DOE-STD-1020-2016,

Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities

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Office of Nuclear Safety Basis & Facility Design (AU-31)

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Overview

Contents:

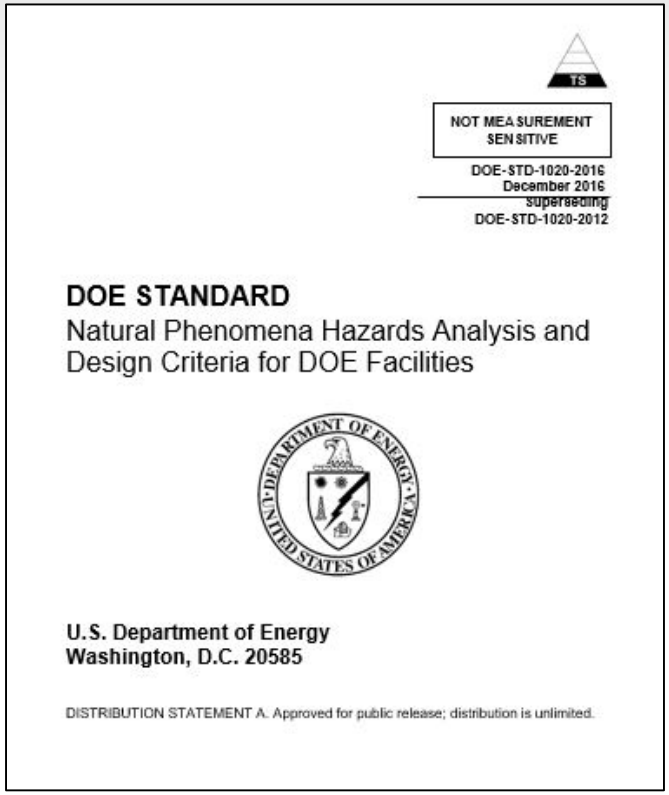
- NPH Program Summary
- DOE Standard 1020-2016
- DOE Handbook 1220-2017

NPH Program Summary

- DOE Office: Office of Nuclear Safety (AU-30)
- Mission: Develop & maintain requirements, standards and guidance for DOE facilities exposed to NPHs
- Driver: Established through DOE Order (O) 420.1C, Facility Safety
- Direction & Guidance: Seismic, extreme wind, tornado, precipitation, flood, volcanic & lightning hazards
- How: Provides assistance, training, communications & support to facilitate effective implementation of DOE's NPH Requirements to assure public & worker health & safety

DOE-STD-1020-2016

DOE Natural Phenomena Hazard (NPH) Requirements



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DOE-STD-1020-2016
December 2016
superseding
DOE-STD-1020-2012

DOE STANDARD

Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities

U.S. Department of Energy
Washington, D.C. 20585

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DOE-STD-1020-2016
Evolution

DOE used the following to support implementation of the NPH requirements:

Year	DOE Standards	Background Documents
1989		UCRL-15910
1994	DOE STD-1020-94	
1996	DOE STD-1020 Change Notice #1	
2002	DOE STD-1020-2002	
2005		ASCE 43
2008		DOE STD-1189-2008
2012	DOE STD-1020-2012	DOE STD-1189, ANS 2.26, ASCE 43
2016	DOE STD-1020-2016	DOE STD-3009-2014

DOE-STD-1020-2016
Revision Scope

- Summary of Technical Changes:
  - Corrected errors & omissions in DOE-STD-1020-2012 (Table 2-1)
  - Aligned with updated DOE-STD-3009-2014, DOE-STD-1189-2016, and DOE O 420.1C, Chg. 1 (Table A-1)
  - Implemented results from 10 Year NPH Assessment Review Report
  - Aligned with updated industry standards and voluntary consensus codes
  - Invoked updated Executive Order (EO) requirements
- Summary of General Changes:
  - Consolidated 'shall' statements from 400 to 140 requirements
  - Minimized rephrasing of requirements from industry standards
  - Improved clarity significantly
  - Overall length reduced from 90 to 55 pages
  - Reorganized sections to better emphasize DOE NPH requirements

DOE-STD-1020-2016
Structure of Standard

Organization - NO change:

Section 1. Introduction

Section 2. General Criteria for NPH Design

Section 3. Seismic Design

Section 4. Wind, Tornado, and Hurricane Design

Section 5. Flood, Seiche, and Tsunami Design

Section 6. Lightning Design

Section 7. Precipitation Design

Section 8. Volcanic Eruption Design

Section 9. Evaluation and Modification of SSCs in Existing Facilities

Section 10. Quality Assurance and Peer Review

1.0 Introduction

Section 1

Purpose (1.1)

- Provide criteria and guidance for the NPH requirements of DOE O 420.1C, Chg. 1
- Ensure that SSCs will perform assigned safety functions during and after design basis NPH events; and
- Provide requirements and guidance in the use of building codes and voluntary consensus standards

Applicability and Scope (1.2)

- Government facilities
  - Owned and leased
- Nuclear and non-nuclear facilities
  - Nuclear, Hazard Category 1,2 and 3
  - Non-nuclear & radiological (HC<3)
- New and existing facilities
  - New construction
  - Major modifications of existing facilities
  - Modifications of existing facilities triggered by periodic NPH assessments

2.0 General Criteria for NPH Design

Overview

Non-Nuclear and < HC 3 Facilities

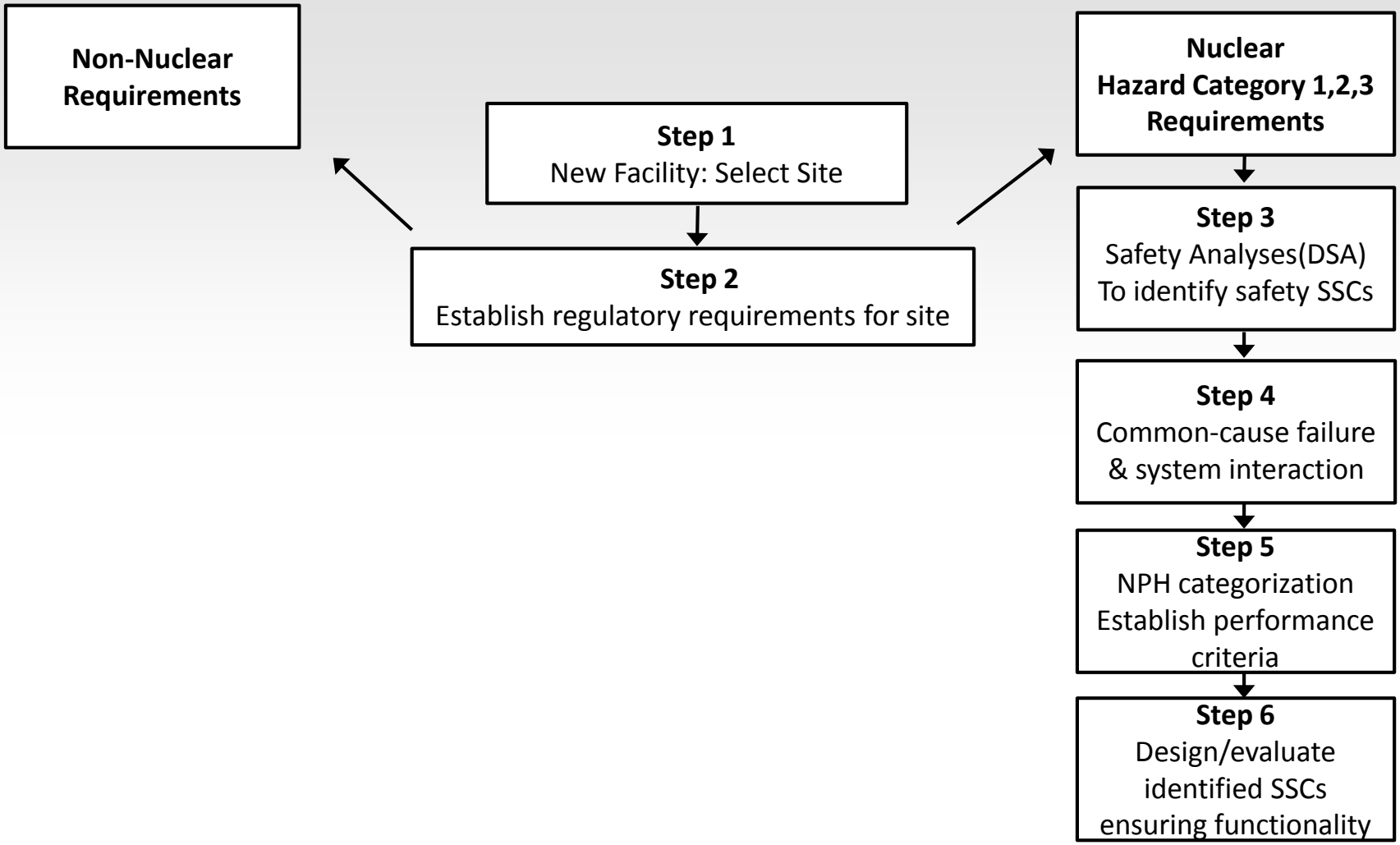
- 2.1 EO Compliance
- 2.2 Non-Nuclear Facilities

Nuclear, HC 1, 2 and 3 Facilities

- 2.1 EO Compliance
- 2.3 NPH Design Category
- 2.4 Limit States
- Sections 3-10

HC = Hazard Category per DOE-STD-1027

NPH Analysis & Design
Overview



Section 2.1.1
PL 101-614 & EO 13717

- EO 13717, *Establishing a Federal Risk Management Standard*, issued February 2016
  - Imposes seismic safety standards for preserving lives (i.e. Life Safety Limit State) of building occupants.
  - Applies to all federally owned, leased, financially assisted and regulated nuclear and non-nuclear facilities
- Requirements
  - New buildings comply with IBC-2015
  - Existing buildings comply with RP-8
    - Limited reevaluation triggers
    - Exempt buildings
    - Benchmark buildings
  - Any building meeting the requirements of STD 1020-2012 are in compliance
  - Many buildings meeting earlier versions of DOE-STD-1020 are in compliance

Section 2.1.2
EO 13690 and EO 11988

- EO 11988
  - Flood risk management
  - Applies to both nuclear and non-nuclear facilities
- DOE-STD-1020-2016:
  - Flood design parameters conform to EO 11988, as amended by EO 13690
    - EO 13690 was REVOKED in August 2017
      - Reference to be removed from DOE-STD-1020 (see FAQ/ page change update)
  - Nuclear facilities have more stringent requirements

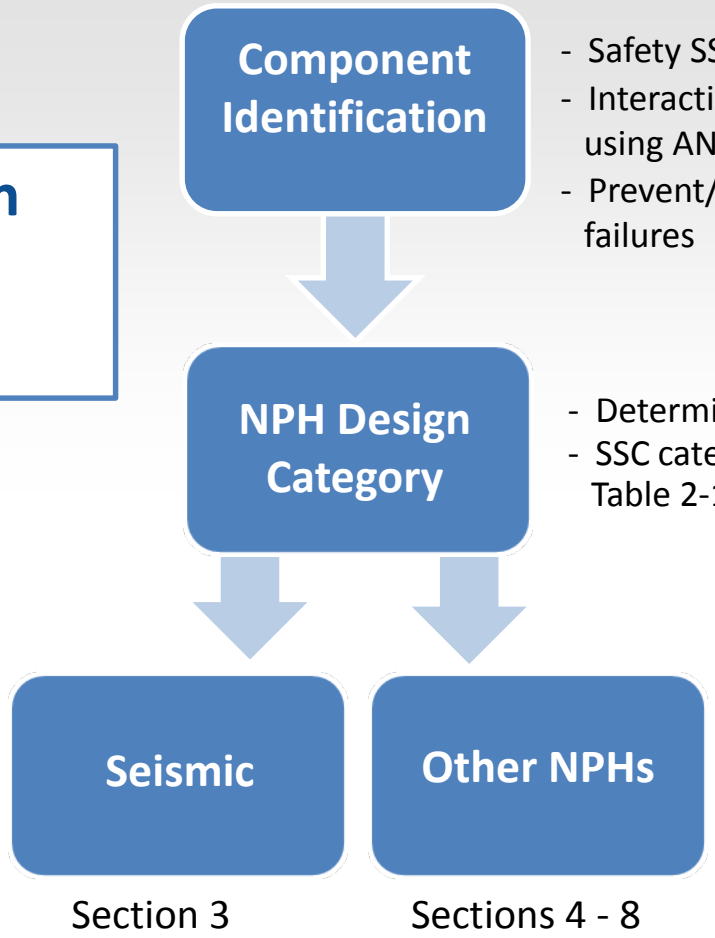
EO 13690 (2015) Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input	EO 11988 (1977) Floodplain Management
Amends EO 11988 500 year flood	Discourage building in flood planes 100 year flood
Lessons learned from Hurricane Sandy Consider climate change	Recommends flood proofing + other flood protection measures

Section 2.2
Non-Nuclear & <HC-3 Facilities

- Requirements:
  - IBC-2015 building design/practices for new buildings
  - EO 13717 Seismic Safety (ICSSC RP-8 for existing buildings)
  - NFPA-780-2017 for lightning protection
  - 29 CFR 1910.1200 for chemical/toxicological facilities
  - DOE-STD-1212-2012 for explosives
  - SSC NPH Design categorization - NOT required
  - 10 year NPH Assessment Review - NOT required

Section 2.3
Nuclear Facilities

SSC NPH Design Categorization Process



Section 2.3
NPH Design Category (1/4)

- ANSI/ANS 2.26, *Categorization of Nuclear Facility Structures, Systems, and Components for Seismic Design*, is used for determining Seismic Design Category (**SDC**) and Limit State (**LS**) for SSCs subjected to seismic hazards.
- DOE-STD-1020 uses ANS 2.26 methodology for determining other NPH events (e.g., Flood, Wind, Precipitation and Volcano) Design Categories (**NDC**), and Limit States.
- ANS 2.26 provides guidance to map common safety functions to limit state.
  - Confinement → LS-C
  - II/I Collapse Prevention → LS-A

Section 2.3
NPH Design Category (NDC)

- Target Performance goal of SSC
  - SSC with low failure consequences have commercial performance goals
  - SSC with high consequences have better performance
- Return period of the design NPH event
- Determines the magnitude of NPH load
- Determines the structural capacity
- Graded Categories NDC-1 thru NDC-5
  - Based on unmitigated consequences of 'failure'
    - 'Failure': SSC does not perform its safety function
    - Failure is determined by deformation
  - NDC-1: Low 'failure' consequences.
    - Commercial building
  - NDC-5: High 'failure' consequences.
    - Reactor containment

Section 2.3
NPH Design Category

Table 2-1: Design Categories in NPH Event

	Unmitigated Consequence Thresholds[1]	
Category	Co-located Worker[2]	Public
NDC-1	< 5 rem TED Or ≥ PAC-1[3]	Not applicable[4]
NDC-2	5 - 100 rem TED Or ≥ PAC-2	5 - 25 rem TED Or ≥ PAC-1
NDC-3	> 100 rem TED Or > PAC-3	> 25 rem TED Or > PAC-2

- **Design categories determined from safety 'hazard evaluation' analysis per DOE-STD-3009-2014.**
- **Methodology determines unmitigated consequences of SSC failure for radiological and chemical releases to co-located workers & public**

Section 2.4
Limit States

- Indicates the level of structural deformation
- Deformation is quantified by Limit States
  - LS-A: Short of collapse, stable
  - LS-B: Moderate permanent deformation
  - LS-C: Limited permanent deformation
  - LS-D: Essentially elastic
- Limit State is independent of NDC
- Limit State is independent of NPH event

- Common safety functions/sample failure modes
  - Equipment operability
  - Leak tightness (leaking pipe fittings)
  - Confinement compromised
  - Control room not habitable
  - Immediate occupancy
  - Life safety
  - Building collapse prevention
- Each of these failure modes can be linked to excessive deformation

Non-seismic Limit States

- For static loads, energy absorption can result in large deformations prior to failure but may not reduce the structural capacity required to resist the static loads:
  - Wind loads on buildings (except Tornado missiles)
  - Precipitation loads
  - Flood loads
  - Volcanic ash loads
- Design to code required strength using code load combinations and strength reduction factors

Seismic Limit States

- Energy absorption can reduce the structural capacity required to resist dynamic loads
  - Seismic ground motion
  - Impact from tornado missile
  - Blast loads

Summary of Changes
Sections 3-5

Section	Topic	Change
3	Seismic Design	Updated response modification coefficient values for SDC 1 & 2 SSCs
4	Wind Design	Added guidance - wind generated missile assessment for extreme straight-line winds Details transferred to NPH Handbook
5	Flood Design	Details transferred to NPH Handbook
6	Lightning Design	No significant change in requirements
7	Precipitation Design	Details transferred to NPH Handbook
8	Volcanic Eruption Design	Clarified sites between 100 and 400km from a Quaternary volcanic vent shall use a graded approach for a volcanic hazard assessment. Return Periods for Volcanic Ashfall Structural/Non-Structural provided

Summary of Changes
Section 9

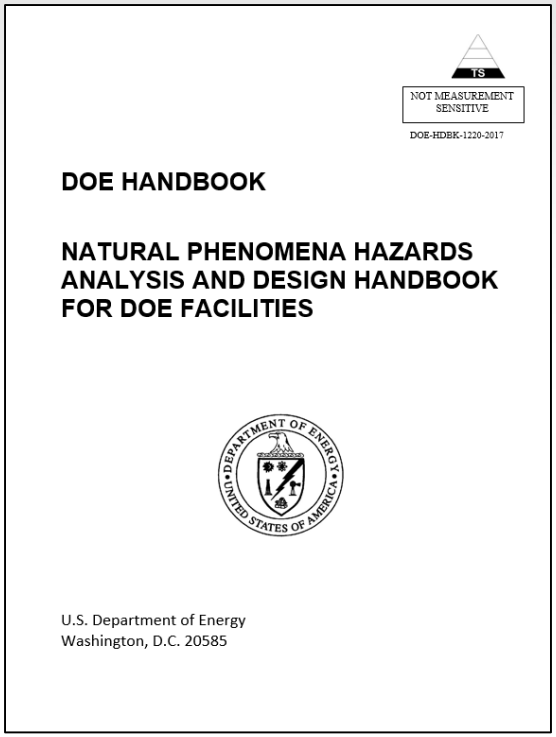
Section	Topic	Change
9.2.1	Periodic Review & Update of NPH Assessments	CLARIFIED: Which Facilities: DOE nuclear facilities with safety SSCs classified as NDC-3 + When: Every 10 years & whenever significant changes in NPH data, models, or analysis methods have been identified. How: Follow criteria in DOE-STD-1020 No Update Needed: Justify & document decision
9.2.1.1	Schedule guidelines for 10 YR NPH assessment review	NEW
9.3.8	Facility Condition Assessment	NEW: Added guidance on aging “beyond planned design lifetime” facilities. Evaluate for aging-related degradation and their ability to continue to perform their safety function.

Summary of Changes
Section 10

Section	Topic	Change
10	Quality Assurance & Peer Review	NEW: Software Quality Assurance (SQA) NEW: section 10.3 Use of Experts and Peer Review for Site Characterization

DOE Handbook 1220-2017

DOE-STD-1020 commentary/guidance/good practices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DOE-HDBK-1220-2017

DOE HANDBOOK

NATURAL PHENOMENA HAZARDS ANALYSIS AND DESIGN HANDBOOK FOR DOE FACILITIES

U.S. Department of Energy
Washington, D.C. 20585

- DOE-STD-1020-2012 and DOE-STD-1020-2016 streamlined to focus the NPH Standard on requirements.
- DOE-STD-1020-2002 and prior revisions addressed the evolution of and technical basis for DOE's unique NPH requirements as well as explanatory material.
- The Handbook does not include any requirements and is not invoked by any DOE Directive or Rule.
- It provides a compilation of good practices, lessons-learned, technical bases and technical insights, practical examples and applications based on DOE and nuclear industry experience.

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http://www.energy.gov/ehss/natural-phenomena-hazards-program