

# **PBMR Design Codes And Standards**

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# PBMR Design Codes & Standards

## Scope Of Presentation

- PBMR Integrated Design Process/Codes & Standards
- Civil, Structural and Seismic
- RPV, Primary Pressure Boundary
- Electrical and Instrumentation & Control
- Fire Protection

**PBMR INTEGRATED DESIGN PROCESS** QAP 4.13

**DESIGN ASSESSMENT**

PLANT DESIGN:  
Performance Requirements  
Maintenance Requirements  
De-Commissioning Requirements  
Safeguards Requirements

Design Review  
QAP 4.1

Design Failure Analysis of SSC  
QAP 4.8

Modify Plant

LBE Open Listing  
QAP 4.9

**EVENTS CLASSIFICATION**

Normal Operation

Inspection & Testing

Abnormal Condition

Initiating Events

Significant Activity Release

Identification of Licensing Base Events and Pre-screening for Analysis  
QAP 4.9

**DESIGN ANALYSIS**

Deterministic Analysis

Deterministic Analysis

Deterministic Analysis

Acceptable Condition

Modify Plant or re-classify event

SAFETY ASSESSMENT  
Probabilistic Analysis  
Deterministic Analysis  
QAP 4.17

Radiation Protection  
ALARA Review  
Defence-in-Depth

Modify Plant

**CLASSIFICATION**  
QAP 4.12

Non-Protective Aim Related System, Structure, Component (SSC)

Protective Aim Related SSC

**DETERMINATION OF SSC LOADS AND ENVIRONMENTAL FACTORS FOR SSC**  
QAP 4.16

Continue Operation after Event

Frequency

$10^{-3} \text{ annum} < f$

$10^{-6} \text{ annum} < f < 10^{-2} \text{ annum}$

A

P

B

C

D

O

**DESIGN RULES**

SSC QA Requirements

SSC Loading Catalogue

SSC Materials Selection

Design Codes and Standards for SSC

International Design Standards and Codes

**DESIGN ACCEPTANCE**  
QAP 4.7

SSC Design Includes Design of:  
Plant, Plant Maintenance  
ILS, ISI, GOR, Safeguards  
De-commissioning

General Design Criteria

Design Qualification  
QAP 4.7

Compliance

SAR

07/18/01

# PBMR Integrated Design Process

## Codes & Standards, Cont'd

### Codes and Standards selection philosophy

- Established internationally recognized design and construction rules will be followed
- Applicability is demonstrated
- Compatible with the PBMR design and safety requirements
- Differing requirements will be resolved by following the most conservative requirement

# Civil, Structural and Seismic

- Civil
  - Primary code used is ACI 349-97  
“Code Requirements for Nuclear Safety  
Related Concrete Structures”  
Subsidiary reference codes also used
  - Guidance – Draft Reg Guide DG-1098  
“Safety-Related Concrete Structures for Nuclear Power  
Plants (other than reactor vessels and containments)”
- Structural
  - Primary code used is ANSI/AISC N690 – 1994  
“American National Standard Specification for the Design,  
Fabrication and Erection of Steel Safety- Related Structures  
for Nuclear Facilities”

# Civil, Structural and Seismic

## Cont'd

- ASME Code Section III 1998 is also used  
“Boiler and Pressure Vessel Code, Div 1,  
Subsection NF, Supports”
- The following Reference Codes are used for  
determining Design Envelope Loadings
  - ASCE 7-8, “Minimum Design Loads for Buildings and Other  
Structures”
  - US DOE STD-1020-94, “Natural Phenomena Hazards Design  
and Evaluation Criteria for DOE Facilities”
  - SABS 0160 – 1989, “South African Standard, Code of  
Practice: General Procedures and Loads to be adopted in the  
design of Buildings”

# Civil, Structural and Seismic Cont'd

- Seismic
  - US NRC guidance (NUREG 0800, RG's 1.122, 1.165, 1.60, etc.)
  - US DOE guidance (DOE STD 1020-94, etc.)
  - IAEA guidance (50-SG-S2, etc.)
  - Design for tornado and other natural hazards as well as protection from missiles, aircraft crashes, etc. are addressed in some of the guidance above.

# RPV, Primary Pressure Boundary

- RPV
  - ASME Section III Class 1, Sub-Section NB 1998
  - ASME approved Code Case N-499 (1994) has been used to address higher temperatures experienced during Pressurized Loss of Forced Coolant (PLOFC) and Depressurized Loss of Forced Coolant (DLOFC) DBE's (420 deg. C and 480 deg. C). The code case permits temperatures up to 538 deg. C for certain pressures and for a certain time that envelope the PBMR DBE's

This code case needs NRC review and approval.



# RPV, Primary Pressure Boundary

## Cont'd

- RPV Internal Core Barrel
  - Designed to ASME Section III, Division 1, Sub-section NG 1998
  - ASME approved Code Case N-201 (1994) has been used to address higher temperatures experienced during PLOFC and DLOFC DBE's (720 deg. C). The code case permits temperatures up to 816 deg. C for certain levels of stress and for a certain time that envelope the PBMR DBE's
  - This code case needs NRC review and approval.

# RPV, Primary Pressure Boundary

## Cont'd

- Primary Pressure Boundary
  - ASME Section III, Division 1, Sub-Section NC 1998
  - ASME Section XI guidance will be used for the Inservice Inspection Program. Inspectability is one of the design considerations

# Electrical and Instrumentation & Control

- Nuclear Safety Related Systems
  - Reactor Protection System (RPS), Post-Event Instrumentation (PEI), Associated Neutronic Instrumentation, RPS & PEI Human Machine Interfaces (HMI)
    - IEEE Std 603 1998 and IEEE Std 7-4.3.2 1993 are the primary standards
    - Applicable IEEE sub references of the above (e.g. IEEE 308, IEEE 344, IEEE 577, IEEE 1023 only for RPS/PEI HMI)
    - NUREG 0800, Chapter 7

# Electrical and Instrumentation & Control

## Cont'd

- Non-Safety Related I & C Systems
  - Equipment Protection System
    - ANSI/ISA S84.01 1996
  - Operational Control Systems
    - IEC Standards are being used. (International Electrotechnical Commission, based in Geneva, Switzerland. IEC is affiliated with ISO and endorsed by 14 countries, including the US, UK, Germany.)

# Electrical and Instrumentation & Control

## Cont'd

- HMI in the Control Room (excluding RPS & PEI HMI)
  - Detailed design is in preliminary stage
  - NUREG 0800, Chapters 13 and 18
  - NUREG 0700, “Human System Interface Review Guidelines” is the primary input to the HMI and control room design. NUREG 0700 refers to:
    - NUREG 0711, “Human Factor Engineering Program Review Model”
    - NUREG CR 5908, “Advanced Human System Interface Design Review Guidelines”
    - NUREG CR 6105, “Human Factors Engineering Guidance for the Review of Advanced Alarm Systems”
    - NUREG CR 6146, “Local Control Station: Human Engineering Issues and Insights”

# Electrical and Instrumentation & Control

## Cont'd

- Radiological Monitoring System, Seismic Monitoring System, etc. are in preliminary design stage.
  - Appropriate Regulatory guidance (e.g. NUREG 0737) will be used.
- Electrical Systems
  - IEC Standards is being used for “50 Hz design”
  - IEEE Standards will be used for “60 Hz design”

# Fire Protection

- The design of this is in preliminary design stage
- Guidance from the following sources is under consideration
  - NFPA, (e.g. NFPA 80, Fire Doors; NFPA 101, Life Safety)
  - NUREG 0800, Section 9.5.1, Fire Protection Program
  - USNRC (Appropriate Secy's, RG's, and other guidance documents)
  - IAEA Safety Standard Series