MDEP TR-CSWG-01 Technical

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Technical Report
TR-CSWG-01

Related to: Codes and Standards Working Group

Technical Report:
Regulatory Frameworks for the Use of Nuclear Pressure Boundary Codes and Standards in MDEP Countries

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1. Background

The Codes and Standards Working Group (CSWG) is one of the issue-specific working groups that the MDEP members are undertaking; its long term goal is harmonisation of regulatory and code requirements for design and construction of pressure-retaining components in order to improve the effectiveness and efficiency of the regulatory design reviews, increase quality of safety assessments, and to enable each regulator to become stronger in its ability to make safety decisions. The CSWG has interacted closely with the Standards Development Organisations (SDOs) and CORDEL[1] in code comparison and code convergence. The Code Comparison Report STP-NU-051 has been issued by SDO members to identify the extent of similarities and differences amongst the pressure-boundary codes and standards used in various countries.

Besides the differences in codes and standards, the way how the codes and standards are applied to systems, structures and components also affects the design and construction of nuclear power plant. Therefore, to accomplish the goal of potential harmonisation, it is also vital that the regulators learn about each other's procedures, processes, and regulations. To facilitate the learning process, the CSWG meets regularly to discuss issues relevant to licensing new reactors and using codes and standards in licensing safety reviews. The CSWG communicates very frequently with the SDOs to discuss similarities and differences among the various codes and how to proceed with potential harmonisation. It should be noted that the IAEA is invited to all of the issue-specific working groups within MDEP to ensure consistency with IAEA standards.

Throughout this document, for brevity, member states' national nuclear safety regulators are referred to as "regulators."

2. Purpose and Scope

The primary focus of this technical report is to consolidate information shared and accomplishments achieved by the member countries. This report seeks to document how each MDEP regulator utilises national or regional mechanical codes and standards in its safety reviews and licensing of new reactors. The preparation of this report, together with code comparison, could be an appropriate starting point for exploring potential harmonisation efforts. Sources of information contained in this report are from the CSWG representatives and information discussed in MDEP CSWG meetings and documents shared between member countries. This technical report would be beneficial to (1) current MDEP member countries as a reference and (2) other non-MDEP regulators or technical support organisations.

[1] Cooperation in Reactor Design Evaluation and Licensing (CORDEL) working group of the World Nuclear Association (WNA)

3. Importance of Codes and Standards to Government Regulators

Codes and standards play an important role by providing a sound and consistent technical basis in ensuring the safety of nuclear power plants. In many MDEP countries, the regulator adopts or approves codes and standards that are developed by standards developing organisations (SDOs) or an equivalent organisation from its country or from other countries. The development of rules for codes and standards are often accomplished through a voluntary consensus process by various organisations (e.g. utilities, constructors, inspection agencies, vendors, architect-engineers, industry consultants, academia, and regulators). Using a voluntary consensus process can benefit government regulators by eliminating the effort and cost that would be needed to develop government-unique standards. In addition, using a voluntary consensus process for developing rules for codes and standards provides improved efficiency, transparency and high-technical quality that come from soliciting diverse views from a group of technical experts with vast experience and working knowledge. In this manner, codes and standards, such as those requiring complex design and construction rules for pressure-boundary components, are developed from a broad range of perspectives that represent common industry practice and incorporate a practical understanding of how these rules will be implemented.

These voluntary consensus codes and standards are a key part of the framework used to establish the necessary design, fabrication, construction, testing, and performance requirements for structures, systems, and components important to safety. Participation by regulatory bodies in the development of voluntary consensus codes and standards provides an opportunity for regulators to ensure that safety views are incorporated and codes and standards are consistent with regulatory positions and requirements.

4. Definitions

The following definitions apply to these arrangements and are intended to provide clarity of understanding.

4.1. *Harmonisation* – with respect to the CSWG work on mechanical codes and standards, harmonisation is a framework or process by which different countries can achieve convergence and a reconciliation of differences with code requirements in order to ensure an acceptable level of quality and safety in nuclear power plants.

4.2. *Convergence* **–** the process of establishing the same or equivalent code requirements in order to increase the areas identified as “same” or “equivalent,” as identified by the Standards Development Organisations (SDOs) in their Code Comparison Report (ASME STP-NU-051).

4.3. *Reconciliation* – the means to accept differences in code requirements by justifying their acceptability.

5. MDEP Country Practices in Using Codes and Standards

5.1. Canada

Using Codes and Standards under CNSC Regulatory Framework

The Canadian Nuclear Safety Commission (CNSC), established under the *Nuclear Safety and Control Act* (NSCA)[2], regulates to protect the health, safety and security of Canadians as well as the environment, and to respect Canada's international commitments on the peaceful use of nuclear energy. CNSC has developed an effective and flexible practice in using codes and standards under the regulatory framework.

CNSC Regulatory Framework

The NSCA gives the CNSC the power to licence, and states that any persons wishing to carry out nuclear-related activities in Canada must first obtain a licence from the CNSC. The NSCA authorises the CNSC to attach any conditions to licences that it deems necessary to meet the NSCA’s requirements; and authorises the CNSC to make regulations and to develop other regulatory tools to establish requirements for, and provide guidance to the use of nuclear energy and materials in Canada.

Based on the NSCA, the CNSC developed and maintains an effective and flexible regulatory framework which consists of (Figure 1):

- NSCA;
- Regulations and by-laws that the Commission has put into place;
- Licences, certificates, licence conditions and orders;
- Documents (including codes and standards) that the CNSC uses to regulate the industry.

These regulatory framework elements fall into two categories: ***Requirements*** and ***Guidance***.

Requirements are mandatory; licensees or applicants must meet them in order to obtain or retain a licence or certificate to use nuclear materials or operate a nuclear facility. ***Guidance*** provides direction to licensees and applicants on meeting requirements.

Codes and Standards under the Canadian Regulatory Framework

Under the CNSC regulatory framework, codes and standards become legal requirements and have the full force of law only if they are incorporated by reference into Licence as Licence Conditions.
Foreign codes and standards are allowed to be used as long as they are referred to in the Licence. In order to do this, CNSC staff identifies and evaluates the applicability, adequacy and sufficiency of codes and standards, and determines which codes and standards to be referred to in the Licence and Licence Conditions. The codes and standards are seen as the minimum requirements for nuclear facilities;

[2] Laws passed by Canadian Parliament that govern the regulation of Canada's nuclear industry which serves as the enabling legislation.

whenever is needed, they may be supplemented[3] or even modified by staff to assure the required level of safety.

CNSC Accepted Codes and Standards

CSA[4] standards are the main source of accepted standards that CNSC usually refers in the regulatory practice[5]. The rationale is summarised as below:

- The Canadian nuclear industry is organised around a unique reactor design and the CSA standards specify the rules and material provisions for the design, fabrication, installation, quality assurance, and inspection and fitness-for-service assessment of pressure-retaining components and supports in CANDU nuclear power plant (NPP). Similar rules and provisions are not available or not sufficient in other codes and standards.

- CSA standards establish provisions in a format that CNSC can easily reference. CNSC regulates Canadian nuclear industry through licensing, and places the full responsibility for adherence to the CNSC requirements on licensees or applicants. The provisions of the CSA nuclear standards are also directed to the licensee even though the actual performance of most of the work is done by others. However other codes and standards may be different; for example, ASME Section III is directed to the construction of components and places the responsibility for adherence to the requirements on the Certificate Holders.

- Although the CSA standards reflect the views of all participants and are developed by a consensus process that requires substantial agreement among committee members rather than a simple majority of votes[6], the users of the CSA Nuclear Standards are reminded that the design, fabrication, installation, commissioning, and operation of nuclear facilities in Canada are subject to the NSCA provisions and the CNSC Regulations. If provisions in CSA Standards conflict with CNSC requirements, the CNSC requirements take precedence.

It has to be noted that the CSA standards make reference to many provisions of the ASME Code where they are applicable to CANDU NPPs.

Both CSA standards and ASME codes further reference many other Canadian or US industry standards that contain technical guidelines, common industry practices, performance criteria, and recommended safety approaches. CNSC supplementary requirements may cite the industry standards other than those referenced in CSA standards and applicable ASME codes. All these indirectly cited industry standards are treated as a best industry practice, approach or method that is acceptable to the CNSC for implementing its regulations.

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[3] CNSC Staff Review Procedures contain many supplementary provisions.
[4] Canadian Standards Association.
[5] Other regulatory agencies in countries where CANDU plants have been built, have also incorporated the CSA standards in their regulatory regime.
[6] As a member, CNSC only has one vote in the CSA nuclear committee.

Using Alternative Codes and Standards

The CNSC regulatory framework allows Licensees in Canada to purchase components or build new NPP using any alternative codes and standards, as long as they demonstrate that the alternative provides an equivalent level of quality and safety and, ultimately, ensures the compliance with CNSC regulatory requirements.

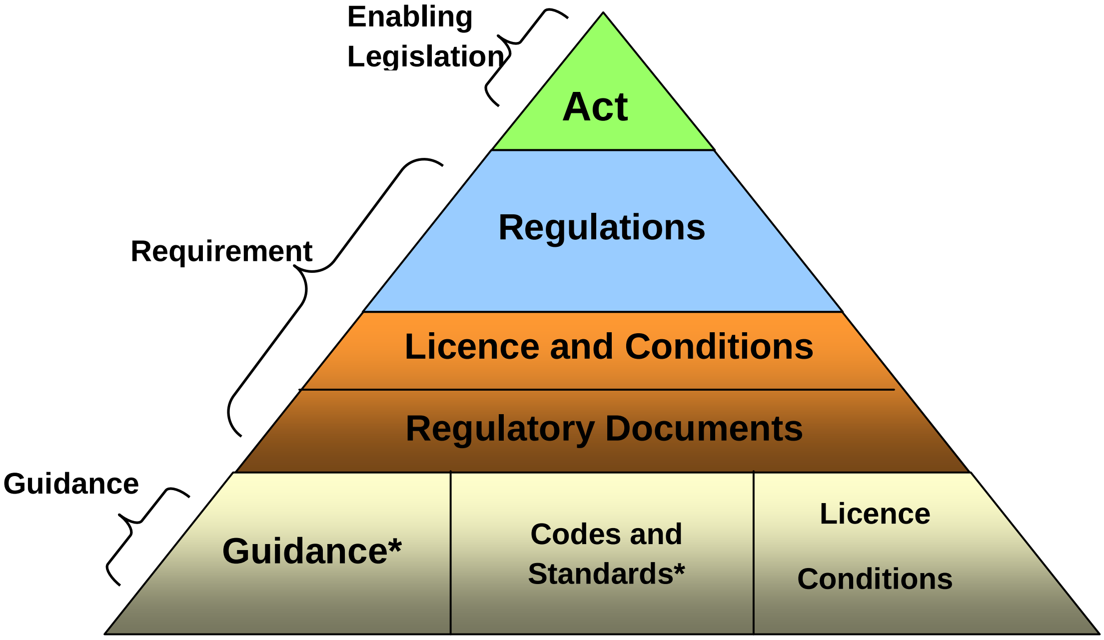


Figure 1: Elements of the CNSC Regulatory Framework

5.2. China

Nuclear Safety in China's Legislative and Statutory Framework

Ministry of Environmental Protection (MEP), also being called National Nuclear Safety Administration (NNSA), is China's regulator that is independent from promotion of nuclear industry. MEP is assigned with adequate authority and power for authorization, regulatory review and assessment, inspection and enforcement, and establishing safety regulations. At the very beginning, China decided to establish legislative system on nuclear safety and radiation safety by referring the IAEA recommendations.

Using Code and Standards under China's Nuclear Safety Regulatory Framework

China's nuclear safety regulatory framework can be illustrated as in Figure 2. Along with this is a hierarchy of the industrial standards illustrated as in Figure 3.

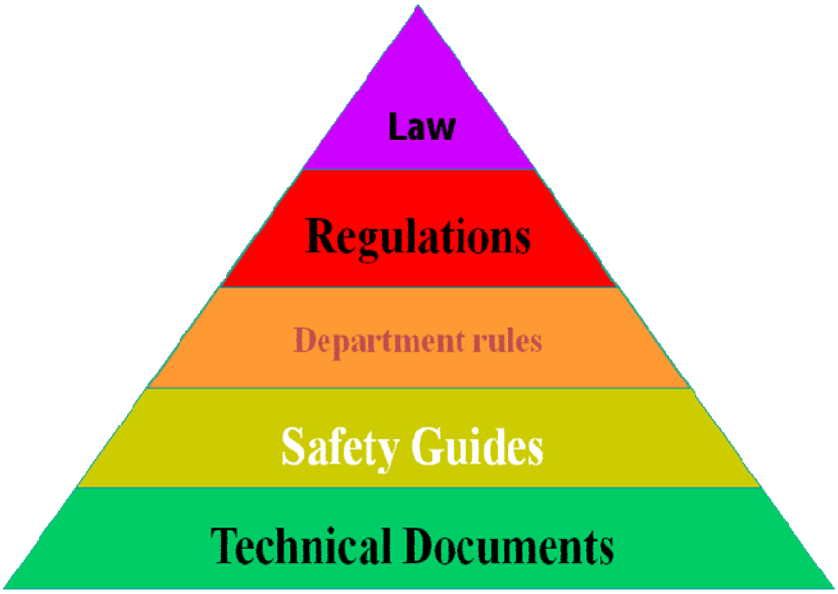


Figure 2: Schematic Illustration of China's Nuclear Safety Regulatory Framework

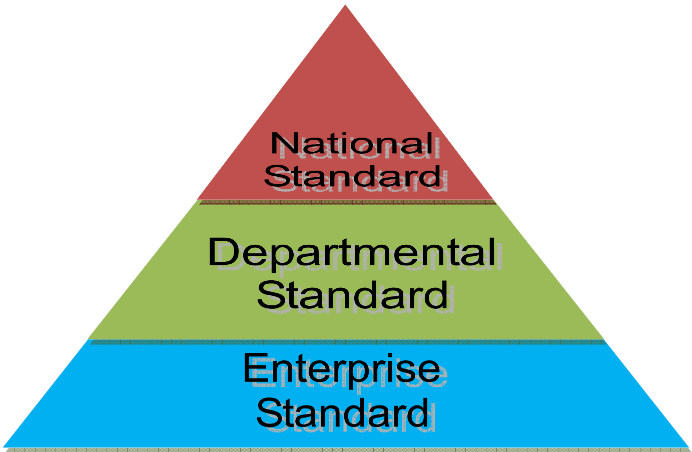


Figure 3: Schematic Illustration of China's Industrial Standards

Laws are issued by the National People's Congress and regulations are issued by the State Council. Departmental rules, safety guides and technical documents are issued by the Ministry of Environmental Protection (NNSA). National standards are issued, usually jointly with other Departments, by the Standardisation Administration. Departmental standards are issued by the relevant Departments of the State Council.

Laws, regulations and rules are all mandatory. Safety guides are recommendatory, but are often regarded as mandatory because of the following statement in the guides: "*This Guide is directive. Means or methods other than those in this guide may be used providing that a safety level of the used means of methods is justified no lower than that of this guide.*" Technical documents are informative. National standards are effective nationwide and departmental standards are effective only within the Department power spheres. Both national and departmental standards split into two categories, mandatory and recommendatory.

"Regulations on Supervision and Control of Civil Nuclear Safety Equipment", issued by the State Council in 2007, specifies "*the standards for civil nuclear safety equipment*" as "*the technical basis for the design, manufacture, installation and non-destructive test of civil nuclear safety equipment.*" The State establishes a sound system for standards for civil nuclear safety equipment. The standards for civil nuclear safety equipment consist of national standards, departmental standards and enterprise standards. The nuclear safety regulatory department of the State Council shall organise the formulation of the national standards that are related to the basic principles and technical requirements for nuclear safety, and publish such standards jointly with the department of the State Council in charge of standardisation. The other national standards for civil nuclear safety equipment shall be formulated by the department of the State Council in charge of the nuclear industry, and shall be published by the department of State Council in charge of standardisation upon approval by the nuclear safety regulatory department of the State Council. The departmental standards for civil nuclear safety equipment shall be formulated by the department of the State Council of the nuclear industry, published by the department upon approval by the nuclear safety regulatory department of the State Council, and submitted for the record to the department of the State Council in charge of standardisation.

Where the national or departmental standards for civil nuclear safety equipment have not been formulated yet, the unit for design, manufacture, installation and non-destructive test of civil nuclear safety equipment shall apply the standards approved by the nuclear safety regulatory department of the State Council.

China's Practices regarding the Usage of Nuclear Safety Equipment Standards

Qinshan Nuclear Power Plant is the first in China and its construction was started before the foundation of NNSA. The design and construction Standards and Norms used were mainly American supplemented by domestic ones. Reparative safety review mainly relied on US NRC documents.

NNSA, after its foundation, started its own regulatory Codes and Guides system mainly based on those of IAEA. The Codes and Guides here correspond to Department Rules and Safety Guides in Figure 2. For imported nuclear power plants, NNSA, in the early stage, generally accepted design and construction standards of the country exporting the NPP with a prerequisite that the four regulatory Codes (siting, design, operation and quality assurance) issued by NNSA must be satisfied. The accepted standards include RCC-M, ПНАЭ Г and ASME etc.

The domestic Qinshan Phase II was based on Daya Bay, but with significant modifications. NNSA accepted RCC series for design and construction of Qinshan Phase II. Other countries' design and construction codes and standards should be used in combination of some additional requirements, if a gap to RCC requirements is identified.

For the presently prevailing domestic NPPs, NNSA accepts the following principles. All the currently effective laws, regulations, department rules on the NPP safety and environmental protection issued by Chinese government must be observed. Safety guides shall also be observed in principle. The French RCC series shall be applied with necessary modifications in need of self design and localisation of fabrication. For the components purchased in foreign countries, the applied codes and standards should be at least equivalent to the French RCCs. For exceptional conditions, design and construction codes or standards other than RCC series can be used, provided that the mandatory safety requirements are justified not to be compromised.

For Sanmen and Haiyang nuclear power plants, imported from America, the following principles were used in safety review. All the currently effective laws, regulations, and national mandatory standards on the NPP safety and environmental protection issued by Chinese government must be observed. Departmental rules shall also be observed in principle. Regulatory guides should be referenced and different methodologies can be used with justification that the safety requirements will not be compromised. American Laws and CFRs applicable to AP1000 may be used in the safety review. NNSA accepts design and construction codes and standards listed in the NRC approved AP1000 DCD, including ASME, ASTM, IEEE and others. The use of design and construction codes different from those in the DCD should be justified case by case, or they should have been accepted by NRC.

For Taishan nuclear power plant, imported from France, the following principles were used in safety review. All the currently effective laws, regulations, and national mandatory standards on the NPP safety and environmental protection issued by Chinese government must be observed. Departmental rules shall also be observed in principle. Regulatory guides should be referenced and different methodologies can be used with justification that the safety requirements will not be compromised. Relevant Decrees in Europe, practices of and accepted methodologies by French nuclear regulatory body, and relevant nuclear safety guides in the world may be used as references. Other standards or norms popular in the world may also be used with the agreement of NNSA, and with special care taken to harmonise the interfaces.

Looking to the future

China will definitely have its own self-designed, self-constructed and self-operated nuclear power plants. A nation-wide project for nuclear power plant design and construction standard is in process and fruitful till now. The use of domestic standards will be very much encouraged for new design reactors. For NPPs having a reference design and also with evolutionary modifications, the preferable selection should be the use of same standard series with that of its reference plant.

5.3. Finland

Overview of regulations and practices in Finland governing the application of mechanical codes and standards in nuclear power plants

STUK's regulatory work and oversight related to nuclear reactors is based on Nuclear Energy Act (990/1987). The guiding principle is given in Section 7a of the Act and it is:

> *"The safety of nuclear energy use shall be maintained at as high a level as practically possible. For the further development of safety, measures shall be implemented that can be considered justified considering operating experience and safety research and advances in science and technology."*

More detailed safety requirements are presented below (Nuclear Energy Act, Section 7r):

> *"The Radiation and Nuclear Safety Authority (STUK) shall specify detailed safety requirements concerning the implementation of safety level in accordance with this Act.*
> *Further, the Radiation and Nuclear Safety Authority (STUK) shall specify the safety requirements it sets in accordance with the safety sectors involved in the use of nuclear energy, and publish them as part of the regulations issued by the Radiation and Nuclear Safety Authority (STUK).*
> *The safety requirements of the Radiation and Nuclear Safety Authority (STUK) are binding on the licensee, while preserving the licensee's right to propose an alternative procedure or solution to that provided for in the regulations. If the licensee can convincingly demonstrate that the proposed procedure or solution will implement safety standards in accordance with this Act, the Radiation and Nuclear Safety Authority (STUK) may approve procedure or solution by which the safety level set forth is achieved."*

The act is supplemented with several decrees. The most important of those is the Nuclear Energy Decree (161/1988). In the hierarchy, on the top is the Nuclear Energy Act, below that are the decrees and below the decrees are the national regulations, the so called YVL-guides, which contain also practical rules and guidelines to perform the regulatory work. Because the YVL-guides are written at STUK, it is possible in some cases to make decisions that may slightly differ from the guides, if the required safety level is achieved.

In Finnish YVL-guides the components are divided into 4 safety classes (SC 1-4) based on their safety significance. Safety classified (SC 1-4) pressure equipment is defined as nuclear pressure equipment. Equipment that has no safety significance is an ordinary (conventional) pressure equipment (EYT). The classification follows practically the classification of ASME (US NRC) and RCC-M.

Complete renewal of STUK's regulatory (YVL) guides is underway. The old guides are applied to the operating power plants and also to Olkiluoto 3 (OL 3), which is under construction. The new guides will be applied when new nuclear power plants will be licensed. The differences between the old and new guide series are more or less in the structure of the guide system, not so much in the substance. Especially series E of the new guides is devoted to design and manufacturing of components:

- E.1: Inspection, testing and certification organizations
- E.3: Pressure vessels and piping
- E.4: Pressure equipment strength analyses
- E.5: Pressure equipment in-service inspections

E.6: Steel and concrete structures
E.8: Valve units
E.9: Pump units
E.11: Lifting devices

STUK's duties in Pressure equipment (PE) surveillance are shown in table 1. The main ideas from the table 1 are given below:

- Approves Construction Plans of nuclear PE;
- Approves the manufacturers of nuclear PE;
- Approves the inspection and testing organisations to carry out control of PE;
- Gives detailed requirements for the safety of nuclear PE;
- Gives detailed requirements for the manufacturing and quality assurance of nuclear PE;
- Controls and inspects the design, manufacturing, installation, operation, maintenance and repair of nuclear PE;
- Controls and inspects the installation, operation, maintenance and repair of ordinary PE;
- Gives requirements for the licensee to ensure the safety of PE and to control the adherence to all the requirements;
- The principles of STUK's control activities for PE are also applied to other mechanical equipment.

Design and manufacturing documents of each component constitute a Construction Plan. The Construction Plan should be submitted to STUK and normally it should have STUK's acceptance before start of manufacturing. Typically the Construction Plan contains such documentation as design basis, drawings, materials, strength analysis, hydraulic analysis, description of manufacturing, qualification, quality control and operating experiences.

The new strength analysis guide E.4 (current 3.5) addresses stress, brittle fracture and Leak before break (LBB) analysis and related monitoring activities. ASME III is a primary minimum requirement for stress analysis, but also other corresponding Codes may be deemed applicable if approved and applied in vendor's country. The current guide YVL 3.5 refers to:

- ASME II, III, XI (ed. 1995);
- RG 1.20, 1.154;
- SRP 3.6.2, 3.6.3;
- ANSI/ANS-58.2;
- ASTM E 1921;
- NAFEMS Quality Standards.

In the new guides also IAEA and WENRA guides will be added to the reference list and some obsolescent references will be omitted.

There have been some specific requirements in Finland so far. Thermal stratification, thermal cycling in cladding and environmental effects have to be considered in fatigue analysis. Design basis accidents (DBA) have been regarded as normal operation for consequently needed safeguard components. Commercial airplane crash is treated as a DBA. Both deterministic and probabilistic PTS analyses and Master Curve approach are applied for RPV. Quality management has been overseen via audits and also with comparative analyses performed by independent organisations or engineering offices.

French RCC-M was applied to OL3 design. It was in some cases supplemented with e.g. ASME, ANSI, KTA or EN. There are some distinguishing features that are still under discussion. A topical Report comparing RCC-M versus ASME was delivered and approved in the context of PSAR review. The plasticity correction for fatigue analysis is in RCC-M typically less conservative than in ASME. Load category 2 combines normal and upset conditions which are thus enveloped by the design pressure and temperature. Fast fracture analysis of Annex Z G also contains ductile tearing in case screening criteria are not met.

The following examples illustrate observed differences between different codes. These cases have emerged during the licensing of OL3 plant.

Example 1: Operability and functional capability
ASME III establishment of level A through D service limits is addressed in NCA 2140. For safeguards components, STUK interprets plant's emergency/faulted conditions as level B service if component's active function (operability) is required and C service if passive function (functional capability) is required.
RCC-M regards plant's 3rd/4th category (emergency/faulted) conditions as "*at least as severe as*" level C/D loads. KTA 2201.4 prescribes level B/C if active functional capability is required during/after the event, D if passive functional capability is required.

Example 2: Standard Piping Products
ASME III and RCC-M permit standard products (fittings) for Class 1 piping to be designed according to dimensional standards such as ANSI/ASME B16.9. This standard sets forth a proof test procedure to qualify the design, i.e. that the burst test pressure is at least as great as for equivalent straight pipe. One test, representative of the production, may qualify other fittings over a wide size and thickness range. Direct proportionality to tensile properties holds for fittings made from various grades of steel.
However, STUK finds this approach unsatisfactory. Representativeness e.g. between carbon steel and austenitic stainless steel fittings is unclear. Fitting wall thickness data is also needed to confirm representativeness and to enable construction inspection.

Example 3: Fast Fracture Analysis
RCC-M 2002 prescribes that brittle fracture analysis should be performed for ferritic steel vessels whenever the lowest operating temperature falls below the transition temperature RT_{NDT} +50°C. Otherwise the potential for ductile tearing shall be analyzed.
STUK decided that this standard application may not be limited to brittle fracture which would have been the sole YVL 3.5 requirement. The +50°C margin may be inadequate. Intermediate regime from RT_{NDT} +40°C to RT_{NDT} +60°C was defined where both types of mechanisms, brittle and ductile, shall be analyzed.

Example 4: LWR Environmental Effects on Fatigue
YVL 3.5 prescribes that the environmental effect shall be considered. ASME III design fatigue curve applications shall be justified. This was applied to operating plants as well when their license extensions were reviewed. For OL3 experimentally verified F_{en} factors were required. RG 1.207 endorses NUREG/CR-6909 methodology in combination with the new ANL air design curve for SS. ASME design

fatigue curve in air respectively changed in 2010 edition. OL 1 and OL 2 pilot study suggests that the air curve dominates change in BWR. STUK schedules to adopt RG 1.207 in the new YVL E.4.

Example 5: Leak-Before-Break
YVL 3.5 refers to SRP 3.6.3 procedure, alternatively MCL breaks shall be postulated according to SRP 3.6.2.
Due to missing national safety authority approval, LBB was not fully adopted to OL3 (EPR), but was combined with the WR concept of French N4s. Design extension analyses on RPV internals integrity in case of postulated MCL break became the third element of the DiP concept. Current international trends: Transition break size in USA, Germany updates Break Preclusion (BP) and prepares KTA 3206 on LBB, STUK is making LBB mandatory for the MCL, applications to MSL and MFWL are also foreseen. Dynamic effects of postulated MCL breaks could be fully eliminated. Further attention should be paid to technical and organisational BP measures.

Table 1. STUK's duties in Pressure equipment (PE) surveillance and control

STUK`s activities in PE surveillance and control

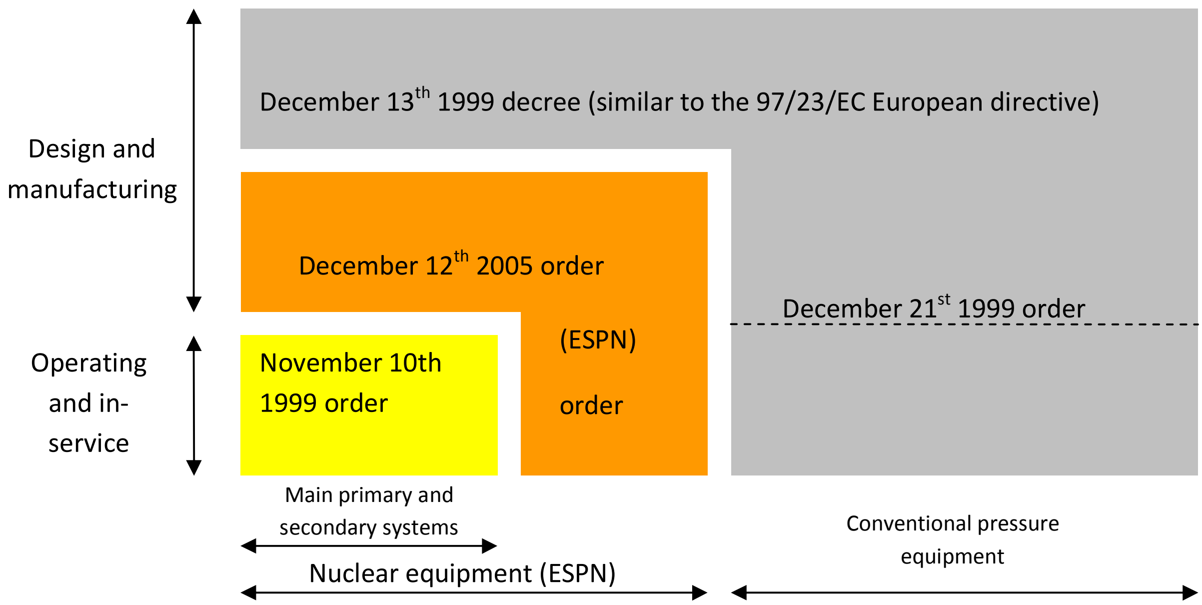
SURVEILLANCE	Safety classes 1-4 Nuclear pressure equipment	EYT Ordinary pressure equipment	Inspections	Safety classes 1	2	3	4	EYT Registered PE	Essential safety requirements	Sound engineering practice
PROCESS DESIGN	yellow	yellow								
CONSTRUCTIOPN DESIGN	yellow	grey	CONSTRUCTION PLAN	yellow	yellow	light cyan	light cyan	grey	grey	grey
PE MANUFACTURERS	yellow	grey	MANUFACTURING SURVEILLANCE	yellow	yellow	red	red	grey	grey	grey
INSPECTION COMPANIES	yellow	grey	CONSTRUCTION INSPECTION	yellow	yellow	light cyan	light cyan	grey	grey	grey
TESTING COMPANIES	yellow	grey	LOCATION PLAN	yellow	yellow	light cyan	light cyan	red	red	teal
AGEING SURVEILLANCE	yellow	yellow	INSTALLATION PLAN	yellow	yellow	light cyan	light cyan	red	red	teal
PLANS FOR PERIODIC INPECTIONS	yellow	yellow	INSPECTION OF INSTALLATION	yellow	yellow	light cyan	light cyan	red	red	teal
RESULTS OF PERIODIC INSPECTIONS	yellow	yellow	COMMISSIONING INSPECTION	yellow	yellow	yellow	yellow	yellow	red	teal
PE REGISTER	yellow	yellow	PERIODIC INSPECTIONS	yellow	yellow	red	red	red	teal	teal
REPAIR AND MODIFICATION PROCESS	yellow	yellow	REPAIR WORK PLANS	yellow	yellow	light cyan	light cyan	light cyan	red	teal
			INSPECTION OF REPAIR WORK	yellow	yellow	red	red	red	red	teal
			MODIFICATION PLANS	yellow	yellow	light cyan	light cyan	light cyan	red	teal
			INPECTION OF MODIFICATIONS	yellow	yellow	red	red	red	red	teal

yellow	STUK
red	Inspection company approved by STUK
light cyan	STUK or Inspection company approved by STUK
grey	Inspection company in accordance PE legislation
teal	Licensee´s inspection organisation

5.4. France

French regulatory framework overview

The French regulatory framework on pressure equipment is transposed from the European pressure equipment directive (PED) 97/23/EC. The December 13th 1999 decree, which is similar to the directive, was implemented by several regulatory orders. A specific order regulates the nuclear pressure equipment:



Conventional pressure equipment principles for design and manufacturing

Those principles are determined in the 97/23/EC European directive.

The directive defines essential safety requirements which have to be met by the equipments. The manufacturer is responsible for that. European harmonised standards can be used (e.g. EN-13445). If such standards requirements are met, the pressure equipment is presumed to comply with the safety essential requirements.

Above 0.5 bar, the directive applies to vessels, pipes, over-pressure protection devices, pressure accessories and assemblies of equipment. The equipment is classified by the level of pressure (categories 0 to IV).

The essential safety requirements are objectives, no technical means are determined to reach them, this is incumbent upon the manufacturer. The requirements can be summarised as follows:

- Design:
  - appropriate loads for intended use and reasonably foreseen operating conditions;
  - appropriate values for material properties;
  - account of all foreseen degradation mechanisms;
  - safety factors;
  - analysis (calculations) or experimental method;
  - over-pressure protection;
  - safety accessories adapted to conditions (resistance, reliability, redundancy, positive safety, …);
  - must allow in-service inspection;
- Materials:
  - appropriate for the lifetime of the equipment;
  - appropriate for welding;
  - compliance with European harmonised standards, or specific material appreciation;
- Manufacturing:
  - no defects, cracks, modification of material properties during manufacturing (thus, appropriate heat treatments must be applied);
  - welds and non destructive examinations must be performed through qualifications;
- Specific quantitative requirements:
  - allowable stress;
  - joint coefficient;
  - over-pressure protection devices;
  - hydrostatic test pressure;
  - ductility of materials.

A final conformity assessment procedure is performed under the control of an independent body.

Nuclear pressure equipment principles for design and manufacturing

The nuclear pressure equipment is regulated on the same basis as the conventional pressure equipment.

The French regulatory specific order (December 12th 2005) determines **additional requirements** to take into account the importance for safety of level 1 components and the importance of radioactive releases in case of failure of other components. These requirements provide a stronger guarantee of the quality of nuclear pressure equipments.

The equipment is classified in three decreasing levels N1, N2 and N3 according to the quantity of radioactivity that could be released in case of failure of the equipment and the importance for safety of theses equipments. For example, the main primary and secondary systems of the French PWR reactors classification is N1.

The highest requirements apply to nuclear pressure equipment classified N1 and pressure categories I to IV:

- Design:
  - hazard analysis;
  - must minimise the loss of integrity risk;

  - description of all the conditions and loads;
  - account of material ageing due to radiation exposure;
- Materials:
  - must not limit the possibility of non destructive examinations during manufacturing and operation;
  - certain mechanical properties must comply with given values;
  - the manufacturer must prove the conformity of the materials;
- Manufacturing:
  - requirements on forging and casting;
  - technical qualification of certain equipment to minimise the risk of heterogeneous material properties;
  - requirements on permanent assemblies and on weld metal overlay;
- Non destructive examinations:
  - on permanent assemblies;
  - 100% of the volume for pressure assemblies and for casting components;
  - must detect unacceptable defects;
  - visual examination of each final surface;
- Final conformity assessment:
  - the manufacturer must comply with the H procedure (quality assurance);
  - for each equipment, the final conformity assessment is the G procedure (detailed verification on every operation);
  - the final conformity assessment is performed by French regulator, ASN.

The codes and standards

The nuclear or conventional pressure equipment must “simply” comply with the safety essential requirements, by any means. This must be proved by the manufacturer.

During the first step of conformity assessment the manufacturer has to provide to the body in charge of conformity assessment a set of documents, including a list of all codes and standards he plans to use in order to meet essential safety requirements. The manufacturer also provides an analysis of all the dangerous hazards that can occur due to pressure and/or radioactivity and identify essential safety requirements to be applied to prevent those risks: a regulatory essential safety requirement only applies when the corresponding risk exists… but when the risk exists, the requirement has to be met.

The body in charge of conformity assessment should verify that the codes and standards chosen by the manufacturer include appropriate means to meet these requirements.

For the conventional pressure equipment, if the European harmonised standards are met, the pressure equipment is presumed to comply with essential safety requirements.

Except for the case above, the French regulation does not approve nor implement any code or standard. For example, the use of RCC-M code doesn’t imply that all essential safety requirements are met.

Role of the regulatory body (ASN or third part inspection body)

The regulatory body must ensure that essential safety requirements are taken into account. This can be achieved in two ways:

- an integrated part of a code (e.g. RCC-M Code) may explain the measures taken to meet the essential safety requirements,
  or
- the manufacturer may provide an analysis explaining how measures from a code meet the essential safety requirements (EDF/AREVA choice).

ASN's review can be performed for multiple components and can deal with various aspects (such as design and manufacturing).
For main primary and secondary systems' equipments (level N1 equipments), ASN actually assesses the capability of RCC-M code to fulfil essential safety requirements (since there is no formal approval of the code).

It should be noticed that the manufacturer sometimes specifies additional requirements in order to fulfil essential safety requirements. Those additional requirements are documented in several documents (equipment specification, internal parts technical specifications…).

For other equipment (level N2 and N3 equipments), the ASME code can be applied, but to fulfil the whole regulatory requirements, counterparts have to be defined by the manufacturer. Third-party bodies have to assess the capability of those counterparts to fulfil essential safety requirements.

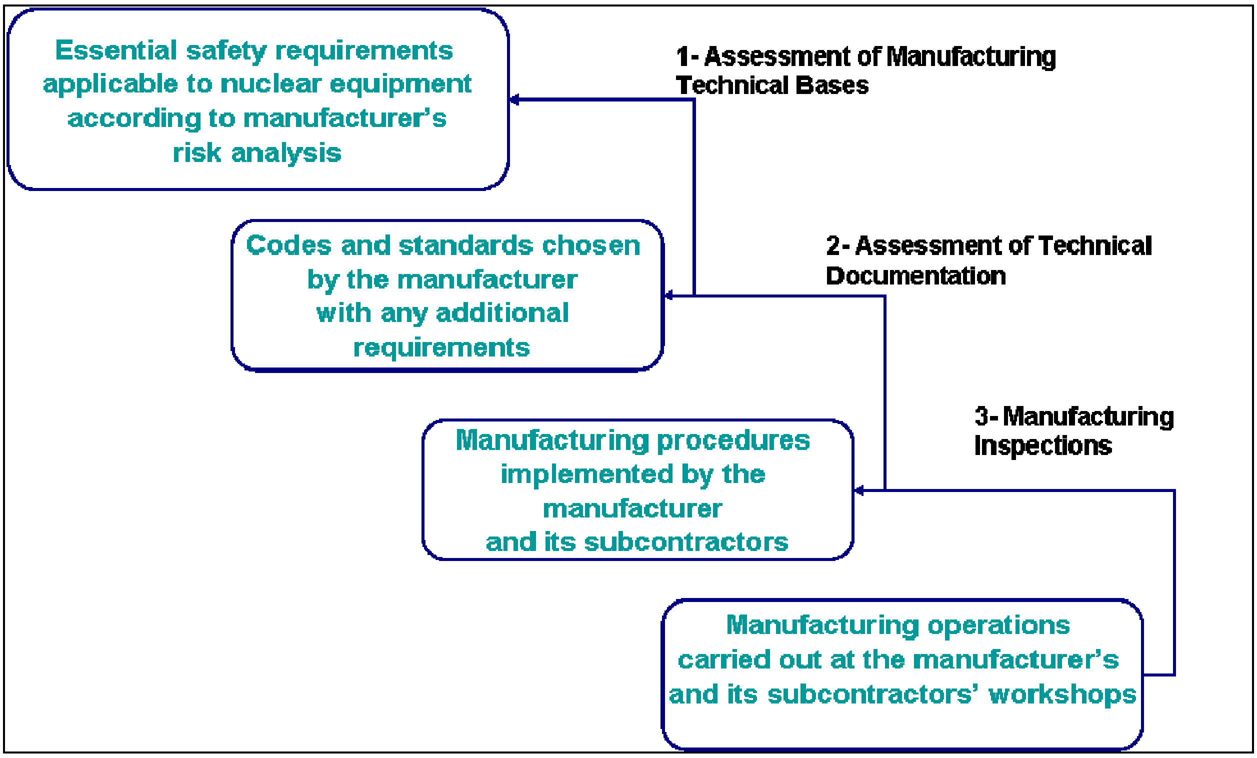


Figure 4: Steps of the conformity assessment

5.5. Japan

Regulatory Practices on Application of the Standard provided by academic societies and associations

The regulatory requirements for securing safety of the nuclear installations are specified in the Reactor Regulation Act or the Electricity Business Act. Based on them, the Ministerial Ordinances for Establishing Technical Standards were provided in accordance with the Reactor Regulation Act or the Electricity Business Act.

The competent minister is responsible for establishment, revision and abolishment of Ministerial Ordinances and Ministerial Public Notices regarding technical standards; namely, preparation and revision of specific regulatory requirements are assigned to the regulator.

In January 2006, NISA (Nuclear and Industrial Safety Agency, the Regulator) revised the Ministerial Ordinance for Establishing Technical Standards for Nuclear Power Generation Equipments (hereinafter referred to as "Technical Standards Ministerial Ordinance") so that the standards provided by academic societies and associations endorsed by the regulator (standards of academic societies and associations) may be used for the codes on the detailed technical specifications in the regulatory requirements. Accordingly, the safety performance with which the nuclear installation should comply is provided by the Technical Standards Ministerial Ordinance, while the specific technical specifications are determined using the standards of academic societies and associations endorsed by NISA. When NISA endorses the standards of academic societies and associations, it implements the technical evaluation with taking into account the opinions of experts from Advisory Committee for Natural Resources and Energy.

In this technical evaluation, for the determination of whether the standards have met the regulatory requirements as the regulatory codes, the following conditions are considered:

- The development process of the standards shall value fair, equitability and openness (an unbiased constituent of members, release of proceedings, implementation of public review, documentation and release of the development procedures, etc.);
- The items and scope of the standards shall comply to the performance required by the technical standards or other legislation and regulations, or the documents based on them (consistency with the scope of the regulatory requirements);
- The specific approaches and specifications for technical matters necessary to achieve the performance required by the technical standards shall be described. The specific approaches, specifications, methods and actions shall be described for the technical matters necessary to attain the requirements by the other legislation and regulations or the documents based on them;
- The technical validity of the specific approaches, specifications, methods and actions shown in the standards of academic societies and associations shall be verified or its rationales shall be described.

In order to improve the efficiency and effectiveness of the regulations, NISA has determined to make its decision promptly, with respecting the engineering insights of the experts participating in the development processes of the standards. As of the end of March, 2010, NISA announced a total of 45 standards of academic societies and associations could be used. One of these endorsed standards is JSME's "Standards for Nuclear Power Generation Equipment: Design and Construction Standards."
(The view above comes from the latest national report of Japan for Convention on Nuclear Safety)

5.6. <u>Republic of Korea</u>

Regulatory Practices Governing the Application of Codes and Standards in Nuclear Power Plants Regulatory Framework

In Korea, The Nuclear Safety and Security Commission (NSSC) is in charge of regulation to protect the public health and to preserve the environment from the radiation hazards that might be accompanied with the peaceful use of nuclear energy. The legal framework for the regulation of nuclear facilities consists of Acts, Enforcement Decrees, Enforcement Regulations, and NSSC Notice. The laws relating to nuclear energy include Nuclear Safety Act (NSA), Nuclear Liability Act (NLA), Act on Physical Protection and Radiological Emergency (APPRE), and so on. Regarding the legal framework, it is noted that: (1) the Enforcement Decree of the NSA addresses the methods to put the philosophy prescribed in the NSA into practice; (2) the Enforcement Regulation of the NSA prescribes procedural items in general; and (3) the Notices of NSSC provide regulatory requirements for the application of Korea Electric Power Industry Code (KEPIC), and so on. There also exist regulatory standards and guidelines that are managed by the Korea Institute of Nuclear Safety (KINS) in accordance with the Rules for Entrusted Regulatory Activities which was developed to facilitate the implementation process of the regulatory work entrusted to KINS by NSSC. Additionally, there are review and inspection guidelines that are used as references in carrying out the regulatory work.

The regulations and guides provide a framework of requirements and conditions for individual authorisation (such as construction permit, operating license, etc.). The safety assessment for construction and operation of a nuclear power plant is prescribed in the following parts of the Nuclear Safety Act: Article 10 for construction permit, Article 12 for standard design approval, Article 20 for operating license, Article 23 for Periodic Safety Review, Article 28 for decommissioning, Paragraph 4 of NSA Enforcement Decree Article 36 for continued operation beyond design life, and so on. The inspection relating to construction and operation of a nuclear power plant is addressed in the following parts of the NSA: Article 16 for construction-related inspection, Article 22 for operation-related inspection. The quality assurance inspection is addressed in NSA Enforcement Decree Article 31.

The specific details for such an individual authorisation (for example, requirements for submittal documents) are included in the Enforcement Decree and Regulation associated with the NSA (such as NSA Enforcement Decree Articles 17, 22, 27, 33, 35, 36), and more details are provided in the NSSC Notices where necessary. KINS, in charge of technical evaluation for an individual authorisation, carries out regulatory activities with a variety of review and inspection guidelines (such as the Safety Review Guidelines for PWR Nuclear Power Plants, the Inspection Guidelines for Periodic Inspections, and so on) established for consistent and effective review and inspection.

Codes and Standards under the Framework

The basic criteria used when evaluating compliance with the requirements and recommendations prescribed by the relevant rules are properly reflected in regulations and guides.

The basic criteria relating to construction permits and operating license are provided in the respective articles of the Nuclear Safety Act, for example: Article 11 for construction permit, Article 21 for operating license, Articles 16 and 22 for inspection, NSA Enforcement Regulation 25 for Periodic Safety Review, and so on.

General design requirements and technical standards to confirm compliance with the requirements and recommendations demanded by permit criteria are reflected in the respective Enforcement Decree and Regulations (such as the Regulation on Technical Standards for Nuclear Reactor Facilities, etc., the Enforcement Regulation Article 6, and so on) and the more detailed technical standards are provided in the respective NSSC Notices. For example, NSSC Notice No. 2012-13 provides guidelines for application of Korea Electric Power Industry Code (KEPIC) issued by the Korea Electric Association (KEA) as the technical standards related to the construction and operation of nuclear power reactor and related facilities, defined in Articles 11 and 21 of the Nuclear Safety Act.

The basic criteria for inspection of a nuclear power plant are prescribed in the NSA related regulations (such as NSA Enforcement Decree Article 27 for pre-operational inspection, or NSA Enforcement Decree Article 35 for periodic inspection), and more details are reflected in the associated NSSC Notices. For example, NSSC Notice No. 2012-10 provides the regulation on in-service inspection of the safety-related facilities and describes guidelines for application of inspection standards such as KEPIC MI, ASME Sec XI, CAN/CSA-N285.4 and N285.5 for the pressurized heavy water reactor and RCC-G Part 3 for the Framatome type reactor.

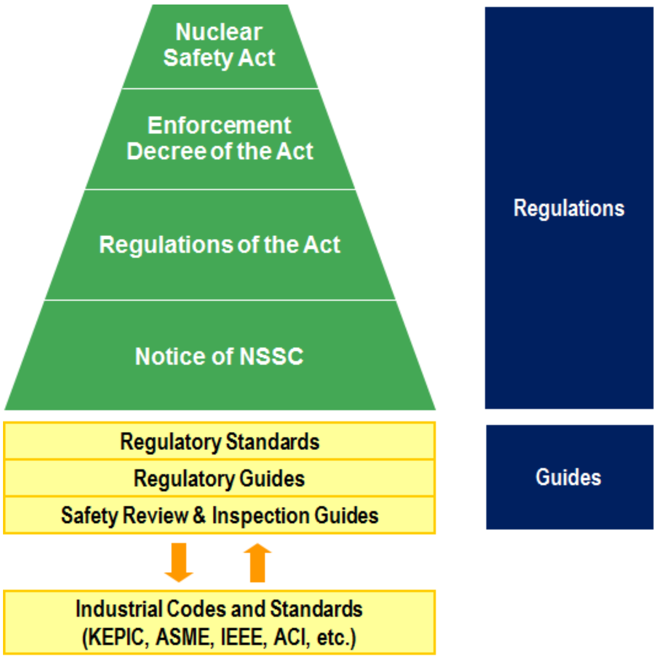


Figure 5: Legal Framework for Safety Regulation of Nuclear Facilities

5.7. Russian Federation

Regulatory practice governing the use of regulatory documents for nuclear facilities (nuclear power plants)

The basis of regulatory activity in the field of atomic energy use in the Russian Federation is laid by Convention on Nuclear Safety (Vienna, 17th June 1994), which entered into force for the Russian Federation on 24.10.1996 (here below called the Convention). Article 7 of the Convention defines a legislative and regulatory framework to govern the safety of nuclear facilities in relation to the subject under review[7], and indicates the required provisions:

- the establishment of applicable national safety requirements and regulations;
- the enforcement of applicable regulations ... , including suspension, modification or revocation.

[7] Licensing is not discussed in this paper.

The Russian Federation established and implements legislative and regulatory framework required for fulfilment of the obligations ensuing from the Convention. The Federal Law on the Use of Atomic Energy was adopted and entered in force in 1995. Article 6 of that Law defines the approaches to enforcement of national requirements and regulatory provisions in the field of safe use of atomic energy and establishes federal rules and regulations;

> "*Federal rules and regulations (hereinafter called rules and regulations) in the sphere of the use of atomic energy establish the safety criteria which are* ***obligatory*** *for the conduct of any type of activity in the sphere of the use of atomic energy.*
> *A schedule of the Federal rules and regulations in the sphere of the use of atomic energy, and also amendments and additions to that schedule shall be approved by the Government of the Russian Federation. The rules and regulations in the sphere of the use of atomic energy are drafted and approved in the manner established by the Government of the Russian Federation".*
> *"After the rules and regulations in the sphere of the use of atomic energy come into force, they shall be* ***binding*** *on all persons who carry out activity in the sphere of the use of atomic energy and shall be in force throughout the territory of the Russian Federation."*

Rules and regulations are developed considering recommendations of international organizations in the sphere of atomic energy, where the Russian Federation participates. Article 23 of the Federal Law on the Use of Atomic Energy establishes that "*State regulation of safety aspects in the use of atomic energy is the activity of Federal executive agencies and State atomic energy corporation 'Rosatom'*". This activity is focused on the organisation of development, approval and enforcement of rules and regulations in the field of atomic energy, and also control (supervision) of their implementation. The kinds of activities in the field of regulation of nuclear, radiation, industrial and fire safety and allocation of powers, rights, obligations and responsibility of respective bodies are established in the regulations of the state safety regulation bodies.

The powers of the Federal Environmental, Industrial and Nuclear Supervision Service were established by the Resolution of the Government of the Russian Federation dated 30.07.2004 No. 401, which endorses the Regulations of the Federal Environmental, Industrial and Nuclear Supervision Service (here below called Rostechnadzor).

The Regulations establish that Rostechnadzor is "*the state safety regulatory body for the use of atomic energy*", and also "*the regulatory body under the Convention on Nuclear Safety*". In particular, Rostechnadzor exercises the following powers:

> *"on the basis and in fulfilment of the Constitution of the Russian Federation, federal constitutional laws, federal laws, acts of the President of the Russian Federation and the Government of the Russian Federation, independently adopts regulatory legal acts in the established sphere of activity, including federal rules and regulations in the field of atomic energy".*

Resolution of the Government of the Russian Federation dated 01.12.1997 No. 1511 endorsed the "*Regulations on the development and approval of federal rules and regulations in the field of atomic energy and the list of federal rules and regulations in the field of atomic energy*". The Regulations established the "*procedure for development, coordination, approval and enforcement of federal rules and regulations in the field of atomic energy, and also introduction of changes and additions*".

Also, a regulatory document establishing "*The system of Rostechnadzor regulatory documents*" is acting in the field of atomic energy. The system of regulatory documents is the entirety of regulatory documents approved by Rostechnadzor, which are aimed at ensuring nuclear and radiation safety of nuclear facilities for the purpose of protecting the employees (personnel) of nuclear facilities, population and the environment against radiation hazards. The system of Rostechnadzor regulatory documents consists of regulatory documents of the following categories: federal rules and regulations in the field of atomic energy; safety guides; regulatory documents.

The federal rules and regulations in the field of atomic energy as approved by the state safety regulatory body for atomic energy regulate technical and administrative aspects of safety assurance for the activities related to the use of atomic energy. Safety guides contain the methods and ways to meet the requirements of federal rules and regulations acceptable for the regulatory body. Regulatory documents contain administrative regulations based on legislative and other regulatory legal acts, which establish rules and procedures in a certain field of activities belonging to the sphere of competence of the regulatory body.

In 2002 the federal law "On Technical Regulation" No. 184-FZ entered in force, which regulates the relationships emerging from:

- development, acceptance, application and fulfilment of obligatory requirements for the products or related design processes (including survey), production, construction, installation, operation, storage, transportation, disposal and recovery;
- development, acceptance, application and fulfilment on a voluntary basis of requirements for the products, design processes (including survey), production, construction, installation, operation, storage, transportation, disposal and recovery, fulfilling works or rendering services.

Regulatory practice in the field of atomic energy also involves application of different standards as defined by the federal law "On Technical Regulation". The following documents belong to the documents in the field of standardisation, which are used in the territory of the Russian Federation:

- national standards - the standards endorsed by the national standardisation body of the Russian Federation;
- codes of practice - the documents in the sphere of standardisation, which contain technical regulations and (or) description of design processes (including survey), production, installation, adjustment, operation, storage, transportation and disposal of products, and which are used on a voluntary basis for the purpose of meeting the requirements of technical specifications;
- international standards, regional standards, regional codes of practice, standards of foreign countries and codes of practice of foreign countries registered with the Federal Information Fund of Technical Regulations and Standards;
- duly authenticated Russian translations of international standards, regional standards, regional codes of practice, standards of foreign countries and codes of practice of foreign countries registered with the national standardization body of the Russian Federation.

The quality of normative and legal safety regulation in the field of atomic energy is achieved, in particular, by:

- analysis of regulatory practices in the field of atomic energy and timely action to improve the regulatory framework;
- development and introduction of regulatory documents containing procedures for fulfilment of the tasks, functions and powers assigned to Rostechnadzor;
- taking into account foreign experience and recommendations of international organisations on the subject of state safety regulation in the field of atomic energy.

In the framework of technical regulation, which is defined by the Federal Law "On the Technical Regulation" as legal regulation of the relationships in the sphere of establishment, application and implementation of obligatory requirements for products, and in the sphere of conformity assessment, the conformity assessment is used for atomic energy applications as prescribed by article 37 of the Federal Law "On the Use of Atomic Energy" in the format of obligatory certification.

For obligatory certification of the items designed for nuclear facilities or those produced by them, a System of certification of equipment, items and technologies for nuclear installations, radiation sources and storage facilities was launched in 1999 as a product of joint effort of Minatom of Russia, Gosstandard of Russia and Gosatomnadzor of Russia.

Organisational structure and basic rules of the System, and procedure of interaction between its participants were established in the documents of the System approved by the managers of Minatom of Russia, Gosstandard of Russia and Gosatomnadzor of Russia.

One of the key issues of conformity assessment of the items against the requirements of regulatory documents is that certification is conducted for the equipment important for safety of nuclear facilities in order to verify that characteristics (parameters) of the equipment meet the established requirements of regulatory documents considering safety classification.

Certification serves to assess conformity with regulatory requirements of the following parameters (characteristics) of the products:

- classification with regard to safety of nuclear power plants;
- safety parameters;
- designation parameters (functional parameters);
- structural requirements;
- resistance to external impacts;
- reliability parameters;
- software requirements;
- electromagnetic compatibility requirements.

The results of completed activities lead to the conclusion that conformity assessment of products against the requirements of regulatory documents in the form of obligatory certification makes significant contribution to assuring acceptable safety level of nuclear facilities.

5.8. South Africa

Overview of Regulations and Practices Governing the Application of Codes and Standards in Nuclear Installations in the Republic of South Africa

Legislation

The South African National Nuclear Regulator (NNR) regulates nuclear activities in accordance with the NNR Act /1/ that confers upon the NNR the responsibility of, inter alia, providing technical and administrative requirements for nuclear authorisations that include the exercising of regulatory control related to safety over the design, construction, operation, and manufacture of component parts of nuclear installations.

The Occupational Health and Safety Act /2/ provides for the promulgation of Regulations controlling aspects related to risks to health and safety arising from or connected with the activities of persons at work. Included in this suite of regulations are requirements for the design, manufacture, construction, installation, operation and use of plant machinery.

In this respect, the Pressure Equipment Regulations (PER) /3/ provides the regulations for the design, construction, and use of pressurised equipment in industry. The main purpose of the PER is to provide the essential safety requirements with respect to the use of pressurised equipment or systems; hence, the legal obligations and responsibilities of manufacturers and owners in respect of design, manufacture, registration, operation, inspection, and maintenance are contained in the document. A number of health and safety standards are incorporated into the regulation by reference.

The PER invokes the application of SANS 347 in terms of categorisation and conformity assessment of pressurised equipment and requires the use of an approved health and safety standard (construction code) incorporated into SANS 347 /4/ for the design, manufacture, repair, modification, inspection and testing of pressure equipment. SANS 347 is modeled on the European Pressure Equipment Directive. It currently does not include specific rules for pressurised equipment for nuclear service. Notwithstanding, this document includes a list of approved codes and standards that are required to be used for the design and construction of approved pressure equipment. It includes nuclear codes.

Implementation of Legislation and National Practice

It is the role of the Department of Labour under the South African government to regulate occupational safety under the Occupational Health and Safety Act. It is also its' mandate to regulate pressurised systems and equipment both in nuclear and other conventional applications through the registration of boilers and pressure vessels, approval and regulation of approved inspection authorities, and enforcement of the regulations.

In practice there is much overlap between the roles of the NNR and the Department of Labour as it is the role of the NNR to have oversight over any nuclear installation's design, construction, commissioning and operation.

The NNR licensing requirements documents specify the submission of a safety case in support of an application for a nuclear authorisation. As a requirement, the safety case must demonstrate the adequacy of the plant design and operational procedures through formalised safety analyses. One aspect of the demonstration of safety adequacy that is assessed by the NNR is the appropriate use of codes and standards in the design, manufacture, construction, operation, inspection, modification, and repair of structures, systems, and components.

The NNR Licensing Requirements require that the Nuclear Installations are designed, constructed and operated in accordance with well-defined standards and rules. The NNR does not specify the use of any specific design code or standard. There are also no specific design codes and standards developed in the Republic of South Africa for the safety of important components used in the South African nuclear industry. The code of construction is selected by the Licensing Applicant; however, this must be in accordance with the relevant South African Regulations and Standards. In principle, any design, construction, and inspection code or standard that is internationally accepted for application at nuclear facilities can be proposed for design and construction. However, the codes and standards must be justified in terms of application and must be applied consistently, without omission of conditions or embedded requirements. Alternatively, new or modified codes and standards can be developed, justified, and proposed for approval by the relevant authority. At the current time, the ASME Nuclear codes and the French RCC-M Code have been incorporated into the Annex of SANS 347, providing two nuclear codes that may be used for pressurised equipment in nuclear use.

While the NNR does not authorise or regulate the use of specific equipment or components, the NNR performs assurance-compliance-related monitoring activities with respect to the applicant’s code of choice from a list of codes as contained in the relevant regulations and as agreed to by the NNR. This includes performing detailed assessments of plant component and system design related material for structural adequacy during the review of safety cases.

There are however areas of code use where embedded code requirements related to conditions of registration of, for example, ASME Section III accredited Approved Inspection Authorities provide a level of inflexibility in the development of a local system of requirements that permit a single system of specific legal requirements that satisfy all the requirements of the different codes endorsed for use in the country. This is an area where further work is required, but that may be significantly eased through the achievement international harmonisation of codes and standards for nuclear power plants.

References

/1/ National Nuclear Regulator Act (Act 47 of 1999).
/2/ Occupational Health and Safety Act (Act 85 of 1993).
/3/ Department of Labour, Pressure Equipment Regulations R.734, 2009.
/4/ SANS 347, Categorization and Conformity Assessment Criteria for all Pressure Equipment, Standards South Africa, 2007.
/5/ SANS 10227, Criteria for the Operation of Inspection Authorities Performing Inspection in Terms of the Pressure Equipment Regulations, Standards South Africa, 2007.

5.9. United Kingdom

Use of codes and Standards in Regulation (pressure systems)

Introduction

The United Kingdom nuclear industry is regulated by the Office for Nuclear Regulation (ONR) (an agency of the Health and Safety Executive). ONR was formed in 2011 from the existing safety, security, safeguards and nuclear transport regulators with the aim of setting up a standalone organisation within the next few years. While this will require changes to the regulatory organisation it is not intended to change the basis of the regulatory system.

Basis of Regulatory Approach

ONR regulates a wide range of sites and issues. The sites range from civil nuclear reactors (operating and decommissioning), chemical plants, and defence sites. The issues range from safety, security, safeguards and transport. For the regulation of safety each site has to be licensed for its use with the expectation that the licensee, site and plant are suitable. Each site licence has 36 standard conditions and the licensee is expected to develop adequate arrangements to comply with the licence conditions. There are no licence conditions which explicitly address codes and standards. However, Licence Condition 14 (Safety Documentation) expects the licensee to have arrangements for the production of safety documentation and within these arrangements ONR would expect to find the licensees approach to codes and standards.

In order to guide its inspectors ONR has produced its Safety Assessment Principles (SAPs) and these are further supported by Technical Assessment Guides (TAGs) and Technical Inspection Guides. Technical Assessment Guide T/AST/016 deals with the integrity of metal components. The SAPs and TAGs are not rules for licensees but they do give a clear indication of the expectations of the regulator. An important concept is that the licensee is expected to take account of relevant good practice in developing its safety cases and it is accepted by ONR that codes and standards form a part of good practice. The SAPs do address codes and standards SAP ECS.3 states "*Structures, systems and components that are important to safety should be designed, manufactured, constructed, installed, commissioned, quality assured, maintained, tested and inspected to the appropriate standards*". The text supporting the SAP goes on to further explain that
"*157 The standards should reflect the functional reliability requirements of structures, systems and components and be commensurate with their safety classification.*
158 Appropriate national or international codes and standards should be adopted for Classes 1 and 2 of structures, systems and components. For Class 3, appropriate non-nuclear-specific codes and standards may be applied.
159 Codes and standards should be preferably nuclear-specific codes or standards leading to a conservative design commensurate with the importance of the safety function(s) being performed. The codes and standards should be evaluated to determine their applicability, adequacy and sufficiency and should be supplemented or modified as necessary to a level commensurate with the importance of the safety function(s) being performed."

ECS.4 states that "*For structures, systems and components that are important to safety, for which there are no appropriate established codes or standards, an approach derived from existing codes or standards* *for similar equipment, in applications with similar safety significance, may be applied."* And ECS.5 *"In the absence of applicable or relevant codes and standards, the results of experience, tests, analysis, or a combination thereof, should be applied to demonstrate that the item will perform its safety function(s) to a level commensurate with its classification.*"

Approach to Nuclear Pressure Systems Codes and Standards

As has been stated above ONR does not approve or enforce the use of any particular code or standard. Also unlike France we do not treat nuclear pressure equipment on the same basis as conventional pressure equipment as we make full use of the exclusion for nuclear equipment in the Pressure Equipment Directive (97/23/EC).

The UK power reactors came into service from the late 1950s with the final operational reactor coming into service in the mid 1990s. These were built to a range of pressure vessel codes from the original British Standard 1500, through BS 5500 to ASME III (the former two are now no longer in force). Standards such as BS 1500 and BS 5500 were not nuclear pressure vessel codes unlike ASME III. With the advent of new nuclear build the UK has been offered a range of reactor designs including the AP1000® and the UK EPR™ reactors. While the AP1000® has made use of ASME III the UK EPR™ has introduced a further pressure vessel code into the UK in the form or RCC-M and the in-service inspection code RSE-M. The approach taken has varied with the codes.

ASME III was familiar to ONR and was seen as a mature and internationally used nuclear code which met our expectations for relevant good practice for a pressure vessel design code. No work was done to further examine this code.

RCC-M was unknown to ONR and so as part of the review of the UK EPR™ design during the GDA process ONR carried out an examination of some of the design aspects of the RCC-M code in order to gain confidence in its use. The report on that review is in the MDEP library (Meeting documents from April 18-20 2011). The similarity of RCC-M to ASME III influenced the scope of ONR's examination of RCC-M. If a totally new code had been offered then a more extensive review would have been carried out (see below).

Expectations Beyond the Basic Codes

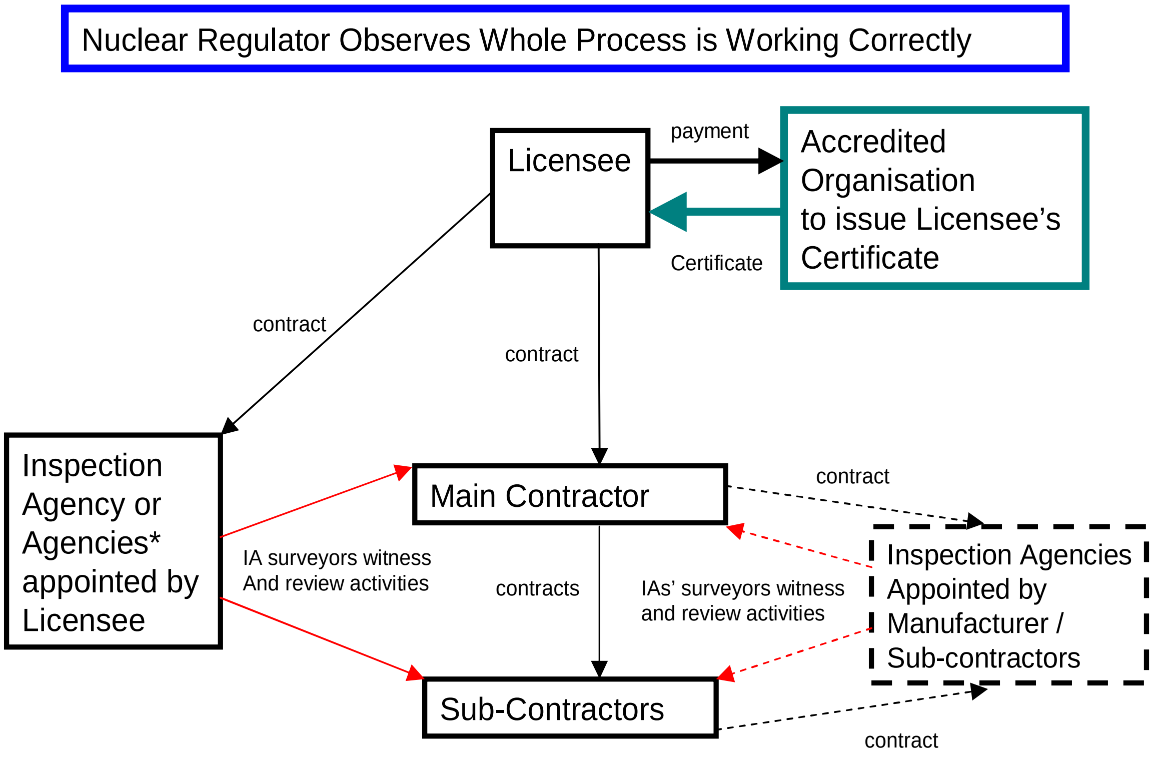
For the highest integrity components such as the Reactor Pressure Vessel, ONR considers that the use of a design code such as ASME III or RCC-M is a necessary but not sufficient requirement on its own. Through the use of the SAPs (EMC.1, EMC.2 and EMC.3), ONR also carries out assessments of topics such as the materials of construction, manufacturing inspections and fracture mechanics analyses. The aim is to ensure that the components before entering service are (1) as defect free as possible and (2) and tolerant of defects.

In order to demonstrate that the components are as defect free as possible ONR has expectations for manufacturing inspections that go beyond typical code requirements. While radiography may be used for some inspections ONR expects that there will be a high level of confidence that defects of concern will be found. This means that an inspection qualification process such as that developed by the European Network for Inspection Qualification (ENIQ) will be need to be used. It also means that it is highly likely that ultrasonic inspections will be required during manufacturing. These may well be more detailed than any subsequent pre-service or in-service inspections as the whole volume a weld may be expected to be examined rather than perhaps some percentage of the inner volume.

The need to demonstrate defect tolerance requires a detailed fracture mechanics assessment. For many years in the UK this has been carried out using the R6 approach. For the UK EPR™ the approach offered was to use Appendix 5.4 of the French RSE-M code. This has not been used in the UK so the approach has been to initially carry out comparative calculations to get confidence that if the safety case had been made using R6 that an adequate results would be obtained. The longer term approach is to have an extensive, independent, review carried out of Appendix 5.4 of RSE-M to understand the differences in the two codes. The aim of this review is to allow ONR significantly improve its knowledge, and to gain confidence, in the use of Appendix 5.4 of RSE-M.

Primary Circuit Component Procurement

The preferred model for procurement in support of new build or development or maintenance of existing facilities positions the Licensee at the head of the supply chain. ONR's expectations for procurement are described in TAG T/AST/077. Examples of organisational roles and responsibilities for the specification, design, manufacture, testing and installation of primary circuit pressure boundary components which represents the highest level of assurance are given below.
The main organisations involved are the (1) Licensee/Purchaser. (2) the Manufacturer/Contractor, (3) the Inspection Agency, and (4) Accredited organisation that issues the Licensee's Certificate.



* Independent Third Party Inspection Agent (ITPIA)

The responsibilities of the Licensee/Purchaser are to:

1 Document a Quality Assurance Programme in accordance with a national/international standards e.g. IAEA GS-R-3 'The Management System for Facilities and Activities', for submission the ONR.

2 Obtain a Licensee's "Certificate" to confirm the Licensee's capability to execute its responsibilities. The organisation that issues this certificate to the Licensee should be agreed with the ONR. Ideally the Certificate should be issued by an organisation engaged by the Licensee for this sole purpose.

3 Engage one or more Inspection Agencies.

4 Certify that the completed installation complies with the design code/technical specifications for the various components/systems.

5 Define in the Technical Specification, those records that are to be included in the lifetime records for the installation and the associated records management arrangements. These will include:

5.1 Identification of the records to be retained by the Licensee and the Contractor.

5.2 Arrangements to safeguard and maintain records to be retained by the Licensee and the Contractor.

5.3 Arrangements which ensure that Contractor's records are transferred to the Licensee if the Contractor is no longer willing or able to retain the records.

6 Evaluate and audit the Quality Assurance arrangements employed by Contractors (and where appropriate, including Sub-Contractors) for design, manufacture and installation of nuclear safety related pressure equipment.
7 Establish the Design Code version to be used and define this in the Design Specification.
8 Prepare, review and certify the Technical Specifications, Design Reports and Certification Forms and designate authorised personnel to carry out those duties.
9 Classify equipment in accordance with applicable safety criteria, define the resulting applicable Design Code, and define the acceptance criteria to be applied to load/design limit combinations.
10 Designate overpressure protection requirements and location for each component or system.
11 Provide a report that explains and justifies the overpressure protection arrangements.
12 Provide adequate structures, foundations and auxiliary systems for pressure equipment.
13 Make available to the ONR those documents which the Inspection Agency are required to endorse and such documentation as is necessary for the Inspection Agency to fulfill its responsibilities.
14 If not required by the Design Code, agree with the Contractor and Inspection Agency a suitable means of physical identification of components and items.

Items 1 – 6 cannot be delegated by the Licensee. Items 7 to 14 may be delegated by the Licensee, provided that the responsibility for compliance remains with the Licensee.

Conclusions

ONR has a non prescriptive approach to codes and standards. This allows licensees and reactor to use codes of their choice providing they can demonstrate to the ONR that they are adequate for their purpose and are relevant good practice.

Where new codes are encountered ONR will make a judgment over the extent of review that is needed of these codes before a design or safety case is accepted.

5.10. United States

Regulatory Practices Governing the Application of Codes and Standards in Nuclear Power Plants

In the United States (U.S.), the U.S. Nuclear Regulatory Commission establishes rules for the application and use of codes and standards in nuclear power plants in its regulations contained in Title 10, “Energy,” of the *Code of Federal Regulations* in Part 50, “Domestic Licensing of Production and Utilization Facilities (10 CFR Part 50).” More specifically, NRC’s regulations in Appendix A to Part 50 contain fifty-five general design criteria for nuclear power plants that establish the minimum requirements for the design, fabrication, construction, testing, and performance of structures, systems and components important to safety in a nuclear power plant to ensure that the nuclear power plant can be operated without undue risk to the health and safety of the public. One of these general design criteria, General Design Criterion (GDC) 1, “Quality Standards and Records,” requires that structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. It also states that where generally recognised codes and standards are used, they shall be identified and evaluated to determine their applicability, adequacy, and sufficiency and shall be supplemented or modified as necessary to assure a quality product in keeping with the required safety function.

The requirements of GDC 1 relating to the use and application of codes and standards are further addressed in NRC's regulations in Section 50.55a, "Codes and Standards," of 10 CFR Part 50. In § 50.55a, the NRC requires the use of certain codes and standards in the design and operation of nuclear power plants, and specifically requires that components in boiling-water reactors and pressurized-water-cooled reactors shall meet the requirements of the American Society of Mechanical Engineers *Boiler and Pressure Vessel Code* (ASME Code), and that protection and safety systems shall meet the requirements of the Institute of Electrical and Electronics Engineers (IEEE) Standard 279, "Criteria for Protection Systems for Nuclear Power Generating Stations," and IEEE Standard 603, "Criteria for Safety Systems for Nuclear Power Generating Stations," respectively. Paragraphs (c), (d), (e) and (h) of § 50.55a provide more specific details governing the use of the ASME Code, Section III rules and IEEE Standards 279 and 603 requirements for the design and construction of nuclear power plant component and systems.

The NRC's adoption of these consensus standards as regulatory requirements for the U.S. nuclear industry complies with Public Law 104-113, the National Technology Transfer and Advancement Act of 1995. This Act requires all Federal agencies to use technical standards that are developed or adopted by voluntary consensus standards bodies as a means to carry out policy objectives or activities determined by the agencies or departments unless compliance is inconsistent with applicable law or otherwise impractical. It should be emphasised that under the Atomic Energy Act of 1954, as amended, the NRC has authority to promulgate regulations governing production and utilization facilities (e.g., nuclear power plants). Generally, the NRC has developed and promulgated its own regulations such as those in 10 CFR Part 50. However, in other areas, the NRC has incorporated by reference into NRC's regulations several consensus standards developed by consensus standards bodies (e.g., the ASME Boiler and Pressure Vessel Code and IEEE Standards 279 and 603). "Incorporation by reference" was established by statute and allows the NRC and other Federal agencies to refer to standards already published elsewhere. These standards are then treated like any other properly issued regulation and has the full force of law.

Most U.S. industry standards containing technical guidelines, common industry practices, performance criteria, and recommended safety approaches are not regulatory requirements, but, rather, are often cited in regulatory guidance documents and treated as a practice, approach or method that is acceptable to the NRC for implementing its regulations. However, practices, approaches or methods other than those referenced in NRC guidance documents may also be used when reviewed and approved by the NRC. In a recent study of standards used in the design and construction of new nuclear power plants, it was found that over 500 industry standards were cited or referenced by NRC in regulatory guidance documents.

In these recent times of globalisation of nuclear power plant designs, the question often arises whether NRC would allow the use of foreign codes and standards for the design and fabrication of components and systems in U.S. nuclear power plants. Although the NRC requires the use of the ASME Boiler and Pressure Vessel Code and IEEE 279 and 603, the NRC's regulations contain a provision that would allow alternatives to the regulations in § 50.55a to be used, and would allow the use of foreign codes and standards in the design and fabrication of components and systems. An applicant seeking to construct a nuclear power plant may propose to use foreign codes and standards as an alternative to the regulations pursuant to 10 CFR 50.55a(a)(3). In doing so, the applicant must demonstrate that the alternative provides an acceptable level of quality and safety or that compliance with the specified requirements of § 50.55a would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. In practice, however, the use of foreign codes and standards has not yet been proposed for any standard nuclear power plant design currently under review by the NRC including those designed in other countries (i.e., Japan and France).

Therefore, in order to achieve international harmonisation of codes and standards for nuclear power plants constructed in the U.S., the NRC's regulations would not need to be revised because they already contain sufficient flexibility to enable the use of foreign codes and standards in the plants' design and construction. However, it is unclear how certain programmatic requirements (e.g., quality assurance, conformance assessment, welding and welder qualifications) can be harmonised without clear regulatory guidance or agreement among regulatory bodies on what acceptance standards would be applicable and appropriate. These are some of the areas that the Codes and Standards Working Group of the Multinational Design and Evaluation Program is addressing.