# November 2000
# NEI 97-04, Revised Appendix B
# Guidance and Examples for Identifying 10 CFR 50.2 Design Bases

## 10 CFR 50.2 Definition

Design bases means that information which identifies the specific functions to be performed by a structure, system, or component of a facility and the specific values or ranges of values chosen for controlling parameters as reference bounds for design. These values may be (1) restraints derived from generally accepted "state-of-the-art" practices for achieving functional goals, or (2) requirements derived from analysis (based on calculation and/or experiments) of the effects of a postulated accident for which a structure, system, or component must meet its functional goals.

## General Guidance

10 CFR 50.2 design bases consist of the following:

- Design bases functions: Functions performed by systems, structures and components (SSCs) that are (1) required by, or otherwise necessary to comply with, regulations, license conditions, orders or technical specifications, or (2) credited in licensee safety analyses to meet NRC requirements.

- Design bases values: Values or ranges of values of controlling parameters established as reference bounds for design to meet design bases functional requirements. These values may be (1) established by NRC requirement, (2) derived from or confirmed by safety analyses, or (3) chosen by the licensee from an applicable code, standard or guidance document

## Specific Guidance:

a) 10 CFR 50.2 design bases include the bounding conditions under which SSCs must perform design bases functions. These bounding conditions may be derived from normal operation or any accident or events for which SSCs are required to function, including anticipated operational occurrences, design basis accidents, external events, natural phenomena, and other events specifically addressed in the regulations such as Station Blackout (SBO) and Anticipated Transient Without Scram (ATWS).

b) The 10 CFR 50.2 design bases of a facility are a subset of the current licensing basis and are required pursuant to 10 CFR 50.34(a)(3)(ii) and (b) and 10 CFR 50.71(e) to be included in the updated FSAR.

c) Underlying 10 CFR 50.2 design bases is substantial supporting design information. Supporting design information includes other design inputs, design analyses, and design output documents. Supporting design information may be contained in the UFSAR (as design description) or other documents, some of which are docketed and some of which are retained by the licensee.

## Relationship of 10 CFR 50.2 Design Bases Functions to Licensing Basis and Part 50 Requirements

10 CFR 50.2 design bases functional requirements are derived primarily from the principal design criteria for an individual facility (the minimum standards for which are set by 10 CFR Part 50 Appendix A) and NRC regulations such as the Emergency Core Cooling System, SBO and ATWS rules that impose functional requirements or limits on plant design. 10 CFR 50.2 design bases are a subset of a plant's licensing basis. While a plant's licensing basis includes all applicable requirements of Part 50, not all Part 50 requirements have corresponding 10 CFR 50.2 design bases. For example, in Appendix A, several GDC contain requirements for fabrication, construction, testing, inspection, and quality. These are process requirements on SSCs—not requirements for the performance of intended SSC functions—and are therefore not 10 CFR 50.2 design bases.

## Relationship of 10 CFR 50.2 Design Bases to Appendix B

Both 10 CFR 50.2 design bases and supporting design information are subject to design control and other requirements of 10 CFR Appendix B, as applicable according to the safety classification of particular SSCs.

## Relationship of 10 CFR 50.2 Design Bases to 10 CFR 50.59

Both 10 CFR 50.2 design bases and supporting design information contained in the UFSAR are controlled in accordance with 10 CFR 50.59. Specific guidance in NEI 96-07, *Guidelines for 10 CFR 50.59 Implementation*, Revision 1, is intended to define the scope of information subject to specific 10 CFR 50.59 criteria for control of design basis limits for fission product barriers (10 CFR 50.59(c)(2)(vii)) and methodology used in establishing design bases or in the safety analyses (10 CFR 50.59(c)(2)(viii)).

The scope of 10 CFR 50.2 design bases functions described in this guidance document is a subset of "design functions" as that term is defined in NEI 96-07, R1, with respect to 10 CFR 50.59 screening.

## Relationship of 10 CFR 50.2 Design Bases to Updated FSARs

The original FSAR, including the 10 CFR 50.2 design bases presented therein in accordance with 10 CFR 50.34(b), was reviewed by the NRC in connection with granting the original license. 10 CFR 50.2 design bases for a plant may change as a result of new NRC requirements subsequent to the initial operating license and as a result of licensee changes to ensure compliance with NRC requirements. UFSARs should be updated in accordance with 10 CFR 50.71(e) and NEI 98-03 to reflect new or modified design bases. In conjunction with NEI 98-03, this guidance may be used to support UFSAR updates to reflect new or modified design bases going forward. However, this guidance is not intended to be used to judge the completeness of existing 10 CFR 50.2 design bases in the UFSAR or as the basis for adding detail to, or removing detail from, the existing design bases in the UFSAR. 10 CFR 50.34(b)(2) requires the FSAR to include a description of structures, systems, and components "…sufficient to permit understanding of the system designs and their relationship to safety evaluations." Thus, design information beyond that considered design bases (i.e., supporting design information) is required to be in the UFSAR.

Based on the differentiation provided by this guidance, a given passage of UFSAR description may contain a mixture of both 10 CFR 50.2 design bases and supporting design information. For example, UFSARs may include supporting design information under the heading of "System XYZ Design Bases." This guidance may be used to distinguish 10 CFR 50.2 design bases from supporting UFSAR descriptions. Licensees are not expected to reformat or reorganize existing UFSAR information based on this guidance.

## Relationship of 10 CFR 50.2 Design Bases to Regulatory Guidance and NRC Commitments

A general commitment to a regulatory guide is not part of the design bases under the 10 CFR 50.2 definition because such a commitment does not define design bases functions or reference bounds for design.

While regulatory guides are not requirements, a specific provision of a guidance document that has been committed to may be chosen by a licensee as a value or range of values for a design basis controlling parameter (e.g., per Regulatory Guide 1.52, charcoal filters shall have a 99% efficiency in order to meet NRC requirements for MCR habitability).

## Relationship of 10 CFR 50.2 Design Bases to Design Bases Documents

To enhance understanding of design bases information in support of specific technical and licensing activities, many licensees have prepared documents commonly known as design bases documents (DBDs). DBDs typically include 10 CFR 50.2 design bases and supporting design information organized on a system or topical basis. Design bases information provided in DBDs should be consistent with the 10 CFR 50.2 design bases and associated description presented in UFSARs.

## Relationship of 10 CFR 50.2 Design Bases to Topical Design Issues

Topical design bases are design bases requirements that apply to multiple systems. The following areas, as applicable to specific SSCs, contain topical design bases (licensees may define additional topical areas beyond those identified):

- Fire Protection
- Flooding (internal and external)
- Tornado / Hurricane
- Seismic Criteria
- Missiles (internal and external)
- Separation (Hazards)
- Electrical Separation/Independence
- Single Failure Criteria
- Pipe Break Criteria
- Environmental Qualification (electrical and mechanical)
- Station Blackout (SBO)
- Anticipated Transients Without Scram (ATWS)

## Relationship of 10 CFR 50.2 Design Bases to SSC Design Requirements and Other Design Information

SSCs are conservatively designed to ensure the capability to perform 10 CFR 50.2 design basis functions. This includes ensuring that SSC designs meet all applicable codes, standards and NRC requirements. Such SSC design requirements (e.g., civil/structural, mechanical, electrical) do not constitute 10 CFR 50.2 design bases unless they coincide with a design basis functional requirement of the SSC. The containment is an example where an SSC design requirement coincides with 10 CFR 50.2 design bases. The design pressure of the containment is a controlling parameter for its design basis function as a fission product barrier that is credited in the safety analyses. Thus, discovery of a condition that indicates that the containment does not meet its design pressure would mean that the containment is outside its design bases.

However, because design bases are a subset of design requirements, deviation from an SSC design requirement does not necessarily place that SSC outside its design bases. For example, AFW system design pressure is not a design basis controlling parameter because it does not coincide with the design basis function of AFW credited in the safety analyses to adequately remove heat from the reactor core in the event main feedwater is lost. Rather, system design pressure is part of the UFSAR description required by 10 CFR 50.34(b)(2) to permit sufficient understanding of the AFW system design bases. This and other design information was considered by the NRC staff in concluding in its SER that the design of the AFW system is adequate to support performance of its design basis (heat removal) function. Deviations from either 10 CFR 50.2 design bases or supporting design information should be evaluated and remedied in accordance with Generic Letter 91-18 (Revision 1), "…*Resolution of Degraded and Nonconforming Conditions*," (i.e., ensure safety first, perform operability/reportability determinations, etc.). Again using the AFW example, discovery of a condition that indicates that AFW piping does not meet its ASME Code design pressure would not place the AFW system outside its design bases unless a licensee evaluation concluded that the piping was so degraded that the AFW system would not be able to perform its design basis function as credited in the safety analyses.

## Relationship of 10 CFR 50.2 Design Bases to Individual SSC Functions

Functions credited in licensee safety analyses or to meet NRC requirements are 10 CFR 50.2 design bases functions. Individual SSC functions are, in general, subsidiary to 10 CFR 50.2 design bases functions. The safety analyses and NRC requirements provide the context for determining whether SSCs have 10 CFR 50.2 design bases functions.

10 CFR 50.2 design bases include the bounding conditions under which SSCs must perform 10 CFR 50.2 design bases functions. These bounding conditions may be established as topical design bases requirements.

## Relationship of 10 CFR 50.2 Design Bases to Design Inputs

Consistent with NUREG-1397 and ANSI N45.2.11-1974, 10 CFR 50.2 design bases are a subset of design inputs. Per the ANSI definition, design inputs are "those criteria, parameters, bases or other design requirements upon which the detailed final design is based." Thus 10 CFR 50.2 design bases are a subset of the requirements that final detailed designs must meet.

## Examples of 10 CFR 50.2 Design Bases and Supporting Design Information

The examples that follow reflect the preceding framework guidance. The examples illustrate the type of information considered to be 10 CFR 50.2 design bases and the distinction between 10 CFR 50.2 design bases and supporting design information. The examples are not intended to completely describe the design bases for a given system for a given plant. Individual licensees may identify additional or different design bases functional requirements or controlling parameters based on plant-specific factors.

## BWR Containment System

| 10 CFR 50.2 Design Bases Functional Requirements | Examples of Design Bases Controlling Parameters Chosen as Reference Bounds for Design |
|---|---|
| A. The Containment System (including the containment structure and isolation system) shall provide an essentially leak-tight barrier against the uncontrolled release of radioactivity to the environment and ensure that the containment design conditions important to safety are not exceeded for as long as postulated accidents require.<br><br>Basis:<br>• GDC 16, *Containment design*<br>• GDC 38, *Containment heat removal*<br>• GDC 50, *Containment design basis*<br>• GDC 51, *Fracture prevention of containment pressure boundary*<br>• GDC 54, *Piping systems penetrating containment* | 1. The Containment System shall provide a barrier which, in the event of a loss-of-coolant accident (LOCA), controls the release of fission products to the secondary containment and the environment to ensure that any radiological dose is less than the values prescribed in 10 CFR Part 100.<br><br>2. The Containment System shall be capable of maintaining its leakage rate performance for at least 30 days following the accident.<br><br>3. The Atmospheric Control shall establish and maintain the containment atmosphere to less than X.X% by volume oxygen during normal operating conditions.<br><br>4. The containment shall be designed to withstand the design basis pressure of XX psig. |

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| B. The containment isolation system shall be capable of rapid, automatic isolation of all piping that connects directly to the containment atmosphere and penetrates the containment boundary upon receipt of a containment isolation signal.<br><br><u>Basis:</u><br>• GDC 54, *Piping systems penetrating containment*<br>• GDC 56, *Primary containment isolation* | 1. The MOVs in the containment isolation system shall be capable of closing against the calculated peak design basis accident pressure in Y seconds following receipt of a containment isolation signal. |
| **Topical Requirements (Examples)**<br><br>C. The containment shall be designed to withstand the effects of earthquakes, tornadoes and other natural phenomena without loss of capability to perform its safety function.<br><br><u>Basis:</u><br>GDC 2, *Design bases for protection against natural phenomena* | <br><br>See draft example Topical Design Bases for seismic and tornadoes (attached.) |
| D. The containment isolation system shall be designed to have sufficient redundancy to perform its safety function in the event of a single failure.<br><br><u>Basis:</u><br>• GDC 54, *Piping systems penetrating containment*<br>• GDC 56, *Primary containment isolation* | See draft example Topical Design Bases for Single Failure (attached). |
| E. Class 1E components in the containment isolation system shall be environmentally qualified to perform their safety function during and following worst case design basis accident conditions.<br><br><u>Basis:</u><br>GDC 4, *Environmental and dynamic effects design bases* | See EQ Topical Design Bases |

Note: This system relies upon performance by interfacing systems of certain design basis functions. For example, generation of auto-start signals is a design basis requirement of ESFAS and RPS, provision of specific indications, controls and alarms may be design basis requirements for the main control room and/or remote shutdown panel, and provision of electrical power from separate 1E busses is a design basis requirement of the Electrical Distribution System.

## Examples of Supporting Design Information for the BWR Containment System

- The containment is designed to permit and facilitate initial demonstrations of structural capabilities at test pressures up to and including 1.15 times the design pressure.
- The containment isolation valves are designed and fabricated in accordance with ASME, Section III.
- The containment is designed to meet the leakage testing requirements of 10 CFR Part 50, Appendix J.
- The containment is designed, fabricated, constructed, and tested as a Class MC vessel in accordance with Subsection NE of the ASME Code.
- The drywell is a steel pressure vessel with a spherical lower portion XX feet in diameter, a cylindrical upper portion XX feet in diameter, and an elliptical top head XX feet in diameter.
- The pressure suppression chamber is a steel torus-shaped pressure vessel located below and encircling the drywell with a major diameter of XXX feet and a cross-sectional inside diameter of XX feet.
- A total of 8 vent pipes having an internal diameter of X feet connect the drywell and the pressure suppression chamber.

## PWR Auxiliary Feedwater System

| 10 CFR 50.2 Design Bases Functional Requirements | Examples of Design Bases Controlling Parameters Chosen as Reference Bounds for Design |
|---|---|
| A. The Auxiliary Feedwater System (AFW), in conjunction with the condensate storage tank, shall automatically provide feedwater to the steam generators to remove residual heat from the reactor core upon loss of main feedwater. The system safety function shall be to transfer fission product decay heat and other residual heat from the reactor core at a rate such that specified acceptable fuel design limits and the design conditions of the reactor coolant pressure boundary are not exceeded.<br><br><u>Basis:</u><br>GDC 34, *Residual heat removal* | 1. The AFW system shall supply a minimum of XXX gpm of feedwater within xx secs to the intact steam generator(s) against a maximum pressure of YYYY psig. |
| B. The AFW system shall be designed to provide for adequate heat removal in the event of a single failure or in the absence of AC power.<br><br><u>Basis:</u><br>GDC 34, *Residual heat removal*<br>10 CFR 50.63, *Station Blackout* | 1. The AFW system shall be capable of removing residual heat from the reactor core without relying on AC power for a period of X hours.<br><br>2. The AFW system shall include two motor driven pumps and one turbine driven pump configured in two separate and independent trains. |

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| C. From a condition of full power, the AFW system shall be capable of providing feedwater for the removal of reactor core decay heat until reactor coolant system temperature and pressure are brought to the point at which the RHR system may be placed into operation. Capability shall be provided to manually initiate and control AFW flow, as credited in the safety analyses.<br><br><u>Basis</u>:<br>GDC 34, *Residual heat removal* | 1. A usable volume of XXX gallons shall be maintained as a safety grade source of water in order to satisfy the AFW system feedwater requirements.<br><br>2. The AFW system shall deliver water to the steam generators at not more than xxx degrees F.<br><br>3. Maximum AFW flow shall be ZZZZ gpm, as credited in the safety analyses. |
| **Topical Requirements (Examples)**<br><br>D. The AFW system and the structure housing the system shall be designed to withstand the effects of earthquakes without loss of capability to perform their safety function. The AFW system shall be protected from tornadoes and other natural phenomena by the structures housing the system.<br><br><u>Basis:</u><br>GDC 2, *Design bases for protection against natural phenomena* | See draft examples of Topical Design Bases for seismic and tornado (attached). |
| E. Class 1E components in the AFW system shall be environmentally qualified to perform their safety function during and following worst case design basis accident conditions.<br><br><u>Basis</u>:<br>GDC 4, *Environmental and dynamic effects design bases* | See EQ Topical Design Bases. |

Note: This system relies upon performance by interfacing systems of certain design basis functions. For example, generation of auto-start signals is a design basis requirement of ESFAS and RPS, provision of specific indications, alarms, and manual controls may be design basis requirements for the main control room and/or remote shutdown panel, and provision of electrical power from separate 1E busses is a design basis requirement of the Electrical Distribution System.

## Examples of Auxiliary Feedwater System Supporting Design Information

- The AFW System provides water to the steam generators for heat removal during plant startup, hot standby, normal cooldown, refueling, and maintenance.
- System (piping) design pressure *is (XXX psi)* and temperature is *(XXX ̊F).*
- The AFW system is designed and constructed in accordance with the requirements of *ASME Section III (19XX).*
- The CST is lined to prevent corrosion and is insulated to mitigate temperature variations.
- The AFW System has control devices and status lights on the AFW shutdown panel for each MDAFW pump, each steam supply valve for the TDAFW pump, and each AFW control valve.
- Provisions are incorporated in the AFW design to allow for periodic operation to demonstrate performance and structural leak tight integrity.
- The AFW pumps are provided with mini-flow protection with a mini-flow return line with a flow control valve that isolates when the flow exceeds a preset minimum.
- The AFW motor driven pumps are horizontal, centrifugal pumps driven by electric motors.

## Emergency Diesel Generator System

| 10 CFR 50.2 Design Bases Functional Requirements | Design Bases Controlling Parameters Chosen as Reference Bounds for Design |
|---|---|
| A. The Emergency Diesel Generator System (EDG) shall be capable of automatically starting and have sufficient capacity to provide AC power to the emergency buses to power required emergency loads during the worst loading situations, shut down the reactor, and maintain it in a safe shutdown condition in the event of a loss of offsite power or degraded bus condition.<br><br>Basis:<br>GDC 17, *Electrical power systems*<br>GDC 4, *Environmental and dynamic effects design bases*<br>GDC 5, *Sharing of SSCs* | 1. To have sufficient capacity and capability to power all required emergency loads under worst-case loading conditions, EDGs shall have a minimum continuous rating of XXXX kW.<br><br>2. A minimum of XXXXX gallons shall be available in the EDG fuel oil storage tank to supply the minimum number of required diesels for X days of operation.<br><br>3. Two independent air start receivers shall each have sufficient capacity to start their associated EDG upon receipt of a start signal.<br><br>4. Each diesel generator shall be capable of operating in its service environment during and after a design bases event without support from offsite power. Each generator shall be able to start and operate with no environment cooling available for the time required to sequence the cooling equipment on to the bus-bar.<br><br>5. The EDG speed and voltage controls shall be designed to achieve rated voltage and frequency and accept load within XX seconds after receipt of an engine start signal.<br><br>6. The EDG auto-start signals shall be initiated for loss of voltage, degraded bus voltage conditions, and upon receipt of an accident signal.<br><br>7. The EDG System shall be designed such that at no time during the EDG loading sequence shall the voltage decrease to less than 75% of nominal.<br><br>8. The EDG System shall be designed such that the voltage will be restored to within 10% of nominal in less than 60% of each load block time interval, except during the first load block when the voltage shall be restored to 100% of nominal prior to the start of the second load block.<br><br>9. The EDG System shall be designed such that at no time during the loading sequence will the frequency decrease to less than 95% of nominal. |

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| | 10. The EDG System shall be designed such that the frequency will be restored to within 2% of nominal in less than 60% of each load block time interval.<br><br>11. During recovery from transients caused by the disconnection of the largest single load, the speed of the EDG shall not exceed the nominal speed plus 75% of the difference between nominal speed and the overspeed trip setpoint or 115% of nominal, whichever is lower. |
| **Topical Requirements (Examples)**<br><br>B. The EDG System shall be designed for Protection Against Natural Phenomena without loss of capability to perform its safety functions. The structures housing the system and the system itself are designed to withstand the effects of earthquakes. The system is protected from other natural phenomena by the structures housing it.<br><br>Basis:<br>GDC 2, *Design bases for protection against natural phenomena* | See draft example Topical Design Bases for seismic and tornado ( attached). |
| C. The EDG system shall have sufficient redundancy to perform its safety function in the event of a single failure.<br><br>Basis:<br>GDC 17, *Electrical power systems* | See draft example Topical Design Bases for single failure (attached). |
| Note: This system relies upon performance by interfacing systems of certain design basis functions. For example, generation of auto-start signals is a design basis requirement of ESFAS and RPS, provision of specific indications, controls and alarms may be design basis requirements for the main control room and/or remote shutdown panel, and provision of electrical power from separate 1E busses is a design basis requirement of the Electrical Distribution System. | |

## Examples of EDG System Supporting Design Information

- When full, each diesel generator fuel oil day tank is designed to provide X hour of operation before starting the first transfer pump. If the automatic transfer pump fails to start, a low-level alarm will sound. This alarm provides X hours of fuel oil remaining. A low-low level alarm warns the operators to start the second (back-up) transfer pump with at least X hour of fuel oil remaining in the tank.
- Each day tank is designed and constructed to ASME Code, Section VIII, Division I.
- The EDG has a rating of XXX% of its continuous rating for a period of two continuous hours out of any 24 hours of operation.
- The air start receivers provide adequate volume to supply starting air for X engine starts without recharging assuming a leak rate of XX.XX psig per hour and a cranking duration of approximately X seconds or sufficient for 2 to 3 engine revolutions.
- The momentary voltage drop on starting any step of loads may not drop below XXXX volts at generator terminals and returns to 90% of rated voltage within one second.
- Diesel fuel oil has a minimum fuel oil heating capacity of XXX,XXX BTU/Gallon at XX °F.
- The generators meet applicable guidance including, Regulatory Guide 1.6 – Independence Between Redundant Standby (Onsite) Power Sources and Between Their Distribution Systems; Regulatory Guide 1.9 – Selection of Diesel Generator Set Capacity for Standby Power Supplies; and NEMA MG1.
- The EDG design should be such that the transient following complete loss of load does not cause the speed of the unit to attain the overspeed protective trip setpoint.

## Containment Isolation MOV's

| 10 CFR 50.2 Design Bases<br>Functional Requirements | Examples of Design Bases<br>Controlling Parameters Chosen as<br>Reference Bounds for Design |
|---|---|
| A. Containment isolation MOVs capable of rapid, automatic isolation of piping that penetrates the containment boundary upon receipt of a containment isolation signal.<br><br>Basis:<br>• GDC 54, *Piping systems penetrating containment* | Containment isolation valves shall be closed or must be capable of closing against the calculated peak design basis accident pressure within XX seconds after receipt of a containment isolation signal. |
| B. Automatic containment isolation MOVs shall be designed to fail in the position of greatest safety.<br><br>Basis:<br>• GDC 55, *Reactor coolant pressure boundary penetrating containment*<br>• GDC 56, *Primary containment isolation* | The fail-safe valve position shall be as credited in the safety analyses. |
| **Topical Requirements (Examples)**<br><br>C. Containment isolation MOVs shall be designed to withstand the effects of earthquakes, tornadoes and other natural phenomena without loss of capability to perform their safety function.<br><br>Basis:<br>GDC 2, *Design bases for protection against natural phenomena* | See draft example Topical Design Bases for seismic and tornadoes (attached.) |

| 10 CFR 50.2 Design Bases Functional Requirements | Examples of Design Bases Controlling Parameters Chosen as Reference Bounds for Design |
|---|---|
| D. Containment isolation MOVs shall be environmentally qualified to perform their safety function during and following worst case design basis accident conditions.<br><br><u>Basis:</u><br>GDC 4, *Environmental and dynamic effects design bases* | See EQ Topical Design Bases |
| E. Containment isolation MOVs and appurtenances shall be protected from missiles and the effects HELBs, e.g., pipe whip, jet impingement.<br><br><u>Basis:</u><br>GDC 4, *Environmental and dynamic effects design bases* | See Pipe Break Criteria Topical Design Bases |
| Note: Containment isolation MOVs rely upon performance by interfacing systems of certain design basis functions. For example, generation of isolation signals is a design basis requirement of ESFAS and RPS, provision of specific indications, controls and alarms may be design basis requirements for the main control room and/or remote shutdown panel, and provision of electrical power from separate 1E busses is a design basis requirement of the Electrical Distribution System. | |

**Examples of Supporting Design Information for Containment Isolation MOVs:**

- Motor-operated valves used for containment isolation that are allowed to be open during normal conditions are equipped with a hand wheel that allows manual operation of the valves in case of a power failure.
- The use of Limitorque operators has been specified for all motor-operated containment isolation valves
- Seismic design for containment isolation MOVs reflects consideration of the valve and operator as a combined unit.

# Turbine Generator System

| 10 CFR 50.2 Design Bases Functional Requirements | Examples of Design Bases Controlling Parameters Chosen as Reference Bounds for Design |
|---|---|
| A. The Turbine Generator System shall be designed to protect systems, structures and components important to safety from the effects of turbine missiles by providing assurance of turbine disc integrity.<br><br><u>Basis:</u><br>GDC 4, *Environmental and dynamic effects design bases* | 1. Turbine discs are made from materials and processes that minimize flaw occurrence and maximize fracture toughness. |
| B. The Turbine Generator Overspeed Protection System shall be designed to minimize the probability of generating turbine missiles.<br><br><u>Basis:</u><br>GDC 4, *Environmental and dynamic effects design bases* | 1. Normal overspeed protection is achieved by the speed governor action of the eletro-hydraulic control system which cuts off steam at approximately XXX percent of rated turbine speed by closing the control and intercept valves.<br><br>2. An emergency overspeed protection mechanical device is set to close all steam valves at approximately XXX percent of rated turbine speed.<br><br>3. A backup overspeed protection electrical trip circuit closes all steam valves at approximately XXX percent of rated turbine speed. |
| Note: This system relies upon performance of interfacing systems for certain design bases functions for a pressurized water reactor. For example, the generation of a turbine trip under conditions indicative of an ATWS event is a design basis requirement in accordance with 10 CFR 50.62(c)(1) for the ATWS mitigating system. If credited in plant-specific safety analyses, another design bases function would be that reactor coolant pumps shall remain connected to the turbine generator for a short duration under certain loss of forced reactor coolant flow events to prevent the DNBR from exceeding its limit. | |

## Examples of Turbine Generator System Supporting Design Information

- The turbine wheels and rotors are made from vacuum-melted, or vacuum-degassed, Ni-C Mo-V alloy steel by processes which minimize flaw occurrence and provide adequate fracture toughness.

- The turbine wheel and rotor materials have the lowest fracture appearance transition temperatures and the highest Charpy V-notch energies obtainable, on a consistent basis, from a water-quenched Ni-Cr-M0-V material at the sizes and strength levels used.

- Charpy tests on the turbine wheel and rotor materials are in accordance with the American Society of Testing Materials (ASTM) Specification A370.

- The turbine generator is equipped with an electro-hydraulic control (EHC) system that combines the principles of solid-state electronics and high-pressure hydraulics to regulate steam flow through the turbine.

- The control system has three major subsystems; a speed control unit, a load control unit, and valve flow control units.

- The turbine speed control unit provides speed control, acceleration, and overspeed protection functions.

- The flow of the main steam entering the high-pressure turbine is controlled by four stop valves and four governing control valves.

- Each stop valve is controlled by an electro-hydraulic actuator, so the stop valve is either fully open or fully closed.

- The combined intermediate stop valves, located in the hot reheat lines at the inlet to the low-pressure turbines are stop and intercept valves in one casing and control steam flow to the low pressure turbines.

- The load control unit develops signals that are used to proportion the steam flow to the stop valves, control valves, and intercept valves.  Signal outputs are based on a proper combination of the speed error signals and load reference signals.

- The valve flow control unit regulates the steam flows as directed by the load control unit.

# Seismic Topical Design Bases

## 10 CFR 50.2 Design Basis Functional Requirements

Structures, systems, and components important to safety shall be designed to withstand the effects of earthquakes without loss of capability to perform their safety function. (GDC 2, Design *Bases for Protection Against Natural Phenomena,* and 10 CFR Part 100, Appendix A)

## Example of Design Bases Controlling Parameters Chosen as Reference Bounds for Seismic Design

**A**. Structures, systems, and components shall be analyzed and designed to withstand the effects of an operating basis earthquake with a peak ground acceleration of X.Xg and a safe shutdown earthquake with a peak ground acceleration of X.Xg.

**Basis:** Seismic loadings are characterized by the safe shutdown earthquake (SSE) and the operating basis earthquake (OBE). The SSE is defined as that earthquake that produces the maximum vibratory ground motion at the plant site that can be reasonably predicted from geologic and seismic evidence. The OBE is that earthquake that, considering the local geology and seismology, could be reasonably be expected to affect the site during the operating life of the plant.

**B.** Category II systems, structures, and components installed in Seismic Category I structures whose failure could result in loss of a required safety function of Seismic Category I structure, system, or component are either separated by distance or barrier from the affected structure, system, or component or designed together with their anchorages to maintain their structural integrity during the SSE.

**Basis:** Seismic Category II systems, structures, and components installed in Seismic Category I structures shall not cause the loss of a required safety function of any Seismic Category I structure, system, or component.

## Examples of Seismic Supporting Design Information

- Seismic classification of plant structures, systems, and components is in accordance with NRC Regulatory Guide 1.29, Seismic Design Classification. Seismic Classification of radioactive waste management systems, structures and components is in accordance with NRC Regulatory Guide 1.143, Design Guidance For Radioactive Waste Management Systems, Structures, And Components Installed In Light Water Cooled Nuclear Power Plants.

- Seismic design response spectra are in conformance with NRC Regulatory Guide 1.60, Design Response Spectra for Seismic Design of Nuclear Power Plants.

- Seismic damping values used in the structural dynamic analysis are the same as those provided in NRC Regulatory Guide 1.61, Damping Values for Seismic Design of Nuclear Power Plants, with the exception of damping values for cable trays and supports. The damping values for cable trays and supports are values based on test reports (specific reference) and were approved by the NRC in (specific reference).

- For Seismic analysis of ASME Boiler and Pressure Vessel Code, Section III, Division 1, Code Class 1, 2, and 3 piping systems, ASME Code Case N-411 damping values given in Reference E may be used provided the following criteria are satisfied:

    1. Increased pipe deflections due to greater piping flexibility do not violate plant separation criteria.

    2. Criteria outlined in NRC Regulatory Guide 1.61 do not mix with the criteria of Code Case N-411 for a given piping analysis.

    3. With the exception of the stress calculations described in Reference F, Code Case N-411 damping values are not used in conjunction with multiple response spectrum methodology piping analysis.

- Category II structures are designed using the Uniform Building Code, XXXX edition.

# Tornado Topical Design Bases

## 10 CFR 50.2 Design Basis Functional Requirements

Structures, systems, and components important to safety shall be designed to withstand the effects of tornadoes without loss of capability to perform their safety function. (GDC 2, *Design Bases for Protection Against Natural Phenomena*, and 10 CFR 100)

## Examples of Design Bases Controlling Parameters Chosen as Reference Bounds for Tornado Design

**A.** Category I structures housing safety related systems and components shall be designed to withstand the effects due to the design basis tornado as described as follows:

- Maximum peripheral tangential velocity – xxx mph.
- Translational velocity – xx mph maximum/ x mph minimum.
- Maximum wind velocity – xxx mph
- Radius from the center of the tornado where the maximum wind velocity occurs – xxx ft.
- Atmospheric pressure drop – x psi.
- Rate of pressure drop – x psi/s.

**Basis**: Nuclear power plants must be designed so that the plants remain in a safe condition in the event of the most severe tornado that can reasonably be predicted to occur at a site as a result of severe meteorological conditions.

**B.** Category II structures, systems, and components not designed for tornado loadings shall be investigated to ensure their failure will not effect the integrity of adjacent Category I structures. This design ensures that Category I structures, systems, and components required for safe shutdown after a tornado will perform their intended safety functions.

**Basis:** Category II structures, systems, and components not designed for tornado loadings shall not cause the failure of adjacent Category I structures.

## Examples of Tornado Supporting Design Information

- The values of parameters that define the design basis tornado conform to those given in U.S. NRC Regulatory Guide 1.76, "Design Basis Tornado For Nuclear Power Plants," August 1974, for Region X plant locations.

- Tornado wind pressure loadings and differential pressures loadings shall be transformed into effect loads on Category I structures in accordance with Topical Report XXXX (specific reference).

# Single Failure Topical Design Bases

## 10 CFR 50.2 Design Basis Functional Requirements

Fluid and electrical systems required to perform their intended safety function in the event of a single failure shall be designed to include sufficient redundancy and independence such that neither (1) a single failure of any active component (assuming passive components function properly) nor (2) a single failure of a passive component (assuming active components function properly), results in a loss of the capability of the system to perform its safety functions. (GDC 17, *Electrical power systems;* GDC 21, *Protection system reliability and testability;* GDC 24, *Separation of protection and control systems;* GDC 25, *Protection system requirements for reactivity control malfunctions;* GDC 34, *Residual heat removal;* GDC 35, *Emergency core cooling;* GDC 38, *Containment heat removal;* GDC 41, *Containment atmosphere cleanup;* GDC 44, *Cooling water*; GDC 54, *Piping systems penetrating containment*; GDC 55, *Reactor coolant pressure boundary penetrating containment*; GDC 56, *Primary containment isolation)*

## Examples of Design Bases Controlling Parameters Chosen as Reference Bounds for Single Failure Design

Fluid and electrical systems shall be designed to assure that a single failure, in conjunction with an initiating event, does not result in the loss of the system's ability to perform its intended safety function. The single failure considered shall be a random failure and any consequential failures in addition to the initiating event for which the system is required and any failures which are a direct or consequential result of the initiating event. Whenever practical, the design shall provide for a 30-minute delay between the indication of the initiating event and the initiation of any operator action, either locally or remotely, from any control panel.

**Basis:** These criteria ensure that the requirements of 10 CFR Part 50 are addressed regarding the design against single active or passive failures in safety-related systems following various initiating events.

## Single Failure Supporting Design Information

- An initiating event is a single occurrence, including its consequential effects, that places the plant or some portion of the plant in an abnormal condition. An initiating event and its resulting consequences are not a single failure. An initiating event can be a component failure, natural phenomenon, or external man-made hazard.

- Active components are devices characterized by an expected significant change of state or discernible mechanical motion in response to an imposed demand upon the system or operation requirement. Examples of active components include switches, circuit breakers, relays, valves, pressure switches, turbines, motors, dampers, pumps, and analog meters, etc.

- Passive components are devices characterized by an expected negligible change of state or negligible mechanical motion in response to an imposed design basis load demand upon the system. Examples of passive components include cables, fuses, piping, valves in stationary positions, fluid filters, indicator lamps, cabinets, cases, etc.

- An active component failure is a failure of an active component to complete its intended safety function(s) upon demand. Spurious action of a powered component originating within its automatic actuation of control systems shall be regarded as an active failure unless specific features or operating restrictions preclude such spurious action.

- A passive component failure is a failure which limits the component's effectiveness in carrying out its design function(s). When applied to a fluid system, this means a breach of the pressure boundary resulting in abnormal leakage. Such leakage shall be limited to that which results from a single pump seal failure, a single valve stem packing failure, or other single-failure mechanism considered possible by a systematic analysis of system components.

- The design of safety-related systems (including protection systems) is consistent with IEEE Standard 379-1972 and Regulatory Guide 1.53 in the application of the single-failure criterion.

- The protection system is designed to provide two, three, or four instrumentation channels for each protective function and two logic train circuits. These redundant channels and trains are electrically isolated and physically separated. Thus any single failure within a channel or train will not prevent protective action at the system level, when required.

- Design techniques such as physical separation, functional diversity, diversity in component design, and principles of operation, shall be used to the extent necessary to protect against a single failure.