MDEP
Technical Report
TR-CSWG-05

Codes and Standards Working Group activities

Technical Report on CSWG Past, Current and Future Activities

Participation

Regulators involved in the MDEP working group discussions:	CNSC (Canada), STUK (Finland), KINS (Korea), NRA (Japan), Rostechnadzor (Russia), NNR (South Africa), ONR (United Kingdom), NRC (United States)
Regulators which support the present report:	CNSC (Canada), STUK (Finland), KINS (Korea), NRA (Japan), Rostechnadzor (Russia), NNR (South Africa), ONR (United Kingdom), NRC (United States)
Regulators with no objection:	-
Regulators which disagree:	-
Compatible with existing IAEA related documents:	Yes

I. INTRODUCTION

The primary goal of the Multinational Design Evaluation Programme Codes and Standards Working Group (MDEP CSWG) is to promote international harmonization of codes and standards, with an initial focus on pressure boundary components in nuclear power plants (NPP) that are important to safety. In working towards this goal, the CSWG collaborated with several standards development organisations (SDOs) from various countries to produce a comparison of several pressure boundary codes and standards.

Having made good progress in its primary goal, the CSWG now finds itself at a crossroads. It is the opinion of the CSWG that it has fulfilled the original goals laid out by the MDEP Steering Technical Committee and that further work would likely exist outside the purview of MDEP. Consequently, the working group members have prepared this document to express their thoughts on the experience of their participation and hopes for future codes and standards harmonisation potential howsoever that would be supported by international bodies. In addition, the CSWG conducted a survey of CNRA members concerning their view of codes and standards, and the potential for an entity such as CSWG to continue within CNRA. The results of this survey are summarixed within this report as well.

II. BACKGROUND

Codes and standards are key components of the design, operation and regulation of nuclear power plants. International co-operation, both in the form of private industry and government regulation, is fundamentally related to the ability to inter-operate, translate and compare between many codes and standards. In some countries, such as Canada, codes and standards become legal requirements and have the full force of law only if they are incorporated by reference into License and/or License Conditions. Alternatively, such as in France, codes and standards are not regulatory. They are used by the pressure equipment manufacturers as means to meet regulatory essential safety requirements; therefore the manufacturers have to demonstrate that the means they use are appropriate to guarantee that essential safety requirements are met, thus leading the regulator to assess the codes and standards.

As the design and supply of commercial nuclear technology has become increasingly international, the need to compare codes and standards under different regimes, regulatory and otherwise, has increased. The CSWG was tasked to both promote the harmonisation of codes and standards. In undertaking this task, a great deal of commonality between international codes was identified. It was determined that while full convergence of codes and standards was not practical, great opportunities existed for harmonisation and bridging of various codes and standards.

The CSWG is particularly heartened by the creation and efforts of the World Nuclear Association Co-operation in Reactor Design Evaluation & Licensing (WNA CORDEL) group. This group works to support technical work; to promote and enhancing harmonisation; and has put forth considerable effort in several technical areas of interest to CSWG such as non-destructive evaluation and non-linear analysis.

III. ACCOMPLISHED WORK

The initial CSWG mandated a programme of work exploring the potential for harmonisation of codes. In working towards this goal, the CSWG published four technical reports (TRs) and a common position (CP). In addition, the CSWG established a positive working relationship with the Standards Development Organization Convergence Board (SDO Board) and WNA CORDEL.

A significant portion of the initial CSWG work focused on information exchange between CSWG members concerning their native use of codes and standards. A corollary was the promotion of the establishment of an SDO counterpart in the form of the SDO Convergence Board. These efforts were further promoted through the creation of, and communication with a WNA/CORDEL counterpart. The CSWG published five reports (not including this one) documenting aspects of this effort:

1. TR-CSWG-01 Regulatory Frameworks for the Use of Nuclear Pressure Boundary Codes and Standards in MDEP Countries

   This report documents how each MDEP regulator utilises national or regional mechanical codes and standards in its safety review and licensing of new NPPs. The document was based on information provided by the CSWG representatives and discussed at MDEP CSWG meetings.

2. TR-CSWG-02 Lessons Learnt on Achieving Harmonization of Codes and Standards for Pressure Boundary Components in Nuclear Power Plants

   This report documents the findings and overall conclusions of the CSWG pertaining to (1) the adequacy and sufficiency of several MDEP-member country's pressure-boundary codes and standards and (2) the potential for harmonisation of those pressure-boundary codes and standards based on the code-comparison work performed by the SDOs from April 2008 to December 2012. It also documents a strategy and process proposed by the SDOs for achieving code harmonisation.

3. TR-CSWG-03 Fundamental Attributes for the Design and Construction of Reactor Coolant Pressure-Boundary Components

   This report documents the fundamental attributes which have been developed for the codes and standards used in the design and construction of reactor coolant pressure boundary components in nuclear power plants. The fundamental attributes are the basic concepts to be considered in the design, materials, fabrication, installation, examination, testing and over-pressure protection requirements for pressure boundary components.

4. TR-CSWG-04 The Essential Performance Guidelines for the Design and Construction of Pressure Boundary Components

   This report provides the essential performance guidelines for the codes and standards used in the design and construction of reactor coolant pressure boundary components in nuclear power plants. These guidelines are qualitative descriptions of the rules and practices derived from the codes and standards of MDEP member countries, which can be considered as essential. These guidelines represent commonalities between the codes and standards of MDEP member countries and consequently must be supplemented to generate a full set of performance guidelines.

5. CP-CSWG-01 Findings from Code Comparisons and a Global Framework towards Code Harmonization

   The report contains a compilation of common positions identified by the CSWG in its pursuit of harmonising the requirements in codes and standards governing the design, materials, fabrication, examination, testing and over-pressure protection requirements of pressure boundary components such as vessels, piping, pumps and valves typically found in large, water-cooled reactor nuclear power plants. These positions stem from the production of TR-CSWG-01 through TR-CSWG-04 and largely cover the contents and context of those TRs.

Based on the code comparison results and the CSWG findings, the CSWG established a global framework of a hierarchy structure for achieving code harmonisation. At the top of the hierarchy, the Fundamental Attributes provide overarching requirements for nuclear power plant design and construction. At the middle level, the Essential Performance Guidelines recommend basic design and construction rules to be included in codes, and provide guidance for code harmonisation. At the bottom level, code harmonisation is performed, which includes convergence and reconciliation of code differences; and prevention of further code divergence. The CSWG proposed a stepwise approach for code convergence and established a regular communication process for information exchange and discussion.

Besides the above documents, CSWG has also been a productive forum for members to exchange information on other topics. These topics include exploration of strategies for code reconciliation, the effect of code classification on NPP design and construction, and supplementary regulatory requirements to codes or standards.

In addition to producing the TRs and CP, the CSWG provided substantial feedback on a number of stakeholder projects and documents. The CSWG provided informal and/or formal feedback on the WNA/CORDEL reports: "Certification of NDE Personnel", "Report on Welding Qualification and Welding Quality Assurance", "Non-Linear Analysis Design Rules, Part 1, Code Comparison", and "Non-Linear Analysis Design Rules, Part 3 Benchmark". The CSWG also provided informal and formal feedback on the SDO Board report "Code Comparison Report for Class 1 Nuclear Power Plant Components".

IV. CURRENT ACTIVITIES

The CSWG is currently engaged in three primary activities. Firstly, the CSWG is investigating the relationship and path forward between codes and the carbon macrosegregation issue first identified at the Flamanville 3 site. The CSWG sees this issue as a symptom of an inadequate process qualification and is pursuing additional information with the intent to produce a report promoting a unified framework for qualification of existing and new manufacturing techniques to the SDOs. In concert with its activities, the CSWG has issued a letter requesting that the members of the SDO Board address their understanding and plans as a consequence of this emergent issue.

Secondly, the CSWG is highly engaged in supporting a transition of the group's mandate, in some form, to the Nuclear Energy Agency's Committee on Nuclear Regulatory Activities (CNRA). This effort encompasses presentations to CNRA representatives, the completion of a draft mandate, and a one-day workshop held on 17 April 2018. The workshop included code experts and stakeholders presenting on the accomplishments of the CSWG, the impact of CSWG work products, the stakeholder interest in a regulator body such as the CSWG, and a discussion panel of code experts representing CNRA members. The audience of the workshop consisted of MDEP, CNRA, and stakeholder code experts and representatives. A survey was sent to CNRA members in preparation for the workshop, the results of which are discussed in more detail in Appendix A. The results of the workshop and survey indicated broad interest in, and support for the continuation of the CSWG.

Finally, the CSWG continues to engage with the SDO Convergence Board and CORDEL on relevant work products. Specifically, the CSWG is providing comment on the CORDEL reports "Certification of NDE Personnel", "Report on Welding Qualification and Welding Quality Assurance", "Non-Linear Analysis Design Rules, Part 1, Code Comparison", and "Non-Linear Analysis Design Rules, Par 3 Benchmark". The CSWG hopes to hear more about the CORDEL report "Non-Linear Analysis Design Rules, Part 2, Code Comparison", and any products that may result from the unified framework effort noted at the beginning of this section.

V. <u>FUTURE WORK</u>

The CSWG has collected member perspectives and a list of potential future topics (Appendix B and C respectively) from participating MDEP CSWG members in order to better inform a transitioned CSWG entity. During the 18 April 2018 CSWG meeting, it was proposed that an initial scope of work for a transitioned CSWG entity would consist of: continue work on carbon macrosegregation related project; begin working on in-service inspection and environmentally assisted fatigue; and review work group interest in non-water cooled reactors. These topics were identified as consistent with MDEP CSWG member interest and CNRA survey responses.

VI. <u>CONCLUSION</u>

The members of the MDEP CSWG have enjoyed a measure of success in their mission to promote and facilitate harmonisation and convergence of international Codes and Standards. Several on-going efforts attest to this, and a framework for future work has been built. The members feel that there is considerable further potential in many topic areas for further work and that it would be a wasted opportunity not to continue building on the foundations laid.

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 safe and efficient nuclear industry worldwide.

APPENDIX A - CNRA Member Survey

The CSWG conducted a survey of CNRA members to determine the level of interest, and topics of interest, pertinent to the CNRA membership. This survey supported a draft mandate for a proposed Working Group on Codes and Standards (WGCS) to be formed within CNRA.

The survey revealed two major groups of stakeholders within the CNRA. Firstly, countries with large native industries, and secondly countries with relatively small nuclear industries. Twenty one countries/organisations responded to this questionnaire revealing great texture concerning their use of Codes and Standards.

Of the countries polled, 14 reported using National Codes, while 13 reported using Foreign Codes. A clear majority of these countries reported regulating/overviewing imported structural materials and components; as well as overviewing domestic technician's qualifications. Similarly a clear majority of countries indicated in interest in cooperating on the following topics:

- In-service inspection
- Repair
- Replacement and modification
- Ageing management
- Safety and seismic classification
- Regulatory requirements to pressure-boundary components for NPPs
- Verifying compliance of NPP equipment with codes and standards
- Promotion of global basis for new technical topics (e.g. non-linear analysis)
- Pursuing harmonization while updating codes and standards.

A significant portion of respondents also supported cooperation concerning:

- Pre-service examination
- Fabrication
- Installation
- Use of risk information in codes and standards
- Development and validation of single and optimal method for regulator's mutual recognition of foreign codes and standards

The respondents also provided feedback on their preferred activities for WGCS indicating that the mutual exchange of regulatory practice, operational experiences, and common position/benchmark on regulatory requirements regarding codes and standards were all valuable.

Several "free answer" questions were included in the questionnaire wherefrom the two major groups of respondents emerged. A wide variety of codes were noted; some industry consensus codes and some governmental codes. The nature and application of codes varied wherein some countries incorporated industrial codes into regulations, while others wrote their own regulatory codes, and some countries allowed codes to form a basis for meeting regulatory criteria. Of these approaches the countries with large native industries were more likely to report incorporating industrial codes as requirements or producing their own governmental codes;

whereas countries with smaller native industries were more likely to interface with codes as a licensee proposed basis to meet regulatory criteria.

Those countries incorporating industrial codes were noted as being more likely to be engaged with those codes directly and have a greater interest in the CSWG as formulated within MDEP. Those countries that did not directly incorporate industrial codes indicated less interest in the historical mandate of CSWG with regards to fabrication, installation, and pre-service examination (i.e. operation rather than construction was generally the focus of these countries) and more interest with topics of concern for operation such as repair, replacement, ageing management, etc.

All respondents indicated direct or indirect application, reliance, or utilization of codes within their licensed facilities. Several respondents indicated that designs constructed or being considered for construction were all developed with native codes and consequently these codes are/would be of interest in proportion to the number of these designs present.

Finally, the questionnaire included several questions concerning topics of interest or WGCS interactions. Respondents largely supported regulator-to-regulator exchange of information. Closely following in interest was improvements in reconciliation between different codes and regulatory regimes. Many respondents indicated a desire to see greater harmonization between regulatory approaches, some by incorporating foreign experience, and some simply to reduce obstacles to cross-border cooperation and industry. While the founding goal of CSWG, harmonization, was noted many times as a positive goal; it was noted just as many times as aspirational and best approached through more practical means. Suggested means included limiting future divergence of codes; cooperating in development of new technical areas within codes; producing/refining of code reconciliations; attempting reconciliation between regulatory approaches; and sharing of experience.

APPENDIX B - WORKING GROUP MEMBERS' FEEDBACK

1. Canada – Canadian Nuclear Safety Commission

The Canadian nuclear industry is organized around a unique reactor concept and has developed design and construction rules specific to CANDU reactors. The CSA Standards reference the ASME Boiler & Pressure Vessel Code (BPVC) and its requirements where applicable, and specify requirements for those pressure-retaining components and supports that are not addressed by the ASME BPVC. Nowadays the design and construction of Nuclear Power Plant has become part of the general globalization. Canada exports CANDU reactors to other countries while importing materials, components, or services from other countries. The Canadian nuclear industry has to demonstrate that the CANDU design meets the safety standards of other countries, and Canadian Nuclear Safety Commission (CNSC) needs to ensure that the materials, components, or services supplied by other countries meet Canadian safety requirements. Therefore, code harmonization is very important to the Canadian nuclear industry and CNSC.

After eight years of close cooperation, SDOs, CORDEL and CSWG have made significant achievements. The SDO's code comparison report STP-NU-051 provided a basis for code harmonization; report STP-NU-078 provided a deep insight in the similarities and differences in welding qualification and quality assurance among the national codes. CORDEL work on NDE personnel certification compared the certification practices of the major nuclear design codes, and recommended a harmonized international alternative for NDE certification. Nonlinear analysis is an accurate method in mechanical design with solid technology basis. CORDEL has thoroughly reviewed the existing nonlinear rules in codes, and is developing a universal new nonlinear code to converge code differences in some fundamental areas such as stress categorization, stress limits and analysis. CSWG explores strategies for code reconciliation; and CSWG documents provided general guidance on using foreign codes.

CNSC is very interested in promoting code harmonization, and is willing to incorporate the code harmonization results into regulatory practice. SDOs and CORDEL have identified a number of significant technical issues with international interest that are not currently addressed in codes, such as corrosion fatigue, RPV indications, flow-induced vibration in SGs, small modular reactor designs, margin under high-seismic loadings, and use of high-density polyethylene piping. CNSC considers it a very effective strategy to include them in the future working scope of the CSWG and to jointly develop universal code requirements with the SDOs and CORDEL. Since code convergence is a long term process, code reconciliation is also important. CNSC regards it as very useful to study code differences, and determine the conditions or identify supplementary requirements with which the different code requirements lead to a similar degree of safety.

CNSC believes that these achievements will benefit the world nuclear industry and regulatory authorities, and supports the continuation of SDOs and CORDEL activities in code harmonization.

2. Finland – Radiation and Nuclear Safety Authority

The NPPs in Finland represent different types and design philosophies, and their designs are also based on different design codes and standards. The design of Loviisa NPP main components is based on Russian code while the design of Olkiluoto 1 and 2 is based on ASME code. The Olkiluoto 3 unit which is under construction, is based on the French RCC-M code. The new project is the Russian 1200 MW VVER-reactor, based on the Russian design code. So in Finland the need to compare different design codes and standards is great.

Finland does not have any own national nuclear industry codes and standards. Radiation and Nuclear Safety Authority (STUK) considers, however, that a well recognized and proven code may be applied if it has been earlier used in licensing of a NPP.

The CSWG was tasked to both evaluate and encourage the harmonization of codes and standards. In undertaking this task a great deal of commonality between international codes was identified. It was determined that while full convergence of codes and standards is not practical, great opportunities exist for harmonization of various codes and standards. Since code convergence is a long term process, code reconciliation is also important.

After about 8 - 9 years of close cooperation, CSWG, SDOs and CORDEL have made significant achievements. The SDO’s code comparison report STP-NU-051 provides a good basis for code harmonization, and the report STP-NU-078 helps in comparing welding qualification and quality assurance between the national codes.

STUK is eager to promote code harmonization, and is willing to incorporate the code harmonization results into regulatory practice, whenever it is possible. SDOs and CORDEL have also identified a number of significant technical issues of great interest that are not currently addressed in codes, such as corrosion fatigue, RPV indications or flow-induced vibration in steam generator tube banks.

STUK supports the efforts of the industry and SDOs to collaborate and to work together towards the goal of harmonization. STUK believes that the CSWG has made real progress in promoting efforts towards these goals both in its own products and those produced in collaboration with the SDOs. The efforts by organizations such as the SDO Convergence Board and CORDEL are promising and should continue.

3. Korea – Nuclear Safety and Security Commission

The Korean Regulatory Body, the Nuclear Safety and Security Commission (NSSC), has a legal system for publication, adoption, improvement, and revision of regulations and guides as a part of the endorsement process for SDO developed codes and standards. The NSSC Notices provide the guidelines on the application of specific technical standards such as the Korea Electric Power Industry Code (KEPIC) developed by the Korean SDO, Korea Electric Associations (KEA). There also exist regulatory guides, review guidelines, and inspection guidelines that are developed and managed by the Korea Institute of Nuclear Safety (KINS).

These provide more detailed acceptance criteria, methods, and procedures used for regulatory activities.

For example, the NSSC Notice on in-service inspection (ISI) of the safety-related facilities describes the guideline for the application of inspection standards such as KEPIC MI, ASME Section XI and RCC-G Part 3 for pressurized water reactor, and CAN/CSA-N285.4 and N285.5 for pressurized heavy water reactor. The NSSC Notice on safety classification and applicable codes & standards is used to endorse the industrial codes and standards and to place conditions on them.

Through the participation in the CSWG, it was found that the efforts towards harmonization in codes and standards have resulted in major progress to identify the similarities and differences. The NSSC and the KINS understand that harmonization could be achieved through the close cooperation and communication between SDOs, vendors and other stakeholders and through the consistent and systematic review by regulatory bodies.

4. Japan – The Secretariat of Nuclear Regulation Authority

The Japanese Nuclear Regulation Authority (NRA) endorses SDO's codes after thorough technical evaluation. NRA's regulations for commercial power plants are stipulated on the basis of performance-based technical requirements. The NRA verifies whether an SDO's code defines adequate technical details corresponding to the regulatory requirements and consequently can be applied to meeting the regulatory requirements. Endorsed codes are listed as acceptable tools in "Regulatory Guide of NRA Ordinance on Standards for the Location, Structure and Equipment of Commercial Power Reactors" and other relevant Regulatory Guides.

SDO's codes are regularly revised by incorporating new knowledge and technical advances. The NRA believes that leveraging the prior endorsement of these revised codes improves the efficiency and efficacy. Sometimes, an SDO adopts specific provisions similar to another SDO's to incorporate new knowledge and technological advances. For example JSME may revise its code by incorporating provisions of the ASME code which adopted new knowledge and technological advances. Efficiencies are gained for JSME in having a model on ASME's part for incorporating the new knowledge or technology, and gained for NRA by leveraging review efforts concerning ASME code in reviewing JSME code as well as speeding the adoption of new knowledge and technologies in Japan.

Based on this, it would be of significant benefit for nuclear safety that SDOs develop universally accepted common code content incorporating the latest technology through collaboration and cooperation among many SDOs; in addition to continuing efforts to carry out code comparison activities and harmonization of existing code requirements. The NRA expects that code harmonization activities will be continuously carried out with participation of many SDOs, contributing to nuclear safety through incorporation of the latest knowledge and technologies.

5. Russian Federation – Federal Environmental, Industrial and Nuclear Supervision Service.

In the nuclear industry of the Russian Federation, the regulatory legal acts establishing requirements for safe use of atomic energy, including safety requirements for nuclear power plants and safety requirements for activities in the field of use of atomic energy, are federal rules and regulations that are mandatory when carrying out activities in the field of use of atomic energy in accordance with Federal Law "On the Use of Atomic Energy."

The above mentioned rules and regulations shall take into account recommendations given by the international organizations in the field of use of atomic energy, in which the Russian Federation takes part. Nuclear power plants in China, India, Finland, Hungary and other countries have been constructed, are in operation, or under construction to Russian designs and specifications.

The goal of the Codes and Standards Working Group to promote harmonization of codes and standards on design and manufacture of NPP pressure boundary components is really a long-term one. As the first step towards code harmonization of, the Working Group encouraged the Standards Development Organizations to carry out comparison of codes and standards.

Participation of the Russian Party in the comparison of codes and standards supports the development of proposals concerning the following:

- Achievement of minimization of differences between various regulatory requirements in national and foreign rules and standards;
- Achievement of the exclusion of principal differences in applied rules and standards;
- Achievement of recognition of regulatory approaches by regulatory bodies of countries constructing or intending to construct NPPs, such as France, Russia, Finland, China, etc.

Report on the comparison of codes and standards was discussed during the meeting of the Scientific and Technical Council of the Federal Environmental, Industrial and Nuclear Supervision Service.

A real step to promote harmonization of codes and standards was the establishment and activities of the Codes and Standards Convergence Board; a representative of the Russian Party was a member of the Board. The CORDEL organization also plays an important role; its members as well as the members of the Codes and Standards Convergence Board take part in the meetings of the Codes and Standards Working Group and work on the agreed upon programmes, including documents review.

Cooperation of the Codes and Standards Working Group with the Codes and Standards Convergence Board and CORDEL leads to the enhancement of understanding differences among codes and reduction of these differences. The Codes and Standards Working Group has become a major forum for discussion and is now an initiating body for achieving harmonization goals.

6. South Africa – National Nuclear Regulator

Regulatory Framework – General

The National Nuclear Regulator (NNR) uses a combination of performance, prescriptive and process based approaches. For performance based approaches NNR sets overall safety goals and performance requirements, partly prescriptive, holding the licensee to the regulatory requirements and the licensing basis approved by the Regulator. For process based approaches NNR holds licensee accountable to its own various processes, in particular a safety screening and evaluation process which identifies which modifications or changes require regulatory approval.

Update of Regulatory Framework

The NNR undertook a process of self-assessment, using the IAEA standards as reference. The assessment yielded a conclusion that the current approach, as stated, is insufficient and thus requires further review.

In response to the results of the assessment, The National Nuclear Regulator Act (47 of 1999), which established the legislative framework of the NNR, is under parliamentary review and amendments are pending.

The new draft regulations are much more detailed and comprehensive compared to the existing regulations and contain many of the requirements from existing requirement documents.

Nuclear New Built Status

The South African Ministry of Energy stated, in a media release on 29 September 2016, that it has received representations for further consultations into the Nuclear New Build programme prior to the commencement of the procurement process. This led the Ministry to delay the release of the Request for Proposals until such consultations have occurred.

Codes and Standards in SA

- South Africa does not have national nuclear industry codes and standards. The NNR is therefore non-prescriptive as it comes to the use of industry codes and standards.
- The NNR requires, however, that well recognised and proven codes and standards, preferably those of the vendor country, are complied with, augmented where necessary to address NNR requirements and local conditions
- Currently, the principal safety requirements formulated in the regulations in terms of section 36, read with Section 47 of the National Nuclear Regulator Act on Safety Standards and Regulatory Practices (SSRPs) as well as Siting regulations, form the basis for the stipulation of the licensing requirements for the New Build.
- The NNR has benefited greatly in the work carried out by CSWG such as the Code Comparisons which then led to many further reports by the CSWG group; some of

the input from the CSWG reports were used in the NNR's update of its regulatory framework.

- With the looming nuclear new built in South Africa, and possible different vendor countries with their own codes and standards to be utilized for the new built, the convergence that is sought to be achieved by harmonization of codes and standards along with the work already achieved within the CSWG will assist South Africa in being well informed on the vendor country codes and standards.

7. United Kingdom – Office for Nuclear Regulation

The UK does not have a national design and construction code for nuclear pressure equipment equivalent to ASME BPVC Section III or AFCEN RCC-M.

The UK's approach to civil nuclear power was through the development of gas cooled, graphite cored, reactor technologies where in most cases the national standards of the day for general pressure equipment were judged to be sufficient, although a British Standard was developed for pre-stressed concrete pressure vessels for nuclear engineering (BS4975) to support the later generations of gas cooled reactor.

The UK started to adopt light water reactor technologies on the early 1980s with the building of the Sizewell B nuclear power station. This was based on the Westinghouse standard four loop pressurised water reactor, which had been designed to ASME Section III. The design and construction of the UK plant was also based on ASME Section III. This was accepted by the Regulator, but with additional UK specific requirements over and above code compliance for components where gross failure is discounted, for example the reactor pressure vessel. These additional requirements relate to demonstrating that the component is a defect free as possible and that it is tolerant to defects in line with Regulator's Safety Assessment Principles (SAPs), and in particular SAP EMC.1 on 'Engineering principles: integrity of metal components and structures: highest reliability components and structures'. The additional requirement expand significantly upon the design code requirements in relation to establishing material toughness, calculating limiting defect sizes and the use of qualified diverse and redundant inspection at manufacture.

Further new build in the UK started to be actively considered again in the 2010s, and the UK is now in a position that a UK variant of the EPR design is being built at Hinkley Point C, and the RCC-M design and construction code is being used for the nuclear pressure equipment on that project. The UK operates a non-prescriptive regulatory regime, and the Regulator's review of the RCC-M code during the Generic Design Assessment process concluded that it was an appropriate basis for design and construction of the nuclear pressure equipment on that project. Whilst the UK is non-prescriptive on the design code used for the project, the project will require the additional UK specific requirement over and above code compliance for components where gross failure is discounted in line with the expectations established for the Sizewell B project.

The UK has also completed the Generic Design Assessment process for the Westinghouse AP1000 design where ASME III would be used for design and construction and the Hitachi ABWR where ASME III will also be used for the nuclear pressure equipment, but again the additional UK specific requirements over and above design code compliance will be required.

Thus the UK Regulator is non-prescriptive in the choice of design code, and is content for well-founded international nuclear pressure equipment design and construction codes to be used as the basis for design and construction in the UK, but will continue to require beyond design code substantiation where gross failure is discounted in line with its current Safety Assessment Principles.

The UK therefore has much to gain from Regulator collaboration and cooperation on nuclear pressure equipment design and construction codes. The UK was therefore initially active in the MDEP Codes and Standards Working Group where the fundamentals of such codes was being considered and the basis of regulation of national codes in the country of origin was being established. More recently it has become active again where cooperation with groups such as the Standards Development Organisations Convergence Board has given an additional focus to the group.

The UK Regulator sees the benefits of the MDEP CSWG in helping to understand the differences between codes in order to reconcile their use as providing equivalent levels of overall safety. It also see the benefit of reducing further divergence in the codes and to work with Standards Development organisations and other bodies in the pursuit if these goals. It also sees the benefit of the group in providing a forum to exchange Regulator information on the use of codes for nuclear pressure equipment and for the group to progress its own agenda to improve nuclear safety in this area.

8. United States of America – United States Nuclear Regulatory Commission

The Nuclear Regulatory Commission (NRC) recognizes that the nuclear industry is an international body, the health and effectiveness of which requires cooperation and good relations between partners operating in very different regulatory and technical oversight regimes. Traditionally the NRC has relied on compliance with the ASME Boiler and Pressure Vessel (BPV) Code to support many of its safety goals by incorporating the ASME BPV Code into its regulations. It is recognized that requiring international suppliers to be fully compliant with the ASME BPV Code in a manner identical to domestic industry presents numerous challenges both to the international entities and to the NRC to verify this compliance.

Consequently the NRC has a natural interest in promoting the harmonization of international codes and standards to the extent possible. As the NRC does not take ownership of codes and standards, we support efforts by the industry and SDOs to collaborate and work towards the goal of harmonization. The NRC believes that the CSWG has made real progress in promoting efforts towards these goals both in its own products and those produced in collaboration with the SDOs. The efforts by organizations such as the SDO Convergence Board and CORDEL are promising and should continue.

Support for groups such as the CSWG is evidence of NRC interest in harmonization. In addition the NRC has regulatory processes in place to incorporate the results of the harmonization process including modifications to the codes and standards themselves; topical reports establishing equivalency; requests for alternatives; and license amendment requests.

The NRC sees particular promise in leveraging international resources and expertise in foundational topics such as nondestructive analysis, non-linear analysis, and materials issues which present fundamental scientific and engineering challenges and for which several potential paths to resolution may present themselves. The greater the initial coordination between international entities on such topics the fuller and more robust the final approaches will be supported by independent but cross-functioning international efforts.

Similarly, civilian deployment of advanced reactor technologies has been historically hamstrung by the novelty associated with advanced reactor concepts. Industry entities are challenged to invest in technologies that typically fall under heavy regulatory scrutiny; regulators are challenged to describe and circumscribe their safety needs for technologies under development with limited or no civilian operating experience.

Codes and Standards are uniquely positioned to help frame these challenges and bring together the best practices and experience of industry and developmental entities with the active participation of regulatory agencies. By forging consensus Codes and Standards, SDOs can help reduce the economic, technical, and regulatory barriers to these new technologies.

APPENDIX C - Working Group Member Proposals for Potential Future Topics

The members of the MDEP CSWG collected this list of potential future topics of interest from a survey within the working group. These topics are presented here in the order in which they were proposed. Many of these topics were noted as being of wide interest within CSWG, although they are not endorsed by the working group and only represent the interest of each individual member country.

1. Codes and Standards for Advanced Reactors

Civilian deployment of advanced reactor technologies has been historically hamstrung by the twin challenges of novelty and uncertainty. Industry entities are challenged to invest in technologies that typically fall under heavy regulatory scrutiny; regulators are challenged to describe and circumscribe their safety needs for technologies under development with limited or no civilian operating experience.

Codes and Standards are uniquely positioned to help frame these challenges and bring together the best practices and experience of industry and developmental entities with the active participation of regulatory agencies. By forging consensus Codes and Standards, SDOs can help reduce the economic, technical, and regulatory barriers to these new technologies.

2. Design and Construction of Small Modular Reactors

Small Modular Reactors (SMRs) are becoming a key part of development of clean, flexible and affordable nuclear power options. They could be used to power significant users of energy, such as large vessels or production facilities (e.g. water treatment/purification, or mines), and are particularly useful in remote locations where there is usually a deficiency of trained workers and a higher cost of shipping. Several MDEP countries (including Canada) are reviewing or will review SMR licence applications.

However at the present, there is no code or standard specifically for SMR design and construction. The current SMR designs normally use the codes or standards developed for large-scale nuclear reactors. The regulatory authorities and vendors usually have to assess the sufficiency of these codes requirements for SMR application. Therefore, it would be very beneficial if SDOs, CORDEL and CSWG could work together to develop universal code requirements for SMR design and construction.

The development of codes and standards for SMRs could promote the accelerated deployment of SMRs by reducing economic, technical, and regulatory barriers, and could enhance safety, operations and performance of SMRs.

3. Engineering Assessment of Ageing Phenomena

Component ageing is a significant safety-related issue as well as a life-limiting factor for the operating nuclear power plants (NPPs), but is not explicitly addressed in codes and standards. Engineering assessment of ageing phenomena (such as low-cycle fatigue, neutron embrittlement, irradiation induced stress corrosion cracking or thermal aging of duplex stainless steel) has drawn broad international attention in the nuclear industry, and has been extensively discussed in International Generic Ageing Lessons Learned (IGALL) of IAEA. It would be beneficial to all parties to jointly develop universal code rules for NPP ageing assessment and ageing management.

4. Environmentally Assisted Fatigue

Environmentally assisted fatigue (EAF) has emerged as a significant issue affecting assessments to justify component lifetimes and in-service inspection requirements.

The established fatigue analysis rules in codes and standards, that provide the basis for design and in-service inspection of NPP components, do not explicitly include allowance for the effects of reactor environments.

In the recent two decades, the world-wide nuclear industry, regulatory authorities, and SDOs have been putting significant effort to develop and improve rules/practices to address the EAF effect on NPP components. A few Code Cases are currently being debated.

EAF study is a very time-consuming work; it would be very beneficial if international nuclear industry, regulatory authorities, and SDOs could work together and jointly develop new code rules for EAF assessment.

5. In-service Inspection

In the current codes and standards, the In-service-Inspection (ISI) provisions regarding acceptance criteria and examination frequency are different even for the same components (including safety-related components). An ISI programme based on insufficient requirements may have significant impact on NPP safety operation. Therefore it is necessary to review and compare the ISI provisions in codes and standards, and harmonize these provisions.

6. Code Requirements for Materials

Material codes and standards identify materials, and specify their chemical composition including homogeneity and material property for the fabrication of nuclear components. However for the same material, the requirements or criteria on chemical composition range and on testing/examinations (including sampling position) are different from code to code. Materials performance during service is essential for ensuing reactor safety operation. Therefore it is necessary to review and compare material provisions in codes and standards, and harmonize these provisions. International standardization of material properties including allowable stress at high temperature, crack growth rate and fracture toughness would be beneficial to all parties.

7. Material Homogeneity

With technology development, the size of nuclear components and the initial ingot used for manufacturing nuclear components are getting larger and larger; the forming operations are becoming more and more complex. These changes have brought significant benefit to the nuclear industry, which includes increasing reactor capacity and efficiency, improving structure integrity (e.g. reducing or eliminating welds), and reducing manufacturing and operating costs.

However, these changes have also brought significant challenging to nuclear industry, and the current code provisions may not be sufficient for ensuring acceptable material homogeneity. It may be necessary for CSWG, SDOs and CORDEL to include Material Homogeneity as an area in code harmonization, and work jointly to modify the existing material codes for ensuring acceptable properties throughout the wall of large high-cost components.

8. Continued Work on ASME BPV Section III AND XI Topic Areas

The core topics covered within the ASME Boiler and Pressure Vessel Code Section III and XI such as design, fabrication, examination, inspection, and repair of nuclear components present a rich variety of potential topics for harmonization and convergence activities. Considerable opportunities remain both at the technical basis level (as demonstrated by CORDEL efforts concerning Non-Linear Analysis) and at programmatic levels such as reconciliation processes and general convergence.

Cooperation between the CSWG and industry entities presents a unique avenue of communication and cooperation to enhance harmonization and convergence at the confluence of interests. Exploration of new or improved methodologies concerning lightly or un-addressed topics is particularly promising.

9. Safety and Seismic Classification Criteria

Comparison of safety and seismic resistance classification criteria for equipment and pipelines would yield valuable insights. It is a key issue in terms of establishing requirements for design, manufacture, installation and operation of equipment and pipelines yet is inconsistently approached.

10. Risk-Analysis

Analysis of requirements and development of recommendations to harmonized approaches to risk-analysis would be a valuable exercise. The documents issued by the Codes and Standards Working Group deal only with the stages of design, manufacture and installation, but do not cover operation. Whereas, an attempt could be made to compare and harmonize regulatory requirements for the stage of operation.

Risk-analysis is a means of classifying equipment and pipelines on the basis of probability and consequences of their failure (risk = probability of failure * failure consequences). In accordance with the classification by means of risk-analysis the scope and periodicity of in-service examination are defined.

11. Compliance Verification of Nuclear Components

Comparison of the methods of assessing compliance of the products applied in nuclear power plants with the established regulatory requirements that are used in the member countries of the Codes and Standards Working Group would yield valuable insights.

12. Regulatory Implementation of Insights gained from Code Comparisons

Upon the results of analysis of the Technical report on the comparison of codes and standards, the Codes and Standards Working Group in cooperation with CORDEL and SDO Convergence Board shall prepare proposals on the topics of future joint activities aimed at minimization of differences among regulatory requirements.