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DOCUMENT TITLE EVENT COMBINATIONS AND ACCEPTANCE CRITERIA

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149A-	711A	743KO	772A	
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1. SCOPE

1.1 Product Line Applicability. This document specifies loading combinations and minimum acceptance criteria for the design of all new and the evaluation of all existing safety related essential equipment, components, and structures for BWR 4, 5, and 6 NSSS and Mark II and III Containments and associated Nuclear Island for the various events occurring during the life of the plant.

1.2 Document Applicability

1.2.1 General Electric Company. The requirements of this document are mandatory for equipment components, and structures supplied by or to the General Electric Company Nuclear Energy Business Operations for the Nuclear Steam Supply System (NSSS) and the Balance of the Nuclear Island (BONI) as defined in Paragraph 1.1.

The document provides the loading combinations due to various events considering loads upon structures in areas of the Nuclear Island, and also groups of components located within these areas and/or attached to these structures. It also provides acceptance criteria to be utilized to determine the acceptability of these loading combinations and the ability of this equipment, components and structures to maintain their structural integrity under the conditions defined in this document.

1.2.2 The Architect Engineer. The requirements of this document are recommendations for the Architect Engineer except where there is an interface with General Electric supplied equipment, components, and structures covered by this document. For these interface cases, the requirements of this document are mandatory.

1.3 Document Nonapplicability. Consideration of environmental conditions is not within the scope of this document. Evaluation of the stresses in the pipe containing a postulated line break and the pipe whip restraints are not within the scope of this document.

1.4 Equipment and Component Applicability. The requirements of this document apply to all equipment and components which are classified as Seismic Category I and/or Safety Class 1, 2, or 3 in design documentation.

1.5 Building Structures Applicability. The requirements of this document apply to safety related Seismic Category I Building Structures, viz the Reactor Building, Fuel Building, Auxiliary Building, Control Building, Diesel Generator Buildings (2), and the Radwaste Building.

1.6 Equipment, Component, and Structures Nonapplicability. The requirements of this document do not apply to Nonsafety Class 1, 2, and 3 equipment and components nor to Nonseismic Category I structures unless failure of such equipment, component or structure during an evaluation basis event would cause failure of or impair the required performance of the safety related equipment, component and structures. The requirements for the Turbine Building and all systems, structures, and components within the Turbine Building are not within the scope of this document.

2. APPLICABLE DOCUMENTS

2.1 General Electric Documents. The following documents form a part of this specification to the extent specified herein.

2.1.1 Supporting Documents. Documents under the following identities are to be used in conjunction with this specification.

	Reference Designator
a. Containment Loads Report (CLR), Mark III Containment	A41/A42-5400
b. Arrangement, Reactor, Fuel, and Auxiliary	A21/A22-2080
c. Arrangement, Auxiliary Building	A21/A22-2080
d. Arrangement, Fuel Building	A21/A22-2080
e. Arrangement, Control Building	A21/A22-2080
f. Arrangement, Radwaste Building	A21/A22-2080
g. Reference Containment Definition	A41/A42-5170
h. NRC Regulations Implementation	A41/A42-2070
i. Regulatory Guide Implementation Positions	A41/A42-4070
j. Reactor Cycles	B13-3040
k. Product Safety Standards	A41/42-4070

2.2 Codes and Standards. The following codes and standards (issue in effect at the placement date of the purchase order or as stated in this specification or its supporting documents) form a part of this specification to the extent specified herein.

2.2.1 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code

a. Section III, Division 1 - Rules for Construction of Nuclear Power Plant Components.

b. Section III, Division 2 - Code for Concrete Reactor Vessels and Containments.

2.2.2 American Iron and Steel Institute (AISI)

a. Stainless Steel Cold-Formed Structural Design Manual 1974 Edition

2.2.3 American Institute of Steel Construction (AISC)

a. Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.

2.2.4 American Concrete Institute (ACI) Standards

a. 318-71, Building Code Requirements for Reinforced Concrete

b. 349-76, Code Requirements for Nuclear Safety Related Structures

2.2.5 Institute of Electrical and Electronic Engineers (IEEE)

a. 279-1971, Standard Criteria for Protection Systems for Nuclear Power Generating Stations

b. 308-1978, Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations

c. 379-1977, Standard-Application of the Single Failure Criterion to Nuclear Power Generating Station Class 1E Systems

2.2.6 American National Standards Institute (ANSI)

a. N45.2.11, Quality Assurance Requirements for the Design of Nuclear Power Plants, 1973

b. N176, Design Basis for Protection of Nuclear Power Plants Against Effects of Postulated Pipe Rupture

2.2.7 Aluminum Association (AA)

a. Aluminum Standards and Data, 1979

b. Aluminum Construction Manual

(1) Section 1, Specification for Aluminum Structures, 3rd Edition, 1976

(2) Section 3, Engineering Data for Aluminum Structures, 3rd Edition, January 1975

2.2.8 Code of Federal Regulations (USNRC)

a. NUREG 0484, Methodology for Combining Dynamic Responses

3. DEFINITIONS AND ABBREVIATIONS

3.1 Plant Conditions. The state of the reactor and its associated structures, systems, and components. Also, see Paragraph 3.5.2.2.7. The event encounter probabilities for these conditions are as stated in the product safety standards, reference Paragraph 2.1.1.k.

3.1.1 Normal. Normal conditions are any conditions in the course of system startup, operation in the design power range, normal hot standby with the main condenser available and system shutdown, other than upset, emergency, faulted, incredible, or testing conditions. Hot standby without the main condenser is an upset condition.

3.1.2 Upset (incidents of moderate probability of occurence). Any deviations from normal conditions anticipated to occur often enough that design should include a capability to withstand the conditions without operational impairment. The upset conditions include those transients which result from any single operator error or control malfunction, transients caused by a fault in a system component requiring its isolation from the system, and transients due to loss of load or power. Upset conditions include any abnormal incidents not resulting in a forced outage, and also forced outages for which the corrective action does not include any repair of mechanical damage to the primary system pressure boundary.

3.1.3 Emergency (infrequent incidents). Those deviations from normal conditions which may require shutdown for correction of the conditions or repair of damage in the system. The conditions have a low probability of occurrence but are included to provide assurance that no gross loss of structural integrity will result as a concomitant effect of any damage developed in the system.

3.1.4 Faulted (limiting faults). Those combinations of conditions associated with extremely-low-probability, postulated events whose consequences are such that the integrity and operability of the nuclear energy system may be impaired to the extent that considerations of public health and safety are involved.

3.1.5 Incredible. A deviation from normal conditions which has a such a low probability of occurrence that it need not be considered in the design. However, some exceptional events with such low probabilities are postulated as design and evaluation bases by Regulatory requirements. These occurrences shall be considered in the design.

3.2 Load Conditions for Concrete Containment Structures

3.2.1 Service Load Conditions. Conditions encountered during construction and in the normal operation of the plant, including any anticipated transient or test conditions during normal startup and shutdown of the nuclear steam supply, safety related, and auxiliary systems. Also included are those severe environmental conditions which may be anticipated during the life of the facility.

3.2.2 Factored Load Conditions. Load combinations, including multipliers based on conditions resulting from a postulated pipe break in the reactor primary coolant system or environmental conditions postulated as upper bound limits for the plant site. Also included are load combinations, with other multipliers, or a postulated pipe break in the reactor primary coolant system plus severe or extreme environmental conditions.

3.3 Events Used in Evaluating the Effect of Loading Combinations on Structures, Systems, and Components

3.3.1 Normal Operation (NO). Operation under any condition permitted by the reactor technical specifications (as delineated in the plant-specific PSAR/FSAR) and control systems, irrespective of the anticipated frequency of occurrence of that condition, which is planned and deliberate but not in specific response to operator errors, control malfunctions, component failure, or transients due to loss of load or power. Normal operation includes loads due to weight, temperature, prestress, pressure, fluid flow, and other loads due to moving parts within a component or system.

3.3.2 Operational Transients (OT). Plant responses to spontaneous single equipment failures or to single operator errors that can reasonably be expected during any normal or planned mode of plant operations. For purposes of applying this specification, the range of operational transients postulated and analyzed in the plant's Preliminary or Final Safety Analysis Report shall be considered in the evaluation. Operational transient event loads include such events as safety relief valve actuation, turbine stop valve closure, rapid valve motion.

3.3.3 Loss of Coolant Accident (LOCA) A postulated accident event from which the plant design bases are established, including both transient and quasi-steady state conditions resulting from the LOCA, or other faulted conditions.

3.3.3.1 Design Basis Accident (DBA). The transient depressurization associated with the sudden, double-ended severance of a recirculation line, or of a main steam line inside or outside the containment, or any class of pipe severence of equivalent flow cross-sectional area. For DBA and IBA, the specific break locations must be postulated and the location-unique consequences such as jet impingement are considered as design loads in the Code stress report. The terminal end pipe break is at the vessel safe end-to-pipe weld joint. Vessel or safe end breaks are not considered. DBA event loads include loads such as annulus pressurization, vent clearing, pool swell, condensation oscillation, and chugging.

3.3.3.2 Intermediate Break Accident (IBA). This classification covers those breaks for which operation of the Emergency Core Cooling System (ECCS) will occur during the blowdown and which result in reactor depressurization. The inventory effect during the blowdown is accounted for with an effective break area of a 0.1 ft^2 break below the reactor vessel water level. This break area is chosen as being representative of the intermediate break area range. These breaks can involve either reactor steam or liquid blowdown.

3.3.3.3 Small Break Accident (SBA). The sizes of primary system blowdowns in this category are those blowdowns which will not result in rapid reactor depressurization due to either loss of reactor fluid or automatic operation of the ECCS equipment. Following the occurrence of a break of this size, the reactor operators should initiate an orderly shutdown and depressurization of the plant. Specific break locations are not postulated. Inadvertent Automatic Depressurization System (ADS) actuation is included in the SBA category.

3.3.3.4 Post Accident Conditions. The quasi-steady state conditions which follow a LOCA or other faulted transient conditions.

3.3.4 Seismic Events

3.3.4.1 Safe Shutdown Earthquake (SSE). That earthquake which is based upon an evaluation of the maximum earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material. It is that earthquake which produces the maximum vibratory ground motion for which certain structures, systems, and components are designed to remain functional.

3.3.4.2 Operating Basis Earthquake (OBE). The earthquake which, considering the regional and local geology and seismology and specific characteristics of local subsurface materials, could reasonably be expected to affect the plant during the operating life of the plant; it is that earthquake which produces the vibratory ground motion for which those features of the nuclear power plant necessary for continued operation without undue risk to the health and safety of the public are designed to remain functional. The OBE includes the displacement limited (OBE_D) and the inertia load (OBE_I) portions.

3.3.5 Environmental and Site Events (ENV)

3.3.5.1 Design Wind (W). The maximum design wind established for the plant site.

3.3.5.2 Design Basis Tornado (W'). The design basis tornado established for the plant site, including the effects of missile impact.

3.3.5.3 Probable Maximum Flood (PMF). The design basis flood is that flood that nuclear power plants should be designed to withstand without loss of capability for cold shutdown and maintenance thereof. This load is considered as a static load on the loading combination tables.

3.3.6 Infrequent Operational Transient (IOT). Any non-LOCA event which has a sufficiently low encounter probability to be considered as an emergency event. Infrequent operational transient event loads include fuel cask drop, for example.

3.3.7 Non-LOCA Fault (NLF). Any non-LOCA event which has a sufficiently low encounter probability to be considered as a faulted event.

3.3.8 Tests. Off-normal operating conditions imposed during preoperational testing or by the operator. Test loads include hydrostatic and pneumatic pressure and weight effects.

3.3.9 Reactor Building Vibration (RBV). Acceleration and displacement of the Reactor Building structures caused by seismic, accident (DBA), environmental events (wind, tornado), and operational transients (SRV, TSVC).

3.4 System, Structure, and Component Classification

3.4.1 Classifications

3.4.1.1 Safety Classes. Structures, systems, and components are classified as Safety Class 1, Safety Class 2, Safety Class 3, or Other in accordance with the importance of the safety functions to be performed by such equipment. Equipment is assigned a specific safety class, recognizing that components within a system may be of differing safety importance. A single system may thus have components in more than one safety class. In addition, one piece of equipment can have multiple safety functions of differing safety classes.

3.4.1.2 Seismic Classification. Those structures, systems, and components important to safety that are designed to remain functional in the event of an earthquake are designated as Seismic Category I. Systems, structures, and components not required to remain functional in the event of an earthquake are designated as Nonseismic Category I.

3.4.1.3 System Quality Group Classification. System quality group classification has been determined for each water, steam, or radioactive waste containing component of those applicable fluid systems relied on to: (1) prevent or mitigate the consequences of accidents and malfunctions originating within the reactor coolant pressure boundary; or (2) permit shutdown of the reactor and maintenance in the safe shutdown condition; or (3) contain radioactive material.

3.4.2 Safety Function. A safety function is any feature or characteristic of a system or piece of equipment that prevents or mitigates the consequences of a release of radioactive material beyond acceptable levels.

3.4.3 Safety Related System. Any system whose unique action is required for safe shutdown of a nuclear power plant, prevention/mitigation of postulated accidents, and prevention of the release of radioactive material from fuel in excess of the guidelines set forth in 10 CFR 100; for maintenance of the integrity of the reactor coolant pressure boundary (RCPB); or to achieve and maintain safe shutdown of the reactor.

3.4.4 Auxiliary System. An auxiliary system of a safety related system may provide a support function that is necessary to accomplish the safety function of the safety related system (ie, electrical power or heat removal). Primary auxiliary systems are auxiliary systems which must provide a support function automatically or remotely. Secondary auxiliary systems are auxiliary systems which provide a support function that can be initiated manually and locally during any design condition event.

3.4.5 Component Classification

3.4.5.1 Component (ASME). ASME components include such items as vessels, concrete containments, piping systems, pumps, valves, core support structures, and storage tanks for which Data Reports and Stamping are required.

3.4.5.1.1 Class 1. Items constructed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Subsection NB.

3.4.5.1.2 Class 2. Items constructed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Subsection NC.

3.4.5.1.3 Class 3. Items constructed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Subsection ND.

3.4.5.1.4 Class MC. Items constructed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Subsection NE.

3.4.5.1.5 Class CS. Items constructed in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section III, Subsection NG.

3.4.5.2 Components (non-ASME). Items from which a system is assembled, such as, sensors, signal conditioners, motors, pumps, valves, piping, heat exchangers, and other devices.

3.4.5.3 Active Component. Any component in which a change in state, measurement, or mechanical motion is needed to perform an automatic safety function such as safe shutdown of the reactor or mitigation of the consequences of a postulated pipe break in the Reactor Coolant Pressure Boundary.

3.4.5.4 Passive Component. A device characterized by an expected negligible change of state or negligible mechanical motion in response to an imposed design basis load demand upon the system.

3.4.6 Component Support. These metal elements which transmit loads or provide a general support function between the nuclear power plant component and the building structure. These elements are constructed in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section III, Subsection NF, or AISC, or AISI.

3.5 Buildings and Structures

3.5.1 Reactor Building. Structural complex composed of the drywell, wetwell, containment, and shield building. In the Mark II the reactor building defines the boundary of the secondary containment.

3.5.1.1 Containment Pool Structure. The structure surrounding the pool of water, located directly above the reactor, providing radiation shielding during power operation and refueling, specifically as applied to the Mark III.

3.5.1.2 Drywell. The structure surrounding the reactor and its recirculation loops which will channel steam resulting from the LOCA through the suppression pool for condensation. In the Mark II it is also a part of the containment boundary.

3.5.1.3 Containment. The gas tight shell or other enclosure around a reactor (pressure vessel) to confine products that otherwise might be released to the atmosphere in the event of an accident.

3.5.1.4 Suppression Pool. A structure surrounding the pool of water, located inside the base of the containment, which provides the water seal between the drywell and the containment. During safety relief valve discharge and postulated LOCAs, the pool serves as a heat sink, and the structure serves as a pressure-suppression chamber. For the Mark II containment, the suppression pool is in the wetwell which with the drywell forms the containment.

3.5.1.5 Shield Building. The reinforced concrete structure which encloses the drywell and containment. Together with portions of the Auxiliary Building and the Fuel Building it forms a secondary containment in the Mark III configuration.

3.5.2 Fuel Building. Structural complex containing the spent fuel storage pool.

3.5.3 Auxiliary Building. Structural complex containing major safety related systems.

3.5.4 Radwaste Building. Structural complex containing radwaste treatment systems.

3.5.5 Control Building. Structural complex containing the Control Room.

3.5.6 Diesel Generator Buildings. Structural complexes containing the diesel generator units.

3.5.7 Secondary Containment. The Shield Building, Fuel Building, and those portions of the Auxiliary Building enclosing the ECCS. The second barrier that encloses the reactor.

3.6 Nuclear Island

3.6.1 Nuclear Island. The buildings, internal structures, enclosed systems, and equipment located within the Reactor Building, Fuel Building, Auxiliary Building, Control Building, Radwaste Building, and Diesel Generator Buildings.

3.6.2 Balance of Nuclear Island (BONI). The conglomerate of systems, structures, and components which, together with the Nuclear Steam Supply System (NSSS) supplied by General Electric Nuclear Energy Business Operations, make up the Nuclear Island.

3.6.3 Nuclear Steam Supply System (NSSS). The systems, structures, and components which generate and supply steam to the balance of plant.

3.7 Load Categories Used in Loading Combinations and Codes

3.7.1 Service Loads

a. Mechanical Load. Mechanical loads are those loads imposed on a system or component which cause load controlled stresses.

b. Sustained Load. Sustained loads are those loads which occur for an extended length of time on a component.

c. Occasional Load. Occasional loads are those loads which occur during normal and abnormal operational phases of plant operation.

d. Inertial Load. Inertial component of a dynamic load is the portion of the load which causes load controlled stresses.

e. Displacement Limited Load. Displacement limited component of a load is the portion which causes secondary stresses which are self limiting. Examples of displacement limited loads are anchor movements (eg, thermal and earthquake) of other items and thermal expansion of the item being considered.

f. Prestress Load. Prestress load is an initial load imposed on a portion of a component or structure, usually to cause an initial state of stress in the member, at ambient conditions.

g. Total Dynamic Load. Total dynamic load is the sum of the inertial portion and displacement limited portion of a load.

h. Dynamic Load. Any time varying load application.

3.7.2 Design Loads. Design loadings for Class 1 components and supports shall be as defined in NB-3112 and NF-3112 of the ASME Code. Design loadings for Classes 2 and 3 components and Classes 2, 3, MC, and CS supports are those pressures, temperatures, and mechanical loads selected as the basis for the items. Design loadings for Class MC vessels are defined in NE-3112 of the ASME Code. Design loadings for Class CS structures are defined in NG-3112 of the ASME Code.

a. Design Pressure (P_D). The specified internal and external design pressure shall not be less than the maximum difference in pressure between the inside and outside of the component, or between any two chambers of a combination unit, which exists under the most severe loadings for which the Level A service limits are applicable. The design pressure shall include allowances for pressure surges.

3.7.2 (Continued)

b. Design Temperature (T_D). Except as otherwise defined in NB-3112 for Class 1 components, the specified design temperature shall not be less than the expected maximum mean metal temperature through the thickness of the part considered for which Level A limits are specified. The temperature so designated may not cover the full range of temperatures for which the component must be designed.

c. Design Mechanical Loads (M_D). The specified design mechanical loads shall be selected so that when combined with the effects of design pressure, they represent the most severe coincident loadings for which the Level A service limits on primary stress are applicable. Note that it may be inadequate to consider only the design loadings and the Level A service limits for initial design.

3.8 Stress Categories and Acceptance Criteria

3.8.1 Stress Categories - ASME B&PV Code Section III

3.8.1.1 Expansion Stresses (S_E). Expansion stresses are those stresses resulting from restraint of free end displacement.

3.8.1.2 Local Primary Membrane Stress (P_L). Cases arise in which a membrane stress produced by pressure or other mechanical loading and associated with a primary or a discontinuity effect produces 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 characteristics of a secondary stress.

3.8.1.3 Peak Stress (F, S_P). Peak stress is that increment of stress which is additive to the primary plus secondary stresses by reason of local discontinuities or local thermal stress, including the effects, if any, of stress concentrations.

3.8.1.4 Primary Bending Stress (P_B). Bending stress is the variable component of normal stress, ie, the stress which varies from the average value with location across the thickness.

3.8.1.5 Primary Membrane Stress (P_m). Primary membrane stress is the component of normal stress which is uniformly distributed and equal to the average value of stress across the thickness of the section under consideration.

3.8.1.6 Secondary Stress (Q). Self-equilibrating stress necessary to satisfy continuity of structure.

3.8.1.7 Stress Intensity. The difference betwee the algebraically largest principal stress and the algebraically smallest principal stress at a point, with tensile stresses being considered positive and compressive stresses being considered negative.

3.8.1.8 Load Controlled Stresses. Load controlled stresses are the stresses resulting from application of a loading, such as internal pressure, inertial loads, or the effects of gravity, whose magnitude is not reduced as a result of displacement.

3.8.1.9 Thermal Stress. Thermal stress is a self-balancing stress produced by a nonuniform distribution of temperature or by differing thermal coefficients of expansion. Thermal stress is developed in an item whenever it is prevented from assuming the size and shape that it normally should under a change in temperature.

3.8.2 Acceptance Criteria - ASME B&PV Code Section III

3.8.2.1 Design Limits. The limits for design loadings.

3.8.2.2 Service Limits. The Design Specification shall designate service limits for nuclear power plant components as defined below and as additionally defined in the appropriate Subsection of the Code.

3.8.2.2.1 Level A Service Limits. Level A service limits are those sets of limits which must be satisfied for all loadings identified in the Design Specification to which the component or support may be subjected in the performance of its specified service function.

3.8.2.2.2 Level B Service Limits. Level B service limits are those sets of limits which must be satisfied for all loadings identified in the Design Specifications for which these service limits are designated.

3.8.2.2.3 Level C Service Limits. Level C service limits are those sets of limits which must be satisfied for all loadings identified in the Design Specifications for which these service limits are designated.

3.8.2.2.4 Level D Service Limits. Level D service limits are those sets of limits which must be satisfied for all loadings identified in the Design Specifications for which these service limits are designated.

3.8.2.2.5 Testing Limits. Testing limits are those sets of limits which must be satisfied during testing of a component or system.

3.8.2.2.6 <u>Alternative Service Limits.</u> Components or supports may be designed using more restrictive service limits than specified in the design specification.

3.8.2.2.7 <u>Equivalent Nomenclature.</u> For purpose of this document and for comparing the nomenclature in this document with that which may appear in other General Electric documents it shall be understood that the following are equivalent:

Normal Limits = ASME Section III Service Level A

Upset Limits = ASME Section III Service Level B

Emergency Limits = ASME Section III Service Level C

Faulted Limits = ASME Section III Service Level D

This statement of equivalency does not apply to Table 2.8. ASME Service Level definitions applied to steel containment structures differ from the definitions applied to other ASME Code component Service Levels.

3.8.2.3 <u>Allowable Stress (S).</u> Stress limit for Class 2 and 3 components and component supports as specified in Appendix I of the ASME Code, also stress limit for concrete containment service load. The allowable stress multiplying factors shall be considered as required by the appropriate section of the ASME Code.

3.8.2.4 <u>Design Stress Intensity (S_m).</u> Design stress intensity values for Class 1, Class CS, and Class MC components specified in Appendix I of the ASME Code.

3.8.2.5 <u>Allowable Stress (U).</u> Stress limit for concrete containment factored load combination.

3.8.3 <u>Acceptance Criteria - AISC</u>

3.8.3.1 <u>Allowable Elastic Working Stress (S).</u> Allowable stress limits as specified in Part 1 of the AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings. The appropriate multiplying factors are given in the applicable tables at the end of this document.

3.8.3.2 <u>Allowable Plastic Design Methods Limit (Y).</u> Allowable limits as specified in Part 2 of the AISC Specification for the Design Fabrication and Erection of Structural Steel for Buildings. The appropriate multiplying factors are given in the applicable tables at the end of this document.

3.8.4 Acceptance Criteria - ACI

3.8.4.1 Allowable Stresses per ACI-318-71 (U). Allowable stress limits as specified in ACI-318-71 Building Code Requirements for Reinforced Concrete.

3.8.4.2 Allowable Stresses per ACI-349-76 (U). Allowable stress limits as specified in ACI-349-76 Code Requirements for Nuclear Safety Related Concrete Structures.

3.8.5 Acceptance Criteria - AISI

3.8.5.1 Allowable Stress Limits (S). Allowable stress limits as specified in Part 1 of the AISI Specification for the Design of Cold-Formed Stainless Steel Structural Members. The appropriate multiplying factors are given in the appropriate tables at the end of this document.

3.8.6 Acceptance Criteria - Aluminum Structures. Allowable stress limits as specified in Section 1 of the Aluminum Construction Manual of the Aluminum Association. Aluminum structures located in BONI should be designed according to the above specifications.

3.9 Nomenclature

AA - Aluminum Association
ADS - Automatic Depressurization System
AISC - American Institute of Steel Construction
AISI - American Iron and Steel Institute
AP - Annulus Pressurization
ASME - American Society of Mechanical Engineers
ATWS - Anticipated Transient Without Scram

B - Uplift Forces on Buildings
BONI - Balance of the Nuclear Island

CDF - Cumulative Distribution Function
CHUG - Chugging Load
CO - Condensation Oscillation
CP - Compartment Pressurization

D - Deadload Including Construction Loads
DF_w - Diaphragm Floor Reaction Load due to differential pressure between drywell and wetwell for Mark II
D_R - Drag Force on Item
D_t - Deadload for Test Condition
D_w - Deadload of Water
DBA - Design Basis Accident

3.9 (Continued)

E - Environmental and Site Events

F - Peak Stress or Aluminum Allowable Stress Limit
F_L - Internal Pressure from Flooding
FIV - Flow Induced Vibration
F_{PS} - Prestress Load
FRS - Floor Response Spectra
F_r - Friction Load

H - Earth Pressure

I - Impact Load
IBA - Intermediate Break Accident
IBL - Intermediate Break Accident Loading
IEEE - Institute of Electrical and Electronics Engineers
IOT - Infrequent Operating Transient - Emergency Event

L - Live Load
LBA - Large Break Accident
LBL - Large Break Accident Loading
LOCA - Loss of Coolant Accident

N - Normal Load Consisting of Pressure, Dead Weight, and Fluid Reaction Loads
NEP - Nonexceedence Probability
NLF - Non-LOCA Fault
NO - Normal Operation

OBE - Operating Basis Earthquake
OBE_D - OBE-Displacement Limited Portion
OBE_I - OBE-Inertia Load Portion
OT - Operational Transients - Upset Event

P - Pressure
P_a - Accident Pressure due to DBA
P_B - Primary Bending Stress
P_D - Design Pressure
P_L - Local Primary Membrane Stress
P_m - Primary Membrane Stress
P_o - Pressure During Normal Operating or Operational Transient Conditions

3.9 (Continued)

P_p - Peak Pressure
P_t - Test Pressure
PMF - Probable Maximum Flood
PS - Pool Swell

Q - Secondary Stress

R - Reaction Load
R_a - Pipe Reactions (including R_o) Generated by DBA
R_D - Design Mechanical Loads
R_f - Fallback Loads
R_o - Reaction Loads During Normal Operating or Shutdown Conditions
RBV - Reactor Building Vibrations due to SRV or DBA
RPMS - Reactor Pump Motor Seizure
RV1 - SRV Discharge Loads
RV2 - SRV Air Clearing Loads
$RV2_{one}$ - SRV Discharge through One Line
$RV2_{Low\ Set}$ - SRV Discharge through Low Set Lines
$RV2_{All}$ - SRV Discharge through All Lines
$RV2_{Two}$ - SRV Discharge through Two Adjacent Lines

RVCO - Rapid Valve Closure or Opening
R_W - Weir Wall Reaction Load due to Negative Drywell Differential Pressure (Mark III)

S - Allowable Stress
S_E - Expansion Stress
S_m - Design Stress Intensity
S_p - Peak Stress
SBA - Small Break Accident
SBL - Small Break Accident Loading
SEIS - Seismic Event
SL - Sloshing Load
SRSS - Square Root of the Sum of Squares
SRV - Safety Relief Valve Event
SRV_D - SRV-Displacement Limited Portion
SRV_I - SRV-Inertia Load Portion
SSE - Safe Shutdown Earthquake
SSE_D - SSE-Displacement Limited Portion
SSE_I - SSE-Inertia Load Portion

3.9 (Continued)

T - Thermal Effects—Total
T_a - Thermal Effects (including T_o) During DBA
T_D - Design Temperature
T_E - Thermal Expansion Loads
T_o - Thermal Effects and Loads During Normal Operating or Shutdown Conditions
T_T - Thermal Effects During Test Conditions
TEMA - Tubular Exchanger Manufacturers Association
TEST - Testing Conditions
TSVC - Turbine Stop Valve Closure

U - Allowable Stress for Factored Loading Combinations, or the Fatigue Usage Factor

VLC - Vent Line Clearing Load

W - Design Wind
W' - Design Basis Tornado
WCO - Water Carryover Load

Y - Yield Stress
Y_j - Jet Impingement Load
Y_m - Local Force due to Missile Impact (including pipe whip)
Y_r - Reaction Force due to DBA

4. DESCRIPTION

4.1 General. The requirements of this specification apply to the design, application, and evaluation of performance of function of structures, systems, and components which are Safety Class 1, 2, or 3, and also to auxiliaries for those structures, systems and components whose failure could cause failure of the safety system, component, or structure under various postulated loading combinations. The established acceptance criteria must be met to ensure structural integrity of these safety related structures, systems, and components. Additional criteria may have to be satisfied to assure operability of active components and functionality of passive components, eg, piping.

4.2 Application

4.2.1 Design. The requirements of this document shall be met at the system design level, the component design level, the subcomponent design level and structural design level. It shall specifically apply to the design, location, and mounting of safety related mechanical equipment such as valves, including operators, piping, pumps, heat exchangers, air systems, heating, ventilating and air conditioning systems, tank, pressure vessels, core support structures, filter demineralizers; electrical equipment such as local junction boxes, local switchgear, electrical penetrations, motors, motor-operators for valves, solenoid operators for valves, conduit installations, cable trays; and control and instrumentation equipment and components such as local sensors, local junction boxes, instrument tubing, penetrations, locally mounted instruments, locally mounted panels and racks; mechanical devices such as baffles, deflector plates; and Structures such as buildings, platforms, component supports, racks, cable trays, pipe hangers.

The design specifications and documents for all safety related structures, systems, and components shall require that an adequate evaluation of the effects of the loading combinations are taken into consideration in the design, including location, installation, and mounting of these structures, systems, and components.

4.2.2 Evaluation. The requirements for the evaluation of existing designs shall be the same as in Paragraph 4.2.1, except that design specifications and documents supporting the original design need not be changed to reflect the evaluation. The evaluation shall be performed in accordance with all procedures applicable to the design and shall be documented and the documentation shall be retrievable.

5. DESIGN RESPONSIBILITY

5.1 Responsibility for the evaluation and documentation of the effect of the combinations of loads on the various structures, systems, and components covered by this specification depends on contractual relationships and the division of scope of work between General Electric Company, the Architect Engineer, the Owner, and Subcontractors thereto. Because of the nature of the requirements, substantial interface will be required between the various organizations and within the various disciplines of these organizations.

6. REQUIREMENTS

The event combinations, loads, and acceptance criteria presented in this specification are applicable to all safety related BWR 4, 5, and 6/Mark II and III systems, structures, and components within the scope of this document. The design loadings shall be established considering all plant and system operating conditions anticipated or postulated to occur during the intended service life of the component, system, or structure.

6.1 Events and Event Combinations

6.1.1 Event Classifications. The following events and subevents shall be evaluated to verify that the resulting loads, when combined as discussed below, meet the acceptance criteria appropriate to the item and location:

Events	Subevents
Normal Operation (NO)*	Startup, Power Operation, Hot Standby, Shutdown, and Refueling
Operational Transients (OT)	Safety Relief Valve Actuation (SRV) Turbine Stop Valve Closure (TSVC)
Infrequent Operation Transients (IOT)	Cask Drop
Loss of Coolant Accident (LOCA)	Design Basis Accident (DBA) Intermediate Break Accident (IBA) Small Break Accident (SBA) High Energy Line Break (HELB)
Environmental and Site (ENV)	Severe Environment (as defined in Extreme Environment Paragraph 2.2.1.b)
Seismic	Operating Basis Earthquake (OBE) Safe Shutdown Earthquake (SSE)
Testing (TEST)	

* This definition of NO is applicable to most components. Containment structures and certain equipment use a different definition which is defined where applicable.

6.1.2 Event Combinations. The combinations of events for which loadings shall be evaluated are shown in Table 1.

The intention of superimposing the OBE loads on the SBA event is to provide margin during the initial stages of the accident. During the period of controlled depressurization and cooldown following an accident, it is not necessary to consider the seismic event. Thus, the peak thermal stress in the drywell plus the OBE load is not a design loading combination.

In the evaluation of the plant response to seismic events (OBE and SSE), it shall be assumed that the seismic event will be associated with the Operational Transient (OT) which produces the most severe loads on the component or structure being evaluated. This combination shall be selected consistent with the encounter probability criteria for the condition defined in Paragraph 3.1. The loads shall then be defined by combining the normal and upset operating loads (including the thermal effects for the OBE evaluation) with the dynamic response of the component or structure due to seismic load and the dynamic load of the operational transient, usually due to SRV or TSVC by the methods defined in Paragraph 6.7.2. This practice is acceptable in lieu of, and is preferable to a detailed mechanistic evaluation of the seismic event.

When a seismic event is considered in combination with a LOCA event, stresses due to plant transient responses to the seismic event shall not be considered. Seismic stresses shall be considered only for Seismic Category I components, thus postulated seismic induced failure due to spurious action of Nonseismic Category I components shall not be assessed.

6.2 Building Interaction

6.2.1 Seismic Interactions. Seismic events, since they originate in the soil, will excite all basemats or foundations and hence excite systems, structures, and components within all buildings.

6.2.2 Nonseismic Interactions. Buildings founded on a common basemat may be affected by the dynamic motion of one of these buildings. The degree of interaction for the given plant conditions should be determined using a combined building/basemat model. If interaction exists, the vibratory motion of the building in which the causative event occurs will excite systems, structures, and components located within an adjacent building.

Some potential exists for interaction between adjacent buildings supported on separate foundations. These potential building interaction effects should be considered. (Based upon analytic data from the BWR6/Mark III Standard Plant analyses there is insignificant interaction between the BONI buildings. Hence, effects from LOCA and SRV events will be considered only for the Reactor Building and the systems, structures, and components contained therein.)

6.2.3 Interaction of Nonseismic Category I Structures with Seismic Category I Structures. The interfaces between Seismic Category I and Nonseismic Category I structures and plant equipment shall be designed for the dynamic loads and displacements produced by both.

In the event of the collapse of any Nonseismic Category I structure it shall not impair the integrity of Seismic Category I structures or components.

6.3 Load Phenomena. This section describes the possible loads which may act on systems, components, and structures during various events. This document is not meant to be independent of the Containment Loads Report Mark III or the DFFR Mark II which outline the phasing of subevents and loads.

6.3.1 Safety Relief Valve Actuation Loads (SRV). Safety relief valve discharge lines are part of the main steam system. This system is subjected to two significant non-DBA and nonseismic events: safety relief valve actuation and turbine stop valve closure. In addition to the internal fluid forces generated by these events the main steam system will be subjected to the Reactor Building Vibrations (RBV) caused by these events. Due to the interconnection of the main steam lines and the safety relief valve discharge line, the dynamic response of one line could induce a dynamic response of the other line. The motion of one line will affect the stresses in the other line.

The safety relief valve system contains several valves. Safety relief valve loads are caused by the actuation of one or more of these valves which are connected to the main steam system. Relief valve actuation can be initiated by reactor pressure increase to the valve setpoints or by an active system such as ADS, or manually. Depending upon main steam system operating conditions, and other plant conditions several combinations of valve actuations are possible. Each combination of valve group actuations cause different hydraulic loads (RV2) in the suppression pool and transient fluid flow forces (RV1) in the pipe. The (RV2) loads cause dynamic response of the Reactor Building Structures (RBV), which in turn, cause dynamic response of all systems connected to the Reactor Building structures. The Containment Loads Report and the DFFR contain a more detailed description of these loads.

Because many events may result in one or more safety relief valve actuations, and since the components and structures responding to the dynamic SRV loading and the resulting Reactor Building Vibration (RBV) can experience a number of load cycles per valve actuation, the possibility of fatigue damage must be considered. An analysis must be performed to show either that the cumulative usage factor U, resulting from SRV loads is not significant or that when it is combined with any other cyclic conditions for which the component or structure is designed, the established fatigue criteria are satisfied. In this analysis, the number of safety relief valve actuations that shall be considered are as shown in Table 3.1. It is generally conservative to consider that for each valve actuation the fatigue damage will be less than

6.3.1 (Continued)

seven cycles of the response calculated; therefore, using seven cycles is a conservative basis. If the fatigue usage determined by considering all load cycles as peak cycles is excessive, a less conservative load distribution may be used. Such distributions must be individually justified.

6.3.1.1 <u>Relief Valve Lift (Acoustic Wave) (RV1).</u> When the relief valve is opened, the transient fluid flow causes time-dependent forces to develop in the discharge pipe. The relief valves discharging into the enclosed piping system create momentary unbalanced forces acting on the piping system during the first few milliseconds following relief valve lift. The pressure waves traveling through the piping system following the rapid opening of the relief valve will cause the relief valve discharge piping to vibrate and create forces and moments. This vibration creates loads on the main steam piping system, relief valve discharge piping support system, submerged discharge device in the suppression pool, and reaction loads on reactor building structures which interface with this piping system. Fluid forces induced by discharge flow within the relief piping system are designated as RV1. Under conditions of steady state flow, the forces associated with a flow acting on the system are virtually self-equalizing and do not create significant bending moments in the piping system.

6.3.1.2 <u>Safety Relief Valve Loads Due to Air Clearing (RV2).</u> The relief valves discharge through the enclosed piping system which carries the steam to the suppression pool. The opening of the safety relief valve results in a rapid compression of the air mass within the discharge pipe, which then drives the water leg out of the end of the submerged discharge device and ejects a high pressure air bubble into the suppression pool, creating an oscillating pressure load on the pool walls and basemat. These pressure loads impart accelerations on the structures and differential movements on the piping; these effects shall be considered in the design and analysis of the safety relief valve discharge piping system, if these loads are shown to be significant. The dynamic response of the structures causes dynamic response of components, supports, systems, and structures attached to the Reactor Building structures. The RV2 responses are typically characterized by Floor Response Spectra.

Since the dynamic phasing of the RV2 discharge forces from multi-line discharges cannot be readily ascertained by deterministic methods, the use of the General Electric Company's SRVA Monte Carlo computer program provides a realistic methodology for determining these pool dynamic loads for Mark III containments. Methods for determining pool dynamic loads for Mark II are summarized in the DFFR.

The local hydrodynamic effects from the following load conditions shall be considered for the portion of the discharge line and quencher device in the suppression pool region, and any other mechanical components located in this region.

6.3.1.2 (Continued)

The number and combinations of valves that will open during a reactor vessel pressure transient are as follows:

a. $RV2_{ONE}$ - Design pressure load (positive or negative) on the suppression pool boundary resulting from discharge of one safety relief valve into the suppression pool. First actuation and subsequent actuation shall be considered.

b. $RV2_{TWO}$ - Design pressure load (positive or negative) on the suppression pool boundary resulting from discharge of two adjacent safety relief valves into the suppression pool.

c. $RV2_{LOW\ SET}$ - Design pressure load (positive or negative) on the suppression pool boundary resulting from discharge of all low set safety relief valves into the suppression pool which cause the largest asymmetric horizontal loading.

d. $RV2_{ALL}$ - Design pressure load (positive or negative) on the suppression pool boundary resulting from discharge of all safety relief valves.

e. ADS - Design pressure load (positive or negative) on the suppression pool boundary resulting from Automatic Depressurization System (ADS) discharge lines into the suppression pool.

The above RV2 loads can be divided into two classifications $RV2_I$ (inertial portion and $RV2_D$ (displacement limited portion).

6.3.1.3 <u>Safety Relief Valve Actuation for Various Events.</u> SRV actuation combinations for various events are presented in Table 3.

6.3.2 <u>Operational Transients Loads (OT)</u>

6.3.2.1 <u>Turbine Stop Valve Closure (TSVC).</u> Prior to turbine stop valve closure, saturated steam flows through main steam piping at nuclear boiler rated pressure and mass rate. Steam flow to the turbine comes to a stop at the instant the turbine stop valve closes. However, the flow of steam from the reactor vessel continues in the main steam line until the fluid compression wave produced by the stop valve closure reaches the vessel nozzle. Repeated reflections of this wave at the vessel end of the main steam line and at the turbine stop valve end generate time-varying forces in the main steam piping. Systems, components, and structures in the Reactor Building, Auxiliary Building-Steam Tunnel and Turbine Building are affected.

6.3.2.2 Rapid Valve Closure or Opening (RVCO). Extremely rapid valve closure or opening in a fluid system can create large pressure waves which can propagate through the piping system and into connected components. This rapid valve motion could be caused by operating characteristics of the valve (eg, stiffness of diaphragm in pneumatic operators), and fluid flow forces acting on the valve parts during all modes of valve operations. Design changes should be reviewed for RVCO problems.

6.3.2.3 Flow Induced Vibration (FIV). Flow of fluids past objects creates local pressure disturbances which create forces on the object. These forces can cause dynamic response if the forcing function and dynamic characteristics of the object have appropriate relationship. Flow induced vibrations have been noted in nuclear power plant systems which contain vortex shedding conditions (eg, heat exchangers, reactor internal structures), pump (reciprocating and centrifugal), and thermodynamic instability conditions.

a. Vortex Shedding. Vortex shedding occurs at certain fluid velocities when the fluid flows past objects. The most common component of BWR plants in which vortex shedding is possible is a heat exchanger. The flow past the tube bundles creates vortices which create forces and cause dynamic responses to the tube bundles. The dynamic response is controlled by proper spacing of the support plates for the tube bundle. The vibration cannot be eliminated but it can usually be controlled. TEMA standards provide guidance for proper design. It is important in these cases to consider all potential modes of component operation. Hydrodynamic mass effects shall be considered. Another group of components susceptible to flow induced vibration are pressure, flow, and temperature sensors which encroach upon the flow stream, and the reactor internal structures such as incore guide tubes, jet pumps, shroud, etc, which are designed for anticipated FIV and confirmed through prototype testing.

b. Pressure Fluctuations. Both reciprocating and centrifugal pumps create pressure fluctuations in the fluid system. In most system designs, these fluctuations are insignificant. However, the possibility exists that these fluctuations, coupled with the proper system characteristics, can cause vibrational response to the system. Pressure attenuation devices can significantly reduce the effects of this phenomenon.

c. Thermodynamic Instability. Under certain system design conditions and operating modes, fluid dynamic forces can be generated which create large pressure variations. These have been noted in certain feedwater systems where a relatively cold fluid layer is in contact with a relatively hot steam region; under certain operating modes significant water-hammer-type phenomena have occurred causing a breach of the pressure retaining boundary.

6.3.2.4 Safety Relief Valve Actuations with Operational Transients. SRV actuation loads associated with Operational Transients are shown in Table 3.

6.3.2.5 Infrequent Operational Transients Loads

a. Cask Drop (F_{cd}). The Fuel Building contains the spent fuel storage pool and serves as a temporary depository for new and spent fuel elements. Fuel elements are transferred to and from the reactor, during refueling outages, through the fuel transfer tube. After a reasonable storage time to permit fuel decay heat to subside, the spent fuel is loaded into casks within the spent fuel pool. These casks are then lifted out of the pool and transported to a reprocessing plant or sent to a long term permanent storage location.

   The building structures immediately below the travel zone of the spent fuel cask shall be designed to sustain the effects of a cask drop if the function of the safety related systems structures or components could be impaired. The cask drop event shall be assumed to occur simultaneously with an OBE event.

6.3.3 Design Basis Accident Loads (DBA). The design basis accident is a postulated event associated with a high energy line break (HELB). Loads from this condition are used for the design basis for systems, structures, and components.

6.3.3.1 Large Break LOCA (LBL). The large break LOCA is a postulated event associated with the rupture of a recirculation line, main steam line, or any class of pipe severance of equivalent cross-sectional flow area. These loads are generally associated with the Reactor Building, and are discussed in more detail in the Containment Loads Report.

a. Annulus Pressurization (AP). After rupture of a pipe (recirculation or feedwater, etc) within the reactor vessel shield wall annulus region, pressurization occurs which imposes forces (pressure, jet impingement, and jet reaction) on the reactor pressure vessel and the shield wall. These are generally asymmetric loads which vary in space and with time. The subsequent accelerations and movements of the reactor pressure vessel and the shield wall are transmitted to the unbroken piping systems at the nozzle connections and the shield wall piping support attachments. Items within the reactor vessel shield wall annulus region will be subjected to the differential pressures and flows that are generated by the postulated rupture. Annulus pressurization loads can occur in other confined annulus regions to which high mass and energy flow rates are injected. Rupture of the steam line at the nozzle produces force and reaction effects similar to those described here except that there is no direct AP.

6.3.3.1 (Continued)

b. Compartment Pressurization (CP). After the postulated rupture of a high energy line, high energy fluid is released into the surrounding compartment. This release will result initially in local pressure surge and ultimately in a uniform pressurization of the compartment. Both the symmetric and asymmetric (pressure and/or jet impingement) loads should be considered in evaluating the systems, structures, and components within the compartment in which the break was postulated to occur and in adjacent compartments. Differential pressure loadings between compartments shall be considered. This loading is similar to annulus pressurization but it occurs in a larger, less confined space.

b. Vent Line Clearing Loads (VLC). The increasing drywell pressure forces the water level in the weir wall annulus region downward, until the top main vent in the drywell wall is exposed to the drywell environment. The water initially standing in the vent system accelerates into the pool and the vents are cleared of water. During this vent clearing process, the water leaving the horizontal vents forms jets in the suppression pool and causes water jet impingement loads on the structures within the suppression pool and on the containment wall opposite the vents. This description is specific to the Mark III; a similar phenomenon takes place in the Mark II with resulting vertical loads on the pool floor.

d. Pool Swell (PS). As the air in the drywell is purged into the wetwell suppression pool through the main vents, the air is injected below the pool surface, giving an upward velocity to the water above the vent exit. This upward motion of the water is called "pool swell". Pool swell creates pressure loadings on the pool walls and basemat. The subsequent acceleration and movement imparts loads on piping and other items in the suppression pool and items attached to structures inside the containment or attached to the containment (RBV). Pool swell also causes a movement of the surface of the water in the suppression pool. Any items in the air region above the initial pool surface will be subjected to the hydrodynamic effects (impact and drag) of the pool swell, up to maximum height of pool swell.

e. Condensation Oscillation (CO). Condensation oscillation is the short term transient dynamic lateral load at the main vents occurring between the main vent clearing phenomenon and the longer term main vent chugging effects.

6.3.3 (Continued)

f. Main Vent Chugging (CHUG). After the pool swell has subsided, the unsteady condensation of steam produces pressure fluctuations on the walls and floor of the wetwell suppression pool. After the steam flow has been reduced to a low level (or during some small break accidents), the steam chugs in the upper row of the vents. The chugging, which consists of a steam bubble intermittently filling a vent and then collapsing, produces loadings on the vent. The loadings on the walls (weir wall, drywell, containment) and basemat result from the sudden collapse of steam bubbles which form at the ends of the vents, and subsequently impart acceleration loads on components within the Reactor Building. This description is specific to Mark III; Mark II is similar.

g. Water Carryover Loads (WCO). Water carryover loads are due to entrainment of water in the main steam line surging from the reactor pressure vessel after the rupture of a main steam line occurs. The water-steam mixture has a much higher density than steam and imposes loads on main steam piping system at each change in direction and at each change in cross-sectional area.

h. Reaction Load (Y_r). Equivalent static load generated by the reaction on the broken high energy pipe during the postulated break, and including an appropriate dynamic factor to account for the dynamic nature of the load.

i. Jet Impingement (Y_j). Jet Impingement equivalent static load generated by the postulated break, and including and appropriate dynamic factor to account for the dynamic nature of the load.

j. Missile Impact (Y_m). Missile impact equivalent static load generated by or during the postulated break, like a whipping pipe, and including an appropriate dynamic factor to account for the dynamic nature of the load.

6.3.3.2 Intermediate Break LOCA (IBA). Those breaks for which the operation of the ECCS will occur during the blowdown and which result in reactor depressurization. IBA is characterized by an effective break area of at least 0.1 ft^2 break below the reactor vessel water level.

Load phenomena associated with this type of break are:

a. VLC-Main Vent Clearing (VLC)

b. Pool Swell (PS)

c. Condensation Oscillation (CO)

d. Main Vent Chugging (CHUG)

6.3.3.2 (Continued)

e. Jet Impingement (Y_j)

f. Annulus Pressurization (ΔP)

g. Blowdown

h. Pipe whip restraint attachment reactions

Load from this accident are generally bounded by the DBA except for effects in the immediate vicinity of the break.

6.3.3.3 Small Break LOCA (SBA). Small break blowdowns which do not result in rapid reactor depressurization due to either loss of reactor fluid or automatic operation of the ECCS equipment produce SBL loadings.

Specific break locations are not postulated, however, the SBA results in the following dynamic loading phenomenon:

a. Reactor Building Vibration

b. Top Main Vent Clearing (Mark III only)

c. Chugging

d. SRV actuation

In addition, the SBA usually results in the largest accident temperature (T_a) inside containment.

6.3.3.4 High Energy Line Breaks. Components, located in regions where high energy lines are located shall consider, in addition to the environmental effects (P_a, T_a, RBV) caused by a DBA, the potential for jet impingement, pipe whip impact, and pipe whip reaction loads. The orientation of the pipe break and the trajectory of the jet stream shall be considered. The postulated break locations shall be consistent with the requirements of ANSI N-176. Local pressure variations shall be considered in addition to overall compartment pressure loads.

Components located in compartments which do not contain high energy lines shall be evaluated for accident pressure (P_a) and temperature (T_a) effects. However, jet impingement (Y_j), pipe whip impact (Y_m) do not require consideration.

a. Y_j - Jet Impingement

b. Y_m - Pipe Whip Impact

6.3.3.4 (Continued)

c. T_r - Pipe Whip Reaction Load on supports and components attached to the broken line.

d. P_a - Compartment Pressure Load (asymmetric and symmetric)

e. T_a - Compartment Temperature

f. R_a - Reaction force by pipes or supports on component jurisdictional boundary, occurring during a postulated rupture in another train of the system being evaluated or in another system.

6.3.3.5 Post DBA Loads. For fuel recovery subsequent to a design basis accident, the containment shall be conservatively designed for flooding to an appropriate level above the top of the active fuel in the reactor core.

6.3.3.6 Safety Relief Valve Actuations with DBA Events. SRV actuation loads associated with DBA events are shown in Table 3.

6.3.4 Environmental and Site Related Loads (ENV). Environmental loads described in this paragraph are associated with natural phenomena which can occur in the atmosphere and hence affect buildings or structures exposed to the atmosphere. Seismic loads are discussed separately.

a. Design Wind (W). Loads generated by the design wind specified for the plant site.

b. Design Basis Tornado (W'). Loads generated by the design basis tornado specified for the plant site including missiles.

c. Probable Maximum Flood (PMF). Hydrostatic load due to probable maximum flood specified for the plant site.

d. External Missiles (Y_m). Missiles generated by the design basis tornado and other probable sources as specified for the plant site.

6.3.5 Seismic Loads. Nuclear power plants are designed for two basic seismic events: Operating Basis Earthquake (OBE) and the Safe Shutdown Earthquake (SSE). Upon slippage at faults in the earth's crust, dynamic waves are propagated through the soil. When these waves encounter a building foundation, the foundation undergoes motion due to the dynamic soil waves. This motion of the foundation(s) causes dynamic time-varying response of building structures connected (directly or indirectly) to the foundation(s). The building dynamic motion in turn causes dynamic response of components, supports, systems, and structures attached to the building. Dynamic seismic response is typically characterized by Floor Response Spectra (FRS).

6.3.5 (Continued)

Loads generated by the SSE include:

a. SSE_I - SSE inertial portion of load.

b. SSE_D - SSE displacement limited portion of load.

Loads generated by the OBE include:

a. OBE_I - OBE inertial portion of load.

b. OBE_D - OBE displacement limited portion of load.

Because the component and structure response to seismic loads results in a number of load cycles the possibility of fatigue damage must be considered. The upset event evaluation shall consider one OBE producing cumulative usage equivalent to 10 cycles of the peak calculated response.

6.3.5.1. Sloshing (SL). Whenever a free water surface exists in a tank or pool, dynamic excitation of that item will cause the water surface to oscillate. This oscillation phenomenon is called sloshing. Sloshing is usually associated with seismic events; however, other dynamic events (DBA, SRV) can also cause sloshing.

Components located inside a pool region below the initial water surface will be subjected to hydrodynamic effects associated with a seismic event. Components located in a region where pool slosh will occur, for example inside the spent fuel pool, components partially filled with water will be subjected to an additional loading resulting from Sloshing Effects (SL).

6.3.6 Testing Loads (TEST)

6.3.6.1 Test Conditions. For short-duration off normal conditions imposed by the operator for code conformance test (eg, RPV hydrostatic testing) or system performance test (eg, high-recirculation-flow test for flow-induced vibration), the following criteria shall apply.

a. Components to which Subarticle NB-3114 of the ASME Code, Section III applies: Test condition criteria, as defined in Section III, Subsection NB, shall be used for components and test conditions to which Subarticle NB-3114 applies.

b. All components to which Subarticle NB-3114 does not apply, other than containment structures: Normal condition criteria may be used for any tests.

6.3.6.1 (Continued)

c. Maximum test condition parameters for mechanical components and systems shall be considered in the design of electrical control and instrumentation devices when portions of these devices are subjected to the test conditions but do not qualify as part of the pressure retaining boundary for the mechanical system.

6.4 Loads on Components. The specific loads which act on a component in a given location, as a result of a specific event, are presented in Tables 4.1 through 4.5.

6.4.1 Component Operability. The loading combinations and acceptance criteria provided in this specification address only the structural integrity of the item to be evaluated; these criteria do not ensure functional capability of the item, which is beyond the scope of this specification. In addition to the structural integrity acceptance criteria presented in the tables in this section, active components shall be designed and evaluated to assure operability and essential safety functionality under the most severe of the event combinations presented in these tables. Special stress or deformation criteria may be applied to piping to assure that its function of having adequate capacity to conduct fluid is maintained.

6.4.2 General Mechanical Component Loads. Many mechanical systems are located in more than one of the BGN1 buildings. Each of these buildings exhibit their own unique response and environmental characteristics. For those portions of mechanical systems located within these buildings, the proper environmental response characteristics of each building, for each portion of the systems, shall be considered, including the potential for building interaction as described in Paragraph 6.2. Thus, the portion of the main steam system located in the Turbine Building need not be analyzed for the floor response spectra associated with the Reactor Building. However, the internal forcing functions caused by a turbine stop valve closing will propagate throughout the entire main system, regardless of building location.

Different structures, even when located within the same building (eg, drywell wall and shield building) will exhibit different dynamic response characteristics and hence excite similar components which are attached to them, differently. Further, these structures may exhibit out-of-phase response which can adversely load a component.

All of these factors shall be considered in defining the appropriate multi-support input data for the analysis of these systems or portions of systems.

Systems located wholly within one building, but supported from another building, will be subjected to multiple excitations and probable differential building movement.

6.4.2 (Continued)

The loads which are generally applicable to all safety related Seismic Category I mechanical components include:

a. D - Weight of component including contents during normal operation and test conditions.

b. P_o - Maximum operating pressure and differential pressure which occurs during normal plant operation.

c. T_o - Thermal effects during normal plant operation including:

(1) T_E - Thermal expansion due to operational loads and environmental temperature including displacement controlled motion of interfacing systems, structures, or components.

(2) T_T - Thermal transients including radial constraint of pipe; primarily applicable to Class 1 components.

d. R_o - Reaction loads at the jurisdictional boundary from other systems, structures, or components; including pipe reaction forces on valves, pumps, and vessels; and component support reaction forces.

e. P_D - Design Pressure

f. FIV - Flow Induced Vibration caused by fluid flow past an item located in the fluid stream.

g. F_{PS} - Prestress loads on bolts, flanges, and gaskets.

h. OBE - Operating Basis Earthquake

i. SSE - Safe Shutdown Earthquake

6.4.2.1 Abnormal Plant Loads on Mechanical Components

a. T_a - Thermal effects due to no [illegible] or abnormal (DBA) plant conditions

b. P_a - Pressure effects

c. R_a - Reaction loads at jurisdictional boundaries

6.4.2.2 Abnormal Loads in the Reactor Building. In addition to the loads defined in Paragraphs 6.4.2 and 6.4.2.1 above, the following loads shall be considered for all components located within the Reactor Building:

a. RBV - Loads due to Reactor Building vibrations caused by an SRV or DBA event.

b. CHUG - Loads from component response or direct fluid forces, on a component located in the suppression pool, caused by chugging phenomenon.

c. CO - Loads from component response or direct fluid forces, on a component located in the suppression pool, caused by condensation oscillation phenomenon.

d. VLC - Loads from component response or direct fluid forces, on a component located in the suppression pool, caused by main vent line clearing phenomenon.

e. RV2 - Loads from component response or direct fluid forces, on a component located in the suppression pool, caused by safety relief valve air clearing phenomenon.

f. PS - Loads from component response or direct fluid forces, on a component located in the suppression pool region affected by the pool swell, caused by the pool swell phenomenon.

g. AP - Loads from component response or direct steamflow forces, on components located in the reactor vessel shield wall annulus region, caused by annulus pressurization.

h. SL - Loads from component response or direct fluid forces, on components located in the sloshing zone of a pool or component, caused by the sloshing phenomenon from any dynamic event.

6.4.2.3 Other Loadings. There are other loadings which may be of a local or restricted nature but which may have a decided effect on some component or structure. The responsibility for identification and application of such loadings lies with the design engineer.

6.4.3 Electrical, Control, and Instrumentation Equipment Loads. Electrical, control, and instrumentation equipment and components and their supports mounted on or attached to the structures and mechanical components will be subjected to dynamic loads. These loads result from the response of structures and mechanical components and to directly applied loads resulting from postulated events. The magnitude of the load is dependent upon the location of the item and the causative event.

6.4.3 (Continued)

Instruments which sense process system parameters by direct connection to fluid lines and are not considered as part of the mechanical system pressure boundary (in terms of the ASME jurisdictional boundary) are considered as electrical equipment.

Items which are located in areas which contain high energy piping shall be designed for the following effects associated with a DBA: Jet impingement and pipe whip impact. In addition, in other areas adjacent to areas containing high energy lines, the effects of T_a, P_a will probably require consideration. This document addresses only the structural integrity effects associated with these loading conditions.

The loads which are generally applicable to all safety related Seismic Category I electrical, instrumentation, and control equipment include:

a. D - Weight of item

b. P_o - Maximum internal operating pressure for items connected to fluid lines.

c. R_o - Reaction loads on interface boundary from structures or components.

d. OBE - Operating Basis Earthquake

e. SSE - Safe Shutdown Earthquake

f. FIV - Loads due to fluid flow conditions (flow induced vibration)

6.4.3.1 <u>Abnormal Plant Loads on Electrical, Control, and Instrumentation Equipment</u>

a. P_a - Maximum external pressure due to any normal or abnormal (DBA) plant condition.

b. T_a - Maximum external temperature due to any normal or abnormal (DBA) plant condition.

c. R_a - Maximum reaction force on interface boundary due to normal or abnormal (DBA) plant condition.

d. Y_j - Jet impingement load.

e. Y_m - Pipe whip impact load.

f. RBV - Loads due to Reactor Building vibrations caused by an SRV or DBA event.

6.5 Loads on Component Supports. The specific loads which act on a component support in a given location as a result of a specific event are presented in Tables 4.1 through 4.5.

All loads on component support anchorages shall be considered as primary loads. Loads from the restrained free end motion of piping shall be considered as primary loads in component and piping supports.

6.5.1 General Component Support Loads. The following loads shall be considered in the design of all component supports which transfer loads from safety related Seismic Category I items to building structures:

a. D - Weight of support and supported item.

b. L - Live loads including construction loads.

c. T_o - Loads due to heat transfer from component during normal and abnormal operating conditions.

d. T_E - Thermal expansion loads from supported component including frictional effects.

e. OBE - Operational Basis Earthquake loads from supported item (including inertial and displacement portions) and dynamic response of component support.

f. SSE - Safe Shutdown Earthquake loads from supported item (including inertial and displacement portions) and dynamic response of component support.

g. T_a - Load on support due to environmental thermal conditions.

h. Y_j - Load on support due to jet impingement effects.

i. Y_m - Load on support due to pipe whip impact.

j. Y_r - Load on support due to pipe whip reaction.

k. F_r - Friction loads due to pipe movement.

6.5.2 Abnormal Loads in the Reactor Building. In addition to the loads defined in Paragraph 6.5.1 above, the following loads shall be considered for all component supports located within the Reactor Building:

a. RBV - Loads due to Reactor Building vibrations caused by an SRV or LOCA event.

6.5.2 (Continued)

b. CHUG - Loads from component response or direct fluid forces, on a support located in the suppression pool, caused by chugging phenomenon.

c. CO - Loads from component response or direct fluid forces, on a support located in the suppression pool, caused by condensation oscillation phenomenon.

d. VLC - Loads from component response or direct fluid forces, on a support located in the suppression pool, caused by main vent clearing phenomenon.

e. FV2 - Loads from component response or direct fluid forces, on a support located in the suppression pool, caused by safety relief valve air clearing loads.

f. PS - Loads from component response or direct fluid forces, on a support located in the suppression pool region affected by the pool swell, caused by the pool swell phenomenon.

g. AP - Loads from component response or direct steamflow forces, on supports located in the Reactor Vessel shield wall annulus region, caused by annulus pressurization.

h. SL - Loads from component response or direct fluid forces, on supports located in the sloshing zone of a pool or component, caused by the sloshing phenomenon from any dynamic event.

6.5.3 Other Loadings. See Paragraph 6.4.2.3.

6.6 Loads on Structures. The specific loads which act on a given structure as a result of a specific event are presented in Tables 4.1 through 4.5.

6.6.1 General Structural Loads. The loads which are generally applicable to all BGNI building and structures include:

a. D - Dead load of structure plus any other permanent loads and includes vertical and lateral pressure of liquids.

b. L - Conventional floor or roof live loads, movable equipment loads, loads caused by static or seismic earth pressures, and other variable loads such as construction loads and hoist loads. The most severe value(s) shall be considered.

c. R_o - Pipe reactions during normal operating or shutdown conditions, based on the most critical transient or steady state condition.

6.6.1 (Continued)

d. T_o - Thermal effects and loads during normal operating or shutdown conditions, based on the most critical transient or steady state condition.

e. Construction Loads - Construction loads are loads which are applied to the structures from start to completion of construction. The definition for D, L, and T_o shall be based on actual construction methods and/or conditions.

6.6.2 Abnormal Plant Loads on Structures. The following are abnormal plant loads which may need to be considered for structures:

a. F_L - Internal pressures resulting from flooding of compartments; hydrostatic head.

b. P_a - Accident pressure due to DBA.

c. R_a - Pipe reactions (including R_o) under thermal conditions generated by the postulated line break.

d. T_a - Thermal effects (including T_o) which may occur during a design accident (high energy line break-HELB).

e. Y_j - Local pressure on structure due to jet impingement caused by the postulated line break including impact effects and drag loads.

f. Y_m - Local force on structure due to missile (including whipping pipe or other missile).

g. Y_r - Reaction force on structure due to postulated line break.

6.6.2.1 Abnormal Loads in the Reactor Building. In addition to the loads defined in Paragraph 6.6.1 and 6.6.2 above, the following loads shall be considered for all component supports located within the Reactor Building:

a. RBV - Loads due to Reactor Building vibrations caused by an SRV or DBA event.

b. CHUG - Loads from component response on direct fluid forces, on components located in the suppression pool, caused by chugging phenomenon.

c. CO - Loads from component response or direct fluid forces, on a component located in the suppression pool, caused by condensation oscillation phenomenon.

6.6.2.1 (Continued)

d. VLC - Loads from component response or direct fluid forces, on components located in the suppression pool, caused by main vent line clearing phenomenon.

e. RV2 - Loads from component response or direct fluid forces, on components located in the suppression pool, caused by safety relief valve air clearing loads.

f. PS - Loads from component response or direct fluid forces, on components located in the suppression pool region affected by the pool swell, caused by the pool swell phenomenon.

g. AP - Loads from component response or direct steamflow forces, on components located in the Reactor Vessel shield wall annulus region, caused by annulus pressurization.

h. SL - Loads from component response or direct fluid forces, on components located in the sloshing zone of a pool or component, caused by the sloshing phenomenon from any dynamic event.

6.6.3 Loads on Containment Structures. Containment structures may sustain the following loads:

a. P_o - Pressure difference between the interior and exterior of the containment, considering both interior pressure changes because of heating or cooling and exterior atmospheric pressure variations.

b. SRV - Safety Relief Valve Loads.

c. I - Impact load due to crane operation.

6.6.3.1 Preoperational Testing Loads

a. P_t - Pressure test loads applied during the structural integrity test.

b. T_t - Thermal effects during the structural integrity test.

6.6.3.2 Severe Environmental Loads. The load due to the Operating Basis Earthquake (OBE) including Fuel Transfer Pool and Suppression Pool Sloshing effects.

6.6.3.3 Extreme Environmental Loads. The load due to the Safe Shutdown Earthquake (SSE) including Fuel Transfer Pool and Suppression Pool Sloshing effects.

6.6.3.4 Abnormal Plant Loads

a. P_a - Local force or pressure on containment structure or penetration caused by rupture of any one pipe.

(1) Local compartmental pressures on the containment wall from ruptured pipes in compartments outside the wall, within the Auxiliary Building.

(2) Local compartmental pressures inside the containment include those from the main steam pipe tunnel.

b. Design Basis Accident (DBA) - The Mark III containment shall be designed to sustain the following loadings as a result of a Loss-of-Coolant Accident (LOCA).

(1) P_a - Containment design pressure load during a loss of coolant accident design basis accident.

(a) P_{CDC} - Containment and drywell design pressure, during a design base accident (DBA).

(b) Design Basis Accident (DBA) suppression pool loads - Immediately following a design basis accident, the containment wall, foundation mat, drywell wall, weir wall, and structures located above the suppression pool will experience various pressure and dynamic loadings as a result of the vent DBA clearing process into the suppression pool.

(i) PS - Pool swell bubble pressure on containment and drywell wall (axisymmetrical) and nonaxisymmetrical on containment.

(ii) P_{TD} - Containment wetwell differential pressure axisymmetrical due to flow restriction of the hydraulic control unit (HCU) floor to pool swell concurrent with a differential drywell pressure.

(iii) I, D_R - Impact and drag loads on structures located above the suppression pool to upward pool swell.

(iv) R_F - Fallback loads of cascading water onto structures above the suppression pool immediately following pool swell.

(v) CO - An oscillatory dynamic loading (condensation oscillation), on the suppression pool boundary due to steam condensation at the vent exits during the period of high steam mass flow through the vents following a LOCA.

6.6.3.4.b (Continued)

(vi) CHUG - An oscillatory dynamic loading (chugging) in the top vent and weir annulus or on the suppression pool boundary due to steam condensation inside the top vent or at the top vent exit during period of low steam mass flow in the top vent only following a LOCA.

(vii) R_V - Inward load through the vents applied to the weir wall, due to negative drywell pressure differential.

(2) T_a - Added thermal effects (over and above operating thermal effects) which may occur during a design accident and which correspond to the unfactored design pressure, P_a. Accident thermal gradients for the containment dome, wall, and foundation mat shall be considered.

c. The Design Basis Accident (DBA) in the Mark II containment produces loading effects which are similar to those described for the Mark III. Reference should be made to the DPFR (Paragraph 2.1.2.b) for details.

6.7 Evaluating Load Combinations

6.7.1 Initial Conditions

6.7.1.1 All Loading Combinations. The initial condition for each loading combination shall consider all of the events and conditions defined in Section 6.3.

6.7.1.2 Static Events. For plant start-up mode, the initial conditions shall be ambient temperature and pressure associated with the plant cold shutdown condition.

For operating transients, the initial conditions shall be the most limiting conditions which exist during steady state power operation.

6.7.1.3 Event Combinations Not Including Seismic Events. The initial conditions for all nonseismic event and loading combinations shall be steady state plant operation at any permissible power condition, including power levels up to that corresponding to rated steam flow and including zero power hot standby with the main condenser in service.

6.7.1.4 Event Combinations Including Seismic Event. The initial conditions for all event and loading combinations, including seismic events, shall be the steady state operation at rated recirculation flow unless the combined probability of the seismic event and the plant condition considered require a different initiation basis and acceptance criteria.

6.7.2 Combining Loads. The event combinations shown in this document are meant only to provide a description of which events are to be considered in combination with other events and are not meant to indicate that the loads or stresses from these events are to be combined algebraically. The following paragraphs are intended to serve as a guide in combining loads and stresses from at least two dynamic events on loading phenomena from the same event.

6.7.2.1 Methods of Mathematical Combinations for Static Events. Static events are considered as deterministic events shall be added algebraically. Weight, thermal expansion, and static anchor movement loading conditions are deterministic events.

6.7.2.2 Approach to Mathematical Combination of Response Time-Histories. This paragraph presents guidelines for combining response time-histories due to:

a. Concurrent loads due to a single event.

b. Concurrent loads due to a combination of events.

There are methods for combining responses that yield results which are or most likely to be "average" (ie, results approximating the expected peak value), and which yield "conservative" results (ie, calculated peak values which have a low probability of being exceeded). In general, it is preferable to use a best estimate method since conservatism introduced in the mathematical combination process is artificial, that is, it is preferable to introduce the desired measure of conservatism in the evaluation of loads and stresses, and in the allowable limits, where the conservatism is tied directly to the phenomena and is thus physically comprehensible.

In particular, in dealing with low probability combinations of events, consideration of the total probability (the product of the probability of simultaneous event occurrence and the probability of exceeding the calculated combined value) may justify the use of a best-estimate method even when the application of such a method is subject to uncertainty. In several important load combinations of Tables 4.1 through 4.5, either the probability of time-history overlap is very low (eg, LOCA + SSE) or the probability of one of the events alone is very low (eg, SSE, including relief valve loads due to turbine trip). In such instances, the probability of the event or event combination as well as the probability of exceeding the calculated combined value should be used in considering the appropriateness of the approach.

When loads can be shown to occur with insignificant overlap in time (eg, pool swell and post-LOCA containment flooding resulting from a LOCA), it is not necessary to combine them at all.

6.7.2.3 Methods for Mathematical Combination of Response Time-Histories.
(Refer to Paragraph 2.2.8.a)

a. Absolute Sum of Peak Amplitudes (ABS). Combining concurrent responses by their peak amplitudes is the most straightforward combination method. If peak amplitudes are added irrespective of their time sequence, a conservative result will be obtained. The method approaches a probable result when the loads are fully expected to overlap in time for mechanistic reasons or by assumption, and when the overlapping response time-histories have substantially different dominant frequencies. If responses are added as functions of time when the phase relationship is known, the method yields a probable result. The measure of conservatism in ABS is extremely variable, being strongly dependent on the frequency content and the phase relationships of the loads being combined. ABS should be used in design evaluations only when:

(1) The waveshapes and timing are such that ABS gives a probable result

(2) A conservative combined value is desired (by contrast to a probable combined value of conservatively determined loads), eg, for active components important to safety as indicated in Paragraph 6.7.2.4.

b. Square Root of the Sum of Squares (SRSS). Combining concurrent response time-histories as the square root of the sum of the squares of their peak amplitudes is frequently a good approximation and is widely used. Use of SRSS has been justified by the use of probability theory. SRSS may be used for the following cases:

(1) Combination of SSE and LOCA dynamic responses for all ASME Class 1, 2, or 3 systems, components, or supports.

(2) Combining responses of dynamic loads other than LOCA and SSE provided a nonexceedance probability (NEP) of 84 percent or higher is achieved for the combined SRSS response. An acceptable method of achieving that goal is if Conditions A and B are both satisfied.

(a) Condition A

The dynamic response time function is varying.

Duration of the strong motion of the function is short.

Function consists of a few distinct high peaks which are random with respect to time.

Response is calculated on linear elastic basis.

Time-phase relationship among functions to be combined is random.

6.7.2.3.b(2) (Continued)

(b) Condition B. For loads which meet Condition A, the SRSS method may be used provided a nonexceedance probability (NEP) of 84 percent or higher is achieved for the combined response. An acceptable method of attaining that goal is meeting all the following requirements:

Define loads at approximately the 84 percentile or 1.15 times the median, whichever is greater.

The SRSS value of the response combination has a NEP $\geq$ 50 percent selected from a Cumulative Distribution Function (CDF) curve constructed on the assumption that individual response amplitudes are known and only random time phasing defined by its probability density function exists. The CDF curve may be developed using the procedures of Appendix N of Section III of the ASME Code, or alternatively, methods developed by Brookhaven National Laboratory, using absolute (unsigned) values of response amplitude may be used. The method selected shall be justified in the submission for the application being analyzed.

1.2 times the SRSS value of the response combination has an NEP 85 percent from the CDF curve constructed as in "b" above, assuming only random time phasing.

6.7.2.4 Methods for Mathematical Load Combination for Active Components (Design Criteria for Active Components). Active component operability to required limits must be demonstrated by testing or analysis at absolute sum levels of combined peak response. This demonstration must include specific consideration of the dynamic nature of the loadings and response, component failure modes and margins, as well as evaluation of the extent to which transient loss in operability affects plant safety.

6.8 Loading Combinations and Acceptance Criteria. Loading combinations and their corresponding acceptance criteria which are applicable to components, component supports and structures presented in Tables 2.1 through 2.10.

6.8.1 Mechanical Components

6.8.1.1 ASME Mechanical Components. Loading combinations and acceptance criteria for ASME mechanical components are presented in Tables 2.1(a) and 2.1(b).

6.8.1.2 Non-ASME Mechanical Components. Loading combinations and acceptance criteria for non-ASME mechanical components are presented in Tables 2.2 and 2.3.

Acceptance criteria for this type of equipment shall be based upon either:

a. Analysis in accordance with the requirements of IEEE, ASME Section III, ASME Section VIII, AISC Specification, AA Specifications, or other applicable Standards.

b. Test per IEEE-344 (1975) or equivalent.

6.8.2 Electrical, Control, and Instrumentation Components. Loading combinations, and acceptance criteria for electrical, control, and instrumentation equipment and components are presented in Tables 2.2 and 2.3.

In general, the acceptance criteria for this type of equipment shall be based upon either:

a. Analysis in accordance with ASME Section III, the AISC Specification, or other applicable Standards.

b. Test. Testing shall be in accordance with IEEE-344 (1975). Nonmetallic parts will require special consideration if their structural integrity must be assured.

6.8.3 Component Supports

6.8.3.1 Component Supports for ASME Section III Components. Loading combinations and acceptance criteria for component supports are presented in Table 2.6.

6.8.3.2 Component Supports for Non-ASME Components. Loading combinations and acceptance criteria for component supports, which transmit loads from non-ASME components (mechanical, electrical, control, and instrumentation) to building structures or other components, are presented in Table 2.10.

6.8.4 Structures

6.8.4.1 Containment. Loading combinations and acceptance criteria for containment are presented in Tables 2.7 and 2.8.

6.8.4.2 Structures Other than Containment. Loading combinations and acceptance criteria for Seismic Category I buildings and structures are presented in Table 2.9 for concrete structures and Table 2.10 for steel structures. Load combinations and acceptance criteria for refueling and servicing equipment are presented in Table 2.11.

6.8.5 Ruptured Pipe Criteria. The criteria for evaluating the effects of a postulated rupture of a high energy line shall be in accordance with ANSI N176 or other similar standards. The detailed requirements for this condition are beyond the scope of this document.

TABLE 1 BASIC EVENT COMBINATIONS AND CATEGORIZATIONS

EVENT(S)	NO(3)	SRV(5)	SEISMIC		ACCIDENT		EVENT CATEGORY
			OBE	SSE	IBL(1&4)	LBL(4)	
OT	X	X					Upset
OT & OBE	X	X	X				Emergency
OT + SSE	X	X		X			Faulted
IBA or SBA	X	X			X		Emergency
IBA or SBA + OBE	X	X	X		X		Faulted
IBA or SBA + SSE	X	X		X	X(2)		Faulted
LBA + SSE	X	X		X		X(2)	Faulted
NO	X						Normal
NO + OBE	X		X				Upset

(1) Use SBA or IBA whichever is governing.

(2) Loading due to LBA/SBA/IBA is determined from rated steady state conditions.

(3) NO - Normal load consists of pressure, dead weight, thermal and fluid reaction loads.

(4) SBA, IBA, and LBA shall include all event induced loads whichever are applicable. Examples of these possibly applicable loads include annulus pressurization load, pool swell load, condensation oscillation load, and chugging load.

(5) See Table 3 for the possible sets of simultaneous SRV actuation concurrent with the event under consideration.

TABLE 2.1(a) CLASS 1 MECHANICAL COMPONENTS AND CORE SUPPORT STRUCTURES

EVENTS	LOADING COMBINATION (1)(2)	ACCEPTANCE CRITERIA (6)
Design	$P_D + T_D + R_D$	Design
NO	N + T	Level A
OT	N + T + TSVC (3)	Level B
	$N + T + SRV_I + SRV_D$	Level B
NO + OBE	$N + T + OBE_I + OBE_D$	Level B
OT + OBE	$N + TSVC + OBE_I + OBE_D + T$	Level B
	$N + SRV_I + SRV_D + OBE_I + OBE_D + T$	Level B
SBA	$N + SRV_I + SBL$	Level C (5)
IOT	$N + SRV_I$	Level C (5)
IBA or SBA + OBE	$N + SRV_I + OBE_I$ + IBL (or SBL)	Level D (5)
OT + SSE	$N + TSVC + SSE_I$	Level D (5)
IBA or SBA + SSE	$N + SRV_I + SSE_I$ + IBL (or SBL)	Level D (5)
NLF	$N + SRV_I + TSVC$	Level D (5)
	$N + SRV_I + SSE_I$	Level D (5)
LBA + SSE	$N + SRV_I + SSE_I + LBL$	Level D (5)
Test	$P_T + D_T$	NB 6000

(1) Where SRV, OBE, SSE, SBL, IBL, and LBL are used, this means the component or structure response to the Reactor Building Vibration (RBV) due to these events.

(2) See Table 3 for the specific SRV actuation cases which combine in each event.

(3) TSVC loads apply only to the main steam piping and components to or mounted thereon.

(5) For active essential valves, the pressure for which the valve must open or close shall not exceed the valve design pressure rating.

(6) Service limits per ASME Section III Subsection NB or NG.

TABLE 2.1(b) CLASS 2 AND 3 MECHANICAL COMPONENTS

EVENTS	LOADING COMBINATION[(1)(2)]	ACCEPTANCE CRITERIA[(5)]
Design	$P_D + T_D + R_D$	Design
NO	$N + T$	Level A
OT	$N + T + TSVC$ (3)	Level B
	$N + T + SRV_I + SRV_D$	Level B
NO + OBE	$N + T + OBE_I + OBE_D$	Level B
OT + OBE	$N + TSVC + OBE_I$	Level B
	$N + SRV_I + OBE_I$	Level B
SBA	N + [illegible]$_I$ + SBL	Level C (4)
IOT	$N + SRV_I$	Level C (4)
IBA or SBA + OBE	$N + SRV_I + OBE_I + IBL$ (or SBL)	Level D (4)
OT + SSE	$N + TSVC + SSE_I$	Level D (4)
	$N + SRV_I + SSE_I$	
IBA or SBA + SSE	$N + SRV_I + SSE_I + IBL$ (or SBL)	Level D (4)
NLF	$N + SRV_I + TSVC$	Level D (4)
LBA	$N + SRV_I + SSE_I + LBL$	Level D (4)
Test	$P_T + D_T$	NC 6000/ ND 6000

(1) Where SRV, OBE, SSE, SBL, IBL, and LBL are used, this means the component or structure response to the Reactor Building Vibration (RBV) due to these events.

(2) See Table 3 for the specific SRV actuation cases which combine in each event.

(3) TSVC loads apply only to the main steam piping and components to or mounted thereon.

(4) For active essential pumps and valves the Design and Level B criteria shall be satisfied except that the basic allowable stress shall be 1.2 times the design allowable stress.

(5) Service Limits per ASME Code, Section III, Subsections NC and ND.

TABLE 2.2 LOADING COMBINATIONS AND ACCEPTANCE CRITERIA

NON-ASME MECHANICAL COMPONENTS AND ELECTRICAL CONTROL AND INSTRUMENTATION EQUIPMENT WORKING STRESS METHOD

EVENTS	LOAD (1)(2)(3)	ACCEPTANCE CRITERIA (5)
NO	D + L	S
	D + L + OBE	S
OT	D + L + SRV	S
NO	D + L + T_o + R_o	S
	D + L + T_o + R_o + OBE	S
OT	D + L + T_o + R_o + SRV	S
OT + OBE + SRV	D + L + T_o + R_o + OBE + SRV	1.2
OT + SSE + SRV	D + L + T_o + R_o + SSE + SRV	1.5S or 1.2Y but $<$ 0.7 UTS
OT + IBA + OBE + SRV (6)	D + L + T_a + R_a + OBE + P_a + SRV + Y_j + Y_r + Y_m	1.5S or 1.2Y but $<$ 0.7 UTS
OT + SSE + LBA	D + L + T_a R_a + P_a + SSE + Y_j + Y_r + Y_m + SRV	1.5S or 1.2Y but $<$ 0.7 UTS

(1) Where SRV, OBE, SSE, SBL, IBL, and LBL are used, this means the component or structure response to the Reactor Building Vibration (RBV) due to these events.

(2) See Table 3 for the specific SRV actuation cases which combine in each event.

(3) Thermal combinations assume that thermal stresses due to T_o and R_o are secondary and self-limiting.

(4) S is allowable stress from AISC Part 1.

(5) Local buckling shall be considered in regions of compressive stress.

(6) Use higher of SBL or IBL.

TABLE 2.3 LOADING COMBINATIONS AND ACCEPTANCE CRITERIA

NON-ASME MECHANICAL COMPONENTS AND ELECTRICAL CONTROL AND INSTRUMENTATION EQUIPMENT STRENGTH DESIGN METHODS

EVENTS	LOAD(1)(2)(3)	ACCEPTANCE CRITERIA(4)(5)
NO	1.7 D + 1.7 L	Y
OT	1.7 (D + L + SRV)	Y
NO	1.3 D + 1.3 L + 1.3 T_o + 1.3 R_o	Y
OT	1.3 D + 1.3 L + 1.3 T_o + 1.3 R_o + 1.3 SRV	Y
OT + OBE + SRV	1.3 D + 1.3 L + 1.3 T_o + 1.3 R_o	Y
OT + OBE + SRV	1.7 D + 1.7 L + 1.7 OBE + 1.7 SRV	Y
OT + SSE + SRV	D + L + T_o + R_o + SSE + SRV	0.9Y
OT + IBA + OBE + SRV	D + L + T_a + R_a + 1.25 P_a + Y_j + Y_r + Y_m + 1.25 OBE + 1.25 SRV	0.9Y
OT + SSE + LBA + SRV	D + L + T_a + R_a + P_a + Y_r + Y_j + Y_m + SSE + SRV	0.9Y

(1) Where SRV, OBE, SSE, SBL, IBL, and LBL are used, this means the component or structure response to the Reactor Building Vibration (RBV) due to these events.

(2) See Table 3 for the specific SRV actuation cases which combine in each event.

(3) Thermal loads can be neglected when it can be shown that they are secondary and self-limiting in nature and where material is ductile.

(4) Y is yield stress from AISC Part 2.

(5) Potential for buckling shall be considered in regions of compressive stress.

TABLE 2.4 Deleted

TABLE 2.5 Deleted

TABLE 2.6 LOADING COMBINATIONS AND ACCEPTANCE CRITERIA

ASME SECTION III COMPONENT SUPPORTS

EVENTS	LOADING COMBINATION (1)(2)	ACCEPTANCE CRITERIA (5)
Design	$P_D + D + R_D + T_D$	Design
NO	$P_o + D + T + R$	Level A
OT	$P_o + D + T + TSVC + R$ (3)	Level B
	$P_o + D + T + SRV_I + SRV_D + R$	Level B
NO + OBE	$P_o + D + T + OBE_I + OBE_D$	Level B
OT + OBE	$P_o + D + TSVC + OBE_I + OBE_D + T + R$	Level B
	$P_o + D + SRV_I + SRV_D + OBE_I + OBE_D + T + R$	Level B
SBA	$P_p + D + SRV_I + SRV_D + SPL + T + R$	Level C
IOT	$P_p + D + SRV_I + SRV_D + T + R$	Level C
IBA or SBA + OBE	$P_p + D + SRV_I + OBE_I + IBL$ (or SBL) $+ R$	Level D
OT + SSE	$P_o + D + TSVC + SSE_I + R$	Level D
IBA or SBA + SSE	$P_o + D + SRV_I + SSE_I + R$	Level D
	$P_o + D + SRV_I + SSE_I + IBL$ (or SBL) $+ R$	Level D
NLF	$P_o + D + SRV_I + TSVC + R$	Level D
LBA + SSE	$P_o + D + SRV_I + SSE_I + LBL + R$	Level D
Test	$P_o + D_t + R_t$	

See Notes on following page.

Notes for Table 2.6

(1) Where SRV, OBE, SSE, SBL, IBL, and LBL are used, this means the component or structure response to the Reactor Building Vibration (RBV) due to these events.

(2) See Table 3 for the specific SRV actuation cases which combine in each event.

(3) TSVC loads apply only to the main steam piping and components to or mounted thereon.

(4) Deleted

(5) Service Limits per ASME Section III, Subsection NF.

TABLE 2.7 LOADING COMBINATIONS AND ACCEPTANCE CRITERIA

CONCRETE CONTAINMENTS

EVENTS	LOADING COMBINATION	ACCEPTANCE CRITERIA(2)
NO	$D + L + T_o + P_o + R_o$	S
OT	$D + L + T_o + SRV + R_o + P_o$	S
OT + OBE	D + L + [illegible] + OBE + SRV + $R_o + P_o$	S
NO + OBE	$D + 1.3L + T_o + R_o + P_o + 1.5$ OBE	U
NO + ENV	$D + 1.3L + T_o + R_o + P_o + 1.5W$	U
	$D + L + T_o + P_o + W' + R_o$	U
OT + SSE	$D + L + T_o + SSE + SRV + R_o + P_o$	U
OT + DBA (1) + SSE	$D + L + T_a + P_a + R_a + SSE + Y_r + Y_j$ + SRV(3) + Y_m	U
OT + DBA (1)	$D + L + T_a + 1.5\ P_a + R_a + 1.25$ SRV	U
OT + DBA (1) + OBE	$D + L + T_a + 1.25\ P_a + R_a + 1.25$ OBE + $Y_r + Y_j + Y_m$ + SRV	U
OT + DBA (1) + ENV	$D + L + T_a + 1.25\ P_a + R_a + 1.25\ W$ [illegible]$_r$ + [illegible] + Y_m + SRV	U
NO + OBE Post Accident	D + L + [illegible] + OBE + T_o	S
NO + ENV Post Accident	$D + L + F_L + W + T_o$	S
Test	$D_t + L + P_t + T_t$	S

(1) DBA = Most severe of LBA, IBA, or SBA.

(2) U = Section strength based on the strength Design Methods given in ASME Section III Division 2 Article CC-3420.

S = Required section strength based on the design methods given in ASME Section III Division 2 Subarticle CC-3430.

(3) See Table 3.

TABLE 2.8 LOADING COMBINATIONS AND ACCEPTANCE CRITERIA

STEEL CONTAINMENTS(1)

EVENTS	LOADING COMBINATION	ACCEPTANCE CRITERIA(2)
Design	$D + L + T_a + P_a + R$	Design
NO	$D + L + T_o + R$	Level A
OT	$D + L + T_o + R_o + SRV$	Level A
DBA (3)	$D + L + T_a + R_a + P_a$	Level A
NO + OBE	$D + L + T_o + R_o + OBE_I + OBE_D$	Level B
NO + SSE	$D + L + T_o + SSE_I$	Level C
OT + OBE	$D + L + T_o + R_o + SRV + OBE$	Level B
OT + SSE	$D + L + T_o + R_o + SRV_I + SSE_I$	Level C
DBA (3) + OBE	$D + L + T_a + R_a + P_a + DBA + OBE + SRV$ (6)	Level B
DBA (3) + SSE	$D + L + T_a + R_a + P_a + SSE_I + DBA$	Level C
DBA (3) + SSE	$D + L + T_a + R_a + P_a + SSE_I + SRV_I + DBA + Y_r + Y_j + Y_m$	Level D (7)
LOCA Post Accident Flooding	$D + L + P_L + OBE$	(4)
Test	$D_t + L + P_t + T_t$	(5)

(1) MC Components such as the drywell head, down comers, equipment hatches, etc, and a liner subjected to mechanical loads condition.

(2) Service Limits as defined in ASME Section III, Subsection NE.

(3) DBA = Most severe of LBA, IBA, or SBA.

(4) For Post Accident flooding Pm 1.5 S_m; P_L or P_L+P_B 1.8 S_m or 1.5 S_y

(5) Requirements per ASME Section III - Article NE-6000.

(6) See Table 3.

(7) For local effects only.

TABLE 2.9 LOADING COMBINATIONS AND ACCEPTANCE CRITERIA

CONCRETE STRUCTURES OTHER THAN CONTAINMENT

EVENTS	LOADING COMBINATION	ACCEPTANCE CRITERIA[(1)]
Normal Operation	$1.4\ D + 1.7\ L$	U
	$1.4\ D + 1.7\ L + 1.7\ SRV$	U
	$1.4\ D + 1.7\ L + 1.9\ OBE$	U
	$1.4\ D + 1.7\ L + 1.7\ W$	U
	$1.4\ D + 1.7\ L + 1.9\ OBE + 1.7\ SRV$	U
	$0.75\ (1.4\ D + 1.7\ L + 1.7\ T_o + 1.7\ R_o)$	U
	$0.75\ (1.4\ D + 1.7\ L + 1.7\ T_o + 1.7\ R_o + 1.7\ SRV)$	U
	$0.75\ (1.4\ D + 1.7\ L + 1.7\ T_o +$ $1.7\ R_o + 1.9\ OBE + 1.7\ SRV)$	U
	$0.75\ (1.4\ D + 1.7\ L + 1.7\ T_o + 1.7\ R_o + 1.7\ W)$	U
Abnormal/Extreme Environmental Conditions (1)	$D + L + T_o + R_o + SRV$	U
	$D + L + T_o + R_o + SSE + SRV$	U
	$D + L + T_o + R_o + SRV + W'$	U
	$D + L + T_a + R_a + 1.5\ P_a + 1.25\ SRV$	U
	$D + L + T_a + R_a + 1.25\ P_a +$ $1.25\ OBE\quad SRV + Y_r + Y_j + Y_m +$	U
	$D + L + T_a + R_a + P_a + SSE + Y_r +$ $Y_j + Y_m + SRV$	U

(1) U = Section strength based on strength Design Methods as defined in ACI-318-71.

TABLE 2.10 LOADING COMBINATIONS AND ACCEPTANCE CRITERIA

STEEL STRUCTURES OTHER THAN CONTAINMENT

EVENTS	LOADING COMBINATION	ACCEPTANCE CRITERIA(3)
Normal Operation	a. Working Stress Design Methods (1)	
NO	D + L	S
NO + ENV (SEIS)	D + L + W (or OBE)	S
OT	D + L + SRV	S
	If thermal stresses due to T_o and R_o are present and are secondary and self-limiting in nature, the following combinations shall also be satisfied.	
NO	D + L + T_o + R_o	1.5 S
OT	D + L + T_o + R_o + SRV	1.5 S
OT + SEIS	D + L + T_o + R_o + OBE + SRV	1.5 S
NO + ENV	D + L + T_o + R_o + W	1.5 S
	b. Strength Design Methods (2)	
NO	1.7 D + 1.7 L	Y
NO	1.3 D + 1.3 L + 1.3 T_o + 1.3 R_o	Y
OT	1.7 D + 1.7 L + 1.7 SRV	Y
OT	1.3 D + 1.3 L + 1.3 T_o + 1.3 R_o + 1.3 SRV	Y
NO + ENV	1.7 D + 1.7 L + 1.7 W	Y
NO + ENV	1.3 D + 1.3 L + 1.3 T_o + 1.3 R_o + 1.7 W	Y
NO + ENV	1.7 D + 1.7L + 1.7 OBE + 1.7 SRV	Y
OT + OBE	1.3 D + 1.3 L + 1.3 T_o + 1.3 R_o + 1.3 OBE + 1.3 SRV	Y

(1) Use Part 1 of AISC

(2) Use Part 2 of AISC

(3) S = Required Section strength based on Working Stress Design Methods

(4) Y = Section strength based on Strength Design Methods

TABLE 2.10 (Continued)

EVENTS	LOADING COMBINATION	ACCEPTANCE CRITERIA[3]
Abnormal/Extreme Environmental Conditions (5)		
	a. Working Stress Design Methods (1)	
OT + SSE	$D + L + T + R_o + SSE + SRV$	1.6 S
NO + ENV	$D + L + T_o + R_o + W'$	1.6 S
OT + DBA	$D + L + T_a + R_a + P_a + SRV$	1.6 S
OT + DBA + OBE	$D + L + T_a + R_a + OBE + P_a + SRV + (Y_j + Y_r + Y_m)$	1.6 S
OT + DBA and SSE	$D + L + T_a + R_a + SSE + P_a + SRV + (Y_j + Y_r + Y_m)$	1.7 S
	b. Strength Design Methods (2)	
OT + SSE	$D + L + T_o + R_o + SSE + SRV$	0.9 Y
NO + ENV	$D + L + T_o + R_o + W'$	0.9 Y
OT + DBA	$D + L + T_a + R_a + 1.5\ P_a + 1.25\ SRV$	0.9 Y
OT + DBA + OBE	$D + L + T_a + R_a + 1.25\ OBE + 1.25\ P_a + SRV + (Y_j + Y_r + Y_m)$	0.9 Y
OT + DBA + SSE	$D + L + T_a + R_a + P_a + (Y_j' + Y_r + Y_m) + SSE + SRV$	

(1) Use Part 1 of AISC

(2) Use Part 2 of AISC

(3) S = Required Section strength based on Working Stress Design Methods

(4) Y = Section strength based on Strength Design Methods

(5) Thermal loads can be neglected when it can be shown that they are secondary and self-limiting in naure and where the material is ductile.

TABLE 2.11 LOAD COMBINATIONS AND ACCEPTANCE CRITERIA

REFUELING EQUIPMENT

EVENTS	LOADING COMBINATION (1)(2)	ACCEPTANCE CRITERIA (4)
NO	$D + L + T_o$	Level A
NO + OT	$D + L + T_o + SRV_I + SRV_D$	Level B
NO + OBE	$D + L + T_o + OBE_I + OBE_D$	Level B
NO + OBE + OT	$D + L + T_o + SRV_I + SRV_D + OBE_I + OBE_D$	Level [illegible] (3)
NO + SBL	$D + L + T_a + SBL + P_a$	Level C
NO + SBL + OBE	$D + L + T_a + P_a + SBL + OBE_I$	Level D
NO + IBL	$D + L + T_a + P_a + IBL$	Level D
NO + LBL	$D + L + T_a + P_a + LBL$	Level D
NO + SSE	$D + L + T_o + SSE_I$	Level D
NO + SSE + OT	$D + L + T_o + SRV_I + SSE_I$	Level D
NO + SSE + SBL	$D + L + T_a + SBL + SSE_I$	Level D
NO + NLF	$D + L + T_o + SRV_I + SSE_I$	Level D
NO + SSE + IBL	$D + L + T_a + P_a + IBL + SSE_I$	Level D
NO + SSE + LBL	$D + L + T_a + P_a + LBL + SSE_I$	Level D

(1) Where SRV, OBE, SSE, SBL, IBL, and LBL are used, this means the component or structure response to the Reactor Building Vibration (RBV) due to these events.

(2) See Table 3 for the specific SRV actuation cases which combine in each event.

(3) No fatigue analysis required.

(4) See Sheet 65 for Note 4.

Notes for Table 2.11 (Continued)

(4) Acceptance Criteria

Code	Stress	Level A	Level B	Level C	Level D
AISC, and ASME Subsection NF Steel	Axial Bending	0.60xY 0.66xY	0.80xY 0.88xY	0.80xY 0.88xY	1.2xY but <0.7 xUTS
Aluminum	Axial	0.60xY	0.80xY	0.80xY	0.80xY
ANSI B31.1	Bending	$1.0xS_h$	$1.15xS_h$	$1.20xS_h$	$1.2xF_y$ but <0.7 xUTS

With the exception of the Inclined Fuel Transfer System, refueling and servicing equipment use industry standards to define design limits, such as AISC code, ASME Subsection NF, or crane design standards. The ASME NC and ND sections have been referenced to be used as a backup when other codes do not apply or where probablistic allowables are not available. Part of the IFTS (the Containment Isolation Assembly) is classified as ASME Code Class NC and the corresponding service levels apply. The balance of the tube is classified as ANSI B31.1.

TABLE 3 SRV ACTUATION FOR VARIOUS EVENTS

PLANT EVENTS	GROUPS OF SRV ACTUATED						REACTOR (3) BUILDING VIBRATION
	ONE	TWO ADJ	LOW SET	ADS	ALL		REV
OT	X	X	X		X		X
IOT	X	X	X		X		X
MLF	X	X	X	X	X		X
(Inside)	X	X	X	X			X
Inadv. ADS (SBA)				X			X
LBA (Feedwater)	(1)		X	(2)			X
LBA (Inside Containment)	(1)			X			X
LBA (Outside Containment)	X	X	X	X			X
IBA (Inside Containment)	X	X	X	(2)			X

(1) One SRV is assumed to fail open for containment analysis only.

(2) ADS Actuation may coincide with main vent chugging after the peak dynamic loads from the break have dissipated.

(3) DBA and SRV events cause a vibration which must be considered in the loading on all components in the reactor building.

TABLE 3.1 TOTAL NUMBER OF RELIEF VALVE ACTUATIONS IN 40 YEARS

Number of Valves Lifting Simultaneously	BWR/4 Target Rock[1]	BWR/4 Crosby[2]	BWR/5 Lo-Lo Set[3]	BWR/5 All Others	BWR/6 All
Many	1100	1100	753 (220)[4]	1100	220 ([illegible])[4]
2	1550	850	–	850	–
1	8750	4750	2550	4750	1580

(1) Shoreham, Fermi-2, Hatch-2, Limerick 1 & 2, Hope Creek 1 & 2

(2) Caorso, Chinshan 1 & 2, Susquehanna 1 & 2

(3) La Salle 1 & 2

(4) Values in () are for vessel and piping values

TABLE 4.1 LOADS FOR NORMAL OPERATION (NO) AND INFREQUENT OPERATIONAL TRANSIENTS (IOT)

	NORMAL OPERATION						IOT	
	D	L	P_o	T_o	R_o	FIV	SRV	F_{cd} (1)
REACTOR BUILDING								
GENERAL	X	X	X	X	X	X		
SUPPRESSION POOL REGION	X	X	X	X	X		X	
RV SHIELD WALL ANNULUS REGION	X	X	X	X	X			
WEIR WALL ANNULUS REGION	X	X	X	X	X			
CONTAINMENT POOL REGION	X	X	X	X	X			
CONTAINMENT	X	X	X	X	X			
SHIELD BUILDING	X	X	X	X	X			
FUEL BUILDING								
GENERAL	X	X	X	X	X			
SPENT FUEL POOL REGION	X	X	X	X	X			X
AUXILIARY BUILDING								
GENERAL	X	X	X	X	X	X		
STEAM TUNNEL REGION	X	X	X	X	X	X		
CONTROL BUILDING								
GENERAL	X	X	X	X	X			
RADWASTE BUILDING								
GENERAL	X	X	X	X	X	X		
DIESEL GENERATOR BUILDINGS								
GENERAL	X	X	X	X	X			

General Note: In addition, for buildings on common basemats, additional loads may be imposed on any particular building from another building on the common basemat.

(1) F_{cd} = forces resulting from cask drop.

TABLE 4.2 LOADS FOR OPERATIONAL TRANSIENTS

	OPERATIONAL TRANSIENTS										
	D	L	P_u	T_o	R_o	SRV (1)	TSVC	FIV (2)		RVCO	RBV (3)
REACTOR BUILDING											
GENERAL	X	X	X	X	X		X	X		X	X
SUPPRESSION POOL REGION	X	X	X	X	X	X					X
RV SHIELD WALL ANNULUS REGION	X	X	X	X	X						X
WEIR WALL ANNULUS REGION	X	X	X	X	X						X
CONTAINMENT POOL REGION	X	X	X	X	X						X
CONTAINMENT	X	X	X	X	X		X				X
SHIELD BUILDING	X	X	X	X	X		X				X
FUEL BUILDING											
GENERAL	X	X	X	X	X						
SPENT FUEL POOL REGION	X	X	X	X	X						
AUXILIARY BUILDING											
GENERAL	X	X	X	X	X			X			
STEAM TUNNEL REGION	X	X	X	X	X		X	X			
RADWASTE BUILDING											
GENERAL	X	X	X	X	X			X			
DIESEL GENERATOR BUILDINGS											
GENERAL	X	X	X	X	X						

(1) See Table 3 for events resulting in SRV actuation.

(2) Applicable only to mechanical components and electrical components in a flow system.

(3) See Note (3), Table 3.

General Note: In addition, for buildings on common basemats, additional loads may be imposed on any particular building from another building on the common basemat.

The RPMS loading condition is not applicable to the BWR 6/ Mark III

TABLE 4.3 LOADS FOR ENVIRONMENTAL, SEISMIC, AND TEST CONDITIONS

	ENVIRONMENTAL					SEISMIC			TEST	
	W	W'	PMF	B	H	OBE	SSE	SL	P_t	T_t
REACTOR BUILDING										
GENERAL						X	X			
SUPPRESSION POOL						X	X	X		
RV SHIELD WALL ANNULUS						X	X			
WEIR WALL ANNULUS						X	X			
CONTAINMENT						X	X		X	X
SHIELD BUILDING	X	X	X	X	X	X	X			
CONTAINMENT POOL						X	X	X		
FUEL BUILDING										
GENERAL	X	X	X	X	X	X	X			
SPENT FUEL POOL REGION						X	X	X		
AUXILIARY BUILDING										
GENERAL	X	X	X	X	X	X	X			
CONTROL BUILDING										
GENERAL	X	X	X	X	X	X	X			
RADWASTE BUILDING										
GENERAL	X	X	X	X	X	X	X			
DIESEL GENERATOR BUILDINGS										
GENERAL	X	X	X	X	X	X	X			

General Note: In addition, for buildings on common basemats, additional loads may be imposed on any particular building from another building on the common basemat.

TABLE 4.4 LOADS FOR DESIGN BASIS ACCIDENTS

	DESIGN BASIS ACCIDENT (DBA)															
	P_a	T_a	R_a	Y_j	Y_m	Y_r	VLC	CO	CHUG	RBV(1)	AP	F_L	SRV(2)	WCO	SL	PS
REACTOR BUILDING																
GENERAL	X	X	X	X	X	X				X		X	X	X(3)		
SUPPRESSION POOL REGION	X	X	X			X	X	X	X	X		X	X		X(4)	X
RV SHIELD WALL ANNULUS REGION	X	X	X	X	X	X				X	X	X	X		X(4)	
WEIR WALL ANNULUS REGION	X	X	X				X	X	X	X		X	X		X(4)	X
CONTAINMENT POOL REGION	X	X	X							X			X			
CONTAINMENT	X	X	X	X	X	X				X		X	X			
SHIELD BUILDING										X			X			
FUEL BUILDING																
GENERAL	X	X	X	X	X	X										
SPENT FUEL REGION	X	X	X													
AUXILIARY BUILDING																
GENERAL	X	X	X	X	X	X								X(3)	X(4)	
CONTROL BUILDING																
GENERAL																
RADWASTE BUILDING																
GENERAL	X	X	X	X	X	X									X(4)	
DIESESL GENERATOR BUILDINGS																
GENERAL	X	X	X	X	X	X									X(4)	

(1) See Note (3), Table 3

(2) See Table 3 for events resulting in SRV actuation

(3) Applicable to Main Steam System only

(4) Applicable to tanks with a free water surface

Note: Timing and loads are obtained from the Containment Load Report, Reference A42-5400

General Note: In addition, for buildings on common basemats, additional loads may be imposed on any particular building from another building on the common basemat.

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TABLE 4.5 LOADS FOR SMALL BREAK LOCAs

	SBL						
	SRV	P_a	T_a	VLC	CHUG	WCO	RBV
REACTOR BUILDING						X(1)	
GENERAL		X	X				
SUPPRESSION POOL REGION	X	X	X		X		X
RPV SHEILD WALL ANNULUS REGION	X	X	X				X
WEIR WALL ANNULUS REGION	X	X	X	X	X		X
CONTAINMENT POOL REGION	X	X	X				X
CONTAINMENT REGION	X	X	X				X
SHIELD BUILDING	X	X	X				X
FUEL BUILDING							
GENERAL		X	X				
SPENT FUEL POOL REGION		X	X				
AUXILIARY BUILDING							
GENERAL		X	X			X(1)	
CONTROL BUILDING							
GENERAL							
RADWASTE							
GENERAL		X	X				
DIESEL GENERATOR BUILDINGS							
GENERAL		X	X				

(1) Applicable to Main Steam System only.

General Note: Additional loads may be transmitted from other buildings.