Waiver #271 exists against this procedure. These waivers provide certain allowances for installation of mobile offices. See Waiver 271 for full text of the waiver.

Ownership matrix

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1.0 PURPOSE AND SCOPE

Current DOE requirements for both general design criteria and natural phenomena hazard (NPH) mitigation for the Hanford site are in Supplemented Contractor Requirements Document (SCRD) DOE O 420.1C, “Facility Safety,” and DOE STD-1020-2016, “Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities.”

DOE-STD-1020-2016 provides NPH design and evaluation criteria for seismic, wind, flood, precipitation, lightning, and volcanic hazards based on natural phenomena design categories (NDCs), replacing the performance categories (PCs) in DOE-STD-1020-2002.

This standard establishes structural design loads and acceptance criteria for use in designing new Structures, Systems, and Components (SSCs), evaluating existing SSCs, evaluating anchorage effects of new and modified systems on existing SSCs, and designing additions and modifications to existing SSCs. Additional requirements may apply based on other TOC and DOE standards.

This standard fulfills three objectives:

• Integration of the Natural Phenomena Hazards (NPH) requirements with U.S. Department of Energy (DOE) and other requirements governing design and evaluation of SSCs

• Limit requirements and NPH criteria to those applicable to the DOE Hanford Site Tank Operations Contractor (TOC)

• Stipulate the appropriate levels of depth, rigor, and thoroughness in complying with the requirements.

Design and analysis requirements for all TOC facilities are provided herein.

2.0 IMPLEMENTATION

This standard is effective on the date shown in the header.

This standard applies to any building acquisition, new or existing facility design, leased facilities (including on-site constructed buildings), pre-engineered buildings, plant-fabricated modular buildings, mobile offices, trailers, equipment, and temporary facilities.

This standard applies to major modifications of existing facilities as determined in accordance with DOE-STD-1189, “Integration of Safety into the Design Process.”

3.0 STANDARD

3.1 General

The use of this information does not preclude the proper evaluation of other structural loads or stress-inducing phenomena such as stability, settlement, differential motions, and construction.
If situations arise where criteria in this standard are inadequate, alternate criteria may be used with justification, with approval by the Engineering Discipline Lead.

This document is intended for use by experienced engineers familiar with DOE orders and standards and national building codes and standards. In accordance with DOE O 420.1C, and Executive Order (EO) 13717, the TOC has implemented TFC-ENG-STD-06 and has required the use of consensus codes and standards where appropriate. The users should be familiar with, and have a working knowledge of, the International Building Code (IBC), DOE-STD-1020, DOE-STD-1189, American Society of Civil Engineers (ASCE) 7, ASCE 4, ASCE 37, ASCE 43 and American National Standards Institute (ANSI) American Nuclear Society (ANS) 2.26. The State of Washington Administrative Code (WAC) 51-50-003 made the 2015 International Building Code (IBC) effective on July 1, 2016. It is anticipated that the state of Washington will adopt IBC 2018 and it will become effective on July 1, 2020.

Users should also be familiar with and have a working knowledge of other national codes and standards published by various organizations such as American Concrete Institute (ACI), American Institute of Steel Construction (AISC), American Iron and Steel Institute (AISI), and American Association of State Highway and Transportation Officials (AASHTO), as applicable to the design, materials, construction, and function of SSCs. The applicable revision of these codes and standards is listed in the “Reference Standards” section of the IBC. If a code or standard is not referenced in the IBC (e.g., AASHTO), the latest edition should be used, provided the latest edition is consistent with the edition of IBC currently in effect.

DOE-STD-1189 provides DOE’s expectations for incorporating safety into the design process for new or major modifications to DOE Hazard Category 1, 2, and 3 nuclear facilities, the intended purpose of which involves the handling of hazardous materials, both radiological and chemical, in a way that provides adequate protection for the public, workers, and the environment. The standard describes the Safety-in-Design philosophies to be used with the project management requirements of DOE O 413.3B and incorporates the facility safety criteria in DOE O 420.1C as a key foundation for Safety-in-Design determinations. Initially this will be applied to all new projects and major modifications to SSCs.

Lightning is a natural phenomenon hazard identified by DOE-STD-1020, that is not addressed in this document. Lightning protection shall be in accordance with the fire protection design criteria addressed in TFC-ESHQ-FP-STD-02, which references National Fire Protection (NFPA) 780, “Standard for the Installation of Lightning Protection Systems,” as required by DOE-STD-1020.

### 3.2 General Design Criteria

SSCs shall be designed and evaluated to withstand loads associated with the operation of the facility and the effects of NPHs. Design and evaluation of SSCs shall comply with the loads and acceptance criteria given in this standard. DOE O 420.1C, the IBC and ASCE 7 shall be used as the minimum basic design requirements for DOE facilities. Implementation of DOE-STD-1189 for new projects and major modifications requires the application of ANSI-ANS 2.26 for the definition of the safety function of the SSCs and utilizes that classification to determine the design criteria in accordance with ASCE 43.

The SSCs need not be subjected simultaneously to any combination of extreme wind, seismic ground motions, volcanic ashfall, and flood. However, common cause events are to be evaluated as single events; e.g., fires that may ignite following earthquakes.
SSCs are now categorized into the following individual Natural Phenomena Design Categories (NDCs):

- For seismic hazards, Seismic Design Categories: SDC-1 through SDC-5
- For extreme wind hazards, including straight-line wind, tornado, and hurricane hazards, Wind Design Categories: WDC-1 through WDC-5
- For flood hazards, including seiche, tsunami, and other flood hazards, Flood Design Categories: FDC-1 through FDC-5
- For precipitation hazards, Precipitation Design Categories: PDC-1 through PDC-5
- For volcanic eruption hazards, Volcanic Design Categories: VDC-1 through VDC-5.

DOE-STD-1020-2016 does not include any “-0” categories that correspond to the previous PC-0 category of DOE-STD-1020-2002. The TOC-specific NDC-0 category (non-permanent) is defined and included in this standard to address unique design considerations for a classification of SSCs specific to the TOC facilities.

### 3.3 Safety and Natural Phenomena Design Category Correlation

(5.1.3, 5.1.4, 5.1.6)

DOE-STD-1020-2016 “Applicability and Scope” Section 1.2 identifies the natural phenomena hazards to be addressed. Section 1.2 (c) specifically identifies earthquakes, extreme winds, floods, lightning, precipitation, and volcanic eruptions. SSCs were previously categorized for probabilistic assessment according to performance categories (PCs); i.e., PC-1, PC-2, PC-3 etc. Starting with DOE-STD-1020-2012, SSCs are now categorized into the individual Natural Phenomena Design Categories (NDCs) described in the section above.

For design purposes and the application of these criteria, the design loads and acceptance criteria for SSCs shall be correlated to Natural Phenomena Hazard Design Category (NDC) and Limit State designations. Guidance for the correlation of safety classification and NDC is shown in Table 1. DOE-STD-1020-2016 uses a graded approach for NPH design of SSCs by specifying NPH requirements based on design basis return period as shown in Table 2.

The TOC documented safety analyses (DSAs), RPP-13033, and HNF-14755, identify Safety-Significant SSCs for the facilities. These Safety-Significant SSCs identified in the DSAs and Risk Category IV (Seismic Design Category D) structures as defined in IBC shall be designed as NDC-2. Additionally, items that are Risk Category IV as defined in IBC Table 1604.5, including items such as underground tanks that contain toxic materials, shall also be categorized as NDC-2.

The DSAs do not currently identify any Safety Class SSCs. Future items may be identified in the DSAs as Safety Class SSC’s, and these shall be categorized as NDC-3.

### 3.3.1 Design Criteria Implementation

(5.1.4)

Figure 1 shows the process for implementing design criteria. It should be used for existing systems in conjunction with the DSAs to determine the tank farm component applicable design
criteria. Documented design requirements are not necessarily available for many existing SSCs. Therefore, for existing safety SSCs functioning during or subsequent to natural phenomena events, at least NDC-1 natural phenomena design loads should be used for existing tank farm components.

Existing facilities that do not meet current requirements, may be evaluated at half the return period in accordance with DOE-STD-1020-2016 Sections 9.3.3 through 9.3.6. This must include evaluation of the reduction relative to the total demand on the SSC to verify that the reduction in total hazard level does not exceed 20%.

For major modifications or new structures, SSC NPH design criteria should be based on safety analyses specific to the modification or new structure using the guidelines in Table 1. All SSCs are to maintain their safety function, as identified by the DSAs and the safety equipment list, under these design loads.

### 3.3.2 Non-Permanent, Temporary, and Construction Project SSCs

“Non-permanent” SSCs are SST tank farm retrieval or closure equipment that may be designated as the TOC specific category NDC-0, (previously designated as PC-1M) and will be designed in accordance with the minimum requirements specified in this standard and the criteria provided in RPP-16643. This category only applies to SSCs whose failure does not pose a life safety hazard. NDC-0 SSCs shall be designed to NDC-1 requirements except that seismic load is not required to be considered.

“Temporary” SSCs are those that are erected for a period of less than 180 days as specified in IBC Section 3103. They may be designed for reduced wind loadings in accordance with the requirements specified in this standard including the notes of Table 3, and as specified in ASCE 37, “Design Loads on Structures During Construction.”

“Construction Project” SSCs shall be designed for NDC-1 loads or construction loads as specified by ASCE 37. Construction loads are those loads imposed on a partially completed or temporary structure, during and as a result of the construction process. ASCE 37 provides graduated load factors for construction periods up to a maximum of 5 years.

Repurposed SSCs may transition from these designations, becoming permanent structures, and shall be evaluated in accordance with the appropriate new NDC criteria.

### 3.3.3 System Interaction

An assessment of the system interaction between different NDCs shall be performed. The effects of lower NDC SSC on the safety function of the higher NDC SSC shall be evaluated for “system interaction” also identified as “zone of influence” or “two-over-one phenomena.” If any behavior of the lower NDC SSC has any adverse effect on the performance of the higher NDC SSC, it shall be documented and appropriate evaluation action taken. Anchorage design considerations are addressed in Section 3.4.4. For further guidance on this issue, see ANSI/ANS-2.26, Section 6.3.2.4.
3.4 Anchorage of Equipment
(5.1.4, 5.1.6)

Anchorage for all SSCs shall follow Table 4 requirements.

All post-installed anchors shall use industry standard anchors having capacities published by the International Code Council (ICC). All post-installed anchor bolts shall be designed and installed in accordance with the ICC standards, and must have listed in the ICC report or otherwise documented that they are qualified in accordance with ACI 355.2, “Qualifications of Post-Installed Mechanical Anchors in Concrete”, or ACI 355.4, “Qualification of Post-Installed Adhesive Anchors in Concrete.”

The ICC evaluation reports provide allowable shear and tension values for installation, both with and without special inspection. Unless otherwise specified in the design documentation, the values without special inspection shall be used. Anchor bolts of a minimum 1/2 inch in diameter are recommended regardless of calculated anchorage requirements.

For vibratory equipment and dynamic loading, undercut anchors are preferred. Undercut anchors are required for:

- Fall protection anchors
- Hoisting and rigging applications
- All overhead applications
- Non-vibration isolated mechanical equipment rated over 10 hp.

Epoxy grouted anchors are not allowed in elevated temperature environments in accordance with manufacturer’s requirements. Epoxy grouted anchors shall not be used in overhead applications.

3.4.1 Anchorage for NDC-0 SSCs

Anchorage of non-permanent NDC-0 SSCs (equipment, piping, and structures used for single-shell tank retrieval and closure and for facility deactivation) shall meet at a minimum WDC-1 requirements in accordance with RPP-16643. Table 4 provides further details.

3.4.2 Anchorage for NDC-1 and NDC-2 SSCs

Design of anchorage for NDC-1 and NDC-2 SSCs shall be performed in accordance with ACI-318, “Building Code Requirements for Structural Concrete Requirements.”

3.4.3 Anchorage for NDC-3 SSCs

Design of anchorage for NDC-3 SSCs shall be performed in accordance with ACI-349.

Epoxy grouted anchorage shall not be used for NDC-3 SSCs without documented qualification by the licensed design professional following ACI 349.

Anchorage for new and existing NDC-3 systems and components using welded attachments shall use allowable weld stresses per AISC N690, “Specification for Safety-Related Steel Structures for Nuclear Facilities.”
3.4.4 Anchorage for Lower–category NDC within zone of influence of NDC-2 or NDC-3 SSCs

Lower Category NDC systems and components (source) that are within the zone of influence of a NDC-2, or NDC-3 item (target) and whose structural failure may compromise the structural integrity of the target to perform its safety function result in what is known as “common-cause failure,” “system interaction,” or “two-over-one.” These Lower Category (NDC-0, NDC-1 or NDC-2) items shall be designed by using the methods of ASCE 7 and ANS/ANS-2.26. The loading for the target shall be used for the loading for the source, except for the number of directions of applied seismic loading. The seismic loading shall be applied in three orthogonal directions. The three orthogonal directions can be combined either by the square-root-of-the-sum-of-the-squares (SRSS) or by assuming 100 percent of the seismic load acts in one primary lateral direction and 40 percent of the peak seismic load acts simultaneously in the other two orthogonal directions. The primary lateral acceleration shall be applied to produce the most severe anchorage loads.

3.4.5 Anchorage of Existing SSCs

Anchorage of existing SSCs using expansion anchors, cast-in-place bolts (j-bolts, headed studs, etc.) and grouted-in-place bolts may use allowable bolt capacities from HNF-SD-GN-DGS-30006, “Guidelines for Assessing the Seismic Adequacy of Existing Performance Category Equipment at the Hanford Site.”

3.5 Design Loads

Design loads shall be applied, depending on the safety classification and NDC of the SSCs considering any potential loading required by code including the following:

- Dead loads
- Live loads
- Snow loads
- Wind loads
- Seismic loads
- Volcanic ashfall loads
- Flood loads
- Earth and groundwater pressure loads
- Thermal loads
- Concrete creep and shrinkage loads.
- Other NPH loads.

3.5.1 Dead Loads

Dead loads shall include the weights of all permanent materials and equipment, including the structures own weight. Design dead loads shall include the weight of all permanent service equipment. Service equipment shall include plumbing stacks, piping, heating, ventilation, and air conditioning (HVAC) equipment, electrical equipment, fire sprinkler piping and valves, and similar fixed furnishings. Consideration shall be given for any loadings anticipated to be added at a later date. The final design loads shall reflect the field configuration as shown on the drawings.
The minimum allowance for the weights of partitions, where partitions are not likely to be rearranged or relocated, shall be as follows:

- For partition weights of 150 lb/ft. or less, an equivalent uniform dead load of 20 lb/ft\(^2\) shall be used
- For partition weights above 150 lb/ft, the actual linear loads shall be used.

Unless other source references are provided, the IBC or ASCE 7 shall be used to determine unit weights. Where unit weights are neither established in the IBC or ASCE 7 nor determined by test or analysis, the weights shall be determined from data in manufacturer drawings or catalogs.

### 3.5.2 Live Loads

Live loads are those loads produced by the use and occupancy of the building or other structure and do not include construction and environmental loads such as wind load, snow load, rain load, earthquake load, flood load, or dead load. Live loads on a roof are produced by maintenance workers and their equipment. Live loads within a structure are produced by partitions, people, and office equipment.

Live loads for buildings and other structures shall not be less than the minimum uniform or concentrated loads specified in the IBC or ASCE 7.

The minimum roof design live load shall be 20 lb/ft\(^2\).

The weight of service equipment that may be removed with change of occupancy of a given area shall be considered as live load.

Partitions that are likely to be rearranged or relocated shall be calculated as live loads.

### 3.5.3 Snow Loads

Snow loads, full or unbalanced, shall be substituted for the roof live loads in Section 3.5.2 where such loading results in larger members or connections. Unbalanced snow loads resulting from drifting or sliding shall be considered. A ground snow load, \(p_{gw}\), of 15 lb/ft\(^2\) shall be used for calculating roof snow load in accordance with the IBC, which adopts the methodology of ASCE 7, and the additional parameters and requirements as provided according to the Precipitation Design Category (PDC) as noted in Table 5.

When designing for rainfall (non-structural loading), see Section 3.9, “Site Drainage.”

**Guidance for snow load design may be found in ASCE Snow Loads: Guide to the Snow Load Provisions of ASCE 7-10.**

### 3.5.4 Wind Loads

Wind design for SSCs shall be in accordance with the IBC, which adopts the methodology of ASCE 7, and shall use the parameters noted in Table 3. The structural frame and exterior components of all buildings, signs, tanks, towers, and other exposed structures including
movable equipment shall be designed to resist pressures from wind from any direction. Partial wind loading shall be considered if it produces a more severe effect.

Design basis tornadoes, hurricanes, and extreme wind missiles are not applicable to TOC SSCs. (see HNF-SD-GN-ER-501).

**Guidance for wind load design may be found in the following ASCE documents:**

- ASCE Wind Loads: Guide to the Wind Load Provisions of ASCE 7-10
- ASCE 41180 Wind Loads for Petrochemical and Other Industrial Facilities.

### 3.5.5 Seismic Loads


For seismic hazard evaluations, consistent with ANSI/ANS-2.26, the failure of an SSC shall be defined in terms of its limit state. For other NPHs where dynamic loads lead to deformation-related SSC failure, the definition of failure shall be consistent with the design codes being used. However, the hazard consequence evaluation process used in ANSI/ANS-2.26 provides applicable guidance for selecting NPH design categories and limit states for other than seismic events.

**Guidance for seismic load design may be found in ASCE Seismic Loads: Guide to the Seismic Load Provisions of ASCE 7-10**

Seismic Design is not required for SSCs designated as NDC-0.

#### 3.5.5.1 SDC-1 and SDC-2 Structures, Systems, and Components

Seismic design load of SDC-1 and SDC-2 SSCs shall comply with the IBC, which adopts the methodology of ASCE 7. SDC-1 SSCs shall be designed for Risk Category I/II (Seismic Design Category D) requirements (with Importance Factor of 1.0 per ASCE 7). SDC-2 SSCs shall be designed for Risk Category IV (Seismic Design Category D) requirements (with Importance Factor = 1.5 per ASCE 7). See Table 6 for the associated limit state and response coefficient requirements for SDC-1 and SDC-2 SSCs.

#### 3.5.5.2 Seismic Parameters for SDC-1 and SDC-2 Structures, Systems, and Components

1. **Site Classification**

   Site Class C shall be used as described in RPP-RPT-27570 for all SDCs in the Double-Shell tank farms. Additionally, the Hanford Site general soil profile supports the use of Site Class C for all SDC-1 SSCs in accordance with ASCE 7 Section 20.1. For any new SDC-2 or SDC-3 facilities outside the tank farms, the Site Class shall be verified.

2. **Design spectral response acceleration parameters:**
Response spectra values from RPP-RPT-27570 for Site Class C shall be used unless determined otherwise by a geotechnical report. The values for Site Class C and Site Class D are as follows:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Site Class C</th>
<th>Site Class D</th>
</tr>
</thead>
<tbody>
<tr>
<td>horizontal $S_{D1}$</td>
<td>0.192</td>
<td>0.244</td>
</tr>
<tr>
<td>horizontal $S_{DS}$</td>
<td>0.588</td>
<td>0.594</td>
</tr>
<tr>
<td>vertical $S_{D1}$</td>
<td>0.098</td>
<td>0.142</td>
</tr>
<tr>
<td>vertical $S_{DS}$</td>
<td>0.346</td>
<td>0.419</td>
</tr>
<tr>
<td>$F_a$</td>
<td>1.2</td>
<td>1.212</td>
</tr>
<tr>
<td>$F_v$</td>
<td>1.66</td>
<td>1.491</td>
</tr>
</tbody>
</table>

3. Site Class other than C or D

Where soil properties are known to support a Site Class other than C or D, the design spectral accelerations, $S_{DS}$ and $S_{D1}$ shall be adjusted by calculating $S_S$ and $S_I$ and determining the corresponding Site Coefficients $F_a$ and $F_v$ in accordance with the recommendations listed in ASCE 7, Section 11.4.3 and Tables 11.4-1 and 11.4-2.

4. Seismic Design Category

Due to the $S_{DS} = 0.588$ value being > 0.50, the Seismic Design Category D shall be used per ASCE Table 11.6-1.

3.5.5.3 SDC-3 Structures Systems and Components

Seismic design of SDC-3 SSCs shall comply with DOE-STD-1020-2016 and ASCE 43-05 by using dynamic analysis. Site-specific design response spectra as provided in RPP-RPT-27570 for the Maximum Considered Earthquake (MCE), or the overall Hanford site response spectra provided in HNF-SD-GN-ER-501 shall be used. An equivalent-static analysis may be used for seismic qualification as outlined in ASCE 43-05.

3.5.5.4 Response Spectra for SDC-3 Structures Systems and Components

PNNL-23361, “Hanford Sitewide Probabilistic Seismic Hazard Analysis (PSHA)” (2006) provides the detailed characterization of the vibratory ground motion hazard at the Hanford Site from potential future earthquakes. The outputs of PNNL-23361 may be used to establish the seismic design of new facilities and for safety reviews of existing facilities, by combining the 1996 PSHA results with site response analyses conducted using site-specific geotechnical information.

3.5.6 Ashfall Loads

Design ashfall loading shall be as follows:

- VDC-1: 3.2 lb/ft²
- VDC-2: 11.8 lb/ft²
- VDC-3: 23 lb/ft²
For VDC-1 and VDC-2 ashfall loads are typically substituted for roof live or snow loads in typical load combinations. Note that the use of 20 lb/ft² minimum roof live load accounts for ashfall loads for VDC-1 and VDC-2 including concurrent moisture loads without further consideration.

For VDC-3, when not considered in combination with concurrent moisture loads such as snow load, an additional 0.5 lb/ft² shall be applied per WHC-SD-GN-ER-30038 Paragraph 3.2.2 to address the concurrent moisture load requirement of DOE-STD-1020-2016 Section 8.4.5.

3.5.7 Flood Loads

(5.1.4)

The 200 Area is approximately 200 ft above the Columbia River at its nearest flood inundation point. These areas are dry sites and need not consider Columbia River flooding in design for any Flood Design Category.

The far southwest corner of the 200 West area may be impacted by flooding of the Cold Creek watershed. FDC-2 and FDC-3 facilities should not be located below an elevation of approximately 640 ft in the southwestern portion of the 200 West Area.

For SSCs in areas where the potential for accumulation or flooding exists due to rainfall, the Design Basis Precipitation Load (DBPL) shown in Table 7, based on the Precipitation Design Category (PDC), shall be used.

3.5.8 Earth and Groundwater Pressures

(5.1.4, 5.1.6, 5.1.7)

3.5.8.1 Soil properties

Soil properties for NDC-3 structures and new NDC-2 structures shall be determined from subsurface investigations (see Section 3.8). A minimum soil density of 110 lb/ft³ shall be used for NDC-1 and NDC-2 structures and may be used for NDC-3 structures until the subsurface soil investigations are completed.

3.5.8.2 Allowable soil bearing pressure

for NDC-1 and NDC-2 SSCs, shall be obtained from the IBC Section 1806, based on information in WHC-SD-GN-ER-30009, for design where precise soil-bearing information is not available. These values are considered acceptable for undisturbed earth.

3.5.8.3 Lateral earth pressures

Every foundation wall or other wall serving as a retaining structure shall be designed to resist (in addition to the vertical loads acting on it) the incident lateral earth pressures and surcharges, plus hydrostatic pressures corresponding to the maximum probable groundwater level.

Lateral earth pressures for NDC-1 and NDC-2 SSCs shall be as follows, unless site-specific soil conditions have been determined from subsurface investigations. Site-specific soil conditions shall be used for NDC-3 structures.

Cantilever or other flexible walls exposed to earth fill shall be designed for a static equivalent fluid pressure of 30 lb/ft², based on an active earth pressure coefficient, K_a, of 0.27 and soil density of 110 lb/ft³.
Basement or other rigid walls exposed to ordinary compacted backfill shall be designed for a static equivalent fluid pressure of 55 lb/ft², based on an at-rest earth pressure coefficient, K₀, of 0.50 and a soil density of 110 lb/ft³.

Rigid walls exposed to backfill compacted to at least 75% of relative density shall be designed for 77 lb/ft², based on a K₀ of 0.70 and a soil density of 110 lb/ft³.

Superimposed lateral pressures resulting from uniform surcharge loadings shall be calculated by using appropriate earth pressure coefficients as shown above. Resultant forces from point and line loads shall be added.

3.5.9 Thermal Forces
(5.1.7)

The design of structures shall include the effects of stresses and movements resulting from variations in temperature. Structures shall be designed for movements resulting from the maximum seasonal temperature change (-25°F to +115°F). The design shall provide for the lags between air temperatures and the interior temperatures of massive concrete members or structures. Consideration shall be given to passive soil loading resulting from thermal growth of sub grade structures. See TFC-ENG-STD-02 for additional environmental/seasonal conditions.

3.5.10 Creep and Shrinkage Forces
(5.1.7)

Concrete and masonry structures shall be investigated for stresses and deformations induced by creep and shrinkage. For concrete and masonry structures, the minimum linear coefficient of shrinkage shall be 0.005 in/in., unless a detailed analysis is undertaken. The theoretical shrinkage displacement shall be computed as the product of the linear coefficient and the length of the member.

3.5.11 Ice Loads
(5.1.4, 5.1.6)

Ice loading shall be evaluated for ice-sensitive structures such as those with lattice type framing in accordance with the requirements of ASCE 7 Chapter 10. The equivalent radial ice thickness due to freezing rain is 0.25 inch, with a concurrent wind speed (3-second gust) of 40 mph.

For hoarfrost effects on ventilation systems refer to TFC-ENG-STD-07.

3.5.12 Load Combinations
(5.1.4, 5.1.6)

Load combinations, allowable stresses, deformation and strength requirements for load conditions for NDC-1 and NDC-2 SSCs, shall comply with IBC Section 1605 for Risk Category II and Risk Category IV SSCs. Load combinations, allowable stresses, deformation and strength requirements for NDC-3 SDCs shall comply with ACI 349 and AISC N690. The exception to this is that for seismic hazards the failure of an SSC shall be defined in terms of its limit state. Additional load combination requirements may apply based on industry standards identified in Section 3.6 below.
3.6 Design Acceptance Criteria
(5.1.4, 5.1.6)

Design of SSCs shall meet or exceed the minimum requirements in the IBC and ASCE 7. In all cases, the manufacturer’s recommendations shall be followed. The following provides additional acceptance criteria.

3.6.1 Ceiling Suspension Systems
(5.1.7)

Suspended ceilings shall be earthquake resistant. They shall meet the requirements of American Society of Testing and Materials (ASTM) E580.

3.6.2 Chimneys and Stacks
(5.1.7)

Design of reinforced concrete chimneys and stacks shall comply with ACI 307, unless otherwise justified in the design documentation. Masonry chimney design shall comply with ACI 530. Design of steel stacks and chimneys shall comply with American Society of Mechanical Engineers (ASME) STS-1.

3.6.3 Concrete Buildings and SSCs
(5.1.3)

Concrete buildings and SSCs shall be designed in accordance with ACI 318 as a minimum. NDC-3 Buildings and SSCs shall be designed in accordance with ACI 349.

3.6.4 Concrete Sanitary Structures
(5.1.7)

Design of sanitary engineering concrete structures shall comply with ACI 350.

3.6.5 Cover Plates
(5.1.6, 5.1.7)

Cover plates in locations with vehicular access shall comply with AASHTO LRFD Table 3.6.2.1-1 and Section LRFD 4.7.2.1. A dynamic load allowance of 16.5% shall be used inside the Tank Farms, which takes into consideration the 5 mph speed limit specified in the WRPS General Hazards Analysis.

Cover plates for protection at walking/working surface openings shall comply with TFC-ESHQ-S-STD-05.

3.6.6 Ecology Blocks
(5.1.7)

Lifting of Ecology Blocks, including similar blocks such as landscaping blocks, shall be performed in accordance with the requirements of DOE-RL-92-36, Attachment 3.

All Ecology Blocks (existing and new) stacked more than two high shall be evaluated for structural stability.
3.6.6.1 Existing Condition

An inspection and lift plan shall be developed prior to lifting or stacking of existing Ecology Blocks, that do not have documented engineering.

3.6.6.2 Future (New) Condition

Ecology Blocks documentation shall be stamped by a licensed professional engineer. Concrete shall be per ACI 318 and ACI 301. Lifting bails, load testing, and marking shall meet the requirements of the requirements of DOE-RL-92-36, Attachment 3.

3.6.7 Freight Containers

Freight container (conex box) lifting, handling, procurement and structural evaluation shall be performed in accordance with RPP-40736 and DOE-RL-92-36. Alterations made to the containers after manufacturing, such as doors, cut openings, and vents, may affect structural integrity and require evaluation by a qualified civil/structural engineer.

3.6.8 Gloveboxes

1. Gloveboxes for General Application

Gloveboxes for General Application should be designed in accordance with American Glovebox Society (AGS) Guideline AGS-G001.

2. Gloveboxes for Nuclear Application

Gloveboxes for Nuclear Application shall be designed in accordance with Standard of Practice AGS-G006. Plutonium gloveboxes shall additionally be designed in accordance with ASTM C852.

3.6.9 Highway Structures, Railway Structures, and Road Design

3.6.9.1 Highway structures

Highway structures shall comply with American Association of State Highway and Transportation Officials (AASHTO) LRFD. The unit weights of materials for highway structures shall be those given by the AASHTO standards. Live loads for highway structures shall comply with AASHTO and an HL-93 loading shall be used, unless otherwise specified. Combination of loads and design requirements for highway structures shall be as stipulated in AASHTO LRFD.

3.6.9.2 Railroad structures

Railroad structures shall comply with American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering. The unit weights for railway structures shall be those given in the AREMA Manual for Railway Engineering. Live loads for railway structures shall comply with AREMA Manual for Railway Engineering, and a Cooper E-80 loading shall be used, unless otherwise specified.
3.6.9.3  **Road and pavement**

Road and Pavement design shall comply with WSDOT M22-01 requirements.

3.6.10  **Hoisting, Rigging, and Transport**  
(5.1.3, 5.1.8)

All hoisting, rigging, and transport design and operations shall comply with the requirements of DOE-RL-92-36, DOE-STD-1090, TFC-ENG-FACSUP-C-25, TFC-ENG-FACSUP-C-10, and RPP-8360.

For Planned Lifts, all lifted items and lifting lugs shall be evaluated in accordance with RPP-8360.

Below-the-hook lifting devices shall be designed in accordance with ASME BTH-1.

3.6.11  **Light Gauge Steel**  
(5.1.6)

Light gauge steel shall comply with American Iron and Steel Institute (AISI) S100.

3.6.12  **Masonry**  
(5.1.6)

Masonry structures shall comply with The Masonry Society (TMS) 402 and TMS 602.

3.6.13  **Metal Fastening**  
(5.1.6)

Structural bolting shall be designed in accordance with AISC 360.

Metal fastening for highway structural supports shall be designed in accordance with AASHTO LTS.

3.6.14  **Mobile Offices**  
(5.1.1, 5.1.7)

Mobile offices (manufactured buildings/structures) shall be designed and manufactured in accordance with this standard using the criteria of ASCE 7 and WAC 296-150F. Mobile offices shall be installed per the manufacturer specifications.

Mobile offices categorized as NDC-0 or NDC-1, and less than 12 feet wide, and Mobile offices categorized as NDC-2 shall be designed using the criteria of ASCE 7. Seismic Design shall include the limit state requirements with the appropriate factors identified in Table 6.

Mobile offices categorized as NDC-0 or NDC-1, and greater than 12 feet wide, may be designed using the criteria of NFPA 225.
3.6.15 Pre-Engineered Metal Buildings

Pre-engineered buildings shall comply with the Metal Building Manufacturers Association (MBMA) “Metal Building Systems Manual.” Pre-engineered metal buildings shall not be used for safety-related structures unless approved by a Civil/Structural Subject Matter Expert (SME).

3.6.16 Shoring

Shoring shall be designed in accordance with the requirements of DOE-0344, WAC 296-155 Part N, and TFC-ESHQ-S-STD-30.

3.6.17 Stairs, Ramps, Landings, Handrail, and Guardrail

3.6.17.1 Loading

Live loads shall be in accordance with requirements of IBC 2015 Section 1607 and 29 CFR 1910 (OSHA).

3.6.17.2 Dimensional Design

Dimensional design shall be in accordance with the requirements of NFPA 101 as specified in TFC-ESHQ-FP-STD-02, Attachment A. Design in accordance with NFPA 101 is performed in lieu of IBC 2015 Chapter 10 requirements and the requirements of “Occupational Safety and Health Standards” (OSHA), 29 CFR 1910.25. NFPA does not provide structural load requirements and those are addressed in the paragraph above. For additional guidance, see TFC-OPS-MAINT-C-15.

3.6.18 Steel Buildings and SSCs

Steel buildings and SSCs shall be designed in accordance with AISC 360 and AISC 325 as a minimum. NDC-3 Buildings and SSCs shall be designed in accordance with AISC N690.

3.6.19 Steel Cables

Steel cables shall comply with ASCE 19 as modified by IBC Section 2208.

3.6.20 Steel Decks

Steel decks for floor and roof construction shall comply with Steel Deck Institute (SDI) DDM04, SDI FDDM, and SDI RDDM.
3.6.21 Steel Joists
(5.1.7)

Steel joist floor and roof construction shall comply with the Steel Joist Institute “Standard Specifications, Load Tables, and Weight Tables for Steel Joists and Joist Girders.”

3.6.22 Tanks
(5.1.1, 5.1.3)

3.6.22.1 Fuel Storage Tanks

Steel fuel storage tanks shall comply with American Petroleum Institute (API) STD 650. Fiberglass tanks shall comply with Underwriters Laboratories (UL)-1316.

3.6.22.1 Water Storage Tanks, Standpipes, and Reservoirs

Steel water storage tanks, standpipes, and reservoirs shall comply with NFPA 22, API 620, and American Water Works Association (AWWA) D100.

3.6.22.2 Pressure Vessels

Pressure vessels and related process piping shall comply with requirements of TFC-ENG-STD-22, which refers to the “Pressure Safety” requirements of 10 CFR 851 requiring that pressurized systems be designed in accordance with the ASME B31 series codes. Requirements shall be in accordance with the specific standard edition identified by date in 10 CFR 851.

3.6.23 Tank Ancillary Structures and Equipment

3.6.23.1 In-Tank Equipment

The design of in-tank equipment that is not required to function during or after an earthquake, and is not safety (is NDC-0 or NDC-1) is not required to be analyzed for the effects of tank sloshing. Note that the basis for this interpretation is that the ASCE 7 is a life safety code, and the discussion of sloshing in ASCE 7 Section 15.7, is directed at the tank design requirements. In-tank equipment that has no safety implication does not require the rigorous sloshing calculations.

Design of riser-installed equipment such as pumps shall consider the vibrational characteristics of the equipment in relation to the tank structure in accordance with the requirements of TFC-ENG-FACSUP-C-10.

In all cases, it shall be demonstrated that the failure of a lower safety classification SSC does not have the potential to damage higher safety classification SSCs, for example adjacent jumpers or equipment.

3.6.23.2 Risers

New risers installed in existing waste tanks should be designed without direct anchorage to the tank dome, to minimize additional concentrated lateral and vertical loading on the tank structure.
3.6.23.3 Pits and Coverblocks

New pits should be designed without direct anchorage to the tank dome, to minimize additional concentrated lateral and vertical loading on the tank structure. In all cases, it shall be demonstrated that the failure of a lower safety classification SSC does not have the potential to damage higher safety classification SSCs.

Evaluation of coverblock lifting bails shall be performed in accordance with RPP-8360 requirements.

3.6.24 Tents

3.6.24.1 Tents - General

Tents that do not meet the requirements of “temporary”, “non-permanent”, or “Construction project” as defined in Section 3.3.2 and are not “Temporary Containment Tents” as described below shall be designed for all loads in accordance with their NDC designation.

3.6.24.2 Temporary Containment Tents

Temporary containment tents shall be designed in accordance with the requirements of RPP-RPT-47003 and RPP-7933.

3.6.25 Towers and Poles

(5.1.6, 5.1.7)

3.6.25.1 Transmission towers

Transmission towers for electrical power lines shall comply with ASCE 10.

3.6.25.2 Antenna towers

Antenna towers shall comply with Telecommunications Industry Association (TIA)-222.

3.6.25.3 Transmission pole structures

Transmission pole structures shall comply with ASCE 48.

3.6.26 Ventilation Systems and Components

For additional information and requirements for various facility ventilation system components, see TFC-ENG-STD-07.

3.6.27 Welding

(5.1.6)

Welding of structures shall comply with American Welding Society (AWS) standards such as, but not limited to:

Personnel and procedures for welding shall be qualified in accordance with the applicable AWS fabrication code before welding. Qualification in accordance with ASME Section IX may be substituted for these requirements.

3.6.28 Wood

Wood SSCs, including items such as stairs, ladders, railing, and anchorage to wood, shall comply with IBC 2015 and the National Design Specification for Wood Design (NDS) requirements.

3.7 Foundations
(5.1.4, 5.1.6, 5.1.7)

The potential adverse effects of frost heave and movements resulting from expansive soils shall be considered in the design.

The design frost depth is 24 inches.

Foundations shall comply with the IBC and ACI 318.

Heavy vibration producing equipment, such as high-pressure air compressors, chillers, fire pumps, and engine/generator sets, shall have separate, isolated foundations or use vibration isolators.

All shoring and underpinning shall comply with the safety requirements of WAC 296-155, Part N and DOE-0344.

Tiebacks analysis of plastic yielding in strutted excavations, analysis of the stability of the bottom of excavations, and shoring for deep excavations shall comply with Scaffolding Shoring and Forming Institute (SSFI)-SH300.

Remedial underpinning shall be performed where existing foundations are inadequate. Precautionary underpinning shall be performed where new construction adjacent to an existing structure requires deeper excavation.

Concrete slab-on-ground foundations are not required to extend to frost depth where used for anchoring of mobile offices and similar type structures. In accordance with ASCE 32 Sections 4.1 and 4.2 (as referenced by IBC Section 1809), foundations placed on non-frost-susceptible undisturbed ground or fill, as defined by a geotechnical engineer, do not require extension below frost depth or protection from freezing. Numerous soils reports for areas across the Hanford site have stated that foundations are not susceptible to frost heave due to the low water-table and low moisture content. Supporting slabs-on-ground should be designed to resist the bearing and anchor uplift forces according to the flexural design requirements of ACI 318.
3.8 **Subsurface Investigations**

(5.1.4, 5.1.6, 5.1.7)

RPP-RPT-27570 provides detailed soil classification and shear wave velocity for the Double-Shell tank farms.

Subsurface investigations shall be made for all new NDC-2 and NDC-3 structures located outside the double shell tank farms. Subsurface conditions shall be determined by means of boreholes or other methods that adequately disclose soil and groundwater conditions. Data and other information obtained from prior subsurface investigations shall be used, supplemented by additional investigations at the specific location as deemed necessary by the structural engineer.

Subsurface investigations shall be performed under the direction of a qualified soils engineer, licensed by the state to practice as such. Appropriate geological investigations shall be made to determine the contribution of the foundation (subsurface) to the earthquake loads imposed on the structure and shall include, but not be limited to, a recommendation of foundation type, determinations of allowable soil bearing design capacity, and the possible effects of seismic activity on the soil mass. A settlement analysis under differential design loads shall be performed where differential settlement may cause structural or architectural damage.

3.9 **Site Drainage**

(5.1.4)

Storm drainage systems shall be designed following the core elements defined in the latest edition of the Washington State Department of Ecology (WSDOE) 04-10-076, “Stormwater Management Manual for Eastern Washington.” The Hydrologic Analysis and Design shall be completed based on the following criteria: Washington, Region 2, Benton County; SCS Type 1A – 24 Hour storm for storm volume with a 25-year return period.

The flow-rate of the storm drainage system shall be designed using the 2-year, 3-hour short duration Eastern Washington Storm for pipe and inlet sizing using SCS or Santa Barbara method; no modifying or adding time of concentration; no surcharging of pipes or structures allowed.

Calculations shall include a profile of the system showing the hydraulic grade line. The calculations should include the representative drainage area into the system with the appropriate runoff coefficients.

4.0 **DEFINITIONS**

**Anchorage.** A device or a collection of devices that provide structural support or restraint for systems and components to prevent falling, sliding, overturning, and excessive displacement.

**Design basis ashfall.** The volcanic ashfall chosen as the basis for the design of structures.

**Design basis earthquake.** The earthquake ground motion chosen as the basis for the design of structures.

**Design basis wind.** The wind velocity chosen as the basis for the design of structures.
Facility. One or more building(s) or structure(s), including systems and components, dedicated to a common function (includes operating and non-operating facilities and facilities slated for decontamination and decommissioning).

Interaction. The potential damage and failure of structures, systems, and components because of both direct natural phenomena hazard effects and response of adjacent structures, systems, and components.

Natural phenomena hazard. An act of nature (e.g., earthquake, wind, tornado, flood, precipitation, volcanic eruption, or lightning strike) that poses a threat or danger to workers, the public, or to the environment by potential damage to structures, systems, and components.

Non-permanent. SSCs used for SST retrieval, closure and facility deactivation that do not meet the definition of a temporary structure, but may be categorized and designed with the NDC-0 designation, (Formerly described as PC-1M) as described in RPP-16643 Rev. 1.

Response Spectrum. A curve calculated from an earthquake accelogram that gives the value of peak response in terms of acceleration, velocity, or displacement of a damped linear oscillator, with a given damping ratio, as a function of its period, or frequency of vibration.

Structures, systems, and components. A structure is an element or a collection of elements to provide support or enclosure (e.g., a building, freestanding tank, basins, dikes, or stacks). A system is a collection of components assembled to perform a function (e.g., piping, cable trays, conduits, or HVAC). A component is an item of equipment (e.g., a pump, valve, or relay, or an element of a larger array such as a length of pipe, elbow, or reducer).

Temporary structure. Temporary structure (e.g., a tent, platform, engineered scaffolding etc.) erected for a period of less than 180 days per IBC Section 3103 requirements.

5.0 SOURCES

5.1 Requirements


5.1.2 DOE O 252.1A, “Technical Standards Program.”

5.1.3 DOE O 420.1C, “Facility Safety.”

5.1.4 DOE-STD-1020-2016, “Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities.”

5.1.5 DOE STD-1189-2016, “Integration of Safety into the Design Process.”

5.1.6 IBC 2015, “International Building Code” until June 30, 2020. IBC 2018 is anticipated to become effective on July 1, 2020. (Note: all codes identified in IBC applicable by reference.)

5.1.7 Codes and Standards in accordance with DOE O 420.1C Attachment 1, Contractor Requirements Document, Section 1.e.
5.1.8 Tank Operations Contract No. DE-AC27-08RV14800, as modified, Attachment J.2, Requirement Sources and Implementing Documents.

5.1.9 TFC-ESHQ-FP-STD-02, “Fire Protection Design Criteria.”

5.2 References

5.2.1 10 CFR 830, “Nuclear Safety Management.”

5.2.2 20 CFR 1910, “Occupational Safety and Health Standards.”

5.2.3 29 CFR 1926, “Safety and Health Regulations for Construction.”

5.2.4 AASHTO LRFD, “AASHTO LRFD Bridge Design Specifications.”


5.2.6 ACI 301, “Specifications for Structural Concrete.”

5.2.7 ACI 307, “Code Requirements for Reinforced Concrete Chimneys.”

5.2.8 ACI 318, “Building Code Requirements for Structural Concrete.”

5.2.9 ACI 349, “Code Requirements for Nuclear Safety-Related Concrete Structures and Commentary.”

5.2.10 ACI 350, “Code Requirements for Environmental Engineering Concrete Structures.”

5.2.11 ACI 355.2, “Qualifications of Post-Installed Mechanical Anchors in Concrete.”

5.2.12 ACI 355.4, “Qualification of Post-Installed Adhesive Anchors in Concrete.”

5.2.13 AGS-G001, “Guideline for Gloveboxes.”

5.2.14 AGS-G006, “Standard of Practice for the Design and Fabrication of Nuclear Application Gloveboxes.”

5.2.15 AISC 325, “Steel Construction Manual.”

5.2.16 AISC 360, “Specification for Structural Steel Buildings.”

5.2.17 AISC N690, “Specification for Safety-Related Steel Structures for Nuclear Facilities.”

5.2.18 AISI S100, “North American Specification for the Design of Cold Formed Steel Structural Members.”


5.2.21 API STD 620, “Design and Construction of Large, Welded, Low-Pressure Storage Tanks.”

5.2.22 API STD 650, “Welded Steel Tanks for Oil Storage.”

5.2.23 AREMA “Manual for Railway Engineering.”

5.2.24 ASCE 4, “Seismic Analysis of Safety-Related Nuclear Structures.”


5.2.26 ASCE 19, “Structural Applications of Steel Cables for Buildings.”

5.2.27 ASCE 10, “Design of Latticed Steel Transmission Structures.”

5.2.28 ASCE 32, “Design and Construction of Frost-Protected Shallow Foundations”

5.2.29 ASCE 37, “Design Loads on Structures During Construction.”

5.2.30 ASCE 37, “Design Loads on Structures During Construction.”


5.2.32 ASCE 48, “Design of Steel Transmission Pole Structures.”

5.2.33 ASCE 41180, “Wind Loads for Petrochemical and Other Industrial Facilities.”


5.2.37 ASME Section IX, “ASME Boiler and Pressure Vessel Code Section IX Welding and Brazing Qualifications.”

5.2.38 ASME STS-1, “Steel Stacks.”


5.2.40 ASTM A615, “Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.”

5.2.41 ASTM A706, “Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.”

5.2.43 ASTM E580, “Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions.”

5.2.44 AWS D1.1, “Structural Welding Code - Steel.”


5.2.46 AWS D1.3, “Structural Welding Code - Sheet Steel.”

5.2.47 AWS D1.4, “Structural Welding Code – Steel Reinforcing Bars.”

5.2.48 AWS D1.6, “Structural Welding Code - Stainless Steel.”

5.2.49 AWS D9.1, “Sheet Metal Welding Code.”

5.2.50 AWS D14.1, “Specification for Welding of Industrial and Mill Cranes and Other Material Handling Equipment.”

5.2.51 AWWA D100, “Welded Carbon Steel Tanks for Water Storage.”

5.2.52 DOE-0344, “Hanford Site Excavating, Trenching, and Shoring Procedure.”

5.2.53 DOE O 413.3B, “Program and Project Management for the Acquisition of Capital Assets.”

5.2.54 DOE/RL-92-36, “Hanford Site Hoisting and Rigging Manual.”

5.2.55 DOE-STD-1090, “Hoisting and Rigging.”

5.2.56 DOE-STD-3009, “Preparation of Nonreactor Nuclear Facility Documented Safety Analysis Reports.”

5.2.57 EO 11988, “Floodplain Management.”

5.2.58 EO 13717, “Establishing a Federal Earthquake Risk Management Standard.”

5.2.59 HNF-14755, “Documented Safety Analysis.”

5.2.60 HNF-SD-GN-DGS-30006, “Guidelines for Assessing the Seismic Adequacy of Existing Performance Category Equipment at the Hanford Site.”

5.2.61 HNF-SD-GN-ER-501, “Natural Phenomena Hazards, Hanford Site, South Central Washington.”

5.2.62 MBMA, “Metal Building Systems Manual.”


5.2.64 NFPA 22, “Standard for Water Tanks for Private Fire Protection.”

5.2.66 NFPA 225, “Model Manufactured Home Installation Standard.”

5.2.67 NFPA 780, “Standard for the Installation of Lightning Protection Systems.”


5.2.69 PNNL-23361, “Hanford Sitewide Probabilistic Seismic Hazard Analysis.”

5.2.70 RPP-7933, “Radiological Containment Selection, Design & Specification Guide.”

5.2.71 RPP-8360, “Lifting Attachment and Lifted Item Evaluation.”

5.2.72 RPP-8728, “Prioritization of Natural Phenomena Hazard Evaluations for CHG Facilities.

5.2.73 RPP-13033, “Tank Farms Documented Safety Analysis.”

5.2.74 RPP-16643, “Seismic Requirements Protocols for Non-Permanent Tank Farm Equipment.”

5.2.75 RPP-40736, “Freight Container Lifting Standard.”


5.2.77 RPP-RPT-47003, “Temporary Structures Wind Tie-Down Guide.”

5.2.78 SDI DDM04, “Diaphragm Design Manual.”

5.2.79 SDI FDDM, “Floor Deck Design Manual.”

5.2.80 SDI RDDM, “Roof Deck Design Manual.”

5.2.81 SSFI SH300, “Standards for Testing and Rating Shoring Equipment.”

5.2.82 SDI-Publ. 31, “Design Manual for Composite Decks, Form Decks and Roof Decks.”

5.2.83 SDI-Publ. DDM03, “Diaphragm Design Manual.”

5.2.84 SSFI-SH300, “Safe Practices for Erecting and Dismantling of Frame Shoring.”

5.2.85 Steel Joist Institute, “Standard Specifications and Load Tables and Weight Tables for Steel Joists and Joist Girders.”

5.2.86 TFC-ESHQ-S-STD-30, “Implementation of DOE-0344, Hanford Site Excavating, Trenching and Shoring Procedure (HSETSP).”

5.2.87 TFC-ENG-FACSUP-C-10, “Control of Dome Loading and SSC Load Control.”
5.2.88  TFC-ENG-FACSUP-C-25, “Hoisting and Rigging.”

5.2.89  TFC-ENG-STD-02, “Environmental/Seasonal Requirements for TOC Systems, Structures, and Components.”


5.2.91  TFC-ENG-STD-22, “Piping, Jumpers, and Valves.”


5.2.93  TFC-OPS-MAINT-C-15, “Use, Control, and Maintenance of Elevated Platforms and Stairs.”

5.2.94  TIA-222, “Structural Standards for Antenna Supporting Structures and Antennas.”

5.2.95  TMS 402, “Building Code for Masonry Structures.”

5.2.96  TMS 602, Specifications for Masonry Structures.”

5.2.97  UL 1316, “Standard for Fibre Reinforced Underground Tanks for Flammable and Combustible Liquids.”


5.2.99  WAC 296-150F, “Factory-Built Housing and Commercial Structures.”


5.2.102 WHC-SD-GN-ER-30009, “Bibliography and Summary of Geotechnical Studies at the Hanford Site.”

5.2.103 WHC-SD-GN-ER-30038 “Volcanic Ashfall Loads for the Hanford Site, Washington River Protection Solutions, Richland, Washington.”

Figure 1. Design Criteria Implementation.

- **Is SSC new or existing?**
  - **New**: Design structures and anchorage of systems and components in accordance with Section 3.0 of this document.
  - **Existing**: Evaluate structures and anchorage of systems and components in accordance with Section 3.0 of this document.

- **Have evaluation criteria been met?**
  - **No**: Consider easy upgrades to remedy deficiencies.
  - **Yes**: Re-evaluate in accordance with section 3.3.1 of this document at half the NPH return period (twice the Annual Exceedance Probability).

- **Have evaluation criteria been met?**
  - **No**: Conduct more rigorous evaluation.
  - **Yes**: Strengthen SSC to meet design criteria.

**Key:**
- **NPH**: Natural phenomenon hazards
- **SSC**: Structures systems and components
# Table 1. Safety and Natural Phenomena Design Category.

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Reactor or PSO designated</th>
<th>Hazardous or Essential Non-Reactor Facility</th>
<th>General Facilities</th>
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<td>HC-1</td>
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<td>HC-3</td>
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Categorizing the Hazard as depicted above does not directly influence the safety classification process nor the category.

<table>
<thead>
<tr>
<th>Structures, Systems, Components, Safety Designation and Mitigating Features</th>
<th>Safety Class (3)</th>
<th>Safety Significant (3)</th>
<th>General Services</th>
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<tr>
<td>Performs or preserves reactor safety function</td>
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<tr>
<td>Prevents or mitigates rad. consequences above risk guidelines to:</td>
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<td>Prevents or mitigates toxic chemical or on-site rad. consequences above risk guidelines to:</td>
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<td>Worker safety. Prevents or mitigates serious injury not controlled by ISP (4) to:</td>
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<td>See Note 10 and Table 2</td>
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<tr>
<th>NDC Design Basis Return Periods</th>
<th>No Goal</th>
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</table>

NOTES:
1. DOE Program Secretarial Officer (PSO) may designate a facility to a higher Natural Phenomena Design Category (NDC).
2. Hazard category (HC) for nuclear facilities per 10 CFR 830 drives the level and rigor of DSA analysis and its references.
3. Safety class and safety significant classification as defined in the DSA.
4. Institutional safety provisions (ISP) protecting against standard industrial hazards per DOE-STD-3009.
5. Natural Phenomena Design goal and NDC per DOE-STD-1020-2016.
6. Evaluate all “Design Features” on an individual basis to determine Natural Phenomena Design Category.
8. The NDC-0 designation is a TOC-specific designation and is used in accordance with the requirements of this standard for non-permanent SST tank farm retrieval or closure SSCs.
9. NDC-3 applies to Safety Significant SSCs that prevent/mitigate off-site chemical doses and on-site worker doses/exposures above 100 rem, in accordance with the requirements of DOE-STD-1020-2002 Section 2.3.3 and Table 4-1.
10. The Target Performance Goals (TPGs) for various categories applicable for all NPHs were given in DOE-STD-1020-2002. DOE-STD-1020-2016 design basis return periods (DBRPs) were selected separately for each of the various NDCs to account for the uncertainties in these hazard and demand estimates to achieve the same TPGs. These are shown in Table 2.
Table 2. Design Basis Return Periods.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Category (Obsolete Designation - DOE-STD-10-1020-2002 Table B-1)</td>
<td>PC-4</td>
<td>PC-3</td>
<td>PC-2</td>
<td>PC-1</td>
</tr>
<tr>
<td>Performance Goal (return period – years)</td>
<td>$1 \times 10^{-5}$ (100,000)</td>
<td>$1 \times 10^{-4}$ (10,000)</td>
<td>$5 \times 10^{-4}$ (2000)</td>
<td>$1 \times 10^{-3}$ (1000)</td>
</tr>
<tr>
<td>Natural Phenomena Design Category (DOE-STD-10-1020-2016)</td>
<td>NDC-5</td>
<td>NDC-4</td>
<td>NDC-3</td>
<td>NDC-2</td>
</tr>
<tr>
<td>Seismic Design Category</td>
<td>SDC-5</td>
<td>SDC-4</td>
<td>SDC-3</td>
<td>SDC-2</td>
</tr>
<tr>
<td>Targeted Performance Goal (return period - years)</td>
<td>$1 \times 10^{-5}$ (10,000)</td>
<td>$4 \times 10^{-5}$</td>
<td>$1 \times 10^{-4}$ (2500)</td>
<td>See Note 3</td>
</tr>
<tr>
<td>Hazard Exceedance Probability (return period - years)</td>
<td>$1 \times 10^{-4}$ (2500)</td>
<td>$4 \times 10^{-4}$ (2500)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extreme Straight-Line Wind Design Category</td>
<td>WDC-5</td>
<td>WDC-4</td>
<td>WDC-3</td>
<td>WDC-2</td>
</tr>
<tr>
<td>Design Basis Return Period - Years</td>
<td>See Note 6</td>
<td>6250</td>
<td>2500</td>
<td>See Note 5</td>
</tr>
<tr>
<td>Flooding Design Category</td>
<td>FDC-5</td>
<td>FDC-4</td>
<td>FDC-3</td>
<td>FDC-2</td>
</tr>
<tr>
<td>Design Basis Return Period - Years - Safety SSCs Exposed to Submersion</td>
<td>See Note 6</td>
<td>25,000</td>
<td>10,000</td>
<td>2000</td>
</tr>
<tr>
<td>Return Period Years - Safety SSCs Not Exposed to Submersion</td>
<td>See Note 6</td>
<td>6250</td>
<td>2500</td>
<td>200</td>
</tr>
<tr>
<td>Precipitation Design Category</td>
<td>PDC-5</td>
<td>PDC-4</td>
<td>PDC-3</td>
<td>PDC-2</td>
</tr>
<tr>
<td>Return Period Years - Design Basis Precipitation Flooding</td>
<td>See Note 6</td>
<td>25,000</td>
<td>10,000</td>
<td>2000</td>
</tr>
<tr>
<td>Return Period Years - Design Basis Precipitation Structural Loads</td>
<td>See Note 6</td>
<td>6250</td>
<td>2500</td>
<td>200</td>
</tr>
<tr>
<td>Volcanic Eruption Design Category</td>
<td>VDC-5</td>
<td>VDC-4</td>
<td>VDC-3</td>
<td>VDC-2</td>
</tr>
<tr>
<td>Return Period Years - Volcanic Ashfall Structural Loads</td>
<td>10,000</td>
<td>6250</td>
<td>2500</td>
<td>200</td>
</tr>
<tr>
<td>Return Period Years - Volcanic Ashfall Non-Structural Failures (See Note 7)</td>
<td>100,000</td>
<td>25,000</td>
<td>10,000</td>
<td>2000</td>
</tr>
</tbody>
</table>

NOTES
1. There are no “PC-0” or other “-0” categories used after DOE-STD-1020-2002. The NDC-0 category is not defined in DOE-STD-1020, but is a TOC-specific designation. See related sections of this standard for design requirements.
2. Not explicitly specified but is the same as that achieved for IBC-2015 for Risk Category II, $I_p = 1.0$ (ASCE 7-10), for Limit States A, B, C, or D.
3. Not explicitly specified but is the same as that achieved for IBC-2015 for Risk Category IV, $I_p = 1.5$ (ASCE 7-10) with response coefficients for Limit States B, C, or D.
4. Not explicitly specified but is the same as that achieved for IBC-2015 for Risk Category II (ASCE 7-10)
5. Not explicitly specified but is the same as that achieved for IBC-2015 for Risk Category IV (ASCE 7-10)
7. Non-Structural failures include those such as filter clogging and other mechanical or electrical malfunction.
![Table 3. Wind Load.](image)

<table>
<thead>
<tr>
<th>Basic Straight Wind Design Speed (3-Second Gust), V</th>
<th>WDC-3</th>
<th>WDC-2</th>
<th>WDC-1/ NDC-0(e)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal(a)(c)</td>
<td>95 mi/h</td>
<td>91 mi/h</td>
<td>85 mi/h</td>
</tr>
<tr>
<td>Ultimate(b)(c)</td>
<td>122 mi/h</td>
<td>115 mi/h</td>
<td>110 mi/h</td>
</tr>
<tr>
<td>Exposure Category</td>
<td>C(d)</td>
<td>C(d)</td>
<td>C(d)</td>
</tr>
</tbody>
</table>

NOTES:

(a) For use with IBC 2009, ASCE 7-05, and other compatible codes and standards, including the exceptions of IBC 2015, Section 1609.1.1.

(b) For use with IBC 2015, ASCE 7-10, and other compatible codes and standards.

(c) Conversion of Nominal Wind speed to Ultimate Wind Speed (Basic Wind Speed ASCE 7-10 corresponds to the rounded value from the following relationship: $V_{asd} = V_{ult} \sqrt{0.6}$ (IBC 2015 Equation 16-33).

(d) Exposure “C,” flat and generally open terrain, should be used for all construction unless it can be shown that the necessary permanent shielding will be provided by natural terrain (not including shielding from trees or adjacent buildings).

(e) NDC-0 SSCs shall be designed for WDC-1 wind loading. Wind loads on temporary SSCs erected for a period of less than 180 days, and Construction Project SSCs may be designed to a reduced basic straight wind design speed, provided wind damage to the structure:

1. Will not result in injury to personnel.
2. Will not result in damage to permanent SSCs.
3. Will not result in significant cost to repair or replace the temporary structure.

The reduced basic straight wind design speed shall be based on ASCE 37, but should not be less than 82 mi/h (ultimate)/64 mi/h (nominal) for a 3-Second Gust.

(f) The WDC-3 wind loading of 122 mph is determined from ANSI/ANS-2.3 Figure 4 for Region III wind hazard Site at return period of 2500 years. There are no requirements for extreme wind missile design at the Hanford Site. This is based on the PWHA site specific wind speed for WDC-3 of 96 mph, which is less than the 110 mph missile criteria of DOE-STD-1020-2016.
Table 4. Anchorage of Equipment.

<table>
<thead>
<tr>
<th>DOE-STD-1020 Natural Phenomena Design Category</th>
<th>NDC-3</th>
<th>NDC-2</th>
<th>NDC-1</th>
<th>NDC-0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent Equipment</td>
<td>(1)</td>
<td>(1)</td>
<td>(1)</td>
<td>N/A</td>
</tr>
<tr>
<td>Temporary or Non-permanent Equipment</td>
<td>(1)</td>
<td>(2)</td>
<td>(2)(3)(4)</td>
<td>(3)</td>
</tr>
</tbody>
</table>

1. Equipment shall be anchored to resist overturning, sliding, and possible floating. Equipment anchorage shall be designed to resist the total design lateral force without benefit from the use of friction that results from gravity loads. Friction that results from overturning forces or from clamping forces may be used. Anchorage for NDC-1 and NDC-2 equipment, whose failure would cause a life hazard or compromise safe access or egress from the facility, shall be designed by using the methods (and the importance factor of 1.5) in the IBC for Risk Category IV. NDC-1 mechanical and electrical components whose failure does not cause a life hazard or compromise safe access or egress from the facility are exempt from anchorage requirements if either: (1) flexible connections between the components and associated ductwork, piping, and conduit are provided; or (2) components are mounted at 4 feet or less above a floor level and weigh 400 pounds or less. The evaluation shall be documented.

2. The NDC-1 and NDC-2 equipment whose failure would cause a life hazard or compromise safe access or egress from a facility shall be anchored, restrained, or shown to be stable such that the equipment item would not overturn, slide, or float. Anchorage of equipment whose failure would cause a life hazard or compromise safe access or egress shall be designed by using the methods (and the importance factor of 1.5) in the IBC for Risk Category IV. Items shown by analysis not to be vulnerable to overturning shall be restrained from sliding, unless it can be shown by analysis that the lateral movement of the item is acceptable. Items shown by analysis as not vulnerable to overturning and whose lateral movement has been shown to be acceptable may be unrestrained. The maximum lateral movement should be estimated and included in the design of rattle space (space allowed for motion such as sliding) and utility connections. NDC-1 mechanical and electrical components whose failure does not cause a life hazard or compromise safe access or egress from the facility are exempt from anchorage and restraint requirements if either: (1) flexible connections between the components and associated ductwork, piping, and conduit are provided; or (2) components are mounted at 4 feet or less above a floor level and weigh 400 pounds or less. The evaluation shall be documented.

3. Non-permanent equipment, piping, and structures used for SST tank farm retrieval, closure and facility deactivation (NDC-0) require design to WDC-1 wind load as a minimum, including overturning due to wind. Temporary structures erected for a period of less than 180 days may be designed to a reduced loading as described in the Table 3 notes. These items generally do not require design for seismic loading, however overturning due to seismic should be considered if this load case would control over wind load due to the item’s weight and configuration. Consult the Engineering Discipline Lead for application requirements for specific or unusual tasks.

Generally, overturning due to seismic activity will occur if the ratio of the vertical distance to the equipment center of gravity to the shortest horizontal distance from an edge of the equipment to its center of gravity is greater than 2.8. If this ratio is exceeded, restraints are needed. Equipment that will contain waste also require evaluation for project-specific safety or hazard analysis requirements. For further information, consult RPP-16643. Equipment installed on skids (such as pumps, tanks, junction boxes) shall meet manufacturer’s requirements for attaching to the skid.

4. NDC-1 equipment that does not pose a threat to life safety is exempt from anchorage or restraint requirements. However, the expense or procurement time to replace damaged equipment should be considered in the decision to have the equipment unanchored.
### Table 5. Structural Precipitation Loads – Snow.

<table>
<thead>
<tr>
<th>PDC</th>
<th>Design Requirement DOE-STD-1020-2016</th>
<th>Snow Load</th>
</tr>
</thead>
</table>
| PDC-1| IBC 2015/ ASCE 7-10 for Risk Category II                                                         | \( P_g = 15 \text{ psf} \)  
  \( I = 1.0 \)                                                             |
| PDC-2| IBC 2015/ ASCE 7-10 for Risk Category IV                                                          | \( P_g = 15 \text{ psf} \)  
  \( I = 1.2 \)                                                             |
| PDC-3| NUREG-0800 2.3.1: Use the 100-year snowpack at ground level, plus the weight of the 48-hour probable maximum winter precipitation at ground level. | With Normal Load Combinations  
  \( P_g = 15 \text{ psf} \)  
  \( I = 1.2 \)  
  And  
  With Extreme Load Combinations  
  (See note 1)  
  Contact the Civil/Structural Engineering Design Lead for specific design requirements |

1) This live load is to be included in Extreme Environmental and Abnormal Load Combinations (as defined in ANSI/AISC N690 and ACI 349) in accordance with NUREG-0800 2.3.1 requirements.
### Table 6. Response Modification Coefficients for Seismic Design of SDC-1 and SDC-2
(Source DOE-STD-1020-2016 Table 3-1).

<table>
<thead>
<tr>
<th>SDC</th>
<th>Limit State</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDC-1</td>
<td>Use Risk Category II I = 1.0 R_a = R (See Note 3)</td>
<td>ASCE 7-10 Use Risk Category II I = 1.0 R_a = R / 1.25 R_a ≥ 1.2</td>
<td>ASCE 7-10 Use Risk Category II I = 1.0 R_a = R / 1.5 R_a ≥ 1.2</td>
<td>ASCE 7-10 Use Risk Category II I = 1.0 R_a = 1.2</td>
<td></td>
</tr>
<tr>
<td>SDC-2</td>
<td>N/A</td>
<td>ASCE 7-10 Use Risk Category IV I = 1.5 R_a = R (See Note 3)</td>
<td>ASCE 7-10 Use Risk Category IV I = 1.5 R_a = R / 1.2 R_a ≥ 1.2 (See Note 3)</td>
<td>ASCE 7-10 Use Risk Category IV I = 1.5 R_a = 1.2</td>
<td></td>
</tr>
</tbody>
</table>

**NOTES:**

1. This table is used to design SDC-1 and SDC-2 SSCs with various safety functions requiring limit states A, B, C, or D, when SDC-1 and SDC-2 SSCs are designed with ASCE 7-10 (which is invoked by IBC 2015).

2. ASCE 7-10 requires the use of R, the Response Modification Coefficient (ASCE 7-10 Tables 12.2-1, 12.14-1, 15.4-1, and 15.4-2). R_a, the Actual (reduced) Response Modification Coefficient, is to be used in the design, and is substituted for the R values given in ASCE 7-10. The use of the R_a values in conjunction with I, the Importance Factor (ASCE 7-10, Table 1.5-2), accounts for the difference between the limit states achieved by ASCE 7-10 and the limit states A, B, C, and D, as defined in ANSI/ANS-2.26-2004 and ASCE 43-05.

3. For SDC-1 SSCs, generally Limit State A is appropriate. For SDC-2 SSCs, generally Limit State B is appropriate, except where radioactive or hazardous material is present use Limit State C. Refer to ANSI/ANS-2.26-2004, Section 5 for guidance on choosing alternative Limit States.
Table 7. Design Basis Precipitation Loads

<table>
<thead>
<tr>
<th>Precipitation Design Category</th>
<th>Return Period/Annual Exceedance Probability</th>
<th>Amount (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDC-1</td>
<td>500/2 x 10^{-3}</td>
<td>1.8</td>
</tr>
<tr>
<td>PDC-2</td>
<td>2000/5 x 10^{-4}</td>
<td>2.5</td>
</tr>
<tr>
<td>PDC-3</td>
<td>10,000/1 x 10^{-4}</td>
<td>4.0</td>
</tr>
</tbody>
</table>