

MULTINATIONAL DESIGN EVALUATION PROGRAMME

Annual Report

April 2018-April 2019



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Foreword from the Policy Group Chair

Since May 2018 it has been my privilege to serve as Chairman of the Multinational Design Evaluation Programme (MDEP) Policy Group. This initiative serves a crucial function in helping regulatory bodies from all over the world to co-operate across a range of international activities related to assessing new reactor designs. Our collective accomplishments this past year underline the fact that MDEP is a unique and timely enterprise that allows us to critically examine projects and prepare for future challenges.

This Annual Report provides an accessible summary of these accomplishments and will help readers reflect on the future of the programme. I am pleased to note that two reactor designs evaluated by MDEP have successfully come into operation in the People's Republic of China in recent months: AP1000s in Haiyang and Sanmen and an EPR unit in Taishan. Other designs currently undergoing safety evaluation are projected to become operational in numerous other locations in the coming years. Now more than ever, MDEP's input promises to be a vital tool for identifying and diffusing best practice for the licensing, construction, commissioning and initial operation of new reactors across the globe.

I would like to take this opportunity to pay tribute to my predecessor as chairman, Petteri Tiippana. MDEP went from strength to strength under his guidance, with the number of member states rising to 16 and the portfolio of reactor designs under evaluation reaching six in 2018. I am sure I speak for all of us when I express profound gratitude to Petteri for his tireless work in facilitating these and other successes, and for his invaluable contribution in strengthening MDEP's reputation as an effective organisation for leveraging the expertise and experiences of regulators from around the world.

This year, the MDEP has continued to build links with regulators, industry, and standards development organisations through regular meetings and conferences. Notably, November 2018 saw the staging of the Nuclear Supply Chain Management Workshop, an event co-organised by MDEP and the Committee on Nuclear Regulatory Activities (CNRA). Throughout this two-day event, representatives from a variety of stakeholders analysed key supply chain issues pertinent to an increasingly globalised nuclear industry. The workshop was a reminder of MDEP's important role in facilitating co-operation and ensuring that multiple perspectives are taken into account. I greatly look forward to continuing this at the fifth MDEP Conference.

Clearly, MDEP is in a period of transition. Some Design-Specific Working Groups (DSWGs) are reaching the end of their time within the MDEP framework; some Issue-Specific Working Groups (ISWGs) are being transferred to the CNRA in order to expand their membership and scope of work; meanwhile, the new HPR1000 Working Group has recently been established, and Argentina's Autoridad Regulatoria Nuclear (ARN) has joined the programme. This should lead to interesting discussions on the future of MDEP and the role it might play for other activities.

I am confident that over the next year we will build upon our excellent track record of enhancing nuclear safety by pursuing information exchanges, building institutional links, and realising cross-border collaborations. The support of the OECD Nuclear Energy Agency (NEA), which operates as the MDEP Technical Secretariat, has been and will continue to be instrumental to MDEP's success; for this reason, I would like to thank our colleagues at the NEA for all their work in ensuring the smooth functioning of the initiative. In particular, I must express my gratitude to Luc Chaniel for his tireless commitment to marshalling knowledge and resources in support of all MDEP members. Many thanks to him for his support throughout my chairmanship so far.

Mark Foy,
MDEP Policy Group Chair

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Executive summary

The Multinational Design Evaluation Programme (MDEP) is an initiative that seeks to leverage the resources and knowledge of national regulatory authorities that are currently, or will shortly be, undertaking the review of new reactor power plant designs. MDEP members are the regulatory authorities of Argentina (ARN), Canada (CNSC), China (NNSA), Finland (STUK), France (ASN), Hungary (HAEA), India (AERB), Japan (NRA), Korea (NSSC), the Russian Federation (Rostechnadzor), South Africa (NNR), Sweden (SSM), Turkey (TAEK), the United Arab Emirates (FANR), the United Kingdom (ONR) and the United States (NRC). The OECD Nuclear Energy Agency (NEA) performs the Technical Secretariat function in support of MDEP. The International Atomic Energy Agency (IAEA) also takes part in the work of MDEP. This programme incorporates a broad range of activities including enhancing multilateral co-operation within existing regulatory frameworks and increasing multinational convergence of codes, standards, guides and safety goals. A key concept throughout the work of MDEP is that national regulators retain sovereign authority for all licensing and regulatory decisions.

Working groups are implementing the activities in accordance with programme plans with specific activities and goals, and have established the necessary interfaces both within and outside of MDEP. This report provides a status of the programme after more than a decade of implementation.

Significant progress is being made on the overall MDEP goals of increased co-operation and enhanced convergence of requirements and practices. In addition, the lessons learnt from the 11 March 2011 accident at the Fukushima Daiichi nuclear power plant have appropriately been addressed by all designs under MDEP and incorporated into MDEP activities in the Design-Specific Working Group (DSWG) programme plans.

Five DSWGs are facilitating the MDEP goal of enhanced co-operation. The EPR Working Group (EPRWG) consists of the regulatory authorities of China, Finland, France, India, Sweden, and the United Kingdom. The AP1000 Working Group (AP1000WG) consists of the regulatory authorities of China, India, and the United States; the regulatory authorities of the United Kingdom and Canada also belong to this working group as non-active members. The APR1400 Working Group (APR1400WG) includes the regulatory authorities

of Korea, the United Arab Emirates and the United States. The VVER Working Group (VVERWG) includes the regulatory authorities of China, Finland, Hungary, India, Russia and Turkey. The HPR1000 Working Group (HPR1000WG) includes the regulatory authorities of Argentina, China, South Africa and the United Kingdom. The DSWGs continued to share information and experience on the safety design reviews with the purpose of enhancing the safety of the design and enabling regulators to make timely licensing decisions. International co-operation also makes it possible to promote safety and the standardisation of MDEP designs.

The accomplishments witnessed to date provide confidence that the MDEP membership, structure and processes offer an efficient method of achieving effective co-operation in regulatory reviews for new designs. At the level of the working groups, the key accomplishments for 2018-2019 include:

- The EPRWG published a Technical Report (TR-EPRWG-04) identifying the main differences in the modelling of a number of reactor faults in the various EPR designs. It also completed a draft Common Position on boron dilution faults and 2A loss-of-coolant accident (LOCA). Additionally, it is revising the Common Position on EPR Instrumentation & Control designs and is developing reports on hydrogen management, extended station blackout.
- The APR1400WG continued to exchange information on country-specific design issues in South Korea, the United Arab Emirates (UAE), and the United States. In October 2018 it published a Common Position (CP-APR1400-03) on fuel thermal conductivity degradation (TCD), following approval with comments by the Steering Technical Committee (STC). The working group continues to develop Technical Reports on Equipment Survivability. It is also developing a Common Position paper on the seismic performance of fuel.
- The AP1000WG continued to exchange information about important design changes, construction issues and vendor issues associated with the AP1000 design. In 2018 it published a Common Position (CP-AP1000WG-03) on AP1000 In-containment Refuelling Water Storage Tank (IRWST) Condensate Return Modelling, and Technical Reports on Lessons Learnt with AP1000 Reactor Coolant Pumps (TR-AP1000WG-01) and AP1000 Squib

Valves Design, Construction, Qualification, and Testing Experience (TR-AP1000WG-02). It is now developing a Common Position on Design Approach to Post Loss-of-coolant Accident (LOCA) Strainer Performance and Debris In-Vessel Downstream Effects, as well as Technical Reports on Lessons Learnt from Implementation of the CP addressing FPOTs, AP1000 Hydrogen Management, and AP1000 Hot Functional Testing Lessons Learnt.

- The VVERWG continues to develop a Common Positions and Technical Reports on a variety of topics: regulatory approaches related to accidents and transients analyses; ex-vessel melt retention in core catcher; Reactor Pressure Vessel and Primary Components Reliability for AES-2006 designs; similarities and differences among VVER designs; regulatory safety review approaches and resulting evaluations. It is also developing a Technical Report on hydrogen management at the STC's request.
- The Vendor Inspection Co-operation Working Group (VICWG) continued to exchange experience on vendor inspection processes in order to understand differences in regulatory approaches and to identify trends and vulnerabilities in international supply chains. In May 2018 the working group published a Common Position on the Preparation and Performance of Vendor Inspections. In October it published a Common Position on Counterfeit, Suspect and Fraudulent Items (CSFI) Procedures and Policies, drawing in particular on detection and mitigation approach surveys conducted by France's ASN. During 2019 and 2020 it intends to build on this work by compiling an Inspection Planning and Tracking Table that clearly communicates opportunities for MDEP VICWG regulators to participate and witness inspections.
- In November 2018 the VICWG sponsored the Nuclear Supply Chain Management Workshop in collaboration with the Committee on Nuclear Regulatory Activities (CNRA). Throughout the two-day workshop, participants discussed the primary supply chain oversight challenges in an increasingly globalised nuclear industry, identifying emerging risks and providing recommendations to further improve supply chain management and oversight arrangements. The VICWG will formally publish the proceedings from the joint workshop; key takeaways will be considered and integrated into its future work.
- The CSWG transferred from MDEP to the CNRA in June 2018, having achieved the goals initially established by the STC to improve design reviews through harmonisation of code requirements for pressure-retaining components. Initially, the transitioned CSWG will focus on three broad themes: carbon macro-segregation; in-service inspection and environmentally assisted fatigue; and non-water cooled reactors. These topics were identified as consistent with MDEP CSWG members' interest and CNRA survey responses. It will work with CORDEL and the SDOs to harmonise code requirements to reduce economic, technical and regulatory barriers.
- The HPR1000WG established two new TESGs: the Severe Accidents (SA) TESG and the Internal and External Hazards TESG. It will develop three Common Positions on the following topics: the Vienna Declaration; Fukushima lessons learnt; and the Post Loss-of-coolant Accident (LOCA) Strainer Performance and Debris in-Vessel Effects. It also intends to complete a survey on hydrogen management and will draft a Technical Report drawing on the results.

1. Introduction

The Multinational Design Evaluation Programme (MDEP) is an initiative that develops innovative approaches to leverage the resources and knowledge of national regulatory authorities who are, or will shortly be, undertaking the review of new reactor power plant designs. MDEP is primarily focused on design evaluation, but also includes inspection activities and generic issues. A key aim is to better inform the decisions of regulatory authorities through multinational co-operation, even as each regulator retains the sovereign authority to make licensing and regulatory decisions.

Working groups are implementing the activities in accordance with their programme plans with specific activities and goals, and the working groups have established the necessary interfaces both within and outside MDEP members. Significant progress has been made over the past year on the overall MDEP goals of increased co-operation and enhanced convergence of requirements and practices. Accomplishments to date provide

confidence that the MDEP membership, structure and processes provide an effective method of increasing co-operation in regulatory design reviews for new reactors.

MDEP was established in 2006 as a multinational initiative for a five-year period. It was extended for another five-year period in 2012 by the Policy Group based on the value gained by the members. In 2015, the Policy Group determined that MDEP should continue in its current form, for at least five more years following 2017. Since MDEP is a temporary organisation, the Policy Group has implemented the transfer of two of the issue-specific working groups (the Codes and Standard Working Group and the Digital Instrumentation and Control [DI&C] Working Group) and one design-specific working group (the Advanced Boiling Water Reactor Working Group) to the NEA Committee on Nuclear Regulatory Activities (CNRA). This report provides a status of the programme after more than 10 years of implementation.

2. Programme goals and outcomes

The main objectives of the MDEP effort are to enable increased co-operation within existing regulatory frameworks and establish mutually agreed upon practices to enhance the safety of new reactor designs. The enhanced co-operation among regulators will improve the effectiveness and efficiency of the regulatory design reviews, which are part of each country's licensing process. The programme focuses on co-operation on regulatory practices that aim at harmonising regulatory requirements. The IAEA safety standards, which provide a general level of harmonisation, provide input to the work and can benefit from the final results.

MDEP is meeting its goal of enabling increased co-operation through the activities of the working groups. MDEP has been successful in providing a

forum for regulatory bodies to co-operate on design evaluations and inspections. In addition to organising working groups, MDEP has provided each regulator with peer contacts who share information, discuss issues informally, and disseminate information rapidly. For example, the design-specific working group members have benefitted significantly from the sharing of questions among the regulators, resulting in more informed and harmonised regulatory decisions. MDEP members have also been highly successful in co-ordinating vendor inspections in which the regulators share observations and insights. MDEP has made improvements in communicating information regarding the members' regulatory practices through development of an MDEP library which serves as a central repository for all documents associated with the programme.

3. Programme implementation

3.1. Membership

Participation in the Policy Group and Steering Technical Committee is intended for national safety authorities of interested countries that already have commitments for new build or firm plans to have commitments in the near future for new reactor designs. The MDEP members are: Argentina, Canada, China, Finland, France, Hungary, India, Japan, Korea, Russia, South Africa, Sweden, Turkey, the United Arab Emirates, the United Kingdom and the United States. The IAEA also takes part in the work of MDEP.

3.2. Organisational structure

The programme is governed by a Policy Group (PG), made up of the heads of the participating organisations, and implemented by a Steering Technical Committee (STC) and its working groups. The Steering Technical Committee consists of senior staff representatives from each of the participating national safety authorities in addition to a representative from the IAEA.

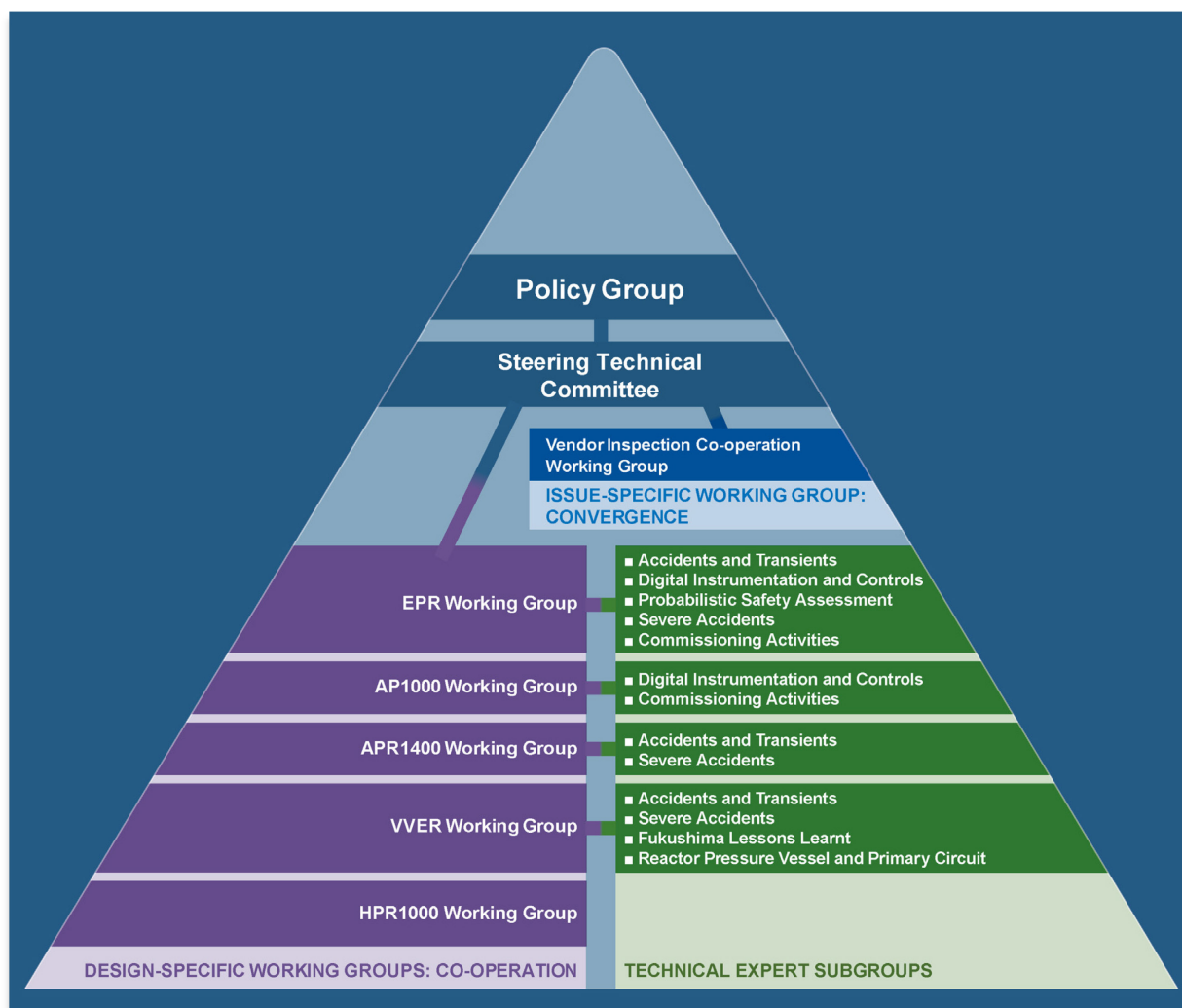
The Policy Group provides guidance to the Steering Technical Committee on the overall focus of MDEP; monitors the progress of the programme; and determines participation in the programme.

The Steering Technical Committee manages and approves the detailed programme of work including: defining topics and working methods; establishing technical working groups and nomination of experts; approving procedures and technical papers developed by the working groups; establishing interfaces with other international efforts to benefit from available work and avoid duplication; developing procedures for the handling of information to be shared in the project; reporting to the Policy Group; identifying new topics for the programme to address; and establishing subcommittees of the STC to study specific topics.

The OECD Nuclear Energy Agency (NEA) performs the Technical Secretariat function in support of MDEP.

Two lines of activities have been established to carry out the work of MDEP:

- Design-specific activities. Design-specific working groups share information on a timely basis and co-operate in the areas of specific reactor design evaluations, construction oversight and the commissioning and early-phase operation of new reactors. Participants in these working groups are the regulatory authorities that are actively reviewing, preparing to review, or regulating the construction of the specific new reactor designs. A design-specific working group is formed when three or more MDEP member countries express interest in working together. Under the design-specific working groups, expert subgroups have been formed to address specific technical issues. Non-MDEP regulators could request MDEP membership in order to join a design-specific working group.
- Issue-specific activities. Working groups may also address specific technical and regulatory process areas within the programme of work. Today, MDEP has one issue-specific working group addressing vendor inspection issues (VICWG); it previously incorporated working groups on codes and standards (CSWG) and digital instrumentation and controls (DICWG). Membership in issue-specific working groups is open to all MDEP participating countries and the IAEA representatives. These topics were chosen because the activities are of generic interest and of safety significance to the licensing of new reactors in MDEP member countries. The approaches followed by the MDEP regulators are not completely alike, and successful completion of the activities related to the issue-specific working groups will likely result in increased harmonisation and convergence in regulatory practices or increased co-operation. In June 2015, the MDEP Policy Group determined that the programme should focus on design-specific activities going forward and the issue-specific working groups should be closed or transferred to another organisation over the next few years. The Digital I&C and Codes and Standards working groups were transferred to the CNRA in 2017 and 2018, respectively. The VICWG has been approved by the PG to remain in MDEP until 2022. The following chart illustrates how the programme is currently organised.



MDEP organisational structure as of April 2019

3.3. MDEP library

In part, MDEP information is communicated among the members through the MDEP library, which serves as a central repository for all documents associated with the programme. The NEA provides the technical support for development and maintenance of the MDEP library on a secured password-protected website. The website provides two levels of access which are: 1) general access open to every member, and 2) restricted area access for each MDEP working groups' member regulators. Publicly available documents related to MDEP are available on the MDEP page of the NEA website (www.oecd-nea.org/mdep). The STC, through the Secretariat, manages the maintenance of the library and makes enhancements to improve the effectiveness of the library.

In order for MDEP to be successful in fulfilling its goal of leveraging the work of peer regulators in the evaluation of new nuclear power plant designs, a framework was developed to facilitate the sharing of technical information among MDEP participants that at times may include proprietary and other types of sensitive information. As a general rule, the information exchanged as part of the MDEP in meetings and the MDEP library is for the sole use of the participating national regulatory authorities. The members of the working groups also follow the communications protocol to share new information related to new reactors with other members in advance of its release to the public. A large portion of the information shared may not be proprietary or sensitive; however, all participating members must protect and properly handle the information that an originator claims to be proprietary or sensitive.

3.4. Common Positions

MDEP has developed a process for identifying and documenting Common Positions on specific issues among the member regulators based on existing standards, national regulatory guidance, best practices and group member inputs. Design-specific Common Positions document common conclusions that each of the working group members have reached during design reviews. Discussions among the members and sharing information in these areas help to strengthen the individual conclusions reached.

Generic Common Positions apply generically rather than only to one specific design. Generic Common Positions document practices and positions that each of the working group members find acceptable. The Common Positions are intended

to provide guidance to the regulators in reviewing new or unique areas, and will be shared with the IAEA, and other standards organisations, for consideration in standards development programmes. After a Common Position is agreed to by a working group, it is presented to the STC for endorsement. Upon endorsement by the STC, the proposed Common Positions are made publicly available on the NEA MDEP website in order to keep external stakeholders informed of the work completed within MDEP. Those Common Positions will become commendable practices, recommended by MDEP. There is no obligation on the part of any regulatory body to follow them. A key concept throughout the work of MDEP is that national regulators retain sovereign authority for all licensing and regulatory decisions. If a regulatory body chooses to formally adopt a Common Position, it would be through that country's regular processes.

4. Interactions with other organisations

MDEP strives to maintain an awareness of, and interactions with, other organisations that are implementing programmes to facilitate international co-operation on new reactors. Interactions focus on ensuring that MDEP does not duplicate efforts and benefits from the outputs of these organisations.

A key outcome of MDEP's co-operation with external organisations was the 2018 Supply Chain Management Workshop. The CNRA, CORDEL, WENRA, the IAEA and industry actors all made significant contributions to the planning and execution of this two-day event, which focused on the primary supply chain oversight challenges. Participants worked to identify emerging risks and provided recommendations to further improve supply chain management and oversight arrangements.

4.1. CNRA WGRNR

The CNRA Working Group on the Regulation of New Reactors (WGRNR) examines the regulatory issues of siting, licensing, and regulatory oversight of generation III+ and generation IV nuclear reactors. The current focus areas of the WGRNR are construction experience and construction inspection issues. The WGRNR co-ordinates its work with the work performed by MDEP such that it utilises its outputs, does not duplicate its efforts, and extends the results of MDEP to other CNRA members. To

avoid overlap of activities between the groups, WGRNR focuses on procedures and guidance, while MDEP focuses on design-specific issues.

MDEP interacts with the CNRA WGRNR and the Working Group on Inspection Practices (WGIP) through the NEA, which also serves as the Technical Secretariat for the CNRA. WGRNR is the focal point of interactions between MDEP and the CNRA and its working groups, and will assist in co-ordinating communications and requests between the two activities in order to ensure that the MDEP's efforts take full advantage of the work already being done by the CNRA.

Since 2014, MDEP and CNRA have worked together to address commissioning activities (hot functional and start-up testing) specific to particular MDEP designs; meanwhile, WGRNR continues to focus on generic commissioning activities. Lessons learnt from MDEP commissioning activities continue to be transferred to WGRNR for it to pursue the work on a generic basis with participation open to a wider range of regulators.

In accordance with the Policy Group direction to transfer the MDEP issue-specific working group activities to the NEA, MDEP has co-operated with CNRA leadership to undertake the transfer of additional activities to CNRA. The benefits of continuing co-ordination among regulators on these topics have been recognised both within and outside of MDEP.

In June 2018, the CSWG was transferred to the CNRA. The decision to do so was reached following the CSWG members' success in their mission to promote and facilitate harmonisation and convergence of international Codes and Standards. Several ongoing efforts attest to this, and a framework for future work has been built. At a workshop held in April 2018, the members identified considerable further potential for further work, though they believed this would likely fall outside the purview of MDEP.

Having surveyed the memberships of the CNRA, the members of the CSWG believe that there is a great deal of profitable and mutually beneficial work left to be done in a forum of similar composition to the CSWG. The proposed new working group would be a valuable support in maintaining a safe and efficient nuclear industry worldwide.

4.2. IAEA

The IAEA takes part in the work of MDEP through participation in the Policy Group meetings, STC meetings and issue-specific working groups. In addition, the generic Common Positions developed in MDEP are shared with the IAEA for consideration in the IAEA standards development programme.

4.3. Advanced reactor forums

Although MDEP is not currently considering the designs of advanced reactors, MDEP interacts with the Generation IV International Forum (GIF) to stay informed of multinational co-operative activities in the area of advanced reactors. MDEP also receives updates, through the NEA, of the work of the Joint CNRA/CSNI Ad hoc Group on the Safety of Advanced Reactors (GSAR), and maintains an awareness of the efforts of the IAEA Small Modular Reactor Forum. While these groups co-operate on the generic issues related to advanced and small modular reactors (SMR), there is an understanding that MDEP may form a design-specific working group if three MDEP member countries begin to consider a specific advanced or SMR design.

4.4. WENRA

The MDEP Steering Technical Committee meets periodically with a representative of the Western Europe Nuclear Regulators Association (WENRA) to discuss the development of WENRA safety objectives and reports. The WENRA Reactor Safety Working Group has welcomed MDEP input when developing its documents.

4.5. Industry

The MDEP working groups are very interested in understanding the perspectives of the design vendors, codes and standards organisations, and component manufacturers, as well as the challenges they face in dealing with numerous regulators and regulatory systems. The MDEP working groups interact with industry groups, and invite them to participate in selective portions of meetings and other activities. For example:

- The Codes and Standards Working Group interacted with a committee of standards development organisations (SDOs) (ASME, JSME, KEPIC, AFCEN, NIKIET and CSA) in a code comparison project. After issuing the code comparison report, the SDOs formed a Code Convergence Board to achieve convergence on individual requirements, where realistic and practical. Members of the MDEP CSWG participate in meetings of the Code Convergence Board. Within the framework of the CNRA, the newly created WGCS is planning to pursue co-operation with industry to achieve its goals.
- The EPR Working Group meets regularly with representatives of Framatome, EDF and other EPR licensees, applicants and potential applicants to discuss similarities and differences among the EPR designs being licensed in each country.
- The AP1000 Working Group meets with Westinghouse and the AP1000 applicants and licensees.
- The APR1400 Working Group meets with KHNP and representatives of the licensee for the Barakah nuclear power plant, an APR1400 in the United Arab Emirates (UAE).
- The VVER Working Group continues to interact with the Russian nuclear industry, as well as invited representatives of Rosatom, Rosenergoatom and design organisations (such as Atomenergoproekt, Atomproekt and Hidropress) to take part in the meetings of the VVERWG and its subgroups to acquire additional information about safety-significant design solutions.
- The Vendor Inspection Co-operation Working Group (VICWG) meets with SDO and World Nuclear Association (WNA) representatives to discuss Quality Assurance and Quality Management (QA/QM) standards for manufacturing nuclear components. Many industry representatives attended the Supply Chain Management workshop held in November 2018.

4.6. World Nuclear Association

The World Nuclear Association CORDEL group acts as the industry counterpart to MDEP.

Since both MDEP and CORDEL have expressed interest in and have established a goal of furthering harmonisation of reactor designs, regulatory practices, and industry and international standards, the MDEP Policy Group has agreed that co-ordination of efforts with CORDEL is appropriate in some cases. While co-ordinating efforts in areas of mutual interest, MDEP members will always retain their individual and independent regulatory roles and positions. CORDEL task forces address many issues, including those currently being worked on by the MDEP issue-specific working groups. Members of the MDEP STC meet with CORDEL periodically, and CORDEL has participated in meetings of the MDEP Vendor Inspections and Codes and Standards Working Groups. CORDEL plays an important role in code harmonisation. The CSWG interfaced with CORDEL's Codes and

Standards Task Force (CSTF) to advance code convergence in partnership with technical experts from companies worldwide.

While MDEP is a regulatory forum and CORDEL is an industry organisation, both parties agree they can benefit from communications and co-operation where the organisations share common goals. Two areas in which CORDEL and MDEP both have programmes of work to increase harmonisation are digital instrumentation and controls and codes and standards. This co-operation remains strong following the working groups' transition to CNRA.

Both MDEP and CORDEL maintain strong interests in the harmonisation of new reactor designs and design reviews, regulatory safety standards and practices, and related industry and IAEA standards. MDEP values continued interaction to assist in achieving these goals while each organisation functions in a manner consistent with its appropriate roles and responsibilities.

5. Current activities

The 2018 activities of MDEP are being implemented through design-specific and issue-specific working groups. The members of the design-specific working groups share information and co-operate on specific reactor design evaluations and construction oversight. MDEP also maintains one issue-specific working group that scrutinises technical and regulatory process areas within the programme of work. Each working group has a lead and co-lead regulator designated as chair and vice chair, and has developed a programme plan which identifies specific activities, schedules and contacts.

The design-specific working groups leverage national regulatory resources by sharing information and experience on the regulatory safety design reviews with the purposes of enhancing the safety of the design and enabling regulators to make timely licensing decisions. Design-specific working groups achieve this goal through:

- Exchanging experiences and lessons learnt on licensing process implementation, design reviews, and design-related construction and commissioning activities;
- Working to understand the differences in regulatory safety review approaches in each country to support potential use of other regulators safety design evaluations, where appropriate;

- Identifying and understanding key design differences including those originating from regulatory requirements and then documenting the reasons for differences in regulatory requirements;
- Looking for opportunities to provide input to issue-specific working groups on potential topics of significant interest;
- Documenting common MDEP positions on aspects of a review;
- Documenting the group's activities in Technical Reports to ensure knowledge transfer;
- Communicating and co-ordinating communications on MDEP views and Common Positions to vendors and operators regarding the basis of safety evaluations and standardisation.

While the design-specific working groups typically address issues that the members find challenging, specific to each design, some topics are addressed by several working groups. Two such topics are commissioning activities and Fukushima Daiichi lessons learnt.

Commissioning activities

Members of design-specific working groups, especially EPRWG and AP1000WG, are presently

devoting resources to co-operate on the commissioning of first-of-a-kind (FOAK) reactor testing. Lessons learnt by MDEP will be transferred to WGRNR for it to pursue the work on a generic basis, with participation open to a wider range of regulators.

The MDEP generic Common Position addressing first plant only tests (FPOTs) provides high-level guidance to applicants and licensees that wish to take credit for a FPOT performed during the commissioning of the first unit of a similar type, if accepted by the applicants, licensees and regulators. An FPOT allows a test performed on the very first reactor of a specific design to be credited for the subsequent units of similar design.

As China AP1000s have moved into the commissioning phase, the Commissioning Activities Technical Expert Subgroup (TESG) shared information on commissioning tests, significant issues related to the testing, and lessons learnt on pre-operational testing. The TESG future activities include drafting a Technical Report on AP1000 hot functional testing lessons learnt from the Sanmen, Haiyang, and Vogtle sites, and increasing co-operation on pre-operational and start-up testing as more reactors start going through these phases.

MDEP co-operation in operational phases

MDEP was established primarily as a forum to co-operate on design reviews. The Policy Group and Steering Technical Committee have discussed the benefits and challenges of continuing co-operation after construction is complete and into the operational stages. MDEP recognises the benefits of continuing the co-operative relationships formed during the design review stage, as well as the benefit to the members of the Design-specific Working Groups (DSWG) who are still in the licensing phase. The Policy Group has determined that the operational stage should not be included in the scope of MDEP. However, they stated there should be a means to ensure that operating experience related to design issues is addressed by DSWGs. With this in mind, MDEP will continue to share information on construction and commissioning of new reactors, and incorporate feedback from operating experience as it pertains to design.

MDEP members agree that operating experience, when it has an impact on designs, should be considered. In particular, information from the first two years of operation may be directly related to commissioning. MDEP members are encouraged to stay and participate in a group after the considered reactor begins to operate in their country to share operating experience.

This issue was raised once more at the STC meeting in June 2017. After an extensive discussion, it was clear that the members value the forum that

MDEP provides. The discussion revolved mostly around the transition of a DSWG from MDEP to another area because there is a real value in the structured co-operation and dialogue that MDEP promotes. The STC discussed this challenge extensively and it is considering the Policy Group's guidance following their September 2017 meeting. The ABWRWG was the first design in MDEP to complete its programme of work and ceased its activities under MDEP in June 2018.

Fukushima Daiichi nuclear power plant accident lessons learnt

All of the DSWGs have discussed the lessons learnt from the Fukushima Daiichi nuclear power plant accident and each working group has developed a Common Position that identifies common approaches to address potential safety improvements, as well as common general expectations for new nuclear power plants. As directed by the MDEP Policy Group, the STC and working groups developed an integrated MDEP Common Position on the lessons learnt from the Fukushima Daiichi accident. The STC finalised this document in 2016 and placed it on the MDEP public webpage. MDEP recognises that other related international initiatives have been implemented that are focused on operating plants. Therefore, it is important for new MDEP designs, such as the HPR1000, to address the Fukushima Daiichi lessons learnt.

5.1. EPR Working Group (EPRWG)

The EPR design-specific Working Group (EPRWG) includes the regulatory authorities of China (NNSA), Finland (STUK), France (ASN), India (AERB), Sweden (SSM) and the United Kingdom (ONR). Numerous meetings and technical exchanges have taken place to share information on the reviews being conducted in each country. Several major construction activities were ongoing at the time of this report: Olkiluoto 3 in Finland, Flamanville 3 in France and the twin unit plant at Taishan in China were all in the final stages of construction, one of which started commercial operation at the end of 2018; the twin unit plant at Hinkley Point C in the United Kingdom was in the early construction phase.

The working group currently includes five technical expert subgroups that are addressing information on specific technical issues: Accidents and Transients, Digital Instrumentation and Control, Probabilistic Safety Assessment, Severe Accidents and Commissioning Activities. Each of these subgroups meet regularly to exchange information on relevant aspects of the design review and commissioning status, share relevant evaluations when they become available, and produce Technical

Reports to identify and document similarities and differences among designs, regulatory safety review approaches and resulting evaluations.

The EPRWG meets occasionally with representatives of Framatome and of EPR licensees, applicants, and potential applicants to discuss similarities and differences among the EPR designs being reviewed and licensed in each country. In June 2018, the EPRWG held a meeting in Bristol, United Kingdom, which included a visit to Hinkley Point C. In November 2018, the EPRWG met in Zhuhai, China before visiting the Taishan plant

Accomplishments and plan of work

In 2018, the EPRWG completed and published a Common Position stating how the EPR design addresses the objectives of the Vienna Declaration, especially with regards to avoiding large and early releases and long-term contamination. This Common Position addresses design basis, design extension and severe accidents.

Given the move of most of the current EPR projects towards final commissioning and operation, a review of the plan of work and TEGs was undertaken, with most TEGs (as outlined below) anticipated to complete their programme of work and close in 2019.

The Probabilistic Safety Assessment (PSA) TEG published a Technical Report identifying the main differences in the modelling of a number of reactor faults in the various EPR designs. It will close following a final meeting to compare the latest EPR PSA models.

The Accidents and Transients (A&T) TEG has been discussing reactor physics data obtained from the post fuel load commissioning tests at Taishan and various aspects of the EPR design, including the effectiveness of the pump filtration in design basis and severe accidents, and Heating, Ventilation and Air Conditioning (HVAC) designs. They have developed a Common Position on boron dilution issues. In addition, the subgroup has completed a draft paper on double-ended guillotine break loss-of-coolant accident (2A LOCA). The A&T TEG will close once the Technical Report on 2A LOCA is issued and discussions on the reactor physics data obtained from the post fuel load commissioning tests at Taishan have been completed.

The Digital Instrumentation and Controls (DI&C) TEG has developed a draft Common Position in EPR I&C designs and is finalising a Technical Report on EPR I&C designs. The subgroup will close following completion of these tasks.

The Severe Accidents (SA) TEG has developed a draft Technical Report on hydrogen management and is now focused on the different approaches

across the EPRs to operating strategies for severe accidents. The SA TEG will close once the hydrogen management report has been issued, and discussions on EPR operating strategies for severe accidents reviews have taken place and any follow-on work completed.

The Commissioning Activities (CA) TEG met twice in 2018 to share experiences on a variety of commissioning-related issues. They also revised the Technical Report on First Plant Only Tests (FPOT) to address learning from observing an EPR FPOT. They intend to continue their activities as long as members continue to show interest in exchanging information regarding commissioning-related issues.

5.2. AP1000 Working Group (AP1000WG)

The AP1000 design-specific Working Group (AP1000WG) includes the regulatory authorities of China (NNSA), India (AERB) and the United States (NRC). The UK regulatory authority (ONR) has ceased regulatory review activities for the AP1000 design in the United Kingdom following NuGen's decision to pursue a different reactor design for the Moorside project in Cumbria. In Canada, since CNSC completed a pre-licensing assessment of the AP1000 in June 2013 as part of its Phase 2 evaluation, there has been no activity with Westinghouse Electric Company (Westinghouse) on further AP1000 review efforts. The Phase 2 vendor design review is now complete. In light of these developments, the regulatory authorities of the United Kingdom (ONR) and Canada (CNSC) remain in the AP1000 Working Group as inactive members.

During this reporting period, four AP1000 units reached commercial operation in China at the Sanmen and Haiyang sites. Construction work remains underway on two units at the Vogtle site in the United States. India is considering building six AP1000 units at the Kovvada site.

On 14 February 2018, the NRC granted Westinghouse an exemption from Title 10 of the Code of Federal Regulations (10 CFR) 52.57(a) to defer by five years the time period during which Westinghouse could submit and the staff could accept a renewal application for the AP1000 Design Certification (DC). The renewal can now be requested between 27 February 2023 and 27 February 2025. Westinghouse had requested the exemption to allow for the completion and initial operation of AP1000 units in the United States, and the subsequent incorporation of lessons learnt from those activities into the DC renewal application.

Accomplishments and plan of work

The working group members have continued to share design, construction and commissioning

information, application documents, evaluations and preliminary findings. They have also continued to identify the most significant design review issues, as well as construction and vendor challenges. In November 2018, members began to consider the initial operational experience of the AP1000 units in China, and discussed changes to the technical specifications as construction was completed and the units entered commercial operation.

Throughout the existence of the working group, members have exchanged information related to licensing, construction, commissioning, and initial operation issues in various countries. The documents have been shared through the MDEP library. Discussion topics have included in-containment condensate return, main control room dose and habitability, reactor coolant pumps, squib valves and equipment qualification, as well as discussions on lessons learnt from the Fukushima Daiichi accident and the prevention and mitigation of severe accidents. In October 2018, these efforts culminated with the publication of Technical Reports on Squib Valves (TR-AP1000WG-02) and Reactor Coolant Pumps (TR-AP1000WG-01) and a Common Position (CP-AP1000WG-03) on In-containment Refuelling Water Storage Tank (IRWST) Condensate Return Modelling.

As the AP1000s in China moved closer to operation and completed hot and cold functional testing, the working group discussed the results and the lessons learnt from these tests. The working group also collected information on how the different member countries are addressing hydrogen management. The working group is currently finalising Technical Reports documenting lessons learnt during the initial test program, hydrogen management and on international co-operation during the design, construction and commissioning of AP1000 reactors. These will be the next three Technical Reports completed by the working group.

In its latest Programme Plan, the AP1000WG has established a number of objectives to be completed during the 2020-2021 period. In response to a request by the STC, the group has begun to plan a Common Position regarding Post Loss-of-coolant Accident (LOCA) Strainer Performance and Debris In-Vessel Downstream Effects. Additionally, the working group is developing a Technical Report on lessons learnt from implementation of the CP addressing FPOTs.

More broadly, it will continue to share AP1000 regulatory evaluations and inspection reports and will conduct discussions on technical issues including commissioning and initial test programs, design changes, construction and vendor issues, and operational challenges.

5.3. APR1400 Working Group (APR1400WG)

The APR1400 design-specific Working Group (APR1400WG) was established in August 2012 with four countries, though Finland later opted to leave following the cancellation of the Olkiluto 4 project in 2015. The current participants are the regulatory authorities of Korea, the United Arab Emirates (UAE), and the United States. The United Arab Emirates leads the working group.

The first APR1400, Shin-Kori Unit 3 in Korea, has been in commercial operation since December 2016. Shin-Kori 4 was connected to the grid in April 2019 and was expected to enter commercial operation in the summer of 2019. Four additional units – Shin-Hanul 1&2 and Shin-Kori 5&6 – were under construction. Four APR1400 units were also under construction at the Barakah site in the UAE. The construction licenses for Barakah Units 1&2 and Barakah Units 3&4 were granted in July 2012 and September 2014, respectively. The operating license application for Barakah nuclear power plant Unit 1 was submitted in March 2015 and was under review by the UAE Federal Authority for Nuclear Regulation. Furthermore, licenses for new fuel import, fresh fuel transportation, and fresh fuel storage in Barakah Unit 1 were granted to the future operator of the UAE nuclear power plants in 2016.

The US NRC certified the APR1400 for the US market in May 2019, following a 42-month design certification review process. The application for design certification was submitted in December 2014 by KHNP and KEPCO and docketed in March 2015. The contents of the application included design control documents, the environmental report, Technical Reports, Inspection, Tests, Analyses, and Acceptance Criteria (ITAAC) and topical reports. The Phase 1 safety evaluation was completed in February 2016 and Phase 2 review was completed in May 2017. The NRC's Advisory Committee on Reactor Safeguards completed its review in July 2017. The Phase 4 review was completed in May 2018. Phase 5 and phase 6 were completed in July and September 2018, respectively. In May 2019, the US NRC published the APR1400 Design Certification rule for public comments.

Accomplishments and plan of work

Throughout 2018 and 2019, the nuclear regulatory agencies of Korea, the United Arab Emirates, and the United States continued to exchange information related to several significant APR1400 issues. In October 2018 the working group met at the NEA in Paris, with the Accident and Transient (A&T) TEGS and the Severe Accident (SA) TEGS also holding their own separate meetings.

At the October 2018 meeting, the A&T TEGS focused on country-specific issues related to new

APR1400 reactors in South Korea, the UAE and the United States. They also held discussions on Fuel Seismic Issues and their impact on different designs. Meanwhile, the SA TEGS discussed Equipment Survivability, particularly with regards to the testing of containment penetration seals and gaskets. Subsequently, the subgroup intends to develop a draft Technical Report on this topic. It will also develop a draft Technical Report on Severe Accident Management Programmes.

In 2018 the working group completed a Common Position (CP-APR1400-03) on fuel pellet thermal conductivity degradation (TCD), which was approved with comments by the STC in October. The APR1400WG is also in the process of developing a Common Position paper on the seismic performance of fuel.

Given the completion of both the NRC's APR1400 licensing process and the 2018 safety review report, the United States will reduce its participation in the activities of the APR1400WG, remaining part of the working group as an inactive member. In light of these circumstances, the working group has decided to focus on completing the Technical Reports and Common Position papers that are currently under development.

5.4. VVER Working Group (VVERWG)

The VVER Working Group (VVERWG) includes the regulatory authorities of China, Finland, Hungary, India, Russia and Turkey. The working group members are reviewing plants at various stages of design and construction. In Russia, the Rostov nuclear power plant's Unit 4 entered commercial operation in September 2018. The Leningrad-II nuclear power plant Unit 1 entered commercial operation in October 2018; Unit 2 is under construction and siting licenses have been issued for Units 3 and 4. The Novovoronezh-II nuclear power plant Unit 1 is in operation; Unit 2 has received its operating license and was connected to the grid in May 2019. The Kursk-II nuclear power plant Units 1 and 2 were under construction. The Smolensk-II nuclear power plant siting licenses have been issued for Units 1 and 2. In Finland, one unit is under review for a construction license at Hanhikivi nuclear power plant. At the Kudankulam plant in India, two units are in operation, two units are construction, and two more have received siting licenses. At Akkyuy in Turkey, Units 1 and 2 are under construction with two additional units being considered for construction licenses. In China, four VVER units are in operation at the Tianwan nuclear power plant. In June 2018, the Chinese and Russian governments signed an agreement to construct two more VVER units in Tianwan. Hungary has granted siting

licenses based on generic design information for two VVER units at the Paks-II nuclear power plant.

Accomplishments and plan of work

The VVERWG currently includes four technical expert subgroups that are addressing specific technical issues: Severe Accidents (SA TEGS), Fukushima accident Lessons Learnt (FUKU TEGS), Reactor Pressure Vessel and Primary Circuit Components (RPV&PC TEGS) and Accidents and Transients (T&A TEGS). The members meet regularly to exchange information and experience in their countries' regulatory activities, approaches and legal framework related to new designs.

In 2018 the VVERWG published its Technical Report (TR-VVERWG-01) on regulatory approaches and criteria used in severe accident analyses and severe accident management after obtaining approval from the STC.

The T&A TEGS has drafted a Technical Report on regulatory approaches related to accidents and transients analyses. The report covers the following four topics: regulatory requirements for accident and transient analyses; computer codes used for modelling of accidents and transients; issues concerning safety demonstration of passive systems; and approaches for regulatory review of safety analyses. The VVERWG is currently reviewing this report before it is submitted to the STC.

The SA TEGS continues to develop a Technical Report and a Common Position addressing ex-vessel melt retention in core catcher, and will incorporate the answers to questionnaires on passive autocatalytic recombiners and on extended station blackout as it discussed at its meeting in February 2018 in Paris. The Technical Report is expected in December 2019 and the draft Common Position in June 2020.

The Fukushima TEGS continues to develop a draft Common Position addressing the Vienna Declaration on Nuclear Safety. At the 10th VVERWG meeting in May 2018, the members decided to postpone the development of this Common Position until receiving the licensing documents from STUK and HAEA.

The RPV&PC TEGS continues to discuss the regulatory approaches and oversight practices related to reactor pressure vessel and primary components. Since its meeting in September 2017, its discussions have also covered the evaluation of surveillance programmes for justification of RPV integrity, the qualification of FOAK components and the qualification of non-destructive testing (NDT) and welding personnel and special processes. The subgroup has drafted a CP on Reactor Pressure Vessel and Primary Components Reliability for AES-2006 designs; this is under review by the members

before submission to the STC. It also intends to develop a Technical Report on the same topic.

Furthermore, the VVERWG intends to draft Technical Reports identifying and documenting similarities and differences among designs, regulatory safety review approaches and resulting evaluations. It will also continue to document lessons learnt from design reviews and design issues faced during construction and commissioning and early phases of operation. Additionally, it will develop a Technical Report on hydrogen management following a request from the STC.

5.5. HPR1000 Working Group (HPR1000WG)

The MDEP HPR1000 Working Group (HPR1000WG) was approved by the MDEP Policy Group in September 2017. The group is focused on safety design reviews of the Hualong Pressurized Water Reactor Technology Co. LTD HPR1000 design. The HPR1000WG includes the regulatory authorities of Argentina (ARN), China (NNSA), South Africa (NNR), and the United Kingdom (ONR).

The first meeting of the HPR1000WG was held in March 2018 in Beijing, China. Members met in Paris, France, in September 2018 and in Liverpool, United Kingdom, in March 2019. A total of four HPR1000 units are currently under construction in China at the Fuqing and Fangchenggang sites.

In the United Kingdom, the HPR1000 design passed Step 2 of the ONR's Generic Design Assessment (GDA) process in November 2018. Step 3 of the 4-step process began in November 2018 and is scheduled to last one year. The Bradwell B HPR1000 nuclear power plant project is in the early stages, with initial site investigations currently underway.

The ARN has signed a Memorandum of Understanding (MOU) with the licensee, Nucleoeléctrica Argentina S.A. (NA-SA). A similar MOU is expected to be signed between NA-SA and the China National Nuclear Corporation (CNNC) in the near future.

Accomplishments and plan of work

In light of its discussions on Fukushima and severe accidents, FPOTs, unique design features affecting safety, and the treatment of external and internal events, the HPR1000WG has opted to establish two new TESSGs to further scrutinise the issues: the Severe Accidents (SA) TESSG and the Internal and External Hazards TESSG. These TESSGs will be required to provide a work plan describing the scope of the issues they will address and will also report on the status of their work at each HPR1000WG meeting.

The HPR1000WG will complete a survey on hydrogen management and will draft a Technical Report on this issue drawing on the results.

It will develop three Common Positions on the following topics:

- Fukushima Lessons Learnt, incorporating the STC statement on the Vienna Declaration.
- Post Loss-of-coolant accident (LOCA) Strainer Performance and Debris in-Vessel Effects.
- The Vienna Declaration.

The STC approved the HPR1000WG's Programme Plan for 2019-2020 at its meeting in April 2019.

5.6. Vendor Inspection Co-operation Working Group (VICWG)

The goals of the VICWG are to:

- Support MDEP design-specific working groups;
- Maximise the use of the results obtained from other regulators' efforts in inspecting vendors;
- Understand the similarities and differences between MDEP national regulators' Quality Assurance and Quality Management (QA/QM) Requirements in order to utilise the information to improve regulators own requirements;
- Facilitate the adoption of good vendor oversight practices by national regulators;
- Harmonise the vendor inspection practices among MDEP regulators for inspections under the MDEP protocol;
- Continue joint and witnessed inspections and perform multinational inspections of vendors according to the common QA/QM requirements;
- Focus vendor attention on areas of emerging risks;
- Focus licensee and vendor oversight on effective supply chain performance;
- Focus licensee and vendor attention on positive nuclear safety culture expected within the supply chain;
- Continue to engage with CNRA to consider how to maximise the use of information gathered through VICWG activities;
- Consider the establishment of an NEA working group for vendor oversight, as part of the transfer of ISWGs to the NEA.

The working group enhances the understanding of each regulator's inspection procedures and practices by co-ordinating witnessed and

multinational inspections of quality assurance arrangements and safety-related components.

Witnessed inspections consist of one regulator performing an inspection to its criteria, observed by representatives of other MDEP countries. The benefits to the observing countries include additional information and added confidence in the inspection results.

Multinational inspections consist of one regulator conducting an inspection according to its own regulatory framework with the active participation of one or more regulators. This allows the participating members to use the results of the inspection that are applicable to their regulations. Multinational inspections are a tool to gain vendor performance insights with minimal inspection resources from the participating regulators.

The working group maintains an annual list of planned inspections providing the opportunity to co-operate and fully maximise the results from vendor inspection activity. The inspection results are shared through the MDEP library. The library includes not only the reports of witnessed and multinational inspections, but other inspection reports that may be of interest to the MDEP members. The VICWG routinely engages with standard development organisations (SDOs) to exchange regulatory experience, encourage co-operation and influence the future activities of the SDOs. It continues to co-operate with important external stakeholders such as the International Atomic Energy Agency (IAEA), CORDEL and the World Nuclear Association (WNA) Supply Chain Taskforce. Furthermore, the VICWG engages with the CNRA Working Group on Inspection Practices (WGIP) to provide opportunities to WGIP members to observe vendor inspections and to share VICWG Common Positions.

Accomplishments and plan of work

During the 2018-2019 period, the VICWG continued to exchange experience on vendor inspection processes in order to understand differences in regulatory approaches and to identify trends and vulnerabilities in the international supply chain encountered in vendor inspections. It also continued to work with standard development organisations (SDOs) of applicable standards to explore harmonisation of QA/QM requirements.

During the 2017-2018 reporting period, five witnessed inspections were completed involving regulators from the United States, Korea, France, United Kingdom, Russia, Japan and Finland. The French and US regulators also collaborated on inspection results from separately conducted vendor inspections. In total, 15 opportunities were identified to co-operate on vendor inspection-

related information. Based on the collaboration and opportunities to witness inspections, the VICWG published its Common Position CP-VICWG-03: Preparation and Performance of Vendor Inspections in May 2018.

The VICWG has continually enhanced its co-operation on areas of emerging risk in supply chain management and vendor activity, notably in relation to Counterfeit, Fraudulent and Suspect Items (CFSIs). In 2017, the group co-operated effectively in dealing with fraudulent material certificates supplied from a Japanese material manufacturer. This approach continued into 2018 as the scope of falsification continued to grow. Ongoing co-operation has enabled regulators to evaluate their measures for addressing the risks of CFSIs entering licensee facilities through vendors. In October 2018, this culminated in the publication of a Common Position (CP-VICWG-04) on CSFI Procedures and Policies. Forward activities will continue to consider co-operation on areas of emerging risk such as reverse engineering.

In further developing its approach to these issues, the VICWG will also draw on the Nuclear Supply Chain Management Workshop which it sponsored in collaboration with the Committee on Nuclear Regulatory Activities (CNRA) in November 2018. This event brought together representatives from industry, regulatory organisations, standard development organisations, technical support organisations, and other international organisations from over 15 countries. Throughout the two-day workshop, participants discussed the primary supply chain oversight challenges in an increasingly globalised nuclear industry. Covering topics such as CFSI lessons learnt, advancing early integration of Safety Culture into the supply chain, and regulatory approaches and international co-operation to prepare for new technologies, participants identified emerging risks and provided recommendations to further improve supply chain management and oversight arrangements. The VICWG will formally publish the proceedings from the joint workshop; key takeaways will be considered and integrated into its future work.

The VICWG continues to ensure that its programme documents and inspection protocols are effectively maintained. In October 2018, it published a Technical Report (TR-VICWG-05) summarising its 2016 inspection of the Creusot Forge facility. The report also offers insights into the planning and organisation of future multinational inspections.

Next steps

As the VICWG has matured and national vendor inspection programmes have developed, the opportunities from VICWG participation have increased from co-operation on vendor inspection

activities to sharing the outcomes of national vendor inspection programmes. The Programme Plan continues to emphasise this additional objective of the VICWG.

The VICWG will continue to organise and conduct witnessed or joint inspections in future. In 2019 and 2020 it intends to compile an Inspection Planning and Tracking Table that clearly communicates opportunities for MDEP VICWG regulators to participate and witness inspections. Following this, it will target at least two inspections to be conducted each year and will discuss lessons learnt from their execution. The frequency of inspections is determined in relation to the activities of the identified vendors; however, it is anticipated that at least one multinational vendor inspection will be completed every two years. The VICWG will also consider any public communication needs associated with the outcome of MDEP multinational vendor inspections and, if necessary, prepare joint/co-ordinated press releases and statements to be issued by the PG.

The VICWG will continue to co-operate on areas of emerging risk and share inspection programme outcomes among regulators and with SDOs to influence appropriate mitigating methods including the development of associated international standards and guidance.

To ensure continued alignment with MDEP goals, the VICWG will continue to engage with the Design-specific Working Groups (DSWG) to assess whether it continues to provide effective support for DSWG issues and identify any opportunities for enhancement. The VICWG is currently collaborating with the CNRA Working Group on Safety Culture (WGSC) to develop a Common Position on Safety Culture in the Supply Chain; it intends to conduct a survey on safety culture to support this work.

The VICWG has been supporting the Working Group on Digital Instrumentation & Controls (WGDIC) in considering how existing vendor inspection processes could be applied to support Digital Instrumentation and Control (DI&C) Vendor Inspections. During the 2019-2020 period, VICWG will contribute to the development of a Technical Report on DI&C inspections.

5.7. Codes and Standards Working Group (CSWG)

The goal of the Codes and Standards issue-specific Working Group (CSWG) was to achieve harmonisation of code requirements for design and construction of pressure-retaining (pressure boundary) components in order to improve the effectiveness and efficiency of the regulatory design reviews, increase quality of safety assessments,

and to make each regulator stronger in its ability to make safety decisions.

The CSWG recognised early on that the first step to achieving harmonisation is to understand the extent of similarities and differences among the pressure boundary codes and standards used in various countries. The CSWG encouraged standards development organisations (SDOs) to compare the requirements in JSME's S-NC1 Code (Japan), AFCEN's RCC-M Code (France), KEA's KEPIC Code (Korea), CSA's N285.0 standard (Canada), and NIKIET's PNAE G-7 Code (Russia) against the requirements in Section III of the ASME Boiler and Pressure Vessel Code (United States) for Class 1 vessels, piping, pumps and valves. The results identified similarities and differences among the national codes, provided insight into the background, history, and philosophy of each code, and provided a basis for developing a general approach to code harmonisation. The report on code comparison was published in December 2012.

Based on the CSWG findings and the code comparison results, the CSWG established a global framework of a hierarchical structure for achieving code harmonisation. At the top of the hierarchy, the Fundamental Attributes provides overarching requirements for nuclear power plant design and construction. At the middle level, the Essential Performance Guidelines recommends basic design and construction rules to be included in codes, and provides guidance for code harmonisation. At the bottom level, code harmonisation was performed, a process that includes convergence and reconciliation of code differences as well as the minimisation of further code divergence. The CSWG proposed a stepwise approach for code convergence and established a regular communication process for information exchange and discussion among regulators, industry, and SDOs.

The CSWG played an important role as an interface between the regulators and industry efforts to harmonise codes and standards. CSWG interacted with the WNA CORDEL group Codes and Standards Task Force (CSTF), consisting of technical experts from various companies worldwide (Framatome, Bentley, Rolls-Royce, EDF, EPRI, Westinghouse, TVO, etc.) working to converge code requirements. They proposed a pilot project plan, which was consistent with CSWG stepwise approach, to harmonise code requirements. The CORDEL CSTF has achieved significant accomplishments in the areas of non-destructive examination (NDE) personnel certification and non-linear analysis. They have compared requirements in the major nuclear design codes, compared the current international industrial certification practices, and recommended a harmonised international alternative for the certification of NDE personnel. They have also

thoroughly reviewed the existing non-linear rules in different codes, and compared the scope, methods and availability of material data needed to perform analysis in very technical detail; they are developing universal new rules for non-linear analysis.

After issuing the code comparison report, the SDOs formed a Code Convergence Board to limit divergence on code requirements, and achieve convergence on individual requirements where realistic and practical. The SDOs and CORDEL are working jointly on code convergence of weld qualification. They extensively reviewed worldwide practices in performance qualification, procedure qualification, and quality assurance of welding, and are exploring strategy to harmonise code requirements on weld qualification. The SDOs are also considering including other significant technical issues with international interest that are not currently addressed in codes, and jointly developing universal code requirements. These include corrosion fatigue, RPV indications, flow-induced vibration in steam generators, small modular reactors, margin under high-seismic loadings, and the use of high-density polyethylene piping.

In parallel to the CORDEL CSTF and the SDOs, the CSWG worked independently on code reconciliation. The code differences with international interests and urgent needs were reconciled through four approaches: 1) demonstrating that different requirements provide an equivalent level of quality and safety; 2) demonstrating that a comparatively less restrictive provision in one code is compensated by other more stringent provisions of this code, and full implementation of the code still results in an equivalent degree of quality and safety; 3) specifying supplementary requirements to conditionally accept code differences; 4) identifying applicable conditions for specific code requirements of difference.

Accomplishments

The CSWG has successfully completed its goal and mandate to achieve some level of harmonisation and has identified the challenges in harmonising codes and standards. The group has established a regular communication process for information exchange and discussion, and has encouraged the industry and the SDOs to move forward and work co-operatively.

The working group has published six key technical documents. The Fundamental Attributes document and Essential Performance Guidelines document provide high-level and middle-level guidance for code harmonisation, respectively. The Regulatory Frameworks for Use of Codes document describes the regulatory practices in each country in using codes and provides insight on the flexibility of the regulatory framework of MDEP countries in using foreign codes. The Lessons Learnt document

provides CSWG's preliminary findings on achieving code harmonisation and provides general guidance on using foreign codes. The Common Position document proposes a hierarchy structure as a global framework for harmonisation and documents the CSWG Common Positions on code harmonisation. The CSWG Past, Current, and Future Activities document summarises the CSWG activities and achievements, develops a work plan, and collects a list of potential topics of interest for future code harmonisation.

Despite the challenges of code harmonisation, with dedicated work and close co-operation among the CSWG, CORDEL CSTF and SDOs, code harmonisation is happening in several technical areas. For example, one SDO is developing its code based on the SDOs' Code Comparison Report, and introducing new code areas. A regulatory authority is using the CORDEL/SDO Weld Qualification report to draft proposals for modifying regulatory requirements. An SDO that requires company-based certification has started to modify its code and to accept the international alternative proposed in the NDE personnel certification report.

Next steps

The CSWG has fulfilled the original goals laid out by the STC and further work will lie outside the purview of MDEP. Consequently, the CSWG's mandate has been transferred to the NEA's Committee on Nuclear Regulatory Activities (CNRA). This effort encompassed presentations to CNRA representatives, the completion of a draft mandate, and a one-day workshop held in April 2018. The workshop included code experts and stakeholders presenting on the CSWG's accomplishments, the benefits of CSWG work products, the stakeholder interest in a regulator body such as the CSWG, and regulators' expectations on code harmonisation work. The audience of the workshop consisted of MDEP, CNRA, and stakeholder code expert representatives. A survey was sent to CNRA members in preparation for the workshop; the results indicated broad support for the continuation of the CSWG work.

At the April 2018 CSWG meeting, it was proposed that an initial scope of work for a transitioned CSWG entity would focus on three broad themes: carbon macro-segregation, in-service inspection and environmentally assisted fatigue, and non-water cooled reactors. These topics were identified as consistent with MDEP CSWG members' interest and CNRA survey responses. The group's mandate to operate under the CNRA was formally established in June 2018.

The Working Group on Codes and Standards (WGCS) will continue, with an extended membership under the CNRA, to encourage CORDEL and the SDOs

to make progress in harmonising code requirements in order to improve operations and reduce technical and regulatory barriers. Some countries are considering developing their own codes. The WGCS will encourage these countries to study the existing codes carefully and minimise the potential

differences between new codes and the existing codes.

The transfer of the CSWG from MDEP to the CNRA is now completed.

6. Interim results

MDEP is considered a long-term programme with interim results. Interim results are those products that document agreement by the MDEP members and are necessary steps in working towards increased co-operation and convergence. The interim results for this reporting period include:

- The EPRWG published a Technical Report (TR-EPRWG-04) identifying the main differences in the modelling of a number of reactor faults in the various EPR designs. It has also completed a draft Common Position on boron dilution faults and 2A LOCA. Additionally, it is revising the Common Position on EPR I&C designs and is developing reports on hydrogen management and extended station blackout.
- The AP1000WG published a Common Position (CP-AP1000WG-03) on IRWST Condensate Return Modelling, and Technical Reports on Lessons Learnt with AP1000 Reactor Coolant Pumps (TR-AP1000WG-01) and AP1000 Squib Valves Design, Construction, Qualification, and Testing Experience (TR-AP1000WG-02). It is developing a Common Position on Design Approach to Post LOCA Strainer Performance and Debris In-Vessel Downstream Effects, as well as Technical Reports on Lessons Learnt from Implementation of the CP addressing FPOTs, AP1000 Hydrogen Management, and AP1000 Hot Functional Testing Lessons Learnt.
- The APR1400WG published a Common Position (CP-APR1400-03) on fuel thermal conductivity degradation (TCD). It continues to develop a Technical Report on Equipment Survivability and a Common Position paper on the seismic performance of fuel.
- The VVERWG continues to develop a Common Positions and Technical Reports on a variety of topics: regulatory approaches related to accidents and transients analyses; ex-vessel melt retention in core catcher; Reactor Pressure Vessel and Primary Components Reliability for AES-2006 designs; similarities and differences among VVER designs; regulatory safety review approaches and resulting evaluations; and hydrogen management.
- The HPR1000WG established two new TESSGs: the Severe Accidents (SA) TESSG and the Internal and External Hazards TESSG. It will develop three Common Positions on the following topics: the Vienna Declaration; Fukushima lessons learnt; and Post Loss-of-coolant Accident (LOCA) Strainer Performance and Debris in-Vessel Effects. It plans to conduct a survey on hydrogen management and will draft a Technical Report drawing on the results.
- The VICWG published Common Positions on the Preparation and Performance of Vendor Inspections and CSFI Procedures and Policies. During 2019 and 2020 it intends to build on this work by compiling an Inspection Planning and Tracking Table that clearly communicates opportunities for MDEP VICWG regulators to participate and witness inspections. Additionally, the VICWG sponsored the Nuclear Supply Chain Management Workshop in collaboration with the Committee on Nuclear Regulatory Activities (CNRA). Participants discussed supply chain oversight challenges, identifying emerging risks, and providing recommendations to further improve supply chain management and oversight arrangements. The VICWG will formally publish the proceedings from the joint workshop; key takeaways will be considered and integrated into its future work.

7. Next steps – future of the programme

The MDEP was established in 2006 as a multinational initiative for a five-year period. It was extended for another five-year period in 2012 by the Policy Group based on the value gained by the members. At its May 2014 meeting, the MDEP Policy Group requested a data collection to be conducted among the members to prepare for a discussion on MDEP's mid- and long-term strategy. The questions focused on MDEP's mission and expected deliverables, the use of MDEP products, and the future of MDEP. The results of the data collection indicated that the members continue to receive significant benefits from participation in MDEP and it should continue beyond 2017. The members confirmed that the core activity should be the design-specific working groups and identified some recommended improvements in the development of the programmes of work, defining the products and ensuring knowledge transfer as reactors begin the operational phase. These findings were shared with the Policy Group at its June 2015 meeting. At this meeting, the Policy Group determined that MDEP should continue in its current form for an additional five-year period after 2017 until the end of 2022. However, the PG stressed that, going forward, MDEP should focus on design-specific activities.

As new cross-cutting issues are identified in the future, the STC will consider setting up specific arrangements, such as ad hoc groups, sub-committees or arrangements with other working groups (e.g. the NEA's CNRA WGDIC, WGRNR and WGIP) to address the issues without duplication rather than creating new issue-specific working groups. The design-specific working groups will

continue to co-operate and exchange feedback on design issues through the construction phase and the first two years of initial operations. The Policy Group has determined that the operational stage should not be included in the scope of MDEP. However, there should be a means to ensure that operating experience related to design issues is addressed by DSWGs. With this in mind, MDEP will continue to share information on construction and commissioning of new reactors, and incorporate feedback from operating experience as it pertains to design.

As the current issue-specific working groups are completing the goals and activities originally assigned to them, the STC and Policy Group have approved the transferring of the generic activities to other organisations. As of April 2019, the working groups on Digital Instrumentation & Control and Codes and Standards had both been transferred to the CNRA.

MDEP member countries have also expressed the need and benefits of continuing co-operation among members even after a specific design review has concluded. To that end, the STC has begun to explore different options that can be utilised to transition existing co-operation within a design-specific working group outside of the MDEP once the working group has achieved its mandate under MDEP. For instance, the ABWRWG has identified topics that include BWR-specific concerns and recommendations for ensuring the continuation of the interactions within the Working Party on Boiling Water Reactors within the CNRA.

Appendix 1: List of abbreviations and acronyms

ABWR	Advanced boiling water reactor
ABWRWG	Advanced Boiling Water Reactor Working Group
AERB	Atomic Energy Regulatory Board (India)
AFCEN	Association française pour les règles de conception, de construction et de surveillance en exploitation des matériels des chaudières électronucléaires (French SDO)
ARN	Autoridad Regulatoria Nuclear (Argentina)
ASME	American Society of Mechanical Engineers
ASN	Autorité de sûreté nucléaire (Nuclear Safety Authority of France)
BWR	Boiling water reactor
CATESG	Commissioning Activities Technical Experts Subgroup
CCF	Common cause failure
CFSI	Counterfeit, Fraudulent and Suspect Item
CNRA	Committee on Nuclear Regulatory Activities (NEA)
CNSC	Canadian Nuclear Safety Commission
CORDEL	Co-Operation in Reactor Design Evaluation and Licensing
CP	Common Position
CSA	Canadian Standards Association
CSTF	Codes and Standards Task Force
CSWG	Codes and Standards Working Group
DICWG	Digital Instrumentation and Controls Working Group
DSWG	Design-specific Working Group
EDF	Electricité de France
ENEC	Emirates Nuclear Energy Corporation
EPRWG	EPR Working Group
FANR	Federal Authority for Nuclear Regulation (United Arab Emirates)
FOAK	First-of-a-kind
FPGA	Field-programmable gate arrays
FPOT	First plant only tests
GDA	Generic design assessment
GIF	Generation IV International Forum
GSAR	Group on the Safety of Advanced Reactors
HVAC	Heating, ventilation and air conditioning
HAEA	Hungarian Atomic Energy Authority
HDL	Hardware description language
I&C	Instrumentation and controls
IAEA	International Atomic Energy Agency
IEC	International Electro Technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IRWST	In-containment refuelling water storage tank
ISWG	Issue-specific Working Group
ITAAC	Inspection, Tests, Analyses, and Acceptance Criteria
JSC	Joint Stock Company (AtomStroyExport, Russia)
JSME	Japanese Society of Mechanical Engineers

KEPCO	Korea Electric Power Corporation
KEPIC	Korean Electric Power Industry Code
KHNP	Korea Hydro and Nuclear Power
KINS	Korea Institute of Nuclear Safety
LOCA	Loss-of-coolant accident
MCCI	Molten core concrete interaction
MDEP	Multinational Design Evaluation Programme
MHI	Mitsubishi Heavy Industries
NDE	Non-destructive examination
NDT	Non-destructive testing
NEA	Nuclear Energy Agency
NIKIET	Scientific Research and Design Institute of Energy Technologies (Russian SDO)
NNR	National Nuclear Regulator (South Africa)
NNSA	National Nuclear Safety Administration (China)
NPP	Nuclear power plant
NRA	Nuclear Regulation Authority (Japan)
NRC	Nuclear Regulatory Commission (United States)
NRO	Nuclear regulatory organisation
NSSC	Nuclear Safety and Security Commission (Korea)
OECD	Organisation for Economic Co-operation and Development
ONR	Office for Nuclear Regulation (United Kingdom)
OOG	Owners and Operators Group
PC	Primary circuit components
PG	Policy Group
PSA	Probabilistic safety assessment
QA	Quality Assurance
QM	Quality Management
RI	Regulatory issue
RO	Regulatory observation
RPV	Reactor pressure vessel
SBLOCA	Small-break loss-of-coolant accident
SDO	Standard development organisation
SMR	Small modular reactor
SSM	Strålsäkerhetsmyndigheten (Swedish Radiation Safety Authority)
STC	Steering Technical Committee
STUK	Säteilyturvakeskus (Radiation and Nuclear Safety Authority of Finland)
TAEK	Türkiye Atom Enerjisi Kurumu (Turkish Atomic Energy Authority)
TESG	Technical Experts Subgroup
TR	Technical Report
TVO	Teollisuuden Voima Oyj (Finnish Nuclear Power Company)
UAE	United Arab Emirates
VICWG	Vendor Inspection Co-operation Working Group
VVER	Water-water energetic reactor
VVERWG	VVER Working Group
WENRA	Western Europe Nuclear Regulators Association
WGIP	Working Group on Inspection Practices (NEA/CNRA)
WGRNR	Working Group on the Regulation of New Reactors (NEA/CNRA)
WNA	World Nuclear Association

Appendix 2: Revised or new documents and publications

- Working group programme plans: www.oecd-nea.org/mdep.
- TR-EPRWG-04 Limited Comparison of EPR Probabilistic Safety Assessment (PSA) 2017, oe.cd/4au.
- CP-EPRWG-07 Common Position Addressing the Vienna Declaration on Nuclear Safety 23 April 2018, oe.cd/4av.
- CP-EPRWG-06 Common Position on EPR Boron Dilution During a Small-Break Loss-of-Coolant Accident (SBLOCA) CP-EPRWG-06 – 16 April 2018, www.oecd-nea.org/mdep/documents/CP-EPRWG-06_Boron_dilution.pdf.
- TR-AP1000WG-02 Technical Report on AP1000 Squib Valves Design, Construction, Qualification, and Testing Experience, 23 October 2018, www.oecd-nea.org/mdep/common-positions/tr-ap1000wg-02.pdf.
- TR-AP1000WG-01 Technical Report on Lessons Learnt with AP1000 Reactor Coolant Pumps, 23 October 2018, www.oecd-nea.org/mdep/common-positions/tr-ap1000wg-01.pdf.
- CP-AP1000WG-03 Common Position on AP1000 In-containment Refuelling Water Storage Tank (IRWST) Condensate Return Modelling, 23 October 2018, www.oecd-nea.org/mdep/common-positions/cp-ap1000wg-03.pdf.
- CP-APR1400-03 Common Position on the Fuel Thermal Conductivity Degradation 11/01/2018, www.oecd-nea.org/mdep/documents/DCP-APR1400-Fuel_Thermal_Conductivity_Degradation.pdf.
- CP-VICWG-04 Common Position: Counterfeit, Fraudulent, and Suspect Items Procedures and Policies, 23 October 2018, www.oecd-nea.org/mdep/working-groups/vicwg.html.
- TR-VICWG-05 Technical Report on Assessment of Multinational Vendor Inspection of AREVA NP Creusot Forge (ACF), 23 October 2018 (not publicly available).
- CP-VICWG-03: Common Position on Preparation and Performance of Vendor Inspections, May 2018, www.oecd-nea.org/mdep/common-positions/cp-vicwg-03.pdf.

MULTINATIONAL DESIGN EVALUATION PROGRAMME

The Multinational Design Evaluation Programme (MDEP) was established in 2006 as a multinational initiative to develop innovative approaches to leverage the resources and knowledge of the national regulatory authorities that are currently or will be tasked with the review of new nuclear power reactor designs. MDEP members are the regulatory authorities of Argentina, Canada, China, Finland, France, Hungary, India, Japan, Korea, the Russian Federation, South Africa, Sweden, Turkey, the United Arab Emirates, the United Kingdom and the United States. The Nuclear Energy Agency serves as technical secretariat for MDEP. The International Atomic Energy Agency also takes part in the work of MDEP.

NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1 February 1958. Current NEA membership consists of 34 countries: Argentina, Australia, Austria, Belgium, Bulgaria, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Poland, Portugal, Korea, Romania, Russia, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Commission and the International Atomic Energy Agency also take 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 cooperation, the scientific, technological and legal bases required for a safe, environmentally sound and economical use of nuclear energy for peaceful purposes;
- 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 analyses in areas such as energy and the sustainable development of low-carbon economies.

Specific areas of competence of the NEA include the safety and regulation of nuclear activities, radioactive waste management and decommissioning, 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.

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