MDEP Technical Report TR-CSWG-04

Related to: Codes and Standards Working Group

Technical Report:

THE ESSENTIAL PERFORMANCE GUIDELINES FOR THE DESIGN AND CONSTRUCTION OF PRESSURE BOUNDARY COMPONENTS

Participation

Countries involved in the MDEP working group discussions:	Canada, Finland, Japan, Republic of Korea, Russian Federation, the UAE, the U.K., and the U.S.
Countries which support the present common position	
Countries with no objection:	China, France, India, Sweden and South Africa
Countries which disagree	
Compatible with existing IAEA related documents	Yes
MDEP Stakeholders	Standard Development Organisations and CORDEL got a comment period. AFCEN comments have been considered.

Contents

I. INTRODUCTION

This CSWG document provides the essential performance guidelines for the codes and standards used in the design and construction[1] of reactor coolant pressure boundary[2] components in nuclear power plants. These guidelines are qualitative descriptions of the rules and practices derived from the codes and standards of MDEP member countries, which can be considered as essential. As these guidelines represent commonalities between the codes and standards of MDEP member countries they should not be used as a stand-alone.

II. BACKGROUND

The primary, long-term goal of MDEP's CSWG is to achieve international harmonisation of codes and standards for pressure boundary components in nuclear power plants that are important to reactor safety. The key to achieving harmonisation is to understand the extent of similarities and differences amongst the pressure boundary codes and standards used in various countries. To assist the CSWG in its long-term goals, several standards development organisations (SDOs) from various countries performed a comparison of their pressure boundary codes and standards to identify the extent of similarities and differences in code requirements and the reasons for their differences. The results of the code-comparison project are documented in a separate report in the MDEP library.

The results of the code-comparison project enabled the CSWG to take the next steps towards harmonisation of codes and standards. The results enabled the CSWG to understand from a global perspective how each country's pressure boundary code or standard evolved into its current form and content. The CSWG recognised the important fact that each country's pressure boundary code or standard is a

[1] According to ASME NCA9000 Glossary, the term "construction" (as used in Division 1) is defined as an all-inclusive term comprising material, design, fabrication etc. meanwhile there are some code that "construction" does not include "design". Then, in this document, construction is defined as all activities except design. Therefore, design and construction is used in this document, meaning all-inclusive term.

[2] In this document, "reactor coolant pressure boundary components" is used instead of "class-1 components", as there are some differences in the definition of "class-1" among codes. Furthermore, the term "reactor coolant pressure boundary component" is hereafter shortened as "pressure boundary component".

comprehensive, living document that is continually being updated and improved to reflect changing technology and common industry practices unique to each country. The rules in the pressure boundary codes and standards include comprehensive requirements for the entire design and construction of nuclear power plant components including design, materials selection, fabrication, examination, testing and over-pressure protection. The rules also contain programmatic and administrative requirements such as quality assurance; conformity assessment (e.g., third-party inspection); qualification of welders, welding equipment and welding procedures; non-destructive examination (NDE) practices; and qualification of NDE personnel.

In the course of reviewing the results of the SDO's code-comparison project, the CSWG found that the similarities and differences between each county's code and standard varied considerably amongst different countries. Some country's code or standard was almost identical to another country's code or standard in key areas while another country's code or standard was vastly different. These differences are due to the historical, cultural, social, industrial and regulatory differences of each country.

In addressing these commonalities and differences, the CSWG found it possible and useful to establish a global framework of a hierarchy structure of the pressure boundary codes and standards, as a basis of harmonisation of the codes and standards. However, certain programmatic and administrative requirements, such as quality assurance and conformity assessment, were not addressed in detail in this document because these programs are unique to each country's national and cultural practices.

III. GLOBAL FRAMEWORK FOR THE PRESSURE BOUNDARY CODES AND STANDARDS

A hierarchy structure of three levels was considered for providing a global framework that would unite the regulatory requirements on the pressure boundary codes and standards in each country, with an ultimate goal of harmonisation of the codes and standards for nuclear components.

The concept of this framework would enable all member countries to share commonalities of their codes as is appropriate to their needs. However, based on this framework, the efforts towards harmonisation can be promoted.

At the top of the hierarchy, the Fundamental Attributes provide fundamental concepts governing the design and construction of pressure boundary components. At the middle level, the Essential Performance Guidelines provide performance based guidelines for nuclear pressure boundary codes. At the bottom level, the pressure boundary codes and standards of each country provide specific rules for the design, material, fabrication, installation, examination, testing, and overpressure protection.

The Fundamental Attributes describe the basic concepts underpinning the pressure boundary codes and standards used in the design and construction of nuclear power plant pressure boundary components. These concepts shall govern the design and construction of pressure boundary components, regardless of the detail differences of each code. Therefore, the fundamental attributes are described in "shall" statements. In the regulatory system of each country, these attributes can be used as requirements or recommendations.

This level corresponds to the Safety Requirements of the IAEA Safety Standards (Figure 1). The Fundamental Attributes could, in the future, be incorporated into the relevant IAEA safety requirements related to nuclear pressure boundary components.

At the middle level, the Essential Performance Guidelines provide qualitative performance descriptions of the rules and practices derived from the codes and standards, which can be considered as essential and are described in most of the codes and standards in the MDEP member countries. These essential guidelines can govern most of the pressure boundary codes and standards but not necessarily all of them. They will therefore be regarded as guides or recommendations and will be described in "should" statements. In the regulatory system of each country, these guidelines can be used as guides or recommendations. They can also be used as regulatory requirements, depending upon the regulatory decision of each country.

This level corresponds to the Safety Guides of the IAEA Safety Standards (Figure 1). It is envisaged that a new IAEA Safety Guide could be developed based on the information contained in the Essential Performance Guidelines.

Pressure-boundary codes and standards are inevitably large, complex and very detailed documents. As a consequence it is difficult for non-code specialists to appreciate the important requirements of the codes and standards. The Essential Performance Guidelines was therefore also written to provide the essence of codes and standards on nuclear pressure boundary components. The Essential Performance Guidelines can be used also as a tutorial material.

The bottom level contains the pressure boundary codes and standards from the individual countries. The intention is that stepwise efforts will commence to harmonise the different pressure codes and standards. This will be performed jointly by the SDOs and WNA/CORDEL[3]. Initially, a few code differences will be selected for trial convergence. If the efforts are a success, then code convergence will be further conducted on more code differences. This process will repeat and the scope of convergence will be expanded.

[3] World Nuclear Association's working group on Cooperation in Reactor Design Evaluation and Licensing

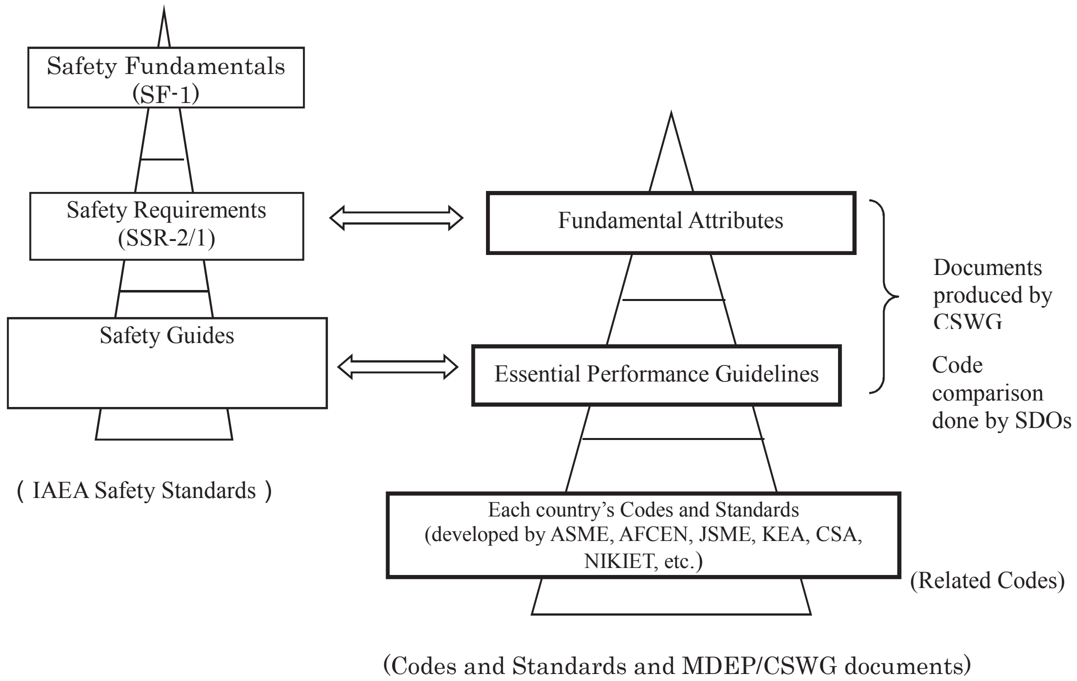

Fig.1 Relationship between the hierarchy structures of the IAEA Safety Standards series and MDEP/CSWG documents

IV. DEVELOPMENT AND POSSIBLE USAGE OF THE ESSENTIAL PERFORMANCE GUIDELINES

1. Consideration of the code comparison results

Although there are many significant differences, the basic structure and essential requirements of the different codes are largely shared. For the majority of the pressure-boundary codes that were compared, the code comparison results show that the number of requirements categorized as "same" or "similar" is larger than those categorized as "different." The differences are mainly due to the differences in social, industrial, historical and regulatory situations of each country. However, the basic structure and major areas in of each code were found to address similar topics and contain many common rules although the scope, and the specific values and limits could vary from code to code. In other words, the code comparisons found that certain technical topics were commonly addressed in each code (or were addressed elsewhere such as in regulatory requirements or other standards) although the manner in which each code topic was addressed could vary. Meanwhile, the ASME code, which was used as benchmark in code comparison, covers comparatively broader areas (e.g. administrative areas) than other codes and therefore gives preferably basic structure as design and construction code and as a top-down approach provides some other topics which were not resulted from code comparison. These common topics, which were referred to as "elements of each technical area" (some of the elements came from code comparison results, meanwhile some topics came from the structure of ASME's code) are identified and described in Subsection 1.1 of each of the six sections in V-1 through V-6 for material, design, fabrication and installation, examination, testing, and overpressure protection requirements, respectively.

In the subsections that follow Subsection 1.1, the commoncode topics that were identified by the code comparisons are described in terms of performance-based guidelines rather than as specific limits or values that would be found in the codes themselves but some of the elements do not have corresponding description. For these common topics, it was found that the code areas categorized as "same" or "similar" in the code comparisons principally relate to those rules in pressure boundary codes and standards that are of the utmost importance (or essential rules) for designing and constructing pressure boundary components.

2. Identification of essence from the various national codes used by MDEP countries

Essential performance guidelines (middle level) identify common code topics and provisions. These guidelines were developed through a bottom-up approach based on the evaluation and analysis of code similarities and differences, as described in the following steps:

- Evaluated code similarities and identified their common essence;
- Assessed code differences, considered the requirements of other related code provisions or considered all referenced industry standards, and then identified common aspects, for example, a requirement may be different among codes, but its purpose, principle, or philosophy may be the same.

3. Potential usage of the essential performance guidelines

(1) The essential performance guidelines together with the fundamental attributes can be used as a first stepping stone from which the discussion on harmonisation

and on prevention of further divergence of codes can be started.

(2) The essential performance guidelines may be used as an international basis for a regulatory body to endorse a domestic or a foreign code. Each regulatory body may prescribe extra requirements as desired.

(3) The essential performance guidelines may be used as an international basis for a regulatory body to describe the technical regulatory requirements in its regulatory system.

(4) The essential performance guidelines may be included in the IAEA safety standards (safety guide).

V. ESSENTIAL PERFORMANCE GUIDELINES FOR PRESSURE BOUNDARY COMPONENTS

V-1. Material

Materials used in pressure-boundary components should be selected taking into consideration their working environment, expected degradation mechanisms, constructability, examinability, and replaceability.

1. General guidelines

1.1. Technical and Administrative rules or items to be addressed for materials

The major technical and administrative rules or items to be addressed for materials are:

(1) permissible material specifications for component design including materials used for welding and bolting;

(2) rules for certification of material;

(3) heat treatment of material to enhance impact properties;

(4) rules for developing material test coupons and specimens for ferritic steel material;

(5) rules for ensuring the material fracture toughness including impact testing and acceptance criteria;

(6) rules for the calibration of test instruments and equipment;

(7) rules for welding material including required tests of the weld metal;

(8) rules for the storage and handling of welding material;

(9) rules for the examination of pressure- and non-pressure-retaining materials;

(10) rules for the repair of pressure- and non-pressure-retaining materials.

1.2. Permitted materials

(1) Materials should be compatible with their environment and comply with specified requirements and with other supplemental requirements such as regulatory requirements. The pressure boundary codes, together with other supplemental requirements such as regulatory requirements, should describe the requirements which are specially applied to the nuclear components, including the selection of materials to minimise radio-activation. For specifying the general or detailed requirements of the materials, the pressure boundary codes may quote other codes and/or industry standards, etc.

(2) The referenced codes and standards for materials can specify chemical composition, microstructure, fabrication suitability, heat treatment, mechanical/thermal properties, etc. as applicable. The mechanical/thermal properties can include allowable stress intensities; allowable stress; ultimate tensile strength; yield strength; thermal expansion properties; nominal coefficient of thermal conductivity and thermal diffusivity; and modulus of elasticity of the material used at room temperature and operating temperatures.

(3) Materials should be homogeneous, and suited to the manufacturing processes and, where required, suitable for welding. They should be mutually compatible once assembled, and not give rise to excessive non-destructive inspection limitations during manufacturing or operation. They should have stable properties; in particular they should have a low sensitivity to thermal aging and a high resistance to corrosion. Corrosion products generated that could be activated - when circulating in the core - should not lead to excessive radiation doses impacting maintenance activities. Materials should be chosen to prevent the risk of fast fracture during the whole operating life and in particular to ensure that normal operation occurs far enough from the brittle zone.

1.3. Quality management/quality assurance

A quality management (or quality assurance / control) system for the material should be established, including certification, identification, and traceability of materials during manufacturing, handling and storage.

2. Heat treatment of materials

2.1. Enhancement of material properties

Carbon steel, low alloy steel, and high alloy chromium steel may be heat treated through processes such as quenching and tempering to enhance their properties.

2.2. Material test coupons

(1) Where ferritic steel material is required to be subjected to heat treatment during fabrication or installation of a component, the material used for any associated tensile and impact test coupons should be heat treated in the same manner as the component.

(2) Where ferritic steel material is subjected to quenching from the austenitizing temperature, the test coupons representing that material should be cooled at a rate similar to and no faster than the main body of the material.

2.3. Procedure for obtaining test coupons

The procedures for obtaining test coupons for quenched and tempered material, including their number, orientation and location, should be specified for each product form such as plates, forgings, bars, bolting materials, tubular products, and fittings.

3. Fracture toughness testing requirements for material

3.1. Material to be impact tested

Pressure-retaining material and material welded thereto should be impact tested, except those kinds of the materials for which exclusion of impact test is authorized such as materials smaller or thinner than prescribed limits which are determined according to the kind, shape and dimension of the material.
The test data should be used as baseline data for in-service operation of the component and for use in fracture prevention evaluation.

3.2. Impact test procedure

(1) The procedure of impact tests, such as drop weight test or Charpy V-notch test, should be specified or should be in accordance with code specified standards.
(2) Location and orientation of test specimen should be specified.

3.3. Impact test requirements on vessel materials

(1) Pressure-retaining material for vessels, other than bolting, should be tested to confirm sufficient toughness by measuring the nil-ductility transition temperature with the drop weight test method, and/or by impact absorption energy, and/or lateral expansion with Charpy V-notch test specimens.
The testing should be done on
(a) Base material,
(b) Weld metal and,
(c) HAZ (heat affected zone) metal.
For bars, nozzles, and appurtenances, for which it is impossible to obtain test specimens for drop weight testing due to the size or form of the materials, only Charpy V-notch testing may be done.

3.4. Impact test requirements on piping, pump, and valves

Pressure-retaining material for piping, pumps, or valves, with a wall thickness less than a pre-determined value, should be tested with the Charpy V-notch testing method. For the material of components of a specified size or larger, the same methods as for vessels should be applied.

3.5. Others

For bolting material, including studs, nuts, and bolts, Charpy V-notch testing should be conducted. The number of test specimen should be determined according to the kind of material product. Conditions for retesting should be determined.

4. Welding material

Welds should have strength greater than the weakest base metal materials. The welds should have complete fusion and should not have harmful defects in the form of cracks, undercut, overlap, crater, slag inclusion, blowholes, etc. For specifying the detailed welding requirements, the pressure boundary codes may use other codes and/or industry standards.

5. Examinations

5.1. Examination of pressure-retaining material

(1) Pressure retaining materials and materials welded thereto should be examined by non-destructive methods applicable to the material and product form.
(2) Other examination codes specifying the specific examination requirements may be used for specifying the details of the non-destructive examination procedures.

5.2. Examination and repair of plates

(1) All plates should be examined by the ultrasonic method.
(2) Appropriate ultrasonic methods should be selected according to the thickness of the plate to be examined.
(3) Extent of examination should be specified.
(4) Acceptance criteria on permissible flaws should be specified.
(5) Repair by welding should be permitted, when specified conditions on repairing are met, including repair size, repair procedure, and examination on repair and the repair is conducted in accordance with a predetermined quality management system. The repair welds should be examined.

5.3. Examination and repair of forgings and bars

(1) Forgings and bars should be examined by the ultrasonic method, in combination with other methods, such as the radiographic method, magnetic particle method, and/or liquid penetrant method according to the type of material. When the ultrasonic examination does not yield meaningful results, a radiographic method should be used. In addition, all external surface and accessible internal surfaces should be examined by a magnetic particle method or a liquid penetrant method.
(2) Acceptance criteria should be specified.
(3) Repair by welding should be permitted, when specified conditions are met.

5.4. Examination and repair of seamless and welded (without filler metal)-tubular products and fittings

(1) Examination of seamless and welded (without filler metal) tubular products should be performed by either by the ultrasonic method or by a combination of the ultrasonic method, radiographic method, eddy current method, magnetic particle method, and/or liquid penetrant method according to the size and kind of the tubular product.
(2) Acceptance criteria should be defined.
(3) Repair by welding should be permitted, when specified conditions are met.

5.5. Examination and repair of tubular products and fittings welded with filler metal

(1) Plate for tubular products should be examined by the ultrasonic method and the welded part should be examined by the radiographic method and/or a combination of the radiographic method, magnetic particle method, and/or liquid penetrate method according to the size and kind of the tubular product.
(2) Acceptance criteria should be defined.
(3) Repair by welding should be permitted, when specified conditions on repair are met, including repair size, repair procedure, and examination on repair, and the repair is conducted in accordance with a predetermined quality management system.

5.6. Examination and repair of statically and centrifugally cast products

(1) Cast products should be examined by the radiographic method in accordance with specified standards. For a part in which the radiographic method does not produce meaningful results, the ultrasonic method can be employed. The complete surface

should be examined by the magnetic particle method or liquid penetrant method as well.

(2) Acceptance criteria should be defined.

(3) Repair by welding should be permitted, when specified conditions on repair are met, including repair size, repair procedure, and examination on repair, and the repair is conducted in accordance with a predetermined quality management system.

5.7. Examination of bolts, studs, and nuts

(1) All bolting material should be examined in accordance with specified standards by either the magnetic particle method, liquid penetrant method or ultrasonic method, according to the size and kind of the bolting materials.

(2) Acceptance criteria should be defined.

(3) Repair of bolting materials by welding is prohibited.

V-2. Design

Components of a nuclear power plant are subjected to identifiable operating conditions. The design and service loadings should be identified considering all operating conditions of the plant

1. General guidelines

1.1. Technical and administrative rules or items to be addressed for design

The major technical and administrative rules or items to be addressed for design are:

(1) loads and loading conditions including design temperature covered by the design;
(2) service conditions for various events or conditions expected during the life of the plant;
(3) any special design considerations to be included in the design;
(4) component design by analysis including design criteria and stress limits;
(5) general and specific design rules for vessels, pumps, valves and piping;
(6) openings and reinforcement, attachment of nozzles and other connections, nozzle design, permissible welded and bolted joints for the design of vessels;
(7) general and specific design rules addressing different types of pumps f;
(8) general and specific design rules addressing different types of valves including pressure-relief valves;
(9) general and specific design rules addressing different types of piping products.

1.2. Loading conditions

The loading conditions that should be taken into account for establishing the design loads on components include following:

(1) Internal and external pressure;
(2) Impact loads, including rapidly fluctuating pressures;
(3) Weight of the components and normal contents;
(4) Induced loads from other components and equipment;
(5) Loads due to natural phenomena such as wind, snow, vibrations, earthquake, and tsunami;
(6) Reaction of supporting lugs, rings, saddles, etc.;
(7) Temperature effects, etc.

1.3. Design loadings

(1) Design pressure

The design pressure for pressure boundary components should be specified in the design specification such that it should not be less than the maximum difference in pressure between inside and outside of the components that exists under the normal and major transient operating conditions of a nuclear power plant. The design pressure should include allowance for pressure surge, system error, and static pressure heads.

(2) Design temperature

The design temperature for pressure boundary components should be specified in the design specification such that it should not be less than the expected maximum mean metal temperature through the thickness of the parts considered, that exists under the normal and major transient operating conditions of a nuclear power plant.

(3) Design mechanical loads

The design mechanical loads for pressure boundary components specified in the design specification should be selected such that, when combined with the effects of design pressure, they produce the highest primary stress.

1.4. Service conditions

Levels of service conditions to which components may be subjected should be defined corresponding to each level of the plant operating condition. The levels of plant operating conditions should be categorized according to the occurrence probability of deviations from normal operation. The design of a component should be based on the service conditions of that component.

1.5. Component under external pressure

The criteria for the permissible external pressure for the material and configuration of components under external pressure such as vessels should be determined, taking into account the buckling behaviour of the vessels under the external loads.

1.6. Others

Special considerations should be given, as appropriate, to corrosion, cladding, dissimilar metal welding, environmental effects, and examination accessibility.

2. Design by analysis

2.1. General design requirements of components

The requirements for the acceptability of design by analysis are:

(1) The stress intensity should not exceed prescribed limits. The limits should be determined on each stress intensity category and on combinations of stress intensity categories.

(2) The design details should conform to rules determined for each component.

(3) Where compressive stress occurs, the critical buckling stress should be considered.

(4) Protection against brittle fracture should be ensured.

2.2. The theory of failure

The theory of failure, used in the essential performance guidelines, is the maximum shear stress theory.

2.3. Definition of terms relating to stress analysis

(1) Maximum shear stress

The maximum shear stress at a point is equal to one half the differences between the algebraically largest and the algebraically smallest of the three principal stresses.

(2) Stress intensity

Stress intensity is defined as twice the maximum shear stress.

(3) Membrane stress,

Membrane stress is the component of normal stress that is uniformly distributed and equal to the average stress across the thickness of section under consideration

(4) Bending stress,

Bending stress is the component of normal stress that varies across the thickness. The variation may or may not be linear.

(5) Primary stress,

Primary stress is a normal stress or shear stress developed by an imposed loading that is necessary to satisfy the laws of equilibrium of external and internal forces and moments. There are two kind of primary membrane stresses: one is general and one is local.

(6) Secondary stress,

Secondary stress is a normal stress or a shear stress developed by the constraint of adjacent material or by self-constraint of structure. The basic characteristic of a secondary stress is that it is self-limiting. Local yielding and minor distortions can satisfy the conditions that cause the stress to occur and failure from one application of the stress is not to be expected.

(7) Local Primary Membrane stress,

Cases arise in which a membrane stress produced by pressure or other mechanical loading and associated with discontinuity would, if not limited, produce excessive distortion in the transfer of load to other portions of the structure. Conservatism requires that such a stress be classified as a local primary membrane stress even though it has some characteristic of a secondary stress.

(8) Peak stress,

Peak stress is that increment of stress that is additive to the primary plus secondary stresses by reason of local discontinuity or local thermal stress including, if any, of stress concentration. The basic characteristic of a peak stress is that it does not cause any noticeable distortion and is objectionable only as a possible source of a fatigue crack or a brittle fracture.

2.4. Stress analysis

A detailed stress analysis of all major structural components should be prepared in sufficient detail to show that each stress limit is satisfied when components are subjected to the loadings.

2.5. Stress limits for other than bolts

The following describes the basic concepts underpinning requirements on the stress limits for vessels. The specific quantitative requirements are defined in the component codes.

2.5.1. Stress limits under design loadings

The limits under design conditions should be defined by the primary stress intensities.

(1) General primary membrane stress intensity

The general primary membrane stress intensity is derived from the average value across the thickness of a section, produced by design internal pressure and other specified design mechanical loads, but excluding all secondary and peak stresses.

The allowable value for the general membrane stress intensity should be the smaller of the following values. One value should be derived from yield strength. The other value should be derived from ultimate tensile strength. Yield strength and ultimate tensile strength should be considered at design temperature and appropriate margins should be developed for the limiting values.

(2) Local membrane stress intensity

This stress intensity is derived from the average value across the thickness of a section of the local primary stresses produced by design pressure and specified design mechanical loads, considering discontinuities but excluding stress concentrations.

The average value of the distributed local membrane stresses intensities should be below the yield stress of the material.

(3) Primary membrane (general or local) plus the primary bending stress intensities

This stress intensity is derived from the highest value across the thickness of a section of the general or local primary membrane stresses plus primary bending stresses produced by design pressure and other specified design mechanical loads, but excluding all secondary and peak stresses.

The highest value for primary membrane stress intensity plus primary bending stress intensity should be below the yield stress of the material.

2.5.2. Limits at service levels and test conditions

The stress limits at different service levels are defined on the primary stress intensities and/or on the primary plus secondary stress intensities.

(1) Limits of primary stress intensities

The primary stress intensity limits at different service levels are determined on the basis of the primary stress intensity limits at the design conditions. Lower limits may be appropriate for service levels with lower probabilities of occurrence than the design conditions. These limits would thus contain a reduction in required margin relative to yield or ultimate tensile strength.

(2) Limits for primary plus secondary stress intensities

The limits on primary plus secondary stress intensities should ensure the following:

a) The maximum local primary plus secondary stress intensities, which are calculated on an elastic basis, are allowed to be beyond the yield strength of the materials, but should be in the range where stabilized re-distribution of the strain can be established and further growth of yielded areas caused by repeated loads can be avoided. Other large distortion phenomena, such as ratcheting, should be prevented.

b) The primary plus secondary stress intensities should not exceed the ultimate strength of the material.

2.5.3. Analysis for cyclic operation

Cyclic operation analysis should be conducted based on total stress intensities added to peak stresses identified in the stress analysis for the service levels corresponding to the normal and transient operation of the plant.

The cyclic operation analysis should be done as follows.

(1) Necessity of analysis for cyclic service should be evaluated on the basis of loading conditions specified separately.

(2) If the evaluation confirms that cyclic operation should be analysed for, an analysis should be conducted to confirm the ability to withstand the specified cyclic service without fatigue failure. Else no cyclic analysis is required.

2.5.4. Special stress limits

Special limits concerning bearing loads, pure shear stress, tri-axial stress, nozzle piping transition, progressive deformation of non-integral connections, etc. should be analysed as appropriate.

2.5.5. Special analysis

When stress intensity limits (based on elastic analysis) are not satisfied at a specific location, special analysis such as limit analysis and application of plastic analysis may be carried out, as appropriate, to confirm the acceptable structural behaviour of a component.

2.6. Stress limits for bolts

The following describes the basic concepts underpinning requirements on the stress limits for bolts.

2.6.1. Stress limits for bolts at design conditions

(1) The number and cross sectional area of bolts should be determined.

(2) The average tensile stress induced at design conditions by the design pressure and any force needed to maintain tight contact on a gasket should be less than the specified limits for the bolting material. This limit value is determined on the basis of the yield strength of the material with a specified safety factor.

2.6.2. Design limits for bolts at service levels

(1) The average stress across the bolt section at service levels should not exceed a specified limit value. Lower limits may be appropriate for service levels with lower probabilities of occurrence than the design conditions. These limits would thus

contain a reduction in required margin.

(2) The maximum value of service stress at the periphery of the bolt cross-section resulting from direct tension plus bending and neglecting stress concentrations should not exceed specified limits.

(3) The suitability of bolts for cyclic service should be confirmed.

3. Vessel design

3.1. Openings and reinforcements

(1) When a shell has an opening that exceeds predetermined criteria, the vicinity of the opening should be reinforced.

(2) The criteria for the reinforcement of an opening should be determined on the basis of factors such as the opening diameter and the shell thickness and radius.

(3) When the openings are reinforced in accordance with the reinforcement requirements, it should ensure satisfaction of the requirements on primary membrane and bending stress.

(4) When the openings are reinforced in accordance with the reinforcement requirements and if separately specified loading conditions which exempt fatigue analysis are not met, a fatigue analysis should be required.

(5) If it is shown by detailed analysis that all the stress requirements have been met, the rules specified in this par. 3.1 should be waived.

3.2. Fatigue analysis of stresses in openings

The peak stresses around the opening which will be used for fatigue analysis should be determined based on analytical methods such as finite element computer analysis, experimental stress analysis, or stress index method.

3.3. Location and types of weld joints

The types of weld joints that can be allowed should be defined according to the location and orientation of the joints in the vessel.

V-3. Fabrication and Installation

Pressure retaining components should be fabricated and installed in accordance with fabrication and installation rules and procedures specified in codes and standards.

1. General guidelines

1.1. Technical and administrative rules or items to be addressed for fabrication and installation

The major technical and administrative rules or items to be addressed are;

(1) Quality management/assurance including materials certification and identification of materials used in fabrication and installation;
(2) rules for repair of material during fabrication;
(3) rules for the forming, fitting and aligning of materials;
(4) tolerances for forming;
(5) allowable offsets for fitting and aligning;
(6) permissible weld joints in components;
(7) rules for welding qualification including welding procedure qualification tests and required records;
(8) rules for making, examining and repairing welds;
(9) rules for welding attachments;
(10) rules for repairing weld metal defects;
(11) rules for brazing, if permitted;
(12) rules for heat treatment including requirements for preheat, post-weld heat treatment, and repair after post-weld heat treatment;
(13) rules for mechanical bolted joints including use of lubricants.

1.2. Quality management/quality assurance

The quality management or quality assurance/control system for fabrication and installation should be established, including the identification and traceability; examination and testing; handling; transportation; storage; and records of materials and components requirements.

2. Forming, fitting and aligning

2.1. Cutting

Requirements for cutting processes including preheat requirements for thermal cutting should be specified.

2.2. Qualification of forming processes

Any process may be used to do hot- or cold- forming or bending of pressure retaining material, provided the required dimensions are attained. However, procedure qualification testing on forming processes should be conducted, using specimens taken from the material of the same production process so far as applicable.

2.3. Forming Tolerances

(1) Cylindrical, conical, or spherical shells of a completed vessel should meet the requirement that differences in cross-sectional diameter are within the pre-determined limits.
(2) When vessels are designed for external pressure, acceptable maximum deviation from true theoretical form should be established.
(3) For formed vessel heads, acceptable deviation from specified shape should be established.
(4) For formed or bent piping, acceptable minimum wall thickness and ovality tolerance should be established.

2.4. Fitting and aligning

(1) Requirements for fitting and alignment methods such as tack welding should be specified.
(2) Alignment requirements for components welded from two sides should be specified.
(3) Alignment requirements for components with inaccessible inside surface should be specified.

2.5. Requirements for weld joints in components

2.5.1. Longitudinal weld joints

Longitudinal weld joints should be full penetration butt joints. Joints that have been welded from one side with backing that has been removed and those welded from one side without a backing ring should be acceptable, provided the surface of the weld root side of the joint satisfies specified requirements of smoothness.

2.5.2. Circumferential weld joints

Circumferential weld joints should be full penetration butt joints, except for small diameter piping (size to be specified by code), which may be socket welded, with consideration for avoiding residual stresses due to shrinkage of welded part. When backing rings are used and when they are not removed after welding, the suitability for cyclic service should be confirmed.

2.5.3. Weld joints connecting flanges to a shell

The weld joints in vessel connecting flanges or flat/formed heads to shells and similar weld joints in other components should be full penetration weld, except the circumferential weld of piping smaller than a specified value. Socket weld joints may be used on components and in piping with consideration for minimizing residual stresses due to shrinkage of welded part. Joints that have been welded from one side with a backing ring that has been removed and those welded from one side without a backing ring should be acceptable, provided the surface of the joint satisfies specified requirements of smoothness.

2.5.4. Weld joints connecting nozzles to a shell

Weld joints in vessels connecting nozzles to a shell and similar weld joints in other components should be full or partial penetration weld joint. The acceptable configuration of weld design should be limited to several weld design types:

(a) Butt welded nozzles;
(b) Full penetration corner welded nozzles;
(c) Deposited weld metal used as reinforcement of openings for nozzles;
(d) Partial penetration welded nozzles;
(e) Oblique nozzles (if used).

The limitations and conditions for accepting partial penetration welds should be specified.

2.6. Welding end transitions

The welding ends of items should provide a gradual change in thickness from the item to the adjoining item.
An allowable maximum envelope of welding end transitions should be established and illustrated.

3. Welding qualification

3.1. General requirements

Only those welding processes which are capable of producing welds in accordance with the requirements for the welding procedure qualification which are given by codes and/or other industry standards should be used for welding pressure-retaining material or attachments thereto.

3.2. Required qualifications

(1) Each organisation responsible for welding should establish procedures; and conduct the tests required by an applicable welding code to qualify both the welding procedures and performance of welders and welding operators who apply these procedures.

(2) A record of the qualified welding procedures and the welders and welding operators qualified by them, showing the date and results of the tests and the identification mark assigned to each welder should be reviewed, verified, certified and maintained.

3.3. General requirements for welding procedure qualification tests

(1) All welding procedure qualification tests should be in accordance with the requirements of the codes and/or referenced industry standards.

(2) Supplements or modification to the codes and/orreferenced industry standards should be established when necessary; these include:

(a) Heat treatment of qualification welds for ferritic materials;
(b) Preparation of test coupons and specimens;
(c) Impact test requirements;
(d) Qualification requirements on build-up weld deposits;
(e) Welding of instrument tubing.

3.4. Special qualification requirements for tube-to-tube sheet welds

The welding qualification for tube-to-tube sheet welds should be qualified in accordance with the welding codes and/or standards.

4. Rules governing welded joints

4.1. Control of welding material

Each fabricator or installer should be responsible for control of welding electrodes and other welding materials. Suitable identification, storage and handling of electrodes, flux, and other welding materials should be maintained, and effects of moisture on electrodes and flux should be minimized.

4.2. Rules for making welded joints

Requirements on the following special items, as applicable, should be specified,

(1) Backing rings,
(2) Miscellaneous welding requirements,
(3) Surfaces of welds,
(4) Gradual transition in welds of different diameter,
(5) Reinforcement of welds,
(6) Fillet weld shape and size,
(7) Seal welds of threaded joints,
(8) Welding of clad parts.

5. Heat treatment

5.1. Welding pre-heat

The welding procedure should specify preheating requirements as the need for pre-heat and the temperature of preheating are dependent on a number of factors.

5.2. Post-weld heat treatment

(1) All welds, including repair welds, should be post-weld heat treated, except for the following,
  (a) Nonferrous material (in welds of austenitic stainless steel and Inconel, post weld heat treatment is neither required nor prohibited),
  (b) Welds exempted on the basis of the size and carbon content,
  (c) Welds which have been subjected to a higher specified range of post-weld heat treatment temperature.
(2) Holding temperature and minimum holding time should be established as well as post-weld heat treatment requirements when different kinds of materials are jointed.
(3) During post-weld heat treatment, the metal temperature should be maintained within a predetermined temperature range and the minimum holding time should be determined according to the kinds and the thicknesses of the materials.
(4) Post-weld heat treatment heating and cooling rate requirements should be determined according to the kinds and size of the materials.
(5) Additional requirements for local heating for post-weld heat treatment such as

minimum width of controlled band should be determined.

V-4. Examination

Non-destructive examinations should be conducted in accordance with examination methods and procedures specified in codes and/or standards.
Examination procedures should be detailed and have been demonstrated to achieve their stated capabilities by actual demonstration or other appropriate method.

1. General guidelines

1.1. Technical and administrative rules or items for examination

The major technical and administrative rules or items to be addressed are;
(1) rules for non-destructive examination (NDE) methods including NDE procedures;
(2) NDE rules for the examination of weld edge preparation surfaces;
(3) NDE rules for the examination of welds and adjacent base material;
(4) rules specifying the examination methods to be used for various types of welded joints;
(5) rules for pre-service examination, if required;
(6) rules specifying acceptance standards for each NDE method used to detect weld imperfections;
(7) rules for qualification and certification of NDE personnel;
(8) rules for retention of personnel qualification records.

1.2. Time of examination

For each category of weld joint, required examination steps during fabrication and installation should be determined for acceptance of welds and weld metal cladding. Consideration of the accessibility of surfaces and volumes, and type of welds should be accounted for in these steps.

1.3. Examination of weld edge preparation surfaces

All full penetration weld edge preparation surfaces and similar joints with material thickness more than a specified value should be examined by the magnetic particle or liquid penetrant method. Indications should be evaluated in accordance with pre-determined acceptance standards.

1.4. Examination of weld and adjacent base material

When performing surface examinations of weld joints the external and accessible internal weld surfaces and adjacent base material affected by welding should be included in the examination area. The minimum width of heat affected zone to be included in the examination should be specified.

2. Required examination of welds for fabrication and pre-service baseline

2.1. Longitudinal welds

Longitudinal weld joints in vessels and other components should be examined by a volumetric and suitable surface examination.

2.2. Circumferential welds

Circumferential welded joints in vessels and other components should be examined by a volumetric and suitable surface examination.

(1) Butt welded joints should be examined by a volumetric and either liquid penetrant or magnetic particle method.
(2) Fillet and partial penetration welded joints should be examined by either liquid penetrant or magnetic particle method.
(3) Instrument tube butt welds should be examined by the liquid penetrant method.

2.3. Weld joints connecting flanges to a shell

(1) Full penetration butt welded joints should be examined by a volumetric and either liquid penetrant or magnetic particle method.
(2) Full penetration corner welded joints should be examined by a volumetric and either liquid penetrant or magnetic particle method.
(3) Partial penetration and fillet welded joints should be examined by either the magnetic particle or liquid penetrant method on all accessible surfaces.

2.4. Weld joints connecting nozzles to a shell

(1) Welded joints of nozzles, branch, and piping connections attached by full penetration butt welded joints should be examined by radiography and either the liquid penetrant or magnetic particle method.
(2) Full penetration corner welded nozzles in vessels should be examined by a volumetric and either liquid penetrant or magnetic particle method.

(3) Full penetration corner welded branch and piping connections having a diameter exceeding a specified value in piping, pumps, and valves should be examined by a volumetric method and either liquid penetrant or magnetic particle method.

(4) Full penetration corner welded branch and piping connections less than or equal to specified value defined above (3) in piping, pumps, and valves should be examined by either the magnetic particle or liquid penetrant method.

(5) When weld metal build-up is made to a surface, the weld metal build-up, the fusion zone, and the parent metal beneath the weld metal build-up should be ultrasonically examined to ensure the absence of lack of fusion and laminar defects. Nozzles, branch, and piping connections may then be attached on the metal build-up by a full penetration weld. The full penetration butt welded joint should be examined by a volumetric method and either the liquid penetrant or magnetic particle method.

(6) For branch and piping connections less than or equal to a specified value in piping, pumps, and valves, full penetration welds should be examined by either the magnetic particle or liquid penetrant method.

(7) Fillet welded and partial penetration welded joints should be examined progressively using either the magnetic particle or liquid penetrant methods.

2.5. Fillet, partial penetration, socket, and attachment welds

(1) Fillet and partial penetration welded joints and socket welds should be examined by the magnetic particle or liquid penetrant method.

(2) Structural attachment welded joints made to pressure retaining material should be examined by either the magnetic particle or liquid penetrant method.

2.6. Special welding joints

(1) Welded joints of specially designed seals should be examined by either the magnetic particle or liquid penetrant method.

(2) Weld metal cladding should be examined by the liquid penetrant method.

(3) Tube-to-tube sheet welded joints should be examined by the liquid penetrant method.

(4) When the joint detail does not permit radiographic examination to be performed in accordance with this article, ultrasonic examination plus liquid penetrant or magnetic particle examination of the completed weld may be substituted for the radiographic examination. The absence of suitable radiographic equipment should not be justification for such substitution. The substitution of ultrasonic examination may be made provided the examination is performed using a detailed written

procedure which has been proven by actual demonstration.

3. Acceptance standards

(1) Evaluation procedures for indications should be established for each non-destructive examination methods.

(2) Indications or imperfections found by non-destructive examinations should be less than predetermined quantitative acceptance criteria.

4. Final examination of vessels

After the pressure test of a vessel:

(1) All weld joints and heat affected zones used to join ferritic material should be examined, when physically accessible, by the magnetic particle or liquid penetrant method.

(2) Required volumetric pre-service examinations should be performed.

5. Qualification of Non-destructive Examination Personnel

Personnel performing non-destructive examinations should be qualified. Detailed qualification requirements should be established either in the code or through other industry standards.

V-5. Testing

All pressure-retaining components, appurtenances, and completed systems should be pressure tested. The preferred method should be a hydrostatic test using water as the test medium. Bolts, studs, nuts, washers, and gaskets may be exempted from the pressure test.

1. General guidelines

1.1. Technical and administrative rules or items for testing

The major technical and administrative rules or items to be addressed for testing are;
(1) rules for the pressure testing of piping systems and components;
(2) acceptance criteria for hydrostatic and pneumatic pressure tests;
(3) rules for the preparation of testing including exposure of joints, addition of temporary supports, restraint or isolation of expansion joints, and isolation of other equipment not subjected to the pressure test;
(4) rules specifying the hydrostatic test procedure including the test medium, minimum and maximum test pressure, and test temperature;
(5) rules specifying the pneumatic test procedure including the test medium, minimum and maximum test pressure, and test temperature, if pneumatic testing is permitted;
(6) rules for use of pressure test gages including the types of pressure test gages, range of indicating pressure gages, and calibration of pressure test gages;
(7) rules for special test pressure situations such as components designed for external pressure only.

1.2. Pneumatic testing

A pneumatic test may be substituted for the hydrostatic test when it is not appropriate to conduct hydrostatic testing. However, special precautions should be taken when gaseous fluid is used as a test medium.

1.3. Witnessing of pressure testing

Pressure testing should be performed in the presence of an inspector, except testing for which it is determined that the presence of an inspector is not required by regulatory rules.

1.4. Time of pressure testing

The installed system should be pressure tested prior to initial operation.

The pressure test may be performed in a sub-assembled condition or progressively on installed portions of the system. Components, appurtenances, and valves should be pressure tested prior to installation in a system. Substitution of system pressure testing for component pressure testing may be acceptable if the component can be repaired, heat-treated, and examined after system pressure testing.

2. Hydrostatic testing

2.1. Test medium and test temperature

The hydrostatic pressure test should be made at a temperature that will minimize the possibility of brittle fracture. The test pressure should not be applied until the component, appurtenance, or system and the pressurizing fluid are at approximately the same temperature.

2.2. Minimum hydrostatic test pressure

(1) The installed system should be hydrostatically tested at a pre-determined pressure higher than the lowest design pressure of any component within the boundary protected by overpressure protection devices.
(2) Valves should be hydrostatically tested in accordance with valve design rules.
(3) Components should be hydrostatically tested at a predetermined pressure higher than their design pressure.

2.3. Maximum permissible test pressure

The stress limits should be taken into consideration in determining the maximum permissible test pressure. In multi-chamber components, pressure may be simultaneously applied to the appropriate adjacent chamber to satisfy these stress limits.

2.4. Hydrostatic test pressure holding time

The hydrostatic test pressure should be maintained for sufficient time to assess pressure-retaining function.

3. Pneumatic tests

3.1. Minimum pneumatic test pressure

(1) The installed system should be pneumatically tested at a pre-determined pressure higher than the lowest design pressure of any component within the boundary

protected by overpressure protection devices.

(2) Valves should be pneumatically tested in accordance with valve design rules.

(3) Components should be pneumatically tested at a predetermined pressure higher than their design pressure.

3.2. Maximum permissible test pressure

The stress limits should be taken into consideration in determining the maximum permissible test pressure.

3.3. Test pressure holding time

The pneumatic test pressure should be maintained for a pre-determined time.

V-6. Overpressure Protection

A system should be protected from the consequences arising from the application of conditions of pressure and coincident temperature that would cause either the design pressure or the given service limits to be exceeded. Pressure relief devices, or devices with equivalent functions, should be required when the operating conditions would cause the service limits to be exceeded.

1. General guidelines

1.1. Technical and administrative rules or items to be addressed for overpressure protection

The major technical and administrative rules or items to be addressed are;

(1) scope of pressure-boundary components subject to the rules of over-pressure protection;
(2) rules for verifying the operation of reclosing pressure-relief devices;
(3) rules for the installation of pressure-relief devices including use of stop valves;
(4) permissible types of pressure-relief devices;
(5) rules for specifying the relieving capacity of pressure-relief devices;
(6) rules for establishing the set pressures of pressure-relief devices;
(7) rules for the operating and design requirements for pressure-relief devices;
(8) rules for non-reclosing pressure-relief devices such as rupture disk devices;
(9) rules for the capacity certification of pressure-relief devices;
(10) rules for marking each pressure-relief device with information including its size, certified capacity, and set pressure.
(11) rules related to reliability, independence, redundancy, diversity, state indication, fail safe operation, auto-control.

1.2. Pressure relief devices

(1) Pressure relief devices should be installed as close as practicable to the major source of over pressure anticipated to arise within the system.

(2) The connection between a system and its safety relief valve or relief device should not result in accumulated line losses that would affect the total system relieving performance.

(3) The installation of the device should be such that there would be no adverse effects

on the function of the device.

1.3. Stop valves

(1) No stop valve or other device should be placed in a location relative to a pressure relief device, that it could reduce the overpressure protection below that required by these rules, unless such stop valves are constructed and installed with controls and interlocks such that the necessary relieving capacity can be obtained.
(2) Stop valves should have interlocks to prevent valves from being closed or have means to confirm that the stop valves are open during all conditions of system operation.

2. Relieving capacity

2.1. Relieving capacity of pressure relieving devices in expected system transient conditions

(1) The total relieving capacity of the pressure relief devices should take into account any losses due to flow through piping and other components.
(2) The total relieving capacity should be sufficient to prevent a rise in pressure of more than a specified limit above the design pressure of any component within the pressure-retaining boundary of the protected system under any expected system pressure transient conditions.

2.2. Relieving capacity of pressure relieving devices in unexpected system transient conditions

The total relieving capacity should be sufficient to limit the maximum system pressure such that the requirements of stress limits for the service condition are satisfied for each of the components of the system for which overpressure protection is provided, under each of the unexpected system excess pressure transient conditions.

2.3. Reliability of pressure relief devices

For ensuring sufficient reliability of relief valve function, it is recommended that the required relieving capacity for overpressure protection of a system be provided by the use of at least two pressure relief devices. When a single relief valve is used, sufficient reliability of the valve should be demonstrated during the development stage of the valve.

3. Set pressure limitations for expected system pressure transient conditions

The set pressure of at least one of the pressure relief devices connected to the system should not be greater than the design pressure of any component within the pressure-retaining boundary of the protected system. Additional pressure relief devices may have higher set pressures, but in no case should these set pressures be such that the total system pressure exceeds the system limitations.

Appendix to the Essential Performance Guidelines

This EXCEL sheet was developed in order to draft the Essential Performance Guidelines, based on the comparison results of each country's mechanical design and construction code with ASME Sec.3.
The structure of the table is as follows;

ASME Articles	Classification of comparison results			Identification of the articles containing the essences to be included in EPG	The Essential Performance Guidelines
	RCCM	JSME	PNAE G7		

Descriptions in the tables are basically developed based on the ideas bellows;
(1) Code comparison were performed based on basis of description of ASME articles, then items of the left column of the tables are ASME paragraph.

(2) Structure and contents of Korea's KEPIC and Canadian CSA are basically equivalent to ASME, then comparison results of these two codes are not described in the tables. Comparison results of French RCCM and Japan's JSME with ASME were described using the description in ASME Report STP-NU-051-1 at the early stage of this works,. But, at the end of year 2012, comparison results of Russian PNAE G7 with ASME were available and indicated there were significant amount of differences were identified. Then the comparison results of Russian code were added to these tables.

(3) Comparison scale with ASME in the second column of the tables is as follows, based on the ASME Report; STP-NU-051-1,;
A1; Same / A2; Equivalent / B1; Different-Not specified / B2; Technically different
Concerning the items classified as A1 or A2, nothing is described in these tables, meanwhile concerning the items classified B1 or B2, some description were extracted the comparison report.

(4) Concerning the third column "Identification of articles containing the essences to be included in EPG" following concept are applied;
(Yes) : An article or a group of articles which contain the essences of performance requirements to be included in Essential Performance Guidelines
(No) : An article which describes the followings can be excluded from the description in Essential Performance Guidelines. owing to following reasons.:
(1)Practical or detail means or detail procedures to realize the essential requirements,
(2)Administrative matters,
(3)Quantative detail requirements or criteria ,
(4)For convenience of usage,
(5)Special cases,
(6)Obvious matter,
(7)Out of scope,
(8) No major issue,
(9) Others, etc.

(5) Concerning the fourth column "The Essential Performance Guidelines", concept for developing description is as follows;
(5-1) Classification A1, A2; The common essences can be extracted from the ASME articles.
(5-2) Classification B1(Different, Not specified) ; There is no article which corresponds to the ASME article. In many cases, the descriptions similar or equivalent to the ASME articles are specified in the other standards which support the code. Taking into consideration the other standards, the common essences can be extracted into the EPG. If there is no supporting standards, it may be better that he EPG should include some descriptions, as the identification of the article is (Yes).
(5-3) Classification B2 (Technically Different) ;The description of the article in the code is "technically different" from the ASME article. But the aims, or the goals to be aimed at, are similar or common. The approaches or the approaching process or procedures are "technically different", In many cases, the concept of approaches are common. These common elements can be considered as the essences.

Development of the Essential Performance Guidelines (Vessel Design)

June 2014

***Note 1**
Comparison scale with ASME
(ASME Report; STP-NU-051-1)

A1; Same
A2; Equivalent
B1; Different-Not specified
B2; Technically different

**** Note2; Identification of articles containing the essences to be included in EPG**
(Yes) : An article or a group of articles which contain the essences of performance requirements to be included in Essential Performance Guidelines
(No) : An article which describes the followings can be excluded from the description in Essential Performance Guidelines. due to following reasons.:
(1)Practical or detail means or detail procedures to realize the essential requirements,
(2)Administrative matters, (3)Quantative detail requirements or criteria , (4)For convenience of usage, (5)Special cases,
(6)Obvious matter, (7)Out of scope, (8) No major issue, (9)etc.

Notes for identifying the essences in each categorization
Classification A1, A2 (Same. Equivalent); The common essences can be extracted from the ASME articles.
Classification B1(Different, Not specified) ; There is no article which corresponds to the ASME article. In many cases, the descriptions simmilar or equivalent to the ASME articles are specified in the other standards which support the code. Taking into consideration the other standards , the common essences can be extracted into the EPG, If there is no supporting standards, it may be better that the EPG should include some descriptions, as the identification of the article is (Yes) .
Classification B2 (Technically Different) ;The description of the article in the code is "technically different" from the ASME article. But the aims, or the goals to be aimed at, are similar or common. The approaches or the approaching process or procedures are "technically different", In many cases, the concept of approaches are common. These common elements can be considered as the essences.

ASME Articles			Classification (The colums for KEPIC and CSA are not needed as they are basically equivalent to ASME.)				Identification of the articles containing the essences to be included in EPG		The Essential Performance Guidelines (Recommendations, or items to be strived for, not requirements)	
			(France) RCCM *Note 1	(Japan) JSME *Note 1	(Russia) PNAE G7 *Note 1	Remarks	To be included or not **Note 2	Remarks	Identified Common Essences (The qualitative essential rules)	Commentary
NB3100- General Design	NB3110- Loading Criteria	NB3111 Loading Condition	.A2	B1 Design loadings are not specified in JSME but JSME requires that the design loadings are to be specified in the design specification. (It has the same effect if the overall codes and standards are considered).	A2		(Yes)	The loading conditions and design conditions are to be established at first for starting designing. These can be considered as essential, although some explicit descriptions are not found in RCCM and JSME.	1. General design Components of a nuclear power plant are subjected to identifiable operating conditions. The design and service loadings should be identified considering all operating conditions of the plant 1.1 Loading conditions The loading conditions that should be taken into account for establishing the design loads on components include following: (1) Internal and external pressure; (2) Impact loads, including rapidly fluctuating pressures; (3) Weight of the components and normal contents; (4) Induced loads from other components and equipment; (5) Loads due to natural phenomena such as wind, snow, vibrations, earthquake, and tsunami; (6) Reaction of supporting lugs, rings, saddles, etc.; (7) Temperature effects, etc.	(Commentary) Design loadings are not specified in JSME but JSME requires that the design loadings are to be specified in the design specification. (It has the same effect if the overall codes and standards are considered). In RCCM, design loadings are specified in B3131&B3121. The loading conditions and design conditions are to be established as a first step for starting designing. These can be considered as essential requirement, although some explicit descriptions do not exist in some codes.
		NB3112 Design Loadings	B2	A2	A2		(Yes)		1.2 Design loadings (1) Design pressure The design pressure for pressure boundary components should be specified in the design specification such that it should not be less than the maximum difference in pressure between inside and outside of the components that exists under the normal and major transient operating conditions of a nuclear power plant. The design pressure should include allowance for pressure surge, system error, and static pressure heads.	

									(2) Design temperature The design temperature for pressure boundary components should be specified in the design specification such that it should not be less than the expected maximum mean metal temperature through the thickness of the parts considered, that exists under the normal and major transient operating conditions of a nuclear power plant. (3) Design mechanical loads The design mechanical loads for pressure boundary components specified in the design specification should be selected such that, when combined with the effects of design pressure, they produce the highest primary stress.	
		NB3113 Service conditions	B2 Level B is not defined.	A2	B2 Categorization of service conditions is different.		(Yes)	The srevice conditions defined in RCCM and PNAE G7are different but the essential concepts as described in the EGP are all the same.	1.3 Service conditions Levels of service conditions to which components may be subjected should be defined corresponding to each level of the plant operating condition. The levels of plant operating conditions should be categorized according to the occurrence probability of deviations from normal operation. The design of a component should be based on the service conditions of that component	(Commentary) The plant operating conditions are classified based on the safety analysis of the plant. The operating conditions are categorized as, normal operating conditions, upset operating conditions, emergency conditions and faulted conditions. However, as the detail categorization of plant operating conditions is a matter of plant safety analysis and beyond the scope of components code, some codes of components do not use the plant operating conditions. Instead, they define and use the service conditions to which components are exposed. These service conditions are categorized according to the service limits of components, in which allowable deformation or damage are defined. The service limits correspond to each service levels, which are actually corresponding to plant operating conditions.
	NB3120–Special Consideration	NB3121 Corrosion	A2 B2	A2	A2		(Yes)	The items of special consideration can be listed up as optional items to cover all the codes without going into details. .	1.5 Others Special considerations should be given, as appropriate, to corrosion, cladding, dissimilar metal welding, environmental effects, and examination accessibility.	Special considerations are not always required, then "as appropriae" is described. Some wordings comes from ASME.
		NB3122 Cladding	B2	A2	B2					
		NB3123 Welding(Dissimilar weld, Attachments weld)	B2	B1	B1					
		NB3124 Environmental Effects (neutron embrittlement)	B2	B1	A2					
		NB3125 Configuration (Test Accessibility)	B2	B1	B1					

	NB3130– General Design Rule	NB3131 Scope	A1	B1						
		NB3132 Dimensional Standards for Standard Products	B2	B1			(No)	This is just referring to the different subsection of the section III.		
		NB3133 Component under external pressure	A2	A2 B1 (B1; NB3133.2 Nomenclature ,NB3133.5 Stiffning Rings for cylindrical shell are not adressed.)	B2 The concept of approaches is the same.	The par.2.1 are derived from ASME and the essence can be applied for all the other codes.	(Yes)	To be included in the essential safety requirements, as there are some cases in a nuclear power plant in which the external pressure is applied.	.1.4 Component under external pressure The criteria for the permissible external pressure for the material and configuration of components under external pressure such as vessels should be determined, taking into account the buckling behaviour of the vessels under the external loads.	(Commentary) In a nuclear power plant, the pressure applied to a component is internal pressure in most cases. However, as there are some cases in which an external pressure is applied, the essential requirements for the external pressure are included in EPG.
		NB3134 Leak Tightness	B1,	B2	B1		(No)	To be considered in relation to NB6000 Testing requirements.		
		NB3135 Attachments NB3136 Appurtenances MB3137 Reinforcement	B1 B1 B2	A2 B1	B1 B1 B1		(No)	Clarification of detail scope		
NB3200 Design by Analysis	NB3210– Design Criteria	NB3211 Requirement for Acceptability	B2 The concept of approaches to acceptability are the same.	A2	B2 The concept of approaches to acceptability are the same.		(Yes)	The general requirements for acceptability of component design is to be established as a basic requirements for the analysis of component strength design. (Design by analysis is mandatory for cass-1 vessel)	2. Design by analysis 2.1 General design requirements of components; The requirements for the acceptability of design by analysis are: (1) The stress intensity should not exceed prescribed limits. The limits should be determined on each stress intensity category and on combinations of stress intensity categories. (2) The design details should conform to rules determined for each component. (3) Where compressive stress occurs, the critical buckling stress should be considered. (4) Protection against brittle fracture should be ensured.	(Commentary) The acceptability of design is summarized based on the description in ASME.
		NB3212 Basis for determining stresses	A1	A2	A1		(Yes)	The theory of failure on which "design by analysis" is based should be clearly identified. All the codes are based on the maximum shear stress theory.	2.2 The theory of failure. The theory of failure, used in the essential performance guidelines, is the maximum shear stress theory. The maximum shear stress at a point is equal to one half the differences between the algebraically largest and the algebraically smallest of the three principal stresses.	(Commentary) In the components codes (ASME, CSA, RCCM, KEPIC, JSME, and PNAE G7), the maximum shear stress theory is used as the basis of stress analysis.

		NB3213 Terms relating to Stress Analysis	B2	A2 B1	A1 B1		(Yes)	Definition is needed for special terms used.	2.3 Definition of terms relating to stress analysis (1) Stress intensity Stress intensity is defined as twice the maximum shear stress. (2) Membrane stress, Membrane stress is the component of normal stress that is uniformly distributed and equal to the average stress across the thickness of section under consideration (3) Bending stress, Bending stress is the component of normal stress that varies across the thickness. The variation may or may not be linear. (4) Primary stress, Primary stress is a normal stress or shear stress developed by an imposed loading that is necessary to satisfy the laws of equilibrium of external and internal forces and moments. There are two kind of primary membrane stresses: one is general and one is local. (5) Secondary stress, Secondary stress is a normal stress or a shear stress developed by the constraint of adjacent material or by self-constraint of structure. The basic characteristic of a secondary stress is that it is self-limiting. Local yielding and minor distortions can satisfy the conditions that cause the stress to occur and failure from one application of the stress is not to be expected. (6) Local Primary Membrane stress, Cases arise in which a membrane stress produced by pressure or other mechanical loading and associated with discontinuity would, if not limited, produce excessive distortion in the transfer of load to other portions of the structure. Conservatism requires that such a stress be classified as a local primary membrane stress even though it has some characteristic of a secondary stress. (7) Peak stress, Peak stress is that increment of stress that is additive to the primary plus secondary stresses by reason of local discontinuity or local thermal stress including, if any, of stress concentration. The basic characteristic of a peak stress is that it does not cause any noticeable distortion and is objectionable only as a possible source of a fatigue crack or a brittle fracture.	(Commentary) Every code has its own definition on the terms used. The definitions in ASME are used in EPG.
		NB3214 Stress Analysis	A1	A2	A2		(Yes)	Stress analysis is the first step for confirming integrity evaluation of component.	2.4 Stress analysis A detailed stress analysis of all major structural components should be prepared in sufficient detail to show that each stress limit is satisfied when components are subjected to the loadings.	(Commentary) It is described that a detail analysis is needed.
		NB3215 Derivation of Stress Intensity	A1	A2	B2		(No)	These are the actual method to derive stress intensity. These are important but can be considered as detail means		

		NB3216 Derivation of stress differences	A1	A2 B1	B2			to realize the essences.		
		NB3217 Classification of Stresses	B1	A2	B2		(No)	This is for convenience of usage.		
	NB3220– Stress Limits for other than bolts	NB3221 Design Loadings (The design pressure and the design temperature are those that exist in the service level A ;NCA-2142.1)	A1 B2 Level 0 of RCCM corresponds to design conditions of ASME. RCCM does not use the term "design conditions" [Table 19of STP-NU-051-1].	A2	B1 However, in PNAE G7 , the design pressure at design temperature is considered in determining the thichness of the wall in the same way as in ASME.. The normal operating conditions of PNAE G7 includes ASME level A service conditions. ASME design loadings that exist in level A are used as design loadings. (Therefore, PNAE G7 considers the design condition of ASME.)	ASME, JSME, KEPIC,and CSA use the term "Design conditions.	(Yes)	(1)All the codes consider the basic conditions for which the design of components is made, although some codes do not use the term "design conditions". (2)In this EPG, the term "design conditions" is adopted as most codes use the term "design conditions" or simillar conditions.	2.5 Stress limits for other than bolts The following describes the basic concepts underpinning requirements on the stress limits for vessels. The specific quantitative requirements are defined in the component codes. 2.5.1 Stress limits under design loadings The limits under design conditions should be defined by the primary stress intensities. (1) General primary membrane stress intensity The general primary membrane stress intensity is derived from the average value across the thickness of a section, produced by design internal pressure and other specified design mechanical loads, but excluding all secondary and peak stresses. The allowable value for the general membrane stress intensity is the smaller of the following values. One value is derived with from yield strength. The other value is derived from ultimate tensile strength. Yield strength and ultimate tensile strength should be considered at design temperature and appropriate margins should be developed for the limiting values.	(Commentary) The descriptions below are the guideline sentences on the stress limits which are described qualitatively in order to meet the purpose of EPG, though it may be not sufficient in accuracy. Quantitatively see commentary in each item. (2.5.1 Commentary) In most of the codes, a general membrane stress (Pm) is required to be less than Sm value of the material in all components codes. That is; Pm < Sm=Min(2/3Sy,1/3Su)、 Sm=Min(0.9Sy,1/3Su) For austenitic steel where Sy; Yield stress, Su; Ultimate tensile stress
									(2) Local membrane stress intensity This stress intensity is derived from the average value across the thickness of a section of the local primary stresses produced by design pressure and specified design mechanical loads, considering discontinuities but excluding stress concentrations. The average value of the distributed local membrane stresses intensities should be below the yield stress of the material.	(Commentary) In most of the codes, a local membrane stress is required to be less than 1.5 Sm value of the material in all components codes. That is, PL < 1.5Sm=1.5 X 2/3Sy=Sy, namely it is described "at least less than Sy".
									(3) Primary membrane (general or local) plus the primary bending stress intensities This stress intensity is derived from the highest value across the thickness of a section of the general or local primary membrane stresses plus primary bending stresses produced by design pressure and other specified design mechanical loads, but excluding all secondary and peak stresses. The highest value for primary membrane stress intensity plus primary bending stress intensity should be below the yield stress of the material.	(Commentary) A local membrane stress is required to be less than 1.5 Sm value of the material in all components codes except the Russian code ((Russian Code not yet compared). That is; PL < 1.5Sm=1.5 X 2/3Sy=Sy, namely it is described " at least less than Sy.

		NB3222 Level A Service Limits	B2 ASME level A & B correspond to RCCM level A [Table 19].	A2 (B1;NB3222.3 Expansion stress intensity is not applicable to vessels.)	B2 ASME Level A corresponds some portion of NOC of PNAE G. [Table 51]	There are some differences in categorization of servive conditions in each code. But the essences(the concept of approaches) are the same. In this EPG, a detai distinction of service conditions is not discussed.	(Yes)		2.5.2 Limits at service levels and test conditions The stress limits at different service levels are defined on the primary stress intensities and/or on the primary plus secondary stress intensities. (1) Limits of primary stress intensities The primary stress intensity limits at different service levels are determined on the basis of the primary stress intensity limits at the design conditions. Lower limits may be appropriate for service levels with lower probabilities of occurrence than the design conditions. These limits would thus contain a reduction in required (2) Limits for primary plus secondary stress intensities The limits on primary plus secondary stress intensities should ensure the following: a) The maximum local primary plus secondary stress intensities, which are calculated on an elastic basis, are allowed to be beyond the yield strength of the materials, but should be in the range where stabilized re-distribution of the strain can be established and further growth of yielded areas caused by repeated loads can be avoided. Other large distortion phenomena such as ratcheting should be prevented. b) The primary plus secondary stress intensities should not exceed the ultimate strength of the material.	(2.5.2(1) Commentary) There are some differences between the codes on how much relaxations from the design conditions can be allowed for each service level. For example, there is no relaxation in JSME for service level B, but the limits are relaxed to 110% in ASME. In RCCM, there is no definition on level B itself and it is defined that such service levels are included in the level A. However in case of level C, ASME, RCCM and JSME adopt the relaxation to 120%. There are some differences in Level D. This is one of the items to be harmonized. (Commentary) For the value of primary stress intensity plus secondary stress intensity, there is a limit of 3 Sm. As 3 Sm is at least equal to Su (3 x Su/3=Su), it can be described that it should be at least less than the ultimate strength of the material. And 3Sm is also at least equal to 2 Sy (3 x 2Sy/3=2Sy), it can be said that it should be in the range in which a shakedown effect can be expected.
									2.5.3 Analysis for cyclic operation Cyclic operation analysis should be conducted based on total stress intensities added to peak stresses identified in the stress analysis for the service levels corresponding to the normal and transient operation of the plant. The cyclic operation analysis is done as follows. (1) Necessity of analysis for cyclic service is evaluated on the basis of loading conditions specified separately. (2) If the evaluation confirms that cyclic operation should be analyzed for, an analysis should be conducted to confirm the ability to withstand the specified cyclic service without fatigue failure. Else no cyclic analysis is required.	(Commentary) Both ASME and JSME have the equivalent requirements, while in RCCM, there is no description requiring evaluation on the necessity of analysis of cyclic operation. There seem to be some differences in the evaluation methods between RCCM and ASME.

NB3223 Level B Service Limits	B1 No level B in RCCM. RCCM level A includes ASME level B. (Table 19)	A2	B1 The coverage of ASME Level B is different from that of PNAE G . Some portions of NOC and VNOC of PNAE G correspond to ASME Level B. [Table51]						
NB3224 Level C Service Limits	B2 ASME Level C correspond to RCCM LevelC. [Table19]	A2 (B1; NB3224.6 Deformation limits is not applicable.)	B2 The coverage of ASME Level C is different fron that of PNAE G . Some portions of VNOC and EC of PNAE G correspond to ASME Level C. [Table 51]						
NB3225 Level D Service Limits	A2 ASME Level D correspond to RCCM Level D. [Table 19]	A2	B2 The coverage of ASME Level D is different fron that of PNAE G ASME level D corresponds to EC and BDA of PNAE G.. [Table51]						
NB3226 Testing Limits	B1(B2?)	A2	B2			(No)	The concept can be included in the same way as in service levels.		
NB3227 Special Stress limits	A2	A2 B1 In JSME, bearing stress purestress, and nozzle piping transition are adressed.	B2 B1 In PNAE G7, bearing stress, pure shear are adressed in different way.			(Yes)	The items of special stress limits can be listed up as optional items to cover all the codes without going into details.	2.5.4 Special stress limits Special limits concerning bearing loads, pure shear stress, tri-axial stress, nozzle piping transition, progressive deformation of non-integral connections, etc. should be analyzed as appropriate.	
NB3227.1 Bearing loards		A2	B2						
NB3227.2 Pure shear stress		A2	B2						

		NB3227.3 Progrssive distortion of non-integral connection		B1	B1					
		NB3227.4 Triaxial stress		B1	B1					
		NB3227.5 Nozzle piping transition		B2	B1					
		NB3227.6 Application of elastic analysis for stresses beyond the		B1	B1					
		NB3227.7 Requirements for specially designed welded seals		A2	B1					
		NB3228 Application of Plastic Analysis	A1	B2 B1 Only limit analysis is specified(Experimental analysis, plastic analysis, and shakedown analysis are not specified.) and JSME simplified elastic-plastic analysis method is the one developed in Japan(The essences are the same.).	B1 B2 The different methodology for the simplified elastic -plastic analysis are used		(Yes)	At a specific location where basic stress limits are not satisfied, it becomes useful to provide the other kinds of analysis approaches. Special stress limits such as bearing loads, pure shear, triaxial stress, nozzle piping pransition, progressive deformation of non integral connection etc. can be determined as an option base.	2.5.5 Special analysis When stress intensity limits (based on elastic analysis) are not satisfied at a specific location, special analysis such as limit analysis and application of plastic analysis may be carried out, as appropriate, to confirm the acceptable structural behaviour of a component.	(Commentary) In ASME, many methods of plastic analysis are described, which can be used for further evaluation, in case when the primary stress intensity plus the secondary stress intensity exceeds the limit value 3 Sm. However, in JSME, only the method of limits analysis is described. In both ASME and JSME, the simplified plastic elastic analysis method is described, but JSME describes different criteria than ASME on the basis of the Japanese own study results. It is reported that the provisions of RCCM is equivalent to ones of ASME.
		NB3228.1 Limit analysis		A2	B1					
		NB3228.2 Experimental analysis		A2	B1					
		NB3228.3 Plastic analysis		B1	B1					
		NB3228.4 Shakedown analysis		B1	B1					
		NB3228.5 Simplified elastic-plasyic analysis		B2	B2					

		NB3229 Design Stress Values	A2	A2	B1 No tables are difined in PNAE G. but the procedure for determination is provided.		(No)	The design stress value is speified in the materialspecification.		
	NB3230– Stress Limits for Bolts	NB3231 Design Conditions	A1	A2	B1 No equivalence. Same as NB3221		(Yes)	The same as NB3321	2.6 Stress limits for bolts The following describes the basic concepts underpinning requirements on the stress limits for bolts. 2.6.1 Stress limits for bolts at design conditions (1) The number and cross sectional area of bolts should be determined. (2) The average tensile stress induced at design conditions by the design pressure and any force needed to maintain tight contact on a gasket should be less than the specified limits for the bolting material. This limit value is determined on the basis of the yield strength of the material with a specified safety factor.	
		NB3232 Level A Service Limits	A2	A2	B2		(Yes)	The same as NB3322	2.6.2 Design limits for bolts at service levels (1) The average stress across the bolt section at service levels should not exceed a specified limit value. Lower limits may be appropriate for service levels with lower probabilities of occurrence than the design conditions. These limits would thus contain a reduction in required margin. (2) The maximum value of service stress at the periphery of the bolt cross-section resulting from direct tension plus bending and neglecting stress concentrations should not exceed specified limits. (3) The suitability of bolts for cyclic service should be confirmed.	
		NB3233 Level B Service Limits	B2	A2	B1 No equivalence.		(Yes)	The same as NB3223		
		NB3234 Level C	A1	A2	B2		(Yes)	The same as NB3224		
		NB3235 Level D	A1	A2	B2		(Yes)	The same as NB3225		
		NB3236 Design Stress Intensity Values	B2	A2	B1 There are no tables but the procedure to determine the allowable values are given in PNAE G7.		(No)	The same as NB3229		

NB3300 Vessel Design	NB3310 General Requirements	NB3311 Acceptability (Same as NB3100,NB3200)	?	B1	?		(No)	Same as NB3100, NB3200	(Same as NB3100, NB3200)	
	NB3320 Design Considerations	NB3321 Design and Service Loadings	?	B1	?			(Same as NB3110)	(Same as above.)	
		NB3324 Tentative Pressure Thickness	?	B1	?	JSME does not require determination of tentative thichness as a regulatory rule.	(No)	Tentative pressure thickness is the first step of vessel design but this is an aid to designer to do the sizing of the vessel in design conditions.	3. Vessel design	
	NB3330 Opening and Reinforcements	NB3331 General Requirements for Openings	These are stated in the nonmandatory appendices(Appendix ZA).	B2	?	JSME permits only circular or ellipsoidal openings, while ASME permits any typepe of opening(The essences are the same).	(Yes)	The reinforcement of openings is a simple and useful approach, in case a vessel has openings, as the strength of shell and head walls is decreased by openings However, the approaches seems to be different among the codes.The rules for openings are mandatory for some codes and non-mandatory for RCCM. Therefore, the essential concept of "re-enforcement design "is to be described on an option basis..	3.1 Openings and reinforcements (1) When a shell has an opening that exceeds predetermined criteria, the vicinity of the opening should be reinforced. (2) The criteria for the reinforcement of an opening should be determined on the basis of factors such as the opening diameter and the shell thickness and radius. (3) When the openings are reinforced in accordance with the reinforcement requirements, it will ensure satisfaction of the requirements on primary membrane and bending stress. (4) When the openings are reinforced in accordance with the reinforcement requirements and if separately specified loading conditions which exempt fatigue analysis are not met, a fatigue analysis should be required. (5) If it is shown by detailed analysis that all the stress requirements have been met, the rules specified in this par. 3.1 should be waived.	(Commentary) The detail criteria for determining the necessity to provide reinforcement are different between JSME and ASME, but the basic approach is the same. In case of RCCM, B3332 and Appendix ZA seem to take the same kind of the basic approach. Only the basic approach is described in EPG.
		NB3332 Reinforcements for Openings in shells and Formed Heads NB3332.1 Openings not requiring re-inforcements NB3332.2 Required area of re-inforcement		B2	?	JSME criteria for not requiring re-inforcement are defferent from ASME(The essences are the same).				

		NB3333 Reinforcement Required for Openings in Flat Heads		A2	?		(Yes)	The essences of this article can be integrated in NB3331,2	(The essences of this article are included in par.3.1.1.)	
		NB3334 Limits of Reinforcements		A2	?		(No)	Detail requirements for openings		
		NB3335 Metal Available for Reinforcement		A2	?		(No)	Detail requirements for openings		
		NB3336 Strength of Reinforced Material		A2	?		(No)	Detail requirements for openings		
		NB3337 Attachment of Nozzles and Other Connections			?		(No)	Referring to NB3352,NB4000.		
		NB3338 Fatigue Evaluation of Stresses in Openings		B1, B2	?	In JSME experimental method is not specified and the dimensional requirements in the stress index method are different from ASME.(The essences are the	(Yes)	The essences of evaluation rule and design rule for nozzle should be mentioned.	3.2 Fatigue analysis of stresses in openings The peak stresses around the opening which will be used for fatigue analysis should be determined based on analytical methods such as finite element computer analysis, experimental stress analysis, or stress index method.	(Commentary) In JSME, there is no description on the evaluation by testing. The details about the dimensional requirements in the stress index method are different between JSME and ASME, but the basic requirements are the same. In RCCM, no descriptions are found in the comparison report, but in Appendix ZD of RCCM, there are some descriptions on a fatigue analysis in the geometrically non-continuous region. These seem to correspond to a fatigue analysis in openings.
		NB3339 Alternative Rules for Nozzle design		B2	?	The shapes for alternative design are different.	(Yes)	The same as NB3331-Nb3336.	(The essences of this article are included in 3.2.)	
	NB3340 Analysis of Vessels		?		?		(No)	Referring to NB3214.		

	NB3350 Design of Welded Construction	NB3351 Welded Joint Category	?	A2	?	Thare the same, but there are some differences in detail welding configulations.	(Yes)	Necessary for defining welding specifications.	3.3 Location and types of weld joints The types of weld joints that can be allowed should be defined according to the location and orientation of the joints in the vessel.	(Commentary) In ASME and JSME, the location of welding are categorized into category A thru D, such as a longitudinal weld of a shell and a circumferential weld of a shell, and the allowable types of weld are defined according to the categories. RCCM takes the equivalent approach. In the first draft of EPG, these categorizations were described, but they were deleted from the point of the descriptions on welding categorization being too detail for EPG.
		NB3352 Permissible Type of Welded Joint	?	A2 B1	?		(Yes)	Necessary for defining welding specifications. Specified also in Fabrication and installation subsection NB4000 and examination subsection NB5000.		
		NB3354 Structural Attachment Weld	?		?		(No)	Specified in Fabrication and installation subsection NB4000		
		NB3355 Welding Grooves	?		?		(No)	Specified in Fabrication and installation subsection NB4000.		
		NB3357 Thermal Treatment	?		?		(No)	Specified in the fabrication and installation subsection NB4000.		
	NB3360– Special Vessel Requirements	NB3361 Category A or B Joints Between Sections of Unequal Thickness	?	B2	?		(No)	This is a special requirement.		
		NB3362 Bolted Flange Connection	?	B1	?		(No)	Referring to the other standards.		
		NB3363 Access Openings	?	B1	?		(No)	This is not the essential safety requirement		
		NB3364 Attachments	?	B1	?		(No)	This is not the essential requirement		
		NB3365 Supports	?	B1	?		(No)	This is not the essential safety requirement		

Development of the Essential Performance Guidelines （Material）

＊Note 1
Comparison scale with ASME
(ASME Report; STP-NU-051-1)

A1; Same
A2; Equivalent
B1; Different-Not specified
B2; Technically Different

＊＊ Note2; Identification of articles containing the essences to be included in EPG
(Yes) : An article or a group of articles which contain the essences of performance requirements to be included in Essential Performance Guidelines
(No) : An article which describes the followings can be excluded from the description in Essential Performance Guidelines due to following reasons.
(1)Practical or detail means or detail procedures to realize the essential requirements, (2)Administrative matters, (3)Quantative detail requirements or criteria , (4)For convenience of usage, (5)Special cases, (6)Obvious matter, (7)Out of scope, (8) No major issue, (9)etc.

Notes for identifying the essences in each categorization
Classification A1, A2 (Same. Equivalent); The common essences can be extracted from the ASME articles.
Classification B1 (Different, Not specified) ; There is no article which corresponds to the ASME article. In many cases, the descriptions simmilar or equivalent to the ASME articles are specified in the other standards which support the code. Taking into consideration the other standards , the common essences can be extracted into the EPG, If there is no supporting standards, it may be better that the EPG should include some descriptions, as the identification of the article is (Yes) .
Classification B2 (Technically Different) ; The description of the article in the code is "technically different" from the ASME article. But the aims, or the goals to be aimed at, are similar or common. The approaches or the approaching process or procedures are "technically different", In many cases, the concept of approaches are common. These common elements can be considered as the essences.

ASME Articles			Classification (The colums for KEPIC and CSA are not needed as they are basically equivalent to ASME.)				Identification of the articles containing the essences to be included in EPG		**The Essential Performance Guidelines (Recommendations, or items to be strived for, not requirements)**	
			(France) RCCM ＊Note 1	(Japan) JSME ＊Note 1	(Russia) PNAE G7 ＊Note 1	Remarks	To be included or not **＊＊Note 2**	Remarks	Identified Common Essences (The qualitative essential rules)	Commentary
NB2100- General Requirements for Material	NB2110- Scope of Principal Terms Employed		A2	B1 JSME does not define these terms in detail.	B1 No equivqlence in PNAE G7.		(Yes)	The introductory description is needed at the beginning instead of the term definition.	1. General requirements 1.1 Introduction The essential performance guidelines for material summarize the major technical essences of the material requirements of the pressure boundary component codes in MDEP member countries.	
	NB2120- Pressure Retaining Material	NB2121 Permitted Material Specification	B2	B2	B2		(Yes)	These subsection describes the requirements on the pressure retaining materials of nuclear components, being based on the material specification given by the other material standards. This article is refering to the material standards.	1.2 Permitted materials (1) Materials should be compatible with their environment and comply with specified requirements and with other supplemental requirements such as regulatory requirements. The pressure boundary codes, together with other supplemental requirements such as regulatory requirements, describe the requirements which are specially applied to the nuclear components, including the selection of materials to minimise radio-activation. For specifying the general or detailed requirements of the materials, the pressure boundary codes may quote other codes and/or industry standards, etc. (2) The referenced codes and standards for materials can specify chemical composition, microstructure, fabrication suitability, heat treatment, mechanical/thermal properties, etc. as applicable. The mechanical/thermal properties can include allowable stress intensities; allowable stress; ultimate tensile strength; yield strength; thermal expansion properties; nominal coefficient of thermal conductivity and thermal diffusivity; and modulus of elasticity of the material used at room temperature and operating temperatures.	(Commentary) In every code, the requirements on the materials used for the pressure boundary components are defined on the basis of the material specifications of other material codes or standards with adding nuclear specific requirements. ASME has 50 years cooperative relationship with ASTM regarding the requirements of the material specifications. In ASME, the rules to describe the specifications are defined in Section II, Part A, B, and the numerical requirements are described in Part D. The requirements for welding materials are defined in Part C. The Tables 2A, 2B, in Part D, are provided for the primary vessel materials. In JSME, the requirements for nuclear materials are provided in SNJ1. In RCCM, the materials for pressurized water reactor are specified in Section II and one portion of it is for primary vessels.

								(3) Materials should be homogeneous, and suited to the manufacturing processes and, where required, suitable for welding. They should be mutually compatible once assembled, and not give rise to excessive non-destructive inspection limitations during manufacturing or operation. They should have stable properties; in particular they should have a low sensitivity to thermal aging and a high resistance to corrosion. Corrosion products generated that could be activated – when circulating in the core – should not lead to excessive radiation doses impacting maintenance activities. Materials should be chosen to prevent the risk of fast fracture during the whole operating life and in particular to ensure that normal operation occurs far enough from the brittle zone.	
	NB2122 Special Requirements conflicting with permitted Material Specificatio[ns]	B1	B1	B1		(No)	This is a description on special case and not essential issues.		
	NB2124 Size Range	B1	B1	B1		(No)	This is a clarification of scope and not essential issues.		
	NB2125 Fabricated Hubbed Flanges	B1	B1	B1	These are technical routine practices in Japan, even though there is no explicit description in the code.	(No)	This is an obvious matter.		
	NB2126 Finned Tubes	A2		B1		(No)	A finned tube is not used in class-1 vessels		
	NB2127 Seal Membrane Material	A2	B1	B1		(No)	Included in permitted material		
	NB2128 Bolting Material	B2	B2	B2		(No)	Included in permitted material		
NB2130 Certification of Material	NB2130	B2	B1,B2 (The essences are described in JEAC,JI	B2	These are for managing quality level. JSME does not have explicit description. But, it has the same	(Yes)	This is for managing quality level. But, This is important for maintaining safety of component, and the essences for QM should be described as the essential requirements.	1.3 Quality management/quality assurance A quality management (or quality assurance / control) system for the material should be established, including certification, identification, and traceability of materials during manufacturing, handling and storage.	(Commentary) The QM requirements on materials are included in ASME, but no explicit descriptions are included in RCCM and JSME. In Japan, the other codes and standards such as JEAC and JIS describe the QM requirements and are used for defining the QM requirements for materials.
NB2140 Welding Material	NB2140 (Refering NB2400)	B2							

	NB2150 Material Identification	NB2150	B2		B1 No equivalence provision in PNAE G7. (Identification is needed to avoid inclusion of non-certified materials.)	effect if the overall codes and standards are considered				
	NB2160 Deterioration of Material in Service	NB2160	B2	B1	B2		(No)	Outside of the scope		
	NB2170 Heat Treatment to enhance Impact Properties	NB2170	B2	A2	B2		(Yes)	Impact property is key issue for nuclear usage. The essences should be described.	2. Heat treatment of materials 2.1 Enhancement of material properties Carbon steel, low alloy steel, and high alloy chromium steel may be heat treated through processes such as quenching and tempering to enhance their properties.	(Commentary) The heat treatment is one of the important measures to enhance the impact property of materials and every code has the description on heat treatment.
	NB2180 Procedure for Heat treatment of Material	NB2180	A2	B1, ISO-9001 applies.(JIS and JEAC are used.)	A2		(No)	These requirements are one of the detail procedures for managing quality level and can be treated as in QM requirements of NB2130-NB2150.		
	NB2190 Nonpressure retaining Material	NB2190	B1	B2	B1		(No)	Referring to requirements of supporting members.		
NB2200 Material Test Coupons and Specifications for Ferritic Steel Material	NB2210- Heat Treatment Requirements	NB2211 Test Coupon Heat Treatment for Ferritic Material	A2	A2	A2		(Yes)	Heat treatment is the key issue for enhancing material property. The essences should be desribed.	2.2 Material test coupons (1) Where ferritic steel material is required to be subjected to heat treatment during fabrication or installation of a component, the material used for any associated tensile and impact test coupons should be heat treated in the same manner as the component.	(Commentary) The impact property is affected by heat treatment and is the important issue for the nuclear grade materials. Every code requires that the impact property should be confirmed by the testing using the test specimens which have been heat treated on the same conditions as the ones to which the components or parts of them are exposed. This provision is essential one, then included in the EPG.
		NB2212 Test coupon heat treatment for quenched and tempered material	A2	A2	B1 No special requirements for cooling procedure. Cooling is considered as one type of heat treatment and as to be included in above (1).				(2) Where ferritic steel material is subjected to quenching from the austenitizing temperature, the test coupons representing that material should be cooled at a rate similar to and no faster than the main body of the material.	

	NB2220 Procedure for obtaining Test Coupons and Specimens for Quenched and Tempered Material	NB2221 General Requirements	A2	A2	B2		(Yes)	It is important to define the proper procedure of obtaining test specimen to confirm the material property. The essences are to be described. .	2.3 Procedure for obtaining test coupons The procedures for obtaining test coupons for quenched and tempered material, including their number, orientation and location, should be specified for each product form such as plates, forgings, bars, bolting materials, tubular products, and fittings.	(Commentary) In order to confirm the material property, it is required that the test specimen should represent the material property of the manufactured components and the care must be taken so that the specimen will be correctly sampled and manufactured. Every code does require it. This provision is essential one, then included in the EPG.
		NB2222 Plates	A2	A2	B1 No Special requirement on the basis of product form.		(No)	Detail requirements.		
		NB2223 Forgings	B1 No technical qualification	A2						
		NB2224 Bar and Bolting Material	A2	A2						
		NB2225 Tublar Products and Fittings	A2	A2						
		NB2226 Tensile test specimen location	B2	A2						
NB2300 Fracture Toughness Requirements for Material	NB2310 Material to be impact tested	NB2311 Material for which material test is required	B2	A2	B1 No special requirements in PNAE G7. Matrial shall be impact tested if it is required by material specification.		(Yes)	The materials to be impact tested should be clarified.	3. Fracture toughness testing requirements for material 3.1 Material to be impact tested Pressure-retaining material and material welded thereto should be impact tested, except those kinds of the materials for which exclusion of impact test is authorized such as materials smaller or thinner than prescribed limits which are determined according to the kind, shape and dimension of the material. The test data should be used as baseline data for in-service operation of the component and for use in fracture prevention evaluation.	
	NB2320 Impact Test Procedures	NB2321 Type of Tests	B2	A2	B1 B2 GOST9454 is used. GOST9454 covers any type of drop weight test including Charpy V-notch tests.		(Yes)	The types of tests should be clarified.	3.2 Impact test procedure (1) The procedure of impact tests, such as drop weight test or Charpy V-notch test, should be specified or should be in accordance with code specified standards.	(Commentary) Details are defined in associated codes or standards. In the case of ASME, ASME uses ASTM E208 for defining drop weight test and ASTM SA-370 for V-notch test, as the testing procedures are described in details in ASTM. JSME uses JSME SNC1, GTM-3300 for drop weight test and JIS Z2242 for V-notch test. In RCCM, the testing procedures are determined in Section III Examination MC1220, MC1230
		NB2322 Test Specimen	B2	A2	B2 A2				(2) Location and orientation of test specimen should be specified.	

	NB2330 Test Requirements and Acceptance Standards	NB2331 Material for Vessels	A2 B2	A2	B2 A2 B1 B1 B2 B2		(Yes)	The basic concepts for testing should be clarified.	3.3 Impact test requirements on vessel materials (1) Pressure-retaining material for vessels, other than bolting, should be tested to confirm sufficient toughness by measuring the nil-ductility transition temperature with the drop weight test method and/or by impact absorption energy, and/or lateral expansion with Charpy V-notch test specimens. The testing should be done on (a) Base material, (b) Weld metal and, (c) HAZ (heat affected zone) metal. For bars, nozzles, and appurtenances, for which it is impossible to obtain test specimens for drop weight testing due to the size or form of the materials, only Charpy V-notch testing may be done.	(Commentary) Details are defined in associated codes or standards. ASME and JSME have almost the same requirements on the confirmation of no-ductility transition temperature, while RCCM has fundamentally the same requirements with some differences.
		NB2332 Material for piping, Pumps, and valves	B2	A2	B1 No special requirements for the product forms. Common rules are used for any pressure retaining equipment materials..		(Yes)	The same as above.	3.4 Impact test requirements on piping, pump, and valves Pressure-retaining material for piping, pumps, or valves with a wall thickness less than a pre-determined value, should be tested with the Charpy V-notch testing method. For the material of components of a specified size or larger, the same methods as for vessels should be applied.	
		NB2333 Bolting Materials	B2	A2	B1 The same as above.		(Yes)	The same as above.	3.5 Others (1) Impact test on bolting material For bolting material, including studs, nuts, and bolts, Charpy V-notch testing should be conducted.	
	NB2340 Number of Impact Test Required	NB2341 Plate	B2	A2	B2		(Yes)	The number of test specimen and the conditions of retesting have to be specified, as the same test results will not necessary be obtained.	(2) Number of test specimen. The number of test specimen should be determined according to the kind of material product.	
		NB2342 Forging and Casting			B2					
		NB2343 Bars			B2					
		NB2344 Tubler Product and Fittings			B2					
		NB2345 Bolting Material			B2					
		NB2346 Test Definition			B2					
	NB2350 Retest		A2	A2	B2		(Yes)		(3) Retest Conditions for retesting should be determined.	
	NB2360 Calibration of Instrument and Requirement		B2	A2	B2		(No)	These requirements are for managing quality level and the essences can be included in QM requirements of NB2130-NB2150.		

NB2400 Welding Material	NB2410 General Requirements	NB2410	A2 B1	B2 In JSME the general performance requirements are described.	B2 B1		(Yes)	The ASME's general requirements describes general procedural requirements.	4 Welding material 4.1 General requirements (1) Welds should have strength greater than the weakest base metal materials. (2) The welds should have complete fusion and should not have harmful defects in the form of cracks, undercut, overlap, crater, slag inclusion, blowholes, etc. (3) For specifying the detailed welding requirements, the pressure boundary codes may use other codes and/or industry standards.	(Commentary) ASME has detail specifications for welding materials in Section II, Part C and the testing requirements for welding materials. JSME has only essential requirements and defines no detail specifications of welding materials and describes no testing requirements for welding materials. In this EPG, only the essential requirements are described.
	NB2420 Required Tests	NB2420	A2	B1 (In JSME welding qualificxation code, the kinds of the test required are described.)	A2		(No)			
	NB2430 Weld Material Tests	NB2431 Mechanical Property Test	A2	B1	B2					
		NB2432 Chemical Analysis Test	A2	B1	B2					
		NB2433 Delta Ferrite Determination	B2	B1	B2					
	NB2440 Storage and Handling of Welding Material	NB2440	A2	B-1, The essences are described in JEAC JIS	A2			These requirements are for managing quality level and can be included in QM requirements of NB2130-NB2150.		
NB2500 Examination and Repair of Pressure-Retaining Material	NB2510 Examination of Pressure-Reatining Material	NB2510	A2	A2	B2		(Yes)	The materials used for class-1 components should be confirmed to be dect-free by examinations.	5 Examinations 5.1 Examination of pressure-retaining material (1) Pressure retaining materials and materials welded thereto should be examined by non-destructive methods applicable to the material and product form. (2) Other examination codes specifying the specific examination requirements may be used for specifying the details of the non-destructive examination procedures.	(Commentary) The materials for primary components are required to be manufactured in accordance with the requirements of the material specifications. In order to confirm the proper property of the materials, non-destructive examinations are required to be conducted on the materials during or after manufacturing corresponding to the kind and shape of the materials. This EPG, as the performance requirements, define the kinds of non-destructive examinations that are required for kinds and shapes of components such as plates, forgings, bars, tubular products, fittings, castings, bolts, studs, nuts, etc. The details on the categorization of kind s and shapes are different among the codes and are not described in this EPG. For the details of the non-destructive examinations, the specifications of other codes and standards are used.
	NB2520 Examination after Quenching and Tempering	NB2520	A2	B1, (These are technical routine practices, even though there is no explicit description in JSME code.)	A2					

NB2530 Examination and Repair of Plates	NB2531 Required Examination	B2	B2	B2		(Yes)	The same as in plates.	5.2 Examination and repair of plates (1) All plates should be examined by the ultrasonic method. (2) Appropriate ultrasonic methods should be selected according to the thickness of the plate to be examined. (3) Extent of examination should be specified. (4) Acceptance criteria on permissible flaws should be specified.	
	NB2532 Examination Procedure	B2	A2 B1	B1		(No)	Detail procedure requirements		
	NB2537 Time of Examination	B2	B2	A2					
	NB2538 Elimination of Surface Defects	B2	B1	B1		(No)	These requirements are for managing quality level and can be included in QM requirements of NB2130–NB2150.		
	NB2539 Repair by Welding	B2	A2 B1	B1 No special provision. (But repair by welding is not prohibited.)		(Yes)	When the material has some dects, the conditions for repair have to be clarified.	(5) Repair by welding should be permitted, when specified conditions on repairing are met, including repair size, repair procedure, and examination on repair and the repair is conducted in accordance with a predetermined quality management system. The repair welds should be examined.	
NB2540 Examination and Repair of Forgings and Bars	NB2541 Required Examination UT,or RT MT or PT	B2	B2 No requirements for RT in case UT does not produce meaningfull results, but the essences are the same.	B2 UT is requirend for materials with dimensions exceeding specified value.		(Yes)	The same as the above.	5.3 Examination and repair of forgings and bars (1) Forgings and bars should be examined by the ultrasonic method, in combination with other methods, such as the radiographic method, magnetic particle method, and/or liquid penetrant method according to the type of material. When the ultrasonic examination does not yield meaningful results, a radiographic method should be used. In addition, all external surface and accessible internal surfaces should be examined by a magnetic particle method or a liquid penetrant method. (2) Acceptance criteria should be specified.	
	NB2542 Ultrasonic Examination	B2	B2	B2		(No)	Detail procedure requirements		
	NB2545 Magnetic Particle Examination	B2	A2 B2	B2			Detail procedure requirements		
	NB2546 Liquid Penetration Examinatiion	B2	A2 B2	B2			Detail procedure requirements		
	NB2547 Time of Examination	B2	B2	B2 A2 B1					
	NB2548 Elimination of Surface Defects	B2	B1	B1		(No)	QM matter These requirements are for managing quality level and can be included in QM requirements of NB2130–NB2150.		
	NB2549 Repair by Weldoing	B2	A2	B1 No special provision. (But repair by welding is not prohibited.)		(Yes)	The same as in plates.	(3) Repair by welding should be permitted, when specified conditions are met.	

NB2550 Examination and Repair of Seamless and Welded(without filler matal)–Tublar Products and Fittings	NB2551 Required Examination	B2	B2 (When the details are compared, there are slight differences as to the application of testing method, but the essenses are the same)	B2	.	(Yes)	The same as in plates.	5.4 Examination and repair of seamless and welded (without filler metal)–tubular products and fittings (1) Examination of seamless and welded (without filler metal) tubular products should be performed either by the ultrasonic method or by a combination of the ultrasonic method, radiographic method, eddy current method, magnetic particle method, and/or liquid penetrant method according to the size and kind of the tubular product. (2) Acceptance criteria should be defined.	
	NB2552 Ultrasonic Examination	B2	B2	B2		(No)	Detail procedure requirements		
	NB2553 Radiographic Examination	B2	B2	B2			Detail procedure requirements		
	NB2554 Eddy Current Examination	B2	B2	B1 No equivqlence inPNAE G7.			Detail procedure requirements		
	NB2555 Magnetic Particle Examination	B2	A2	B2			Detail procedure requirements		
	NB2556 Liquid Penetrant Examination	B2	A2	B2			Detail procedure requirements		
	NB2557 Time of Examination	B2	B2	B2 B1 B2 A2			The essence can be included in NB2520.		
	NB2558 Elimination of Surface defects	B2	B1	B1		(No)	QM matter Or, these requirements are for managing quality level and can be included in QM requirements of NB2130–NB2150.		
	NB2559 Repair by Welding	B2	B1 No special requirements.JIS is applied.	B1 No special provision. (But repair by welding is not prohibited.)		(Yes)	The same as in plates..	(3) Repair by welding should be permitted, when specified conditions are met.	

NB2560 Examination and Repair of Tubular Products and Fitting welded with Filler Metal	NB2561 Required Examination	B2	B2	A2	When the details are compared, there are slight differences as to the application of testing method, but the essences sre the same.	(Yes)	The same as in plate.	5.5 Examination and repair of tubular products and fittings welded with filler metal (1) Plate for tubular products should be examined by the ultrasonic method and the welded part should be examined by the radiographic method and/or a combination of the radiographic method, magnetic particle method, and/or liquid penetrate method according to the size and kind of the tubular product. (2) Acceptance criteria should be defined.	
	NB2662 Ultrasonic Examination	B2	B2	B2		(No)	Detail procedure requirements		
	NB2563 Radiographic	B2	B2	B2					
	NB2565 Magnetic Particle Examination	B2	A2	B2					
	NB2566 Liquid Penetrant Examination	B2	A2	B2					
	NB2567 Time of Examination	B2	B2			(No)	The essence can be included in NB2520 in broader scope.		
	NB2568 Elimination of Surface defects	B2	B1	B1		(No)	QM matter Or, these requirements are for managing quality level and can be included in QM requirements of NB2130–NB2150.		
	NB2569 Repair by Welding	B2	B1 No special requirements.JIS is applied.	B1 No special provision. (But repair by welding is not prohibited.)		(Yes)	The same as in plates.	(3) Repair by welding should be permitted, when specified conditions on repair are met, including repair size, repair procedure, and examination on repair, and the repair is conducted in accordance with a predetermined quality management system.	
NB2570 Examination and Repair of Statically Centrifugally Cast Products	NB2571 Required Examination	B2	A2	B2		(Yes)	The same as in plates.	5.6 Examination and repair of statically and centrifugally cast products (1) Cast products should be examined by the radiographic method in accordance with specified standards. For a part in which the radiographic method does not produce meaningful results, the ultrasonic method can be employed. The complete surface should be examined by the magnetic particle method or liquid penetrant method as well. (2) Acceptance criteria should be defined.	
	NB2672 Time of non-destructive Examination	B2	A2	B2					

		NB2573 Provision for Repair of Base Material by Welding	B2	A2 B1	B1 No special provision. Requirements may be in technical specification.		(Yes)	The same as in plates.	(3) Repair by welding should be permitted, when specified conditions on repair are met, including repair size, repair procedure, and examination on repair, and the repair is conducted in accordance with a predetermined quality management system.	
		NB2574 Ultrasonic Examination of Ferritic Steel Castings	B2	B2	B2		(No)	Derail procedure requirements	(Included in par.5.6)	
		NB2575 Radiographic Examination	B2	A2 B1	B2					
		NB2576 Liquid Penetrant Examination	B2	A2	B2					
		NB2577 Magnetic Particle Examination	B2	A2	B2					
	NB2580 Examination of Bolts, Studs, and Nuts	NB2581 Required Examination	B2	B2 When the details are compared, there are slight differences as to the application of testing method, but the essences are the same.	B1 No special provision. Requirements may be in technical specification.		(Yes)	The same as in plates.	5.7 Examination of bolts, studs, and nuts (1) All bolting material should be examined in accordance with specified standards by either the magnetic particle method, liquid penetrant method or ultrasonic method, according to the size and kind of the bolting materials. (2)Acceptance criteria should be defined.	
		NB2582 Visual Examination	B2	B1	B1		(No)	Obvious matter. No need of explicit description.		
		NB2583 Magnetic Particle Examination	B2	B2	B1 The same as above.		(No)	Detail procedure requirements.		
		NB2584 Liquid Penetrant Examination	B2	B2 (NB2584.2;A2)	B2 The same as above.					
		NB2585 Ultrasonic Examinatiion (greater than 2”)	B2	A2 B2	B3 The same as above.					

		NB2586Ultrasonic Examination (0ver4")	B2	A2 B2	B4 The same as above.					
		NB2587 Time of Examination	B2	B2	B1		(No)	The essence can be included in NB2520 in broader meaning.		
		NB2588 Examination of Surface Defects	B2	B1	B1		(No)	Not essential requirements		
		NB2589 Repair by Welding	B2	A2	A2		(Yes)	This rule is necessary as the par. 5.6 (3) is described.	(3) Repair of bolting materials by welding is prohibited.	
NB2600 Material Organizations for Quality System Programs	NB2610 Documentation and Maintenance of Quality System Program	NB2610	B2	B1	B1		(No)	Included in QM requirements described for NB2140		
NB2700 Dimensional Standards			B2	B1	B1		(No)	Does not include essential issues.		

Development of the Essential Performance Guidelines (Fabrication and Installation)

***Note 1**
Comparison scale with ASME (ASME Report; STP-NU-051-1)

A1; Same
A2; Equivalent
B1; Different-Not specified
B2; Technically different

**** Note2; Identification of articles containing the essences to be included in EPG**
(Yes) An article or a group of articles which contain the essences of performance requirements to be included in Essential Performance Guidelines
(No) An article which describes the followings can be excluded from the description in Essential Performance Guidelines.:
(1)Practical or detail means or detail procedures to realize the essential requirements, (2)Administrative matters, (3Quantative detail requirements or criteria , (4)For convenience of usage, (5)Special cases, (6)Obvious matter, (7)Out of scope, (8))No major issue, (9)etc.

Notes for identifying the essences in each categorization
Classification A1, A2 (Same. Equivalent); The common essences can be extracted from the ASME articles.
Classification B1(Different, not specified) ; There is no article which corresponds to the ASME article. In many cases, the descriptions simmilar or equivalent to the ASME articles are specified in the other standards which support the code. Taking into consideration the other standards , the common essences can be extracted into the EPG, If there is no supporting standards, it may be better that the EPG should include some descriptions, as the identification of the article is (Yes) .
Classification B2 (Technically different) ; The description of the article in the code is "technically different" from the ASME article. But the aims, or the goals to be aimed at, are similar or common. The approaches or the approaching process or procedures are "technically different", In many cases, the concept of approaches are common. These common elements can be considered as the essences.

ASME Articles			Classification (The colums for KEPIC and CSA are not needed as they are basically equivalent to ASME.)				Identification of Essences to be described in the Essential Performance Guidelines		**The Essential Performance Guidelines (Recommendations, or items to be strived for, not requirements)**	
			(France) RCCM ***Note 1**	(Japan) JSME ***Note 1**	(Russia) PNAE G7 *** Note 1**	Remarks	To be included or not ****Note 2**	Remarks	Identified Common Essences (The qualitative essential rules)	Commentary
NB4100-General Requirements	NB4110-Introduction		A2	A2	B2		(Yes)	An introductory sentence is necessary.	1. General requirements 1.1. Introduction Pressure retaining components should be fabricated and installed in accordance with fabrication and installation rules and procedures specified in codes and standards.	
	NB4120-Certification of Materials and Fabrication by Certificate Holder	NB4121 Means of Certification	B2	B1	B1		(No)	Difference of regulatory system		
		NB4122 Material Identification	B2	B1 (JSME does not have an explicit description but the other applicable industry codes on a quality management system describe this requirement.)	B1 Marking may be required by material specification.	Requirements for QM are determined probably by other documents including technical speifications.	(Yes)	This requirement is for managing quality level. The essences of requirements for QM should be described as the essential requirements.	1.2 Quality management/quality assurance The quality management or quality assurance/control system for fabrication and installation should be established, including the identification and traceability; examination and testing; handling; transportation; storage; and records of materials and components requirements.	(Commentary) In ASME, there is explicit description on QM. But JSME and RCCM have no explicit description on QM. France and Japan use other codes or standards for QM. In this EPG, it is described that the basic concepts on QM are to be established.
		NB4123 Examinations	B2	B1	B1		(No)	This is a note for visual examination and not the essential requirement.		
		NB4125 Testing of Welding and Brazing Material	B2	B2	B2		(No)	Only referring to NB2400. No need to be described in the essential safety requirements. The qualification testing		

	NB4130 Repair of Material	NB4131 Examination and Repair of Defects	B2	B2	B1		(No)	Referring to NB2500.		
		NB4132 Documentation of Repair Welds of Base Material	B2	B1 This can be included in the other management system document.	B2		(No)	This requirement is for managing quality level and QM requirements.		
NB4200 Forming Fitting , and Aligning	NB4210– Cutting, Forming, and Bending	NB4211 Cutting	B2	B1 (May be specified in a technical specification.)	B2		(Yes)	Referring to Appendix D of ASME.	2. Forming, fitting and aligning 2.1 Cutting Requirements for cutting processes including preheat requirements for thermal cutting should be specified.	
		NB4212 Forming and Bending Processes	B2	B1	B2		(No)			
		NB4213 Qualification of Forming Processes for Impact Property Requirements	B2	B2 ASME requires qualification. JSME requires the testing of formed material after forming.	B1 No equivqlent provision in the code(but may be in a technical specification.)		(Yes)	Necessary to confirm the impact property of formed material.	2.2 Qualification of forming processes Any process may be used to do hot– or cold–forming or bending of pressure retaining material, provided the required dimensions are attained. However, procedure qualification testing on forming processes should be conducted, using specimens taken from the material of the same production process so far as applicable.	
		NB4214 Minimum Thickness of Fabricated Material	B2	B1	B1		(No)	Referring to NB3000.		
	NB4220 Forming Tolerances	NB4221 Tolerances for Vessel Shells	B2	B2 In JSME, cylindrical requirements are equivalent but no requirements for external pressure, but the number of components subjected to external pressure is few. Necessity of the requirement is small.	B2		(Yes)		2.3 Forming Tolerances (1) Cylindrical, conical, or spherical shells of a completed vessel should meet the requirement that differences in cross–sectional diameter are within the pre–determined limits. (2) When vessels are designed for external pressure, acceptable maximum deviation from true theoretical form should be established. (3) For formed vessel heads, acceptable deviation from specified shape should be established. (4) For formed or bent piping, acceptable minimum wall thickness and ovality tolerance should be established.	(Commentary) The equivalent descriptions are found both in ASME and RCCM. JSME has the equivalent requirements on cylindrical parts of vessels, but no requirements on vessel heads. The requirements against external pressure are not determined in JSME. The above descriptions are considered to be needed in EPG for covering all scope.
		NB4222 Tolerances for Formed Vessel Heads	B2	B2	B2					

		NB4223 Tolerances for Formed or Bent Piping	B2	B1 (In JSME, the tolerances on formed head are not adressed. But the same concept as cylindrical shape can be applied.	B2		(No)	Piping Requirements (To be determined later)		
	NB4230 Fitting and Aligning	NB4231 Fitting and Aligning Methods	B2	B1 (May be specified in a technical specification.)	B2		(Yes)	The rules on fitting or alighning for welding should be clarified.	2.4 Fitting and aligning (1) Requirements for fitting and alignment methods such as tack welding should be specified. (2) Alignment requirements for components welded from two sides should be specified. (3) Alignment requirements for components with inaccessible inside surface should be specified.	(Commentary) This descriptions are summarized from ASME and considered to be needed for coverage of all scope.
		NB4232 Alignment Requirements When Components are Welded From Two Sides	B2	B2	B2					
		NB4233 Alignment requirements When Inside Surfaces are Inaccessible		B1	B2					
	NB4240 Requirements for Weld Joints in Components	NB4241 Category A Weld Joints in Vessels and Longitudinal Weld Joints in Other Components	A2	A2	B2		(Yes)	Essences of requirements for Weld Joints in Components should be described for each category.	2.5 Requirements for weld joints in components 2.5.1 Longitudinal weld joints Longitudinal weld joints should be full penetration butt joints. Joints that have been welded from one side with backing that has been removed and those welded from one side without a backing ring should be acceptable, provided the surface of the weld root side of the joint satisfies specified requirements of smoothness. 2.5.2 Circumferential weld joints Circumferential weld joints should be full penetration butt joints, except for small diameter piping (size to be specified by code), which may be socket welded, with consideration for avoiding residual stresses due to shrinkage of welded part. When backing rings are used and when they are not removed after welding, the suitability for cyclic service should be confirmed. 2.5.3 Weld joints connecting flanges to a shell The weld joints in vessel connecting flanges or flat/formed heads to shells and similar weld joints in other components should be full penetration weld, except the circumferential weld of piping smaller than a specified value. Socket weld joints may be used on components and in piping with consideration for minimizing residual stresses due to shrinkage of welded part. Joints that have been welded from one side with a backing ring that has been removed	(Commentary) The permitted types and configurations for the weld joints of vessels are defined according to the location of the joints. ASME, RCCM and JSME have the equivalent descriptions. The full penetration butt weld is generally the permitted welding type but there are some exceptions.
		NB4242 Category B Weld Joints in Vessels and Circumferential Weld Joints in Other Components	A2	A2	B2					
		NB4243 Category C Weld Joints in Vessels and Similar Weld Joints in Other Components	A2	A2 Either a butt welded joint or a full penetration corner joints should be used.	B2					

		NB4244 Category D Weld Joints in Vessels and Similar Weld Joints in Other Components	A2	B2 SME does not provide the example of oblique connection, bu the essences are the same.	B2				and those welded from one side without a backing ring should be acceptable, provided the surface of the joint satisfies specified requirements of smoothness. 2.5.4 Weld joints connecting nozzles to a shell Weld joints in vessels connecting nozzles to a shell and similar weld joints in other components should be full or partial penetration weld joint. The acceptable configuration of weld design should be limited to several weld design types. (a) Butt welded nozzles; (b) Full penetration corner welded nozzles; (c) Deposited weld metal used as reinforcement of openings for nozzles; (d) Partial penetration welded nozzles; (e) Oblique nozzles (if used). The limitations and conditions for accepting partial penetration welds should be specified.	
		NB4245 Complete Joint Penetration Welds	B1	B1	B2		(No)	Does not contain substantial requirements		
		NB4246 Piping Branch Connection	B1	B2	B2		(No)	Out of scope for the time being		
	NB4250 Welding End Transitions–Maximum Envelope	Welding End Transitions–Maximum Envelope	B2	B2 In JSME, the requirements for PSI is specified in another code(Fitness for Service Code)	B1 PNAE G7 does not include any specific requirements. (But this requirements may be satisfied in practice.)		(Yes)	This is important to avoid a sharp change of welding end configuration.	2.6 Welding end transitions The welding ends of items should provide a gradual change in thickness from the item to the adjoining item. An allowable maximum envelope of welding end transitions should be established and illustrated.	(Commentary) JSME and RCCM have no explicit description on this topic, but this is included as it is considered to be an important requirement.
NB4300 Welding Qualifications	NB4310 General Requirements	NB4311 Types of Processes Permitted	A2 B2	B2 JSME does not adress stud welding, capacitor discharge welding, friction welding.	A2		(Yes)	The qualification is innevitable for performing welding on class-1 components.	3. Welding qualification 3.1 General requirements Only those welding processes which are capable of producing welds in accordance with the requirements for the welding procedure qualification which are given by codes and/or other industry standards should be used for welding pressure-retaining material or attachments thereto. 3.2 Required qualifications (1) Each organization responsible for welding should establish procedures; and conduct the tests required by an applicable welding code to qualify both the welding procedures and performance of welders and welding operators who apply these procedures. (2) A record of the qualified welding procedures and the welders and welding operators qualified by them, showing the date and results of the tests and the identification mark assigned to each welder should be reviewed, verified, certified and maintained.	(Commentary) In ASME, the detail welding requirements are described not in Section III but in Section IX, In JSME, the requirements on welding qualification are described in Welding Code Part 2. In RCCM, the requirements are in Section IV, S3000.

NB4320 Welding Qualifications, Records, and Identifying Stamps	NB4321 Required Qualifications	B2	B2	B2		(No)	This requirement is for managing quality level and QM requirements and can be included in general requirements for QM in NB4122.		
	NB4322 Maintenance and Certification of Records	B2	B2	B2					
	NB4323 Welding Prior to Qualifications	B2	B2	B1					
	NB4324 Transferring Qualifications	B2	B2	B1					
NB4330 General Requirements For Welding Procedure Qualification Tests	NB4331 Conforming To Section IX Requirements	B2	A2 JSME rules on Welding,Part2	B2		(Yes)	Referring to Section IX.	3.3 General requirements for welding procedure qualification tests (1) All welding procedure qualification tests should be in accordance with the requirements of the codes and/or referenced industry standards. (2) Supplements or modification to the codes and/or referenced industry standards should be established when necessary; these include: (a) Heat treatment of qualification welds for ferritic materials (b) Preparation of test coupons and specimens, (c) Impact test requirements, (d) Qualification requirements on build-up weld deposits (e) Welding of instrument tubing.	
	NB4333 Heat Treatment of Qualification Welds for Ferritic Materials	B2	B2 100%instead of ASME's 80%	B2			NB4620		
	NB4334 Preparation of Test Coupons and Specimens	B2	A2 101%instead of ASME's 80%	B2			Section IX		
	NB4335 Impact Test Requirements	B2	B2 102%instead of ASME's 80%	B2			NB2310		
	NBNB4336 Qualification Requirements for Build-up Welds Deposits	B2	B1	B1		(No)	Requirements for special cases		
	NB4337 Welding of Instrument Tubing	B2	B1	B1					
NB4350 Special Qualification Requirements for Tube -to- Tube sheet Welds	Special Qualification Requirements for Tube-to-Tube sheet Welds	B2	A2	B1 No equivqlence in PNAEW 7. (May be in a technical specification).		(Yes)	The tube to tube weld is a technically important issue.	3.4 Special qualification requirements for tube-to-tube sheet welds The welding qualification for tube-to-tube sheet welds should be qualified in accordance with the welding codes and/or standards.	

	NB4360 Qualification Requirements for Welding Specially Designed Weld Seals	NB4361 General Requirements	B2	B1	B1		(No)	The special weld like omega shaped seal can be treated essentially as one type of butt weld.		
		NB4362 Essential Variables for Automatic, Machine, and Semiautomatic Welding	B2	B1	B1					
		NB4363 Essential Variables for Manual Welding	B2	B1	B1					
		NB4366 Test Assembly	B2	B1	B1					
		NB4367 Examination of Test Assembly	B2	B1	B1					
		NB4368 Performance Qualification Test	B2	B1	B1					
NB4400 Rules Governing Making, Examining, and Repair Welds	NB4410 Precautions to be taken Before Welding	NB4411 Identification, Storage, and handling of Welding Material	B2	B1	B2		(No)	QM matter. Can be treated in the other quality management document.		
		NB4412 Cleanliness and Protection of Welding Surfaces	B2	A2	A2					
	NB4420 Rules for Making Welded Joints	NB4421 Backing Rings	A2	A2	B2		(Yes)	There are many special rules that are defined in the code. It can not be considered that all the rules are essential. It may be appropriate to show only some examples.	4. Rules governing welded joints 4.1 Control of welding material Each fabricator or installer is responsible for control of welding electrodes and other welding materials. Suitable identification, storage and handling of electrodes, flux, and other welding materials should be maintained, and effects of moisture on electrodes and flux should be minimized. 4.2 Rules for making welded joints Requirements on the following special items, as applicable, should be specified, (1) Backing rings, (2) Miscellaneous welding requirements, (3) Surfaces of welds, (4) Gradual transition in welds of different diameter, (5) Reinforcement of welds, (6) Fillet weld shape and size, (7) Seal welds of threaded joints, (8) Welding of clad parts.	(Commentary) There are many specific rules in the codes, bet it is not considered that all the rules are essential. Some examples are listed up.
		NB4422 Peening	A2	B1	B1 No equivqlence in PNAE G7.		(No)			
		NB4423 Miscellaneous Welding Requirements	A2	B1	B1 No equivqlence in PNAE G7.					
		NB4424 Surface of Welds	B2	B2	B2					
		NB4425 Welding Items of Different Diameters	A2	A2	A2					

	NB4426 Reinforcement of Welds	A2	B2 JSME requires less weld reinforcement especially for very thin and very thick weld than ASME	B2		(Yes)			
	NB4427 Shape and Size of Fillet Welds	B2	B2 JSME requires a minimum fillet throat of 0.85tn, while ASME requires o.77tn.	B1		(No)			
	NB4428 Seal Welds of Threaded Joints	B1	B1	B1					
	NB4429 Welding of Clads Parts	B1	B1	B1		(No)			
NB4430 Welding of Attachments	NB4431 Materials for Welding	B2	A2	B1		(No)	A welding of attachment can be done in a less stringent way as that of a pressure retaining welding and does not contain additional essential requirements.		
	NB4432 Welding of Structural Attachment	B2	A2	B1					
	NB4433 Structural Attachments	B2	A2	B1					
	NB4434 Welding of Internal Structural Supports in Clad Components	B2	B1	B1					
	NB4435 Welding of Nonstructural Attachments and Their Removal	B2	B2	B1					
	Nb4436 Installation of Attachments to Piping Systems After Testing	B1	B1	B1		(No)	Installation of Attachments to Piping Systems After Testing is a rare case. This is not the essential requirements		
NB4440 Welding of Appurtenances		B1	B1	B1		(No)	Appurtenances can be treated essentially in similar way as in the category C or D.		

	NB4450 Repair of Weld Metal Defects	NB4451 General Requirements	A2	B1	A2		(No)	An obvious matter. No need to be described explicitly.		
		NB4452 Elimination of Surface Defects	B2	B1	B2		(No)	These are detail procedural matter. No need to be described as an essential matter.		
		NB4453 Requirements for Making Repairs of Welds	B2	B1	B2					
NB4500 Brazing	NB4510 Rules for Brazing	NB4511 Where Brazing may Be Used	B1	B1	B1		(No)	Brazing is not applicable to class-1 vessels and can be treated as out of scope..		
		NB4512 Brazing Material		B1	B1					
	NB4520 Brazing Qualification Requirements	NB4521 Brazing Procedure and Performance Qualification	B1	B1	B1					
		NB4522 Valve Seat Ring	B1	B1	B1					
		NB4523 Reheated Joints	B1	B1	B1					
		NB4524 Maximum Temperature Limits	B1	B1	B1					
	NB4530 Fitting and Aligning of Parts to be Brazed		B1	B1	B1					
	NB4540 Examination of Brazed Joints		B1	B1	B1					
NB4600 Heat Treatment	NB4610 Welding Preheat Requirements	NB4611 When Preheat is Necessary	B2	A2	B2		(Yes)	The preheating becomees necessary, depending on the materials and the weldings.	5. Heat treatment 5.1 Welding pre-heat The welding procedure should specify preheating requirements as the need for pre-heat and the temperature of preheating are dependent on a number of factors.	(Commentary) ASME, Section III defines the necessity for pre-heat treatment, etc. and the detail heat treatment procedures are determined in Section IX. In JSME, the same kinds of rules are determined with some differences. In RCCM, the Section IV, S1320, S7520 define the requirements.
		NB4612 Preheating Methods	B2	B1	B2		(No)	An obvious matter. No need to be described explicitly.		
		NB4613 Interpass Temperature	B2	B1	B2					

	NB4620 Post Weld Heat Treatment	NB4621 Heating and Cooling Methods	B2	A2	B1 No equivalence in PNAE G7.		(No)			
		NB4622 PWHT Time and Temperature Requirements	A2	B2 JSME allows short time than ASME. JSME does not have exempting PWHT of nozzles to component welds, temper bead weld repair and repair welds to cladding after final PWHT.	B2		(Yes)	The post weld heat treatment becomes important, depending on the materials and the weldings.	5.2 Post-weld heat treatment (1) All welds, including repair welds, should be post-weld heat treated, except for the following, (a) Nonferrous material (in welds of austenitic stainless steel and Inconel, post-weld heat treatment is neither required nor prohibited), (b) Welds exempted on the basis of the size and carbon content. (c) Welds which have been subjected to a higher specified range of post-weld heat treatment temperature (2) Holding temperature and minimum holding time should be established as well as post-weld heat treatment requirements when different kinds of materials are jointed. (3) During post-weld heat treatment, the metal temperature should be maintained within a predetermined temperature range and the minimum holding time should be determined according to the kinds and the thicknesses of the materials. (4) Post-weld heat treatment heating and cooling rate requirements should be determined according to the kinds and size of the materials. (5) Additional requirements for local heating for post-weld heat treatment such as minimum width of controlled band should be determined.	(Commentary) In ASME, PWHT is described in Section III, NB4620. In JSME, there are descriptions in Welding rules Part1, N1090, Table-5 and JSME and ASME are almost equivalent with some differences in treatment time and temperature requirements. For example, JSME allows shorter treatment time than ASME. RCCM has the descriptions in Section IV, S1340, F8000, S7540, S7620 and it is reported that RCCM and ASME are globally equivalent.
		NB4623 PWHT Heating and Cooling Rate Requirements	B2	A2	B1 No equivalence in PNAE G7. (May be in a technical specification.)					
		NB4624 Methods of Postweld Heat Treatment	B2	B2 JSME requires stricter temperature torelances.	B1		(No)	These are the description on practical method of PWHT. No need to be described as the essential requirements.		
	NB4630 Heat Treatment of Welds Other Than The Final Post Weld Heat Treatment		B1	B1	B1		(No)	This is an explanatory note. No need to be described as an essential requirement.		
	NB4650 Heat Treatment After Bending or Forming For Pipes, Pumps, and	NB4651 Conditions Requiring Heat Treatment After Bending or Forming	B2	B1	B2		(No)	These are not applicable to class-1 vessels.		

	Valves	NB4652 Exemptions from Heat Treatment After Bending or Forming	B2	B1	B2		(No)	These are not for vessels.		
	NB4660 Heat Treatment of Electro slag Welds		B1	B1	B1		(No)			
NB4700 Mechanical Joints	NB4710 Bolting and Threading	NB4711 Thread Engagement	B2	B1	B1		(No)	An obvious matter. No need to be described explicitly.		
		NB4712 Thread Lubricants	B2	B1	B1		(No)	An obvious matter. No need to be described explicitly.		
		NB4713 Removal of Thread Lubricants	B2	B1	B1		(No)	An obvious matter. No need to be described explicitly.		
	NB4720 Bolting Flanged Joints		B1	B1	B1		(No)	An obvious matter. No need to be described explicitly.		
	NB4730 Electrical and Mechanical Penetration Assemblies		B2	B1	B1		(No)	No electrical penetration in cless-1 vessels.		

Development of the Essential Performance Guidelines (Examination)

***Note 1**
Comparison scale with ASME (ASME Report; STP-NU-051-1)

A1; Same
A2; Equivalent
B1; Different-Not specified
B2; Technically different

**** Note2; Identification of articles containing the essences to be included in EPG**
(Yes) An article or a group of articles which contain the essences of performance requirements to be included in Essential Performance Guidelines
(No) An article which describes the followings can be excluded from the description in Essential Performance Guidelines.:
(1)Practical or detail means or detail procedures to realize the essential requirements, (2)Administrative matters, (3Quantative detail requirements or criteria , (4)For convenience of usage, (5)Special cases, (6)Obvious matter, (7)Out of scope, (8)No major issue, (9)etc.

Notes for identifying the essences in each categorization

Classification A1, A2 (Same. Equivalent); The common essences can be extracted from the ASME articles.
Classification B1 (Different, not specified) ; There is no article which corresponds to the ASME article. In many cases, the descriptions simmilar or equivalent to the ASME articles are specified in the other standards which support the code. Taking into consideration the other standards , the common essences can be extracted into the EPG, If there is no supporting standards, it may be better that the EPG should include some descriptions, as the identification of the article is (Yes) .
Classification B2 (Technically different) ; The description of the article in the code is "technically different" from the ASME article. But the aims, or the goals to be aimed at, are similar or common. The approaches or the approaching process or procedures are "technically different", In many cases, the concept of approaches are common. These common elements can be considered as the essences.

ASME Articles			Classification (The colums for KEPIC and CSA are not needed as they are basically equivalent to ASME.)				Identification of Essences to be described in the Essential Performance Guidelines		**The Essential Performance Guidelines (Recommendations, or items to be strived for, not requirements)**	
			(France) RCCM ***Note 1**	(Japan) JSME ***Note 1**	(Russia) PNAE G7 ***Note 1**	Remarks	To be included or not ****Note 2**	Remarks	Identified Common Essences (The qualitative essential rules)	Commentary
NB5100 General Requirements	NB-5110 Methods, Nondestructive Examination Procedures and Cleaning	NB-5111 Methods	A2	A2	B2		(Yes)	The introduction paragraph should be provided at first.	1. General Requirements 1.1 Introduction Non-destructive examinations should be conducted in accordance with examination methods and procedures specified in codes and/or standards. Examination procedures should be detailed and have been demonstrated to achieve their stated capabilities by actual demonstration or other appropriate method.	(Commentary) The details for the examination requirements are described in Section V in ASME.
		NB-5112 Nondestructive Examination Procedures	A2	B1 Not addressed by JSME, These provisions are mostly administrative	B2		(No)			
		NB-5113 Post-Examination Cleaning	B1	B1	B1			Not essential, but obvious matter.		
	NB-5120 Time of Examination of Welds and Weld Metal Cladding		B2	B1 Not addressed by JSME. (But the time of examination is important.)	B2		(Yes)	It is important when the examination is performed.	1.2 Time of examination .For each category of weld joint, required examination steps during fabrication and installation should be determined for acceptance of welds and weld metal cladding. Consideration of the accessibility of surfaces and volumes, and type of welds should be accounted for in these steps.	(Commentary) In RCCM, the requirement on the timing of examination is described in Section IV, S7710 and equivalent to ASME, but JSME has no description. The requirement on examination timing is considered to be one of the important items that are to be included.

	NB-5130 Examination of Weld Edge Preparation Surfaces		A2	B2	B2		(Yes)	The quality of weld is dependant on the conditions of weld edges.	1.3 Examination of weld edge preparation surfaces All full penetration weld edge preparation surfaces and similar joints with material thickness more than a specified value should be examined by the magnetic particle or liquid penetrant method. Indications should be evaluated in accordance with pre-determined acceptance standards.	(Commentary) Concerning the examination on weld edge preparation, in RCCM, the requirements are described in Section IV, S7300 and equivalent to ASME, while the descriptions in JSME Welding Rules Part1, N-1030(3) are different in details. However, the essential points are described as the intent of JSME code is considered to be same.
	NB-5140 Examination of Welds and Adjacent Base Material		B2	A2	B2		(Yes)	The area to be examined should be clarified.	1.4 Examination of weld and adjacent base material When performing surface examinations of weld joints the external and accessible internal weld surfaces and adjacent base material affected by welding should be included in the examination area. The minimum width of heat affected zone to be included in the examination should be specified.	(Commentary) In JSME, there are the equivalent descriptions in the welding rule Part 1, Table 2. RCCM has the same kind of the descriptions in Section IV, S7710 that are reported to coves ASME.
NB-5200 Required Examination of Welds for Fabrication and Preservice Baseline	NB-5210 Category A Vessel Welded Joints and Longitudinal Welded Joints in Other Components		B2	A2	B2		(Yes)	The most suitable type of examinations should be selected for the type and location of welds.	2. Required examination of welds for fabrication and pre-service baseline 2.1 Longitudinal welds Longitudinal weld joints in vessels and other components should be examined by a volumetric and suitable surface examination.	(Commentary) The type of necessary examinations are defined for location and type of welding of vessels. JSME and RCCM are essentially equivalent to ASME.
	NB-5220 Category B Vessel Welded Joints and Circumferential Welded Joints in Piping, Pumps and Valves	NB-5221 Vessel Welded Joints	B2	A2	B2		(Yes)	The same as above.	2.2 Circumferential welds Circumferential welded joints in vessels and other components should be examined by a volumetric and suitable surface examination.	
		NB-5222 Piping, Pump, and Valve Circumferential Welded Joints	B2	A2	B2		(Yes)	The same as above.	(1) Butt welded joints should be examined by a volumetric and either liquid penetrant or magnetic particle method. (2) Fillet and partial penetration welded joints should be examined by either liquid penetrant or magnetic particle method. (3) Instrument tube butt welds should be examined by the liquid penetrant method.	
	NB-5230 Category C Vessel Welded Joints and Similar Welded Joints in Other Components	NB-5231 General Requirements	B2	A2	B2		(Yes)	The same as above.	2.3 Weld joints connecting flanges to a shell (1) Full penetration butt welded joints should be examined by a volumetric and either liquid penetrant or magnetic particle method. (2) Full penetration corner welded joints should be examined by a volumetric and either liquid penetrant or magnetic particle method. (3) Partial penetration and fillet welded joints should be examined by either the magnetic particle or liquid penetrant method on all accessible surfaces.	

NB-5240 Category D Vessel Welded Joints and Branch and Piping Connections in Other Components	NB-5241 General Requirements	B2	A2	B2		(Yes)	The same as above.	2.4 Weld joints connecting nozzles to a shell (1) Welded joints of nozzles, branch, and piping connections attached by full penetration butt welded joints should be examined by radiography and either the liquid penetrant or magnetic particle method.	
	NB-5242 Full Penetration Butt Welded Nozzles, Branch, and Piping	B2	A2						
	NB-5243 Corner Welded Nozzles, Branch, and Piping Connections	B2	A2	B2		(Yes)	the same as above.	(2) Full penetration corner welded nozzles in vessels should be examined by a volumetric and either liquid penetrant or magnetic particle method. (3) Full penetration corner welded branch and piping connections having a diameter exceeding a specified value in piping, pumps, and valves should be examined by a volumetric method and either liquid penetrant or magnetic particle method. (4) Full penetration corner welded branch and piping connections less than or equal to specified value defined above (3) in piping, pumps, and valves should be examined by either the magnetic particle or liquid penetrant method.	
	NB-5244 Weld Metal Buildup at Openings for Nozzles, Branch, and Piping Connections	B1 RCCM MC2700 states methodology requirements which are in ASMEbNB5244.	A2	B2		(Yes)	the same as above.	(5) When weld metal build-up is made to a surface, the weld metal build-up, the fusion zone, and the parent metal beneath the weld metal build-up should be ultrasonically examined to ensure the absence of lack of fusion and laminar defects. Nozzles, branch, and piping connections may then be attached on the metal build-up by a full penetration weld. The full penetration butt welded joint should be examined by a volumetric method and either the liquid penetrant or magnetic particle method. (6) For branch and piping connections less than or equal to a specified value in piping, pumps, and valves, full penetration welds should be examined by either the magnetic particle or liquid penetrant method.	
	NB-5245 Fillet Welded and Partial Penetration Welded Joints	B1	A2	B2		(Yes)	the same as above.	(7)Fillet welded and partial penetration welded joints should be examined progressively using either the magnetic particle or liquid penetrant methods.	
	NB-5246 Oblique Full Penetration Nozzles, Branch, and Piping Connections	B1	B1	B2		(No)	Examination on special design, not applied in current NPP.		

NB-5260 Fillet, Partial Penetration, Socket and Attachment Welded Joints	NB-5261 Fillet, Partial Penetration, and Socket Welded Joints	B2	A2	A2		(Yes)	The same as above.	2.5 Fillet, partial penetration, socket, and attachment welds (1) Fillet and partial penetration welded joints and socket welds should be examined by the magnetic particle or liquid penetrant method.	
	NB-5262 Structural Attachment Welded Joints	B2	A2	A2		(Yes)	The same as above.	(2) Structural attachment welded joints made to pressure retaining material should be examined by either the magnetic particle or liquid penetrant method.	
NB-5270 Special Welded Joints	NB-5271 Welded Joints of Specially Designed Seals	B2	A2	B1 No equivalent provision in PNAE G7. (But this provision has no problem as it describes only that the volumetric examination can not be performed on special welded joints.)		(Yes)	The same as above.	2.6 Special welding joints (1) Welded joints of specially designed seals should be examined by either the magnetic particle or liquid penetrant method.	
	NB-5272 Weld Metal Cladding	B2	A2	B2		(Yes)	The same as above.	(2) Weld metal cladding should be examined by the liquid penetrant method.	
	NB-5273 Hard Surfacing	B2	B1	B2		(No)	Not essential but special process		
	NB-5274 Tube-to-Tubesheet Welded Joints	B2	A2	B2		(Yes)	The most suitable type of examinations should be selected for the type and location of welds.	(3) Tube-to-tube sheet welded joints should be examined by the liquid penetrant method.	
	NB-5275 Brazed Joints	B1	B1			(No)	Not essential but special process		
	NB-5276 Inertia and Continuous Drive Friction Welds	B1	B1	B1		(No)	Examination on a not essential but special process, not applied in current NPP		
	NB-5277 Electron Beam Welds	B1	B!1	B1		(No)	Examination on special procedure		
	NB-5278 Electroslag Welds	8	B1	B1		(No)	Examination on special procedure		

		NB-5279 Special Exceptions	B1 (The rescue measures can be permitted even though they are not explicitly described.)	B2	A2		(Yes)	It is usefull to define the rescue measures for the special case when the required examination can not be performed due to various reasons.	(4) When the joint detail does not permit radiographic examination to be performed in accordance with this article, ultrasonic examination plus liquid penetrant or magnetic particle examination of the completed weld may be substituted for the radiographic examination. The absence of suitable radiographic equipment should not be justification for such substitution. The substitution of ultrasonic examination may be made provided the examination is performed using a detailed written procedure which has been proven by actual demonstration.	
	NB-5280 Preservice Examination	NB-5281 General Requirements	B1	A2	B2		(No)	Preservice examination is defined in associated standards		
		NB-5282 Examination Requirements	B1	A2	B1					
		NB-5283 Components Exempt From Preservice	B1	A2	B1					
NB-5300 Acceptance Standards	NB-5320 Radiographic Acceptance Standards		B2	B2	B2		(Yes)	The acceptance standards should be established. Harmonization of different acceptance criteria is needed among the various codes and standards.	3 Acceptance standards (1) Evaluation procedures for indications should be established for each non-destructive examination methods. (2) Indications or imperfections found by non-destructive examinations should be less than predetermined quantitative acceptance criteria.	(Commentary) The details of acceptance criteria are different among the codes and harmonization is necessary. JSME is based on the Japanese former welding ordinance and differs from ASME. It is reported that RCCM has the more detail descriptions.
	NB-5330 Ultrasonic Acceptance Standards	NB-5331 Fabrication	B2	A2	B2					
		NB-5332 Preservice Examination	B1	B1	B1		(No)	Criteria for preservice inspection.		
	NB-5340 Magnetic Particle Acceptance Standards	NB-5341 Evaluation of Indications	B2	B2	B1 No equivqlent provision in PNAE G7.		(No)			
		NB-5342 Acceptance Standards	B2	B2	B2		(Yes)	The same as NB5320		
		NB-5343 Preservice Examination	B1	B1	B1		(No)	Criteria for preservice inspection.		
	NB-5350 Liquid Penetrant Acceptance Standards	NB-5351 Evaluation of Indications	B2	B2	B2		(Yes)	The same as NB5320		
		NB-5352 Acceptance Standards	B2	B2	B2					

		NB-5353 Preservice Examination	B2	B1	B1		(No)	Criteria for preservice inspection.		
	NB-5360Eddy Current Preservice Examination of Installed Nonferromagnetic Steam Generator Heat Exchanger Tubing		B2	B2	B1		(No)	Criteria for preservice inspection.		
	NB-5370 Visual Acceptance Standards for Brazed Joints		B1	B1	B1		(No)	No usage of brazing for class-1 components		
	NB-5380 Bubble Formation Testing		A2	A2	(But		(No)	Not a usual testing method for class-1 components.		
NB-5400 Final Examination of Vessels	NB-5410 Examination After Hydrostatic Test		A2	B2	B1 There is no corresponding entry in PNAE G7. (But,these are to be done for confirming no damage due to hydrstatic testing.)		(Yes)	It should be confirmed that nothing happened in the welds after the hydrostatic testing.	4. Final examination of vessels After the pressure test of a vessel: (1) All weld joints and heat affected zones used to join ferritic material should be examined, when physically accessible, by the magnetic particle or liquid penetrant method. (2) Required volumetric pre-service examinations should be performed.	(Commentary) The details of acceptance criteria are different among the codes and harmonization is necessary. JSME is based on the Japanese former welding ordinance and differs from ASME. It is reported that RCCM has the more detail descriptions.
NB-5500 Qualifications and Certification of Nondestructive Examination Personnel	NB-5510 General Requirements		A2	B2	B2		(Yes)	Detais are administrative matters, but general requirements should be described in the Essential Safety References. Only introductory remarks.	5. Qualification of Non-destructive Examination Personnel Personnel performing non-destructive examinations should be qualified. Detailed qualification requirements should be established either in the code or through other industry standards.	(Commentary) In JSME, the detail qualification procedure of personnel on non-destructive examinations is in accordance with ISO9001. ASME has the description in NB5500. RCCM has the descriptions in B4233, MC8000, MC2121, MC3121, etc. and reported to be in European approach but equivalent to ASME.
	NB-5520 Personnel Qualification, Certification and Verification	NB-5521 Qualification Procedure	B2	B1 JSME requirements are simillar to ISO-9001 JSME does not aress accreditation fabricators or NDE personnel. (These are covered industry standards.)	B2					
		NB-5522 Certification of Personnel	B2		B2					
		NB-5523 Verification of Nondestructive Examination Personnel Certification	B2		B2					
	NB-5530 Records		B2	B1	B2					

Development of the Essential Performance Guidelines（Testing)

＊Note 1
Comparison scale with ASME (ASME Report; STP-NU-051-1)

A1; Same
A2; Equivalent
B1; Different-Not specified
B2; Technically different

＊＊ Note2; Identification of articles containing the essences to be included in EPG
(Yes) An article or a group of articles which contain the essences of performance requirements to be included in Essential Performance Guidelines
(No) An article which describes the followings can be excluded from the description in Essential Performance Guidelines.:
(1)Practical or detail means or detail procedures to realize the essential requirements, (2)Administrative matters, (3Quantative detail requirements or criteria , (4)For convenience of usage, (5)Special cases, (6)Obvious matter, (7)Out of scope, (8))No major issue, (9)etc.

Notes for identifying the essences in each categorization
Classification A1, A2 (Same. Equivalent); The common essences can be extracted from the ASME articles.
Classification B1 (Different, not specified) ; There is no article which corresponds to the ASME article. In many cases, the descriptions simmilar or equivalent to the ASME articles are specified in the other standards which support the code. Taking into consideration the other standards , the common essences can be extracted into the EPG, If there is no supporting standards, it may be better that the EPG should include some descriptions, as the identification of the article is（Yes）.
Classification B2 (Technically different) ; The description of the article in the code is "technically different" from the ASME article. But the aims, or the goals to be aimed at, are similar or common. The approaches or the approaching process or procedures are "technically different", In many cases, the concept of approaches are common. These common elements can be considered as the essences.

ASME Articles			Classification (The colums for KEPIC and CSA are not needed as they are basically equivalent to ASME.)				Identification of Essences to be described in the Essential Performance Guidelines		**The Essential Performance Guidelines (Recommendations, or items to be strived for, not requirements)**	
			(France) RCCM **＊Note 1**	(Japan) JSME **＊Note 1**	(Russia) PNAE G7 **＊Note 1**	Remarks	To be included or not **＊＊Note 2**	Remarks	Identified Common Essences (The qualitative essential rules)	Commentary
NB-6100 General Requirements	NB-6110 Pressure Testing of Components, Appurtenances and Systems	NB-6111 Scope of Pressure Testing	A2	A2	A2		(Yes)	The introduction paragraph is necessary.	1. General requirements 1.1 Introduction All pressure-retaining components, appurtenances, and completed systems should be pressure tested. The preferred method should be a hydrostatic test using water as the test medium. Bolts, studs, nuts, washers, and gaskets may be exempted from the pressure test.	
		NB-6112 Pneumatic Testing NB-6112.1 Pneumatic Test Limitations NB-6112.2 Precautions to Be Employed in Pneumatic Testing.	B2	(And it is carried out in practise)	B2 A2		(Yes)	Usually a hydrostatic testing is conducted. This is for the case in which a pneumatic testing is necessary.	1.2 Pneumatic testing A pneumatic test may be substituted for the hydrostatic test when it is not appropriate to conduct hydrostatic testing. However, special precautions should be taken when gaseous fluid is used as a test medium.	(Commentary) In France, no pneumatic test is applied to the primary components, as it is only for PWR. But this requirement could be left as it is, because it is described on the assumption that there may be the case in which the hydrostatic test is not appropriate.
		NB-6113 Witnessing of Pressure Tests	B2	B1, JSME does not adress the ANI. (But, hydrostatic test is required in the regulatory law.)	B1 No equivqlence in PNAE G7. (But it may be carried out in practice.)		(Yes)	Witnessing of pressure test by authority or by entrusted body is necessary.	1.3 Witnessing of pressure testing Pressure testing should be performed in the presence of an inspector, except testing for which it is determined that the presence of an inspector is not required by regulatory rules.	(Commentary) In Japan and France, this is not described in the component code but is described in the other regulatory rule. There is no problem if this is included in EPG.

		NB-6114 Time of Pressure Testing NB-6114.1 System Pressure Test NB-6114.2 Component and Appurtenance Pressure Test NB-6114.3 Material Pressure Test.	B2	A2 B2 A2	B2		(Yes)	The timing of the pressure testing should be clarified.	1.4 Time of pressure testing The installed system should be pressure tested prior to initial operation. The pressure test may be performed in a sub-assembled condition or progressively on installed portions of the system. Components, appurtenances, and valves should be pressure tested prior to installation in a system. Substitution of system pressure testing for component pressure testing may be acceptable if the component can be repaired, heat-treated, and examined after system pressure testing.	(Commentary) This is an obvious matter. There is no problem if this is included in EPG.
		NB-6115 Machining After Pressure Test		B1,	B1		(No)	Obvious matter		
	NB-6120 Preparation for testing	NB-6121 Exposure of Joints	B2	A2	A2		(No)	Not esstential matter but describing detail		
		NB-6122 Addition of Temporary Supports		A2	B1		(No)	Not esstential matter but describing detail		
		NB-6123 Restraint or Isolation of Expansion Joints		A2	B1		(No)	Not esstential matter but describing detail		
		NB-6124 Isolation of Equipment Not Subjected to Pressure Test		A2	B1		(No)	Not esstential matter but describing detail procedures.		
		NB-6125 Treatment of Flanged Joints Containing Blanks		A2	B1		(No)	Not esstential matter but describing detail procedures.		
		NB-6126 Precautions Against Test Medium Expansion		A2	B1		(No)	Not esstential matter but describing detail procedures.		
		NB-6127 Check of Test Equipment Before Applying Pressure		A2	B1		(No)	Not esstential matter but describing detail procedures.		
NB-6200 Hydrostatic Tests	NB-6210 Hydrostatic Test Procedure	NB-6211 Venting During Fill Operation	A2	B1,	A2		(No)	Not esstential matter but describing detail procedures.		
		NB-6212 Test Medium and Test Temperature	A2	B1, Appendix 4-1 contains simillar provision for protection against brittle fracture during hydrostatic tests	B2		(Yes)	The test medium temperature should be defined to avoid a brittle fracture.	2. Hydrostatic testing 2.1 Test medium and test temperature The hydrostatic pressure test should be made at a temperature that will minimize the possibility of brittle fracture. The test pressure should not be applied until the component, appurtenance, or system and the pressurizing fluid are at approximately the same temperature.	(Commentary) In JSME, there is no such description but, the care is taken actually for securing the safety.

	NB-6220 Hydrostatic Test Pressure Requirements	NB-6221 Minimum Hydrostatic Test Pressure	B2	B2	B2		(Yes)	The test pressure is the most important parameter.	2.2 Minimum hydrostatic test pressure (1) The installed system should be hydrostatically tested at a pre-determined pressure higher than the lowest design pressure of any component within the boundary protected by overpressure protection devices. (2) Valves should be hydrostatically tested in accordance with valve design rules. (3) Components should be hydrostatically tested at a predetermined pressure higher than their design pressure.	(Commentary) JSME is equivalent to ASME. It is reported that RCCM 2007 has the stricter rule but RCCM 2008 is equivalent to ASME.
		NB-6222 Maximum Permissible Test Pressure	A2 B1 B1	B2	B1		(Yes)	The permissible test pressure should be clarified.	2.3 Maximum permissible test pressure The stress limits should be taken into consideration in determining the maximum permissible test pressure. In multi-chamber components, pressure may be simultaneously applied to the appropriate adjacent chamber to satisfy these stress limits.	(Commentary) JSME has no explicit description. However, but this is to be included in EPGas this is essentially required.
		NB-6223 Hydrostatic Test Pressure Holding Time	B2	B2	A1		(Yes)	The holding time of the presure should be defined.	2.4 Hydrostatic test pressure holding time The hydrostatic test pressure should be maintained for sufficient time to assess pressure-retaining function.	(Commentary) This is an obvious and essential matter. Then this is to be included in EPG
		NB-6224 Examination for Leakage After Application of Pressure	B2 A1 B1	B2	B2		(No)	Not esstential but describing detai procedures.		
NB-6300 Pneumatic Tests	NB-6310 Pneumatic Testing Procedures	NB-6311 General Requirements	B1	B1,	B2		(No)	General; description		
		NB-6312 Test Medium and Test Temperature	B1	B1,	B2		(No)	Precaution for safety		
		NB-6313 Procedure for Applying Pressure	B1	B1,	B1		(No)	Precaution for safety		
	NB-6320 Pneumatic Test Pressure Requirements	NB-6321 Minimum Required Pneumatic Test Pressure	B1	B2	B2		(Yes)	The same as th hydrostatic testing.	3. Pneumatic tests 3.1 Minimum pneumatic test pressure (1) The installed system should be pneumatically tested at a pre-determined pressure higher than the lowest design pressure of any component within the boundary protected by overpressure protection devices. (2) Valves should be pneumatically tested in accordance with valve design rules. (3) Components should be pneumatically tested at a predetermined pressure higher than their design pressure.	(Commentary) This is include in EPG, as this is a description corresponding to paragraph 1.2 in this section.
		NB-6322 Maximum Permissible Test Pressure	B1	B2	B2		(Yes)	The same as th hydrostatic testing.	3.2 Maximum permissible test pressure The stress limits should be taken into consideration in determining the maximum permissible test pressure.	
		NB-6323 Test Pressure Holding Time	B1	B2	B2		(Yes)	The same as th hydrostatic testing.	3.3 Test pressure holding time The pneumatic test pressure should be maintained for a pre-determined time.	

		NB-6324 Examination for Leakage After Application of Pressure	B1	B2	B2		(No)	Not esstential but describing detail procedures.		
NB-6400 Pressure Test Gages		NB-6411 Types of Gages to Be Used and Their Location	B2	B1,	B1		(No)	Not esstential but describing detail procedures.		
		NB-6412 Range of Indicating Pressure Gages	B2	B1,	A2		(No)	Not esstential but describing detail procedures.		
		NB-6413 Calibration of Pressure Test Gages	B2	B1,	B1		(No)	Not esstential but describing detail procedures.		
NB-6600 Special Test Pressure Situations	NB-6610 Components Designed for External Pressure		B1	B2	A2		(No)	Special case		
	NB-6620 Pressure Testing of Combination Units	NB-6621 Pressure Chambers Designed to Operate Independently	B1	B1,	B1		(No)	Obvious matter		
		NB-6622 Common Elements Designed for a Maximum Differential Pressure	B1	B1,	B1		(No)	Not essential matter, special case.		

Development of the Essential Performance Guidelines（Overpressure Protection）

***Note 1**
Comparison scale with ASME
(ASME Report; STP-NU-051-1)

A1; Same
A2; Equivalent
B1; Different-Not specified
B2; Technically different

**** Note2; Identification of articles containing the essences to be included in EPG**
(Yes) An article or a group of articles which contain the essences of performance requirements to be included in Essential Performance Guidelines
(No) An article which describes the followings can be excluded from the description in Essential Performance Guidelines.:
(1)Practical or detail means or detail procedures to realize the essential requirements,
(2)Administrative matters, (3Quantative detail requirements or criteria ,
(4)For convenience of usage, (5)Special cases,
(6)Obvious matter, (7)Out of scope, (8))No major issue, (9)etc.

Notes for identifying the essences in each categorization
Classification A1, A2 (Same. Equivalent); The common essences can be extracted from the ASME articles.
Classification B1 (Different, not specified) ; There is no article which corresponds to the ASME article. In many cases, the descriptions simmilar or equivalent to the ASME articles are specified in the other standards which support the code. Taking into consideration the other standards , the common essences can be extracted into the EPG, If there is no supporting standards, it may be better that the EPG should include some descriptions, as the identification of the article is (Yes) .
Classification B2 (Technically different) ; The description of the article in the code is "technically different" from the ASME article. But the aims, or the goals to be aimed at, are similar or common. The approaches or the approaching process or procedures are "technically different", In many cases, the concept of approaches are common. These common elements can be considered as the essences.

ASME Articles			Classification (The colums for KEPIC and CSA are not needed as they are basically equivalent to ASME.)				Identification of Essences to be described in the Essential Performance Guidelines		**The Essential Performance Guidelines (Recommendations, or items to be strived for, not requirements)**	
			(France) RCCM *Note 1	(Japan) JSME *Note 1	(Russia) PNAE G7 **Note 1	Remarks	To be included or not **Note 2	Remarks	Identified Common Essences (The qualitative essential rules) & Commentary	Remarks
NB-7100 General Requirements	Scope	NB-7111 Definitions	A2		B2 B1		(Yes)	The introduction paragraph is necessary.	1. General requirements 1.1 Introduction A system should be protected from the consequences arising from the application of conditions of pressure and coincident temperature that would cause either the design pressure or the given service limits to be exceeded. Pressure relief devices should be required when the operating conditions would cause the service limits to be exceeded. (Commentary) In JSME code chapter 10, there are related descriptions on safety valve, etc. which are not limited to class 1 component. The JSME' s comparison work has not been done for the Over Pressure Protection from the reason of the understanding that this is not a matter of a component design but rather a matter of system design. In RCCM, it is reported that RCCM is almost equivalent to ASME. In this EPG, the essential portions are described on the basis on ASME.	
	NB-7120 Integrated Overpressure Protection		A2		B2		(No)	This is a systen design matter and not a component matter..		
	NB-7130 Verification of the Operation of Reclosing Pressure Relief Devices	NB-7131 Construction	A2		B2		(No)	This belongs to a detail design		

	NB-7140 Installation	NB-7141 Pressure Relief Devices	A2		B2		(Yes)	The installation of pressure relief valves should not be such that it wolud hinder the function of the plant system.[	1.2 Pressure relief devices (1) Pressure relief devices should be installed as close as practicable to the major source of over pressure anticipated to arise within the system. (2) The connection between a system and its safety relief valve or relief device should not result in accumulated line losses that would affect the total system relieving performance. (3) The installation of the device should be such that there would be no adverse effects on the function of the device.	
		NB-7142 Stop Valves	A2		B2		(Yes)	The installation of stop valves should not be such that it wolud hinder the function of the plant system.[	1.3 Stop valves (1) No stop valve or other device should be placed in a location relative to a pressure relief device, that it could reduce the overpressure protection below that required by these rules, unless such stop valves are constructed and installed with controls and interlocks such that the necessary relieving capacity can be obtained. (2) Stop valves should have interlocks to prevent valves from being closed or have means to confirm that the stop valves are open during all conditions of system operation.	
		NB-7143 Draining of Pressure Relief Devices	A2		B2		(No)	This belongs to a detail design		
	NB-7150 Acceptable Pressure Relief Devices	NB-7151 Pressure Relief Valves4	A2				(No)	This belongs to a detail design		
		NB-7152 Nonreclosing Pressure Relief Devices5	A2							
	NB-7160 Unacceptable Pressure Relief Devices	NB-7161 Deadweight Pressure Relief Valves Dead weight valves should not be used.	A1		B1					
	NB-7170 Permitted Use of Pressure Relief Devices	NB-7171 Safety Valves	A2		B1					
		NB-7172 Safety Relief Valves	B1		B1					
		NB-7173 Relief Valves	B1		B1					
		NB-7174 Pilot Operated Pressure Relief Valves	A2		B1					
		NB-7175 Power Actuated Pressure Relief Valves	A2		B1					
		NB-7176 Safety Valves With Auxiliary Actuating Devices	A2		B1					
		NB-7177 Pilot Operated Pressure Relief Valves Wth Auxiliary Actuating Devices	A2		B1					
		NB-7178 Nonreclosing Devices	A2		B2					

NB-7200 Overpressure Protection Report	NB-7210 Responsibility for Report		A2		B2		(No)	Administrative matters		
	NB-7220 Content of Report		A2		B1					
	NB-7230 Certification of Report		B2		B1					
	NB-7240 Review of Report After Installation		B1		B1					
	NB-7250 Filing of Report		B1		B1					
NB-7300 Relieving Capacity	NB-7310 Expected System Pressure Transient Conditions	NB-7311 Relieving Capacity of Pressure Relief Devices	B2 A2		B2		(Yes)	The relieving capacity is one of the key factors to obtain the proper function of the over pressure protection device.	2 Relieving capacity 2.1 Relieving capacity of pressure relieving devices in expected system transient conditions (1) The total relieving capacity of the pressure relief devices should take into account any losses due to flow through piping and other components. (2) The total relieving capacity should be sufficient to prevent a rise in pressure of more than a specified limit above the design pressure of any component within the pressure-retaining boundary of the protected system under any expected system pressure transient conditions.	
		NB-7312 Relieving Capacity of Pressure Relief Devices Used With Pressure-Reducing Devices	B2		B1		(No)	The essences are included above.	2.2 Relieving capacity of pressure relieving devices in unexpected system transient conditions The total relieving capacity should be sufficient to limit the maximum system pressure such that the requirements of stress limits for the service condition are satisfied for each of the components of the system for which overpressure protection is provided, under each of the unexpected system excess pressure transient conditions.	
		NB-7313 Required Number and Capacity of Pressure Relief Devices	B1 (As the EPG is a mild recommen dation , it may have no problem.)		B2		(Yes)	Redundancy should be considered for securing a high reliability.	2.3 Reliability of pressure relief devices For ensuring sufficient reliability of relief valve function, it is recommended that the required relieving capacity for overpressure protection of a system be provided by the use of at least two pressure relief devices. When a single relief valve is used, sufficient reliability of the valve should be demonstrated during the development stage of the valve.	
		NB-7314 Required Number and Capacity of Pressure Relief Devices for Isolatable Components	B2		A2		(No)	This belongs to a detail design		
	NB-7320 Unexpected System Excess Pressure Transient Conditions	NB-7321 Relieving Capacity of Pressure Relief Devices	A2, B2		B2		(Yes)	The relieving capacity is one of the key factors to obtain the proper function in unexpected plant situation..	2.2 Relieving capacity of pressure relieving devices in unexpected system transient conditions The total relieving capacity should be sufficient to limit the maximum system pressure such that the requirements of stress limits for the service condition are satisfied for each of the components of the system for which overpressure protection is provided, under each of the unexpected system excess pressure transient conditions.	

NB-7400 Set Pressures of Pressure Relief Devices	NB-7410 Set Pressure Limitations for Expected System Pressure Transient Conditions		B2		B2		(Yes)	The set pressure limitation is one of the key factors to obtain the proper function of the over pressure protection device.	3 Set pressure limitations for expected system pressure transient conditions The set pressure of at least one of the pressure relief devices connected to the system should not be greater than the design pressure of any component within the pressure-retaining boundary of the protected system. Additional pressure relief devices may have higher set pressures, but in no case should these set pressures be such that the total system pressure exceeds the system limitations.	
	NB-7420 Set Pressure Limitation for Unexpected System Excess Pressure Transient Conditions		A2		B2		(No)	This is a detail design matter.		
NB-7500 Operating and Design Requirements for Pressure Relief Valves	NB-7510 Safety, Safety Relief and Relief Valves	NB-7511 General Requirements NB-7511.1 Spring-Loaded Valves. NB-7511.2 Balanced Valves NB-7511.3 Antisimmer Type Valves.	B2		B1		(No)	The requirements on each kind of safety relief, and relief valves belong to the detail design.		
		NB-7512 Safety Valve Operating Requirements NB-7512.1 Set Pressure Tolerance NB-7512.2 Blowdown.	B2		B1					
		NB-7513 Safety Relief and Relief Valve Operating Requirements NB-7513.1 Set Pressure Tolerance NB-7513.2 Blowdown.	B1		B2					
		NB-7514 Credited Relieving Capacity	A2							
		NB-7515 Sealing of Adjustments	A2		A2					

NB-7520 Pilot Operated Pressure Relief Valves	NB-7521 General Requirements	B2		A2		(No)	The requirements on pilot operated pressure relief belong to the detail design.		
	NB-7522 Operating Requirements NB-7522.1 Actuation NB-7522.2 Response Time NB-7522.3 Main Valve Operation NB-7522.4 Sensing Mechanism Integrity NB-7522.5 Set Pressure Tolerance NB-7522.6 Blowdown	A2		B1					
	NB-7523 Credited Relieving Capacity	A2		B1					
	NB-7524 Sealing of Adjustments	A2		B1					
NB-7530 Power Actuated Pressure Relief Valves	NB-7531 General Requirements	A2		B1		(No)			
	NB-7532 Operating Requirements NB-7532.1 Actuation. NB-7532.2 Response Times NB-7532.3 Main Valve Operation NB-7532.4 Sensors, Controls, and External Energy Sources	A2		B1					
	NB-7533 Certified Relieving Capacity	A2		B1					
	NB-7534 Credited Relieving Capacity NB-7534.1 Expected System Pressure Transient Conditions. NB-7534.2 Unexpected System Excess Pressure Transient Conditions.	A2		B1					
	NB-7535 Sealing of Adjustments	A2		A2					

	NB-7540 Safety Valves and Pilot Operated Pressure Relief Valves With Auxiliary Actuating Devices	NB-7541 General Requirements	B2		B1					
		NB-7542 Construction	B2		B1					
		NB-7543 Auxiliary Device Sensors and Controls	B2		B1					
		NB-7544 Relieving Capacity NB-7544.1 Expected System Pressure Transient Conditions. NB-7544.2 Unexpected System Excess Pressure Transient Conditions. For unexpected system excess NB-7544.3 Credited Relieving Capacity	B2		B1					
		NB-7545 Response Time	B2		B1					
	NB-7550 Alternative Test Media	NB-7551 General Requirements	B1		B1					
		NB-7552 Correlation	B1		B1					
		NB-7553 Verification of Correlation Procedure	B1		B1					
		NB-7554 Procedure	B1		B1					
NB-7600 Non-reclosing Pressure Relief Devices	NB-7610 Rupture Disk Devices	NB-7611 Burst Pressure Tolerance	B1		B2		(No)	A rupture disk is not used in the primary pressure boundary. The use of a rupture disk belongs to the detail design of a system.		
		NB-7612 Tests to Establish Stamped Burst Pressure	B1		B1					
	NB-7620 Installation	NB-7621 Provisions for Venting or Draining	B1		B1					
		NB-7622 System Obstructions	B1		B2					
		NB-7623 Rupture Disk Devices at the Outlet Side of Pressure Relief Valves	B1		B!					

NB-7700 Certification	NB-7710 Responsibility for Certification of Pressure Relief Valves		B2		B1		(No)	Administrative matter		
	NB-7720 Responsibility for Certification of Nonreclosing Pressure Relief Devices		B2		B1					
	NB-7730 Capacity Certification Pressure Relief Valves – Compressible Fluids	NB-7731 General Requirements NB-7731.1 Capacity Certification NB-7731.2 Test Media NB-7731.3 Test Pressure NB-7731.4 Blowdown NB-7731.5 Drawings NB-7731.6 Design Changes	B2		B1					
		NB-7732 Flow Model Test Method NB-7732.1 Flow Capacity. NB-7732.2 Demonstration of Function	B2		B1					
		NB-7733 Slope Method	B2		B1					
		NB-7734 Coefficient of Discharge Method NB-7734.1 Number of Valves to Be Tested NB-7734.2 Establishment of Coefficient of Discharge NB-7734.3 Calculation of Certified Capacity NB-7734.4 Demonstration of Function	B2		B1					

		NB-7735 Single Valve Method NB-7735.1 Valve Capacity Within Test Facility Limits NB-7735.2 Valve Capacity in Excess of Test Facility Limits. NB-7735.3 Valve Demonstration of Function.	B2		B1						
		NB-7736 Proration of Capacity	B2		B1						
		NB-7737 Capacity Conversions	B2		B1						
		NB-7738 Laboratory Acceptance of Pressure Relieving Capacity Tests	B2		B1						
		NB-7739 Laboratory Acceptance of Demonstration of Function Tests	B2		B1						
	NB-7740 Capacity Certification of Pressure Relief Valves — Incompressible Fluids	NB-7741 General Requirements NB-7741.1 Capacity Certification NB-7741.2 Test Medium NB-7741.3 Test Pressure. NB-7741.4 Blowdown. NB-7741.5 Drawings. NB-7741.6 Design Changes	B2		B1						
		NB-7742 Valve Designs in Excess of Test Facility Limits	B2		B1						
		NB-7743 Slope Method	B2		B1						

		NB-7744 Coefficient of Discharge Method NB-7744.1 Number of Valves to Be Tested. NB-7744.2 Establishment of Coefficient of Discharge NB-7744.3 Calculation of Certified Capacity NB-7744.4 Demonstration of Function	B2		B1					
		NB-7745 Single Valve Method	B2		B1					
		NB-7746 Laboratory Acceptance of Pressure Relieving Capacity Tests	B2		B1					
		NB-7747 Proration of Capacity	B2		B1					
		NB-7748 Capacity Conversions	B2		B1					
		NB-7749 Laboratory Acceptance of Demonstration of Function Tests	B2		B1					
NB-7800 Marking, Stamping and Data Reports	NB-7810Pressure Relief Valves	NB-7811 Marking and Stamping	B1		B2		(No)	Administrative matter		
		NB-7812 Report Form for Pressure Relief Valves	B1		B1					
	NB-7820 Rupture Disk Devices	NB-7821 Rupture Disks	B1		B1					
		NB-7822 Disk Holders (If Used)	B1		B1					
	NB-7830 Certificate of Authorization to Use Code Symbol Stamp		B1		B1					