standing committees, made up of senior nuclear regulators
- Responsible for the programme of the NEA, concerning the regulation, licensing and inspection of nuclear installations with regard to safety.
- It comprises 4 working groups on Operating Experience, Inspection Practices, Regulation of New Reactors and Public Communications
- CNRA products: Green Booklets, WG's Reports, Workshop Proceedings

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### Working Group on the Regulation of New Reactors (WGRNR)

- Established in 2007
- Responsible for the programme of work in the CNRA dealing with regulatory activities in the primary program areas of siting, licensing and oversight for new commercial nuclear power reactors (Generation III+ and Generation IV reactors).
  - Forum of experts for the licensing of new NPP
  - Co-ordinate its work with the work performed by MDEP
  - Closely co-ordinate its work with others CNRA and CSNI WGs and international organisations





### WGRNR Current Membership

- Chair – Mrs. Laura Dudes (USNRC)
- Vice Chair – Mrs. Rosa Sardella (ENSI)
- Participating Countries
  - Canada, Czech Republic, Finland, France, Hungary, Japan, Korea (Republic of), Russian Federation, Slovak Republic, Slovenia, Spain, Switzerland, United Kingdom, United States of America
  - IAEA and EC
- Expected Participants
  - Italy, Poland, China, South Africa, United Arab Emirates

## Construction Experience Database (ConEx)

- Objective
  - To develop a database of findings and deficiencies related to design, construction, and commissioning of new NPPs
  - to provide the means for assessing the findings in order to extract and share construction experience lessons learned, developing a qualitative assessment scheme on the safety significance
  - Past construction experience will be included if the lessons learned are applicable to new reactors
- Existing records involving French, Finnish, Japanese, UK and US findings





## Construction Experience Database (ConEx)

- An Evaluation and Clearinghouse group is established to assess the findings in order to extract and share construction experience lessons learned
- Periodic assessments of construction experience
  - Synthesize report of the current information available on construction experience, underlying causes and lessons learned
  - Identify areas for future activities

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Nuclear Energy Agency

OECD

## Regulation of Nuclear Sites Selection and Preparation

- Report based on a survey is under development, covering the Evaluation and selection of nuclear sites as well as the Preparation of the selected site
- Review practices used by regulators in NPP siting
  - Seismicity, security, multi-units
- Consider regulatory practices on sites where a mixture of activities is taking place
  - Operating units, decommissioning

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## Regulation of Nuclear Sites Selection and Preparation

- Further considerations under review
  - Public consultation/involvement during the site selection process
  - Definition of construction, site preparation
  - Commissioning activities
  - Impact of the site on the design

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Nuclear Energy Agency
OECD

***Licensing structure of Regulatory Staff and Regulatory licensing process for new reactors***

- Review of recent regulatory experience
  - licensing structures,
  - number of regulatory personnel and the skill sets needed to perform reviews, assessment and construction oversight, and
  - training needed for these activities
- Comparison report on the licensing processes
  - level of detail of design information needed for regulatory authorisation at the various stages of licensing

NEA/MDEP Conference on the New Reactor Design Activities, 10-11 September 2009 10

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Nuclear Energy Agency
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***Interaction with MDEP***

- Most of the MDEP countries participate in the WGRNR
- Joint meetings of MDEP STC and WGRNR Chairs
- Report on current status of MDEP in all meetings of the WGRNR and vice versa

NEA/MDEP Conference on the New Reactor Design Activities, 10-11 September 2009 11

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Nuclear Energy Agency
OECD

### *Expected Use of WGRNR Results and Products*

- Uses and Feedback for design and siting reviews and construction oversight of the ConEx collection and assessment
- Improvement of the regulatory reviews of the Site Selection and Preparation thru the comparison report on current practices used by member countries
- Enhancements of the regulatory licensing process by the comparison of best practices used in member countries
- Promote cooperation among member countries to feedback the experience to safety improving measures, enhancing the efficiency and effectiveness in the regulatory process

NEA/MDEP Conference on the New Reactor Design Activities, 10-11 September 2009 12

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Nuclear Energy Agency
OECD

### Working Group on New Reactors: Summary

- Complementary to MDEP
- Broadens MDEP work to wider range of nuclear regulators
- Looking at the regulatory activities associated with the implementation of regulatory Design Evaluation, e.g.
  - Licensing sites
  - Regulating Construction
  - Regulating Supply
  - Regulating commissioning
- Aims to maximise mutual learning, harmonisation, efficiency and effectiveness of regulation of new reactors construction, commissioning, etc
- Uses the work of other CNRA, CSNI, NEA working groups and committees – acts as the interface

**WENRA representative**

*Dana Drábová, WENRAChair, Chairman, State Office for Nuclear Safety*

WENRA
Western European Nuclear Regulator's Association

### Basic Facts

- WENRA is an association of the heads of Nuclear Regulatory Authorities of the EU countries with NPPs and Switzerland
- The original ToR* was signed on **4 February 1999**
- WENRA has
  - **17 members:** Belgium*, Bulgaria, Czech Republic, Finland*, France*, Germany*, Hungary, Italy*, Lithuania, Netherlands*, Romania, Slovakia, Slovenia, Spain*, Sweden*, Switzerland*, United Kingdom*
  - at present **5 observers** (non-nuclear countries): Austria, Ireland, Luxemburg, Norway and Poland

www.wenra.org

WENRA
Western European Nuclear Regulator's Association

### Expectations

- Workers & public in Europe expect equivalent levels of safety in operation of nuclear power plants
- In practice this means that there should be:
  - "No substantial differences between countries from the safety point of view in generic, formally issued, national safety requirements, and in their resulting implementation on Nuclear Power Plants"
- Also
  - Independent of regulatory regime & NPP design

www.wenra.org

WENRA
Western European Nuclear Regulator's Association

## Main Objectives

- **To develop a common approach to selected nuclear safety and radiation protection issues and regulation, in particular within the EU**
  - *National safety approaches have been developed from IAEA Safety Standards, the Convention on Nuclear Safety, industrial standards etc., but independently…*
- **To provide the EU with an independent capability to examine nuclear safety and regulation in (future) applicant countries**
  - *Nuclear safety was included in the European Union set of enlargement criteria…*
- **To serve as a network of chief nuclear safety regulators exchanging experience and discussing significant safety issues**

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WENRA
Western European Nuclear Regulator's Association

## Main Achievements in 10-Year History

- **WENRA has become an internationally recognized association with a unique methodology, and has**
  - contributed to improvement of national nuclear safety requirements through the formulation of common SRLs
  - contributed to improvement of the IAEA safety standards
  - created a new platform for open information exchange among regulators
- **2000 – Report on Nuclear Safety in EU Applicant Countries**
- **2006 – Report on Harmonization of Reactor Safety in WENRA Countries**

www.wenra.org

Western European
WENRA
Nuclear Regulator's Association

## Working Groups – RHWG and WGWD

Two Working Groups established to **harmonise** safety approaches with the aim to continuously improve nuclear safety in the following target areas:

- **Reactor Safety**
  - **Reactor Harmonisation Working Group (RHWG)**
- **Radioactive Waste, Spent Fuel Storage, Decommissioning**
  - **Working Group on Waste and Decommissioning (WGWD)**

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## RHWG Activities

- **Original mandate** of RHWG (harmonization of requirements for existing reactors) **fulfilled, follow-up ongoing:**
  = monitoring of national action plans
  = experience feedback on update of regulations
  = ensuring non-divergence of interpretations
- **New task** (2008) – formulation of **safety objectives for „new reactors"**

www.wenra.org

WENRA

## Rationale for a study on new reactors

- Support WENRA's vision of a comparable, high level of nuclear safety in Europe
  - Influence, from the European regulators' perspective, the safety standards for new plants
  - Further improve the safety of existing plants
  - Basis for keeping Reference Levels for existing reactors up to date

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WENRA

## Expected content of the report on new reactors

- What do we mean by "new reactors"
- Safety objectives for new reactors
  - Qualitative high-level objectives
  - Improvements gained using these objectives (compared to existing reactors)
- Quantitative safety goals to drive compliance with safety objectives
- Areas for technical improvements in meeting the safety objectives
- Recommendations on the use of the safety objectives
- Applicability of Reference Levels for existing reactors

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WENRA

## Review of the relevant documentation

- IAEA SF-1 (2006) - Fundamental safety principles
  - Systematic investigation of the FSP
- INSAG-10 and 12
- NEA documentation
- National regulations:
  - Bulgaria, Finland, France/Germany, UK
  - USA, Canada
  - SKI reports on probabilistic safety goals
- European Utilities Requirements document

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## Safety objectives (1)

- The IAEA SF-1 document is a sound basis for the safety objectives for new reactors
- FSP 5 : "optimization of protection" (improve safety as far as reasonably achievable)
  - For new reactors, more significant improvements become reasonably achievable, in particular concerning severe accident management in the short and long term
- FSP 3, 6, 7, 8 are especially relevant to formulate safety objectives for new reactors

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## Safety objectives (2)

- FSP 3 "effective leadership and management of safety"
  - Safety objective related to a coordinated safety approach among organizations
- FSP 6 "limitation of risks to individuals" and FSP 7 "protection of present and future generations"
  - Reduce the impact of normal operation
- FSP 8 "Prevention of accidents"
  - Reinforce each level of defence-in-depth
  - Reinforce the independence of these levels

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## On-going work (1)

- Quantitative goals to drive compliance
  - For each safety objective : are there quantitative goals related to this objective
  - Exploration of potential quantitative safety goals that are already used in some countries
  - Including probabilistic goals
  - On which of these goals can we find a consensus ?
  - How to use of these goals ?

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## On-going work (2)

- Reinforcement of the Defence in Depth for new reactors
  - the practicability of safety improvements at design stage is greater than that for an operating plant, more stringent application of the reference levels is expected for new reactors.
  - there is room for safety improvements that go beyond the intent of the reference levels for existing reactors and which reflect the use of state-of-the art methodologies and techniques and the results of safety research.

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## On-going work (3)

Classification of the applicability of the RLs to new reactors :

- Fully applicable
- Applicable but greater expectations
- More stringent description is necessary
- Issue which is not covered by the RLs

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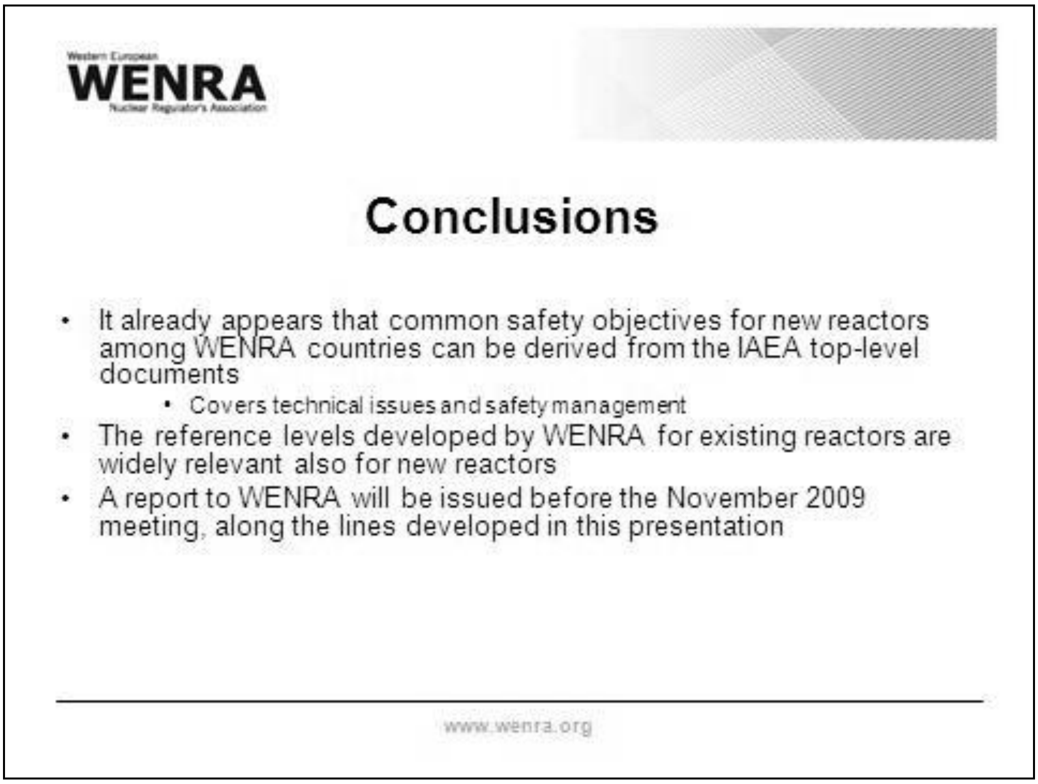
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Conclusions
• It already appears that common safety objectives for new reactors among WENRA countries can be derived from the IAEA top-level documents
• Covers technical issues and safety management
• The reference levels developed by WENRA for existing reactors are widely relevant also for new reactors
• A report to WENRA will be issued before the November 2009 meeting, along the lines developed in this presentation
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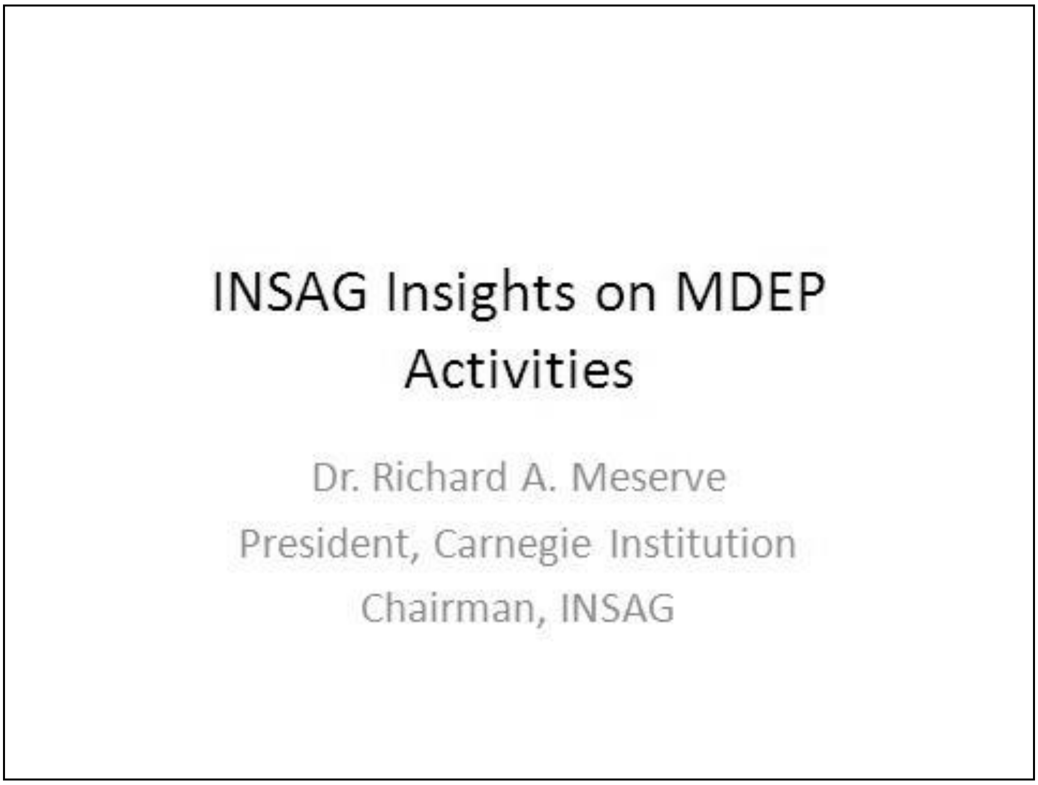
**INSAG insights on MDEP activities**

*Richard Meserve, Chair, INSAG*
*President, Carnegie Institution*



## Outline

- Context for remarks
- MDEP and the Global Nuclear Safety Regime
- The special challenge of new entrant states

## Context

- Special role of nuclear power in a changing world
- The abiding responsibility to ensure safe operations
- The special challenges in fulfilling this responsibility
  - New construction around the globe
  - Interest in new construction by new entrant states

# The Global Nuclear Safety Regime

- Essential and continuing central for operators and national regulators to maintain safety.
- But Global Nuclear Safety Regime is an important backstop of increasing importance.

# Global Nuclear Safety Regime

## MDEP and the Global Nuclear Safety Regime

- MDEP is an important vehicle for sharing safety insights
- MDEP serves to advance international harmonization
- MDEP nurtures coordination among regulators in assuring compliance with standards for internationally sourced parts and components

## New Entrants

- A country embarking on its first NPP must make a commitment to safety that endures for over a century and includes financial, legal, regulatory, technical, cultural, educational and social components.
- An early obligation is the development of a full understanding of the design of a prospective plant.
- MDEP should play a role in assisting the new entrants in this task, either directly or through a participating regulator

## Conclusions

- The world is changing in dimensions important to safety
- MDEP can play an important role in the Global Nuclear Safety Regime.
- Assistance to the new entrant states is in the interest of all and MDEP should play a role either directly or through a participating regulator.

# Session 6

## Concluding panel

## Session 6 summary

The following participants made remarks and/or presentations on the conference results and discussed how to interact in the future to benefit from the work of MDEP and other groups on harmonisation efforts:

- André-Claude Lacoste, President of the French Nuclear Safety Authority, chair of MDEP's Policy Group and chair of the concluding panel
- Luis Echávarri, Director-General of the OECD/NEA
- Gregory Jaczko, US Nuclear Regulatory Commission, Chairman, and MDEP Policy Group member
- Luc Oursel, AREVA, President and CEO of AREVA NP
- Yonezo Tsujikura, Senior Advisor, Japanese Federation of Electric Power Companies
- Bryan Erler, American Society of Mechanical Engineers (ASME) Nuclear Codes and Standards, Vice-President
- Ulrich Schmocker, Director, Federal Nuclear Safety Inspectorate (ENSI)

During the panel two brief presentations/papers were introduced by Dr. Tsujikura, regarding MDEP activities in Japan, and by Mr. Schmocker, regarding the Swiss situation on new builds. The different panel members expressed their assessment of the conference results and suggested different aspects to reinforce MDEP and enhance the programme. MDEP members noted the importance of the activity for their regulatory organisation and stated that openness of programme for other regulators, not part of MDEP, should be strengthened. They underlined the sovereign authority of each member of MDEP and cautioned against proposals where this national responsibility would be questioned. From the industry side, MDEP was seen as an important initiative towards a larger degree of harmonisation and a key condition for strong public acceptance. Convergence was considered as a win-win subject for all stakeholders. They supported the CORDEL proposal to dedicate more resources to be able to reach meaningful results in the short term. The representative from the code organisations welcome the MDEP initiative and the chance to interact with specific activities. The importance of standardisation of codes and procedures for large components was underlined. From the non-MDEP regulators, the conference was well received and the need to continue interacting with MDEP was fully supported. MDEP was also seen as a good input for existing plants.

Mr. Lacoste then closed the panel discussion with some preliminary conclusions:

- MDEP is an initiative pooling an effective and efficient expert network. Efforts need to be maintained.
- Great expectations from MDEP up to worldwide certification of new designs. Proposal to be discussed by Policy Group.
- Standardisation vs. harmonisation. Further efforts are needed.
- Strenghthen the use of MDEP results. Application to operating plants.
- Improve dissemination of MDEP information to other stakeholders.

He then concluded that in view of the success of the conference he will propose to the MDEP Policy Group to hold another conference in two years. He finally thanked all participants and the NEA for arranging the conference.

Mr. Echávarri thanked Mr. Lacoste for chairing the meeting, thanked all the Policy Group members for supporting the event and all the participants for making the conference a very valuable and successful conference. He expressed the continued support from the NEA to the MDEP initiative.

## Concluding remarks

*André-Claude Lacoste, Chairman, ASN*
*MDEP Policy Group (PG) Chair*

## Initial Personal Views and Expectations

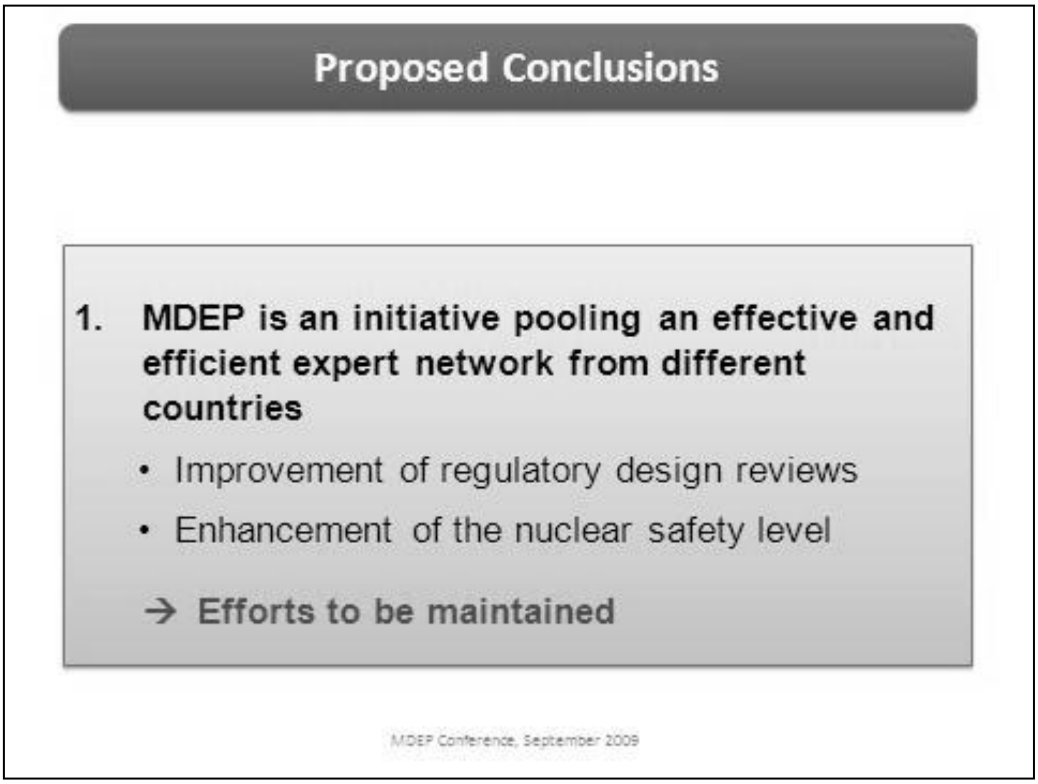
1. **MDEP is a key programme** for new build activities
2. **MDEP is a mid and long-term programme, but short-term concrete results are necessary**
3. To be efficient, MDEP needs to concentrate on **a limited number of pertinent topics**
4. Each working group needs to have an **action plan** :
   → Final and interim objectives, clear schedule and periodic reports
5. Convergence of regulatory practices will finally lead to convergence of regulatory requirements

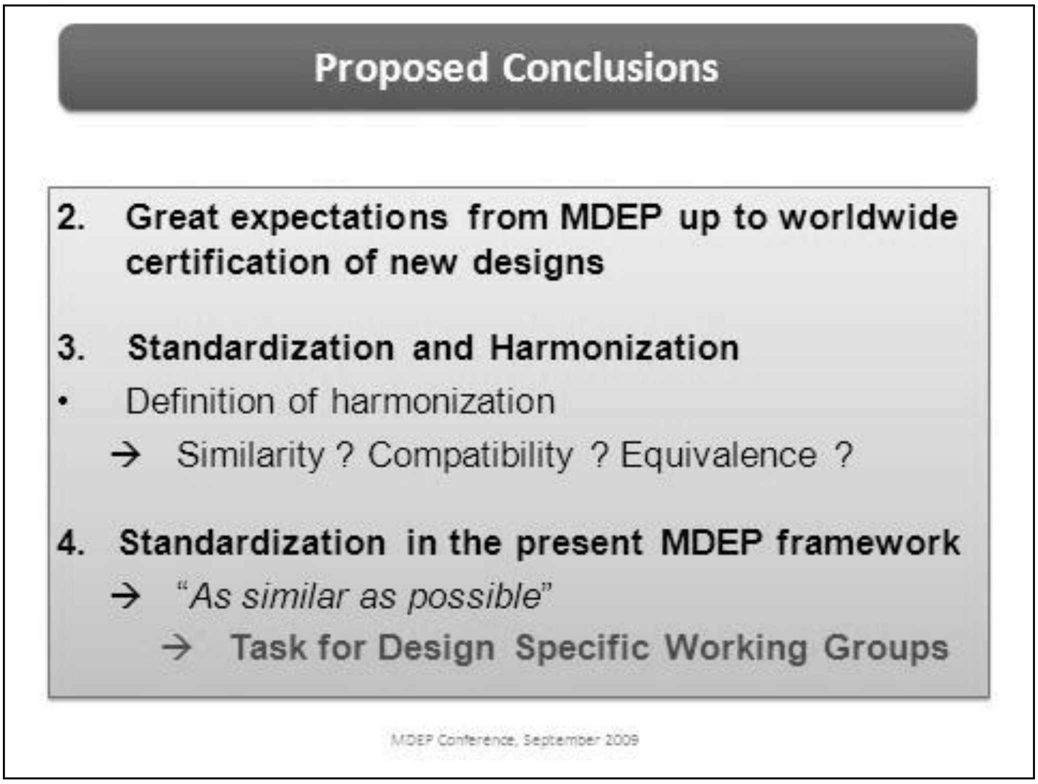
MDEP Conference, September 2009

## Initial Personal Views and Expectations

6. **MDEP needs the active involvement of all stakeholders** : Regulatory Bodies, Vendors and Operators
   → **Regular exchanges between all stakeholders**

MDEP Conference, September 2009


Proposed Conclusions
1. MDEP is an initiative pooling an effective and efficient expert network from different countries
• Improvement of regulatory design reviews
• Enhancement of the nuclear safety level
→ Efforts to be maintained
MDEP Conference, September 2009


Proposed Conclusions
2. Great expectations from MDEP up to worldwide certification of new designs
3. Standardization and Harmonization
• Definition of harmonization
→ Similarity ? Compatibility ? Equivalence ?
4. Standardization in the present MDEP framework
→ "As similar as possible"
→ Task for Design Specific Working Groups
MDEP Conference, September 2009

## Proposed Conclusions

5. **Serial manufacturing of primary components**
→ Anticipated manufacturing
→ Certification and approval of off the shelt components
→ **Task for Vendor Inspection Working Group**

6. **Codes and Standards**
7. **Instrumentation and Control**

**To maintain WG efforts**

MDEP Conference, September 2009

## Proposed Conclusions

8. **CORDEL proposal**
→ **Need for a policy discussion**

9. **To strengthen the use of MDEP achievements**
→ For operating NPP (Ageing, Updating, Periodic Safety Reviews)

10. **To improve information dissemination to:**
- Participating Authorities
- Non-Participating Authorities
- Newcomers
- Industry stakeholders
- Public

MDEP Conference, September 2009

# Appendix A

## Additional contributions from Sessions 2, 3, 4 and 6

## Additional contributions from Session 2

**AREVA representative (EPR Reactor Vendor)**

*François Bouteille*
*Senior Vice-President, Safety and Licensing, Olkiluoto 3 Licensing Manager*

# Design specific activities panel

François Bouteille
Senior Vice President
Safety and Licensing
AREVA NP

AREVA

## Introduction

- AREVA is engaged in several Licensing process based on the same original design but in different Regulatory framework
  - Construction of Olkiluoto 3
  - Construction of Flamanville 3
  - Construction of Taishan 1&2
  - Design Certification ongoing in the USA
  - GDA process ongoing in the UK
- There are a lot of exchanges between Regulators within the EPR WG which is welcome by AREVA
- But interactions between the MDEP EPR WG and AREVA have been scarce

The issue of managing the design differences which may result from these different regulatory landscape is a key issue for AREVA

NEA/MDEP Conference on New Reactors Design Activities - September 10-11, 2009 – Paris (France) 3

AREVA

## How AREVA manage this issue internally

- Key objective is to combine into a <u>reference design</u> a consistent and optimum set of technical features based on experience feedback accumulating from actual on-going EPR projects, bids, licensing or other initiatives, in order to:
  - Improve quality by stabilized continuous industrial processes
  - Facilitate Licensing
  - Minimize risks for all parties during Project implementation
  - More generally, take into account the Lessons Learnt from the experience
  - Facilitate EPR Projects engineering activities through:
    - Replication of a sound and optimized design to the maximum extent possible
    - Focus on project-specific adaptation studies
  - Introduce scale effects which should be favorable on the quality
    - For AREVA NP manufactured primary components
    - For subcontracted equipments

The target is to converge as much as possible towards a unique reference design : The Standard EPR™ Reactor

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AREVA

## The Standard EPR™ Reactor: a real project

- The Standard EPR™ definition is managed like a real project and is implemented/deployed in gradual steps. It is currently benefiting from:
  - Current on-going projects: Olkiluoto 3, Flamanville 3, Taishan 1&2
  - AREVA NP internal Project to optimize the product
  - R&D
  - US EPR Design Certification
  - UK EPR Generic Design Assessment
- A dedicated management and coordination unit has been established with its own resources to work on the Standard EPR™ Nuclear Island
- A dedicated internal Committee has been established:
  - EPR Configuration Management Board (ECMB) to review major technical topics and to monitor the configuration evolution

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AREVA

## Anticipated Manufacturing of Primary Components

- One key objective of AREVA is to standardize the design and manufacturing of NPP major components in order to
  - Improve quality by stabilized continuous industrial processes
  - Reduce risks during the project Implementation
- The regulatory conformity assessment process as it is today induces constraints which does not allow manufacturing of components independently of the end-user
- AREVA proposes that the Vendor Inspection Co-operation WG analyze the issue and work out with the Vendors/Manufacturers alternate schemes which would allow for anticipation of primary components manufacturing

AREVA

## Conclusions

- AREVA welcomes MDEP initiatives
  - To increase knowledge transfer between Regulators to improve the efficiency of the Regulatory processes and create the conditions of mutual recognition of the regulatory work already performed.
  - To move towards convergence on regulatory practices
  - To work for establishing a framework which allows for collecting and sharing regulatory documents
- AREVA is ready to contribute to help the work of the EPR-WG and of the other specific issue WGs

*AREVA is expecting that MDEP will strengthen its organization and increases its resources*

*AREVA is in line with the CORDEL proposal which will be presented later during the conference*

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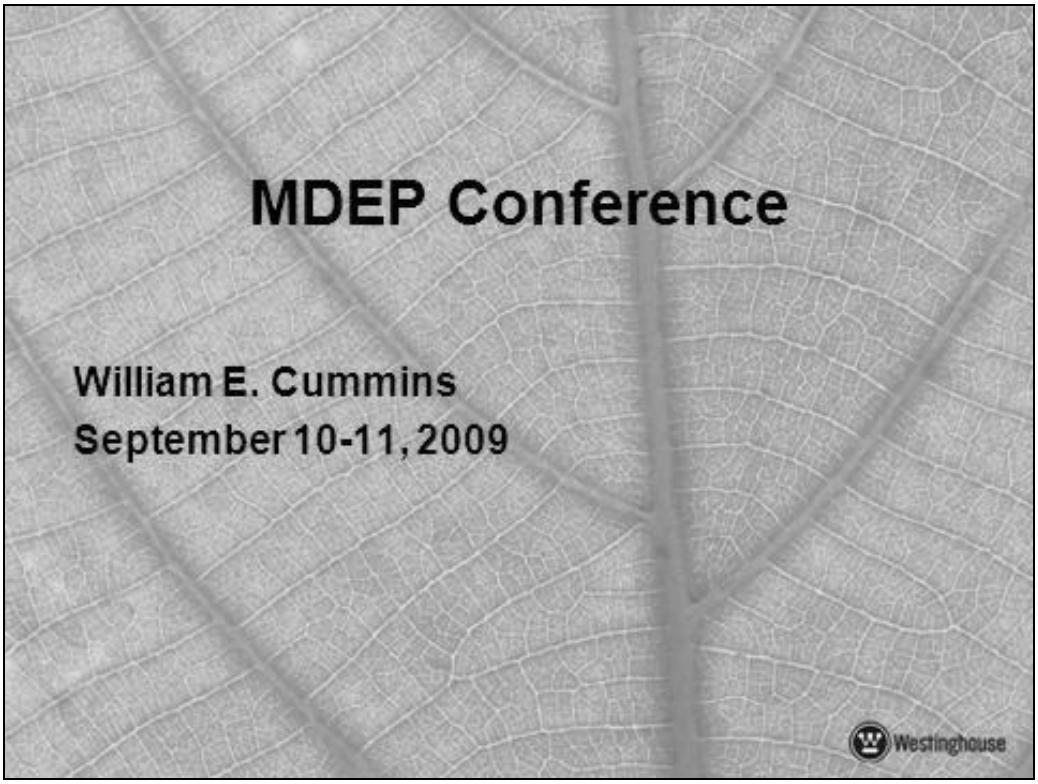
AREVA

**Westinghouse representative (AP1000 Reactor Vendor)**

*Ed Cummins, Vice-President, Regulatory Affairs and Standardisation*



## AP1000 MDEP

- Participants:
  - China
  - United States
  - United Kingdom
  - Canada (observer)

2

Westinghouse

## AP1000 Topics for MDEP Review

- Squib Valves
- Civil and Structural Engineering
- Control Rod Drive Mechanisms

3

Westinghouse

## AP1000 Standard Approach to Licensing

U.S.

- Design Control Document Revision 15 certified in January, 2006.
- Revision to the certified design scheduled for certification in August, 2011.
- One stop licensing process.
- Current review is of DCD Revision 17.

4

Westinghouse

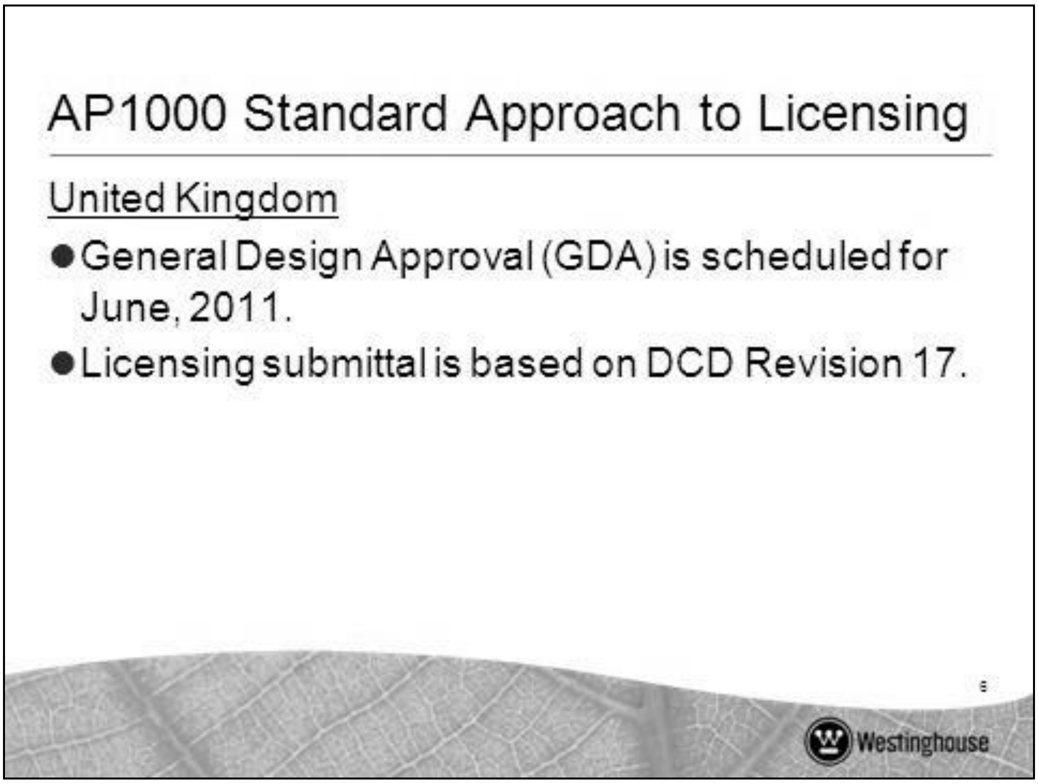
## AP1000 Standard Approach to Licensing

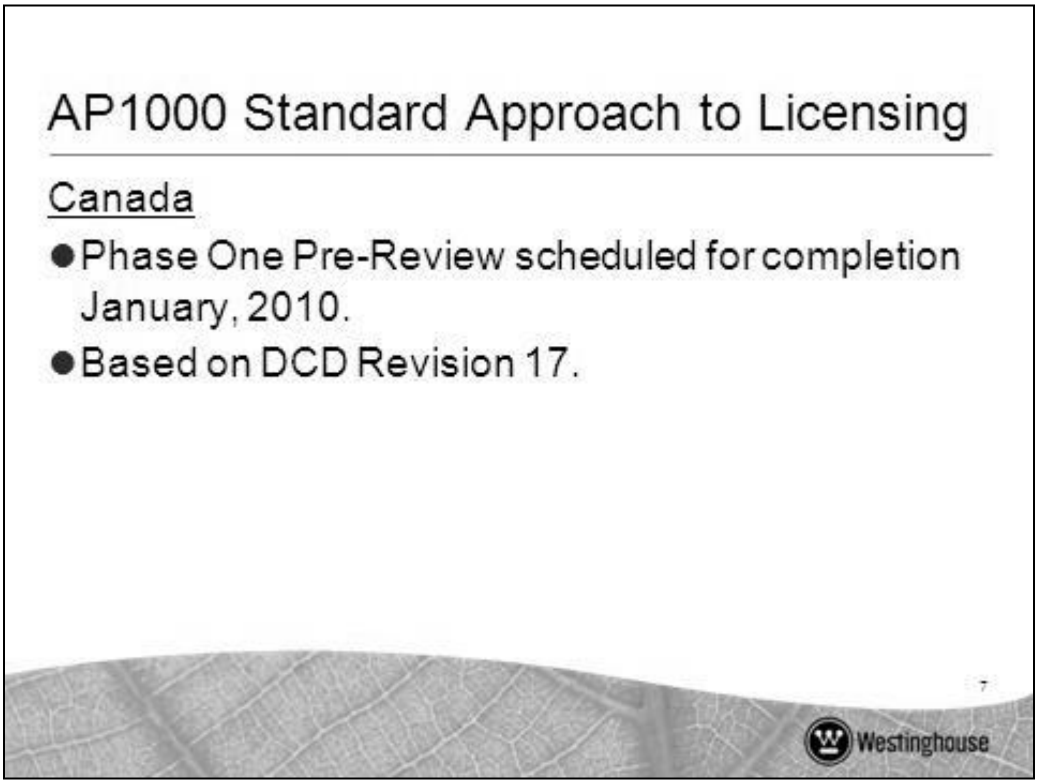
China

- Two step Licensing Process with construction permit and an operating permit.
- Sanmen Construction Permit Issued March 2009.
- Haiyang Construction Permit Scheduled September 2009.
- Operating Permit to be issued.
- Westinghouse input to the Owners FSAR was Design Control Document Revision 16.
- Westinghouse will use the latest Revision of the DCD as input for the FSAR.

5

Westinghouse


AP1000 Standard Approach to Licensing
United Kingdom
● General Design Approval (GDA) is scheduled for June, 2011.
● Licensing submittal is based on DCD Revision 17.
Westinghouse


AP1000 Standard Approach to Licensing
Canada
● Phase One Pre-Review scheduled for completion January, 2010.
● Based on DCD Revision 17.
Westinghouse


AP1000 Standard Approach to Licensing
Summary
● Westinghouse has made every effort to maintain a Standard Licensing Basis for AP1000 in each country.
8
Westinghouse

**Operator/licensee representatives**

*Jouni Silvennoinen*
*Project Director, Teollisuuden Voima, Ltd. Olkiluoto (TVO)*

## Utility's Benefits

- Utility's benefits from a standardized plant concept and large installed base of similar plants are evident
- Plant level benefits: operational experience feedback, review of disturbances, ageing mechanisms, organisational topics, etc. → improved safety
- Utility benefits as service / equipment purchaser: competent service / equipment suppliers who have large enough installed base for gathering experience and expertise → improved safety and better economic efficiency
- Example: TVO's experience with OL1/2

7.9.2009 2 Jouni Silvennoinen

## TVO Situation

- TVO is now in the middle of OL3 EPR project
- TVO is preparing for OL4 project with five different reactor alternatives included in the feasibility studies
- Finnish licensing requirements control the work
- Multinational co-operation brings collective expertise in evaluation of new plant designs, especially certain areas such as severe accidents
- Potential benefits of multinational authority co-operation could be for licensing procedures, e.g. enhance manufacturer certification and approval of off-the-shelf components (serial manufactured)

7.9.2009 3 Jouni Silvennoinen

## Additional contributions from Session 3

**Representatives from pressure boundary components standards development organisations**

*Bryan A. Erler, Vice-President, ASME Nuclear Codes and Standards*

## America Society of Mechanical Engineers, ASME, -Role in Nuclear Standards

- Rules for design, materials, fabrication and examination of pressure vessel since 1915
- Standard for nuclear pressure components since 1963
- Many other countries based their codes on ASME BPV Code
- Eight Nuclear Codes and Standards

## ASME
## Process for Development of Standards

- An open consensus process
- Experts from all sectors of the industry and around the world
- Individual volunteers contribute their time an expenses

## Scope of ASME Nuclear Codes and Standards

- Pressure component design, materials, fabrication and examination BPV-Section III
- Pressure component inservice inspection BPV-Section XI
- Quality assurance
- Probable Risk Assessment, PRA, standard
- Cranes for nuclear plants
- Nuclear air and gas treatment standard
- Active mechanical equipment qualification
- Operating and maintenance standard

ASME SETTING THE STANDARD

## ASME Pressure Component Scope

- Rules for vessels, valves, pumps and piping for metallic pressure boundaries
- Rules for concrete containments
- Rules for spent fuel transportation and storage containments
- Rules for polyethylene buried pipe
- Developing rules for fusion reactor components
- Developing rules for high temperature reactors gas and liquid medal cooled

ASME SETTING THE STANDARD

## Participation with the MDEP program

- February, 2007 Paris, France met with Component Manufacturing Oversight WG
  - Discussed comparison ASME Nuclear BPV Code and French RCCM
  - Discussed Quality assurance differences
- May, 2007 met with MDEP in Busan, South Korea
  - Developed combined set of observations
  - Agree to move forward with a detail ASME/RCC-M/JSME/KEPIC comparison project
- February, 2008 Paris, France-Meeting Codes and Standard WG
  - Start with Class 1 vessels -ASME, RCC-M, JSME and KEPIC
- October, 2008 Dijon, France to discuss interim results
- July, 2009 Paris, France with Codes and Standards Working group

ASME SETTING THE STANDARD

## Status of Class 1 code comparison

- JSME - ASME comparison complete
- KEPIC-ASME comparison complete
- AFCEN-ASME comparison being finalized
- Meeting on October 11, 2009 in Kobe, Japan to finalize the three comparisons

ASME SETTING THE STANDARD

## How ASME manages our MDEP activities

- Directed by the ASME Board of Nuclear Codes and Standards –BNCS
- Task Group on New Reactors and Globalization leads the effort
- Work done through ASME nonprofit subsidiary Standards Technology LLC ST-LLC
- Representative from France, Japan, Canada, Korea are on the Task Group

## Summary

- The completion of this, first project "Class 1 Vessel Comparison" will provide an insight as to the benefit of bringing these codes closer together
- It appears we will find the technical rules are essentially equivalent.
- The QA, conformity assessment, and country unique licensing requirements have significant variation in approaches
- It has generally been found that vessels design, fabricated, examined in accordance with the rules of their country result in equivalently safe components
- There should be a safety, financial and business benefit to move forward
- To move forward:
  - Need to define and agree on common objective of "harmonization"
  - Individual country licensing bodies and SDOs need to work closely
  - More involvement of reactor suppliers would be beneficial

**Representatives from pressure boundary components standards development organisations**

*Cécile Laugier, President, AFCEN*

## Contents

afcen

- ✓ First lessons learned from code comparisons
- ✓ The AFCEN point of view on code convergence

MDEP 2009 Conference 2

## MDEP Working methodology

afcen

- ✓ ASME structure taken as reference
  - ➢ Exercise made on ASME Subsection NB scope for vessels
- ✓ Identification and classification of differences
  - ➢ Due to technical reasons
    - Industry responsibility
  - ➢ Due to regulatory context
    - Safety Authority responsibility

MDEP 2009 Conference 3

## First MDEP lessons learned

afcen

- ✓ Many other documents beyond the Codes …
  - ➢ Codes refer to a large number of Standards
  - ➢ RCC-M integrates aspects which may be part of Owner specification according to ASME practice
    - Examples: Ageing and radiation protection considerations are included in RCC-M code / owner responsibility in ASME code
- ✓ Some provisions are different, but may be judged technically equivalent
    - Example: Qualification of processes and personnel

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## Some examples of significant differences

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- ✓ General
  - ➢ No AFCEN accreditation system
  - ➢ ASME referred to in US regulation. No mandatory status of codes in France
- ✓ Materials
  - ➢ Part qualification where heterogeneity hazard is identified (M 140)
  - ➢ Material selection procedures are different
- ✓ Design
  - ➢ Fatigue and Rupture analysis are strongly different
  - ➢ Pressure tests
- ✓ Fabrication / Examination
  - ➢ All welding aspects grouped in one Section in RCC-M

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## AFCEN Point of View

afcen

✓ Code comparison table is a significant step

...to be continued on behalf of *MDEP*

- Exchanges between Safety Authorities on provisions resulting from national regulation
- Exchanges between SDOs on technical aspects

✓ Codes shall refer as far as possible to existing international standards

- Use of ISO standards where appropriate

✓ Examples of harmonization in RCC-M Add. by *AFCEN*

- 20MND5 integrated
- Pressure test conditions

*Basic RCC-M requirement now similar to ASME III*

MDEP 2009 Conference 6

## AFCEN Standards

afcen

French Society for design, construction and surveillance in operation Rules for Nuclear Island Components


RCC-M

*AFCEN codes edited in French and English*
(combined Paper and CD-Rom versions)
*Other translations with Afcen agreements (Russian, Chinese)*





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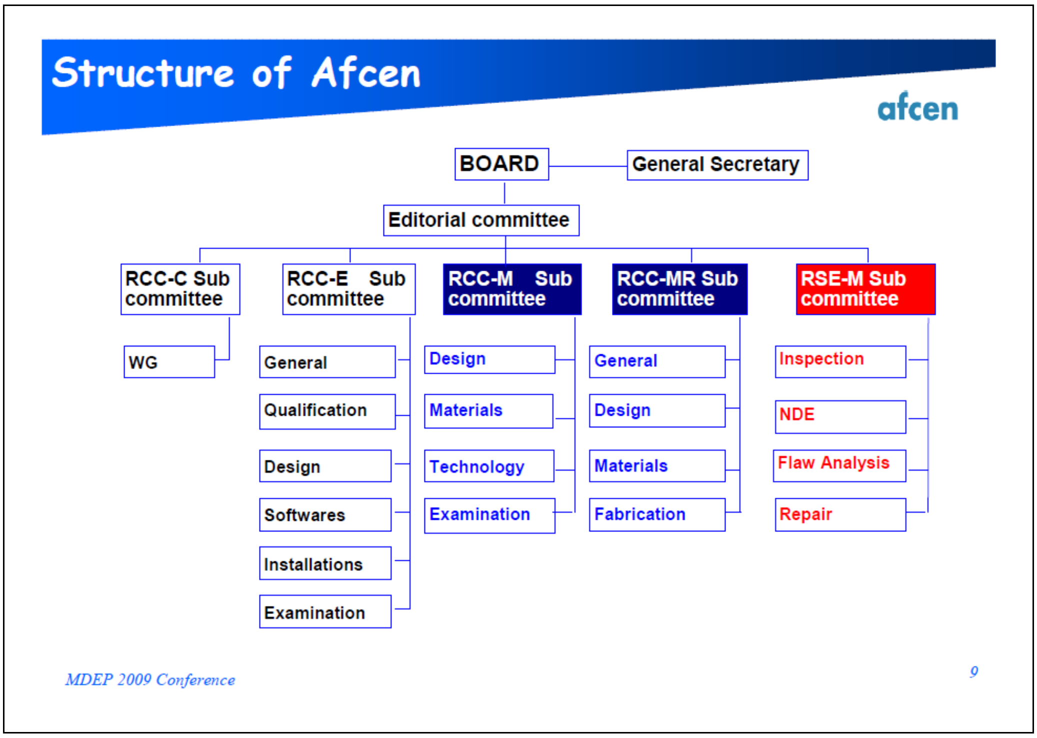
Structure of Afcen
afcen
BOARD
General Secretary
Editorial committee
RCC-C Sub committee
RCC-E Sub committee
RCC-M Sub committee
RCC-MR Sub committee
RSE-M Sub committee
WG
General
Qualification
Design
Softwares
Installations
Examination
Design
Materials
Technology
Examination
General
Design
Materials
Fabrication
Inspection
NDE
Flaw Analysis
Repair
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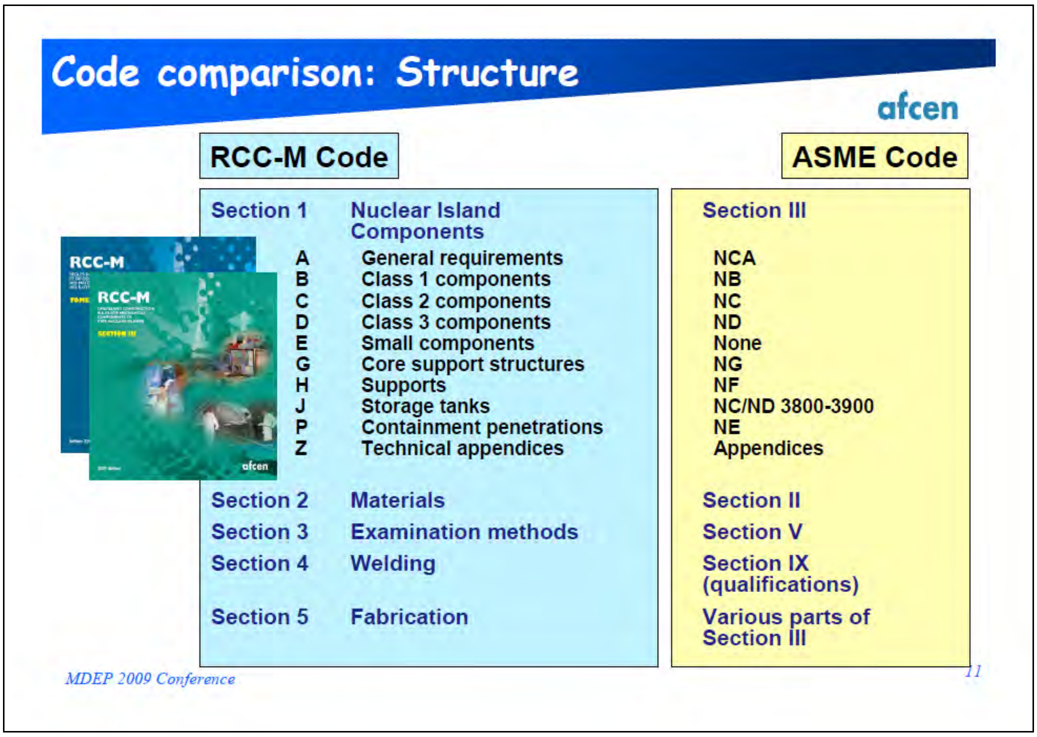
Code comparison: Structure
afcen
RCC-M Code
ASME Code
RCC-M
Section 1 Nuclear Island Components
A General requirements
B Class 1 components
C Class 2 components
D Class 3 components
E Small components
G Core support structures
H Supports
J Storage tanks
P Containment penetrations
Z Technical appendices
Section 2 Materials
Section 3 Examination methods
Section 4 Welding
Section 5 Fabrication
Section III
NCA
NB
NC
ND
None
NG
NF
NC/ND 3800-3900
NE
Appendices
Section II
Section V
Section IX (qualifications)
Various parts of Section III
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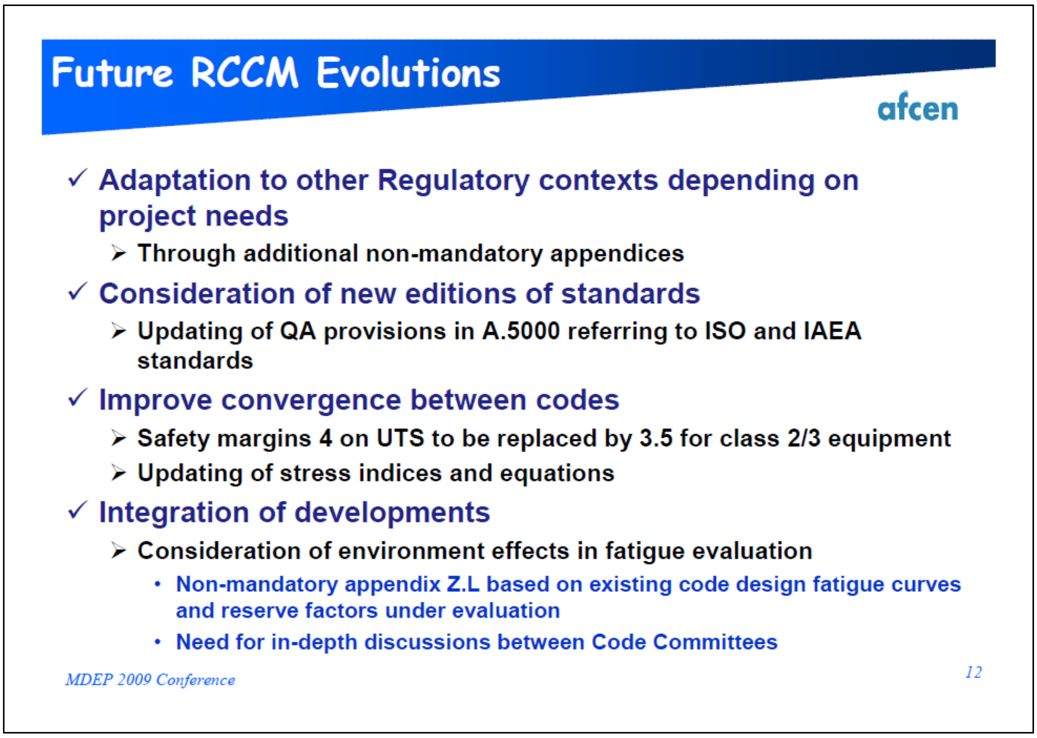
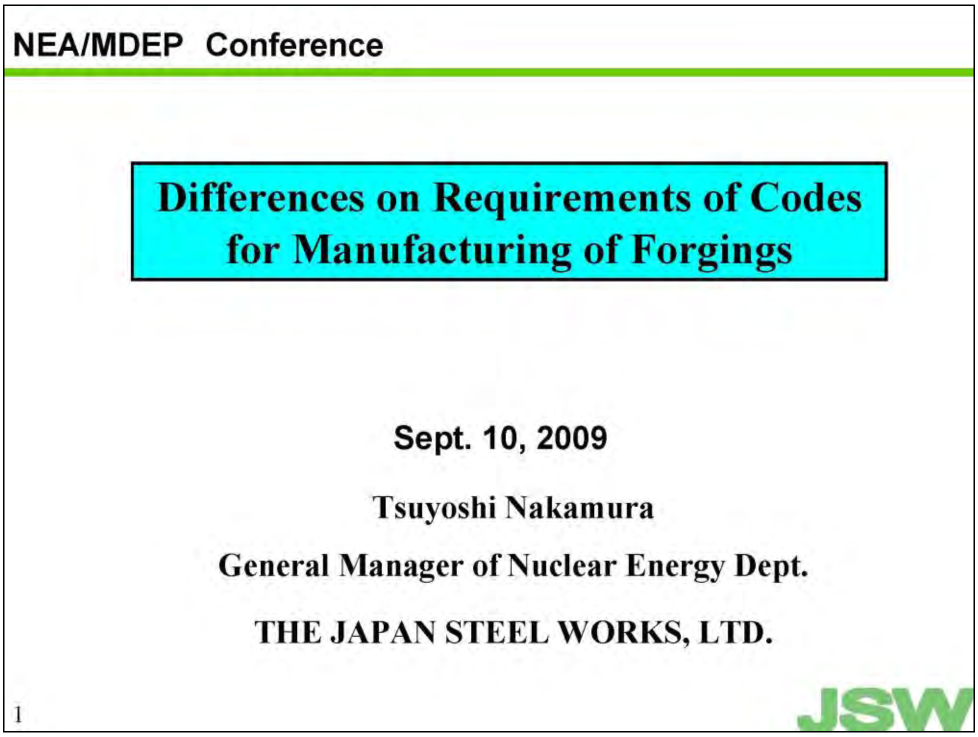


Future RCCM Evolutions
afcen
Adaptation to other Regulatory contexts depending on project needs
Through additional non-mandatory appendices
Consideration of new editions of standards
Updating of QA provisions in A.5000 referring to ISO and IAEA standards
Improve convergence between codes
Safety margins 4 on UTS to be replaced by 3.5 for class 2/3 equipment
Updating of stress indices and equations
Integration of developments
Consideration of environment effects in fatigue evaluation
Non-mandatory appendix Z.L based on existing code design fatigue curves and reserve factors under evaluation
Need for in-depth discussions between Code Committees
MDEP 2009 Conference
12

**Representatives from manufacturers**

*Tsuyoshi Nakamura, General Manager, Japan Steel Works,Ltd.*



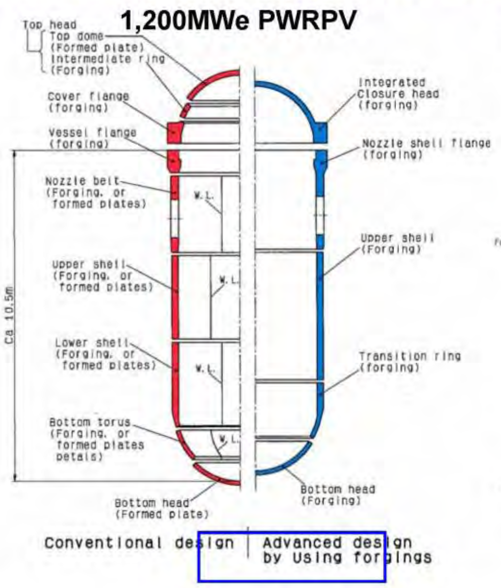
## Contents

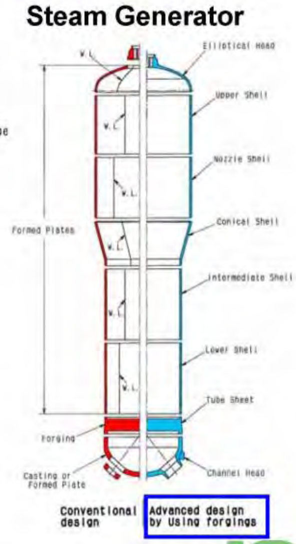
1. Manufacturing Experience of Nuclear Forgings
2. Main Applicable Codes for Forgings
3. Differences on Requirements of Codes
4. Vender Inspection
5. Expectation to MDEP's Activities

2

## 1. Manufacturing Experience of Nuclear Forgings

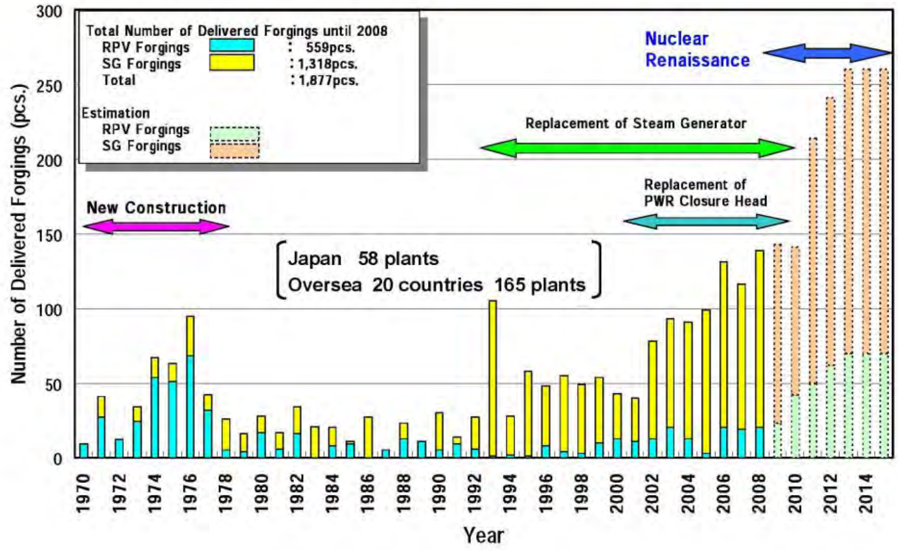
### 1.1 Development of Large Integrated Forgings



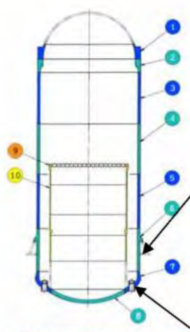

3

## 1.2 Manufacturing Experience of Forgings for RPV & SG




4

## 1.3 Manufacturing Experience of Forgings for ABWR



Shell 4 with skirt

| No. | Item \ Plant | #1 Kashiwazaki-6 | #2 Kashiwazaki-7 | #3 Lungmen-1 | #4 Lungmen-2 | #5 Hamaoka-5 | #6 Shiga-2 | #7 Shimane-3 | #8 Ohma-1 | #9 STP−3 | #10 STP−4 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Cover Flange | F | F | F | F | F | F | F | F | * | * |
| 2 | Shell Flange | F | F | F | F | F | F | F | F | (F) | * |
| 3 | Shell No.1 | − | P | − | − | − | F | F | F | − | − |
| 4 | Shell No.2 | − | P | − | − | − | F | F | F | − | − |
| 5 | Shell No.3 | F | F | F | F | F | F | F | F | (F) | * |
| 6 | Shell No.4 | F | F | F | F | F | F | F | F | (F) | * |
| 7 | Bottom Petal | F | F | F | F | F | F | F | F | (F) | (F) |
| 8 | Bottom Dome | F | F | F | F | F | F | F | F | (F) | * |
| 9 | Core Grid Disk | F | F | F | F | F | F | F | F | (F) | * |
| 10 | Shroud | − | − | − | − | − | − | F | (F) | − | − |

F:Forging P:Plate ( ):Under manufacturing *:Before manufacturing

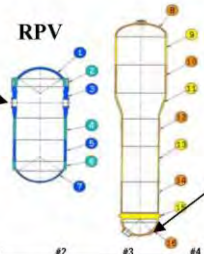
Bottom Petal with Nozzles

5

## 1.4 Manufacturing Experience of Forgings for EPR

Nozzle Shell Flange

RPV



4-SGs

Primary Head

| Component | No. | Product \ Project | #1 Olkiluoto-3 | #2 Flamanville | #3 TaiShan-1 | #4 TaiShan-2 | #5 USA | #6 TBD |
|---|---|---|---|---|---|---|---|---|
| RPV | 1 | Closure Head | F | - | - | - | - | * |
| | 2 | Head Flange | F | F | F | - | - | * |
| | 3 | Nozzle Shell Flange | F | F | F | (F) | (F) | (F) |
| | 4 | Upper Core Shell | F | F | F | - | - | * |
| | 5 | Lower Core Shell | F | F | F | - | - | * |
| | 6 | Transition Ring | F | F | F | - | - | * |
| | 7 | Bottom Head | F | - | - | - | - | * |
| SG | 8 | Elliptical Head | F | F | F | - | * | - |
| | 9 | Upper Shell | F | - | - | - | - | - |
| | 10 | Nozzle Shell | F | - | - | - | - | - |
| | 11 | Conical Shell | F | F | F | * | * | - |
| | 12 | High Shell | F | - | - | - | - | - |
| | 13 | Intermediate Shell | F | - | - | - | - | - |
| | 14 | Lower Shell | F | - | - | - | - | - |
| | 15 | Tube Sheet | F | F | F | - | * | - |
| | 16 | Primary Head | F | F | F | * | * | - |

F : Forging ( ) : Under manufacturing * : Before manufacturing

TBD: To Be Determined

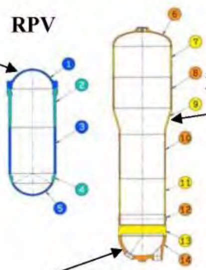
JSW

6

## 1.5 Manufacturing Experience of Forgings for AP1000

Closure Head

RPV



2-SGs

Transition Cone

Channel Head

| Component | No. | Product \ Project | #1 Sanmen-2 | #2 Vogtle-3 | #3 TBD | #4 TBD |
|---|---|---|---|---|---|---|
| RPV | 1 | Closure Head | F | (F) | * | * |
| | 2 | Vessel Flange Shell | F | (F) | * | * |
| | 3 | Lower Shell | F | (F) | * | * |
| | 4 | Transition Ring | F | (F) | * | * |
| | 5 | Bottom Head Dome | F | (F) | * | * |
| SG | 6 | Upper Head | F | * | * | * |
| | 7 | Upper Shell B | - | * | * | * |
| | 8 | Upper Shell A | - | * | * | * |
| | 9 | Transition Cone | F | * | * | * |
| | 10 | Lower Shell C | - | * | * | * |
| | 11 | Lower Shell B | - | * | * | * |
| | 12 | Lower Shell A | - | * | * | * |
| | 13 | Tube Sheet | F | (F) | * | * |
| | 14 | Channel Head | F (Separate type) | (F) | * | * |

F : Forging ( ) : Under manufacturing * : Before manufacturing

TBD: To Be Determined

JSW

7

## 2. Main Applicable Codes for Forgings

**Applicable code is difference for each reactor design.**

**AP1000 : ASME**

**ABWR : JSME, ASME**

**EPR : RCCM, ASME**

**Customers require sometimes to apply bi-codes for manufacturing of forgings.**

8

JSW

## 3. Differences on Requirements of Codes

**There are differences of requirements on codes for manufacturing of forgings.**

- **Material Specification (Chemical Compositions, Mechanical Properties)**
- **Qualification of Personnel (NDE, Tests)**
- **Calibration Procedure for Tests & Examination Equipments (NDE, Mechanical Tests, Length Measuring , Temperature Measurements, etc.)**
- **Tests & Examinations Procedure and Acceptance Standards**
- **Units for Measuring**
- **Scope of Vender Inspection**

9

JSW

## 4. Vender Inspection

JSW has many experience to receive vender inspection (audit/survey) by,

USA : NRC, ASME

France : DEP

Germany : TUEV

Owners

Customers (Reactor Venders, Fabricators)

10 JSW

## 5. Expectation to MDEP's Activities

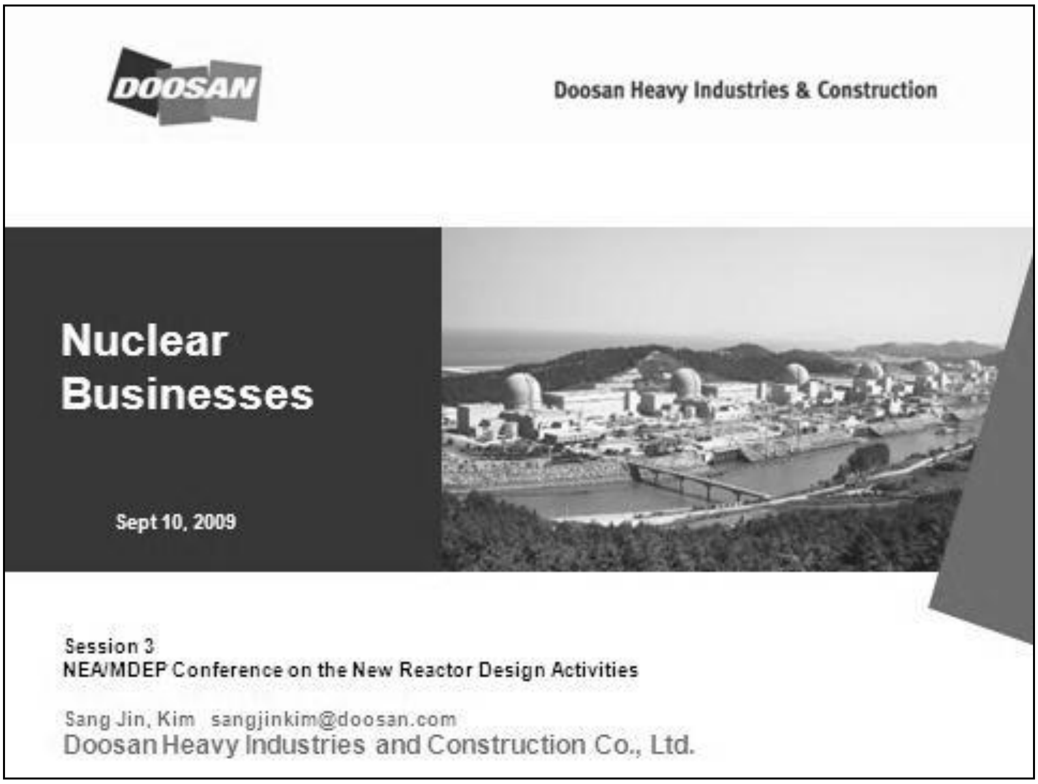
JSW (material manufacturer) expects to MDEP's activities,

- To harmonize requirements of Code and Standard for material manufacturing.
- To simplify the process of manufacturer qualification.

11 JSW

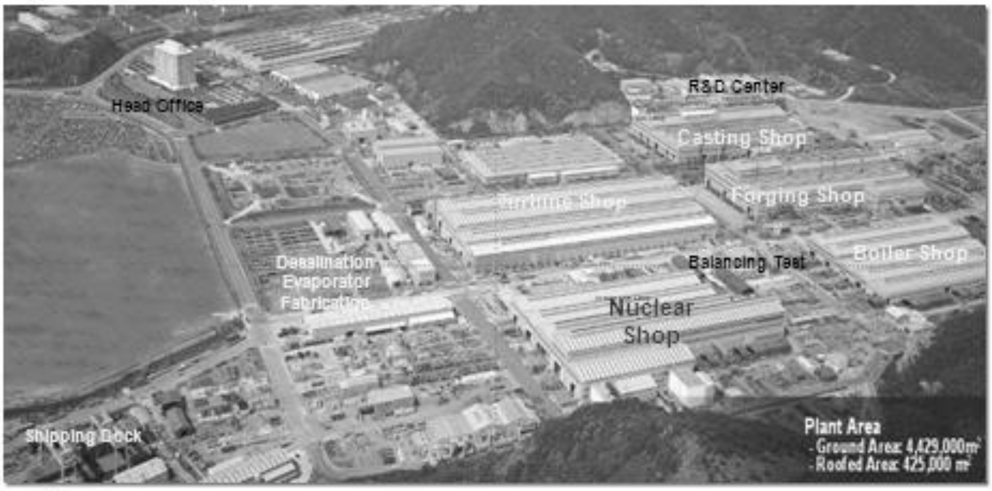
**Representatives from manufacturers**

*Mr. Kim, Vice-President, NPP Quality Control, Doosan (PPT)*



## Fully Integrated Single Site Manufacturing Facility

Casting & Heavy Forging → Heavy Machining → Fabrication & Assembly → Test → Shipment




Doosan Heavy Industries & Construction    DOOSAN Proprietary    2

## Major Nuclear Products (PWR)

- Nuclear Steam Supply System
  - Reactor Vessel
  - Reactor Internals
  - Control Element Drive Mechanism
  - Integrated Head Assembly
  - Steam Generator
  - Pressurizer
  - Primary Piping
  - Fuel Handling System Equipment
- Balance Of Plant
  - Heat Exchangers
  - Pressure Vessels & Tanks
  - Gas Stripper
  - Boric Acid Concentrator
  - Moisture Separator Reheater
- Fuel Storage
  - New and Spent Fuel Racks
  - Spent Fuel Transportation Cask / Canister

NSSS of OPR (Optimized Power Reactor)

Spent Fuel Transportation Cask/Canister for Kori site

Doosan Heavy Industries & Construction    DOOSAN Proprietary    2

## Major Nuclear Products (PHWR)

- Major Products for CANDU plants
  - Calandria
  - Feeder/Header
  - Steam Generator
  - Pressurizer
  - Degasser Condenser
  - Major Heat Exchangers
  - Tanks
  - Fuelling Machine Bridge

Shipping of Wolsong #4 Calandria at DOOSAN Shop

Fabrication of Feeder/Header Assembly

Doosan Heavy Industries & Construction DOOSAN Proprietary 4

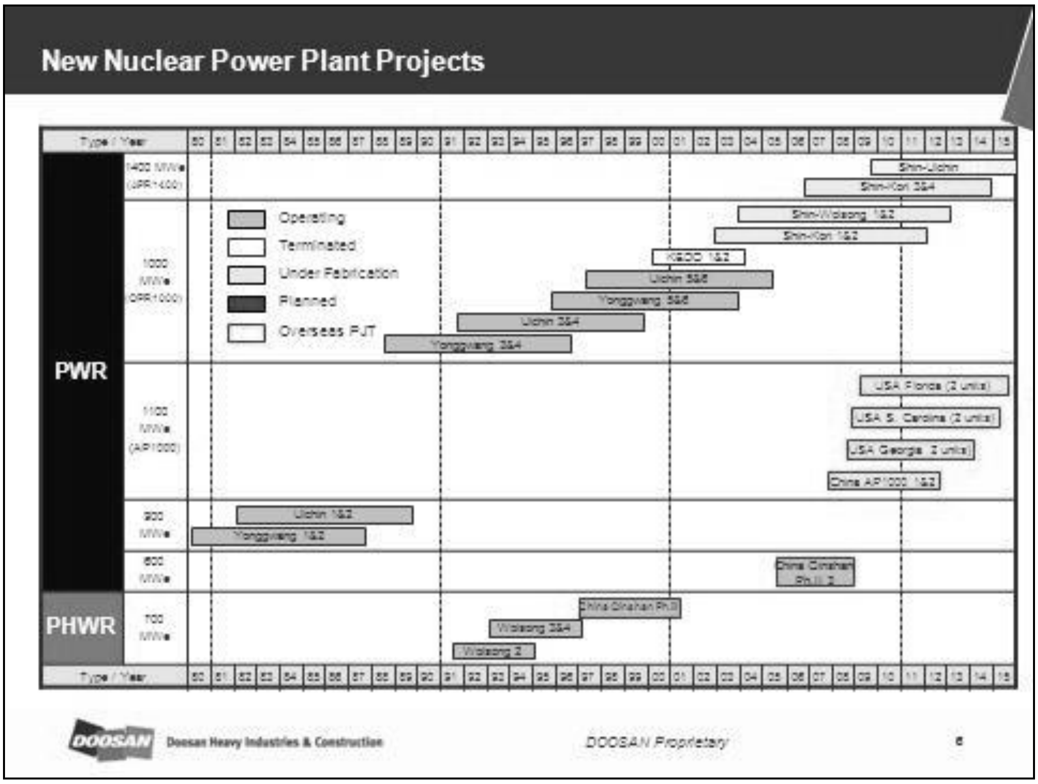
## Development of Korea Nuclear Technology

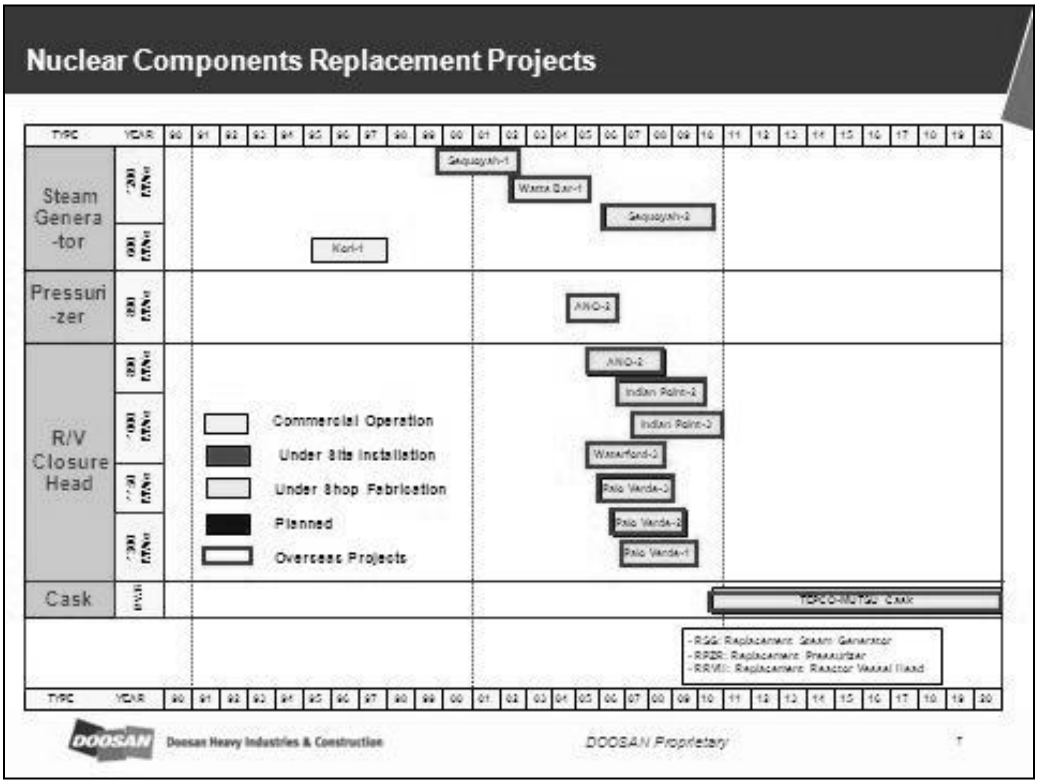
Over 30 years experience in nuclear power, Korea has accomplished accumulated proven and state-of-the-art technology.

- DOOSAN completed supplying components of 8 units of new NPP in Korea
- DOOSAN is fabricating components of 6 units of new NPP in Korea
- DOOSAN has supplied components for new NPP and replacements to China and U.S.A.

| 1970s | 1980s | 1990s | 2000s |
|---|---|---|---|
| Introduction of Nuclear Power | Promotion of Localization | Achieved Technology Self-reliance | Development of Advanced Reactor |
|  |  |  |  |
| Construction of Kori #1 ('71-'78) | Establishment of Localization Plan ('84) | OPR1000 Development ('95) | APR1400 Development ('01) |

Doosan Heavy Industries & Construction DOOSAN Proprietary 5


New Nuclear Power Plant Projects
Type / Year
PWR
PHWR
1400 MWe (APR1400)
1000 MWe (OPR1000)
1100 MWe (AP1000)
900 MWe
600 MWe
700 MWe
Operating
Terminated
Under Fabrication
Planned
Overseas PJT
Shin-Uljin
Shin-Kori 3&4
Shin-Wolsong 1&2
Shin-Kori 1&2
KEDO 1&2
Ulchin 5&6
Yonggwang 5&6
Ulchin 3&4
Yonggwang 3&4
USA Florida (2 units)
USA S. Carolina (2 units)
USA Georgia 2 units)
China AP1000 1&2
Ulchin 1&2
Yonggwang 1&2
China Qinshan Ph.II 2
China Qinshan Ph.III
Wolsong 3&4
Wolsong 2
Doosan Heavy Industries & Construction
DOOSAN Proprietary


Nuclear Components Replacement Projects
TYPE
YEAR
Steam Genera -tor
Pressuri -zer
R/V Closure Head
Cask
Sequoyah-1
Watts Bar-1
Sequoyah-2
Kori-1
ANO-2
ANO-2
Indian Point-2
Indian Point-3
Waterford-3
Palo Verde-3
Palo Verde-2
Palo Verde-1
TEPCO-MUTSU Cask
Commercial Operation
Under Site Installation
Under Shop Fabrication
Planned
Overseas Projects
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Major Experiences of Supplying Nuclear Components
Qinshan Phase III #1&2
Steam Generator
Sequoyah #1
Steam Generator
Watts Bar #1
Steam Generator
Arkansas Nuclear One #2
Pressurizer
Ulchin #5
Reactor Vessel
Qinshan Phase II #3
Reactor Vessel
DOOSAN
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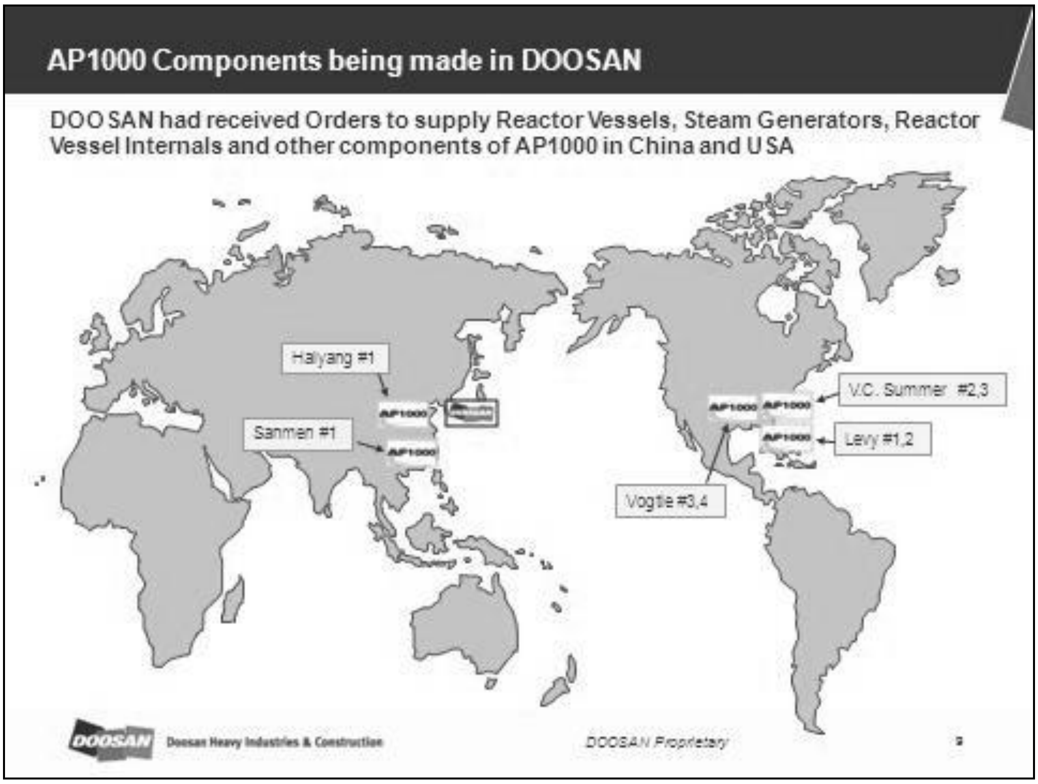

AP1000 Components being made in DOOSAN
DOOSAN had received Orders to supply Reactor Vessels, Steam Generators, Reactor Vessel Internals and other components of AP1000 in China and USA
Haiyang #1
Sanmen #1
AP1000
V.C. Summer #2,3
Levy #1,2
Vogtle #3,4
DOOSAN
Doosan Heavy Industries & Construction
DOOSAN Proprietary

## Summary

- DOOSAN recognizes its role in the success of new US nuclear plants is to supply high quality products and on time delivery.
- DOOSAN is investing to ensure that we can meet all of the customer value in US new plant projects by
  - Maintaining high manufacturing capabilities
  - Well qualified and experienced employees
  - Reliable and quality supply chain
  - Cooperative support to & communication with customer.

DOOSAN Doosan Heavy Industries & Construction DOOSAN Proprietary 10

## 2009 NEA/MDEP Conference Topics

- How new reactor design review activities is managed in DOOSAN
- Expectations to the Future MDEP Activities

DOOSAN Doosan Heavy Industries & Construction DOOSAN Proprietary 11

## NEA/MDEP Expectations

**•Codes and Standards Working Group (CSWG) Activities**

- Evaluation of the similarities and differences among Codes & Standards are underway
- Things are different...Codes and Standards harmonization is difficult
- 1st Step : Quality Assurance Criteria be harmonized
  2nd Step : Design and Fabrication Codes for pressure boundary be reconciled

**•Vendor Inspection Cooperation Working Group (VICWG) Activities**

- New Reactor vendor inspections is being reinforced
- Many components be manufactured Outside of Country
- Global Supply Chain oversight activities be cooperated International Regulators
- Joint vendor inspection by Regulators be Needed [Examples: NUPIC and NIAC]
- But, in any case, International Regulators' vendor inspection Policy, Requirements, Program and Interests are different

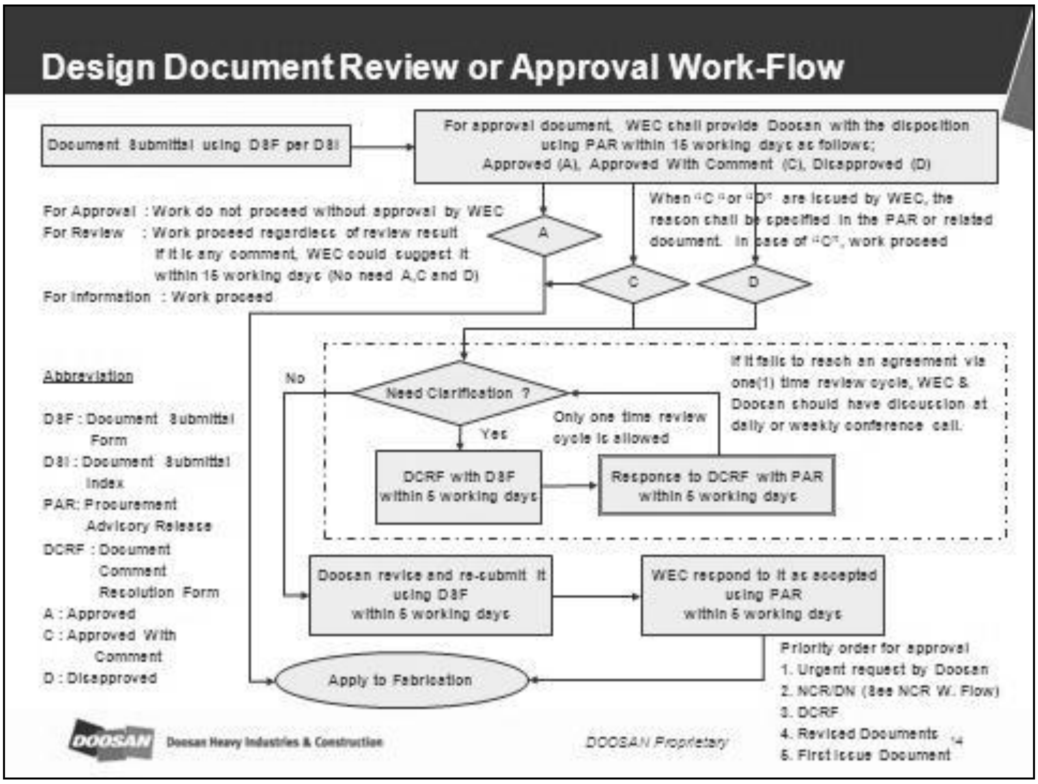


## DOOSAN, as AP1000 major component supplier

**To introduce Design Review working process with Westinghouse for AP1000**

Westinghouse as a design company and DOOSAN as a component manufacturer, we do keeping strong business partnership in various projects.
WEC develop design drawings and various design requirements and transmit to DOOSAN through WEC's e-room. And DOOSAN review WEC requirements and make manufacturing drawings, MPS (material purchase specification), QP (quality plan), WPS (welding process specification) and detail manufacturing procedures.

DOOSAN submits all manufacturing drawings and documents to WEC for their review.
DOOSAN has 30years manufacturing experiences and engineering capability. So, **when we review WEC design documents, DOOSAN would like to add our knowledge and experiences to their AP1000 design. And comparing our previous experience, the differences and unique things notified our relevant team and for some cases we discuss with WEC to find best way to manufacturing.**
DOOSAN well understands that AP1000 is the most outstanding plant among GEN III+ types. Even though our contribution is too small for AP1000 design, DOOSAN believes that our experiences can make AP1000 more perfect one.




## Communication and Response

- *Geographical distances between Korea manufacturing facilities, designers (Westinghouse), utility customers and US construction sites*

DOOSAN maintains SDMS (Site Document Management System) for customers in the geographical distances.

- Submits all documents for customer approval and receives documents from customers.

Main window of SDMS

What for use

- Document registration, transmittal and storage
- Communication tools (review and approval)

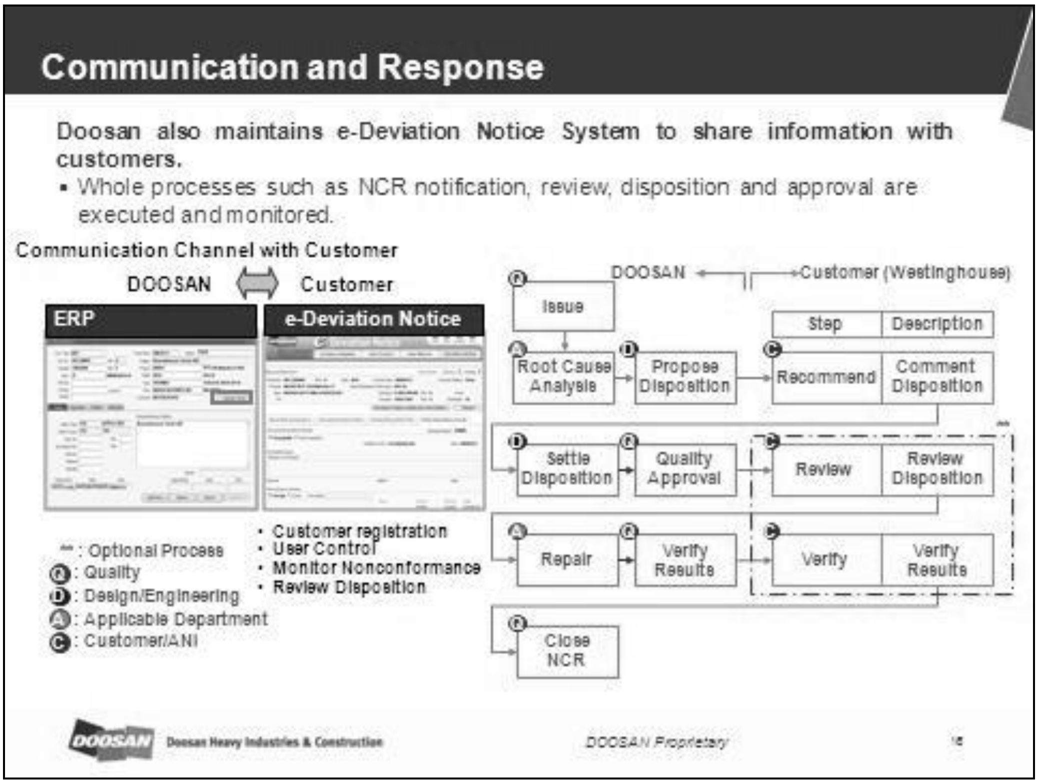
How to use

- Easy to access on web-site and log-in
- Good reputation from customer

What to achieve

- Sharing information in real time
- Safe document storage

Doosan Heavy Industries & Construction DOOSAN Proprietary 15



Communication and Response
Doosan also maintains e-Deviation Notice System to share information with customers.
▪ Whole processes such as NCR notification, review, disposition and approval are executed and monitored.
Communication Channel with Customer
DOOSAN
Customer
ERP
e-Deviation Notice
• Customer registration
• User Control
• Monitor Nonconformance
• Review Disposition
: Optional Process
Q: Quality
D: Design/Engineering
A: Applicable Department
C: Customer/ANI
DOOSAN
Customer (Westinghouse)
Step
Description
Issue
Root Cause Analysis
Propose Disposition
Recommend
Comment Disposition
Settle Disposition
Quality Approval
Review
Review Disposition
Repair
Verify Results
Verify
Verify Results
Close NCR
Doosan Heavy Industries & Construction
DOOSAN Proprietary

# Additional contributions from Session 4

## Reactor vendor representatives

*Mr. Head, Senior Vice-President, Regulatory Affairs, GE-Hitachi*

Design activities within GE-Hitachi are rigorously controlled within a framework of procedures. Early in the GE-Hitachi design process, there is a requirement to gather design inputs and customer technical requirements. As defined in the controlling procedure, "design inputs include, but are not limited to design bases, design criteria, design parameters, performance requirements, regulatory requirements, codes and standards". Customer Technical Requirements often include the additional regulatory requirements, codes and standards. We actively maintain a comprehensive library of such codes and standards for easy reference, including the applicable NRC Regulatory Guides that may exist. In order to ensure a comprehensive design, the design process often, depending upon the complexity of the design, includes an independent verification of the design inputs early in the process (prior to actual initiation of the design efforts) to preclude rework.

Maintaining the library of applicable regulatory requirements, codes and standards is an area where international collaboration would be useful. There are sometimes conflicts between codes and standards and maintenance of a matrix of applicability would be useful similar to the Nuclear Energy Standards Co-Ordination Collaborative (NESCC), except on an international scale.

## Additional contributions from Session 6

**Operator/licensee representative**

*Yonezo Tsujikura, Senior Advisor, Japanese Federation of Electric Power Companies*

# Understanding on MDEP Activities

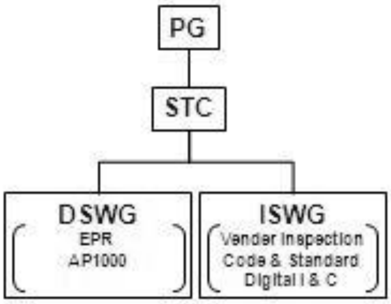
➢Objectives

•To pursue multinational harmonization of nuclear safety regulations
•Advanced reactors (Generation Ⅲ, Ⅲ+, Ⅳ)

➢Status of development

•Issue-specific WGs are examining regulatory differences between countries.

•The study at Issue-specific WGs is now at the fact- finding stage, albeit different progress at each issue.




MDEP structure

•Design-specific W/Gs have been set up for pursuing the harmonization for AP-1000 and EPR (Generation Ⅲ+).
Studies are underway at the each Design-specific WG.

•Information shared only among the countries related to EPR and AP-1000.



# View on MDEP

- Licensing risk reduced through the harmonization of regulatory requirements
- Design, manufacturing and construction streamlined through the harmonization of regulatory practice
- Social understanding promoted by internationally-recognized regulations
- Current regulations and regulatory practices expected to be improved through the scientific and rational approach

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- Objective and its associated development process in each WG are not clearly disclosed.
Clarification of objective and development process is desired.

## Expectation for MDEP

- Important to ensure applicability based on individual countries' industrial and social backgrounds
- Review process enabling the reflection of Industry side requests at suitable stage
- Clear-cut distinction of MDEP exercise from the regulation for existing plants
- MDEP outcomes reflected to streamline the home countries' regulation from the viewpoint of scientific and rational regulatory system
- Active information disclosure on the MDEP progress

The Federation of Electric Power Companies 5

## View on "Harmonization"

- Presenting the concept of safety assurance with transparency
- Streamlining of the industrial activities
- Averting licensing risks to facilitate early construction
- Offering applicability to various countries around the world

The Federation of Electric Power Companies 6

# Future Initiatives of Utilities

- Continue cooperation for MDEP with vendors
- Actively present our comments at various stages through the development process
- Continue attention to the process for gauging the Impact on the Industry
- Work on regulatory authorities to reflect the state-of-the-art knowledge to the current regulations from scientific and rational viewpoint
- Enhanced communication between Industry and regulator at MDEP activity as well in line with the general understanding of the growing importance in communication

## Non-MDEP regulator

*Ulrich Schmocker Director, Federal Nuclear Safety Inspectorate (ENSI)*

## New builds in Switzerland: current Situation (September 2009)

*U. Schmocker, R. Sardella, Swiss Federal Nuclear Safety Inspectorate (ENSI)*

According to the Nuclear Energy Act of 2003 the licensing of new builds in Switzerland is a three-step process in which the applicant has to sequentially submit requests and get grants for a general license, a construction license and an operating license. It has been estimated that the whole process may take 16 to 18 years until a new unit can start operating in Switzerland.

The first step, the so called general license is essentially a site license, but it also serves the purpose of forming a public opinion. In fact the general license, as issued by the Swiss government, has to be approved by the Swiss parliament and it is subject to a countrywide public vote.

For the general license the applicant has to select a site and submit a comprehensive site evaluation that allows defining the site specific hazards which the new NPP has to be design against. Very few details about the reactor that the applicant proposes to build have to be provided, namely indications about the reactor type (e.g. LWR), its thermal power, its main cooling system (e.g. cooling tower) and the arrangement of the main buildings. Besides the technical suitability of the site, an environmental impact assessment has also to be provided by the applicant.

By the end of 2008 three general license applications have been submitted by the Swiss electrical companies ALPIQ Holding Ltd., the Axpo Group and BKW FMB Energie Ltd. The proposed sites are already existing NPP sites where one to two units are in operation since 1979 (Gösgen NPP), 1969 resp. 1971 (Beznau I and II NPPs) and 1972 (Mühleberg NPP). For the sites of Beznau and Mühleberg the proposed new builds are explicitly aimed at providing power generation in substitution of the older units.

The assessment of the nuclear safety aspects of the general license applications is being carried out by the ENSI and the safety evaluation reports for the three applications are expected to be issued by the autumn 2010. The Federal Office for the Environment is in charge of doing the evaluation of the environmental aspects related to the proposed new builds. The site characteristics that need to be discussed in the application are:

- Geography and population distribution
- Traffic routes and industry (includes aircraft crash hazards)
- Logistics and construction site

- Meteorology
- Hydrology and ground water
- Geology, foundation material and seismology
- Connection to the power grid

The hazards originated by a combination of external events shall be investigated too. Deterministic and probabilistic arguments need to be considered as well as the newest data and state-of-the-art models.

Besides the general license, the applicants are pursuing the preparation work for the construction license. The main topic in this phase is the definition of the requirements on the design which will be included in the call for tenders. The ENSI is also devoting some resources to this subject building an internal know-how on the most common reactor designs of generation III/III+ and planning a rethinking of some of its guidelines, e.g. the safety classification of structures, systems and components

From the perspective of a small nuclear country as Switzerland and a correspondingly small nuclear regulator as the ENSI it is of vital importance to be able to rationalise resources and don't do duplicate work. Hence for the ENSI it is important to share knowledge with other regulators and lift some results that have already been produced. Though the undergoing ENSI activities for new builds concentrate in the current phase on siting issues and the work on design requirements has not started at full speed yet; the ENSI provides for existing reactors quite advanced work in some areas (e.g. PSA), which could be beneficial also for new builds. As a further point it should be noted that the interaction of the ENSI with the vendors runs officially always through the applicants. Taking part in a multinational vendor inspection or auditing program would give the ENSI the possibility to gain additional insights in areas like quality assurance and project management which have proven critical in the current new builds projects.

In more general terms it is certainly in the interest of the nuclear regulators community to have a common understanding and possibly an agreement on regulatory practices applied to critical issues like external events, passive systems, digital I&C, etc. This would equal to define a sort of state-of-the-art from the regulatory point of view as a counterbalance to the „reactor standardisation' that has been pushed forward by the vendors.

# Appendix B

## List of participants

**Multinational Design Evaluation Programme (MDEP)**
**Conference on New Reactor Design Activities**

**Paris, France**
**10-11 September 2010**

**List of participants**

## BELGIUM

RORIVE, Paul — E-mail: paul.rorive@gdfsuez.com
President
FORATOM

## CANADA

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Ontario Power Generation

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Atomic Energy of Canada Limited (AECL)

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JAMIESON, Terry — Email: terry.jamieson@cnsc-ccsn.gc.ca
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WEBSTER, Philip — Email: philip.webster@cnsc-ccsn.gc.ca
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VASA, Ivo
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Nuclear Power and Safety Division
Nuclear Research Institute Rez plc (NRI)
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REIMAN, Lasse
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TIIPPANA, Petteri
Director
Nuclear Reactor Regulation
Radiation and Nuclear Safety Authority (STUK)
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Commissariat à l'Energie Atomique (CEA)
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Senior Vice-President of Safety and Licensing and Licensing Manager for Olkiluoto 3 Project
AREVA
Email: francois.bouteille@areva.com

BUET, Baptiste
Manager
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