



ANS

Probabilistic Seismic Hazard Analysis

An American National Standard

ANSI/ANS-2.29-2020

Published by the
American Nuclear Society
555 N. Kensington Ave
La Grange Park, IL 60526



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**American National Standard
Probabilistic Seismic
Hazard Analysis**

Secretariat
American Nuclear Society

Prepared by the **American
Nuclear Society Standards
Committee Working
Group ANS-2.29**

Published by the
**American Nuclear Society
555 North Kensington Avenue
La Grange Park, Illinois 60526 USA**

Approved April 16, 2020
by the
American National Standards Institute, Inc.

American National Standard

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Foreword

(This foreword does not contain any requirements of American National Standard “Probabilistic Seismic Hazard Analysis,” ANSI/ANS-2.29-2020, but is included for informational purposes.)

This standard establishes requirements for performing probabilistic seismic hazard analyses (PSHAs). It is one of a group of five standards that address the seismic design process for nuclear facilities. The overall objective of these standards is to achieve a risk-informed design that protects the public, the environment, and workers from potential consequences of earthquakes.

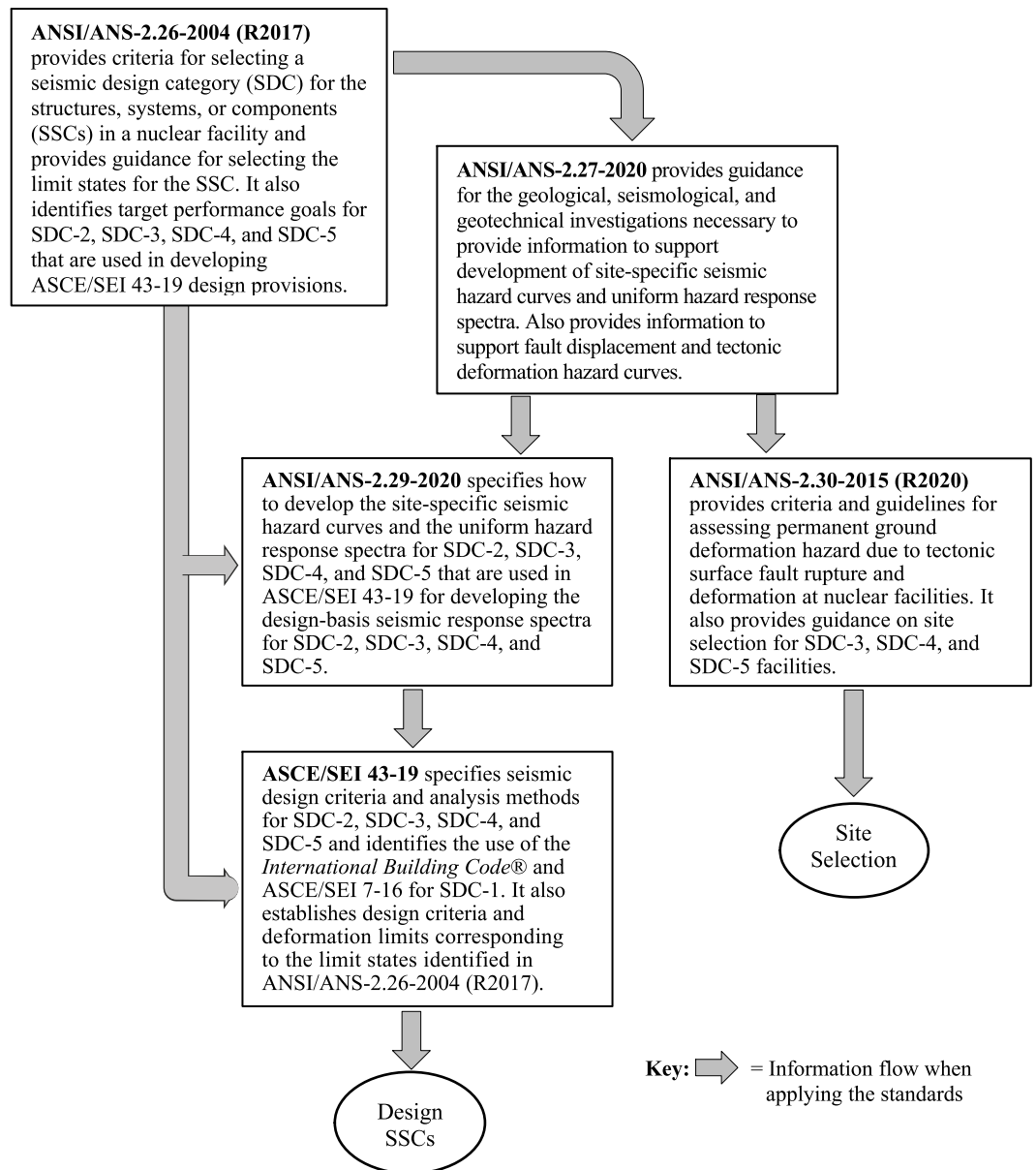


Figure A – The set of standards that operate together to inform the assessment of seismic hazards and seismic design at nuclear facilities.

Figure A shows the relationship between this standard and the other four seismic standards: ANSI/ANS-2.26-2004 (R2017), “Categorization of Nuclear Facility Structures, Systems, and Components for Seismic Design”; ANSI/ANS-2.27-2020, “Criteria for Investigations of Nuclear Facility Sites for Seismic Hazard Assessments”; ANSI/ANS-2.30-2015 (R2020), “Criteria for Assessing Tectonic Surface Fault Rupture and Deformation at Nuclear Facilities”; and ASCE/SEI 43-19, “Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities.” The procedural relationship among these standards is further described in ANSI/ANS-2.26-2004 (R2017). The user should consult ASCE/SEI 43-19 to see how the information produced by this standard (ANSI/ANS-2.29-2020) is used in developing seismic loads specific to a structure, system, and (or) component (SSC).

As described in ANSI/ANS-2.26-2004 (R2017) and ASCE/SEI 43-19, the seismic design process for nuclear facilities is based on the consequences of seismically initiated failure of SSCs and specified limit states and design requirements. The seismic design categories identified in ANSI/ANS-2.26-2004 (R2017) and the design requirements in ASCE/SEI 43-19 aim to satisfy target performance goals defined in terms of the annual frequency of exceeding specified SSC performance.

Achieving a target performance goal is directly related to the frequency of a seismic load. Therefore, the results of a PSHA are required as input to the seismic design process. This standard establishes procedures for performing a PSHA needed to support selection of the seismic loads used in ASCE/SEI 43-19. The methods specified herein can also be used to support other applications, such as seismic probabilistic risk analyses.

The working group has incorporated risk-informed and/or performance-based requirements into this standard. This standard might reference documents and other standards that have been superseded or withdrawn at the time the standard is applied. A statement has been included in the references section that provides guidance on the use of references.

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Probabilistic Seismic Hazard Analysis

1 Introduction, scope, purpose, and application

1.1 Introduction

This standard¹⁾ is one of a series of national standards designed to provide criteria and guidelines to promote uniform and effective assessment of seismic hazards at sites of nuclear facilities. As defined in ANSI/ANS-2.26-2004 (R2017) [1],²⁾ a nuclear facility is a facility that stores, processes, tests, or fabricates radioactive materials in such form and quantity that a nuclear risk to the workers, to the off-site public, or to the environment may exist. This includes, but is not limited to, nuclear fuel manufacturing facilities; nuclear material waste processing, storage, fabrication, and reprocessing facilities; uranium enrichment facilities; tritium production and handling facilities; radioactive material laboratories; and nuclear reactors.

1.2 Scope

This standard provides guidance for performing a probabilistic seismic hazard analysis (PSHA) for developing design and safety evaluation criteria for nuclear facilities. Criteria provided in this standard address various aspects of conducting PSHAs, including

- (1) purpose, objective, and process;
- (2) detailed requirements;
- (3) PSHA framework;
- (4) seismic source model (SSM);
- (5) ground motion model (GMM);
- (6) site effects;
- (7) implementation of PSHA for seismic design and seismic probabilistic risk assessment (SPRA);
- (8) documentation;
- (9) quality assurance.

1.3 Purpose

This standard was developed to be used in coordination with four other seismic standards: ANSI/ANS-2.26-2004 (R2017) [1], ANSI/ANS-2.27-2020 [2], ANSI/ANS-2.30-2015 (R2020) [3], and ASCE/SEI 43-19 [4]. This coordination is vital to the collection and evaluation of data required to perform the PSHA, to establish the level and scope of the analysis consistent with an application, and for consistency with the intended use of the PSHA results. The guidelines and requirements provided in this standard are applicable for the design-basis development as well as for use in risk assessments for nuclear facilities.

¹⁾ The current standard, ANSI/ANS-2.29-2020, is hereinafter referred to as “this standard.”

²⁾ Numbers in brackets refer to corresponding numbers in Sec. 7, “References.”

1.4 Application

This standard does not specify methods for estimating the probability of fault displacement. These methods are discussed in ANSI/ANS-2.30-2015 (R2020) [3]. Additionally, seismically induced hazards such as soil liquefaction, soil settlement, landsliding, and earthquake-induced flooding may also be applicable to certain sites and need to be evaluated and included in structure, system, and component (SSC) design requirements. This standard does not reference criteria for screening sites for these hazards. ASCE/SEI 7-16 [5] provides guidance on evaluating some of these other hazards.

This standard does not address criteria, procedures, or methods for collecting information and data required to perform a PSHA. These are specified in ANSI/ANS-2.27-2020 [2]. In addition, this standard does not address the use of PSHA results or the selection of design-basis earthquakes for nuclear facilities. This topic is covered in ANSI/ANS-2.26-2004 (R2017) [1] and ASCE/SEI 43-19 [4]. The PSHA is also used in seismic risk assessments, and this topic is covered in ASME/ANS RA-Sb-2013, Case 1 [6].

2 Acronyms and definitions

2.1 Acronyms

AFE:	annual frequency of exceedance
ANS:	American Nuclear Society
ANSI:	American National Standards Institute
ASCE/SEI:	American Society of Civil Engineers/Structural Engineering Institute
CBR:	center, body, and range
CEUS:	central and eastern United States
CFR:	<i>Code of Federal Regulations</i>
DOE:	U.S. Department of Energy
DRS:	design response spectrum
EPRI:	Electric Power Research Institute
FAS:	Fourier amplitude spectrum
FIRS:	foundation input response spectrum
GMM:	ground motion model
GMPE:	ground motion prediction equation
HID:	hazard input document
IM:	intensity measure
IRVT:	inverse random vibration theory
M-D:	magnitude-distance
M_{max}:	maximum magnitude
NGA:	Next Generation Attenuation
NRC:	U.S. Nuclear Regulatory Commission
NUREG:	U.S. <u>N</u> uclear <u>R</u> egulatory Commission technical report
NUREG/CR:	U.S. <u>N</u> uclear <u>R</u> egulatory Commission technical report prepared by contractor

PBSRS:	performance-based surface response spectrum
PM:	project manager
PPRP:	participatory peer review panel
PSHA:	probabilistic seismic hazard analysis
PTI:	project technical integrator
QA:	quality assurance
RVT:	random vibration theory
SDC:	seismic design category
SHA:	seismic hazard analysis
SPRA:	seismic probabilistic risk assessment
SSC(s):	structure(s), system(s), and (or) component(s) [SSC(s)]
SRA:	site response analysis
SSHAC:	Senior Seismic Hazard Analysis Committee
SSI:	soil–structure interaction
SSM:	seismic source model
TDI:	technically defensible interpretations
TI:	technical integration
UHRS:	uniform hazard response spectra
V/H ratio:	vertical-to-horizontal amplitude ratio

2.2 Shall, should, and may

shall, should, and may: The word “shall” is used to denote a requirement; the word “should” is used to denote a recommendation; and the word “may” is used to denote permission, neither a requirement nor a recommendation.

2.3 Definitions

acceptable: In many places, this standard contains statements indicating that a certain reference provides an “acceptable” for satisfying the intent of a given requirement. This should be interpreted as the referenced method being one way to meet the given requirement. The intent is permissive, meaning that the analysis team can use another method, if justified, without prejudice. However, it is important to understand that whenever the phrasing “acceptable” is used, the intent is that if the analysis uses another method, the other method shall satisfy the stated requirement with a comparable level of rigor considering a similar level of details pertinent to the scope of analysis. The analysis shall not use another method that does not satisfy the requirement at least as well as the acceptable method would satisfy it. Whenever an alternative to the acceptable method is selected, the peer review team should pay particular attention to this topic.

aleatory variability: The variability inherent in a nondeterministic (stochastic, random) phenomenon. In principle, aleatory variability of a nondeterministic phenomenon cannot be reduced by the accumulation of more data or additional information, but the accumulation of more data or additional information can better constrain the aleatory variability of a probabilistic model of a nondeterministic phenomenon. Note that aleatory variability is also called “aleatory uncertainty” or “randomness.”

areal source: A volume of the earth's crust, commonly represented in map view as a bounded region, within which future seismicity is assumed to have a continuous distribution.

central and eastern United States (CEUS): That portion of the United States east of the Rocky Mountains (east of approximately 105° W longitude).

deaggregation: A process used to determine the contribution to the seismic hazard from potential seismic sources. The contribution is typically binned in terms of magnitude, distance, and epsilon for a range of frequencies. Epsilon is the number of standard deviations that the binned ground motion is above or below the predicted median ground motion for the given magnitude and distance.

epicenter: The point on the earth's surface directly above the focus (i.e., hypocenter) of the earthquake source.

epistemic uncertainty: The uncertainty attributable to incomplete knowledge about a phenomenon that affects our ability to model it. Epistemic uncertainty is reflected in ranges of values for parameters of a particular model, a range of viable models, the level of model detail, multiple expert interpretations, and statistical confidence. In principle, epistemic uncertainty can be reduced by the accumulation of additional information. Note that epistemic uncertainty is sometimes also called "modeling uncertainty".

fault, fault zone: A fracture in the earth along which blocks on either side have moved with respect to one another. Faulting can occur along multiple planes. The area encompassing this faulting is a fault zone.

fault displacement: The relative movement of the two sides of a fault, measured in any chosen direction; also, the specific amount of such movement. As used here, the term applies to either slip or separation as measured or inferred along a fault. Principal faulting occurs along a main plane (or planes) that is (are) the locus of release of seismic energy. Secondary or distributed faulting is rupture that occurs in the vicinity of the principal faulting, possibly on splays of the main fault or antithetic faults.

fault source: In a seismic source model (SSM), a fault or zone for which the tectonic features causing earthquakes have been identified. These are usually individual faults, but they may be zones comprising multiple faults or regions of faulting if surface evidence of these faults is lacking but the faults are suspected from seismicity patterns, tectonic interpretations of crustal stress and strain, and other evidence.

fractile hazard curve: A hazard curve representing a particular percentile associated with the epistemic uncertainty distribution. For example, a spectral acceleration at the 95th fractile level means that 5% of all the spectral acceleration values, computed from all branches of the logic tree for epistemic uncertainty, are greater than that value.

frequency of exceedance: The number of times within a particular time period that a specified amplitude of ground motion is exceeded. Many past seismic hazard studies have referred to this as a "probability of exceedance." When the frequency of exceedance is low (e.g., 0.01 or less), it is numerically the same as the exceedance probability during the same time period. However, the frequency of exceedance can be greater than 1 (e.g., for very low amplitudes), but the exceedance probability cannot.

ground acceleration: Acceleration at the ground surface produced by seismic waves. Typically expressed in units of gravity (g), the vertical acceleration of gravity at the earth's surface (standard conventional value of 9.80665 m/s²).

hazard curve: A numerical plot that shows the frequency of exceedance for a certain ground motion parameter [e.g., peak ground acceleration, peak ground velocity, response spectral values, fault displacement]. Hazard curves are generally generated for periods of exposure of 1 year, and they give annual frequencies of exceedance (AFE).

hypocenter: The point in the earth's crust where a rupture initiates, creating an earthquake.

liquefaction: A phenomenon that occurs in cohesionless soils that involves the transfer of overburden stress from the soil skeleton to the pore fluid under undrained conditions, with the associated increase in pore water pressure and reduction in effective stress and strength. For earthquake-induced liquefaction, this transfer is due to the contractive tendencies of the soil skeleton during earthquake shaking.

magnitude: A parameter that characterizes the relative size of an earthquake. Traditionally, magnitude has been based on measurement of the maximum motion recorded by a seismograph. Several scales have been defined, but the most commonly used are (a) local magnitude (M_L), commonly referred to as “Richter magnitude”; (b) surface-wave magnitude (M_S); (c) body-wave magnitude (m_b); and (d) moment magnitude (M). Scales M_L , M_S , and m_b have limited range and applicability and do not satisfactorily measure the sizes of the largest earthquakes. The moment magnitude scale, based on the concept of the seismic moment, is a more physical measure, is uniformly applicable to all sizes of earthquakes, and, as such, should be used as the magnitude scale for siting critical facilities. All magnitude scales yield approximately the same value for earthquakes of about magnitude 5; however, for larger events, m_b , then M_L , and finally M_S progressively diverge and increasingly underestimate the size of the earthquake compared to M . It is important, therefore, to specify the magnitude scale being referenced, especially for larger earthquakes.

maximum magnitude (M_{max}): The largest earthquake that a seismic source is assessed to be capable of generating. The maximum magnitude is the upper bound to recurrence curves.

mean hazard curve: Corresponds to the mean of the probability distribution of hazard curves.

median hazard curve: Corresponds to a 50%, or the 50th fractile, hazard curve.

peak ground acceleration: The maximum absolute value of acceleration displayed on an accelerogram, the largest ground acceleration produced by an earthquake at a site. This also refers to the spectral acceleration at a frequency of 100 Hz or higher.

peak ground velocity: The maximum value of the integral of an accelerogram and the largest ground velocity produced by an earthquake at a site.

probabilistic seismic hazard analysis (PSHA): An analytical methodology that estimates AFE for a certain ground motion parameter [e.g., peak ground acceleration, peak ground velocity, response spectral values, fault displacement] at a site.

randomness: See “aleatory variability.”

response spectrum: A curve calculated from an earthquake accelerogram that gives the value of peak response of a damped linear oscillator, with a given damping ratio, as a function of its period or frequency of vibration. Peak response is given in terms of acceleration, velocity, or displacement or is given in terms of derived parameters, such as pseudo-acceleration and pseudo-velocity.

seismic design category (SDC): A category assigned to an SSC that is a function of the severity of adverse radiological and toxicological effects of the hazards that could result from the seismic failure of the SSC on workers, the public, and the environment. SSCs are assigned to SDCs that range from 1 through 5. For example, a conventional building whose failure may not result in any radiological or toxicological consequences is assigned to SDC-1; a safety-related SSC in a nuclear material processing facility with a large inventory of radioactive material is assigned to SDC-5. See ANSI/ANS-2.26-2004 (R2017) [1] for additional information.

seismic source: Faults or volumes within the earth where future earthquakes are expected to occur. In a PSHA, all seismic sources with a potential to contribute significantly to the hazard at the site are considered.

seismic source model (SSM): The definition of parameters that characterize a seismic source for PSHA, including source geometry, style of faulting, seismogenic probability, maximum magnitude, and earthquake recurrence.

seismogenic crust: The brittle portion of the earth's crust capable of generating earthquakes.

seismogenic probability: The probability that a fault is capable of generating earthquakes significant to damage and risk.

seismotectonic: Adjective that describes relationships between earthquakes, faults, and tectonic processes that pertain to the state of stress in the crust and its strain response. Seismotectonic studies incorporate knowledge from multiple geoscience disciplines (e.g., seismology, geology, geodesy) and are useful for characterizing geologic structures generated by earthquakes and the time/space variations in tectonic processes.

Senior Seismic Hazard Analysis Committee (SSHAC): A committee sponsored by the U.S. Nuclear Regulatory Commission (NRC), U.S. Department of Energy (DOE), and Electric Power Research Institute (EPRI) to review the state of the art and improve the overall stability of the PSHA process. The SSHAC [7] concluded that most of the differences in the results from PSHAs performed by different analysts for the same sites were consequences of differences in the process of elicitation of the information from experts. The SSHAC made recommendations on the process, which is now almost uniformly adopted by analysts worldwide assessing seismic hazard for critical structures.

site response (amplification): The amplification (i.e., increase or decrease) of earthquake ground motion by rock and soil near the earth's surface in the vicinity of the site of interest. Topographic effects, the effect of the water table, and basin edge wave-propagation effects are sometimes included under site response.

spectral acceleration: Pseudo-absolute response spectral acceleration, given as a function of oscillator period or frequency and damping ratio (typically 5%). It is equal to the peak relative displacement of a one-degree-of-freedom linear oscillator of frequency f attached to the ground, times the quantity $(2\pi f)^2$. It is expressed in units of gravity (g) or centimeters per second-squared (cm/s^2).

structure(s), system(s), and component(s) [SSC(s)]: A general term encompassing all the elements (items) of a facility. A structure is an element, or a collection of elements, to provide support or enclosure, such as a building, free-standing tanks, basins, dikes, or stacks. A system is a collection of components assembled to perform a function, such as piping; cable trays; conduits; or heating, ventilation, and air conditioning (HVAC). A component is an item of mechanical or electrical equipment, such as a pump, valve, or relay, or an element of a larger array, such as a length of pipe, elbow, or reducer.

uncertainty: A general term. See “variability,” “epistemic uncertainty,” and “aleatory variability.”

uniform hazard response spectra (UHRS): Response spectra derived such that the AFE of any value of the spectral quantity (i.e., spectral acceleration, spectral displacement, etc.) is the same for all one-degree-of-freedom linear oscillator frequencies.

variability: See “epistemic uncertainty” and “aleatory variability.”

verify: To determine that a particular action has been performed in accordance with the rules and requirements of this standard, either by witnessing the action or by reviewing records.

3 PSHA purpose, objectives, and process

This section presents attributes that shall be met and recommendations that should be followed in conducting a PSHA. The attributes and recommendations draw heavily from Senior Seismic Hazard Analysis Committee (SSHAC) procedural guidance given originally in NUREG/CR-6372 [7], subsequent implementation guidance given in NUREG-2117 [9], and the most recent guidance in NUREG-2213 [10]. NUREG-2213 is a stand-alone document and supersedes the previous guidance documents. The recommendations also benefit from experience gained by the seismic hazard community in previous seismic hazard studies.

This section begins with a discussion of the purpose and fundamental objectives of a PSHA (Sec. 3.1), followed by a discussion of the attributes that shall be met during the PSHA process to meet the objectives. The attributes can be met through either the SSHAC process (summarized in Sec. 3.3) or a clearly defined alternative process (Sec. 3.4). The five attributes in Sec. 3.2 are the criteria by which any PSHA shall be judged for acceptability.

3.1 Purpose and objectives

The fundamental purpose of a PSHA is to provide a technically defensible assessment of the annual frequency of exceeding various levels of ground motion, including an explicit expression of the uncertainty in that assessment. The products of the PSHA are several and are usually a function of the intended purpose of the PSHA (Sec. 5). For example, a PSHA conducted for seismic design typically requires mean hazard curves and response spectra; risk analyses require mean and fractile hazard curves throughout a broad range of annual frequencies of exceedance (AFEs) and structural periods or frequencies; nuclear design and risk analyses require hazard products at very low AFEs.

The objective of the SSHAC process outlined in Sec. 3.3 is to result in a PSHA that meets the PSHA purpose described above. Consistent with the SSHAC process, the three fundamental PSHA activities of evaluation, integration, and documentation are executed to achieve a technically defensible assessment of the seismic hazard [10]. Thus, the fundamental goal of the SSHAC process outlined in Sec. 3.3 is to carry out properly and document completely the activities of evaluation, integration, and documentation, which are defined as follows:

- **Evaluation:** the consideration of the complete set of data, models, and methods proposed by the larger technical community that are potentially relevant to the hazard analysis.
- **Integration:** the representation of the center, body, and range (CBR) of technically defensible interpretations (TDI) in light of the evaluation process (i.e., informed by the consideration of existing data, models, and methods).
- **Documentation:** thorough documentation of the project databases, the evaluation process, and the technical bases for the final integrated distributions, including evidence of the participatory peer review.

3.2 Essential attributes of a PSHA

The PSHA approach shall be designed to execute the three fundamental activities as described in Sec. 3.1. Outlined below are attributes that, if met, enhance the likelihood of the PSHA being judged as acceptable, whether following the SSHAC process (Sec. 3.3) or using an alternative approach (Sec. 3.4):

- (1) Roles of participants should be clearly defined and implemented with responsibilities assigned to each role.
- (2) Objective evaluation of all available data, models, and methods that could be relevant to the characterization of the hazard at the site should be performed. This may include additional new data collected specifically for the hazard analysis. This process includes identifying the limits of the existing data, identifying gaps in the existing data, and characterizing the uncertainties in the available data.
- (3) Integration follows the evaluation process and should include the development of models that reflect both the best estimate of each element of the hazard input with the current state of knowledge as well as the associated uncertainty. This distribution is referred to as the center, body, and range of technically defensible interpretations (CBR of the TDI).³⁾ This should generally involve the construction of hazard input models for the SSM and the GMM that addresses both aleatory variability and epistemic uncertainties. This may involve the assessment of site response given the unique site conditions that exist at the site being assessed.
- (4) Documentation should provide a complete and transparent record of the evaluation and integration process. Specifically, the documentation should identify all of the data, models, and methods considered in the evaluation and justify in sufficient detail the technical interpretations that support the hazard input models. In addition, the documentation should be sufficiently detailed to allow reproduction of the hazard analyses. A hazard input document (HID) that provides the necessary numerical values for each of the PSHA input models is a common way for allowing other analysts to reproduce the hazard results.
- (5) Independent participatory peer review should be performed. In this context, “participatory” means that the peer review should occur throughout the project and not just at the end. The peer reviewers should be tasked with performing a technical review and, as needed, a PSHA process review to ensure that the fundamental activities of evaluation, integration, and documentation have been conducted. The peer review should independently assess whether the SSM and the GMM, and as needed the site response analysis, capture the CBR of the TDI. The peer review should also assess whether the technical bases for all elements of the models are documented adequately. The participatory peer review panel (PPRP), which might be only a single person in small studies, should provide a closure letter to the sponsor for the peer review process to be considered complete.

In addition to the criteria listed above, a general requirement is that the PSHA shall be conducted with an appropriate level of effort needed to achieve the regulatory assurance required for the intended nuclear facilities. For example, levels of effort are categorized according to SSHAC Levels 1 through 4 ranging from relatively simple to very effort-intensive. The intent of the various SSHAC levels described below in Sec. 3.3.1 is to provide increasing regulatory assurance as one moves toward higher SSHAC levels.

³⁾ Per NUREG-2213 [10], the center is the best estimate of the resulting interpretations, the body describes the shape of the distribution about the best estimate, and the range encapsulates the upper and lower limits of the technically defensible interpretations.

3.3 SSHAC process

The SSHAC process is designed to achieve the fundamental objectives identified in Sec. 3.1 and to include the attributes given in Sec. 3.2. The SSHAC process is recognized as part of regulatory guidance [11], regulatory actions and requirements regarding safety assessments [12], and SSHAC PSHAs conducted for nuclear facilities throughout the United States [13], [14], [15]. Experience gained from actual applications has been used to update the implementation guidance for SSHAC projects such that the studies provide the necessary regulatory assurance that all data, models, and associated uncertainties have been properly quantified in the hazard analysis and that the study is fully documented and vetted by reviewers [10].

3.3.1 SSHAC levels

The SSHAC guidelines in NUREG-2213 [10] specify four different levels of SSHAC hazard studies, increasing in complexity from Level 1 to Level 4. The five attributes listed in Sec. 3.2 are essential at all four SSHAC levels. The core objective of developing a hazard estimate that reflects the CBR of the TDI is the same at every study level. The likelihood of effectively capturing the CBR of the TDI is expected to be greater at the higher SSHAC levels due to the increased number of participants and greater interaction among the various experts, including the peer reviewers. Since higher levels of regulatory assurance may require higher levels of study, a key criterion in selecting the SSHAC level for a hazard study is the degree of required regulatory assurance.

The remainder of Section 3.3 defines the way in which the SSHAC process should be implemented in the application of this standard, including the definition and selection of SSHAC levels, the roles and responsibilities of project participants, the evaluation and integration phases of the project, the project documentation, and the peer review process.

3.3.1.1 Definition of SSHAC levels

The basic attributes of acceptable PSHA studies given in Sec. 3.2 apply to all SSHAC levels; however, there are differences in implementation. Figures 1 through 4 are from NUREG-2213 [10] and provide brief summaries of the workflow and sequence of activities associated with each of the four levels. Additional details are given in NUREG-2213, including more detailed descriptions of the activities associated with each level and the criteria to consider in the selection of the SSHAC level for any given PSHA study. As discussed in NUREG-2213, a PPRP is required for all SSHAC levels. Although formal workshops are not required for SSHAC Levels 1 and 2, it is still critical that the PPRP be involved throughout the entirety of the process and not be reserved for a “late-stage” review. Figures 1 and 2 show several suggested points at which the PPRP can be engaged and provide feedback, starting with the review of the project plan that lays out the objectives of the study; the general approach to be adopted; and the data, models, and methods to be considered.

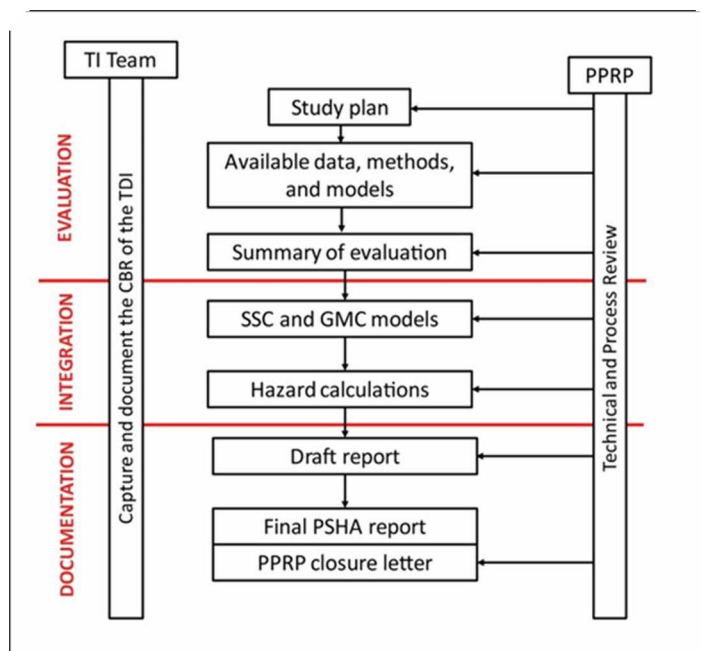


Figure 1 – Flowchart for a SSHAC Level 1 PSHA study, with order of events running from top to bottom.

The activities that address the three objectives of evaluation, integration, and documentation are identified. The study is based on the TI team compiling and evaluating the available data, models, and methods as well as building the SSM and the GMM. The PPRP reviews the various activities of the TI team throughout the project. This figure was developed for NUREG-2213 [10] and is reproduced courtesy of the NRC. The referenced SSC (seismic source characterization) and GMC (ground motion characterization) are equivalent to SSM and GMM in this standard.

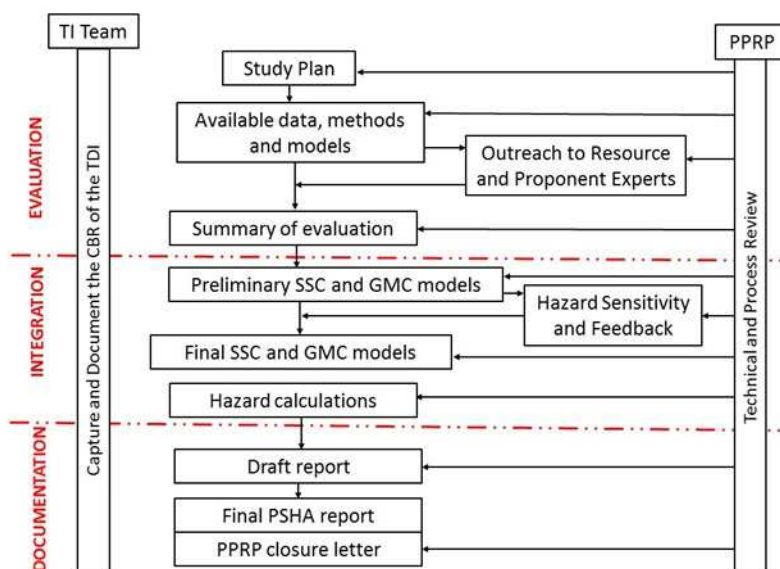


Figure 2 – Flowchart for a SSHAC Level 2 PSHA study, with the order of events running from top

to bottom. Note that Level 2 includes outreach to resource and proponent experts as well as more extensive hazard sensitivity and feedback than a Level 1 study. This figure was developed for NUREG-2213 [10] and is reproduced courtesy of the NRC. The referenced SSC (seismic source characterization) and GMC (ground motion characterization) are equivalent to SSM and GMM in this standard.