1.0 PURPOSE AND SCOPE

(5.1.1)

This standard identifies the climatological conditions of the Hanford Site to be addressed in the design of facilities, systems, structures, and components (SSCs) under the responsibility of the Tank Operations Contractor (TOC) and establishes requirements for winterization/summerization of SSCs to provide protection from expected seasonal changes.

This information applies to any new facility design, existing facility addition and alteration, new equipment, systems and structures supporting facility operation and modification to existing equipment systems and structures in the Hanford 200 Areas, under the responsibility of the TOC.

This standard does not include climatological conditions for use in heating, ventilation and air conditioning (HVAC) system equipment sizing calculations and design. Use TFC-ENG-STD-07 for the design of new ventilation systems or significant modification of existing ventilation systems.

The meteorology data apply to the design of SSCs that are exposed to the outdoor environment unless temperature controls are implemented or other temperatures are specified in governing codes or standards (e.g., ASHRAE). Safety significant SSC temperatures are expected to be maintained above the minimum design temperatures, e.g., freeze protection. If the temperature drops below the minimum design temperature, the SSC shall be tested to ensure it still performs its safety function.

The technical basis for the requirements in this standard and approved deviations can be found in RPP-RPT-28513, "Technical Basis for TFC-ENG-STD-02, Environmental/Seasonal Requirements for TFC Systems, Structures, and Components."

2.0 IMPLEMENTATION

(5.1.5)

This standard is effective on the date shown in the header. Responsible engineers should review on-going designs to ensure that they meet the requirements of this standard.

NOTE: Deviations to any requirements of this standard shall be requested from the standard document owner. Approved clarifications and deviations shall be documented for implementation in this standard after approval of this document.

3.0 STANDARD

3.1 CLIMATOLOGICAL CONDITIONS

Sections 3.1.1 through 3.1.8 provide key climatological data for the Hanford Site to be used for the design of SSCs within TOC facilities based on their performance categories. These data are to be used in conjunction with the design loads required by TFC-ENG-STD-06 to ensure that facilities and SSCs will be compatible with expected Hanford Site environmental conditions. The data presented in Sections 3.1.1 through 3.1.8 are obtained from PNNL-15160, "Hanford Site Climatological Summary with Historical Data," and HNF-SD-GN-ER-501, "Natural Phenomena Hazards, Hanford Site, Washington." The data presented herein are the key data to be considered in SSC design in accordance with TFC-ENG-DESIGN-C-62, "Qualifying and/or Using Existing

Data." More detailed information is provided in PNNL-15160. The outside air temperatures are to be adjusted accordingly for SSCs that are located within buildings and structures, or otherwise insulated. Data is provided for:

- Temperature
- Precipitation
- Winds
- Psychrometric data
- Thunderstorms, dust, and glaze
- Solar radiation
- Atmospheric pressure
- Ashfall airborne concentration.

TFC-ENG-STD-07 environmental/seasonal design conditions shall be used for HVAC system equipment sizing or load calculations and system design.

3.1.1 Temperature

(5.1.2, 5.1.4)

The highest temperatures are experienced in July and August, with the observed maximum of 113°F. The lowest temperatures are experienced in January and February, with the observed minimum of -23°F.

Tank Farm SSCs in all performance categories shall be designed to operate in an ambient temperature range of 115°F to -25°F:

Design Basis Air Temperatures*

Maximum (°F)	Minimum (°F)
115	-25

* The indicated minimum and maximum ambient air temperatures apply to the design of SSCs that are exposed to the outdoor environment unless temperature controls are implemented or other temperatures are specified in governing codes or standards (e.g., ASHRAE).

The monthly average differences between daily maximum and minimum temperatures show that a much greater range of temperatures is experienced in the summer months than in the winter months. Tank Farm SSCs shall be designed to withstand a maximum daily temperature range of 50°F. Diurnal temperature variations may be used for the design.

Subsurface temperature for frost and freeze protection of buried SSCs shall be provided in accordance with appropriate current codes and consensus standards. For example, IBC 2012, *International Building Code*, contains requirements for frost protection of building foundations. UPC 2009, *Uniform Plumbing Code*, addresses freeze protection for water supply piping. These code requirements refer to the local average frost depth or frost line, which is established in Benton County as 24 inches (Benton County, WA 2012, Climatic and Geographic Design Criteria).

The monthly average maximum and minimum subsurface soil temperatures and the absolute hourly extreme temperatures are reported in PNNL-15160. For purposes other than frost heave and pipe freeze protection (above), SSCs in all performance categories shall be designed for operation with subsurface temperatures based on the hourly extreme subsurface soil temperatures recorded at depths of 15 and 36 inches as shown in the following table. The values at 0.5 inch may be used for consideration of a reflective surface, but have no value for facility structures that may be placed on grade (which requires some amount of stabilization, i.e., grading, backfill and/or compaction, prior to placement) or below grade which requires some amount of excavation and stabilization prior to construction. When designing below grade structures for thermal performance, site specific moisture content shall be considered along with the natural diurnal temperature variation. Thermal modeling may be performed in accordance with National Renewable Energy Laboratory publication NREL/TP-550-33954 ("A Model for Ground-Coupled Heat and Moisture Transfer from Buildings") or other models that considers parameters such as moisture content, porosity/compaction, soil (or backfill composition), and diurnal temperature variations.

Temperature Ranges for Subsurface SSC Operation

Depth	Design Temperature Range*
0.5 inches	160°F to -25°F (1)*
15 inches	95°F to 10°F
36 inches	87°F to 30°F (2)*

*

1. The maximum temperature, without heat island effect as described in NREL/TP-550-33954 above, is based on data from a site with no vegetation or shade and there is no verification that the probe was covered with 0.5 inches of soil during the high hourly readings. The soil is sandy and mixed with large gravel. The minimum temperature is considerably lower than the minimum recorded at this depth to accommodate the extreme differences in exposure and isolation at the Hanford Site.
2. For depth 36 inches and below, use the stated values unless it is determined by analysis or actual historical data, e.g., ARH-2983.

3.1.2 Precipitation

(5.1.4)

The annual average precipitation at the Hanford Meteorology Station is 7.0 inches. The wettest year on record was 1995, with 12.3 inches; the driest was 1976, with 3 inches. Historically, the months of November through February provide 3.64 inches (52%) of the normal annual precipitation. July and August are the driest months, each normally receiving only 0.27 inches.

Tank Farm SSCs shall be designed for the rainfall precipitation loads shown below:

Design Basis Precipitation Loads

Performance Category	Probability	Amount (in.)
1	2×10^{-3}	1.8
2	5×10^{-4}	2.5
3	1×10^{-4}	4.0

The average snowfall is 14.5 in. per year at the Hanford Site. The maximum snowfall was recorded at 15.6 in. in December of 1985. Tank Farm SSCs shall consider average for the snow loads given in TFC-ENG-STD-06.

3.1.3 Winds

(5.1.5)

The prevailing wind direction for every month of the year is either WNW or NW, and the peak gusts for every month are from the SSW, SW, or WSW. The highest monthly average wind speeds occur in June, the lowest in December. The variability in monthly average wind speeds is much greater in the winter months than during the remainder of the year. The ambient wind speeds are recommended as defined in ASHRAE Fundamentals Handbook for the Hanford Site HVAC design conditions. For SSCs, Performance Categories as defined in DOE-STD-1021 are recommended to be based on wind speeds mph corresponding to 1% (25.2 mph), 2.5% (21.0 mph), and 5% (18.6 mph) annual cumulative frequency of occurrence. SSCs classified as SS correspond to 1% wind speed (25.2 mph) condition for the Hanford Site.

TFC-ENG-STD-07 shall be used for stack dispersion model, HVAC process conditions, and equipment qualification.

Tank Farm SSCs shall be designed for the wind directions and wind loads, e.g., structure, supports, etc., given in TFC-ENG-STD-06.

3.1.4 Psychrometric Data

(5.1.4)

Psychrometric data include observations of dry bulb, wet bulb, dew point temperatures, and relative humidity. The annual mean relative humidity recorded at the HMS is 55%, with the highest average monthly relative humidity (80%) occurring in December and the lowest average monthly relative humidity (33%) occurring in July. Daily relative humidity can change 20% to 30% between early morning and late afternoon. Changes in relative humidity are less pronounced during the winter months (PNL-4622). Higher relative humidity can be expected at locations near the Columbia River and at some locations on the Hanford Site periphery where there is increased airborne water vapor from the Columbia River and from irrigated land.

The minimum and maximum ambient air temperature and relative humidity apply to the design of SSCs that are exposed to the outdoor environment unless other temperatures and relative humidities are specified in governing codes or standards (e.g., ASHRAE).

3.1.5 Thunderstorms, Dust, and Glaze

(5.1.4)

Tank Farm SSCs shall be designed for operation under the conditions specified below.

Thunderstorms occurred in every month of the year. The thunderstorm season is essentially from April through September, but thunderstorms can occur during any month of the year. The average number of thunderstorm days per year is 10.

The criterion for both dust and blowing dust is that horizontal visibility be reduced to 6 miles or less. Dust is carried into the area from a distant source and may occur without strong winds. Blowing dust occurs when dust is picked up locally and occurs with stronger winds. The average number of days per year with dust or blowing dust is 5. The greatest number of such days in any year was 20 in 1980 subsequent to the Mount St. Helens eruption. The greatest number of days with dust or blowing dust in any month was 9 in May 1980. SSCs subjected to dust shall be designed for a concentration of 0.177 g/m^3, with wind speeds of 18 m/s at a height of 3 m. Under these conditions, the bulk of the particles are likely to be less than 150 µm in size.

Glaze is a coating of ice formed when rain or drizzle freezes on contact with any surface having a temperature that is below freezing. The average number of days with freezing rain or freezing drizzle is 6. The highest number of days with glaze in any winter season was 18 during the winter of 1969-1970; the least, 1 day during the winter of 1987-1988 and earlier winters. The greatest number of such days in any single month was 9 in January 1970.

3.1.6 Solar Radiation

(5.1.4)

The highest daily solar radiation values (reported in Langleys) occur with a clear sky and clean air; the lowest commonly occur on days overcast with low stratus clouds. Tank Farm SSCs shall be capable of operation in a solar radiation environment of 900 Langleys (ASHRAE 2013, Chapter 14).

3.1.7 Atmospheric Pressure

(5.1.5)

The Hanford Meteorology Station atmospheric pressure is measured at an elevation of 733 feet; sea-level pressure is the station pressure adjusted to sea level. The highest sea-level pressure ever recorded at the Hanford Meteorology Station was 31.12 inches of mercury in January 1979; the lowest was 28.91 inches of mercury in December 2002. The greatest sea-level pressure change during a 1-day period was 1.02 inches of mercury (December 8, 1971). Tank Farm SSCs shall be designed to operate within these extremes.

3.1.8 Ashfall Airborne Concentration

(5.1.4)

Airborne ash concentrations include the combined effects of the initial ashfall event and ash resuspension. Safety-significant SSCs that must operate in an ash environment (e.g., double shell tank primary ventilation system fans and support systems) shall be designed for a total peak ashfall concentration of 1,325 mg/m^3 or shall use Figures 6 and 7 in HNF-SD-GN-ER-501 for total airborne ash concentration over time. RPP-RPT-58380, Ashfall Effects on Ventilation System HEPA Filters, shall be used for protecting systems and equipment from after effects of an eruption in the current tank farms ventilation system HEPA filters. (NOTE: Design ashfall loads are given in TFC-ENG-STD-06.)

3.2 SEASONAL (WINTERIZATION/SUMMERIZATION) REQUIREMENTS

The following facility and equipment-related requirements derive from DOE G 433.1-1A, Section III.N., "Seasonal Facility Preservation," and operational experience.

3.2.1 Cold Weather Protection

(5.1.3)

Cold weather protection measures shall be incorporated into design of new SSCs and modification of existing SSCs as applicable.

- Protect heating system power and temperature controls against inadvertent deactivation.
- Secure air intakes, windows, doors, and other access ways that could provide abnormal inflows of cold air. Functionally test automatically controlled systems of this type.
- Provide temperature alarms and/or automatic backup heat sources for systems that require or deserve special protection due to hazards or costs associated with freeze damage.
- Ensure the main water supply cutoffs for each facility are marked and readily accessible to emergency personnel responding to freeze/thaw incidents.
- Provide heat traced systems with power indication lights or temperature indication. Functionally test heat trace in accordance with manufacturer's guidance.
- Locate portable heaters away from sensitive instruments, and route the heating circuits separate from instrumentation. The switching of inductive loads in instrumentation cabinets has proven to cause instrumentation errors. The use of direct current (DC) heaters or self-regulating heat trace is preferable to alternating current (AC) heaters to reduce noise and interference.
- Provide heat trace, heaters, and/or insulation to protect against condensation as well as freezing, especially sample lines running from cabinet to cabinet.
- Consider over-sizing the ampacity of supply circuits to self-regulating heat trace. Damp and humid conditions in Hanford valve pits and the "campaign" approach to many Hanford projects cause these circuits to be left un-energized for long periods of time in damp locations. The initial inrush of current to "dry" these circuits may be considerably in excess of regular steady state current draw needed to maintain equilibrium.
- Provide protection to shield sensitive equipment from the elements.

The following requirements shall apply to cold weather protection of safety-significant SSCs.

- Ensure temperatures are maintained above the minimum design temperatures of safety-significant SSCs. If temperatures drop below the minimum design temperatures, evaluate or test the SSCs for damage and document the evaluation/test.
- Protect safety-significant waste transfer system SSCs from damage due to freezing by the following measures, unless a documented analysis shows there is no potential for freeze damage: draining; heat tracing or other heating system; and/or temperature monitoring. Provide freeze protection measures (from a documented analysis) when the minimum daily temperature is ≤ 32.0°F based on measurements at the Hanford Meteorological Station. If freeze damage is suspected, evaluate or test the waste transfer SSCs for

damage and document the evaluation/test. When design conditions or physical configuration of safety-significant waste transfer system SSCs are changed, evaluate the change and document the analysis.

NOTE 1: Safety-significant waste transfer system SSCs include waste transfer primary piping systems, isolation valves for double valve isolation, SS facility process and SS HVAC systems and instrumentation.

NOTE 2: Freeze protection is not required for hose-in-hose transfer lines and flexible non-metallic hoses, including their hose barb and Chemjoint connectors (see RPP-RPT-42153 and RPP-RPT-42297, respectively).

NOTE 3: Freeze protection requirements for safety-significant waste transfer system SSCs when physically connected to a waste transfer pump not under administrative lock are established by the tank farms technical safety requirements (see HNF-SD-WM-TSR-006). Freeze protection of safety-significant waste transfer systems at all other times is provided by TOC winterization/freeze protection requirements (i.e., safety basis defense-in-depth feature).

3.2.2 Hot Weather Protection

(5.1.3)

Hot weather protection measures shall be incorporated into design of new SSCs and modification of existing SSCs as applicable.

- Provide auxiliary cooling and/or plans for the safe shutdown of systems that require special protection from extremes of hot weather.
- Shield instrumentation displays and equipment labels that are susceptible to ultraviolet radiation from direct sunlight or place in a position protected from direct sunlight.
- Protect cooling system power and temperature controls against inadvertent deactivation.
- Place instrument cabinets on the north side of control trailers or in the shade.
- Provide sunshades over temperature sensitive cabinets to shield displays from direct sunlight, and to minimize the duty cycle of engineered cooling systems.
- Specify cabinets with an air gap between the back of the cabinet and instrument mounting plane. This provides insulation between exterior cabinet surfaces struck by solar radiation and the instruments.
- Specify separate instrument power supplies and repeaters to reduce instrument heat generation. Often devices such as Programmable Logic Controllers and Vector drives include DC power supplies for instrument loops. Use of separate, hardier DC power supplies, located away from these devices is preferable to minimize the internal heat produced by sensitive microprocessor equipment.
- Minimize the number of intermediate connectors on data buses (such as RS 232 or 485 protocols) connecting field instruments to remote operator control stations. These

connections increase network resistance, and therefore heat. Provide network repeaters to minimize strain on sensitive instruments.

- Specify Programmable Logic Controller carriages with extra "slots" and larger power supplies than anticipated for initial service needs. This allows the power supply to be less "taxed," provides for better heat dispersion, and allows future upgrade capability.

The following requirement shall apply to hot weather protection of safety-significant SSCs.

- Ensure temperatures do not exceed the maximum design temperatures of safety-significant SSCs. If temperatures exceed the maximum design temperatures, evaluate or test the SSCs for damage and document the evaluation/test.

4.0 DEFINITIONS

No terms or phrases unique to this standard are used.

5.0 SOURCES

5.1 REQUIREMENTS

1. DOE O 252.1A, "Technical Standards Program."
2. DOE O 420.1B, "Facility Safety."
3. DOE O 433.1B, "Maintenance Management Program for DOE Nuclear Facilities."
4. HNF-SD-GN-ER-501, Rev 2, "Natural Phenomena Hazards, Hanford Site, Washington."
5. RPP-RPT-28513, "Technical Basis for TFC-ENG-STD-02, Environmental/Seasonal Requirements for TOC Systems, Structures, and Components."

5.2 REFERENCES

1. ARH-2983, Soil Moisture Transport in Arid Site Vadose Zones.
2. ASHRAE, Fundamentals Handbook, 2013.
3. Benton County, WA 2012, Climatic and Geographic Design Criteria, http://www.co.benton.wa.us/pView.aspx?id=1606&catid=45.
4. DOE G 433.1-1A, "Nuclear Facility Maintenance Management Program Guide for Use with DOE O 433.1B," Section III.N., "Seasonal Facility Preservation."
5. HNF-SD-GN-ER-501, Rev 2 "Natural Phenomena Hazards, Hanford Site, Washington."
6. HNF-SD-WM-TSR-006, "Tank Farms Technical Safety Requirements."
7. IBC 2012, "International Building Code," 2012 Edition, International Code Council, Inc., Country Club Hills, Illinois, 2011, with errata posted through 08/11/2011.

8. NREL/TP-550-33954, "A Model for Ground-Coupled Heat and Moisture Transfer from Buildings."

9. PNNL-15160, "Hanford Site Climatology Summary 2004 with Historical Data," Pacific Northwest National Laboratory, Richland Washington, 2005.

10. RPP-RPT-42153, "Safety-Significant Hose-in-Hose Transfer Line (HIHTL) Systems – Functions and Requirements Evaluation Document."

11. RPP-RPT-42297, "Safety-Significant Waste Transfer Primary Piping Systems – Functions and Requirements Evaluation Document."

12. RPP-RPT-58380, "Ashfall Effects on Ventilation System HEPA Filters."

13. TFC-ENG-STD-06, "Design Loads for Tank Farm Facilities."

14. TFC-ENG-STD-07, "Ventilation System Design Standard."

15. TFC-ENG-DESIGN-C-62, "Qualifying and/or Using Existing Data."

16. UPC 2009, "Uniform Plumbing Code."