ASME Nuclear Codes and Standards

Supporting New Build and Nuclear Manufacturing in South Africa

Sandton, South Africa, October 7-8, 2008

Session 3

Section III - Component Design and Construction

Ralph S. Hill III, PMP
Consulting Engineer, Westinghouse Electric Company
Today’s Agenda

1. Small Advertisement for the ASME Code
2. Structure and Use of Section III
3. Code Interpretations and Code Cases
4. Basic Terms & Important Concepts
5. Subsections of Section III
6. Appendices
ASME Code Usage

60 Countries – ASME B&PV Code
15 Countries – Section III/XI Nuclear Code
20 Countries – Section III Certificate Holders
30 Countries purchase items to Section III/XI
Trend for Boiler Explosions in the U.S.
Today’s Agenda

1. Small Advertisement for the ASME Code
2. **Structure and Use of Section III**
3. Code Interpretations and Code Cases
4. Basic Terms & Important Concepts
5. Subsections of Section III
6. Appendices
III Subsection NCA – General Requirements for Division 1 and Division 2

III Division 1
- Subsection NB – Class 1 Components
- Subsection NC – Class 2 Components
- Subsection ND – Class 3 Components
- Subsection NE – Class MC Components
- Subsection NF – Component Supports
- Subsection NG – Core Support Structures
- Subsection NH – Class 1 Components - Elevated Temperature Service
- Appendices
ASME Section III, Div. 1

- 8 Subsections
  - NCA: General Requirements
  - NB: Class 1 Components
  - NC: Class 2 Components
  - ND: Class 3 Components
  - NE: Class MC Components
  - NF: Supports
  - NG: Core Support Structures
  - NH: Class 1 Components in Elevated Temp. Service

- Appendices
- Code Cases Nuclear Components
Component Classification

Class 1  Components (III, Subsection NB)
Those components that are part of the primary core cooling system

Components (III, Subsection NH)
Those components that are used in elevated temperature service

Class 2  Components (III, Subsection NC)
Those components that are part of various important-to-safety emergency core cooling systems

Class 3  Components (III, Subsection ND)
Those components that are part of the various systems needed for plant operation
Section III Subsection Organization

“construction” = organization =

- materials  NX-2000
- design      NX-3000
- fabrication NX-4000
- examination NX-5000
- inspection  NX-5000
- testing     NX-6000
- overpressure protection  NX-7000
- certification NX-8000
NCA-1140 Use of Code Editions and Addenda

(a)(1) Under the rules of Section III, the Owner or his designee shall establish the Code Edition and Addenda to be included in the Design Specifications. All items of a nuclear power plant may be constructed to a single Code Edition and Addenda, or each item may be constructed to individually specified Code Editions and Addenda.
(a)(2) In no case shall the Code Edition and Addenda dates established in the Design Specifications be earlier than:

(a) 3 years prior to the date that the nuclear power plant construction permit application is docketed; or

(b) The latest edition and addenda endorsed by the regulatory authority having jurisdiction at the plant site at the time the construction permit application is docketed.
Today’s Agenda

1. Small Advertisement for the ASME Code
2. Structure and Use of Section III
3. **Code Interpretations and Code Cases**
4. Basic Terms & Important Concepts
5. Subsections of Section III
6. Appendices
Code Interpretations

• Provide answers to questions about the Code
• Anyone can request
  – Appendix XX provides instructions
• Are published in the Code so answers are available to everyone
Inquiry on Code Edition and Addenda

10CFR52 Design Certification Process

• Regulator may have approved Edition and Addenda earlier than latest endorsed by regulator at time Combined License Application is docketed

• Regulator may have approved Edition and Addenda from the Design Certification Document at time Combined License Application is docketed
Inquiry on Code Edition and Addenda

Inquiry: As described in NCA-1140(a)(2)(b), does “the endorsement of the latest Code Edition and Addenda by the regulatory authority at the time the construction permit is docketed” include the Code Edition and Addenda endorsed by the regulator through the design certification process and included in the combined operating license (COL) at the time the COL is docketed?

Proposed Reply: Yes.
NCA-1140 USE OF CODE EDITIONS, ADDENDA, AND CASES

(a) (1) Under the rules of this Section, the Owner or his designee shall establish the Code Edition and Addenda to be included in the Design Specifications. All items of a nuclear power plant may be constructed to a single Code Edition and Addenda, or each item may be constructed to individually specified Code Editions and Addenda.

(2) In no case shall the Code Edition and Addenda dates established in the Design Specifications be earlier than:

(a) 3 years prior to the date that the nuclear power plant construction permit application is docketed; or

(b) the latest edition and addenda endorsed by the regulatory authority having jurisdiction at the plant site at the time the construction permit application is docketed.

(c) the edition and addenda endorsed for a design certified or licensed by the regulatory authority.
Code Cases

Provide:
- Relief from an existing Code requirement
- Treatment of topics not currently addressed

Are:
- Permissive, not mandatory
- Issued periodically by Code Committee
Code Case N-XXX

Use of Code Editions, Addenda, and Cases
Section III, Division 1

Inquiry:

What Code Editions, Addenda, and Cases may be used as an alternative to NCA-1140(a)(2)(a) and NCA-1140(a)(2)(b)?

Reply:

It is the opinion of the Committee that as an alternative to NCA-1140(a)(2)(a) and NCA-1140(a)(2)(b), the following requirements may be used:

1. The Edition and Addenda endorsed for a design certified or licensed by the regulatory authority.

2. This code case number shall be recorded on the documentation for the item.
Regulatory Approval of Code Cases

U.S. NUCLEAR REGULATORY COMMISSION

REGULATORY GUIDE

OFFICE OF NUCLEAR REGULATORY RESEARCH

REGULATORY GUIDE 1.84
(Draft was issued as DG-1133, dated October 2006)

DESIGN, FABRICATION, AND MATERIALS CODE CASE ACCEPTABILITY, ASME SECTION III
Other Code Case Regulatory Guides

• Regulatory Guide 1.147 lists Code Case Acceptability for Section XI, In-Service Inspection

• Regulatory Guide 1.192 lists the Operation and Maintenance Code Case Acceptability.

• Unendorsed Code Cases are listed in Regulatory Guide 1.193
Today’s Agenda

1. Small Advertisement for the ASME Code
2. Structure and Use of Section III
3. Basic Terms & Important Concepts
4. Subsections of Section III
5. Appendices
6. Code Cases
Basic Definitions

• Material

• Component
Section III Material Requirements

• Material Specification
  – Section II: Parts A, B, C, & D

• Control of Material
  – Section III: NCA-3800

• Special Material Requirements
  – Section III: NX- 2000
Important Concepts/Requirements

TRACEABILITY

• Identification
  – NCA-3856  Identification, Marking, and Material Control
  – NB-4122  Material Identification

• Certification of Material
  – NCA-3861  Certification Requirements for Material Organizations
  – NCA-3862  Certification of Material
  – NCA-3862.1 Material Certification
  – NCA-3862.2 Quality System Program Statement
Important Concepts/Requirements

• Thermal stresses explicitly considered
• Basis for stress limits shifted from maximum principal stress theory to more accurate maximum shear stress theory
• Fatigue recognized as possible failure mode
• Brittle fracture specifically treated
• Plastic limit analysis established as a reliable predictor of ductile failure after some plastic action
Jurisdictional Boundaries

1. Component shall conform to Subsection NB.
2. Pressure retaining portion of the component.
3. Jurisdictional boundary (heavy line).
4. Cast or forged attachment or weld buildup shall conform to Subsection NB.
5. Beyond 2t from the pressure retaining portion of the component, the design rules of NF-3000 may be used as a substitute for the design rules of NB-3000.
6. At or within 2t from the pressure retaining portion of the component, the first connecting weld shall conform to Subsection NB.
7. Beyond 2t from the pressure retaining portion of the component or beyond the first connecting weld, the attachment shall conform to Subsection NF [see Note (1)].
8. Bearing, clamped, or fastened attachment shall conform to Subsection NF [see Note (1)].
9. Attachment connection shall conform to Subsection NF [see Note (1)].
10. At or within 2t from the pressure retaining portion of the component, the interaction effects of the attachment shall be considered in accordance with NB-3135.
11. Drilled holes shall conform to Subsection NB.
Jurisdictional Boundaries (Detail)

3. Jurisdictional boundary (heavy line).

4. Cast or forged attachment or weld buildup shall conform to Subsection NB.

6. At or within $2t$ from the pressure retaining portion of the component, the first connecting weld shall conform to Subsection NB.

7. Beyond $2t$ from the pressure retaining portion of the component or beyond the first connecting weld, the attachment shall conform to Subsection NF [see Note (1)].

10. At or within $2t$ from the pressure retaining portion of the component, the interaction effects of the attachment shall be considered in accordance with NB-3135.
Today’s Agenda

1. Small Advertisement for the ASME Code
2. Structure and Use of Section III
3. Code Interpretations and Code Cases
4. Basic Terms & Important Concepts
5. Subsections of Section III
6. Appendices
Structure of Section III Subsections

- Article NX-1000 Introduction
- Article NX-2000 Material
- Article NX-3000 Design
- Article NX-4000 Fabrication and Installation
- Article NX-5000 Examination (NDE)
- Article NX-6000 Pressure Testing
- Article NX-7000 Overpressure Protection
- Article NX-8000 Nameplates, Stamping & Reports
Subsection NB Class 1 Components

Article NB-1000     Introduction
Article NB-2000     Material
Article NB-3000     Design
Article NB-4000     Fabrication and Installation
Article NB-5000     Examination (NDE)
Article NB-6000     Pressure Testing
Article NB-7000     Overpressure Protection
Article NB-8000     Nameplates, Stamping & Reports
Article NB-2000 Materials

NB-2100 General Requirements for Material
NB-2200 Material Test Coupons and Specimens for Ferritic Steel Material
NB-2300 Fracture Toughness Requirements
NB-2400 Welding and Brazing Material
Article NB-2000 Materials (cont.)

NB-2500 Examination and Repair of Pressure Retaining Material

- Plate
- Forgings and Bars
- Seamless and Welded Tubular Products and Fittings
- Tubular Products and Fittings with Filler Metal
- Statically & Centrifugally Cast Products
- Bolts, Studs and Nuts
## Article NB-2000 Materials (cont.)

<table>
<thead>
<tr>
<th>NB-2600</th>
<th>Material Manufacturers’ Quality System Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB-2700</td>
<td>Dimensional Standards</td>
</tr>
</tbody>
</table>

### NB-2160 Deterioration of Material
- Outside scope of Section III
- Covered in Design Specification
Design NB-3000

NB-3100  General Design
NB-3200  Design by Analysis
NB-3300  Vessel Design
NB-3400  Pump Design
NB-3500  Valve Design
NB-3600  Piping Design
NB-3100 General Design

• Loading Criteria
  – Loading conditions (pressure, impact loads, weight, reaction, etc.)
  – Design loadings (design pressure, design temperature and design mechanical loadings)

• Special Considerations
  – Corrosion
  – Cladding stresses
  – Welding (dissimilar welds, fillet weld attachments)

• External Pressure Analysis
NB-3200 Design by Analysis

• Design Criteria
  – Basis for determining stresses (maximum shear stress theory)
  – Terms relating to stress analysis
  – Stress classification
  – Derivation of stress intensities
## NB-3200 Design By Analysis (cont.)

<table>
<thead>
<tr>
<th>Stress Limit</th>
<th>Failure Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary (P&lt;sub&gt;m&lt;/sub&gt;, P&lt;sub&gt;b&lt;/sub&gt; &amp; P&lt;sub&gt;L&lt;/sub&gt;)</td>
<td>Plastic deformation and provide nominal factor of safety on ductile burst pressure</td>
</tr>
<tr>
<td>Primary plus secondary (P+Q)</td>
<td>Excessive plastic deformation leading to incremental collapse and validate fatigue evaluation elastic analysis</td>
</tr>
<tr>
<td>Peak (S&lt;sub&gt;a&lt;/sub&gt;)</td>
<td>Fatigue failure as a result of cyclic loadings</td>
</tr>
<tr>
<td>Special</td>
<td>Elastic and inelastic instability</td>
</tr>
</tbody>
</table>
NB-3200 Design By Analysis (cont.)

• Stress Limits for Components
  – Design Condition Limits
  – Level A Service Condition Limits (Normal)
  – Level B Service Condition Limits (Upset)
  – Level C Service Condition Limits (Emergency)
  – Level D Service Condition Limits (Faulted)
  – Test Condition Limits

• Fatigue Analysis Procedure
• Thermal Stress Ratchetting
• Plastic Analysis
• Limit Analysis
• Simplified Elastic Plastic Analysis
Section III Design by Rule

• Uses simple equations
• Sets rules on geometry of construction
• Uses conservative design values for pressure and temperature
• Justification is based on allowing only low stresses combined with “over-design”
NB-3300 Vessel Design

• General Requirements
• Design Considerations
  – Minimum Pressure Thickness Calculations
• Openings and Reinforcement
• Design of Welded Construction
NB-3300 Vessel Design
Design, Fabrication & Examination Integration

NB-3352.1 Joints of Category A

All welded joints of Category A as defined in NB-3351 shall meet the fabrication requirements of NB-4241 and shall be capable of being examined in accordance with NB-5210.
Design NC/ND-3000

NC/ND-3100 General Design
NC/ND-3200 Alternate Design Rules for Vessels
NC/ND-3300 Vessel Design
NC/ND-3400 Pump Design
NC/ND-3500 Valve Design
NC/ND-3600 Piping Design
NC/ND-3700 Electrical and Mechanical Penetration Assemblies
NC/ND-3800 Atmospheric Storage Tanks
NC/ND-3900 Storage Tanks 0-15 psig (0-103 kPa)
Fabrication and Installation NB-4000

NB-4100  General Requirements
NB-4200  Forming, Fitting and Aligning
NB-4300  Welding Qualifications
NB-4400  Making, Examining and Repairing Welds
NB-4500  Brazing
NB-4600  Heat Treatment
NB-4700  Mechanical Joints
NB-4100 General Requirements

- Certification of materials
- Fabrication by certificate holder
- Repair of materials
NB-4200 Forming Fitting and Aligning

• Cutting
  – Material may be cut to shape and sized by mechanical means, such as:
    • Machining
    • Shearing
    • Chipping
    • Grinding
    • Thermal cutting

• Recommendations for preheating prior to thermal cutting in Appendix D Preheat Procedures
NB-4200 Forming Fitting and Aligning (cont.)

• Forming and Bending Processes
  – May be hot or cold provided impact properties are not reduced below specified values
  – Heat treatment may be used to restore properties

• Qualification of Forming Processes for Impact Property Requirements
  – Procedure qualification test required
  – Acceptance standard based on impact properties
NB-4200 Forming Fitting and Aligning
NB-4200 Forming Fitting and Aligning
NB-4200 Forming Fitting and Aligning
NB-4200 Forming Fitting and Aligning
NB-4200 Forming Fitting and Aligning
NB-4300 Welding Qualifications

• Types of processes permitted
• Required qualifications
• Requirements for welding procedure qualification tests
• Special qualification requirements for tube-to-tubesheet welds
• Qualification requirements for welding specially designed welded seals
NB-4400 Rules Governing Making, Examining and Repairing Welds

- Precautions before welding
- Rules for making welded joints
- Welding of attachments
- Repair of weld metal defects
NB-4500 thru NB-4700

**NB-4500  Brazing**
- Rules for brazing
- Qualification requirements
- Fitting and aligning
- Examination

**NB-4600  Heat Treatment**
- Welding preheat requirements
- Post-weld heat treatment requirements
- Intermediate post-weld heat treatment
- Heat treatment after bending or forming for pipes, pumps and valves
- Heat treatment of electroslag welds

**NB-4700  Mechanical Joints**
# NB-4600 Postweld Heat Treatment

## TABLE NB-4622.1-1
MANDATORY REQUIREMENTS FOR POSTWELD HEAT TREATMENT OF WELDS

<table>
<thead>
<tr>
<th>P-No. (Section IX, QW-420)</th>
<th>Holding Temperature Range, °F (°C) [Note (1)]</th>
<th>Minimum Holding Time at Temperature for Weld Thickness (Nominal)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>¾ in. (18.5 mm) or less</td>
</tr>
<tr>
<td>1, 3</td>
<td>1,100–1,250 (595–675)</td>
<td>30 min</td>
</tr>
<tr>
<td>4</td>
<td>1,100–1,250 (595–675)</td>
<td>30 min</td>
</tr>
<tr>
<td>5A, 5B, 5C, 6 except P-No. 5B Gr. 2 and P-No. 6 Gr. 4</td>
<td>1,250–1,400 (675–760)</td>
<td>30 min</td>
</tr>
<tr>
<td>5B Gr. 2</td>
<td>1,350–1,425 (730–775)</td>
<td></td>
</tr>
<tr>
<td>6 Gr. 4</td>
<td>1,050–1,150 (565–620)</td>
<td></td>
</tr>
</tbody>
</table>
NC/ND-4000 Fabrication and Installation

NC/ND-4100  General Requirements
NC/ND-4200  Forming, Fitting and Aligning
NC/ND-4300  Welding Qualifications
NC/ND-4400  Making, Examining and Repairing Welds
NC/ND-4500  Brazing
NC/ND-4600  Heat Treatment
NC/ND-4700  Mechanical Joints
NC/ND-4800  Expansion Joints
Examination NB-5000

NB-5100 General Requirements
NB-5200 Examination of Welds
NB-5300 Acceptance Standards
NB-5400 Final Examination of Vessels
NB-5500 Qualification and Certification of NDE Personnel
NB-5000 Examination

NB-5100 General Requirements for Examination
  – Fabrication (F) Preservice Base Line (PS)

NB-5200 Required Examination of Welds
  – Category A Welded Joints (Longitudinal Welds)
  – Category B Welded Joints (Circ Welds)
  – Category C Welded Joints (Flange to Shell, etc.)
  – Category D Welded Joints (Nozzle to vessel, etc.)
  – Fillet, partial penetration and socket welds
  – Structural attachment welds
  – Special welds (e.g., Canopy Seal Welds)
  – Preservice Examination
NB-5000 Examination (cont.)

NB-5300 Acceptance Standards
  – Radiographic
  – Ultrasonic
  – Magnetic particle
  – Liquid Penetrant
  – Eddy Current
  – Visual
  – Gas and bubble formation testing

NB-5400 Final Examination of Vessels

NB-5500 Qualifications and Certification of Nondestructive Examination Personnel
NC/ND-5000 Examination

- NC/ND-5100 General Requirements
- NC/ND-5200 Examination of Welds
- NC/ND-5300 Acceptance Standards
- NC/ND-5400 Final Examination of Components
- NC/ND-5500 Qualification and Certification of NDE Personnel
- NC/ND-5700 Examination Requirements for Expansion Joints
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NB-6100</td>
<td>General Requirements</td>
</tr>
<tr>
<td>NB-6200</td>
<td>Hydrostatic Tests</td>
</tr>
<tr>
<td>NB-6300</td>
<td>Pneumatic Tests</td>
</tr>
<tr>
<td>NB-6400</td>
<td>Pressure Test Gauge</td>
</tr>
<tr>
<td>NB-6600</td>
<td>Special Test Pressure Situations</td>
</tr>
</tbody>
</table>
NB-6000 Testing

NB-6220 HYDROSTATIC TEST PRESSURE REQUIREMENTS

NB-6221 Minimum Hydrostatic Test Pressure

(a) The installed system shall be hydrostatically tested at not less than 1.25 times the lowest Design Pressure of any component within the boundary protected by the overpressure protection devices which satisfy the requirements of NB-7000.

(b) Valves shall be hydrostatically tested in accordance with the rules of NB-3500.

(c) Components shall be hydrostatically tested at not less than 1.25 times their Design Pressure.
NC/ND-6000 Testing

- NC/ND-6100 General Requirements
- NC/ND-6200 Hydrostatic Tests
- NC/ND-6300 Pneumatic Tests
- NC/ND-6400 Pressure Test
- NC/ND-6600 Special Test Pressure Situations
- NC/ND-6500 Atmospheric & 0-15 psig Storage Tanks
- NC/ND-6900 Proof Tests to Establish Design Pressure
Overpressure Protection NB/NC/ND-7000

- NB-7100  General Requirements
- NB-7200  Overpressure Protection Report
- NB-7300  Relieving Capacity Requirements
- NB-7400  Set pressures of Pressure Relief Devices
- NB-7500  Operating and Design Requirements for Pressure Relief Valves
- NB-7600  Non-reclosing Pressure Relief Devices
- NB-7700  Certification
- NB-7800  Marking, Stamping & Data Reports
NB-7300 Relieving Capacity Requirements

At least 2 relief devices are needed for a system

- Capacity of the smallest must exceed 50% of the largest
- At least 1 relief device needed for each isolatable component
NB-7500 Operating Design
Requirements for Pressure Relief Valves

• Safety, safety relief and relief valves
• Pilot operated pressure relief valves
• Power actuated pressure relief valves
• Safety valves and pilot operated pressure relief valves with auxiliary actuating devices
Article NB/NC/ND-8000
Nameplates, Stamping and Reports

NA components that are being installed in the power plant.

NPT piping, parts, and appurtenances.

N completed ASME Code component that the Certificate Holder supplies to a customer.
Today’s Agenda

1. Small Advertisement for the ASME Code
2. Structure and Use of Section III
3. Code Interpretations and Code Cases
4. Basic Terms & Important Concepts
5. Subsections of Section III
6. Appendices
Section III, Appendices

Mandatory

• Invoked within the text of a Code paragraph and are required.

Nonmandatory

• Invoked by a footnote to a Code paragraph and provide information or guidance.
Mandatory Appendix Example

NB-3680 Stress Indices and Flexibility Factors

NB-3681(d) For piping products not covered by NB-3680, stress indices and flexibility factors shall be established by experimental analysis (Appendix II) or theoretical analysis.
Nonmandatory Appendix Example

NB-3252 Contents of Design Specifications

(a) The Design Specification shall contain sufficient detail to provide a complete basis for Division 1 construction …

3 See Appendix B
## Section III: Mandatory Appendices

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I*</td>
<td>Design Stress Intensity Values, Allowable Stresses, Material Properties, and Fatigue Curves</td>
</tr>
<tr>
<td>II</td>
<td>Experimental Stress Analysis</td>
</tr>
<tr>
<td>III</td>
<td>Basis for Establishing Design Stress Intensity Values and Allowable Stress Values</td>
</tr>
<tr>
<td>IV</td>
<td>Approval of New Materials Under the ASME Boiler and Pressure Vessel Code</td>
</tr>
<tr>
<td>V</td>
<td>Certificate Holders’ Data Report Forms, Instructions, and Application Forms</td>
</tr>
<tr>
<td>VI</td>
<td>Rounded Indications</td>
</tr>
<tr>
<td>VII</td>
<td>Charts and Tables for Determining Shell Thickness of Cylindrical and Spherical Components Under External Pressure</td>
</tr>
<tr>
<td>XI</td>
<td>Rules for Bolted Flange Connections for Class 2 and 3 Components and Class MC Vessels</td>
</tr>
<tr>
<td>XII</td>
<td>Design Considerations for Bolted Flange Connections</td>
</tr>
<tr>
<td>XIII</td>
<td>Design Based on Stress Analysis for Vessels Designed in Accordance With NC-3200</td>
</tr>
<tr>
<td>XIV</td>
<td>Design Based on Fatigue Analysis for Vessels Designed in Accordance With NC-3200</td>
</tr>
<tr>
<td>XVIII</td>
<td>Capacity Conversions for Pressure Relief Valves</td>
</tr>
<tr>
<td>XIX</td>
<td>Integral Flat Head With a Large Opening</td>
</tr>
<tr>
<td>XX*</td>
<td>Submittal of Technical Inquiries to the Boiler and Pressure Vessel Committee</td>
</tr>
<tr>
<td>XXI</td>
<td>Adhesive Attachment of Nameplates</td>
</tr>
<tr>
<td>XXII</td>
<td>Design of Reinforcement for Come-to-Cylinder Junction Under External Pressure</td>
</tr>
<tr>
<td>XXIII*</td>
<td>Qualifications and Duties of Specialized Professional Engineers</td>
</tr>
</tbody>
</table>
### Section III: Nonmandatory Appendices

<table>
<thead>
<tr>
<th>Appendix A</th>
<th>Stress Analysis Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix B*</td>
<td>Owner’s Design Specifications</td>
</tr>
<tr>
<td>Appendix C*</td>
<td>Certificate Holder’s Design Report</td>
</tr>
<tr>
<td>Appendix D</td>
<td>Nonmandatory Preheat Procedures</td>
</tr>
<tr>
<td>Appendix E</td>
<td>Minimum Bolt Cross-Sectional Area</td>
</tr>
<tr>
<td>Appendix F*</td>
<td>Rules for Evaluation of Service Loadings With Level D Service Limits</td>
</tr>
<tr>
<td>Appendix G</td>
<td>Protection Against Nonductile Failure</td>
</tr>
<tr>
<td>Appendix J*</td>
<td>Owner’s Design Specifications for Core Support Structures</td>
</tr>
<tr>
<td>Appendix K</td>
<td>Tolerances</td>
</tr>
<tr>
<td>Appendix L</td>
<td>Class FF Flange Design for Class 2 and 3 Components and Class MC Vessels</td>
</tr>
<tr>
<td>Appendix M</td>
<td>Control of Welding, Postweld Heat Treatment, and Nondestructive Examination of Welds</td>
</tr>
<tr>
<td>Appendix N</td>
<td>Dynamic Analysis Methods</td>
</tr>
<tr>
<td>Appendix O</td>
<td>Rules for Design of Safety Valve Installations</td>
</tr>
<tr>
<td>Appendix P</td>
<td>Contents of Certified Material Test Reports</td>
</tr>
<tr>
<td>Appendix Q</td>
<td>Design Rules for Clamp Connections</td>
</tr>
<tr>
<td>Appendix R</td>
<td>Permissible Lowest Service Metal Temperature From $T_{NDT}$ for Classes 2 and MC Construction</td>
</tr>
<tr>
<td>Appendix S</td>
<td>Pump Shaft Design Methods</td>
</tr>
<tr>
<td>Appendix T</td>
<td>Recommended Tolerances for Reconciliation of Piping Systems</td>
</tr>
<tr>
<td>Appendix U</td>
<td>Rules for Pump Internals</td>
</tr>
<tr>
<td>Appendix V</td>
<td>Interruption of Code Work</td>
</tr>
<tr>
<td>Appendix W</td>
<td>Environmental Effects on Components</td>
</tr>
</tbody>
</table>
Appendices of Interest

**Mandatory Appendices**
I  Material Properties (Fatigue curves and other properties in older Codes)
XX  Submittal of Technical Inquiries to the Boiler and Pressure Vessel Committee
XXIII  Qualifications and Duties of Specialized Professional Engineers

**Non-Mandatory Appendices**
B  Owner’s Design Specification
C  Certificate Holder’s Design Report
E  Minimum Bolt Cross Sectional Area
F  Rules for Faulted (Level D) Condition Analysis
G  Rules for Fracture Mechanics Analysis
W  Environmental Effects on Components
Overall Summary

ASME Code:

- Is Comprehensive - provides rules for materials, design, fabrication, examination, inspection, testing, certification, and pressure relief
- Is Integrated – materials, design, fabrication, inspection and testing rules are integrated – a change in one area may require a change in another
- Is Dynamic – evolves and changes to reflect new technology and industry needs
Thank You

Ralph Hill
Westinghouse Nuclear Power
hillrs@westinghouse.com
+1 724-722-6332