Nuclear Regulation
NEA/CNRA/R(2023)4
April 2025
www.oecd-nea.org

Proceedings of the Working Group on Codes and Standards (WGCS) International Workshop on Mechanical Codes and Standards: In-Service Inspection

11-14 April 2022

OECD
BETTER POLICIES FOR BETTER LIVES

NEA
NUCLEAR ENERGY AGENCY

Nuclear Energy Agency

NEA/CNRA/R(2023)4

Unclassified English text only

3 April 2025

NUCLEAR ENERGY AGENCY
COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES

Proceedings of the Working Group on Codes and Standards (WGCS) International Workshop on Mechanical Codes and Standards: In-Service Inspection, 11-14 April 2022

This document is available in PDF format only.

JT03563672

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of 38 democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

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

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

NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1 February 1958. Current NEA membership consists of 34 countries: Argentina, Australia, Austria, Belgium, Bulgaria, Canada, Czechia, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, Norway, Poland, Portugal, Romania, Russia (suspended), the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Türkiye, 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 co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly 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 policy analyses in areas such as energy and sustainable development.

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.

COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES (CNRA)

The Committee on Nuclear Regulatory Activities (CNRA) addresses NEA programmes and activities concerning the regulation, licensing and inspection of nuclear installations with regard to both technical and human aspects of nuclear safety. The Committee constitutes a forum for the effective exchange of safety-relevant information and experience among regulatory organisations. To the extent appropriate, the Committee reviews developments which could affect regulatory requirements with the objective of providing members with an understanding of the motivation for new regulatory requirements under consideration and an opportunity to offer suggestions that might improve them and assist in the development of a common understanding among member countries. In particular it reviews regulatory aspects of current safety management strategies and safety management practices and operating experiences at nuclear facilities including, as appropriate, consideration of the interface between safety and security with a view to disseminating lessons learnt. In accordance with *The Strategic Plan of the Nuclear Energy Agency: 2017-2022*, the committee promotes co-operation among member countries to use the feedback from experience to develop measures to ensure high standards of safety, to further enhance efficiency and effectiveness in the regulatory process and to maintain adequate infrastructure and competence in the nuclear safety field.

The committee promotes transparency of nuclear safety work and open public communication. In accordance with the NEA Strategic Plan, the committee oversees work to promote the development of effective and efficient regulation.

The committee focuses on safety issues and corresponding regulatory aspects for existing and new power reactors and other nuclear installations, and the regulatory implications of new designs and new technologies of power reactors and other types of nuclear installations consistent with the interests of the members. Furthermore, it examines any other matters referred to it by the NEA Steering Committee for Nuclear Energy. The work of the committee is collaborative with and supportive of, as appropriate, that of other international organisations for co-operation among regulators and consider, upon request, issues raised by these organisations. The Committee organises its own activities. It may sponsor specialist meetings, senior-level task groups and working groups to further its objectives.

In implementing its programme, the committee establishes co-operative mechanisms with the Committee on the Safety of Nuclear Installations (CSNI) in order to work with that committee on matters of common interest, avoiding unnecessary duplications. The committee also co-operates with the Committee on Radiological Protection and Public Health (CRPPH), the Radioactive Waste Management Committee (RWMC), and other NEA committees and activities on matters of common interest.

Acknowledgements

The members of the Nuclear Energy Agency (NEA), the Committee on Nuclear Regulatory Activities (CNRA) and the Working Group on Codes and Standards (WGCS) acknowledge the significant contributions of those individuals who had a key role in the preparation of these proceedings, and those who had a leadership role in the conduct and success of the international in-service inspection workshop. Additional thanks are extended to those working group members who participated in the workshop and to Sangmin Lee, chair of the WGCS for his leadership and guidance.

Leading authors

David RUDLAND	US Nuclear Regulatory Commission, United States

Contributors

Carol NOVE	US Nuclear Regulatory Commission, United States
Patrick RAYNAUD	US Nuclear Regulatory Commission, United States
Thomas BUCKENMEYER	Nuclear Energy Agency
Christele TEPHANY-M'PANIA	Nuclear Energy Agency

This report was approved by the CNRA at its 47th meeting on 2-3 June 2022.

List of abbreviations and acronyms

AI	Artificial intelligence
AM	Additively manufactured
ASN	Autorité de Sûreté Nucléaire (Nuclear Safety Authority, France)
BPV	Boiler and pressure vessel
BWR	Boiling water reactor
CAPS	CNRA activity proposal sheet
CASS	Cast Austenitic Stainless Steel
CNRA	Committee on Nuclear Regulator Activities (NEA)
CORDEL	Cooperation in Reactor Design Evaluation and Licensing
CRIEPI	Central Research Institute of Electric Power Industry (Japan)
CRPPH	Committee on Radiological Protection and Public Health (NEA)
CSNI	Committee on the Safety of Nuclear Installations (NEA)
ENIQ	European Network for Inspection Qualification
EPRI	Electric Power Research Institute (United States)
FMC	Full matrix capture
HF	Human factors
ISI	In-service inspection
JSME	Japanese Society of Mechanical Engineers
KEPIC	Korea Electric Power Industry Code
KHNP	Korea Hydro & Nuclear Power Co. LTD. (Korea)
KINS	Korean Institute for Nuclear Safety (Korea)
ML	Machine learning
NDE	Non-destructive examination
NEA	Nuclear Energy Agency
NEI	Nuclear Energy Institute (United States)
NRA	Nuclear Regulation Authority (Japan)
NRC	Nuclear Regulatory Commission (United States)
NUCOBAM	Nuclear Components Based on Additive Manufacturing
ONR	Office for Nuclear Regulation (United Kingdom)
PAUT	Phased array ultrasonic testing
PFM	Probabilistic fracture mechanics
PNNL	Pacific Northwest National Laboratory (United States)

POD	Probability of detection
PWR	Pressurised water reactor
RIM	Reliability and integrity management
RPV	Reactor pressure vessel
RWMC	Radioactive Waste Management Committee (NEA)
STUK	Säteilyturvakeskus (Finland)
SUJB	State Office for Nuclear Safety (Czechia)
SNETP	Sustainable Nuclear Energy Technology Platform (European Union)
TFM	Total focusing method
UT	Ultrasonic techniques
WGCS	Working Group on Codes and Standards (NEA)
WNA	World Nuclear Association

Table of contents

List of tables

Executive summary

The Nuclear Energy Agency (NEA) Committee on Nuclear Regulatory Activities (CNRA) Working Group on Codes and Standards (WGCS) sponsored a online international workshop on in-service inspection (ISI) on 11-14 April 2022. Among international codes and standards, the ISI acceptance criteria and examination frequency vary, even for identical components (including safety-related components). ISI programmes based on different or inconsistent requirements may have significant impact on nuclear power plant safety operation. Therefore, it is necessary to review and compare the ISI provisions in codes and standards, document the difference and determine if modifications to harmonise are necessary. Through a member survey, the WGCS members chose to focus the workshop on component specific ISI programmes and extending ISI intervals. In addition, several members suggested related topics on the evolution of non-destructive examination (NDE) techniques and design for inspection.

Participation in the workshop was open to nuclear industry representatives for new and operating reactors, international organisations, laboratories, and regulatory organisations. Participation by regulators and operating reactor licensees was strongly encouraged. In response to the invitations, the online workshop was attended by over 150 people each day (200 maximum) with presentations from eight countries with regulatory, industry, laboratory, and codes and standards representation.

The first session of the workshop focused on reactor vessel ISI programmes and additional regulatory requirements related to interval, coverage and qualification. For this session, regulatory presentations from Czechia, Finland, France, Hungary, Japan, Korea, the United Kingdom, and the United States illustrated the differences in regulatory requirements for inspection of the reactor pressure vessel (RPV) welds. These differences were highlighted by similar industry presentations from France, Japan and Korea. The main discussion in this session focused on these differences, especially as they pertained to topics such as NDE qualification. From the discussion it is clear there are country-to-country differences in why a particular inspection interval was chosen; some are codes and standards requirements (some countries do not mandate code and standards in regulations), others are direct regulatory requirements, but all are influenced by societal and cultural tradition.

The second session of the workshop focused on the evolution of NDE techniques. This highly technical session contained presentations from Japan on novel NDE techniques including shape adaptive beam steering and soft shoe, flexible probes, advanced eddy current techniques, and full matrix capture (FMC) and total focusing method (TFM) ultrasonic (UT) techniques. In addition, presentations from Pacific Northwest National Laboratory (PNNL) and the Cooperation in Reactor Design Evaluation and Licensing (CORDEL) working group focused on the evolution of ISI for RPV welds, artificial intelligence (AI) in inspections, and harmonisation of NDE personnel qualification. From the discussion, the need for harmonisation of NDE personnel qualifications became clear as it impacts the development of new and advanced reactors worldwide. It was apparent from the discussion that the further development of AI in inspection might be useful in this area.

The third session of the workshop focused on extending ISI intervals. The six presentations from the US Nuclear Regulatory Commission (NRC), the Electric Power Research Institute (EPRI), Westinghouse and Southern Nuclear focused on technology and the history of extending ISI intervals for RPV welds. Discussion topics included probabilistic fracture mechanics (PFM), performance monitoring, risk-informed decision-making, permanent

relief of inspection from some RPV welds, a licensee perspective to ISI programme updates, and US NRC plans for ISI of advanced reactors. Most of the ISI frequency extensions approved in the United States have been done on a plant-specific basis. Even though there have been discussions on developing general code requirements in this area, the group felt it would be difficult due to the need to demonstrate plant-specific applicability.

The fourth session of the workshop focused on design for inspection. Presentations from the United Kingdom and the United States focused on the accomplishments in the United Kingdom in increasing the inspectability of new reactors and the impacts of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (BPV) code, Section XI, Division 2 on inspectability. Discussion focused on the generic implications of the UK specific change to increase inspectability of a particular plant design and how to encourage vendors to develop components with increased inspectability.

A discussion on harmonisation served as the final session of the workshop. The group concluded that complete harmonisation of international codes and standards is probably unrealistic; however, harmonisation in several areas of ISI is needed but it may take much work and co-ordination before successful harmonisation is possible. Overall, the consensus opinion was that harmonisation of inspection requirements can increase safety and is worth the effort if the differences in technical basis and culture are understood, active communication is employed, and the benefit to both the regulator and utilities is clear.

Through this workshop, the WGCS recommends that:

- The standards development organisations (SDOs) investigate the harmonisation of NDE personnel qualification with the inclusion of performance demonstration.
- The SDOs investigate the harmonisation of inspection intervals for future use. This harmonisation needs to include a strong technical basis for any modification of the current interval requirements.
- Nuclear component designers, vendors, and regulators consider component inspectability aspects for all new designs to ensure that proper inspections occur over the lifetime of the facility.

Organisations like the ASME SDO Convergence Board, which has representation from many worldwide SDOs, are well positioned to embark on efforts for harmonisation. By addressing differences in the current bases, ensuring no duplication of effort, and developing international standards, the SDOs can develop harmonised standards that will increase safety and decrease the burden on industry and regulators.

1. Organisation of the Workshop

1.1. Planning

Planning for the international workshop on in-service inspection (ISI) began after the NEA Committee on Nuclear Reactor Activities (CNRA) accepted the CNRA Activity Proposal Sheet (CAPS) for this effort in June 2019. The first step in the development of this workshop was a survey of the NEA Working Group on Codes and Standards (WGCS) members to determine the interest in different ISI topics. The options under consideration for the survey included:

- Augmented inspection: While many of the countries follow codes and standards requirements for baseline inspections, some require additional augmented inspections. For this option, the focus would be on what augmented programmes are being used worldwide, and what is the technical basis for both the augmented inspection programme, and the inspection intervals required for those augmented inspection programmes.
- Component specific ISI programmes: Choosing one component, for example the reactor vessel, the focus would be on ISI programmes for that component. Areas covered could include country-specific history of inspections, basis for inspection intervals, inspection coverage, evolution of non-destructive examination (NDE) techniques, and additional regulatory requirements for this component.
- Extending ISI intervals: For a variety of reasons, licensees request extensions to typical ISI intervals. These requests may be related to dose limits, costs or other plant-specific reasoning. This option will focus on areas where ISI interval extension has been approved, the reason for the need, the reason for the approval, and the technical justification used by the regulator to approve the request.
- In-service inspection accuracy: While most ISI programmes are required to be qualified for procedures, equipment and personnel, many different qualification programmes are available for use worldwide. This option would focus on the commonly used ISI qualification programmes, their regulatory acceptance and their effectiveness.

Each WGCS member was asked to participate in the survey and rank the options based on their preference (with "1" being the highest priority). The results of the survey are shown below:

Country	Option			
	Augmented Inspection	Component Specific ISI Programmes	Extending ISI Intervals	Inservice Inspection Accuracy
United States	3	2	1	4
Canada	1	3	2	4
Japan	3	2	1	4
Czechia	3	3	2	4
Korea	1	2	3	4
United Kingdom	1	1	1	4
Hungary	4	1	4	4
Finland	3	1	4	2
Sweden	3	1	2	4
Final ranking based on average	3	1	2	4

Therefore, component specific ISI programmes and extending ISI intervals were chosen as the main topics of interest. In addition, several members suggested related topics on the evolution of NDE techniques and design for inspection.

1.2. Participation

Participation in the workshop was open worldwide to nuclear industry representatives for new and operating reactors, international organisations, laboratories and regulatory organisations.

Participation by regulators and operating reactor licensees was strongly encouraged. In response to the invitations, the online workshop was attended by over 150 people each day (200 maximum) with presentations from eight countries with regulatory, industry, laboratory, and code and standards representation.

1.3. Language

All presentations and discussions were held in English.

1.4. Venue

Originally, the workshop was planned to be held at the US Nuclear Regulatory Commission (NRC) auditorium on 5-6 April 2021. However, due to the COVID-19 pandemic, the workshop was postponed until 12-13 April 2022. In February 2022, the COVID-19 pandemic was still ongoing and many members had issues with travel to the United States, so the workshop transitioned into a fully online format, and was held for four hours a day from 11-14 April. All sessions were recorded.

2. Summary of the workshop

The virtual workshop was held online from 11-14 April 2022. The topics covered in each session are shown below:

Table 2.1. Day 1: 11 April 2022

Session	Title or Topic
Opening	Welcome and agenda
Session 1: Reactor vessel ISI programmes and additional regulatory requirements - Interval, coverage, qualification, etc.	RPV ISI in the United Kingdom
	RPV ISI in the United States
	Reactor vessel ISI programmes and regulatory requirements in Japan
	Regulatory status on in-service inspection programme for reactor vessel in Korea
	Q&A session
	Break
	RPV ISI in France
	RPV ISI in Czechia
	Application of ASME at ISI of VVER-440 Units
	Q&A session
Adjourn	

Table 2.2. Day 2: 12 April 2022

Session	Title or Topic
Opening	Welcome and agenda
Session 1: Reactor vessel ISI programmes and additional regulatory requirements - Interval, coverage, qualification, etc.	RPV ISI in Finland
	EDF Vessel ISI programme
	KHNP's experience on conventional in-service inspection for reactor vessel in Korea
	RV-ISI programme from Japanese industrial side
	Q&A session
Break	
Session 2: Evolution of NDE techniques	Inspection technology to reduce non-detectable parts
	New technology of inspection method
	Applicability of Full Matrix Capture (FMC) / Total Focusing Method (TFM):
	Q&A session
Adjourn	

Table 2.3. Day 3: 13 April 2022

Session	Title or Topic
Opening	Welcome and agenda
Session 2 continued Evolution of NDE techniques	The evolution of ISI of nuclear reactor pressure vessels
	AI in ultrasonic technique (UT) inspection of welds
	Harmonisation of the certification of NDE personnel
	Q&A session
Break	
Session 3: Extending ISI intervals - approvals and basis	Use of probabilistic fracture mechanics in ISI extension - Regulatory perspective
	BWR RPV circ weld inspection elimination
	PWR ISI Interval Extension
	ISI programmes updates from a Utility Point of View
	Q&A session
Adjourn	

Table 2.4. Day 4: 14 April 2022

Session	Title or Topic
Session 3: Extending ISI intervals - approvals and basis	Welcome and agenda
	Can ISI be eliminated with risk-informed decision-making?
	Perspective on RIM for advanced reactor
	Q&A session
Break	
Session 4: Design for inspection	Design for inspectability – UK approach
	ASME Section XI Division 2 - RIM - Importance of designing for inspection for advanced reactor technologies
Harmonisation Discussion	
Adjourn	

At the start of the workshop, Mr Thomas Buckenmeyer (NEA) explained the online meeting logistics, the objectives of the workshop and introduced the chairman of the workshop, Dr David Rudland from the US NRC, who is also the vice chair of the WGCS.

Dr Rudland welcomed the speakers and participants to the workshop and reviewed the agenda and topics to be covered for the four-day workshop. He also introduced Dr Sangmin Lee from the Korea Institute of Nuclear Safety (KINS), the chairman of the WGCS, to welcome the participants. During his welcome speech, Dr Lee pointed out the importance of harmonisation of international codes and standards.

Before the first session began, Mr Buckenmeyer presented the results of the first participant poll question: “Where are you from?” The results of this poll were: 22% from industry, 32% from regulators, 2% from academia, 5% from international organisations, 5% from other and 34% did not respond.

3. Session 1 - Reactor vessel ISI programmes and additional regulatory requirements - interval, coverage, qualification, etc.

3.1. Day 1 – 11 April 2022

Dr Rudland (US NRC), the workshop chairman and session moderator, began the session by describing the focus of the session: reactor vessel ISI programmes and requirements. Because of the varying requirements between different component types, the WGCS decided to focus this session of the workshop on the ISI requirements for the reactor pressure vessel (RPV) to gain an understanding of the differences in both regulatory and codes and standards requirements.

The first presentation of the session was from Mr Steven Taylor of the Office for Nuclear Regulation (ONR), United Kingdom, and his presentation was titled, "Reactor pressure vessel ISI". In his presentation, Mr Taylor provided the design and inspection requirements for the Sizewell B reactor vessel and the regulatory footprint provided by ONR. He mentioned that the regulatory regime is non-prescriptive and is a sampling programme to confirm inspection requirements are being met.

The second presentation of the session was from Dr Michael Benson from the US NRC and his presentation was entitled, "Reactor pressure vessel in-service inspection requirements in the US". Dr Benson described the ASME Section XI requirements for the RPV welds and the associated US NRC incorporation by reference of those requirements in 10 CFR 50.55a.

The third presentation of the session was from Ms Haruko Sasaki from Nuclear Regulation Authority (NRA), Japan, and the title of her presentation was, "Reactor vessel ISI programmes and regulatory requirements in Japan". Ms Sasaki described the regulatory requirements for the RPV welds and their relationship to the Japanese Society of Mechanical Engineers (JSME) requirements. Ms Sasaki asked whether the NRA should require licensees to examine essentially 100% of the welds in the RPV, as is required in the United States. After describing work done in Japan, she explained that the NRA will be changing their requirements of inspection from 7.5% of the welds to essentially 100%.

The fourth presentation of the session was from Mr Young Eui Kwon from the Korean Institute for Nuclear Safety (KINS) and his presentation was titled, "Regulatory status on in-service inspection programme for reactor vessel in Korea". Mr Kwon described the regulatory framework in Korea as it pertains to technical standards and in-service inspection. In addition, Mr Kwon presented two recent examples of ISI inspection on upper and lower head penetrations.

During the first question and answer session, the questions submitted were mainly for clarification of the presentation details, and/or the regulatory/code requirements. It was clear from the presentations and the questions and answer session that the details of these requirements are different between the countries. Dr Rudland led a discussion on the basis of the ten-year inspection interval and the 100% coverage requirements. The conclusion was that there is a limited basis to the ten-year interval requirement, and it may have been set for convenience since the original US licences were set for 40 years and inspections at 25% intervals seemed reasonable. In addition, from a regulatory point of view, inspecting 100% of the weld volume seems reasonable for safety significant components, but this requirement also does not have a strong basis.

After a break, the fifth presentation of the session was from Mr Adrien Thibault and Ms Clémentine Peron from Autorité de Sûreté Nucléaire (ASN), France, and the title of their presentation was "Presentation of France reactor pressure vessels (RPV)". First, Mr Thibault provided an overview of the in-service inspection programme in France focusing on NDE qualification. In France, the ISI programme is defined by what happened in the manufacturing process, lessons learnt from operational experience and the expected failure modes of the components. The inspection programmes must be updated every ten years and repairs must occur if cracks are found. The NDE process and operators are qualified separately and follow criteria that are either conventional (performance demonstration), general (areas where defects may occur) or specific (defects have occurred in past). Ms Peron provided details of the RPV specific ISI requirements, noting that inspections are done in two zones: where defects are expected and other locations (used for defence-in-depth). The inspection requirements for bottom mounted nozzles, upper head nozzles, and shell welds were provided.

The sixth presentation of the session was from Ms Jolana Rydlova from the State Office for Nuclear Safety (SUJB), Czechia, and the title of her presentation was "In-service inspections of RPV in the Czech Republic". After describing the nuclear power plant status in Czechia, Ms Rydlova gave the history of the codes and standards development for the Czech plants. She also described that the ISI programme was developed based on the original Soviet regulations for nuclear power plants, technical specifications and individual quality assurance programme for reactors established by the manufacturer. The ISI programmes are also living programmes that may be modified based on operational experience. She provided the requirements and criteria for the RPV inspections including the NDE qualification via the European Network for Inspection Qualification (ENIQ), and the disposition of NDE findings.

The seventh presentation of the session, the last one for the day, was from Mr Peter Deak from the Hungarian Atomic Energy Authority and the title of his presentation was "Application of ASME at ISI of VVER-440 units". Mr Deak presented the status of the current operating plants in Hungary and their process for long-term operation, which follows the US NRC licence renewal process. Hungary adapts the ASME Boiler and Pressure Vessel (BPV) and operational and maintenance codes into Hungarian standards. Over the years, their frequency of inspections has increased from four years to eight years to ten years. Ultrasonic technique (UT) qualification is done via ENIQ standards and the coverage for inspection is at 100% of the weld with inspections from both the inside and outside of the RPV. The Hungarian approach to ISI is quality ISI instead of quantity ISI.

During the second question and answer session, the initial questions submitted were for clarification of the presentation details and/or the regulatory/code requirements. There was a discussion on the difference between ENIQ and ASME Section XI, Mandatory Appendix VIII Performance Demonstration for Ultrasonic Examination Systems. It was noted that ENIQ requires an open demonstration of procedures and equipment, with a technical justification, followed by blind demonstration of personnel, while Section XI, Appendix VIII requires all blind testing - no accompanying technical justification required. From the discussion, it was clear that there are differences in why the inspection interval was chosen: some are codes and standards requirements, while some are direct regulatory requirements.

3.2. Day 2 – 12 April 2022

Mr Buckenmeyer began the second day of the workshop with a review of the meeting logistics and introduced the workshop chairman, Dr Rudland. Dr Rudland gave an overview of the workshop objective and introduced the moderator for the day's topics, Dr Patrick Raynaud from the US NRC.

The first presentation of the day and the eighth presentation of the first session was from Ms Tarja Nuoranne from Säteilyturvakeskus (STUK), Finland, and the title of her presentation was "RPV ISI in FINLAND". Ms Nuoranne began by summarising the regulatory structure for ISI in Finland. She then described the steps in the ISI approval process. After describing the NDE qualification, she proceeded to discuss the inspections at the different Finnish plants, which had different ISI intervals. For example, at Loviisa 1 and 2, the full inspection of the RPV occurs every eight years, while at Olkiluoto 1 and 2, the full inspection of the RPV is done in a ten-year cycle.

The ninth presentation of the session was from Mr Emmanuel Lemaire from EDF, France and the title of this presentation was "EDF RPV ISI Programme". Mr Lemaire's presentation provided the French industry perspective of the ISI programme for RPV welds. He explained that the vessel "beltline" region is inspected every ten years, and the inspection capability is for a 5x25 mm underclad crack. Inspections are also driven by operating experience, with a complete review taking place every ten years. He also described fracture toughness surveillance programmes and fuel management optimisation to both measure the toughness and control the fluence level on the beltline materials. Finally, Mr Lemaire presented the ongoing inspection requirements for vessel penetrations and the plans for upper head replacements due to stress corrosion cracking concerns on the upper head penetrations.

The tenth presentation of the session was from Mr Taehun Lee from Korea Hydro & Nuclear Power Co. LTD. (KHNP) and the title of his presentation was "KHNP's experience on conventional in-service inspection for reactor vessel in Korea". Mr Lee presented the Korean RPV ISI requirements from a licensee perspective. After providing a summary of the KHNP operating reactors in Korea, Mr Lee described the Korea Electric Power Industry Code (KEPIC) for in-service inspection that is very similar to the ASME BPV code. Mr Lee then described the performance demonstration efforts within the KEPIC code and the field equipment used for the inspection of the vessel and nozzle welds. He also provided an example of how the inspections are laid out across each of the periods of the four expected inspection intervals. Finally, he described some of the coverage issues and the examination methods used to increase coverage in limited access configurations.

The eleventh and final presentation of the session was from Mr Yasukazu Takada from the Kansai Electric Power Co., Inc. and Mr Takeo Kimura from Tokyo Electric Power Company Holdings, Inc. and their presentation was "RV-ISI programme from Japanese industrial side". Mr Yasukazu began the presentation by giving the background of the inspection requirements from the JSME fitness-for-service code. He stated that most of the high stress, high potential for damage locations were 100% inspected, and 7.5% of the RPV welds are inspected except for high fluence locations, which are 100% inspected. He also mentioned that the NRA required the increase in all RPV welds to 100%. After this change, inspections have been carried out at all plants and no indications have been found. Mr Kimura provided the response of the BWR and PWR owners to this change in the inspection requirement. The utilities are worried about the addition radiation exposure with these increased inspections. They are aware of the approved alternative requests in the United States to extend ISI intervals using probabilistic fracture mechanics (PFM) techniques. The utilities plan to benchmark PFM codes through EPRI soon.

During the third question and answer session, the initial questions submitted were for clarification of the presentation details and/or the regulatory/code requirements. Most of the discussion was focused on the use of advanced techniques for changing intervals but direct fracture toughness and other non-ISI requirements were also discussed.

4. Session 2 - Evolution of NDE techniques

After a short break, Dr Raynaud introduced the second session, "Evolution of NDE techniques". The first presentation of this session was from Mr Shiro Otake from Toshiba Energy Systems & Solutions Corporation, Japan, and his presentation was entitled "Inspection technology to reduce non-detectable parts". Mr Otake's presentation focused on two techniques, shape adaptive beam steering plus soft shoe, and comprehensive phased array ultrasonic testing (PAUT) for cast austenitic stainless steel (CASS) materials that are meant to aid in better detection for those components where inspections are difficult. His discussion of adaptive beam steering demonstrated how the addition of the soft shoe can easily overcome complicated surfaces. This process has been employed at several Japanese plants. In addition, the increased number of PAUT transmitting elements seemed to show promise for inspection of CASS materials.

The second presentation of the session was from Mr Hajime Shohji from Central Research Institute of Electric Power Industry (CRIEPI), Japan, and his presentation was entitled "New technology of inspection method". After presenting an overview of CRIEPI, Mr Shohji focused on NDE techniques developed for nozzle-to-safe-end welds. He described inspection techniques being developed for both inner and outer diameter examinations of these welds, as well as eddy current technology for inspecting the inner radius of the nozzles. Finally, he described new technology for observing ultrasonic vibration using a three-dimensional laser doppler system.

The third presentation of the session was from Mr Seiji Asada from Mitsubishi Heavy Industries, Ltd., and his presentation was entitled "Applicability of Full Matrix Capture (FMC)/Total Focusing Method (TFM)". Mr Asada described how the FMC/TFM method is different from the conventional PAUT technique that focuses the beam on a specific location. FMC/TFM can generate UT images for all areas that have high lateral resolution and high signal to noise ratios. He also introduced the use of adaptive processing that uses the shape of the surface to correct the ultrasound signal. He presented several verification cases including mock-ups of piping and plate welds with both machined and grown defects. However, it appears the method may have thickness limitations and more work is needed before it can be applied to thick structures.

During the fourth question and answer session, many of the questions sought clarification of the presentation details. Many of the questions focused on details such as error measurements, ultrasonic frequencies used in CASS materials, and the qualification and limitations of the new techniques. There was a discussion on probability of detection (POD) for the new techniques, and the speakers noted that the largest impact to POD are human factors (HF) and the focus should be placed on improving HF to improve inspectability. Finally, the speakers were asked to describe the biggest challenge to NDE. The presenters mentioned stress corrosion cracking in complex configurations, machine learning and artificial intelligence (ML/AI), new locations or configurations, small modular reactors, and the impacts of NDE on advanced manufacturing technologies, such as additive manufacturing.

4.1. Day 3 – 13 April 2022

Mr Buckenmeyer began the third day of the workshop with a review of the meeting logistics and introduced the workshop chairman, Dr Rudland, who gave an overview of the

workshop objective and introduced the moderator for the day's topics, Ms Carol Nove from the US NRC.

The first presentation of the day, the fourth of the second session, was from Mr Joel Harrison from the Pacific Northwest National Laboratory (United States) and the title of his presentation was "The evolution of ISI of nuclear reactor pressure vessels". Mr Harrison provided a comprehensive history of the RPV NDE ASME requirements for the shell, upper and lower head, and reactor vessel internals. He provided the history of the ASME Section XI Appendix VIII implementation and touched on the main inspection issues related to each of the inspection categories noted.

The fifth presentation for this session was from Dr Nawal Prinja from the World Nuclear Association (WNA), CORDEL and the title of his presentation was "AI for UT of Welds". Dr Prinja provided background on AI and differentiated AI from machine learning (ML): machine learning is an application of AI that provides the ability to automatically learn and improve from experience (past data) without being explicitly programmed. He presented how other industries have excelled in the implementation of AI or ML, but the nuclear industry seems to be lagging. He explained how AI could help in the use of UT by accelerating the process, making it more automated, and increasing safety by removing some of the human element. He then provided several examples of how AI could be used to enhance NDE.

The sixth presentation of this session was from Mr Ronan Tanguy from the World Nuclear Association, CORDEL and the title of his presentation was "CORDEL: Certification of NDE personnel harmonisation of international code requirements". After a brief introduction to both the WNA and CORDEL, Mr Tanguy focused his presentation on the need to harmonise NDE personnel qualification. Through his presentation, he proposed that harmonisation of personnel certification would provide greater confidence in certified personnel and better international transferability of personnel. He suggested that the transfer of certain certifications may be an issue, so the development of harmonised third-party certification may help eliminate most issues and provide consistency as inspectors move from site to site. However, harmonisation is still needed at the standards development organisational level.

During the fifth question and answer session, many of the questions sought clarification of the presentation details. However, two main topics were discussed. The first was how to implement AI into the UT programmes. The panellists described that once these models are developed, they should be easy to use and easily implemented. However, there needs to be support from industry and a path forward in codes and standards space. There are still many outstanding questions on data such as the use of multiple data formats and the development of a worldwide database on UT. The second topic was on the need to harmonise the UT qualification. The panellists stressed that there are no ongoing efforts to compare ENIQ and ASME Section XI Appendix VIII qualification requirements. However, there is a need from the new and advanced reactor vendors that may want to sell their designs to several different countries to have unified qualification requirements. From a vendor perspective, some of the hesitancy of using a third-party qualification may be due to the potential loss of detail in requirements and the added need of companies to add training to their own processes. Further discussion on harmonisation NDE qualification is needed.

5. Session 3 - Extending ISI intervals - approvals and basis

After a short break, Ms Nove introduced the third session, "Extending ISI intervals - approvals and basis". The first presentation of this session was from Mr David Dijamco from the US NRC and the title of his presentation was "Use of probabilistic fracture mechanics for ISI extension: a regulatory perspective". Mr Dijamco described the use of probabilistic fracture mechanics in determining ISI intervals with an example supported by sensitivity analyses and sensitivity studies and stressed the need to include examination coverage in the analyses. He explained the importance of continuing to monitor the locations analysed to determine if there has been a change relative to the assumptions of the analyses; he tied that back to one of the principles of risk-informed decision-making: performance monitoring. He provided an example of the BWR RPV vessel weld inspection elimination as an example of a successful application of PFM with performance monitoring.

The second presentation of this session was from Mr Nathan Palm from EPRI (United States) and the title of his presentation was "BWR RPV circumferential weld inspection elimination". Mr Palm described the basis and history for the elimination of the ASME required inspections for the BWR RPV circumferential welds. Through a series of reports, e.g. BWRVIP-05, BWRVIP-329, EPRI developed the technical basis that the use of PFM for elimination of these exams produced a probability of failure lower than the NRC safety limits. However, the axial welds are still inspected and, in fact, a portion of the circumferential welds attached to the axial welds are also inspected during each interval.

The third presentation of this session was from Mr Anees Udayawar from Westinghouse (United States), and the title of his presentation was "Pressurised water reactor (PWR) vessel in-service examination extension". Mr Udayawar described the extension of the PWR vessel welds inspection from every 10 years to every 20 years. Like the BWRs, a topical report (WCAP-16168-NP-A) contained the technical basis that leveraged PFM to demonstrate that changing the inspection frequency had little effect on the overall probability of failure. At this point, approximately 70% of the US PWR fleet have been granted approval for extension of their RPV weld inspections.

The fourth presentation of this session was from Mr Gary Lofthus from Southern Nuclear (United States), and the title of his presentation was "ISI programmes updates from a utility point of view". Mr Lofthus described the ISI programmes at plants Hatch, Farley and Vogtle. He described the ISI programme update considerations, including knowledge management when senior staff retire. He also mentioned that Southern Nuclear is considering changing their intervals from 10 years to 12 years per a recently approved ASME code case.

During the sixth question and answer session, many of the questions were for clarification of the presentation details. One of the general topics discussed was whether the standards development organisations were planning on changing the RPV inspection requirements based on the efforts of the US industry to extend the inspection intervals. In all cases where this has been successful, the US industry has developed generic analyses that have demonstrated low risk of extending inspection intervals; however, any plant that wants to apply those analyses needs to demonstrate that the analyses bound their plant-specific circumstances. Therefore, developing a generic code action would be difficult due to the need to demonstrate plant-specific applicability. The speakers also pointed out that these analyses would be applicable to similar international plants if they demonstrated that their plant-specific circumstances are bounded by the generic analyses. Another general topic

was the validation of low probability events. The speakers commented that it is difficult to validate these events with actual plant behaviour, but the focus is placed on proper input and validation of individual models to ensure confidence in the results. Finally, the discussion again came back to the need to harmonise NDE qualification requirements; however, the speakers from the US utility stated that what is currently in the ASME code is working, and if a change were to be made for harmonisation purposes, it would be necessary to understand the cost impact and the benefit to the plants before considering this change.

5.1. Day 4 – 14 April 2022

Mr Buckenmeyer began the fourth day of the workshop with a review of the meeting logistics and introduced the workshop chairman and moderator for the day, Dr Rudland. Dr Rudland went over the day's agenda, which concludes with a panel discussion on harmonisation.

The first presentation of the day, the fifth of the third session, was by Dr David Rudland from the US Nuclear Regulatory Commission, and the title was "Can ISI be eliminated with risk-informed decision-making?" After providing a background of the ASME Section XI inspection programme, Dr Rudland discussed the process for implementing risk-informed decision-making for adjusting the inspection intervals for passive components. Within that discussion he described US operational data that suggest that new degradation mechanisms are revealed every six years on average. Because of this trend, analyses that model only the known degradation may not properly represent the total risk. Therefore, additional performance monitoring is needed to ensure that the models continue to properly predict the behaviour of the ageing of passive components. He presented several examples of how performance monitoring has been used with PFM calculations to develop a strong basis for ISI interval extension.

The sixth presentation of the session was by Ms Margaret Audrain from the US Nuclear Regulatory Commission, and was entitled "Perspectives on ISI for advanced reactors". After providing a background on materials issues with non-light water reactors, Ms Audrain shared that ISI for advanced reactors will be different than the traditional light water reactors due to the different materials, degradation and safety concerns. She briefly discussed ASME Section XI Division 2, and how work is still needed on the development of reliability targets, materials test data and refined flaw evaluation techniques. She closed her presentation with the thought that while it may be possible to eliminate some inspection for locations with no degradation, low consequence of failure and proper defence-in-depth, more experience with these advanced reactors is needed before this is possible.

Before the start of the question and answer session, Dr Rudland presented the results of the second poll question, "Is harmonisation of ISI needed for safety". For this question 35% of the participants said yes, 5% said no, 8% had no opinion and 53% did not respond.

During the seventh question and answer session, many of the questions sought clarification of the presentation details. One of the questions focused on the NRC requirement for performance monitoring. Dr Rudland pointed out that analyses used for ISI extension need to be able to account for all uncertainties, including plant-specific uncertainty. In assessing ISI extensions, the applicant also needs to account for unknown mechanisms, or the associated uncertainties, and that can be done in a variety of ways. Dr Rudland pointed back to earlier presentations on RPV welds where inspection plans were co-ordinated across the fleet to ensure the behaviour of components was well predicted and understood. There were also many questions on advanced reactors, focusing on the topics of volumetric exams and online monitoring. The speakers stated that in many cases there is limited

operational experience of these techniques for advanced reactors. The speakers also pointed out that the US NRC is developing guidance for materials compatibility and ISI as well as a regulatory guide endorsing ASME Section XI Division 2. Part 53 of 10 CFR is being drafted and will not contain the prescriptive requirements for ISI that are currently in Part 50.

After the question and answer session, Dr Rudland presented the results of the third poll question, "For class 1 and class 2 safety significant components, can ISI be eliminated using analytical techniques only?" For this question, 33% of the participants said no, 2% said yes, 13% said it depends, 1% had no opinion and 51% did not respond.

6. Session 4 - Design for inspection

Dr Rudland introduced the final session of the workshop entitled, “Design for inspection”. The first presentation of the session was by Mr Andrew Holt from the Office for Nuclear Regulation, United Kingdom, and the title was “Design for inspectability”. Mr Holt described the history of inspectability in the United Kingdom and described the regulatory documents that describe the position for design for inspection. There are two safety assessment principles that describe that the design and materials need to be chosen for proper examination over the lifetime of the facility. Mr Holt gave some examples of how the ONR has required changes to the design of reactor components to increase inspectability.

The second presentation of this session was by Mr Tom Roberts of POMO18 Consult LLC, United States, and the title of his presentation was “ASME Section XI Division 2 – RIM - Importance of designing for inspection for advanced reactor technologies”. Mr Roberts provided an overview of Section XI Division 2, which included a discussion of the reliability and integrity management (RIM) methodology and the associated monitoring and NDE (MANDE) requirements. He described how RIM is a technology-neutral standard that sets reliability targets for each risk significant component. The component MANDE, which can be used to confirm that the component’s reliability target is met, is selected based upon a credible and postulated material degradation assessment and must be performance demonstrated. Expert panels for both RIM and MANDE are required to develop the programmes, including in-service inspection programmes. The programme is considered a living programme that will be updated as operational experience is obtained.

During the final question and answer session, many of the questions sought clarification of the presentation details. Mr Holt commented that the changes made for the United Kingdom to meet their design for inspection requirements were specific to their reactors only and may not be available to others that want to use that design in the future. There was a question on how to encourage vendors of valves to update designs for better inspectability. The speakers mentioned that it is up to the designers to clarify to the vendors the importance of inspectability. ASME has a current effort to better align Section III and XI to improve the inspectability of components. There were several questions on RIM and its applicability to light water reactors. Mr Roberts pointed out that RIM may not be a cost-effective choice for operating reactors, but it could be used for reactors still in the design stage. While there is not a lot of actual operating experience with RIM, it was used once and several advanced reactor vendors are developing their reactors to include RIM programmes.

7. Harmonisation discussion

Dr Rudland introduced the harmonisation panel speakers (Dr Sangmin Lee, Dr Nawal Prinja, Dr Seiji Asada and Mr Tom Roberts) and began the discussion. Dr Rudland began by reminding the participants of the objective of the workshop, and posing another poll question, "What RPV weld inspection is best suited for harmonisation: NDE qualification, NDE procedure, NDE inspection frequency, or inspection coverage?" For this question, 2% of the participants said NDE procedures, 9% said NDE qualification, 6% said inspection intervals/coverage, 26% said all the above, 2% said none of the above and 54% did not answer.

Dr Rudland led the harmonisation discussion by posing questions to the panel and participants. The responses and discussion are described below.

7.1. Question 1: From what we have learnt from this workshop, what are possible harmonisation topics for WGCS to consider?

The overwhelming answer from the panels was "NDE personnel qualification". Since there are many different qualification requirements available (e.g. ASME, ENIQ, CP189), and since different countries may require different qualifications, vendors have difficulty maintaining multiple qualifications due to the differences and costs of implementation. Harmonising personnel qualification and including performance demonstration may be key to reducing burden while maintaining quality inspections.

Some of the panellists also recommended that inspection of advanced manufactured materials might benefit from harmonisation. The development of advanced manufacturing techniques, including additive manufacturing, is rapidly evolving, especially in the nuclear field. With these new fabrication techniques comes the ability to develop new and unique geometries that may challenge current inspection techniques. Harmonisation of inspection and/or manufacturing process qualification of advanced manufactured components would produce higher quality, consistent components across all vendors.

There was also discussion about harmonising inspection frequency and coverage. Most participants believed that safety would be improved with the harmonisation of these requirements. It was clear that cultural and regulatory differences among countries may make a complete harmonisation effort unsuccessful.

7.2. Question 2: How do we encourage harmonisation in codes and standards development?

Most of the panellists and participants agreed that good communication was the number one path to successful harmonisation. As the authors of codes and standards begin development of requirements, discussions need to occur to understand the differences in the technical basis that may be leading to discrepancies in requirements. However, the roles of each SDO participant needs to be fully understood. Since most of the participants in SDOs are volunteers, the sponsoring companies need to be able to see the need and take the initiative to harmonise. The regulators can encourage harmonisation, but it is the SDO that must work to harmonise the requirements. It is necessary to also be aware of the cost of harmonisation, since there may be significant implications in both cost and time to changing a process, i.e. post-implementation qualification.

Some suggested that the development of an international governing body on harmonisation might make the transition more manageable. While this may be a difficult task, CORDEL is currently developing a proposal for a similar activity. In this effort, national regulators would work together, with industry providing a supporting role, to undertake equivalence/harmonisation studies to support joint regulatory design reviews.

One of the workshop participants asked about recognising a successful path to harmonisation once it is possible to encourage its development. The panellists described a possible approach to measuring harmonisation success in three levels. First is communicating and accepting each other's findings. Once discussions are held, success can be judged when each technical basis is understood and accepted, even if there are differences. The second is no duplication in the development of requirements. Once there is understanding and acceptance, success can then be judged when requirements with no duplication are developed. The third is the development of an international standard. After the other successes, the development of an international standard will be the final success of harmonisation. To encourage discussion, ASME and RCC-M make the technical basis documents for their codes and standards requirements publicly available. However, the panellists were clear to point out that it is more efficient to harmonise as technology is being developed and before commercialisation or standardisation.

7.3. Question 3: Are there examples of harmonisation success?

The panellists pointed out that many of the processes in the aerospace industry are harmonised, which allows them to be available for many international situations. One good example of harmonisation success from the United States is the US nuclear materials management programme that is defined in a Nuclear Energy Institute (NEI) document – NEI 03-08, "Guideline for the management of materials issues". This guideline document provides a unifying standard for US nuclear power plant owners for dealing with material degradation related issues. Through this effort, the owners talked with each other, helped identify duplicity in their efforts and harmonised the response to degradation of the primary system passive components. This programme allows the users to provide a unified basis while focusing on the proper resources to mitigate the issues.

Another example given is an ongoing programme developed under the Sustainable Nuclear Energy Technology Platform (SNETP) called Nuclear Components Based on Additive Manufacturing (NUCOBAM). This programme will develop a harmonised qualification process and provide the evaluation of the in-service behaviour for additively manufactured (AM) components. This programme began collaboratively and currently has 13 partners working to develop these procedures. While the programme has only been active for a year or so (since about 2021), the direction seems to be on the path to success.

7.4. Question 4: Is harmonisation worth the effort?

There was a lot of discussion on the worth of harmonisation both in general and in particular on ISI intervals. One of the first steps in understanding the worth of harmonisation is to first understand why the requirements are different. Is there a distinct difference in technical basis, or are there local customs and regulations that are driving the requirements? Most panellists agreed that regulatory differences will make harmonisation efforts difficult, mainly due to the process and safety basis needed to make a regulatory change. From a utility standpoint, harmonisation will be more likely if there is a clear benefit to the licensee. All agreed that it is extremely important to understand the cultural and historical differences among the countries and how those differences may impact the development of requirements.

Panellists agreed that once the differences are known and understood, then communication is key to develop harmonised requirements. However, it may be more advantageous to move away from full harmonisation and focus on optimising current processes with new and evolving technologies in a harmonised manner. In addition, it might be desirable to start with a low safety significant application since the requirements for these components might be less stringent and easier to harmonise.

Overall, the consensus was that harmonisation of requirements can increase safety and is worth the effort if the differences in technical basis and culture are understood, active communication is employed, and the benefit to both the regulator and utilities is clear.

Near the end of the workshop two additional polls were presented to the workshop attendees. The first was, “In the future, would you prefer workshops to be in person, online or hybrid?”. For this poll, 24% of the participants chose an online meeting, 15% chose in person, 19% chose hybrid and 42% did not answer. The second poll was, “Was the duration of this workshop too long, too short, or appropriate?”. For this question, 1% said it was too short, 5% said it was too long, 50% said it was of appropriate length, and 43% did not answer.

8. Recommendations

The purpose of this workshop was to review and compare the ISI provisions in codes and standards, document the differences and determine if modifications to harmonise ISI are beneficial. Through the four-day online event, over 150 participants per day discussed a variety of topics related to the harmonisation of RPV weld in-service inspection requirements.

There were many harmonisation topics discussed. However, the overwhelming consensus was that the SDOs should focus on the harmonisation of NDE personnel qualification requirements. Currently, there are several qualification processes available worldwide, and international vendors struggle to maintain the different qualifications as they attempt to build facilities in different countries. As an example, some of the qualification procedures include performance demonstration as a vital aspect of the qualification process while others do not. Harmonisation in this area will reduce the burden on the vendors and provide a unified qualification approach that will promote consistency across the industry. From a regulator's point of view, this harmonisation will also decrease the level of burden since it promotes efficiency in the review and implements only a single set of qualification requirements from multiple vendors and increases safety by providing consistent and repeatable NDE.

Many participants of the workshop felt there was a large safety benefit in considering the harmonisation of inspection intervals. However, the technical, regulatory and cultural differences that drive these requirements needs to be fully understood before harmonisation can occur. It is possible that these differences may not lead to complete harmonisation of the intervals, and it may be more practical to focus on optimising current inspection processes with new and evolving technologies in a harmonised manner. However, for any optimisation to be effective, a strong technical basis is needed to ensure the reliability of future inspections.

In all cases, communication between parties is key to harmonisation. Discussions of the harmonisation driver, the difference in requirements and how to reconcile those differences must occur between the SDOs before harmonisation can occur. The SDO must consider regulatory differences, the utility and vendor needs, and the impacts of harmonisation while having these discussions. While this seems to be a difficult task for mature and commercialised processes, it may be less difficult for new and evolving technologies. There are ongoing successes in harmonisation that demonstrate that with the proper communication and driver harmonisation is possible.

Even though the panel did not discuss the importance of design for inspectability as it relates to new designs, the WGCS believes this is an important aspect of any design to ensure that repeatable and reliable inspections occur over the lifetime of the facility. It is also important to align the level of inspectability with the safety significance of the component. As was discussed in Session 4, it is important that designers, vendors and regulators consider that the proper materials and inspection techniques are chosen for new designs to ensure the maximum inspection coverage can be achieved.

Therefore, the WGCS recommends the following:

- The SDOs should investigate the harmonisation of NDE personnel qualification with the inclusion of performance demonstration.

- The SDOs should investigate the harmonisation of inspection intervals for future use. This harmonisation needs to include a strong technical basis for any modification of the current interval requirements.
- Nuclear component designers, vendors and regulators should consider component inspectability aspects for all new designs to ensure that proper inspections occur over the lifetime of the facility.

Organisations like the ASME SDO Convergence Board, which has representation from many worldwide SDOs, are well positioned to embark on efforts for harmonisation. By investigating differences in the current bases and ensuring no duplication of effort, working together the SDOs can develop harmonised international standards that will increase safety, and decrease burden to the industry and regulator.

Annex A.

The presentations given during the workshop can be found on the Nuclear Energy Agency website at: www.oecd-nea.org/jcms/pl_60566/wgcs-international-workshop-on-mechanical-codes-and-standards-in-service-inspection.