

# OPTIMISING THE EUROPEAN NUCLEAR SUPPLY CHAIN

## USE OF HIGH-QUALITY INDUSTRIAL GRADE ITEMS IN EUROPEAN NUCLEAR INSTALLATIONS

### FOREWORD

*FORATOM is the Brussels-based trade association for the nuclear industry in Europe. It acts as the voice of the European nuclear industry in energy policy discussions with EU institutions and other key stakeholders. Some of the key topics FORATOM deals with include security of energy supply, competitiveness, economics of nuclear, nuclear safety, nuclear liability, radioactive waste management, decommissioning, nuclear transport, environment, enabling factors for new nuclear projects, R&D, energy mix, non-proliferation, public opinion, Euratom Treaty and emergency preparedness. The membership of FORATOM is made up of 15 national nuclear associations and the companies that they represent, and three corporate members CEZ (Czech Republic), Fermi Energia OU (Estonia) and PGE EJ 1 (Poland). Overall, FORATOM represents nearly 3,000 European companies.*

*As the European Union's institutions are currently working on the bloc's future energy landscape, nuclear energy should have an important role to play thanks to the long-term operation of the current nuclear fleet and new build projects.*

*The goal of this report is to analyse the current state of play and to put forward a list of recommendations on what should be done to improve the operation of the European nuclear supply chain. This will enable a continuous development of the safety and reliability of the current nuclear fleet, which will allow it to help the EU meet its 2050 climate-neutrality goals and ensure energy security.*

*FORATOM plans to share the conclusions of this report with the European Commission and other key stakeholders, including national regulators and industry, in order to discuss and implement the proposed recommendations.*

*On this occasion, FORATOM would like to thank its members and associated stakeholders for their highly valuable contribution during the preparation of this report.*

# EXECUTIVE SUMMARY

## ***The safe and reliable operation of the European nuclear fleet requires the availability of appropriate supply chain options.***

The average age of the nuclear fleet in Europe is 35 years<sup>1</sup>. Without the lifetime extension of nuclear power plants in Europe, 90% of current nuclear capacity will be shut down by 2035 and will thus need to be replaced<sup>2</sup>. Nuclear is an important contributor of low-carbon energy which helps the EU mitigate climate change. As stated in the European Commission's "A Clean Planet for All" strategic vision, nuclear, together with renewables, will form the backbone of a carbon-free power sector in 2050 providing an estimated 15% of electricity demand<sup>3</sup>.

Continuous improvement in operational practices and nuclear safety are of fundamental importance to the European nuclear industry. Safety upgrades are an integral part of plant lifetime extension programmes. As a consequence, securing a strong and diversified supply chain is essential to ensuring the high levels of safety, quality and reliability required for new build projects and long-term operation alike. The Supply Chain Optimisation Working Group of FORATOM gathers industry experts to contribute to this essential goal.

Many of the nuclear industry's Original Equipment Manufacturers (OEM) are no longer on the market or have stopped manufacturing their originally designed items. At the same time, the market has become more challenging for new entrants due to the stringency and diversity of requirements across the globe. In order to overcome these issues, the European nuclear industry could leverage modern, high-quality and proven products manufactured by well-established suppliers to other industries which also require high quality items. In many cases, certain items used in other industries are comparable, or even physically identical to items used within the nuclear industry. These could become more widely available to the European nuclear industry if appropriate steps are taken.

The use of high-quality industrial grade items in safety-classified applications at nuclear power plants is not a new concept. In countries such as the United States, Canada, South Korea, Spain and Slovenia a mature methodology for the acceptance of high-quality industrial grade items known as Commercial Grade Dedication (CGD) is followed. The experience gained from CGD programmes has been positive and enabled procurement of a range of items from a broad supply chain.

In Europe there are several ongoing national supply chain development projects and initiatives, such as in Finland, Sweden and the Czech Republic. Many of these aim at enabling the use of high-quality industrial grade items.

There are two principles at the heart of this report:

1. Utilities / Licensees should be empowered to demonstrate the suitability of high-quality industrial items for safety classified applications.
2. The European nuclear industry should take advantage of existing European supply chain projects and international experience with respect to commercial grade dedication to promote the use of high-quality industrial grade items and a harmonised approach.

<sup>1</sup> [Nuclear Power in a Clean Energy System, IEA Report, May 2019](#): The lifetimes of several plants have already been extended well beyond those originally planned, and many others will soon face extension decisions. Most nuclear power plants have a nominal design lifetime of 40 years, but engineering assessments have established that many can operate safely for longer. In most cases, such extensions (typically to 50 or 60 years) require significant investment in the replacement and refurbishment of key components to allow units to continue to operate safely.

<sup>2</sup> [European Nuclear Energy Forum 2019 conclusions](#).

<sup>3</sup> [A Clean Planet for All a European Strategic Long-Term Vision...Climate Neutral Economy](#).

To secure a robust and diversified supply chain for the European nuclear industry, enabling continuous improvement of safety and reliability of the nuclear fleet, FORATOM proposes the following recommendations:

**[A] A common understanding should be sought between nuclear installation licensees and regulators on a European guideline presenting a common methodology for the acceptance of high-quality industrial grade items in certain safety classified applications.**

Enabling actions include:

- FORATOM, with the support of ENISS, should develop a European guideline, leveraging existing international experience and accounting for European specifics.
- ENISS should ensure appropriate interfaces with WENRA and ENSREG to enable common understanding and inputs to the development of the guideline.

**[B] The European Commission acknowledges the importance of harmonisation in this field and should support Member States to review and, where necessary, adapt their existing national legal and/or regulatory frameworks to enable greater use of high-quality industrial grade items in certain safety-classified applications.**

Enabling actions include:

- The European Commission should encourage further dialogue between Member States on this subject and the European guideline.
- The European Commission should include significant contributions to this subject in European Commission work programmes such as those under DG ENERGY and the Joint Research Centre (JRC). This could include support for workshops with regulatory bodies, licensees and suppliers.

**[C] EU Member States and other European countries should develop national guidance for the use of high-quality industrial grade items based on the common European guideline where necessary.**

Enabling actions include:

- Member State level stakeholders should support collaborative workshops between regulatory bodies, licensees and supply chain representatives.

**[D] With the goal of harmonising to provide the basis for a larger market and more efficient interfaces with suppliers, licensees should review their existing procedures. The European guideline, by presenting a common methodology, can support the development of these procedures.**

Enabling actions include:

- License holders and national regulators should hold workshops and maintain continuous dialogue to establish best practices for the acceptance and use of high-quality industrial grade items.

In addition, FORATOM believes that a further assessment of nuclear industry supply chain practices through comparisons between licensees' practices (technical and process-wise), feedback from suppliers and benchmarking against other high-quality industries will lead to the identification of additional optimisation solutions. The FORATOM Supply Chain Optimisation Working Group recommends that:

**[E] The European nuclear industry should carry out a self-assessment to identify additional optimisation solutions, particularly around the harmonisation of requirements and manufacturing best practices, to broaden the nuclear supply chain and secure high levels of quality and reliability.**

Enabling actions include:

- The European nuclear industry should conduct an assessment of the interaction between management systems and supply chain management practices. This could include dedicated workshops and analysis of procurement best practices.
- The European nuclear industry should analyse areas for the harmonisation of technical requirements used within nuclear projects (including design, manufacturing and construction codes and standards).
- The European nuclear industry should perform an analysis of quality management practices and requirements used within other high-quality industries, including benchmarking and assessment of areas of harmonisation.

# REPORT OVERVIEW

This report is organised in two main parts:

<b>Part 1</b>	Provides an overview of the background and environment that the nuclear industry is confronting concerning the nuclear supply chain:
<a href="#">Chapter 1</a>	Recalls the key concepts associated with the nuclear safety philosophy.
<a href="#">Chapter 2</a>	Describes the evolutions that the nuclear supply chain has undergone since the initial start-up of the European nuclear fleet.
<a href="#">Chapter 3</a>	Finally provides a further description of the current nuclear supply chain environment and the challenges associated with it.
<b>Part 2</b>	Focuses on the use of high-quality industrial grade items in nuclear safety related applications:
<a href="#">Chapter 4</a>	Describes the approaches taken in various European countries to address the challenges associated with the supply chain.
<a href="#">Chapter 5</a>	Discusses in more detail the commercial dedication approach used in some countries, as well as how and why this approach should be generalised at a European level.
<a href="#">Chapter 6</a>	Discusses the considerations of this approach for nuclear safety and quality.
<a href="#">Chapter 7</a>	Discusses the additional benefits that this approach would provide to the nuclear industry.
<a href="#">Chapter 8</a>	Finally discusses other potential optimisation solutions that will be explored by the FORATOM Supply Chain Optimisation Working Group in its future activities.
Finally, the report concludes with <a href="#">recommendations</a> .	

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# INTRODUCTION

FORATOM has established working groups to foster a common view among its members on key topics. The goal of the Supply Chain Optimisation Working Group (SCOWG) is to analyse key challenges and provide recommendations for a more robust and diversified supply chain. The working group endeavours to enable continuous implementation of best practices, and progress towards enhanced quality and cost competitiveness within the nuclear industry. The scope of this SCOWG work focuses on the existing European nuclear fleet, with considerations for the new build of large scale and advanced reactors.

The SCOWG would like to stress the importance of the use of high-quality industrial grade items in nuclear safety related applications as an area of supply chain optimisation. This has been proven to be a mature and robust practice which brings significant benefits in those countries where it has been implemented.

This report draws on existing supply chain projects and initiatives related to procurement of lower safety class equipment. It seeks to open up further dialogue between stakeholders to address the challenges related to the procurement and acceptance of high-quality industrial grade items for nuclear power plants in Europe. The development of a European guideline, which would describe the acceptance process, is encouraged as a common goal between stakeholders. This would allow for the best practices developed in different European countries to be shared and utilised by all.

The optimisation of supply chain practices is a matter that will require consensus among nuclear installation license holders, vendors, manufacturers, regulators and national level stakeholders with appropriate interactions with international organisations.

An essential prerequisite for investments in the nuclear industry, be it for long-term operation, nuclear new build or for the development of advanced nuclear reactors, is access to a strong and diversified supply chain. The option to choose the most pragmatic supply chain strategy for a given project should be encouraged, and it is this belief that underpins the discussion and recommendations provided in this report.

- The FORATOM SCOWG is assessing various optimisation solutions to tackle key nuclear supply chain challenges.
- A mature and robust practice in several European countries is the use of high-quality industrial grade items in nuclear safety related applications.
- This report seeks to open dialogue on the harmonisation of acceptance processes for high-quality industrial grade items within nuclear installations in Europe.

# PART 1

## SUPPLY CHAIN ENVIRONMENT OF THE EUROPEAN NUCLEAR FLEET

### 1. NUCLEAR SAFETY PHILOSOPHY

The supply chain strategy of a nuclear installation is intertwined with nuclear safety considerations and is based on internationally accepted principles. This section introduces a few concepts in support of the discussions within this report.

***The prime responsibility for nuclear safety rests with the licensee.***

The *licensee* is the person or organization holding the license and bearing overall responsibility for a nuclear installation or activity<sup>4</sup>.

In line with the first fundamental safety principle defined by the IAEA<sup>5</sup>, the *licensee* has the prime responsibility for nuclear safety and is responsible for “verifying appropriate design and the adequate quality of facilities and activities and of their associated equipment.” This is generally achieved through a safety assessment. The findings of this safety assessment, together with “any other arguments and evidence in support of the safety of a facility or activity” form the plant *safety case*<sup>4</sup>.

***The nuclear safety philosophy is based on a combination of many principles and approaches, especially through the implementation of the concept of Defence-in-Depth.***

*Nuclear safety* may be defined as “the achievement of proper operating conditions, prevention of accidents and mitigation of accident consequences, resulting in protection of workers, the public and the environment from undue radiation risks.”<sup>4</sup>

The primary means of preventing accidents and mitigating their consequences is the implementation of the ‘Defence-in-Depth’ (DiD) concept through consecutive and independent levels of protection that would have to fail before harmful effects could be caused to people or the environment. If one level of protection or barrier were to fail, a subsequent level or barrier would be available. When properly implemented, DiD ensures that no single technical, human or organizational failure could lead to harmful effects, and that the combination of failures that could give rise to significant harmful effects are of very low probability. The independent effectiveness of the different levels of defence is a necessary element of DiD.

- The prime responsibility for nuclear safety rests with the licensee.
- The nuclear safety philosophy is based on a combination of many principles and approaches, especially through the implementation of the concept of Defence-in-Depth.
- Nuclear power plant Structures, Systems and Components (SSCs) are assigned to safety classes on the basis of their functions and their safety significance. These safety classes drive the requirements applied to those items.
- Utilisation of high-quality industrial grade SSCs in lieu of nuclear grade SSCs, when appropriately justified, aligns with nuclear safety philosophy.

<sup>4</sup>[Safety Glossary, IAEA, 2018.](#)

<sup>5</sup>[SF-1, Fundamental Safety Principles, IAEA, 2006.](#)



As stated in the ENISS Position Paper<sup>6</sup> DiD is adequately implemented via a comprehensive set of safety-related considerations, requirements and rules:

“Much has been done by European countries in benchmarking and continuously improving their nuclear safety frameworks and regulations, in great part through the application of the DiD concept.

This application is based chiefly on:

- the choice of an appropriate site, with particular consideration for the potential natural or human-induced risks that could affect the nuclear installation;
- the identification of the whole set of safety functions contributing to the demonstration of nuclear safety;
- a proportionate approach according to risk;
- a cautious design approach, integrating design margins and wherever necessary introducing adequate redundancy, diversification and physical separation of the items important for safety that fulfil safety functions necessary to achieve a high safety level;
- the quality of equipment and activities important for safety, to reach a high reliability level;
- a good preparation (training, regular exercise...) for the management of incident and accident situations.

The high level of nuclear safety of ENISS members' nuclear power plants is demonstrated by a prudent deterministic approach (including conservative assumptions and bounding analyses) which reflects the sound application of the DiD concept. This approach integrates the technical, organisational and human dimensions. Safety analyses are performed to demonstrate that barriers to the release of radioactive material prevent an uncontrolled release to the environment. This demonstration includes the control of the fission process within the acceptable design limits, the cooling of the reactor core with the heat transferred to ultimate heat sinks, the confinement of radioactive material, shielding against radiation, along with ensuring various other acceptance

criteria. Moreover, the deterministic safety analysis is complemented by probabilistic safety analysis of accidents and their consequences”.

***Nuclear power plant Structures, Systems and Components (SSCs) are assigned to safety classes on the basis of their functions and their safety significance<sup>7</sup>. These safety classes drive the requirements applied to those items.***

“The goal of safety classification is to identify and classify those SSCs that are needed to protect people and the environment from harmful effects of ionizing radiation, based on their roles in preventing accidents, or limiting the radiological consequences of accidents should they occur. On the basis of their classification, SSCs are then designed, manufactured, constructed, installed, commissioned, operated, tested, inspected and maintained in accordance with established processes that ensure design specifications and the expected levels of safety performance are achieved.”<sup>8</sup>

Those SSCs which are identified as important to safety through the safety classification are generally required to meet certain specifications in accordance with nuclear-specific codes and standards. Items or SSCs procured from suppliers that have management systems which conform to nuclear-specific rules are referred to as ‘nuclear grade’ items or SSCs.

***Utilisation of high-quality industrial grade items in lieu of nuclear grade SSCs when appropriately justified aligns with nuclear safety philosophy.***

A significant focus of this report is on the use of high-quality industrial grade items in lieu of *nuclear grade* SSCs when appropriately justified. High-quality industrial grade items are items and equipment procured from suppliers that have management systems which conform to the rules applicable in other industries. These suppliers are also known to put a strong emphasis on equipment quality and reliability, such as those supplying the aviation, aerospace, telecommunications or chemical industry. In the context of this report, high-quality industrial grade items are any items which could be used in lieu of ‘mid-level to lower safety class’ (e.g. safety class 2 or 3), for example some mechanical SSCs such as certain valves, pumps, pipework or some electrical items.

<sup>6</sup> ENISS Position Paper - Defence-in-Depth (DiD) Implementation, 28<sup>th</sup> Nov.2019.

<sup>7</sup> SSR-2/1 Safety of Nuclear Power Plants: Design, IAEA, 2016.

<sup>8</sup> SSG-30, Safety Classification of Structures, Systems and Components in Nuclear Power Plants, IAEA, 2014.



## 2. EVOLUTION OF CODES AND STANDARDS

***The creation of nuclear specific codes and standards occurred over 50 years ago with the goal of addressing the inadequacies of existing industrial codes at the time.***

From the start of peaceful nuclear energy production more than 50 years ago the existing industrial standards used for planning, manufacturing, Quality Control (QC) and Quality Assurance (QA) did not meet the expectations for safety related SSCs within nuclear installations. In order to secure the necessary quality and reliability of SSCs, the nuclear industry developed its own nuclear specific codes and standards. These nuclear design and quality criteria differed from those of industrial items in terms of specific requirements, such as design, manufacturing techniques, facilities utilised in their assembly, QA and QC requirements, documentation, inspections, qualifications, testing and other product life-cycle development aspects. This then established the nuclear specific codes and standards widely used in the nuclear supply chain.

***The diversification of nuclear specific codes and standards has evolved across different European countries.***

Historically, European and non-European countries developed for their nuclear industry their own codes and standards. These covered requirements for the design, construction, testing and inspection of equipment important to nuclear safety. The European nuclear industry uses different codes and standards related mainly to the nuclear reactor technology adopted. Currently, most of the existing European reactors and potential future advanced reactors either use or plan to use codes and standards such as ASME (*American*), AFCEN (*French*), KTA (*German*), or GOST (*Russian*). The use of specific standards is often required and specified in national legislation, in the regulatory framework and finally in technical specifications to suppliers.

The difference between design codes is a challenge for the nuclear industry not because they themselves contain significant differences, but because the national legislation and regulations of one country may specifically require one design code whilst another country requires a different design code or standard. Furthermore, the nuclear installation may not be allowed to mix equipment manufactured according to different codes and standards (e.g. ASME III and KTA 3201) within the same plant system. As a result, the available supply chain for high-quality equipment may be artificially limited to those supplying products designed and manufactured to one nuclear standard or the other. In addition to design requirements for technical, material and environmental conditions, nuclear specific codes and standards often include quality management system requirements. The flow of how supply chain requirements may be quite different from one country to the next is illustrated within Figure 1.

- Different European and non-European countries have developed their own codes and standards for equipment important to nuclear safety.
- Internationalisation of industrial codes and standards means they are under continuous development in order to account for advances in safety, quality and reliability.
- There is great interest in the comparison between nuclear specific codes and standards and international industrial standards. As well as the benefits of harmonising approaches across different countries.

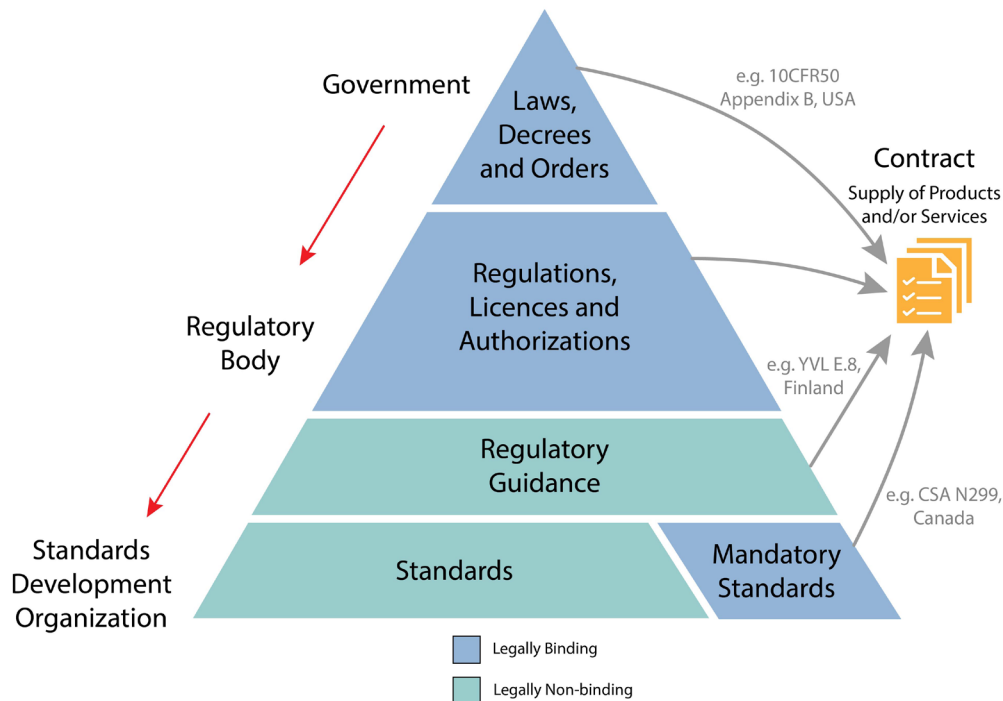


Figure 1 Overview and examples of the flow of quality assurance requirements from legislation, regulation and standards into contracts from IAEA TECDOC 1910<sup>9</sup>

***The use of high-quality grade items in safety-classified applications in nuclear installations has a long history in many countries.***

Rigorous nuclear quality assurance requirements exist in many forms. One example are the 18 requirements of 10CFR50 Appendix B, described in more detail in the ASME NQA-1<sup>10</sup>. Countries in which these rules are required for suppliers of safety-classified SSCs have in some cases run into difficulties in finding qualified suppliers or solutions for obsolete items, such as in the United States, South Korea, Spain and Slovenia. As a result, a process for accepting items designed and manufactured under a 'commercial' QA programme rather than a nuclear-specific one was developed in the late 1980's. This acceptance process is today referred to as Commercial Grade Dedication (CGD). The first nuclear standard to specifically address commercially 'off the shelf' items was published by ANSI in 1976 in the United States. Later, in 1988, EPRI published a consistent Guideline for the Utilisation of Commercial

Grade Items in Nuclear Safety Related Applications (NP-5652). The guidance was developed to address licensees' need for a documented methodology which had been lacking at the time.<sup>11</sup> One of the factors which contributed to the need for the guideline was that, due to a decreasing number of new-build projects, suppliers were no longer maintaining the nuclear-specific QA programs necessary for operating power plants to procure safety-related spare parts.

The EPRI guideline became widely used in the U.S. and elsewhere. Within Europe, the Krško nuclear power plant in Slovenia introduced CGD into their procurement process in the mid-1990s, based on the EPRI guideline and supplemental guidance.<sup>12</sup> During this period, Spain also developed domestic standards on the use of commercial grade items in safety-related applications within nuclear facilities.<sup>13</sup> More recently, Romania and the Czech Republic have also introduced CGD in line with the updated EPRI guideline published in 2014.<sup>14</sup>

<sup>9</sup> [Quality Assurance and Quality Control in Nuclear Facilities and Activities: Good Practices and Lessons Learned, IAEA, 2020.](#)

<sup>10</sup> [ASME NQA-1 Overview.](#)

<sup>11</sup> [EPRI NP-5652, Guideline for the Utilization of Commercial Grade Items in Nuclear Safety Related Applications, EPRI, 1988.](#)

<sup>12</sup> [Introduction of the Commercial Grade Dedication into Nuclear Power Plant Krško \(NEK\) Procurement Process, NEK, 1996.](#)

<sup>13</sup> [UNE 73-403-88, Utilización de Elementos de Calidad Comercial en Aplicaciones Relacionadas Con la Seguridad de Instalaciones Nucleares, AENOR, 1988.](#)

<sup>14</sup> [3002002982 - Plant Engineering: Guideline for the Acceptance of Commercial-Grade Items in Nuclear Safety-Related Applications: Revision 1 to EPRI NP-5652 and TR102260, EPRI, 2014.](#)

CGD can therefore be seen today as a well-established acceptance process performed to provide reasonable assurance that a commercial item will perform its intended safety function in a nuclear power plant. The practice of CGD has made a larger and more robust supply chain accessible, giving licensees options for the procurement of items beyond only those suppliers that have management systems which conform to nuclear-specific rules.

***The internationalisation of quality management and standards has enabled the utilisation of high-quality items in many industries.***

The QA of most commercial industrial products and service providers is based on the QM standards in the International Organisation for Standardization (ISO) 9000 family. This also applies to nuclear standards and national nuclear safety regulatory QA and QM requirements in many countries. All industrial codes and standards, as well as the ISO 9000 standard family and European Standards (EN-standards) are under continuous development and are frequently updated in order to enhance safety, quality and reliability. The standards within the ISO 9000 family have become the most globally used standards to ensure that products and services consistently meet customer's requirements, and that quality is consistently improved. As an example, now in circulation is a nuclear specific QM standard, ISO 19443:2018<sup>15</sup>.

***There is great interest in the comparison between nuclear specific codes and standards and international industrial standards, as well as the benefits of harmonising approaches across different countries.***

Since the 1960s, when the first QM requirements for the nuclear industry were developed, there have been similar requirements for QA and QM for other industries which have also become an important part of industrial standards. To explore these similarities a study<sup>16</sup> commissioned by Finnish utility TVO compared a safety class 3 shut-off valve from a specific manufacturer for a nuclear installation in Finland and requirements for the supply of the same item to the oil and gas industry. The main conclusion of the study found that there are only some minor differences in QA and QM requirements,

which are in some cases more stringent for nuclear and in some cases more stringent for oil and gas. However, overall the requirements were found to be mainly comparable. It is evident from the experience of nuclear licensees and from ongoing national supply chain projects as listed in Appendix 1, that the same high-quality and reliability can be achieved by using SSCs manufactured according to well established industrial standards. For example API<sup>17</sup> (*Petroleum Industry*), IEEE<sup>18</sup>/IEC<sup>19</sup> (*Electrotechnical*), ANSI<sup>20</sup> (*Covers various industrial domains*), ISA<sup>21</sup> (*Automation*) all publish a wide range of standards, mostly general in nature or applicable to industries other than nuclear. Additionally, European Norms (EN) standards exist and these are a key component of the EU's single market. EN-standards codify best practices, are regarded as state of the art, and are widely applied by manufacturers inside and outside the territory of the EU.

The OECD-NEA Multinational Design Evaluation Programme (MDEP) is an example of a multinational initiative which seeks to enable a more harmonised approach to the review of new nuclear power reactor designs. One of its aims is to search for ways to harmonise and converge the national codes, standards, and regulatory requirements of national regulators and stakeholders' practices in carrying out their safety reviews of new reactor designs. The appraisal of the supply chain optimisation to enable greater quality within the nuclear industry is an area reflected within the scope of the MDEP.<sup>22</sup> FORATOM has engaged with members of the MDEP Vendor Inspection Co-operation Working Group<sup>23</sup> (VICWG) as part of the process in developing this report and has gathered feedback which is supportive to the report's recommendations. Other associations such as the World Nuclear Association, through its Cooperation in Reactor Design Evaluation and Licensing (CORDEL) Working Group, and international agencies such as the IAEA have also undertaken studies and activities which include comparison of nuclear codes and standards and those from non-nuclear industries. This shows that there is great interest from many stakeholders in identifying solutions to optimise and achieve harmonisation in nuclear supply chain practices.

<sup>15</sup> [ISO 19443:2018, Specific requirements for the application of ISO 9001:2015 by organizations in the supply chain of the nuclear energy sector supplying products and services important to nuclear safety \(ITNS\), ISO, 2018.](#)

<sup>16</sup> [Use of Commercial-Grade Items in Nuclear Facilities, Raitanen, 2016.](#)

<sup>17</sup> [American Petroleum Institute.](#)

<sup>18</sup> [Institute of Electrical and Electronic Engineers.](#)

<sup>19</sup> [International Electrotechnical Commission.](#)

<sup>20</sup> [American National Standards Institute.](#)

<sup>21</sup> [International Society of Automation.](#)

<sup>22</sup> [Annual Report, Multinational Design Evaluation Programme, 2018.](#)

<sup>23</sup> [OECD-NEA VICWG.](#)

### 3. SUPPLY CHAIN EVOLUTION AND ENVIRONMENT

***Over the last few decades there is evidence of nuclear suppliers diversifying and seeking new industrial markets.***

During the last few decades the business environment for the nuclear industry in Europe has changed. As a result, this makes for a complicated and confusing time from a supplier's point of view. Understandably, this has resulted in some nuclear suppliers diversifying and seeking new industrial markets, with some opting to leave the nuclear market altogether. This is clear from European nuclear operators who are seeing a declining number of appropriately qualified nuclear suppliers as a result of some companies leaving the market.

The number of equipment supplier companies holding ASME N-Type certificates<sup>24</sup> has also fallen over the same period in both Europe and North America. Not all nuclear suppliers are certified by ASME, but the trend is clear, with an observed drop of around 5% per year in the number of certificate holders since 2013. This indicator of the volume of nuclear-grade item suppliers shows that the nuclear-grade supply chain is shrinking.

***There is a considerable need for a robust and diversified supply chain for the existing European nuclear fleet operation and for long-term operation.***

A recent study by FTI-CL commissioned by FORATOM<sup>25</sup> shows that if Europe is to achieve its goal of becoming carbon neutral by 2050, then a considerable amount of nuclear energy will be required. The role which nuclear will have to play in the future is also recognised in the European Commission's 2050 long-term strategy. Irrespective of the exact percentage of nuclear energy within the European energy mix, it is clear from both studies that LTO and new build are required. This poses the question whether the existing supply chain options available are sufficient. If not, then what changes and optimisation is needed to ensure a capable and robust supply chain for the European nuclear industry?

- There is evidence of nuclear suppliers diversifying and seeking new industrial markets with some leaving the nuclear market altogether.
- There is a considerable need for a robust and diversified supply chain for the existing European nuclear fleet operation and for long-term operation.
- The challenge posed by obsolete items has become very important within the European nuclear industry.
- In many cases, the ability to use the most modern, innovative items within the European nuclear industry can be overcome with supply chain optimisation.

<sup>24</sup> [ASME Nuclear Component \(N-type\) Certification](#) is a company level certification of an organisation's quality assurance program in accordance with Section III of the ASME Boiler and Pressure Vessel Code (BPVC) for components installed in nuclear facilities.

<sup>25</sup> [Pathways to 2050: role of nuclear in a low-carbon Europe, FTI Study, 2018.](#)

***The challenge posed by obsolete items has become very important within the European nuclear industry.***

One of the fundamental principles in the nuclear industry is to use proven and reliable technology. This technology is often known, widely used and supplied by well-established and capable suppliers. However, the European supply chain has become smaller, and in some cases the originally approved SSC is not available on the market anymore. Thus, the challenge posed by obsolescence has become very important. This is further put into perspective with the following two quotations from the 2019 ENSREG conference summary report:

*“As regards the supply chain, **challenges include the unavailability of qualified and willing suppliers** and the fact that the low level of activity in commissioning of new NPPs in the EU could cause **problems for supplies of qualified components**. There is a **need for increased collaboration** within the nuclear sector, both cross-border **and with other industry sectors, such as aviation.**”*

*“Operators of nuclear installations are now sometimes facing a difficult choice between the **replacement of obsolete licensed components with identical ones that need to be designed and manufactured again and licensing and use of new components, developed with more recent technologies**, but that are currently used in other types of industries and not licensed specifically for a nuclear environment.”*

**ENSREG Conference 2019<sup>26</sup>**

***In many cases, the ability to use the most modern, innovative items within the European nuclear industry can be overcome with supply chain optimisation.***

There have been many advances internationally in technology and industrial development across many modern industries, in areas such as materials, digitalisation, automation, inspection techniques, products functionality and reliability. However, in many cases there are barriers to the use of the most modern and innovative items in the nuclear industry. This is because they have not been designed, manufactured and qualified in accordance with specific nuclear codes and standards. This has resulted in a situation where an advanced, reliable and modern technology or item that could be used in the maintenance,

refurbishment or new build of a nuclear power plant is in practice not - or seldom - used. This is mainly due to the challenges to use such items in conjunction with the QM, conventional practices and design standard authorised or commonly accepted by the regulatory framework of many European countries.

However, in parallel it is known that the continuous development of nuclear safety requires the use of best available proven technology. Often, all or most of the technical requirements for many items used within the nuclear industry outside the primary containment are common whether it is a nuclear-grade or an industrial-grade available item (material, pressure boundary limits, operating temperature etc.). In fields relating to digitalisation, such as Instrumentation and Control (I&C), software, electrical systems and components, the technical advances have been significant during the last few decades. For such items the only possibility is to use industrial grade items within the nuclear industry for many applications, with some limited exceptions. In certain cases, nuclear specific environmental requirements are necessary and added, like resistance to radiation, temperature transients, operation to humidity, seismic withstand, cobalt content etc.

Higher safety class SSCs (e.g. fuel, reactor pressure vessel and primary system components, reactor protection systems) are assigned many nuclear specific requirements and have then to be manufactured according to nuclear specific standards and codes. However, the majority of SSCs, especially in the lower safety classes, have a limited number of nuclear specific requirements. Thus there are various international examples whereby high-quality industrial grade items are used for the low and mid-level safety classes. Examples can be found within some national supply chain projects highlighted in Appendix 1.

Furthermore, the justification that any item, be it nuclear-grade or industrial-grade, is suitable for use in a nuclear power plant to provide a safety function usually implies extensive inspection and auditing at many stages of manufacturing by the licensees, the national regulators and third-party bodies<sup>27</sup>. This also applies to items of lower safety classes (such as safety class 3) and then often adds obstacles for some lower tier suppliers to be involved in some projects and can cause difficulties in maintaining their involvement and supply to the nuclear industry.

<sup>26</sup> [Summary Report of the Fifth ENSREG Conference on Nuclear Safety, 2019.](#)

<sup>27</sup> [Benchmarking the European inspection practices for components and structures of nuclear facilities, WENRA, 2012.](#)



# PART 2 - USE OF HIGH-QUALITY INDUSTRIAL GRADE ITEMS IN NUCLEAR SAFETY RELATED APPLICATIONS

## 4. EUROPEAN SUPPLY CHAIN APPROACHES

***The European nuclear industry is working to address supply chain related challenges.***

Recently the European Commission Joint Research Centre (EC-JRC) conducted an initiative to assess the supply chain situation in EU Member States (*plus Switzerland, the Ukraine and the United Kingdom*). This included an analysis of the challenges and solutions for using non-nuclear industry standard items and equipment for safety-related functions<sup>28</sup>. Inputs included details from utilities, licensees and national nuclear industry fora. Extracts of the preliminary findings provided by stakeholders during this initiative have been summarised within this chapter. Supplementary considerations have been provided by FORATOM.

***There is a considerable obsolescence issue throughout Europe. Some countries are turning to various mitigation actions to address the issue.***

A study conducted by EPRI in 2008 found that approximately 20% of identifiable plant equipment is obsolete and no longer available in the marketplace<sup>29</sup>. Based on feedback received from FORATOM members there is consensus amongst the existing European nuclear fleet operators that this value is now considerably higher.

Furthermore, a key finding of the EC-JRC supply chain initiative is that several licensees from various countries are significantly concerned about SSC obsolescence. They are becoming increasingly concerned about their ability to replace SSC when required. Less concerned licensees with limited or no problems in finding new suppliers are those which have the advantage of operating large fleets of standardised reactors, cooperate with other utilities and participate in joint international efforts to tackle the problem.

Some licensees also maintain large stocks of spare parts which are continuously replenished from the open market and other sources. One notable solution which many countries are showing an interest in, and which is gaining momentum, is the establishment and greater use of CGD to qualify high-quality industrial grade items. Additionally, the development and implementation of a proactive obsolescence management programme is seen by the IAEA and many nuclear industry stakeholders as a necessity to tackle the issue head on in order to maintain a secure supply of equipment<sup>30</sup>.

- Different approaches are used across European utilities and countries to address nuclear supply chain challenges.
- Some countries have taken a proactive approach to obsolescence issues which has enabled greater supply chain options.
- One of the key enablers for an optimised nuclear supply chain is the ability to procure high-quality industrial grade items. This can be seen from considerable interest in many countries in commercial-grade-dedication programmes.

<sup>28</sup>Current Challenges of the European Nuclear Supply Chain and Possible Solutions, EC JRC, 2020 (*DRAFT at time of writing*).

<sup>29</sup>[Plant Support Engineering: Obsolescence Management, EPRI, 2008.](#)

<sup>30</sup>[SSG-48, Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants, IAEA, 2018.](#)

It is important to recognize that when suppliers are no longer able or willing to fulfill the nuclear-specific procurement requirements stipulated by the licensee, their products are rendered effectively obsolete. In such cases the supplier might continue to manufacture the same products for other industries, or in theory would be ready to deliver to the licensee, but not according to stringent nuclear procurement conditions. It is in these increasingly frequent scenarios that CGD has demonstrated success as a solution to obsolescence.

***There is considerable difficulty in finding new suppliers to engage in new procurement programmes across Europe.***

Utilities are also experiencing difficulties in finding new suppliers. Therefore, several European licensees choose to apply specialist or elaborative inspection and maintenance practices to uphold the quality of items where there is an issue in obtaining a full replacement due to a limited supply chain. Only if the maintenance or repair is not possible then replacement with a similar SSC is performed. This requires in most cases, a lengthy modification process involving qualification and approval by the regulator. Furthermore, some utilities requiring the replacement of an obsolete SSC but which are unable to replace it with the same 'like-for-like' item have been participating in programmes with other utilities and equipment vendors. These programmes try to assure access to the item from another utility or vendor who has a spare one within their inventory. This practice has developed considerably over the last decade globally. Examples of such programmes include the Nuclear Utility Obsolescence Group<sup>31</sup> (NUOG), Proactive Obsolescence Management System<sup>32</sup> (POMS) and RAPID<sup>33</sup>. This practice does have its advantages but is limited as the inventories of spare parts are reduced.

***The procurement of items according to legacy requirements has caused challenges in many European countries.***

Licensees procure SSCs according to legacy requirements because the SSC is known to perform well, and

personnel are trained in its procedures, operation and maintenance. Therefore, the confidence in a specific item and willingness to continue with the use of a 'like-for-like' replacement where possible is one of the reasons many utilities would wish to have the exact same item for a replacement. Moreover, there is an added interest at some utilities to avoid qualification uncertainties and potential risks associated with a more modern SSC replacement if possible. In the case that the supplier discontinued the nuclear product line, the item might still be available as commercial industrial grade. Some countries are starting to perform 'reverse engineering' of SSCs due to the original design documentation not being fully available and the fact that Original Equipment Manufacturers (OEM) are no longer in business. This results in considerable complexity and delays in completing some equipment replacement programmes.

***The manufacturing and equipment used within the European nuclear industry could use more state-of-the-art techniques and products that are already utilised in other industries.***

Modern technology practices and applications such as additive manufacturing and advanced digitalisation for safety-related SSCs, are only possible in some countries, and this is the case if the technologies are either covered by nuclear codes and standards or specifically qualified for nuclear applications. There is considerable interest across licensees and some regulators to identify ways to reduce perceived or imposed barriers so that benefits, including those prudent to safety, could be delivered thanks to innovations which have the potential of fulfilling the quality and reliability required for the nuclear installations. Notably, reverse engineering<sup>34, 35</sup>, digitalisation, industry 4.0 and use of additive manufacturing technologies are considered to be very important for use in supply chain strategies in the nuclear industry. Internationally, there have been mixed levels of practice within the nuclear industry to date<sup>36</sup> for both existing reactor fleets and new advanced reactors such as SMRs. An example of the possible supply chain benefits can be seen from the delivery of one of the

<sup>31</sup> [NUOG](#) is set up with an aim to share information and solutions for dealing with equipment obsolescence at nuclear power plants.

<sup>32</sup> [POMS](#) is a software and services based tool designed to provide quick and easy retrieval of equipment and vendor obsolescence information.

<sup>33</sup> [RAPID](#) is a virtual inventory platform used to locate, buy and sell spare parts and equipment.

<sup>34</sup> [Replacing Obsolete Nuclear Instrumentation and Control Equipment, European re-engineering and reverse engineering experience, Energiforsk, 2016.](#)

<sup>35</sup> [Guidance for the Use of Reverse-Engineering Techniques: Revision 1 to EPRI TR-107372, EPRI, 2018.](#)

<sup>36</sup> [An Internet of Nuclear Things Emerging Technology and the Future of Supply Chain Security, Stanley Foundation, 2018.](#)



first additive manufactured replacement parts for an operating nuclear plant which was for a pump impeller within a fire protection system. This took place at the Krško NPP in Slovenia.<sup>37</sup>

***The ability to use non-nuclear industry standard items for safety-related equipment is possible in some European countries. However, it is also found to be challenging or overly complex in other countries.***

Licensees who have replaced SSCs which were previously 'nuclear-grade' with new non-nuclear

industry standard equipment have done so successfully via such practices as CGD. However, they have noted the considerable challenges for substantiation and regulatory approval to make the change necessary within some countries. Appendix 1 of this report outlines further details on supply chain projects and initiatives which include the use of high-quality industrial items via practices such as CGD across various European countries.

<sup>37</sup> [First 3D-Printed Replacement Part Operating in a NPP, 2017](#): The original impeller was in operation since the plant was commissioned in 1981; its original manufacturer is no longer in business. Obsolete, non-OEM parts are particularly well-suited for this new technology as they and their designs are virtually impossible to obtain. This technology thus allows mature operating plants to continue operating and achieving or, as in the Krško case, even extending, their full life expectancy.

## 5. COMMERCIAL GRADE DEDICATION IN A EUROPEAN CONTEXT: KEY PRINCIPLES AND NEEDS

Commercial Grade Dedication is a methodology that many licensees and utilities are turning towards to help optimize their supply chain.

***The suitability of high-quality industrial grade items intended for nuclear safety applications must be assessed and verified.***

The IAEA Fundamental Safety Principles<sup>38</sup> call for design and engineered safety features to be assessed to demonstrate that they fulfil the safety functions required of them. CGD is fundamentally concerned with verifying the ability of high-quality industrial grade items to fulfil NPP-specific safety functions. The IAEA Safety Guide GS-G-3.5<sup>39</sup> states that “when a commercial grade product is proposed for any safety function, a process should be used to determine the product’s suitability”. In Europe, there is currently no consensus on what such a process should look like. European nuclear operators would benefit greatly from a guideline on the use of high-quality industrial grade items in-lieu of nuclear grade items, around which consensus could be built. The guideline should establish a robust acceptance process based on existing CGD principles and best practices.

***According to existing guidelines a high-quality industrial grade item which has successfully undergone Commercial Grade Dedication is equivalent to a nuclear grade item.***

High-quality industrial grade items are, by definition, not specifically designed, manufactured, assembled or tested to fulfil nuclear safety functions. The CGD acceptance process results in what is essentially a nuclear grade item, since it provides reasonable assurance that the procured high-quality industrial grade item will perform its safety function(s) once installed in the NPP.

It is the responsibility of the organization performing CGD, typically the licensee, to undertake a technical evaluation which determines which item attributes support its nuclear safety function(s). Acceptance activities are then performed to verify these critical attributes (often called critical characteristics) using well-defined acceptance methods and criteria. These methods include, but are not limited to, tests, inspections, surveillance or performance-based audits of the supplier’s quality management program. Additionally, and of particular importance in the context of this report, certain critical attributes may also be verified by recognizing non-nuclear certifications or other qualifications held by the supplier or item. Other industries in which significant risks and hazards are present have developed mature schemes for certifying, accrediting or qualifying organisations and items. The nuclear industry could benefit from these programmes within the scope of CGD activities. A simplified CGD workflow is shown in Figure 2.

- Commercial Grade Dedication is a mature, proven methodology which supports safety assessment principles.
- Absence of a standard and accepted approach for the procurement of high-quality industrial grade items in Europe.
- A new guideline for European nuclear operators should be developed based on established Commercial Grade Dedication principles.

<sup>38</sup> [SF-1, Fundamental Safety Principles, IAEA, 2006.](#)

<sup>39</sup> [The Management System for Nuclear Installations, IAEA, Safety Guide GS-G-3.5, 2009.](#)

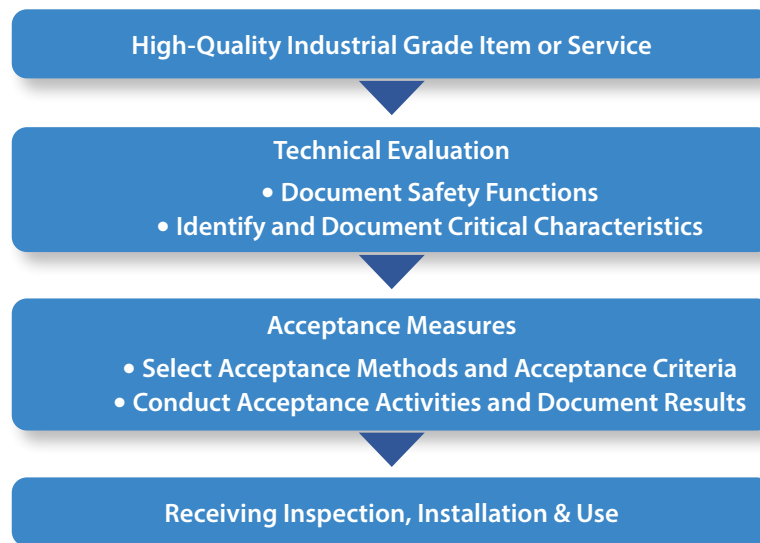


Figure 2 – Basic steps of Commercial-Grade Dedication

CGD supports the application of a graded approach<sup>40</sup> to the procurement and acceptance process. During acceptance activities, quality assurance and quality control efforts are focused in a graded manner on critical attributes. CGD is not the waiving of requirements (sometimes referred to as 'grading to zero'), rather, it is concentrating efforts in a manner which is ultimately commensurate with the associated risks.

It is important to be aware of CGD's limits, as it exists in today's accepted guidance. It is not a means by which equipment qualification requirements, such as demonstrating resistance to earthquakes, can be circumvented. Nor is it a suitable method for justifying the use of alternative design codes when a nuclear-specific design code is explicitly required by the technical specification. CGD is ideally applied to high-quality industrial grade items which can fulfil the technical and design requirements of mid level to lower safety class (e.g. safety class 2 or 3) applications within an NPP. Many SSCs in lower safety classes do not necessarily benefit from unique nuclear-specific requirements, especially when they are highly similar to established requirements found in other similar industries.

***A new European guideline based on the principles of Commercial Grade Dedication would be of benefit to the safety and sustainability of European NPPs. The guideline should promote the harmonisation of existing high-quality industrial grade item acceptance processes.***

Existing CGD guidelines are incompatible with many of Europe's existing legal and regulatory regimes. A new guideline is needed, one which could be more readily adopted by European countries' regulatory bodies, licensees and utilities. The lack of such a guideline is hindering the ability of Europe to take advantage of CGD as a cornerstone of the safety justification process for the acceptance of high-quality industrial grade items in a harmonised manner.

<sup>40</sup>[TECDOC-1740, Use of a Graded Approach in the Application of the Management System Requirements for Facilities and Activities, IAEA, 2014.](#)

Individual European countries could reconcile their legislation, regulations and/or authorizations with a common guideline for the acceptance of high-quality industrial grade items. Nuclear power plant operators could then establish their own processes, procedures

and workflows for implementing the new guideline and local specificities into their management systems (see Figure 3 – How a new European guideline could be implemented at the national level to support the safety and sustainability of nuclear power plants).



Figure 3 – How a new European guideline could be implemented at the national level to support the safety and sustainability of nuclear power plants.

***A new guideline would provide a robust framework to enable European licensees to procure high-quality industrial grade items manufactured according to mature codes, standards and best practices found in other industries.***

The new guideline is foreseen as:

- Being developed specifically for the European nuclear industry.
- Including acceptance methods taking advantage of item reliability data, supplier performance history, certifications or other qualifications.
- Being fully compatible with existing Commercial Grade Dedication guidelines, rules and regulations which are already implemented or under preparation in some EU Member States.

- A vehicle to promote further dialogue and harmonisation between European regulators, licensees and the supply chain.
- Engaging stakeholders across EU Member States and other European countries plus bodies/organisations (e.g. ENSREG, WENRA, MDEP, CORDEL, IAEA, ENISS etc.).

## 6. SAFETY AND QUALITY PERSPECTIVE

***Licensees must demonstrate conformity of items that provide a safety function, regardless of whether the items are manufactured to nuclear specific codes and standards, or to the standards of another industry.***

In many cases it would be suitable to procure equipment from high-quality industrial grade suppliers, for lower to mid-level safety classes (i.e. typically class 3 to class 2). Regardless of whether the class 3 or class 2 items are produced according to specific nuclear standards or other industrial high-quality standards, they must meet regulatory requirements. Therefore, the licensee must demonstrate conformity with those requirements which may require equivalence analyses and possibly complementary justifications for items to be accepted from a supplier certified to the standards of some other industry. Qualification to specific environmental conditions may be one of the complementary justifications.

***The use of high-quality industrial grade items in nuclear safety-related applications is a proven practice and has a methodology based on CGD that aligns with nuclear safety principles.***

Several nuclear safety regulators already accept that high-quality industrial grade items may substitute nuclear grade items and align with the nuclear safety principles described in Chapter 1. This provides other options to install proven and reliable items possibly based on new technologies not specifically developed for the nuclear industry. In addition, relying on proven suppliers' practices guarantees high levels of quality assurance with lower risks of nonconformity. The customer can take advantage of often automated, serially manufactured items (e.g. standardised batches) where production is monitored and reviewed rigorously. Manufacturing companies routinely apply thorough product quality control, publish considerable data on their products' in-service performance and make use of customer feedback for product improvement. The use of high-quality industrial grade items does not challenge the fundamental principles of defence-in-depth, redundancy, diversity and separation that are the basis of the safety demonstration for nuclear power plants. In fact, the ability to supply high-quality industrial grade items has shown to enable higher levels of quality in many cases and is consistent with IAEA safety guidance.

- Licensees must demonstrate conformity of items that provide a safety function, regardless of whether these items were manufactured to nuclear specific codes and standards, or to the standards of some other industry.
- The use of high-quality industrial grade items in nuclear safety-related applications is a proven practice and has a methodology based on CGD that aligns with nuclear safety principles.

## 7. NUCLEAR INDUSTRY PERSPECTIVE

### ***Greater use of high-quality industrial grade items supports plant availability and reduces the risks associated with component replacement and safety upgrade projects.***

Many licensees have stated they conducted CGD programmes to overcome the reduced availability of nuclear equipment suppliers or to increase confidence in the product itself. In some cases, only industrial grade items are available on the market. This applies especially to many software, digital instrumentation & control and electrical items. The ability to procure and accept items according to a harmonised European guideline for high-quality industrial grade items would enable the ability to more quickly achieve safety modernisation programmes and component replacement projects.

Procurement of high-quality industrial grade items and their acceptance through a CGD programme is also of benefit to suppliers as it would allow them to rely on their existing, proven processes and procedures and, in this way, mitigates risks which the use of unfamiliar, nuclear-specific requirements have the potential to introduce. Given the limited size of the nuclear industry in Europe, suppliers may not have the human capacity available to maintain a strong knowledge of nuclear end-user demands, especially when those demands are not harmonised.

One of the ultimate benefits associated with greater use of high-quality industrial grade items is the positive impact it would have on the availability of equipment and systems that may otherwise not be operable due to an issue with the replacement of a part. Thus, this would enable even higher nuclear power plant availability, and thus the contribution of nuclear power to low-carbon energy production in Europe.

### ***Economic benefits for re-investment in the European supply chain.***

Many licensees have stated the savings in procurement costs offset the additional effort in engineering reviews necessary to identify critical characteristics and create dedication plans to procure high-quality grade components from non-nuclear certified suppliers. The procurement of high-quality industrial grade items can deliver considerable cost-competitiveness within the nuclear industry. Consensus of real examples from nuclear licensees from the last few decades, shows that procurement according to nuclear specific codes and standards can increase costs by 2-10+ times compared to the procurement and dedication of physically identical high-quality industrial grade items<sup>41</sup>.

- Greater use of high-quality industrial grade items supports plant availability and reduces the risks associated with component replacement and safety upgrade projects.
- Economic benefits for re-investment in the European supply chain.
- Support the case for plant life-time extension and long-term operation programmes.
- Shared benefits for the acceptance of high-quality industrial grade items between nuclear licensees, supply chain and regulatory stakeholders.

<sup>41</sup> [EPRI TR-1011234 Electric Power Research Institute, January 2006, Program on Technology Innovation: 10CFR50.69 Implementation Guidance for Treatment of Structures, Systems, and Components.](#)

***Support the case for plant life-time extension and long-term operation programmes.***

For nuclear power plants SSCs are assigned to safety classes on the basis of their functions and their safety significance. The higher safety classes tend to have more nuclear specific technical requirements, such as more stringent ambient and transient conditions<sup>42</sup>. However, most of the classified equipment in a nuclear power plant usually belongs to the lower safety classes. In the lower safety classes, the SSCs installed are often the same as industrial-grade items manufactured according to industrial standards, and used in other industries, but are qualified to nuclear-grade QA requirements, resulting in significant additional costs as discussed previously. Allowing the potential use of high-quality industrial grade items in nuclear safety-related applications, given that the appropriate justification is provided, is therefore expected to result in more cost competitive modernisation programmes and equipment replacement projects. This will further improve the economic justification for many LTO programmes which will require considerable replacement of various equipment for safety classified applications.

***Shared benefits for the acceptance of high-quality industrial grade items between nuclear licensees, supply chain and regulatory stakeholders.***

A licensee must be able to manage the procedure competently and be able to draw upon experienced engineering and other professional resources, either in-house or from technical support organizations. This should also encompass a proper degree of oversight at supplier level and to manage interfaces along the supply chain. A common European guideline approach would allow the sharing of lessons learned and experiences between licensees, supply chain and regulatory stakeholders. Furthermore, it would help to avoid potentially detrimental practices and poor management of CGD programmes<sup>43</sup>.

<sup>42</sup> Qualification of equipment important to safety in nuclear power plants ensures its capability to perform designated safety functions on demand. The environmental conditions considered for the qualification considers both normal operation and those arising from postulated events including harsh accident environment (e.g. loss of coolant accident, high energy line break and seismic or other vibration conditions).

<sup>43</sup> [Managing Counterfeit and Fraudulent Items in the Nuclear Industry, IAEA, No. NP-T-3.26, 2019](#): 4.3.2 Inadequate engineering involvement in the CGD process is a common weakness in procurement programmes. Some nuclear facilities use the CGD or an engineering equivalency process to ensure that the applicable commercial items meet the technical and quality requirements for safety related end uses in a nuclear facility. Both internal and external engineering staff can play a key role in this CGD or engineering equivalency evaluation...



## 8. OTHER OPTIMISATION SOLUTIONS

This section describes the orientations which will be considered by the SCOWG in the coming years.

Three areas will be assessed by the SCOWG to identify the potential impacts and benefits of harmonisation:

- ***Harmonisation of supply chain and management activities between the nuclear industry procurement programmes.***

National rules and regulations, licensee-specific management system, and the plant-specific design and licensing bases influence how the procurement activities are carried out. Nevertheless, an opportunity may exist to harmonise supply chain practices to some extent among nuclear power plant licensees. Such partial harmonisation would decrease the risk to work in the nuclear industry for both suppliers and buyers by reducing the 'first-of-a-kind' aspects of a purchase.

In the next phase of the SCOWG work, the group will evaluate the merits and impacts of harmonisation of each of the steps in the procurement process to identify key recommendations. This evaluation will be based on a benchmark with other high-quality industries, on feedback from suppliers, and on other ongoing industry efforts.

- ***Harmonisation of technical requirements (including design, manufacturing and construction codes and standards).***

Key activities in the procurement process are the establishment of technical and quality requirements for the scope of supply. These requirements are heavily influenced by the plant design and licensing bases, including the construction codes and standards which they refer to.

Suppliers desiring to supply to the whole European nuclear plant fleet will require several qualifications in the diverse suites of nuclear-specific codes and standards. Each qualification represents a fixed cost, which is independent of the volume of supply in that specific suite of codes and standards. This cost may be a barrier to market entry for suppliers in markets where volumes are small.

Solutions to widen the supply chain options could include establishing equivalency between standards, or the adoption of a harmonised standard between different countries in lieu of the current standard. In the next phase of the SCOWG work, the group will evaluate the merits and impacts of these solutions to identify key recommendations. This evaluation will leverage other ongoing industry efforts.

- Three areas will be assessed by the SCOWG to identify the potential impacts and benefits of harmonisation:
  - Harmonisation of supply chain and management activities between the nuclear industry procurement programmes.
  - Harmonisation of technical requirements (including design, manufacturing and construction codes and standards).
  - Benchmarking and harmonisation of QA/QC requirements with other high-quality industries.
- Digitalisation of the supply chain and equipment used within the nuclear industry is a further area of optimisation within the European nuclear industry.

- **Benchmarking and harmonisation of QA/QC requirements with other high-quality industries.**

As discussed under Chapter 2, international QA requirements of today's industries are well established and mainly based on standards within the ISO 9000 family. It is evident from the experience of nuclear licensees and from ongoing national supply chain projects that the same high-quality and reliability can be achieved by using SSCs manufactured according to well established industrial standards, for example API, IEC, ANSI, ISA which are non-nuclear standards.

An opportunity therefore exists to benchmark the nuclear QA/QC requirements against

these industrial standards to identify if additional requirements are needed, or whether the nuclear QA/QC standards could be harmonised with established industrial standards. This analysis will form part of the next phase of the SCOWG work.

Digitalisation and advanced manufacturing within the supply chain and equipment used within the nuclear industry are further areas of optimisation that shall be explored and analysed. Thus, the SCOWG shall continue supporting and enabling modern supply chain integration within the existing and future nuclear power operations.

## RECOMMENDATIONS

Enabling the nuclear industry to change the present approach for procurement and to broaden supply chain options is important to support continuous improvement of safety and reliability and to enhancing the operability and cost-competitiveness of nuclear installations.

Many of the LTO programmes will require different degrees of modernisation and equipment replacement. Securing an appropriate supply chain is fundamental to guarantee a high level of safety, reliability and efficiency for the existing European nuclear fleet, as well as aiding the pace of new build developments.

Access to a healthy and diversified supply chain is also a requirement for investments in the construction of new nuclear reactors. New nuclear construction may also be held back if current supply chain constraints are not eased. The option to choose the most pragmatic supply chain strategy for a given project should be encouraged, and it is this belief that underpins the recommendations provided in this report by the FORATOM SCOWG.

Examples of experience in improving the supply chain already exist in many European countries, specifically via the greater use of high-quality industrial grade items within nuclear installations. In practice, this means:

- Selecting reliable, capable and well-established suppliers through a robust supplier approval process.
- Procurement of SSCs manufactured according to the existing production process.
- That licensees by themselves – or within a joint license holder effort – take the responsibility for qualification and approval of high-quality industrial grade items used in nuclear safety related applications.

To support a wider application of this direction within Europe, FORATOM proposes a number of recommendations which flows from the initiative of producing a European guideline.



Figure 4 – Proposed flow of the FORATOM recommendations

More specifically, FORATOM proposes the following recommendations:

**[A] A common understanding should be sought between nuclear installation licensees and regulators on a European guideline presenting a common methodology for the acceptance of high-quality industrial grade items in certain safety classified applications.**

A generally applicable and robust safety justification process would support a harmonized European approach to high-quality industrial grade item procurement and acceptance.

Enabling actions include:

- FORATOM, with the support of ENISS, should develop a European guideline, leveraging existing international experience and accounting for European specifics.
- ENISS should ensure appropriate interfaces with WENRA and ENSREG to enable common understanding and inputs to the development of the guideline.

**[B] The European Commission acknowledges the importance of harmonisation in this field and should support Member States to review and, where necessary, adapt their existing national legal and/or regulatory frameworks to enable greater use of high-quality industrial grade items in certain safety-classified applications.**

An important enabling step is to ensure that national legislation, rules and regulations do not specifically preclude the use of high-quality industrial grade items in nuclear installations.

Enabling actions include:

- The European Commission should encourage further dialogue between Member States on this subject and the European guideline.
- The European Commission should include significant contributions to this subject in European Commission work programmes such as those under DG ENERGY and the Joint Research Centre (JRC). This could include support for workshops with regulatory bodies, licensees and suppliers.

**[C] EU Member States and other European countries should develop national guidance for the use of high-quality industrial grade items based on the common European guideline where necessary.**

Where desired or necessary, additional supporting activities to endorse and allow the use of the European guideline could be delivered with support from Member States and other European country stakeholders.

Enabling actions include:

- Member State level stakeholders should support collaborative workshops between regulatory bodies, licensees and supply chain representatives.

**[D] With the goal of harmonising to provide the basis for a larger market and more efficient interfaces with suppliers, licensees should review their existing procedures. The European guideline, by presenting a common methodology, can support the development of these procedures.**

Licensees should review their existing procurement procedures and challenge any requirement that is no longer relevant and constitutes a barrier for the use of high-quality industrial grade items. Thus, nuclear operators should establish their own processes, procedures and workflows for implementing the new European guideline and local requirements into their management systems.

Enabling actions include:

- License holders and national regulators should hold workshops and maintain continuous dialogue to establish best practices for the acceptance and use of high-quality industrial grade items.

In addition, FORATOM believes that a further assessment of nuclear industry supply chain practices through comparisons between licensee practices (technical and process-wise), feedback from suppliers and benchmarking against other high-quality industries will lead to the identification of additional optimisation solutions. The FORATOM SCOWG recommends that:

**[E] The European nuclear industry should carry out a self-assessment to identify additional optimisation solutions, particularly around the harmonisation of requirements and manufacturing best practices, to broaden the nuclear supply chain and secure high levels of quality and reliability.**

Enabling actions include:

- The European nuclear industry should conduct an assessment of the interaction between management systems and supply chain management practices. This could include dedicated workshops and analysis of procurement best practices.
- The European nuclear industry should analyse areas for the harmonisation of technical requirements used within nuclear projects (including design, manufacturing and construction codes and standards).
- The European nuclear industry should perform an analysis of quality management practices and requirements used within other high-quality industries, including benchmarking and assessment of areas of harmonisation.

## APPENDIX 1: PERSPECTIVES FROM EUROPEAN SUPPLY CHAIN PROJECTS AND INITIATIVES

The following table has an overview of related projects, initiatives and/or the use of non-nuclear standard equipment within European nuclear installations<sup>44</sup>.

Country	Project or Initiative	Scope	Main Conclusions/Outcomes
<b>Belgium</b>	Equipment qualification and obsolescence” project <sup>45</sup> (EQO), common between ENGIE Electrabel, Tractebel ENGIE and Bel V.	<p>Equipment Qualification and Obsolescence.</p> <p>Use of components qualified under other regulatory systems.</p> <p>Use of CGD is viewed to be possible for certain sub-components / equipment applications but is not readily used and is being reviewed.</p> <p>Use of additive manufacturing for reverse engineering.</p>	<p>Challenges exist due to the existence of specific Belgian qualification rules, requiring additional efforts to be able to use components qualified according to American, French or German rules in Belgian power plants, combined with the fact that the size of the Belgian market for qualified material is limited.</p> <p>Dialogue between license holders and regulatory authorities.</p> <p>Seeking solutions to the existing challenges faced by the customer and suppliers in Belgium due to specific qualification rules.</p>
<b>Czech Republic</b>	CGD item implementation according to EPRI guideline in CEZ Nuclear division started in 2016.	<p>Use of CGD for safety class 2 or 3 parts and components. Scope may be increased to safety class 3 equipment.</p> <p>Development of company procedures and best practice for implementation of high-quality industrial grade items.</p>	<p>Pilot project of real procurement SSC of class 3 underway.</p> <p>Dialogue between license holders and regulatory authorities.</p>
<b>Finland</b>	KELPO. <sup>46</sup>	<p>Streamline the licensing and qualification processes with a focus on enabling increased use of high-quality industrial-standard equipment across the Finnish Nuclear licensees.</p> <p>Use of CGD is possible.</p>	<p>Pilot project of real procurement underway.</p> <p>Dialogue between license holders and regulatory authorities<sup>47</sup>.</p> <p>Harmonisation between utilities for use of high-quality industrial grade standard equipment.</p>

<sup>44</sup> This list is not a bounding description or picture of the situation in all countries. It is used to show the diversity and level of interest in addressing issues with the nuclear supply chain across the countries listed. It highlights that commonality exists in many countries and this could be harnessed to achieve support for a common European guideline on the use of high-quality industrial items.

<sup>45</sup> [Belgium National Report, Eighth Meeting of the Contracting Parties to the Convention on Nuclear Safety, 2019.](#)

<sup>46</sup> [KELPO Project Overview](#): The purpose of the KELPO-project initially carried out in its first phase in 2018 is to suggest ways to develop the licensing and qualification practices in Finland. The Project is a co-operation of the Finnish license holders/licensees, to which also the Finnish nuclear authority STUK participated... The Project has focused on mechanical equipment in lower safety classes as well as on the Finnish licensing framework. However, the goal is to utilize the results in EU-level development work later. The objectives of the Project were set as: widening the use of the graded approach principle, utilizing standard equipment and securing a comprehensive supplier network as well as increasing co-operation between license holders.

<sup>47</sup> Finnish 8th national report as referred to in Article 5 of the Convention on Nuclear Safety, 2019: Addressing the potential challenge related to the too stringent regulatory requirements preventing licensees to find suppliers to provide structures, systems and components needed for plant modifications and maintenance. Finnish licensees have established a project (KELPO) in which this challenge is partly being resolved by piloting the use of industrial standard components in safety class 3 applications.

Country	Project or Initiative	Scope	Main Conclusions/Outcomes
<b>France</b>	<p>Manufacturing Monitoring.</p> <p>EDF – Framatome working group on qualification of suppliers.</p> <p>RTI 2 programme management of engineering technical references<sup>48</sup>.</p> <p>Strategic decision to increase the percentage of commercial grade valves procured from manufacturers.</p>	<p>Procurement of sub-components of an Emergency Diesel Generator system using CGD.</p> <p>Program to harmonise the process of qualification of suppliers between EDF and Framatome.</p> <p>This program will challenge, simplify and move the technical references used in engineering and procurement closer to industrial standards.</p>	<p>Manufacturing inspection adapted to manufacturer constraints.</p> <p>Ongoing project with aim of defining a shared methodology.</p> <p>New industrial policy adopted by EDF.</p>
<b>Romania</b>	<p>Supplier guide under development.</p> <p>Improved methodology of quality class grading.</p> <p>A range of supply chain programmes and obsolescence management activities to tackle the replacement and refurbishment of certain equipment<sup>49</sup>.</p>	<p>Enabling potential suppliers to better understand the procurement processes at Cernavoda NPP. Including, expectations of the national nuclear regulator, qualification requirements and whether their existing authorisations can be suitable.</p> <p>Enabling a better grading of quality requirements for spare parts / components of existing equipment and systems.</p> <p>Use of CGD is possible.</p>	<p>Initial findings highlight suppliers who do not have a clear picture at the bidding stage of what is required from them to have a national regulator authorisation or just to work under their own equivalent QMS program.</p> <p>There are challenges for spare parts / sub-components to have the same system / equipment quality requirements. In many cases this adds a restriction which even the OEM cannot provide. Benchmarking at other CANDU NPPs, improved methodology to be presented to the National Regulator.</p> <p>Ongoing use of CGD with focus on availability of component/parts, their quality and development of best practice.</p>

<sup>48</sup> [EDF Reference Document 2018, 1.4.1.2.3](#), SWITCH Programme: The programme seeks to mark a turning point in engineering by: transforming and simplifying processes and methods to better grasp the complexity of large-scale industrial projects throughout their lifecycle by applying systems engineering standards, among other methods; digitise processes using a data-centric approach based on an integrated, collaborative and industrial high-performance information system within an extended enterprise model.

<sup>49</sup> [8th National Report under the Convention on Nuclear Safety, 2019](#): 18.4: When selecting a manufacturer's standard product, the design is subjected to review and/or testing to demonstrate the satisfactory performance of the item. Alternatively, to ensure satisfactory performance of the item, the design authority may evaluate the manufacturer's evidence of verification.

Country	Project or Initiative	Scope	Main Conclusions/Outcomes
<b>Slovenia</b>	CGD has been established for a number of years (1995).	<p>Implementation of international best practice within company CGD methodology procedures. Based on the original EPRI 5652 guidance, subsequent revisions and supporting reports.</p> <p>Development of know-how, capabilities, relationships with third party qualifiers and improvements in procurement lead times and deliveries.</p>	<p>Ongoing use of CGD with focus on availability of component/parts, their quality and development of best practice.</p> <p>CGD prerequisite is availability of critical characteristics (design and acceptance), acceptance criteria and methodology for verification.</p> <p>Due to the technology origin, CGD process is in accordance to USA NRC regulatory requirements. This enables cooperation with USA Utilities and participation in joint efforts.</p> <p>In the future cooperation on harmonising regulatory requirements USA/EU in order to cooperate with EU utilities.</p>
<b>Spain</b>	CGD is an established and allowed method for commercial grade item acceptance.	<p>Use of CGD is established and supported by national regulatory guidance<sup>50</sup>. Regulation on CGD is published by CSN: Security Guide 10.8 (Rev. 1) Quality assurance for the management of elements and services for nuclear facilities<sup>51</sup>.</p>	<p>Ongoing use of CGD<sup>52</sup> and the development of national best practice.</p> <p>Standard: Use of commercial quality elements in applications related to the safety of nuclear facilities<sup>53</sup>.</p> <p>Guidelines for Dedication of Commercial Grade Components in Nuclear Power<sup>54</sup>.</p>

<sup>50</sup> [Spain National Report, Convention on Nuclear Safety, 2019](#): 13.6: In recent years, quality assurance evaluation and inspection has focused in particular on the following: Management and use of spare parts in safety systems: acquisition of alternative spare parts, management of spare parts in warehouses, activities to prevent work orders being postponed due to lack of spare parts, purchase of nuclear class spare parts and purchases of commercial grade spare parts, and carrying out the corresponding dedication processes.

<sup>51</sup> [Guía de Seguridad 10.8 \(Rev. 1\) Garantía de calidad para la gestión de elementos y servicios para las instalaciones nucleares.](#)

<sup>52</sup> [Application for Authorization of the Modification of Update Design for the Control of Auxiliary Feeding Water..., Centrales Nucleares Almaraz-Trillo AIE \(CNAT\)](#). Within the CNS report it is stated "the CNAT request for authorization of the design modification related to the update of the AFW turbo pump control in the Almaraz CN, units I and II and approval of the official documents affected by the modification. The documentation included CGD report: CGDR 11N8670/1. Commercial Grade Dedication Report for Class I E Qualified Dresser Rand Positioner. Rev. 3. Furthermore, it is stated in 2016 the additional report was submitted EPRI-TR 106439 "Commercial Grade Dedication of a Digital Valve Positioner. Assessment against EPRI Methodology".

<sup>53</sup> [UNE 73-403-95 Utilización de elementos de calidad comercial en aplicaciones relacionadas con la seguridad de instalaciones nucleares.](#)

<sup>54</sup> [UNE 73-104-94 Guía para la dedicación de componentes de grado comercial en centrales nucleares.](#)

<sup>55</sup> KSKG Position Paper - Application of Standard Equipment, 2018. Report defines the Swedish nuclear safety industry's (KSKG) position on an enhanced opportunity to use Standard Equipment in nuclear installations in Sweden. Standard Equipment includes equipment provided according to nuclear standards as well as equipment provided according to industry standards.



Country	Project or Initiative	Scope	Main Conclusions/Outcomes
<b>Sweden</b>	Swedish National Supply Chain Project.	To implement a process for the use of high-quality industrial items. <sup>55</sup>  Shared supplier audit cooperation between the Swedish licensees. <sup>56</sup>	Pilot procurement of isolation valve in safety class 2 completed.  Implementation of a CGD process underway.
<b>Switzerland</b>	Plant Supply. <sup>57</sup>	A joint procurement concept for increased efficiency, potentials and to take advantage of existing synergies.  Currently pursuing / following international projects (EU, FORATOM) to have further basis for establishing national approaches and projects. This could also lead to contributions to European efforts in the future.	Project is ongoing. Generally, due to different power plant types constructed by different vendors which are based on a mix of ASME and KTA, in combination with Swiss regulation, there is the necessity for an improved supply chain management and procurement process.  However, due to the unique aspects of the situation in Switzerland, approaches in other countries cannot be mapped 1-1 although the general principles may apply for Switzerland. Swiss nuclear operators continue to pursue supply chain optimisation in individual and common approaches.
<b>United Kingdom</b>	Fit4Nuclear. <sup>58</sup>	Supports UK manufacturing companies enter and bid for work in the nuclear supply chain.	More than 730 companies have engaged in the programme.  Enabled companies measure their operations against the standards required to supply the nuclear industry (new build, operations and decommissioning) – and take the necessary steps to close any gaps.
<b>Ukraine</b>	CGD approach is currently not used.	Currently investigating suitable ways to optimise the supply chain.	Expect involvement of Regulatory Body.

<sup>56</sup> [Sweden's Eighth National Report under the Convention on Nuclear Safety, 2019](#): 13.2.3. Audits of suppliers are carried out jointly and in cooperation between the Swedish licensees. Swedish licensees have a joint working group for shared development of procedures and methods for supplier audits. The working group meets two or three times per year. A shared procedure is used for executing a supplier audit, which is maintained and developed as a collaborative effort between the Swedish licensees.

<sup>57</sup> [Plant Supply](#) Project in Switzerland.

<sup>58</sup> [Nuclear Advanced Manufacturing Research Centre, Fit4Nuclear](#) Participating companies range from contract manufacturers with no nuclear experience aiming to take a first step into the sector, to established suppliers wanting to benchmark their position and drive business excellence.

## LIST OF ACRONYMS

AFCEN	Nuclear Design Code Standards ( <i>France</i> )
API	American Petroleum Institute standards
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CGD	Commercial Grade Dedication
CORDEL	Cooperation in Reactor Design Evaluation and Licensing
DiD	Defence-in-Depth
EC-JRC	European Commission's Joint Research Centre
EPRI	Electric Power Research Institute
EN	European Standards
ENISS	European Nuclear Installations Safety Standards network
EU	European Union
GOST	Nuclear Regulatory Standards ( <i>Russia</i> )
IAEA	International Atomic Energy Agency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
ISA	International Society of Automation
ISO	International Organization for Standardization
KTA	Nuclear Safety Standards Commission ( <i>Germany</i> )
LTO	Long Term Operation
MDEP	Multinational Design Evaluation Programme
NRC	Nuclear Regulatory Commission ( <i>of the United States</i> )
NUPIC	Nuclear Procurement Issues Corporation
QC	Quality Control
QA	Quality Assurance
SC	Safety Class
SCOWG	Supply Chain Optimisation Working Group ( <i>of FORATOM</i> )
SSC	Structures, Systems and Components
VICWG	Vendor Inspection Co-operation Working Group ( <i>of the OECD-NEA</i> )
WENRA	Western European Nuclear Regulators Association



Avenue des Arts 56

1000 Brussels

tel +32 2 502 45 95

[foratom@foratom.org](mailto:foratom@foratom.org)

[www.foratom.org](http://www.foratom.org)

