

# DEFINITIONS: SSE & OBE

NRC / INDUSTRY MEETING

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## PURPOSE:

- Obtain clarification on definition of Safe Shutdown Earthquake Ground Motion (SSE) for COL referencing a CD
- As part of the licensing basis, need a clear distinction between the CD CSDRS and Site-specific SSE ground motion called the GMRS.
- Provided basis that there is only one Site SSE and that should be the site-specific SSE call the GMRS.  
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- Present possible approaches for defining Operating Basis Earthquake Ground Motion (OBE) for use in OBE Exceedance Criteria to determine need for plant shutdown in regards to a COL referencing a CD



10 CFR Part 52 Requirements for COL  
Referencing CD

- CSDRS is part of the design requirement for a CD.
- COL applicant must maintain the CSDRS as a design input.
- To use an alternate seismic input for the CD would require an exemption.

Certified Standard Design: Site-Independent  
Design Ground Motion (10 CFR Part 52)

- For standardized design the term "SSE" is used to identify the site-independent (generic) design ground motion.
- The term "SSE" is used purely as a design load identifier which includes its design acceptance criteria.
- CD site-independent SSE design ground motion forms part of the design requirements for a CD.
- CD site-independent SSE is not based on 10 CFR 100.23 and should not be called the Site SSE in a COL.
- To help make that distinction the term CSDRS is now used to define the CD design ground motion.

## Development of SSE for a Site Following Federal Regulations

- 10 CFR 100.23: "The Safe Shutdown Earthquake Ground Motion for a site is determined considering...investigations [geological, seismological, and engineering characteristics]...uncertainties must be addressed through an appropriate analysis [PSHA]."

SSE ground motion based on site characteristics.

- 10 CFR Appendix S Part 50: "SSE is the vibratory ground motion for which certain structures, systems, and Components must be design to remain functional." Also provides minimum horiz. SSE requirements at fdn.

Design application for SSE

- Using performance-base implementation of regulation per RG 1.208:

GMRS is the site SSE

## NRC Guidance for SSE

- RG 1.165 & 1.208 provide guidance to develop a site SSE that satisfies 10 CFR 100.23
- NUREG-0800 Section 3.7.1 provides guidance on evaluating a site GMRS to the CD CSDRS under the part 52 process
- Guidance is very helpful
- But industry wishes to clarify statements like in RG1.208 Section 5.4 "...CSDRS become the SSE for the site."

## Applications of Site-specific SSE: GMRS

- As part of COL: Demonstrate the site seismic demand is enveloped by the CD
- As part of COL: Show no soil liquefaction or slope stability failures. This includes showing adequate seismic margin.
- Plant operation under COL: Determine plant safety/operability for as-found condition not meeting CD design requirements. For site specific safety evaluations, the site-specific SSE ground motion, i.e., GMRS, must be used. (Note condition must be corrected to bring the plant to its original design basis.)

## Applications of Site-specific SSE: GMRS continued

- Plant operation under COL: Future design applications not directly related to the CD like ISFS installation (dry cask storage)
- Note any site-specific applications using the site-specific SSE (GMRS) must satisfy the minimum requirements for SSE per 10 CFR Appendix S Part 50.

## Conclusion: Use of the Term SSE

- For a COL referencing a CD, the CSDRS is a design requirement of the CD and must be maintained by the COL applicant.
- Separate from the CD there are site features that need to be evaluated to the site-specific SSE ground motion, i.e., GMRS as part of the COL application.
- The site-specific SSE ground motion, i.e., GMRS, must be maintained as part of the licensing basis for future site-specific applications like safety/operability evaluations
- As part of the licensing basis, a clear distinction is needed between the CD CSDRS and Site-specific SSE ground motion called the GMRS.
- There is only one Site SSE and that should be the site-specific SSE call the GMRS.

## Definition of OBE

- OBE is a damage parameter used to determine need for plant shut down due to earthquake.
- OBE not explicitly a design load; therefore, OBE is defined as one-third of a design ground motion

## RG 1.166

- Appendix D: "Operating Basis Earthquake Ground Motion (OBE)...The value of the OBE is set by the applicant."
- B Discussion: "Seismic Category I structures at a nuclear power plant site may be designed using different ground motion response spectra; for example, one used for the certified standard design and another for site-specific applications. The spectrum ordinate criterion is based on the lowest spectrum used in the design of the Seismic Category I structures."
- 4.1.1 "the OBE response spectrum check is performed using the lower of:
  1. The spectrum used in the certified standard design, or
  2. A spectrum other than (1) used in the design of any Seismic Category I structure.

## Site Selection of the OBE

(Examples of Some Possible OBE Selections)

- Case A) If the site-specific features important to safety have acceptable capacities  $> \text{CSDRS}$

Then  $\text{OBE} = \text{CSDRS}/3$

- Case B) If the site-specific features important to safety have capacities  $< \text{CSDRS}$

Then  $\text{OBE} = \text{GMRS}/3$

## Location of the OBE

- Using the methodology of site amplification to obtain the GMRS one can obtain, in a hazard consistent manner, the FIRS at any horizon in the site soil column profile.
- If the OBE is to be measured on the free-field that location must reflect the CSDRS or the GMRS / FIRS at that location.
- Issues with meeting requirements for site location of seismic instrumentation & obtaining meaningful data will be discussed in the next presentation.

## GMRS

- **Site-Specific Ground Motion Response Spectra (GMRS):** The Site-Specific GMRS are defined as follows:
- ***The Site-Specific Ground Motion Response Spectra (GMRS) are characterized by site-specific horizontal and vertical response spectra determined as free-field motions on the ground surface or as free-field outcrop motions on the uppermost in-situ competent material defined by shear-wave velocity of 1000 fps or greater, using performance-based procedures described in Regulatory Guide 1.208. When the Site-Specific GMRS are determined as free-field outcrop motions on the uppermost in-situ competent material, only wave propagation effects of the materials below this elevation are included in the site response analysis.***
- The Site-Specific GMRS are appropriate for performance-based implementation of the requirements of 10 CFR Part 100.23(d)(1) – “Determination of the Safe Shutdown Earthquake Ground Motion”. The Site-Specific GMRS also satisfy the **Safe Shutdown Earthquake Ground Motion** requirement for performance-based implementation of 10 CFR Part 50 Appendix S(IV)(1), “*Application To Engineering Design*”, and are the bases for deriving Foundation Input Response Spectra.



## CSDRS

- **Certified Seismic Design Response Spectra (CSDRS):** CSDRS are defined as follows:
- ***The Certified Seismic Design Response Spectra (CSDRS) are site independent seismic design horizontal and vertical response spectra that have received Commission approval, issued pursuant to Subpart B of 10 CFR Part 52, as the seismic design response spectra for an approved certified standard design nuclear plant. The input or control location for the CSDRS is specified in the certified standard design.***
- In order to ensure that CSDRS are suitable for a range of site-specific geotechnical conditions CSDRS are evaluated and approved for a specified range of site geotechnical parameters. Standard design nuclear plants that have received Commission design certifications to date have used the Regulatory Guide 1.60 standard site independent spectrum shape or some small modification of that spectrum shape, scaled to 0.3g at 33 Hz to obtain CSDRS.

## FIRS

- **Foundation Input Response Spectra (FIRS):** FIRS are defined as follows:
- ***The Foundation Input Response Spectra (FIRS) are characterized by site-specific horizontal and vertical response spectra derived at the foundation level of safety related structures such that the derived spectra are hazard-consistent with the Site-Specific GMRS. The FIRS are the Site-Specific GMRS transferred to the base elevations of foundations. FIRS are derived as free-field outcrop spectra; that is, only wave propagation effects in materials that are below the base elevation of a safety related structure are included in site response analysis.***
- The FIRS are input for analysis of the soil-structure interaction system meeting the requirements of Part 50 Appendix S(IV).