

*IAEA Experts Meeting on Reactor and Spent Fuel Safety in the Light of  
the Accident at the Fukushima Daiichi Nuclear Power Plant  
19 -22 March 2012*

## *OECD/NEA Technical Assessments and Nuclear Safety Research*

### *Responding to the Members' Needs Post- Fukushima*

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# Outline

- ❑ Brief Overview of NEA/CSNI
- ❑ NEA Integrated Response Plan to the Fukushima Dai-ichi Accident
- ❑ Areas of NEA Technical Study Being Considered in Response to Fukushima
- ❑ Joint International Research Projects
- ❑ NEA Safety Research Going Forward
- ❑ Concluding Remarks

# OECD/NEA Membership

- Australia
- Austria
- Belgium
- Canada
- **Chile**
- Czech Republic
- Denmark
- **Estonia**
- Finland
- France
- Germany
- Greece
- Hungary
- Iceland
- Ireland
- **Israel**
- Italy
- Japan
- Korea
- Luxembourg
- Mexico
- Netherlands
- **New Zealand**
- Norway
- Poland
- Portugal
- Slovak Republic
- Slovenia
- Spain
- Sweden
- Switzerland
- Turkey
- United Kingdom
- United States



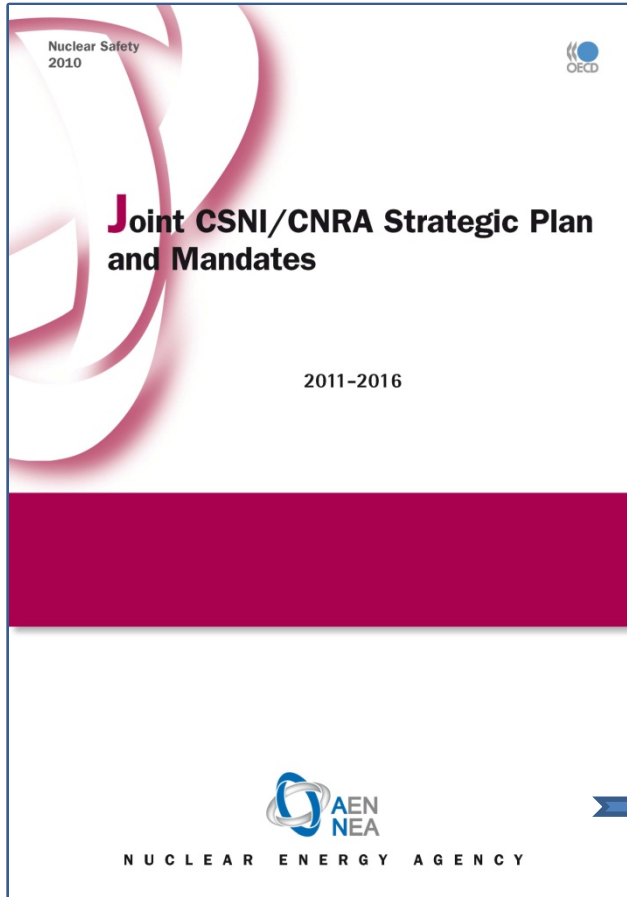
**Not member of NEA**

## NEA Strategic Areas of Work

- ❑ 1. Nuclear safety and regulation :
  - CNRA (Committee on Nuclear Regulatory Activities)
  - CSNI (Committee on the Safety of Nuclear Installations)
  - OECD/NEA Joint International Research Projects (on Safety Research)
- ❑ 2. Radioactive waste management
- ❑ 3. Radiation protection and public health
- ❑ 4. Nuclear science
- ❑ 5. Economics, resources and technology
- ❑ 6. Legal affairs



## Main Challenges (2011 - 2016)



- Adequate Nuclear Skills and Infrastructure
- Effectiveness and Efficiency of Activities Related to Safety
- Safe Operation of Current Nuclear Facilities
- Safety in New Nuclear Facilities
- Safety in Advanced Reactor Designs

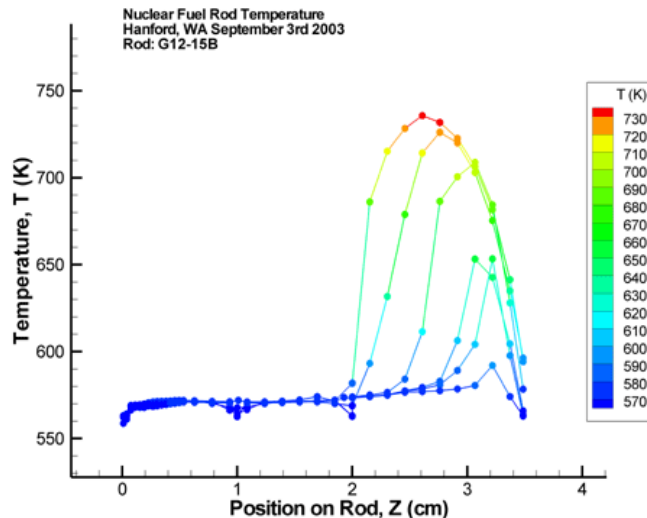


**Plus Additional Challenges and Areas of Focus following Fukushima**

# Committee on the Safety of Nuclear Installations (CSNI)



- Senior regulators, TSO and research leaders, some utility representation
- Maintaining, harmonizing and further developing the scientific and technical knowledge base required to assess and enhance the safety of nuclear reactors and fuel cycle facilities
- Main areas of work include:
  - Analysis and management of accidents
  - Integrity and ageing of components and structures
  - Risk assessment
  - Fuel safety
  - Safety of fuel cycle facilities
  - Human and organizational factors
  - Safety research projects and activities



# Programme of Work within CSNI and its WGs

## Baseline CSNI Programme of Work

- Risk Analysis Studies
- Fuel Safety Assessments
- Fuel Cycle Facility Safety Reviews
- Human and Organizational Performance Evaluations
- Accident Analysis Technical Studies (T-H, SA)
- Integrity of Structures and Ageing of Components Assessments
- Other

## CSNI Follow-up Issues from Fukushima Dai-ichi Accident

- Probabilistic and Deterministic Assessments of Accident Initiating Sequences and Phenomena
- Plant Robustness and Defence-in-Depth Reviews (containment, hydrogen mitigation strategies, electrical systems, other)
- Studies of human and organizational performance under extended SA conditions
- Accident progression modeling comparative studies
- Off-site emergency preparedness

FULLY INTEGRATED  
PROGRAMME OF WORK

## NEA Integrated Response to Fukushima Accident Cont'd

- Soon after accident CNRA Senior Task Group Fukushima established - group coordinates integrated NEA response
- CSNI, CNRA and CRPPH developed a cross-functional integrated process to support the development of new tasks and management of the program supporting post-Fukushima response
- Importance of maintaining strong links with IAEA (Fukushima Action Plan), EC and national bodies to ensure no overlap or duplication
- NEA to focus its Fukushima response actions on discrete shorter term products to assist TSOs, regulators in member countries



# NEA Integrated Response to Fukushima Accident

- In immediate aftermath of accident, CSNI developed a Concept Paper on “Considerations and Approaches for Post-Fukushima Dai-ichi Follow-up Activities”
  - Provided initial technical opinions along the following topical lines:
    - External and Internal Hazards Assessments
    - Plant Robustness and Defence-in-Depth Evaluations
    - Review of Safety Management Approaches
    - Assessment of Emergency Preparedness and Response Arrangements (EPR Management) and Approaches
    - Research Needed to Close Technical Knowledge Gaps (e.g., severe accident progression phenomenon, modelling of human behaviour under SA conditions, etc.)

# New Technical Studies Being Considered

## *Ref. NEA Integrated Fukushima Safety Enhancements Programme*

### **Improvements in the Characterization of Internal and External Hazards**

Review of current methodologies for assessing risk due to postulated internal and/or external initiating events

- Cliff edge effects
- Coupled initiating events
- Multi-unit scenarios
- Deterministic/probabilistic approaches

Review technical assessments of earthquakes, fires, floods, and other extreme environmental conditions

- Propose enhanced methods for properly characterizing the risk of external hazards

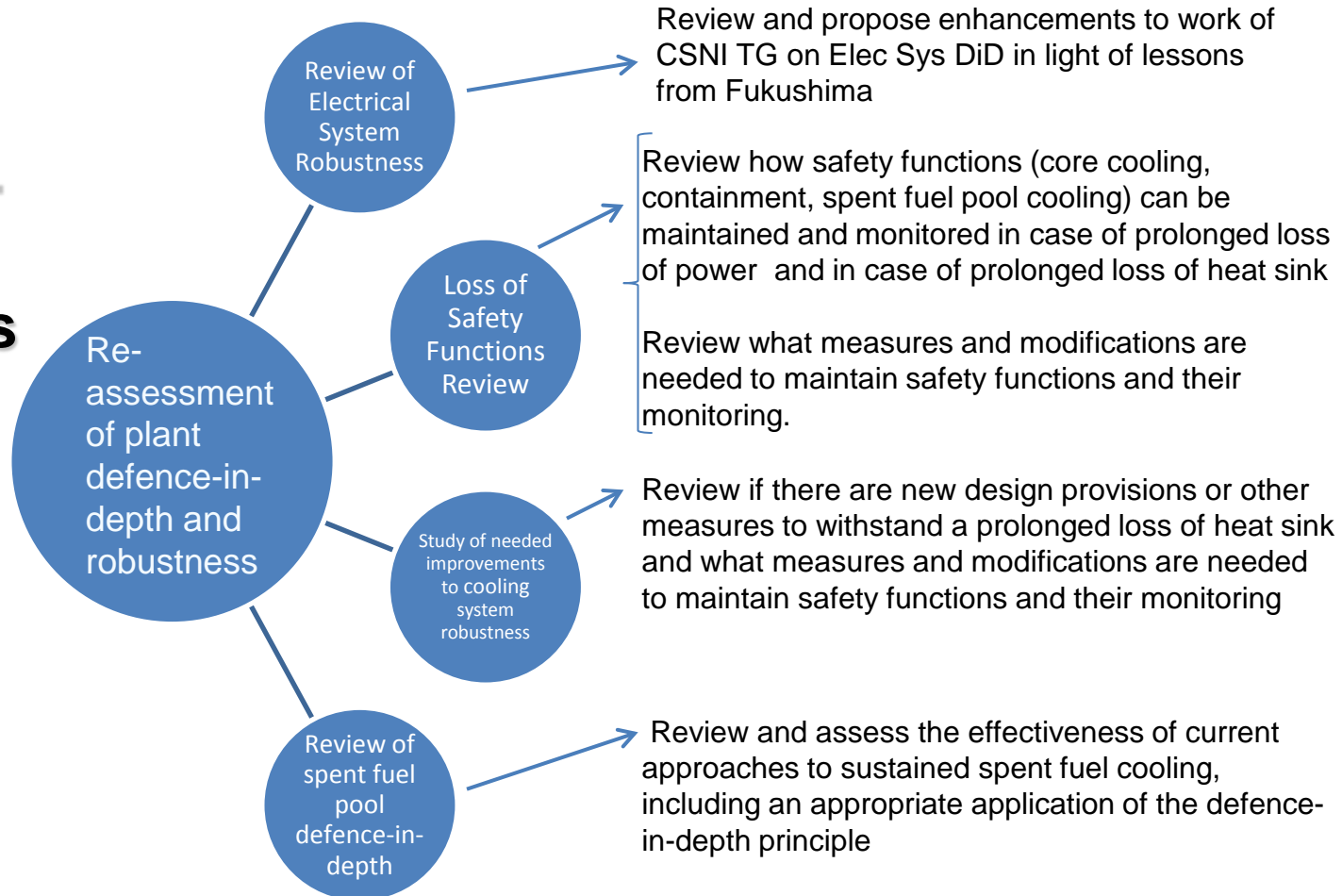
Review of effectiveness of the use of operating experience regarding internal and/or external initiating events

- Identify precursor events from available databases
- Carry out a detailed analyses of some of these
- Identification of new insights and commendable practices
- Identification of improvements to the implementation of OP EX lessons learnt

# New Technical Studies Being Considered

## *Ref. NEA Integrated Fukushima Safety Enhancements Programme*

### **Plant Defence-in- Depth and Robustness**



# New Technical Studies Being Considered

## *Ref. NEA Integrated Fukushima Safety Enhancements Programme*

To gain a thorough understanding of the Fukushima accident progression

*Performance of a blind simulation study using common boundary conditions*

To improve knowledge in the area of fuel degradation in the spent fuel pools

*Carry out a fundamental review of current knowledge in the phenomenology and conditions promoting fuel degradation in SFPs*

### Enhancements in Accident Analysis and Management

Review of human performance and reliability under SA conditions

Assessment of current knowledge of HRA for actions under extreme conditions

Review of decision-making capabilities under very demanding situations

Study of procedural adequacy, resources, training for prolonged SA situations

Management of core melt situations

Review of containment venting approaches, hydrogen generation and management

Study of instrumentation survivability for core melt situations

Predictive capabilities of FP behaviour

# New Technical Studies Being Considered

*Ref. NEA Integrated Fukushima Safety Enhancements Programme*

## Advancements in Off-Site Emergency Preparedness

### **Improvement of Off-Site Emergency Preparedness**

- Knowledge sharing on core melt accident progression and source term analysis to improve modeling tools and off-site emergency preparedness and response procedures

### **Enhance International Decision Coordination**

- Study how national governmental recommendations and decisions could be better coordinated, how to coordinate these and with whom. Best practice review of effective international decision coordination approaches

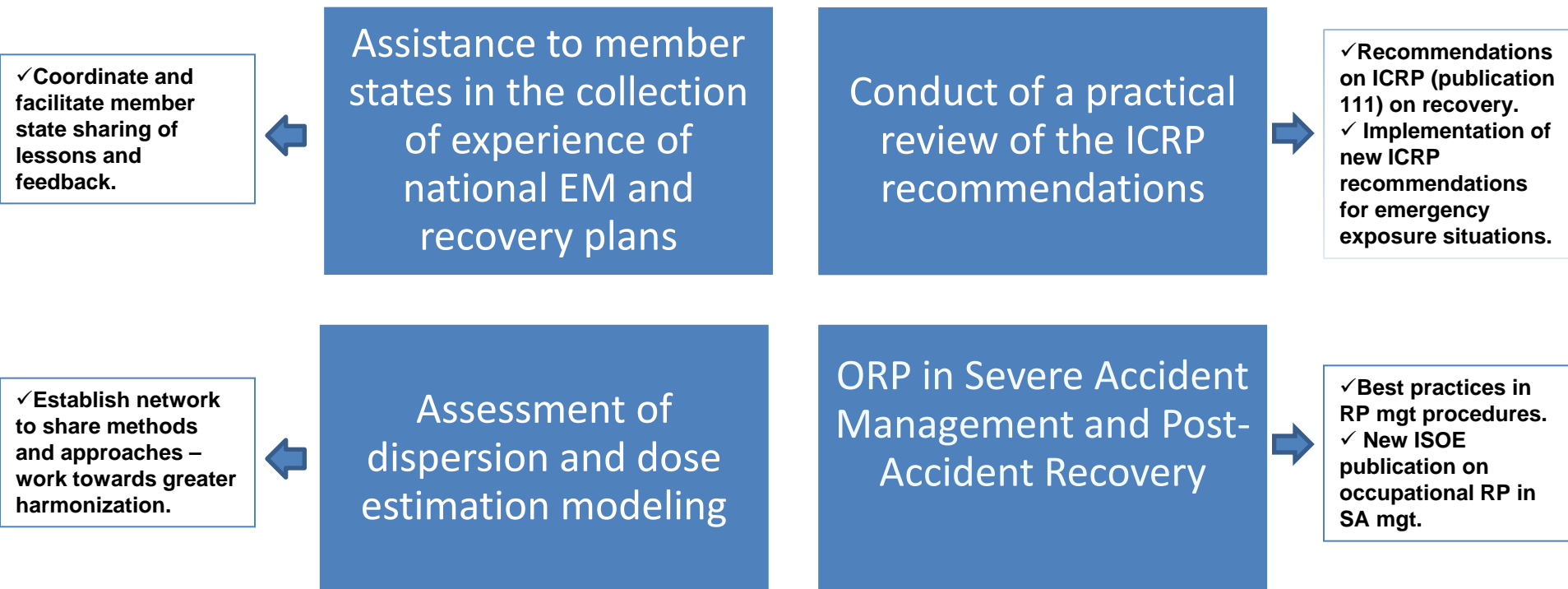
### **Update NEA Short-Term Countermeasures Report**

- Review report on national approaches and criteria for short-term countermeasures and propose enhancements

# New Technical Studies Being Considered

*Ref. NEA Integrated Fukushima Safety Enhancements Programme*

## Radiological Protection and Public Health



# NEA Integrated Response to Fukushima – Next Steps

- Action list of technical issues being considered by CSNI, CNRA, CRPPH and its working groups and task groups
- New task proposals (CAPS) to be brought forth by WGs, TGs for support by the committees at their meetings between now and June 2012 (and beyond). Committees to direct that new working groups/task groups be formed if req'd
- CNRA Senior Task Group on Fukushima will continue to oversee and coordinate the integrated response going forward
- Short term/high priority actions to be completed within one year
- NEA website being created to track progress of integrated response plan

## □ Motivations and Goals

- **Resolve issues** relevant for the nuclear community by means of research shared by many countries
- **Enhance technical exchange**, co-operation and consensus-building internationally
- **Support** the continued operation of **unique test facilities** which are of value to the OECD/NEA nuclear community
- **CSNI is committed to promote** and facilitate Safety Research, through scientific and technical cooperation between member countries
- The availability of **safety research results** is key in assuring the high level and long-term safety of nuclear facilities
- This goal can however only be reached if **dedicated and sustained funding** for safety research is maintained. The availability of experimental infrastructures is also essential



# NEA Joint International Research Projects



- |   |   |   |
|---|---|---|
| <ul style="list-style-type: none"> <li>➤ <b>HALDEN</b></li> <li>➤ <b>CABRI</b></li> <li>➤ <b>SCIP-2</b></li> <li>➤ <b>SFP</b></li> <li>➤ <b>PRISME2</b></li> <li>➤ <b>ROSA</b></li> <li>➤ <b>PKL-2</b></li> <li>➤ <b>LOFC</b></li> <li>➤ <b>BIP-2</b></li> <li>➤ <b>SERENA</b></li> <li>➤ <b>THAI-2</b></li> <li>➤ <b>STEM</b></li> <li>➤ <b>Databases</b></li> </ul> | <ul style="list-style-type: none"> <li>Fuel and Materials, I&amp;C, Human Factors</li> <li>Fuel in RIA transients</li> <li>Fuel integrity</li> <li>Spent fuel safety</li> <li>Fire Safety</li> <li>System TH</li> <li>PWR SG behaviour</li> <li>RCS safety in GCR</li> <li>Iodine chemistry</li> <li>Steam explosion</li> <li>Containment (H<sub>2</sub>, I)</li> <li>Source term mitigation</li> </ul> | <ul style="list-style-type: none"> <li>Norway</li> <li>France</li> <li>Sweden</li> <li>USA</li> <li>France</li> <li>Japan</li> <li>Germany</li> <li>Japan</li> <li>Canada</li> <li>Korea &amp; France</li> <li>Germany</li> <li>France</li> </ul> |
|---|---|---|
- |  |
|--|
| <ul style="list-style-type: none"> <li>1. FIRE</li> <li>2. ICDE</li> <li>3. CODAP</li> <li>4. CADAK</li> <li>5. COMPSIS</li> </ul> |
|--|

## Component Integrity

PRISME  
PRISME-2  
HEAF

## RCS Thermal-Hydraulics

SETH/PKL  
PKL - PKL-2  
ROSA - ROSA-2  
PKL-3

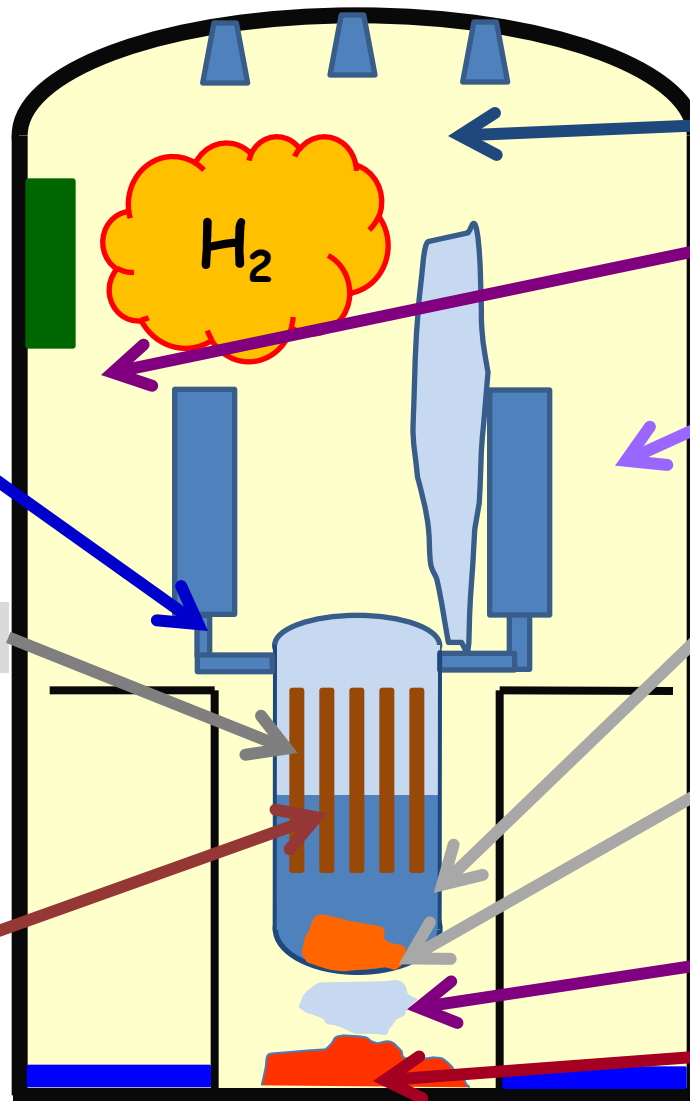
## Advanced Reactors

LOFC

## Fuel Safety

Halden  
SCIP - SCIP2  
CIP - SFP

LOFT



## Containment issues

SETH - SETH-2  
HYMERES  
THAI - THAI2  
BIP - BIP-2  
STEM

## Vessel integrity

TMI-VIP  
OLHF

## S.A. In-Vessel

RASPLAV  
MASCA

## S.A. Ex-Vessel

SERENA  
MCCI  
MCCI-2

- Importance of future safety research highlighted in CSNI Concept Paper on Fukushima, CNRA STG Recommendations to CNRA and other supporting strategy/policy documents
- Phased approach within NEA:
  - ✓ Compilation of past safety research conducted – **done**
  - ✓ Comprehensive review of safety assessment and research already carried out - **ongoing**
  - ✓ Gap analysis based on research issues from Fukushima - **ongoing**
    - Discuss possible expansion of existing projects and/or
    - New R&D project proposals
  - ✓ CSNI review of research direction – **ongoing**

Thermal Hydraulics Projects	Fuel Behaviour Projects	Severe Accident Phenomenology Projects	Other (Systems and Event Database Projects)
<ul style="list-style-type: none"> <li>• LOFT, Loss-of-Fluid Test Project (1983-1989)</li> <li>• BUBCON, Bubbler Condenser Project (2001-2002)</li> <li>• SETH, SESAR Thermal-hydraulics Project (2001-2006)</li> <li>• SETH-2, SETH Phase 2 Project (2007-2010)</li> <li>• PSB-VVER Project (2003-2008)</li> <li>• PKL, Primärkreislauf Project (2004-2007)</li> <li>• PKL-2, PKL Phase 2 Project (2008-2011)</li> <li>• ROSA, Rig of Safety Assessment Project (2005-2009)</li> <li>• ROSA-2, ROSA Phase 2 Project (2009-2012)</li> <li>• PRISME, Fire propagation in elementary, multi-room scenarios Project (2006- 2011), PRISME-2 Project (2011-2016)</li> <li>• LOFC, Loss of Forced Coolant Project (2011-2013)</li> </ul>	<ul style="list-style-type: none"> <li>• HALDEN, Halden Reactor Project (1958-present)</li> <li>• CIP, Cabri Water Loop International Project (2000-2015)</li> <li>• PAKS, OECD-IAEA Paks Fuel Project (2004-2007)</li> <li>• SCIP, Studsvik Cladding Integrity Project (2004-2009)</li> <li>• SCIP-2, SCIP Phase 2 (2009-2014)</li> <li>• SFP, Sandia Fuel Project (2008-2012)</li> </ul>	<ul style="list-style-type: none"> <li>• TMI-VIP, TMI-2 Vessel Investigation Project (1988-1993)</li> <li>• RASPLAV Project (1994-2000)</li> <li>• OLHF, Sandia Lower Head Failure OECD Project (1998-2002)</li> <li>• MASCA, Material Scaling Project (2000-2003)</li> <li>• MASCA-2, MASCA Phase 2 Project (2003-2007)</li> <li>• MCCI, Melt Coolability and Concrete Interaction Project (2002-2005)</li> <li>• MCCI-2, MCCI Phase 2 Project (2006-2010)</li> <li>• BIP, Behaviour of Iodine Project (2007-2011); BIP-2 (2011-2014)</li> <li>• SERENA, Steam Explosion Resolution for Nuclear Applications Project (2007-2012)</li> <li>• THAI, Thermal-hydraulics, Hydrogen, Aerosols, Iodine Project (2007-2009); phase 2 (2011-2014)</li> <li>• SFP, Sandia Fuel Project (2008-2012)</li> <li>• STEM, Source Term Evaluation and Mitigation (2011-2015)</li> </ul>	<ul style="list-style-type: none"> <li>• SCORPIO Project (1996-1998)</li> <li>• PLASMA Project (1998-2000)</li> <li>• International Common-cause Failure Data Exchange (ICDE) Project (1994-2014)</li> <li>• Piping Failure Data Exchange (OPDE) Project (2002-2011)</li> <li>• Fire Incidents Records Exchange (FIRE) Project (2002-2014)</li> <li>• Computer-based Systems Important to Safety (COMPSIS) Project (2006-2011)</li> <li>• Stress Corrosion Cracking and Cable Ageing Project (SCAP) (2006-2010)</li> <li>• Component Operational Experience, Degradation and Ageing (CODAP) Project (2011-2014)</li> <li>• Cable Ageing Data And Knowledge Project (CADAK) (2011-2014)</li> </ul>

# Concluding Remarks

- First priority for NEA countries is safety and regulation
- CSNI has a long history of supporting NEA member country safety institutions in producing valuable and timely outputs towards continual enhancement of nuclear safety including safety research
- CSNI is a recognized forum to coordinate and where appropriate cooperate on safety R&D activities among NEA member countries
- CSNI products (e.g. SOARs, ISPs) have been key contributors to assisting in harmonizing national safety assessment practices
- NEA joint research projects have contributed to address common safety concerns and to retain countries' technical expertise and infrastructure in strategic fields of nuclear safety
- From NEA perspective, concerted actions among technical safety institutions should build upon the successful framework existing today

# Concluding Remarks

- In the future, NEA/CSNI will continue to advance the science of nuclear safety through the work of its working groups, task groups and joint international research projects
- Clear focus in short to medium term on follow-up activities from the Fukushima Dai-ichi accident ensuring continued strong coordination with IAEA, EC and other international nuclear safety partners
- Meeting the NEA member countries' needs in safety research will continue to be an important part of our mandate and work

# The OECD Nuclear Energy Agency

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