U.S. Criteria for Assessing Tectonic Surface Fault Rupture and Deformation at Nuclear Facilities

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Introduction

- ANSI/ANS-2.30-2015 Criteria for Assessing Tectonic Surface Fault Rupture and Deformation at Nuclear Facilities
- Prepared by American Nuclear Society (ANS) Working Group ANS-2.30
- Approved by American National Standards Institute (ANSI)
- Published by ANS

Introduction (continued)

- This standard complements two other standards:
  - ANSI/ANS-2.27-2008 “Criteria for investigations of nuclear facility sites for seismic hazard assessments.”
  - ANSI/ANS-2.29-2008 “Probabilistic seismic hazard analysis.”
- The standard is applicable to Seismic Design Category (SDC) 3 to 5.
- Assumes a site characterization program has or will be performed following requirements in ANSI/ANS-2.27-2008.

Purpose

- The purpose of the standard is to provide criteria and guidelines for assessing permanent ground deformation (PGD) hazard due to tectonic surface fault rupture and deformation at nuclear facilities
- Specifically, the purpose of this standard is to provide an outline of procedures and methods for performing probabilistic fault displacement hazard analysis (PFDHA) for surface rupture hazard and probabilistic tectonic deformation hazard analysis (PTDHA) for surface deformation due to displacements along blind (buried) faults
- Probabilistic approaches for assessing surface fault displacement and tectonic deformation hazard are relatively new; thus, criteria and guidelines have not been defined previously

ANS-2.30 Working Group

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Contents

Definitions

- PGD – Inelastic movement of the ground surface resulting from displacement on a fault, either expressed at the surface or at depth, including (but not limited to) discrete (or distributed) fault displacement or offset ("faulting") and simple to complex changes in geometry of surface and near-surface materials ("tilting" or "folding")
- Only coseismic PGD is considered in the standard
- Creep or afterslip and uplift and subsidence during subduction zone earthquakes is not addressed nor is non-tectonic deformation

Requirements to Characterize PGD

- Any known Quaternary fault or fold (generally within 5 km) that could pose a surface deformation hazard at the site shall be evaluated
- Regional and site-specific investigations shall be performed to support PGD characterizations
- Seismic source characterization activities shall be performed
- Recognize sources of uncertainty – epistemic and aleatory.

Seismic Source Characterization

- PGD zone activity
- PGD zone location, orientation, and width
- Sense of movement
- Distribution of PGD within PGD zone
- Amount of coseismic deformation
- Rate of recurrence of deformation
- Maximum earthquake magnitude

Regional and Site-Specific Investigations

- Selection of area for investigation
- Review of available technical information
- Analysis of tectonic setting
- Detailed geologic and geomorphic mapping
- Detailed geomorphic analyses
- Subsurface investigations

PFDHA Methodology

- Model approaches
  - Fault offset – earthquake approach
  - Fault offset – displacement approach
  - Selection of approach for PFDHA
- Model framework
  - PFDHA aleatory model
  - PFDHA epistemic uncertainty
  - Communication of uncertainty
- Earthquake approach inputs
  - Evaluation of rupture location
  - Occurrence of surface rupture
  - Estimation of fault displacement
- Displacement approach inputs
  - Evaluation of fault location and displacement
  - Recurrence rate/timing of past earthquakes

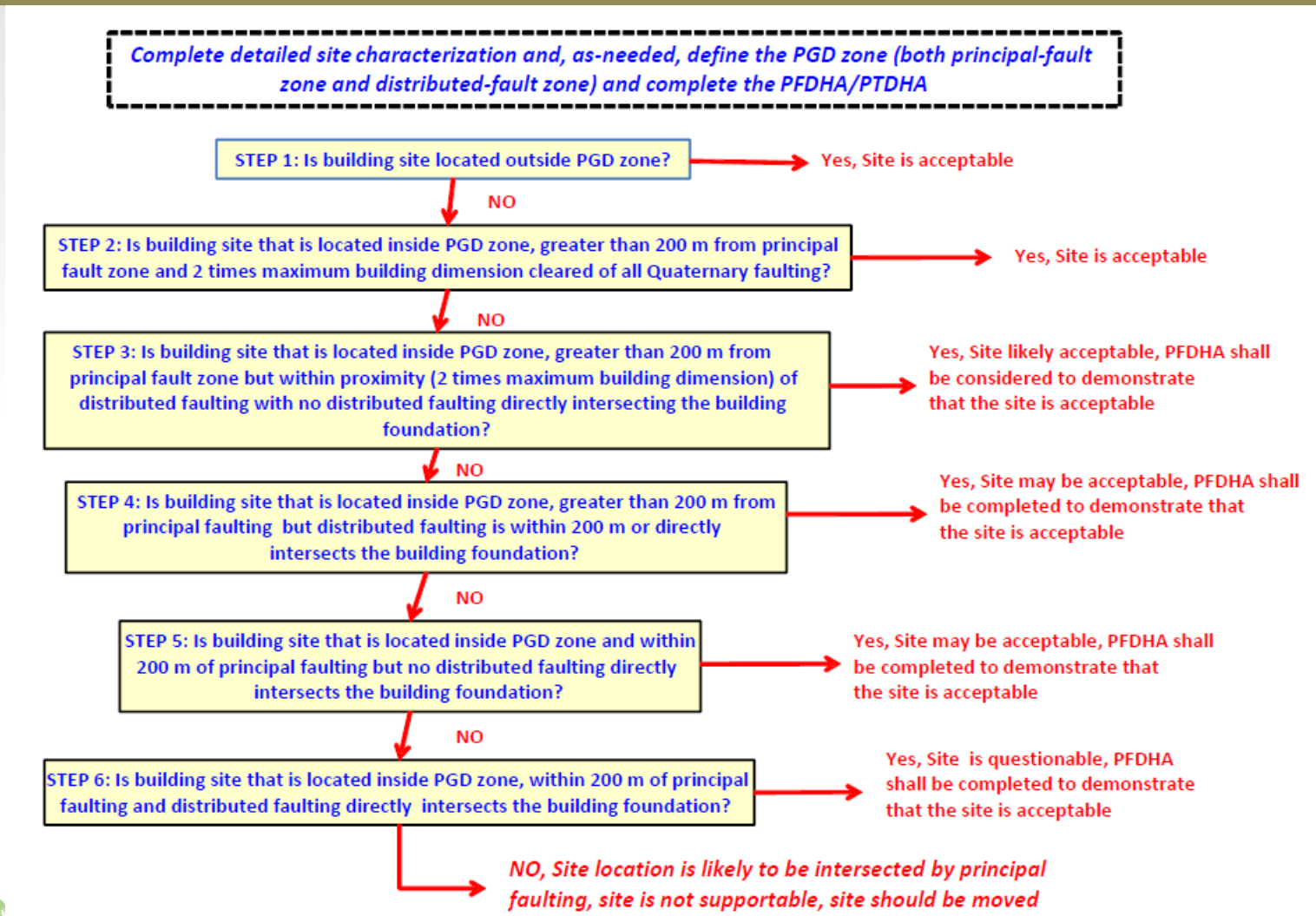
PFDHA Aleatory Model

1. Characterization (i.e., a model) of the temporal and spatial distribution of earthquake occurrences on all faults that have the potential of producing surface rupture at a site;
2. Characterization of the natural variability in the location of potential surface rupture around an earthquake fault;
3. A model of principal-fault displacement as a function of earthquake magnitude and location of the point on the fault closest to the site; and
4. A model of distributed-fault displacement as a function of earthquake magnitude and site-to-fault distance.

PTDHA Aleatory Model

1. Characterization (i.e., a model) of the temporal and spatial distribution of earthquake occurrences on all faults that have the potential of producing surface deformation (but not surface rupture) at a site;
2. A model of displacement on the fault as a function of earthquake magnitude and location of the point on the fault closest to the site;
3. A model for propagation of fault displacement through overlying earth materials, resulting in deformation at the ground surface, including effects of variability in physical properties of the earth materials; and
4. Characterization of the natural variability in the location of potential surface deformation associated with the underlying buried fault.

Site Criteria Conceptual Approach for SDC3-5 Nuclear Facilities



Summary

- ANSI/ANS-2.30-2015 outlines criteria and guidelines for assessing PGD hazard due to tectonic surface fault rupture and deformation at nuclear facilities.
- The standard is one of several national standards designed to provide criteria and guidelines to promote uniform and effective assessment of seismic hazards at nuclear facilities.
- Hopefully the standard, which we believe is the first of its kind in the U.S., is relevant to assessing the PGD hazard at other types of facilities particularly the description of PTDHA.