September 23, 2024

Oregon Department of Environmental Quality

700 NE Multnomah St, Suite 600

Portland, OR 97232

Re: Risk Mitigation Implementation Plan – PDX Fuel Facility

To Whom It May Concern:

Project Background

The purpose of this document is to provide a Risk Mitigation Implementation Plan (RMIP) of the structures being designed for the Portland International Airport (PDX) Fuel Facility in accordance with Or. Admin. R. section 340-300-0007. The PDX Fuel Facility is owned by Portland International Airport (PDX) and leased to and operated by PDX Fuel Company, LLC (PFC). The lease requires PFC to complete the Seismic Vulnerability Assessment (SVA) and subsequent Mitigation Planning for the PDX Fuel Facility. As updated in September of 2023, Chapter 99 of the State of Oregon Laws now mandates the following:

> An Owner or Operator of a bulk oils or liquid fuels terminal must conduct and submit to the Department of Environmental Quality (DEQ) a comprehensive seismic vulnerability assessment for the entire bulk oils or liquid fuel terminal.

PDX Fuel Facility is both a bulk oil and liquid fuel terminal. The law further describes that the term "Owner or Operator" does not include any person or entity that owns the land underlying a facility if the person or entity is not involved in the operations of the facility.

The PDX Fuel Facility receives jet fuel via pipeline from Kinder Morgan (not in PFC mitigation scope) that is then filtered at the Hydrant Pump Pad and then subsequently stored in a series of above ground storage tanks (AST) for later transmission to the PDX airport via the underground hydrant system.

The PDX underground hydrant system will continue to be handled completely separately from the Fuel Facility Risk Mitigation Implementation Plan and is not a part of this document.

Geotechnical data specific to the PDX Fuel Facility was collected and analyzed in both 2019 and 2023 on behalf of Burns & McDonnell. Geotechnical data was obtained by cone penetration test (CPT), drilling mud rotary borings and shelby tube sampling. After collection of these samples a series of laboratory testing on select soil samples collected during the exploration were run to better understand the geotechnical make-up of the soil at the project site. Haley & Aldrich (Airport Consultant) also performed engineering analyses to evaluate seismic hazards, ground settlement and geotechnical design parameters for foundations and pavements.

Site-specific seismic modeling was also performed to produce better estimates of the seismic hazards important to the existing and new fuel facility infrastructure at the PDX Fuel Facility. These findings included information relevant to determining the anticipated amount of vertical settlement, lateral spread and bearing pressures needed for the purposes of designing the new infrastructure and evaluating the few components of the existing facility that are to remain. A series of Geotechnical Reports signed and sealed by a Professional Geotechnical Engineer registered with the State of Oregon were provided to Burns & McDonnell. PFC has also hired Burns & McDonnell to provide a comprehensive SVA on their behalf. Only assets leased by PFC were evaluated in that document which was provided to the DEQ in May of 2024.

The PDX Fuel Facility is tasked with providing reliable jet fuel to PDX airport and must remain operational during construction. While most of the existing fuel facility infrastructure will be removed because of the previously submitted SVA. The existing fuel facility infrastructure must remain in place until the new facility infrastructure is installed and commissioned. Therefore, a phased construction approach with an approximate four-year duration from notice to proceed will be utilized to provide no interruption of fuel service in the transition from existing to new storage.

Code References

The State of Oregon has their own State Building Code titled the Oregon Structural Specialty Code (OSSC). As of October 1, 2022, the City of Portland has adopted the 2022 OSSC. The 2022 OSSC is based on the 2021 International Building Code (IBC).

The 2021 IBC references the American Society of Civil Engineers (ASCE) 7-16; Minimum Design Loads and Associated Criteria for Buildings and Other Structures. ASCE 7-16 references American Petroleum Institute (API) Standard 650, Welded Tanks for Oil Storage, 12th Edition. Burns & McDonnell & Haley & Aldrich in accordance with Or. Admin. R. section 340-300-0002 have utilized the codes and standards previously indicated.

The United States Department of Defense utilizes their own codes and standards. Unified Facilities Criteria (UFC) 3-460-01, Design: Petroleum Fuel Facilities, while not a reference directly cited within Or. Admin. R. section 340-300-0002 is a relevant document utilized by the United States Government in their design of petroleum fuel facilities within the United States and its various facilities around the World. Background on this document is being provided above as excerpts from this document will be cited later in this document.

Risk Categorization Per ASCE 7 / UFC 3-460-01 & Implementation of Risk Category IV

The PDX fuel facility stores Jet-A which is the world's most common fuel for jet turbine engines. Oregon Laws related to Terminal SVA studies require this type of facility to be designed to Risk Category IV classification. This facility has been designed to meet the requirements of ASCE 7-16 Risk Category IV.

According to the CEI Hub Seismic Risk Analysis report published by Multnomah County [1].

> *"The State of Oregon's Critical Energy Infrastructure (CEI) Hub is a six-mile stretch of industrial development along the west shore of the Willamette River. More than 90% of all liquid fuel in Oregon is stored at facilities in the CEI Hub. This includes the gas and diesel supply for the Portland metro area, as well as all of the jet fuel for the Portland International Airport."*

Based on the Oregon DEQ Overview of CEI Hub and CSZ Earthquake [2].

> *"90% of Oregon's fuel supply passes through the CEI Hub including 100% of PDX Airport fuel."*

The critical nature of this facility is understood and all infrastructure at the PDX Fuel Facility post-mitigation has been designed to meet the Fuel Tank Seismic Stability Rules requirements of Risk Category IV based on ASCE 7. It is our understanding that the intent of this document is to help inform the public and help assuage any concerns regarding the integrity of the facility.

The following information is being provided with the objective of providing the reader with a better understanding of how risk categorization of infrastructure is determined by engineers, municipalities and Government entities.

If this facility were to be constructed in a jurisdiction other than Multnomah County Oregon, this facility would not be considered as a Risk Category IV facility, absent some unique features not relevant to PDX. Designing this Jet A fuel storage facility at a large Federal Aviation Administration (FAA) Part 139 certificated airport to Risk Category IV is beyond the typical requirements of ASCE 7 Risk Categorization. That said, PDX Fuel has elected to not challenge the recent Oregon State Law changes despite the question of their propriety for this project.

To better understand how Risk Categorization is determined by ASCE 7, one must review the definitions of Risk contained within ASCE 7. One factor in the determination of risk is the level of toxicity relative to the product being stored and whether a risk management plan (RMP) is in place. The following excerpts from ASCE 7 pertaining to the classification of Jet-A are provided as information to the reader.

ASCE 7-16 – 1.5.3 Toxic, Highly Toxic, and Explosive Substances [3].

> *"Buildings and other structures containing toxic, highly toxic, or explosive substances are permitted to be classified as Risk Category II structures if it can be demonstrated to the satisfaction of the Authority Having Jurisdiction by a hazard assessment as part of an overall risk management plan (RMP) that a release of the toxic, highly toxic, or explosive substances is not sufficient to pose a threat to the public.*
>
> *To qualify for this reduced classification, the owner or operator of the buildings or other structures containing the toxic, highly toxic, or explosive substances shall have a RMP that incorporates three elements as a minimum: a hazard assessment, a prevention program, and an emergency response plan. As a minimum, the hazard assessment shall include the preparation and reporting of worst-case release scenarios for each structure under consideration, showing the potential effect on the public for each. As a minimum, the worst-case event shall include the complete failure e.g., instantaneous release of entire contents of a vessel, piping system, or other storage structure. A worst-case event includes, but is not limited to, a release during the design wind or design seismic event. In this assessment, the evaluation of the effectiveness of subsequent measures for accident mitigation shall be based on the assumption that the complete failure of the primary storage structure has occurred. The off-site impact shall be defined in terms of population within the potentially affected area. To qualify for the reduced classification, the hazard assessment shall demonstrate that release of the toxic, highly toxic, or explosive substances from a worst-case event does not pose a threat to the public outside the property boundary of the facility."*

Per the Safety Data Sheet (SDS) for Jet A [4]; Jet A aviation fuel acute oral toxicity LD50 requires a concentration greater than 5,000 mg/kg when administered to rats. Per 29 CFR 1910.1200 [5], Jet A therefore falls under the classification of toxic, but not highly toxic.

ASCE 7-16, Risk Category III structures are indicated as follows [6]:

> *"Buildings and other structures, the failure of which could pose a substantial risk to human life.*
>
> *Buildings and other structures, not included in Risk Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure.*
>
> *Buildings and other structures not included in Risk Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing **toxic** or explosive substances where their quantity*

> *exceeds a threshold quantity established by the authority having jurisdiction and is sufficient to pose a threat to the public if released."*

Per ASCE 7-16, Risk Category IV structures are indicated as follows [6]:

> *"Buildings and other structures designed as essential facilities.*
>
> *Buildings and other structures, the failure of which could pose a substantial hazard to the community.*
>
> *Buildings and other structures (including, but noted limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemical, or hazardous waste) containing sufficient quantities of **highly toxic substances** where the quantity exceeds a threshold quantity established by the authority having jurisdiction to be dangerous to the public if released and is sufficient to pose a threat to the public if released.*
>
> *Buildings and other structures required to maintain the functionality of other Risk Category IV structures."*

If this facility were to reside on a military installation it would be subject to Department of Defense requirements which follow the Unified Facilities Criteria (UFC). Regarding risk categorization at a military installation, one can review the Unified Facilities Criteria (UFC) UFC 3-460-01 - Design: Petroleum Fuel Facilities [7] which indicates the following:

> *"General Risk Categories for fuel facilities are to be in accordance with UFC 3-301-01. The risk categories are:*
>
> *II for operations buildings, canopies, truck load/off-load facilities and similar structures.*
>
> *III for storage tanks, pumphouses, filter buildings and control rooms."*

Mitigation Drawings

All new structures as indicated on the new facility engineering drawings prepared by Burns & McDonnell and as discussed earlier in this paper meet the requirements of Risk Category IV design and follow the requirements of the following codes:

Oregon Structural Specialty Code 2022

ASCE / SEI 7 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures, 2016 and the International Building Code 2021.

API Standard 650 Thirteenth Edition, March 2020 – Welded Tanks for Oil Storage

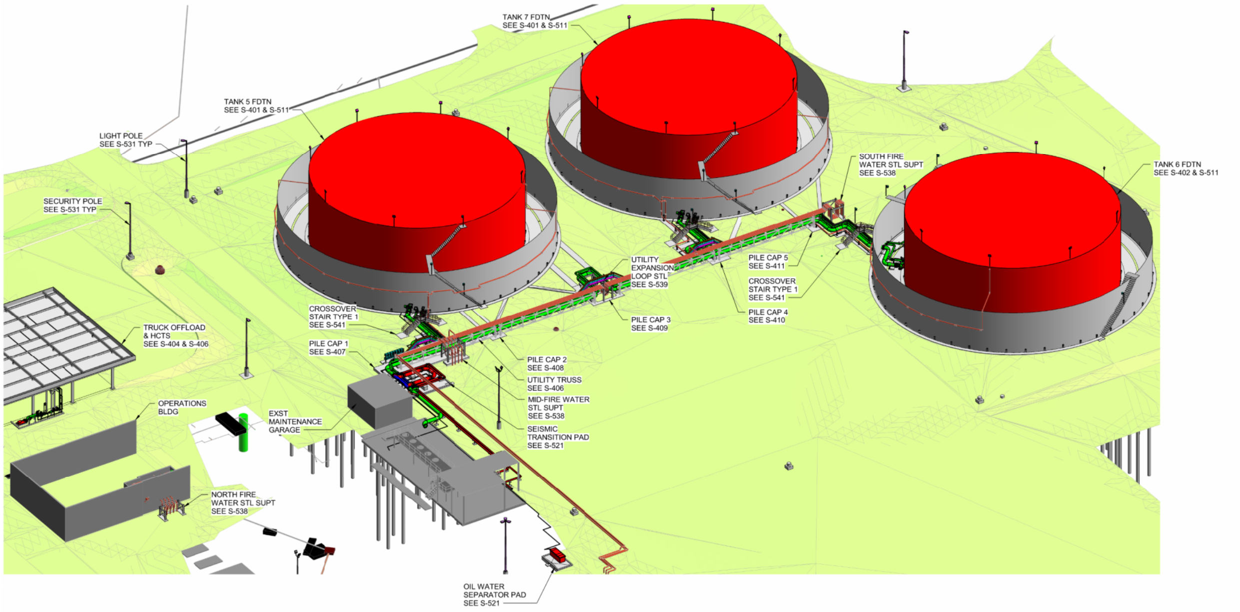
ACI 318, Building Code Requirements for Structural Concrete, 2019.

ACI 350, Code Requirements for Environmental Engineering Concrete Structures, 2020.

AISC 325, Steel Construction Manual, 15th Edition, 2017.

AISC 360, Specification for Structural Steel Buildings, 2016.

All new structures were designed following ASCE 7-16 / API 650 load requirements. Loads were incorporated into ASCE 7-16 load combinations. Using computer aided analytical analysis software, spreadsheets, hand calculations, etc. the results of the combined analyses were reviewed and the results of these developed the overall structural demand on the project steel and foundation components. Where prudent, finite element analysis for the distribution of forces throughout the facilities deep foundation and shallow foundation supported systems was also utilized. The results of all analysis findings were carried into the PDX Fuel Facility Improvement Drawings designed by Burns & McDonnell (Mitigation Drawings) for construction of the future replacement structures.



3D Overall Structural Layout – S-100 – Rev A

Design Criteria:

A. Risk Category IV.

B. Dead Load

    a. Concrete Structures 150 PCF

    b. Equipment Loads: Actual Weights

  c. Exterior rated cable tray with cabling:
    i. 6-inch = 11 plf;
    ii. 12-inch = 20 plf
  d. Rigid galvanized steel conduits:
    i. 1-inch = 1.32 plf
    ii. 2-inch = 2.38 plf

C. Live Loads
  a. Pile supported floor live load: 100 psf
  b. Slab on grade: 250 psf

D. Wheel Loads
  a. AASHTO HS20-44
  b. Magnitude: 32 kips
  c. Contact area: 100 square inches
  d. Center-to-center spacing: 60”

E. Rain Load
  a. Rain Intensity: 1” Per hour

F. Snow Loads
  a. Ground snow load: 11 psf
  b. Snow importance Factor: 1.20
  c. Minimum snow load for low-slope roofs: 24 psf
  d. Rain-on-snow roof surcharge: 5 psf

G. Ice Loads
  a. Ice thickness: 2 inches
  b. Importance Factor: 1.25
  c. Wind on Ice Speed: 30 mph 3-second gust

  d. Wind on ice importance factor: 1.00

H. Wind Loads

  a. Basic design wind speed: 110 mph 3-second gust

  b. Allowable stress design wind speed: 85 mph 3-second gust.

  c. Exposure: C

I. Earthquake Loads

  a. Mapped spectral response acceleration parameters:

    i. Ss = 0.848, S1 = 0.376.

  b. Site Class E.

  c. Design spectral response acceleration parameters:

    i. Sds = 0.590, Sd1 = 0.739.

  d. Seismic design category: D

  e. Importance factor: 1.5

  f. Analysis procedure: Equivalent Lateral Force

J. Thermal Loads

  a. Design Temperature Change: 46 degrees Fahrenheit.

K. All reinforced concrete pile caps, structural slabs and associated tie beams: Proportion normal-weight concrete mixture as follows:

  a. Minimum Compressive Strength: 6,000 psi at 28 days.

  b. Maximum W/CM Ratio: 0.40.

  c. Minimum Cementitious Materials Content: 520 lb/cu. yd.

  d. Slump Limit: 4 inches, plus or minus 1 inch (prior to admixture).

  e. Air Content: 6% plus or minus 1.5% at point of delivery for 1-inch nominal maximum aggregate size.

L. All drive slabs, slab on grade, curbs, sidewalks, and shallow foundations:

  a. Minimum Compressive Strength: 4,500 psi at 28 days.

b. Maximum W/CM Ratio: 0.40

c. Slump Limit: 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.

d. Air Content: 6 % plus or minus 1.5% at point of delivery for 1-inch nominal maximum aggregate size. 5.5% plus or minus 1.5% at point of delivery for 1 1/2-inch nominal maximum aggregate size.

M. Basic materials:

Steel: Conform to the following unless otherwise indicated or specified.

1. Wide flange (W) shapes and tees cut from W and Channels 8 inches or greater: ASTM A992.
2. Channels less than 8 inches: ASTM A36.
3. Plates, angles and bars: ASTM A572.
4. Hollow Structural Sections: ASTM A1085.
5. Steel Pipe: ASTM A53, Type E or S, Grade B.
    a. Weight Class: Standard unless indicated otherwise.
    b. Finish: Galvanized and then coated per Protective Coating System B-4 VOC.

ii. Floor Grating:

1. Steel: Conform to ASTM A1011, CS (Type B).

iii. Strut Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of channels: 1-5/8 by 1-5/8 inches or as indicated.
2. Material: Cold-rolled steel, ASTM A1008, structural steel, Grade 33; 0.0677-inch nominal thickness. Hot-dip galvanized after fabrication unless indicated otherwise.

New Infrastructure Foundations

A rigorous lateral performance analysis was performed by Burns & McDonnell utilizing LPILE v2022 to estimate the facility foundations capacity demands based on five (5) separate loading conditions. This analysis was based on soil profiles and other data obtained from the project's Geotechnical investigation and subsequent analyses performed by Haley & Aldrich as previously indicated in the Project Background section of this report.

Based on these analyses, most of the new infrastructure is being installed on a series of heavily steel reinforced concrete pile caps. These concrete pile caps are supported on concrete filled steel pipe piles founded to depths of 101 to 131 feet below the ground surface.

Subsurface considerations regarding the proposed improvements include the potential for strong shaking motions/large seismic displacements and the protection of existing groundwater aquifers. Systems must meet with the State of Oregon Department of Environmental Quality Fuel Tank Seismic Stability Rule 340-300, 2019 Oregon State Structural Code (OSSC), and American Society of Civil Engineers (ASCE) 7-16.

Results of the geotechnical investigation performed by Haley & Aldrich indicated ductile deep foundation systems to be sufficient for the support of major structures without the need for ground improvement. Average estimated liquefaction-induced vertical settlements ranged from 8 to 12 inches. Lateral spreading-induced horizontal displacements ranged from 30-inches to 6-inches and generally trended away from the Columbia River, mitigating driving environmental concerns with respect to the jet fuel storage tanks.

To meet seismic stability requirements, 18-inch outer diameter, 0.5 inch thick, 6,000 psi concrete-filled steel pipe (CFSP) piles were selected by the designer for the following considerations:

Strain Behavior

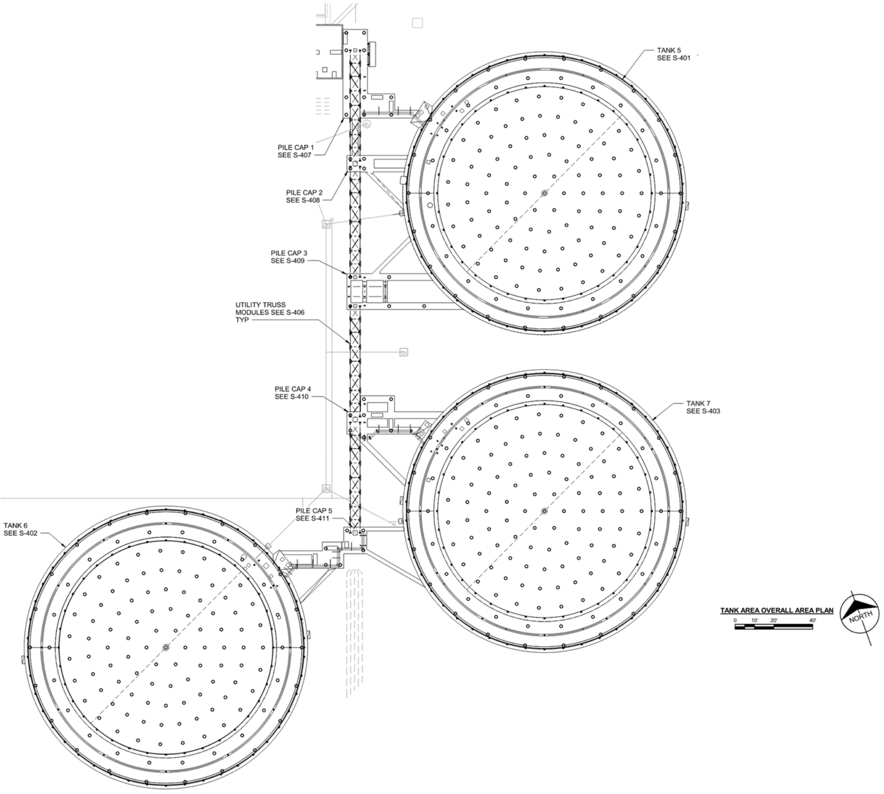
CFSP piles are symmetrical by nature and do not rely on the differential determination of performance in different axes (i.e., strong axis vs weak axis commonly associated with steel H-pile sections). Due to the unpredictable nature of seismic ground motions, a structural section capable of similar performance in all horizontal directions was required. CFSP piles are fabricated from 45 ksi steel and during a design seismic event exhibit yielding prior to failure rather than 'brittle' failure and section degradation commonly associated with comparable concrete-cast elements.

Installation

CFSP piles are full-displacement systems that densify the surrounding soil as forwarded to the target design depth, offering a relative amount of soil improvement immediately surrounding the section. During construction, CFSP piles do not require the traditional use of large diesel impact hammers or vibrating mandrels, which can impart unnecessary excitation forces to the subsurface with depth (i.e., causing additional disturbance and potentially undermining design capacity). These traditional methods are often noisy and can cause public nuisance. CFSP piles however, are forwarded via crowd (downward pressure) and torque (rotation) and are theoretically installed in a comparable fashion to a hardware screw. The installation of CFSP piles also provides the advantage of continuous torque monitoring during installation, allowing the inspector to correlate in-situ soil strength with depth in real time and make time-sensitive decisions related to target termination criteria.

Environmental Disturbance

CFSP piles are a closed system featuring a hollow steel pipe with a welded conical tip at the base. Upon torquing the pile to the target elevation, steel reinforcement is lowered into the pipe and the section is then filled with concrete. This concrete 'plug' prevents the risk of water (or contaminant) transport from other elevations along the stem of the section. The conical pile tip often features small cutting teeth or small flights welded directly to the cone to promote forwarding through dense soil layers. However, the size of these teeth/flights will not exceed the overall diameter of the pile, thus maintaining a minimal zone of disturbance and maintaining the benefits traditionally associated with displacement piles (partial densification around the pile with depth). CFSP piles generate little to no spoils. CFSP torque down driven piles are best practice in contaminated soils.



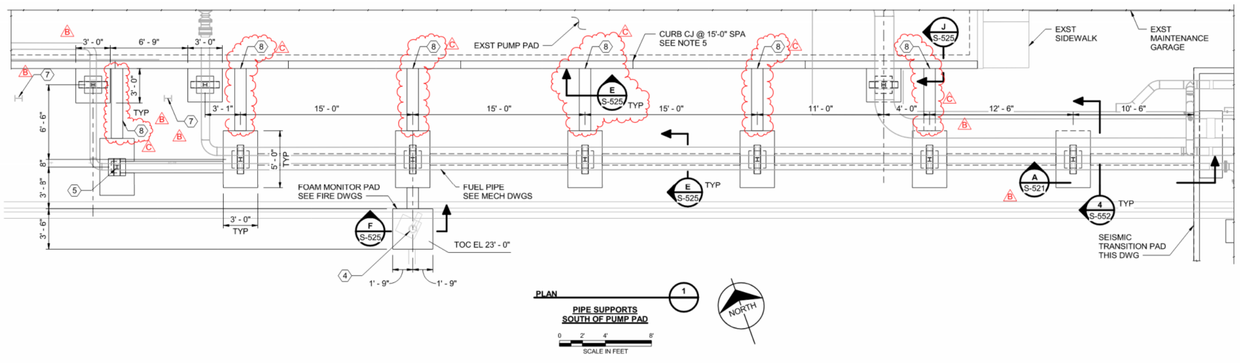
Tank Area Overall Area Plan – S-400 – Rev A

Discussion on Foundation Systems and Pipe Supports

As seen above in Figure “Tank Area Overall Area Plan – S-400-Rev A” Tank 5 (the northern most tank) is connected back to the adjacent utility truss pile caps 1, 2 & 3 by a series of Foundation Ties [8], required by ASCE 7-16. Tanks 6 & 7 are connected to one another and to pile caps 4 & 5 by another series of Foundation Ties [8], required by ASCE 7-16. The foundation ties are spread in multiple directions to help distribute the combined bending and axial loading that these concrete ties will absorb and translate. The steel Utility Truss Modules support the jet fuel piping running from the tanks back to the existing Hydrant Pump Pad. Utility Truss Modules 1, 2 and one side of Module 3 are supported by the Tank 5 support system. The other side of module 3 and Utility Truss Module 4 are supported by the Tank 6 & 7 support system.

Tank 5 pile caps system and Tanks 6 & 7 pile cap systems are intentionally kept separate, as the amount of lateral spread varies across the site from north to south. The Geotechnical analysis data provided by Haley & Aldrich was analyzed and from that data the anticipated vertical and lateral displacements have been designed for between the two pile cap systems. Utility Truss Module 3 which spans between Tank 5 pile cap system and Tank 6 & 7 pile cap systems has been designed as a guided slide assembly, with uplift anchorage tabs. With the Tank 5 support system side having the guided slide assembly and the south end of that module guided in all directions. The individual utility truss modules and associated mechanical piping supported by the truss modules have been designed for the anticipated vertical and lateral translation.

While most of the new infrastructure will be founded on deep foundations as previously described, there are aspects of the new infrastructure that will be installed on shallow supported systems. ASCE 7-16 – 12.13.9.2.1 Shallow Foundation Design [9] allows shallow foundations to be utilized at this location so long as all shallow foundations have been interconnected by foundation ties. Pipe supports just south of the of the existing Hydrant Pump Pad are designed with foundation ties that tie each shallow foundation together and back to the existing Hydrant Pump Pad. These series of shallow foundations are furthermore tied back to the adjacent “seismic transition pad” which will be described below.



Pipe Supports South of Pump Pad

The “seismic transition pad” consists of a concrete reinforced shallow supported mat foundation and is being provided as a means of providing fuel piping flexibility. This flexibility is necessary as the fuel piping system transitions from deep founded infrastructure to shallow founded infrastructure. It is necessary to make this transition point from deep foundations to shallow because the existing Hydrant Pump Pad is supported on a shallow mat foundation system. The existing Hydrant Pump Pad was deemed sufficient in the previously submitted SVA with those findings being repeated under the Existing Hydrant Pump Pad heading of this document.

The design of the piping systems connection to the Above Ground Storage Tanks (AST) also follows the provisions required in ASCE 7-16 – 15.7.4 Flexibility of Piping Attachments [10]. The fuel piping system was designed utilizing software to analyze and design piping systems. This software calculates pipe stress, loads and deflections under various loading conditions. Interface between the software and design engineer allowed the system to be designed with piping guided in some areas and free to move in other areas (non-guided). This design has been carried through into the design documents. In areas that are non-guided the piping does not have lift-off lugs so vertical movement is unrestrained. Areas where the system is guided, these guides restrain the movement of the piping in the lateral and vertical direction.

As previously discussed, additional seismic ties (grade beams) have been added to the system. Free field displacements have been provided from a geotechnical standpoint and are shown in the Summary Table of Design Movements shown below. Tank 5 and the adjacent utility rack are interconnected by a series of seismic ties and pile caps. Tank 6 and 7 and the adjacent utility rack are interconnected by a series of seismic ties and piles caps. These two "structures" are considered independent of one another. With free field displacements of up to 6 1/4″ in the north-south in conjunction with 6 1/4″ east-west. The piping system has been analyzed for this displacement and is adequate. The utility truss module 3 (which spans between these two structures) has been designed with a guided slide support system shown to handle the 6 1/4″ north-south movement.

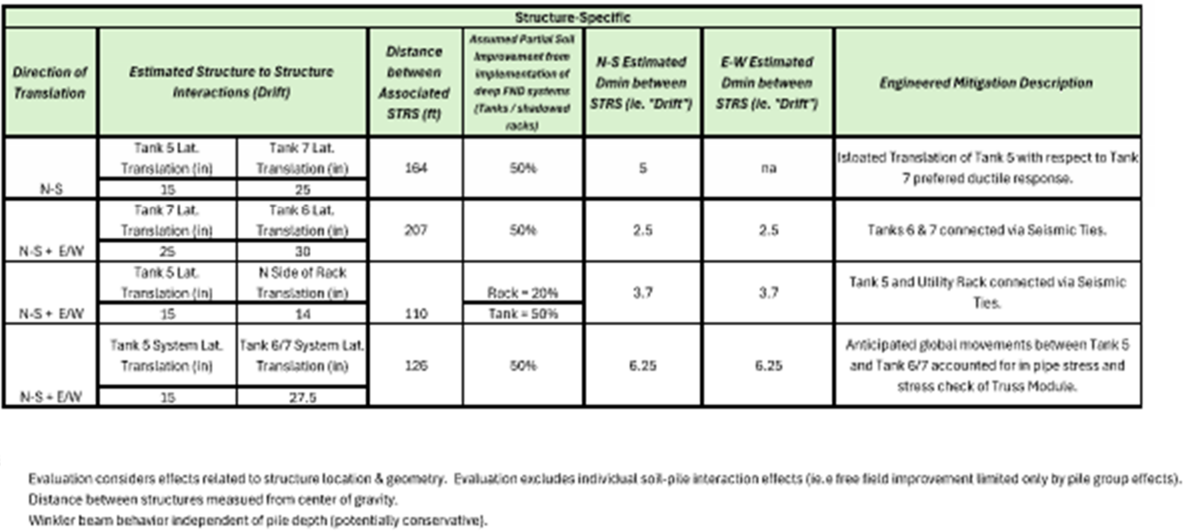
Furthermore, the truss modules have been checked for 6 1/4″ out of plane (east-west) movement in conjunction with a 2″ settlement drop from end to the other (to account for localized pockets of liquefaction). The truss module is sufficient and can handle this designed deformation / deflection.

It should also be noted that the seismic ties have been designed with the following methods:

Method 1 consists of a Finite Element Analysis model that combines the entire Utility Rack Truss Module Foundations with seismic ties back to each of the Tanks. Additionally, combined axial and bending checks were also performed. This method includes the seismic ties provision of ASCE 7-16 12.13.8.2.

Method 2 consists of the Utility Rack Truss Module Foundations with Seismic Ties attached back to “rigid” piles to simulate where they would connect back to the tanks. The difference with this model is that the shear capacity of the piles at the Truss Module Rack is set to zero. This forces all lateral loads to be absorbed by the rigid piles (which simulate the tanks). It should be noted that the Truss Module Rack piles still support vertical load. The purpose of this is to simulate a "swinging action" of the tanks not moving but the adjacent racks moving; thus, inducing very large forces into the seismic ties. The intent of this was to conservatively simulate varying periods between the two tied together structures.

The results of these analyses models (which includes specific structure based 50% fixity moments at each of the pile heads) were analyzed, utilizing a series of concrete tools to check the beams for combined bending, shear and torsion. The worst-case reactions of these two (2) methods were carried through into the details of the seismic ties.



Structure-Specific							
Direction of Translation	*Estimated Structure to Structure Interactions (Drift)*		*Distance between Associated STRS (ft)*	*Assumed Partial Soil Improvement from implementation of deep FND systems (Tanks / shadowed racks)*	*N-S Estimated Dmin between STRS (ie. "Drift")*	*E-W Estimated Dmin between STRS (ie. "Drift")*	*Engineered Mitigation Description*
	Tank 5 Lat. Translation (in)	Tank 7 Lat. Translation (in)	164	50%	5	na	Isloated Translation of Tank 5 with respect to Tank 7 prefered ductile response.
N-S	15	25					
	Tank 7 Lat. Translation (in)	Tank 6 Lat. Translation (in)	207	50%	2.5	2.5	Tanks 6 & 7 connected via Seismic Ties.
N-S + E/W	25	30					
	Tank 5 Lat. Translation (in)	N Side of Rack Translation (in)		Rack = 20%	3.7	3.7	Tank 5 and Utility Rack connected via Seismic Ties.
N-S + E/W	15	14	110	Tank = 50%			
	Tank 5 System Lat. Translation (in)	Tank 6/7 System Lat. Translation (in)	126	50%	6.25	6.25	Anticipated global movements between Tank 5 and Tank 6/7 accounted for in pipe stress and stress check of Truss Module.
N-S + E/W	15	27.5					

Notes

1 Evaluation considers effects related to structure location & geometry. Evaluation excludes individual soil-pile interaction effects (ie.e free field improvement limited only by pile group effects).

2 Distance between structures measued from center of gravity.

3 Winkler beam behavior independent of pile depth (potentially conservative).

Summary Table of Design Movements

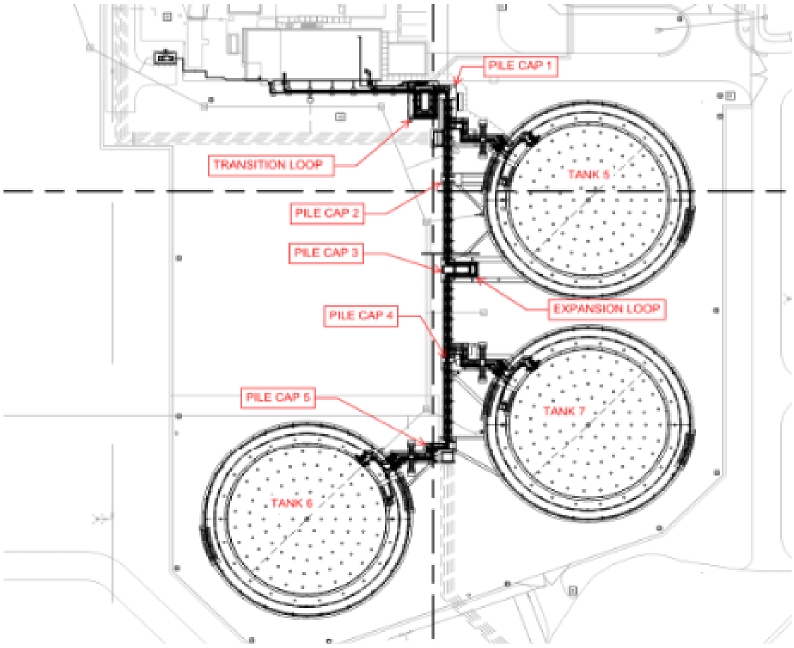


Diagram of Overall Project Foundations

Summary of Fuel Facility Structures Being Replaced

The PDX Fuel Facility was designed and built in the early 1970’s for the purpose of storing and transporting fuel to aircraft at the PDX Airport.

The Level of Seismicity is considered High as the facility falls within Seismic Design Category D.

Further considerations pertaining to seismic include lateral spread and its influence on existing structures. Lateral spreading is defined as lateral movement of gently to steeply sloping, saturated soil deposits caused by earthquake-induced liquefaction. Lateral spreading occurs because of an increase in porewater pressure in the soil from an earthquake. An earthquake reduces the stiffness and shear strength of the soil.

Or. Admin. R. section 340-300-0003 (f) indicates evaluation of existing structures, however most of the existing structures are being removed and replaced with new structures as a means of mitigation. These structures that are noted for removal are being removed because their continued usage in conjunction with a design level seismic event would result in a spill greater than the maximum allowable uncontained spill.

As highlighted within the Seismic Vulnerability Assessment provided May 31, 2024, there are several structures that are deficient and do not comply with the Oregon Seismic Stability Tank Rules.

The following structures are being demolished and replaced with more resilient structures that are compliant with OAR 340-300-0002(2) and to achieve the performance objective and meet the specifications of OAR 340-300-0003.

Operations Building

Above Ground Storage Tank 1

Above Ground Storage Tank 2

Tank 1 & 2 dike walls and associated impervious flexible membrane liner

Above Ground Storage Tank 3

Tank 3 dike walls and associated impervious flexible membrane liner

Foam Building

2,000 Gallon Oil Water Separator

Jet Fuel Piping Supports

See Figures 1, 2 and 3 at the end of this report for additional detail.

Above Ground Storage Tanks

Above Ground Storage Tank 1 & 2

Existing above ground storage tanks (AST) 1 & 2 were constructed in 1971. According to measurements from the most recent American Petroleum Institute (API) 653 Out-of-service inspection, these tanks are 67’-0” in diameter and 31’-4” in overall height. Each tank can nominally store up to 20,000 BBLS (840,000 gallons) of Jet-A fuel. Existing drawings show that the foundation of these tanks consists of a ten-foot-thick compacted aggregate. The bottom eight feet consists of a bed of compacted sand and gravel. The remaining two feet directly below the tanks consists of a two-foot crushed rock base.

In 1996 the existing tank bottoms were retrofitted with a new steel tank bottom, flexible member liner for secondary containment and cathodic protection.

The existing tank 1 & 2 construction and foundation are not sufficiently designed to prevent a spill that is less than the Maximum Allowable Uncontained Spill resulting from a design level earthquake. It is highly likely that the differential and lateral movement placed on the existing tanks will compromise the tank nozzles resulting in a release greater than the Maximum Allowable Uncontained Spill.

Tank 1 & 2 will be decommissioned and replaced with a tank system designed to meet Oregon Law within the next four years as part of the PDX Fuel Facility Improvements project.

Existing Above Ground Storage Tank 3

Existing above ground storage tank (AST) 3 was constructed in 1995. According to measurements taken during the latest API 653 Out-of-service inspection, this tank is 95'-0" in diameter and 32'-1" in overall height. Tank 3 can nominally store up to 40,000 BBLS (1,680,000 gallons) of Jet-A fuel. Existing drawings show that the foundation of this tank consists of a reinforced concrete ringwall foundation beneath the perimeter of the storage tank. This foundation is 3'-0" thick and 1'-8" wide. The subgrade beneath the ringwall consists of a 2'-0" compacted layer of gravel.

The existing tank construction and foundation are not sufficiently designed to prevent a spill that is less than the Maximum Allowable Uncontained Spill resulting from a design level earthquake. It is highly likely that the differential and lateral movement placed on the existing tank will compromise the tank nozzles resulting in a spill.

Tank 3 will be decommissioned and replaced with a system designed to meet Oregon Law within the next four years as part of the PDX Fuel Facility Improvements project.

Jet Fuel Pipe Supports

Because of the age of the facility and the number of previous additions, there are a large variety of pipe supports. All existing pipe supports under the leasehold responsibility of PFC are founded on shallow foundations. Most of these pipe supports are supported by structural steel that is anchored to the shallow foundation.

Most of the existing pipe supports will be demolished and replaced with a system designed to meet Oregon Law within the next four years as part of the PDX Fuel Facility Improvements project. Refer to the following figures for further explanation of structures and pipe supports that are to be demolished:

Figure 4 – PDX Fuel Facility Demolition Plan

Figure 5 – MD101 – Mechanical Demolition Overall Site Plan

Figure 6 – MD401 – Enlarged Demolition Plan Hydrant Pump Pad

Previous Secondary Containment System

Existing Tank 1 & 2 Dike Walls

The dike walls for tanks 1 and 2 were constructed in the early 1970's. Existing drawings show their construction as a reinforced concrete footing with 8-inch-thick lightweight grade "A" load bearing concrete masonry units (CMU), conforming to ASTM C90.

Information available to PDX Fuel indicates in the 1990's a flexible membrane liner was added to the dike areas. This liner exists to prevent any incidental spills from migrating into the surrounding subgrade.

The existing dike walls for tanks 1 and 2 are not sufficiently designed to prevent a spill that is less than the Maximum Allowable Uncontained Spill resulting from a design level earthquake. The CMU block cannot handle differential settlement and vertical stair-step cracks will likely form because of a design level event, compromising secondary containment. Failure at the attachment point between the flexible membrane liner and the CMU block wall is also likely, which would compromise containment.

Dike containment walls for tanks 1 & 2 will be demolished and replaced with a system designed to meet Oregon Law within the next four years as part of the PDX Fuel Facility Improvements project as outlined in the Mitigation Drawings.

Tank 3 Dike Walls

The dike walls for tank 3 were constructed alongside tank 3 in 1995. Existing drawings show its construction consisting of a reinforced concrete retaining wall. The retaining wall is 8 inches in thickness with a varied height. A flexible membrane liner that is attached to the concrete retaining (dike) wall exists to prevent any incidental spills from migrating into the surrounding subgrade.

The existing dike walls for tank 3 are not sufficiently designed to prevent a spill that is less than the Maximum Allowable Uncontained Spill resulting from a design level earthquake.

Dike containment walls for tank 3 will be demolished and replaced with a system designed to meet Oregon Law within the next four years as part of the PDX Fuel Facility Improvements project as outlined in the Mitigation Drawings.

New Above Ground Storage Tanks & Secondary Containment System

New Above Ground Storage Tanks 5, 6 & 7

The AST 5, 6, and 7 (as part of this project) will be 110 feet in diameter and 36 feet in overall height. The storage tanks have been designed to have adequate space above the safe tank fill height to accommodate the Risk Category IV sloshing height of 7'-3" as determined by API 650.

As previously stated, Burns & McDonnell has designed the above ground storage tank (AST) foundation, associated piping, valves, etc. that dovetail into the tanks themselves. For the purposes of discussion, the actual AST may be referred to as the primary tank. The primary tank is 110 feet in diameter and surrounded by a 142 feet diameter outer secondary containment shell. The actual design of the primary steel tank and the secondary steel containment system, access stairs, tank anchorage requirements and internal tank components for AST 5, 6 & 7 are a Burns & McDonnell delegated design item. Delegated design is a collaborative process in construction, when a design professional such an engineer, assigns responsibility for certain design details to another design professional. In this instance, Burns & McDonnell will directly collaborate with an Above Ground Storage Tank Designer / Fabricator who is an specialist in Petroleum Storage Tank Design. The Tank Design Professional will be provided with all Burns & McDonnell's design criteria which includes the following:

A. Design Drawings

B. Design Specifications

C. Design Criteria

The use of delegated design for the actual design of the steel storage tank and internal components is common industry practice and has been successfully implemented on countless projects around the World.

It should be reiterated that even though the steel storage tank design is a delegated design item, the design of this will adhere to the Fuel Tank Seismic Stability Rules, which require risk Category IV requirements per ASCE 7-16 and in accordance with API 650 standards as previously mentioned. The Tank Design Professional must be a Structural Engineer licensed in the State of Oregon.

The design of this AST system, while not completely unprecedented, is somewhat unique to the industry. All Petroleum storage tanks industry wide are surrounded by some kind of code-mandated secondary containment system known as a dike area. This dike area is intended to act as an impervious retention basin in the event the AST leaks or ruptures. This dike area typically consists of a concrete outer perimeter wall or soil berm. The ground within the dike area and the surrounding perimeter dike walls or soil berm are lined with a flexible membrane liner that is impervious. These dike areas are typically very large as they are sized to contain the volume of fuel from the largest fuel tank in the event of a spill. Dike areas also typically cover relatively large areas as they have limitations on how tall the walls can be due to OSHA regulations on confined space entry. Because of the anticipated lateral and vertical displacement, the site is expected to see during a design level seismic event, a secondary containment shell around the AST will be utilized in lieu of the usual shallow supported concrete dike wall or secondary berm system. This is particularly advantageous in terms of mitigation as each of the (3) three primary AST will each have their own secondary containment system that surrounds each individual tank, as opposed to a traditional system which would typically provide a shared containment system.

The secondary steel containment shell will be designed by the delegated Tank Design Professional as part of the overall AST system. This secondary steel shell will be field erected to surround the primary steel storage tanks for the purpose of secondary containment. On the interior side of the base connection of the secondary containment shell a flexible membrane liner is shown on Burns & McDonnell foundation design documents to create a water-tight seal around the interior secondary shell perimeter. The tank foundation pile cap has been designed to meet ACI 350-20 concrete crack requirements, which are followed in the design of water-tight concrete foundations, such as concrete water tanks, concrete waste-water tanks / vaults.

The outer shell has been designed and verified by Burns & McDonnell to be 24 feet in height. The structural steel design of this shell will be designed by the delegated Tank Design Professional to follow ASCE 7-16 – 15.6.5 Secondary Containment Systems [11], which states the following:

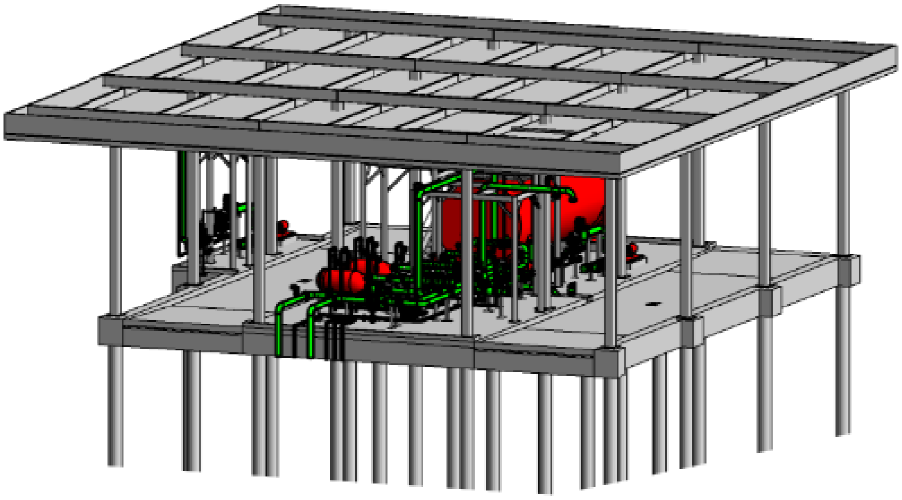
> *"Secondary containment systems, such as impoundment dikes and walls, shall meet the requirements of the applicable standards for tanks and vessels and the Authority Having Jurisdiction.*
>
> *Secondary containment systems shall be designed to withstand the effects of the maximum considered earthquake ground motion where empty and two-thirds of the maximum considered earthquake ground motion where full including all hydrodynamic forces as determined in accordance with the procedures of Section 11.4.*
>
> *Where determined by the risk assessment required by Section 1.5.3 or by the Authority Having Jurisdiction that the site may be subject to aftershocks of the same magnitude as the maximum considered motion, secondary containment systems shall be designed to withstand the effects of the maximum considered earthquake ground motion where full including hydrodynamic forces as determined in accordance with the procedures of Section 11.4."*

The new secondary containment system will be more seismically resilient and can be considered "a belt and suspenders approach" when compared with the previous existing secondary containment system, which relied on a series of shallow supported concrete dike walls with a flexible membrane liner. It is highly likely that if the previous concrete walls were to be subjected to a design level earthquake, they would have cracked resulting in a breach in secondary containment.

New Hydrant Cart Test Stand (HCTS) / Truck Offload

The Hydrant Cart Test Stand (HCTS) / Truck Offload area consists of two (2) fifteen-foot drive lanes with adjacent concrete islands. The central fueling island between the two (2) drive lanes supports fuel piping, valves, a low aircraft test connection point, sump separators, horizontal filters, meter provers, fuel offload connections and a 20,000 gallon reclaim tank.

As required by the Portland Source Control Manual an overhead canopy has been designed to cover the entire HCTS / Truck Offload area. This cover must overhang at least five (5) feet beyond the perimeter of the fueling pad on all sides. The entire structure, (canopy and foundation system) has been designed to risk category IV per Seismic Stability Tank Rules and therefore is supported by a network of concrete reinforced grade beams supported by CFSP. The drive lanes have also been designed as a structural slab that will span from between the grade beam systems. In the unlikely event of a truck spilling fuel during offloading, the drive lanes have a shared containment system with a shared trench that ties both containments together. This fuel would then be vacuumed by a vac truck for reuse following treatment.



HCTS / Truck Offload Area

Figure 6-5. Aboveground Storage, Processing, or Transfer of Liquids

A. COVERED SECONDARY CONTAINMENT

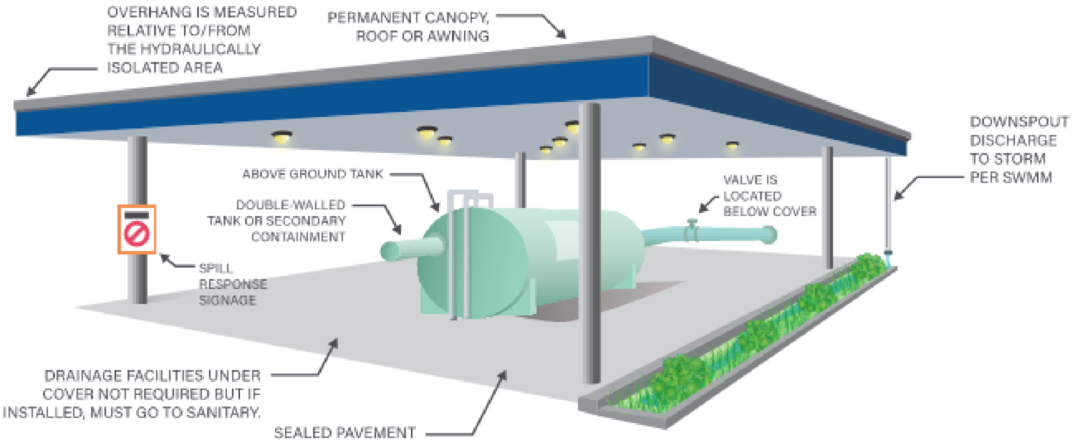


Figure from 2020 City of Portland Source Control Manual

Fuel piping that travels underground from the south and then goes above grade and is supported by the central island has been designed with ball joints at the transition. These ball joint sections are designed to allow for pipe movement from displacement of the surrounding soil to the HCTS / Offload structure in accordance with the Structural and Geotechnical Calculations.

Expected Seismic Performance of Mitigated Structures

Based on the analysis methods indicated in the previous sections, the overall new and improved facility is expected to perform well during a seismic event. While vertical and lateral displacements are expected to occur during a design level seismic event, flexibility in the facilities fuel piping, firewater lines, electrical distribution system and structural components of the facility have been implemented into the facilities design. Concrete filled steel pipe piles have been placed in groups at pile caps to allow load redistribution should localized liquefaction occur. The AST and AST foundations are designed for a seismic event when the primary tank is full and a secondary seismic event where the unlikely event that the primary tank fails, and the secondary containment then becomes full and seismic aftershocks occur.

Expected Seismic Performance of Existing to Remain Structures

The following existing structures are to remain as their continued usage will not result in a spill greater than the maximum allowable uncontained spill.

Existing Hydrant Cart Testing Facility Building

The existing Hydrant Cart Testing Facility building is a steel supported and steel cladded building. The original building's lateral force resisting system based on field reconnaissance appears to consist of ordinary concentrically braced moment frames. The original conceptual drawings do not show enough detail to completely understand if this building relies solely on moment frames or also has a series of roof purlins with a diaphragm for the roof. The interior of the building is clad in steel which prevents inspection of portions of the building's structural system.

The dimensions of the building are 22' x 24' x 13' tall, with a series of glazed windows on the north and south side of the building. The foundation consists of a 6" slab on grade mat foundation with an integral 9" x 12" wide perimeter footing. The building is a single-story structure and utilized for miscellaneous facility maintenance operations and storage. The building also currently contains jet fuel piping and a high wing testing system.

Upcoming mitigation plans will remove all jet fuel piping within the shell of the Hydrant Cart Testing Facility Building. Once the existing piping is demolished this facility will not be capable of potentially causing a Maximum Allowable Uncontained spill resulting from a design level earthquake.

The building is small enough and has a large enough exit point such that any personnel within the building can quickly exit the facility during a seismic event. Furthermore, in the future this building will only be utilized as a maintenance garage. Because this building is not a permanently occupied structure, there is minimal risk to life-safety.

Based on table 11 & 12 of the Enhanced Seismic Design Considerations report [12] provided by Haley & Aldrich the following settlement and lateral displacements are anticipated to occur at the Hydrant Cart Testing Facility Building:

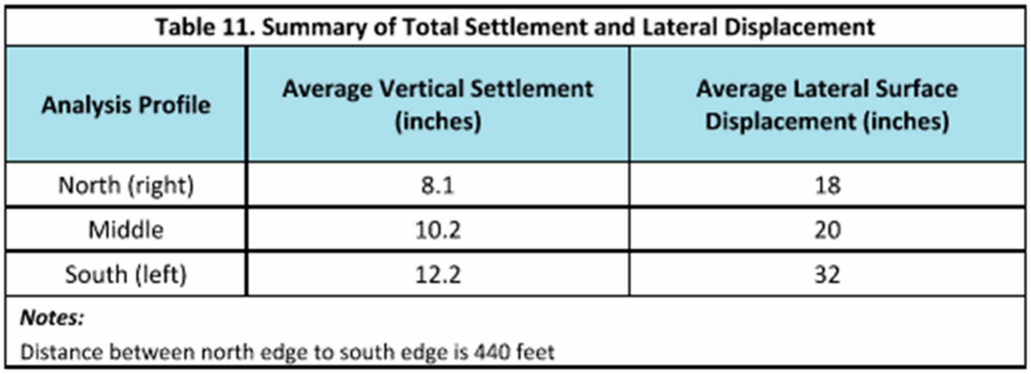


Table 11. Summary of Total Settlement and Lateral Displacement

Analysis Profile	Average Vertical Settlement (inches)	Average Lateral Surface Displacement (inches)
North (right)	8.1	18
Middle	10.2	20
South (left)	12.2	32

Notes:

Distance between north edge to south edge is 440 feet

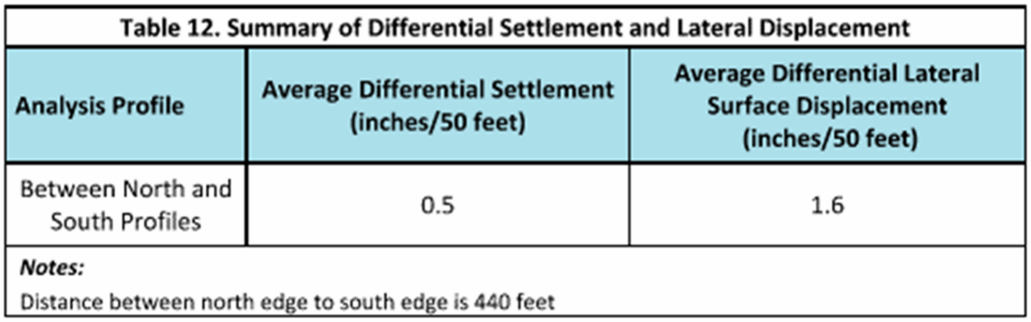


Table 12. Summary of Differential Settlement and Lateral Displacement

Analysis Profile	Average Differential Settlement (inches/50 feet)	Average Differential Lateral Surface Displacement (inches/50 feet)
Between North and South Profiles	0.5	1.6

Notes:

Distance between north edge to south edge is 440 feet

Total settlement: 8.1 inches

Lateral surface displacement: 18 inches

Average Differential Settlement:

a. 0.22 inches (east-west)

b. 0.24 inches (north-south)

Average Differential Lateral Surface Displacement:

a. 0.70 inches (east-west)

b. 0.77 inches (north-south)

Based on the cladding of the building consisting of metal siding and being supported by a moment frame system, the anticipated differential settlement results in L/1200, well within tolerance for this type of structure.

Existing Hydrant Pump Pad

Based on drawing MF-2166238 from 1971 the Hydrant Pump Pad consists of a reinforced concrete slab on grade that is 8-inches thick with an integral one-foot x one-foot square thickened edge at the perimeter of the mat. The mat is approximately

36’ x 85’ in plan. There is an expansion joint at the approximate center point of the mat foundation.

The Hydrant Pump Pad piping system consists of ASME B31.1 welded carbon steel pipe that is supported on steel pipe supports that bear on the Hydrant Pump Pad mat foundation. All piping is inspected on a five-year interval in accordance with API 570, with the latest inspection reflecting the piping is in good condition. Five (5) hydrant pump trains are supported on steel reinforced concrete housekeeping pads along with various other jet fuel filtration equipment. All filter vessels are inspected on a ten-year interval in accordance with API 510, with the latest inspection reflecting the vessels are in good condition.

In 2019 Burns & McDonnell was hired by PFC to perform the PDX Facility Upgrades project which included a revamping of the existing Hydrant Pump Pad. As of the time of this report construction based on the engineering documents provided is still on-going with full commissioning of the improvements anticipated in mid to late 2024.

Drawing M-402 of the 2019 PDX Facility Upgrades project shows adjustments to the existing pump pad that included shifting the pump trains to the east with an expansion of two additional pump trains. The existing pump pad was also extended to the east to accommodate the additional pump trains. Blind flanges at the two (2) western most points of the 20-inch suction header have been installed for a total of five (5) pump trains and two (2) future pump train positions. The existing pumps were removed and replaced with modern day fuel pumps. Furthermore, the existing Hydrant Pump Pad platform on the east end (94-1014-S-3) designed in 1994 was demolished to make way for a new updated platform designed by Burns & McDonnell in 2019 (S-108). The existing platform on the west end of the Hydrant Pump Pad that surrounds the existing prefilter PF-1, clay treater and filter separator FS-6 as shown on 3405-P-02 was analyzed and retrofitted by Burns & McDonnell in 2019 to be more seismically resilient (S-101 & S-544).

The Hydrant Pump Pad piping system penetrates the ground at the northeast corner of the Hydrant Pump Pad as the starting point of the PDX Aircraft Hydrant System. The Hydrant Pump Pad and hydrant system is not applicable to the storage facility resiliency requirements addressed in this report.

Because this structure is supported on a shallow foundation system, this structure may be susceptible to settlement from a design level earthquake. However, in this application, the mat foundation is ideally suited in seismic zones because of its continuity and rigidity. The mat foundation system will act more cohesively and help to distribute any irregular stresses imposed upon it during a design level seismic event.

Based on table 11 & 12 of the Enhanced Seismic Design Considerations report [12] provided by Haley & Aldrich the following settlement and lateral displacements are anticipated to occur at the Hydrant Pump Pad:

Total settlement: 8.1 inches

Lateral surface displacement: 18 inches

Average Differential Settlement:

0.85 inches (east-west)

0.36 inches (north-south)

Average Differential Lateral Surface Displacement:

2.72 inches (east-west)

1.15 inches (north-south)

In applying these worst-case movements, it is anticipated that the Hydrant Pump Pad foundation could potentially crack and settle to some degree during a design level seismic event. The expansion joint at the approximate center point of the mat foundation is anticipated to be separated to some extent as it does not appear that reinforcement steel bridges across this joint based on the 1971 drawing (MF-2166238). However, the amount of average differential settlement along the length of the pump pad in either direction is L/1200, far less than what is required for most masonry structures, with which are limited to L/600 for crack control per the National Concrete Masonry Association.

As previously indicated, the Hydrant Pump Pad piping system consists of ASME B31.1 welded carbon steel pipe that is supported on steel pipe supports that bear on the Pump Pad mat foundation. Welded standard weight carbon steel pipe has significantly more flexibility than the concrete foundation and will behave in a more ductile manner.

It is not anticipated that a spill greater than the Maximum Allowable Uncontained Spill will occur from a design level earthquake. Double block-and-bleed plug valves are installed for positive isolation of each pump train in addition to the main supply to the hydrant system, which can be manually closed to isolate from the rest of the fuel system.

Based on historical earthquake performance data for similarly constructed, fully welded carbon steel pipe networks (refer to FEMA-233 “Earthquake Resistant Construction of Gas and Liquid Fuel Pipeline Systems Serving, or Regulated by, the Federal Government”) [13], the piping at the Hydrant Pump Pad and the Aircraft Hydrant System (AHS) is expected to perform favorably during the design level seismic event. As previously described, the Hydrant Pump Pad and associated remaining platforms will remain in place and will not be decommissioned as part of the future mitigation plan. The amount of anticipated differential settlement over the length of the entire structure is not enough to be considered out of allowable tolerance for either the mat foundation or the structural steel platforms supported by the mat foundation.

Existing 10,000 Gallon Above Ground Off-Spec Product Tank (Slop Tank)

The existing 10,000 gallon off-spec product tank was installed in 1994 to replace the underground 10,000-gallon slop tank which was original to the fuel facility. The tank is primarily used for holding contact water collected from hydrant pits and fuel vaults throughout the hydrant system. Any other off-spec product or unreclaimable fuel collected while servicing and maintaining the fuel system is also stored in the tank. The tank's contents are drained and collected by a third-party disposal company monthly, or as needed if rain events are heavier than normal for the Portland area. On average the tank is half full and varies from completely empty after a collection to 90% capacity over the course of the month.

Existing facility drawings lack information pertaining to its construction. Based on a visit to the facility it appears that the existing tank consists of a skid that is supported on a concrete mat foundation. The surrounding pipe supports are on 1'-6" diameter circular foundations that are 3'-3" in depth per existing facility drawings.

The primary tank itself is a cylindrical UL 142 horizontal steel tank, equipped with a rectangular steel secondary containment shell. All penetrations through the primary tank are through the top ("roof") portion of the tank, consistent with double-wall tank standards. The tank is inspected every ten years in accordance with STI-SP001, with the latest inspection reporting the tank is in good condition. The risk of a maximum allowable uncontained spill resulting from a design level earthquake is minimal.

The existing tank foundation tank nozzle connections and surrounding pipe supports and their foundation are not sufficiently designed to prevent a spill resulting from a design level earthquake. However, the low volume and infrequent use of the piping (normally not pressurized) would likely not result in a spill greater than the Maximum Allowable Uncontained Spill.

Measures to Mitigate Environmental Pollutants

As requested by the Oregon Department of Environmental Quality Cleanup Program, the Contaminated Media Management Plan (CMMP) Revision 1 describes an approach to monitor the Columbia River Sand Aquifer (CRSA) for PFAS impacts.

Stormwater Management (Surface Water Management)

See Appendix 1 – PDX Stormwater Narrative for an in-depth description of measures to mitigate effects on surface water and ground water.

As stated above the secondary containment system for each tank is not covered and will collect rainwater. A series of drains are to be installed in a radial pattern around the diameter of each tank to allow rainwater to be collected and drained through an 8” HDPE piping network that is cast into the above ground storage tank pile cap. Each tank drainage system is isolated by an eccentric plug valve (EPV) located on the outside of the secondary containment that is normally closed. All EPV’s are supported on each AST foundation pile cap. The only way to drain the secondary containment system is by an operator unlocking the valve, which occurs only after the absence of sheen on stormwater has been confirmed by the operator.

Foam Room within Operations Building

As deemed by the SVA, the existing Operations building is not seismically resilient and thus is being demolished and replaced. The Replacement Operations building is a Delegated Design item that has been Delegated to Sargent Engineers, Inc. The Operations building is being founded on concrete filled steel pipe piles and will serve as a headquarters for the Operators who maintain the facility. In addition to supporting operations, the building will also house a replacement for the fire suppression foam building as a room. The foundation and Operations Building have been designed to ASCE 7-16 risk category IV in compliance with Fuel Tank Seismic Stability Rule requirements and is anticipated to be accessible after an earthquake.

The primary fire water supply to the foam building will be from a new fire water loop around the facility. Five foam/water supply pipes will be provided throughout the site:

One (1) line for each new above ground storage tank for a total of three (3)

One (1) to the Pump Pad Monitor.

One (1) underground only supply pipe for the future fourth tank.

The water supplies will be both below and above grade. The below grade pipe will be HDPE. There will be seismic separation assemblies at each transition from below to above grade as well as between deep and shallow foundation supported assemblies. The above grade piping will be galvanized steel. The five supplies originate from the Operations Building foam room.

Below is a summary of the components that will appear in the foam room:

- A new 1,100-gallon foam concentrate tank will be provided.
- A new 6” variable range proportioner will be provided to supply the demand of 500 gpm for the monitor and 1,050 gpm for the foam chambers.
- The isolation valves for the foam concentrate tank will be ¼” turn ball valves and the supply pipe will be stainless steel or brass in accordance with NFPA 11.
- A Reduced Pressure Zone (RPZ) backflow preventer will be provided to protect the other fire water systems from the foam concentrate.

- A diesel fire pump rated at 1000 gpm at 85 psi will be provided to boost the pressure from the dedicated fire water supply.
- A sprinkler system will be provided off the fire pump system for the foam room only.
- A hydraulic ball valve will be provided for the foam concentrate supply to the proportioner for simplifying the operation and lack of accessibility
- Seismic bracing will be added in compliance with Oregon Structural Specialty Code Seismic requirements. Additionally, the tank systems will be seismically resilient and provided with seismic separation assemblies at locations where foundation support systems transition from shallow to deep or vice versa.
- A foam/water test header will be provided outside the foam room to provide backflow preventer, fire pump, and foam system testing. This will also double as hose handlines where seen as necessary for firefighting.
- Flow meters and hose connections will be provided on the foam system to allow for alternate foam or water only proportioner testing

Water Supply

A new fire water loop around the existing and new site will be installed to provide additional pressure to the fire hydrants and a new fire suppression system on site. This improvement is part of an overall PDX airport improvement plan. PDX performed a fire water study that showed great improvement to site pressures when providing a loop around the facility supplied from the dedicated fire water loop on the airport property.

The number of fire water hydrants on site will increase from three to five, with one located on each side of the site next to fire department connections, and adjacent to the hydrant cart test stand and fuel offloading. A hydrant south of the site, used for the drill pit mockup, is being removed with the proximity of the new hydrants on site. There will be two Fire Department Connections (FDC) locations for foam/water, one located north of the tanks, and one located south. There will be a water-only FDC on the operations building and a post-indicator valve adjacent to the operations building for the sprinkler and foam systems. The existing water supply, FDCs, and hydrants will be demolished or relocated to support the new system.

Fire Alarm System

The existing fire alarm system located in the Electrical building will be expanded to monitor the water supply, fire pump, and sprinkler system within the foam room. The manual foam suppression system will be mechanically supervised as agreed upon by the AHJ in a meeting on June 20, 2023. A fire alarm annunciator will be provided within the new Operations Building Control Room for notification of any EFSO activity or fire alarm information. This is consistent with the existing fire alarm system configuration. The existing panel dials out to a supervising station for local fire department notification.

Emergency Responder Access

There will be three routes to approach the new facility. Two routes are from the airport side Aircraft Rescue and Fire Fighting (ARFF). The facility will be normally accessible through an open gate on the east side. Public side, city-access will be available Northwest of the facility through a dedicated gate equipped with a key box.

Emergency Access was reviewed with the AHJ and agreed upon in a meeting on October 13, 2023.

Operational Sequence

The fuel storage tanks fire suppression foam system, and the foam monitor will be manually actuated from inside the foam building. Signage will be provided inside the foam building and on valves to guide emergency responders with a step-by-step procedure on operation of the foam/water systems.

Operational Procedure:

- Fuel Facility: This facility is staffed 24 hours a day, 7 days a week. It is protected with a manually operated 3% fluorine free foam foam/water fire suppression system.
- Initiation: Upon detection of a fire event, the onsite personnel will call 911 and prepare the site for the arrival of emergency responders.
- Fire within a Fuel Tank: Open the associated foam chamber valve in the foam building to discharge foam/water into the tank.
- Fire at the fuel transfer pumps: Open the valve within the foam building to pressurize foam/water underground loop to the foam monitor.
- If foam concentrate is exhausted: Additional foam/water can be supplied to all distribution systems through (4) 2-1/2 in foam/water fire department connections at two independent staging locations.

Emergency Response & Preparedness

Fire Department Response and Access:

Emergency access to the site is provided through three (3) points of entry:

- One (1) on the airport side main entrance on the northeast side of the site.
- One (1) on the public side on the northwest end of the site.
- One (1) on the southeast corner of the site.

The entrance on the south side leads to an access road along the east side of the storage tanks. The north side of the site is accessible; however, the north side of the tanks are obstructed by buildings and the pump pad on the eastern half. The western and southern ends of the site are completely accessible for the fire department. The current fire access roads are 20 feet wide per International Fire Code (IFC) section 503.2.1.

There are three (3) fire department connection locations at the site. The fire department connections for foam water are located north of the tanks and south of the tanks for pumping foam directly into the infrastructure systems supplying the foam chambers and foam monitors. There is additionally a fire water department connection on the south side of the operations building.

Fire hydrants are located around the perimeter of the entire fuel facility for supplemental fire water connection. Additional foam/water hose connections are provided on the exterior of the operations building at the foam room.

Instructional signage for system use is composed of maps of the site at key locations such as the fire department connections and the foam room as well as instructional signage in the foam room.

The facility is located on the Northwest side of Portland international Airport. Each tank is equipped with a secondary containment area to prevent the spill of fuel and spread of fire. The nearest residential area is one and a half miles from the facility. Additional firewalls or fire rated assemblies are not provided as there are no residential communities in the immediate vicinity.

Operational Safety Measures

Safety of Operating Conditions:

The PDX Fuel System is monitored 24/7 by one or more on-site personnel. The PDX Fuel System is equipped with several redundant protection and alarm systems to monitor the safety of operating conditions.

All PDX fuel storage tanks are equipped with radar type automatic tank gauges (ATG) to constantly measure the liquid level inside each tank. The ATGs are equipped with redundant radar sensors such that an alarm is generated if liquid level readings for either sensor are different from the other. In the event a radar sensor fails completely, the redundant sensor will provide the primary liquid level reading and alert the Operator of the failed sensor. The ATG systems are programmed with separate high and high-high level alarm setpoints.

In the event the liquid level reaches the ATG high level setpoint, an alarm will alert the Operator so they can manually stop the operation. If flow of fuel continues to the ATG high-high level setpoint, an alarm will be sent to the Operator. Additionally, the system will automatically shut closed the receipt (inlet) motor operated valve and stop all transfer and offload pumps at the Fuel Facility.

Further supplementing the ATG system, each tank is equipped with an independent high-high level alarm switch. Activation of the independent high-high level switch will also activate an alarm. This alarm will close the receipt valve and shut down all transfer and offload pumps at the Fuel Facility. During a pipeline receipt, if either of the high-high level alarms (ATG or independent switch) are activated, the pipeline's ready to receive permissive will be removed, automatically shutting down the pipeline pumps and stopping flow of fuel into the storage tank.

The hydrant pumps are equipped with internal bearing temperature sensors to automatically alert the Operator of a high-temperature condition. If the bearing temperature continues to rise to the high-temperature threshold, the hydrant pump will automatically be shut down and an alarm is sent to the Operator to prevent or mitigate any fire risk.

The hydrant pumps are also equipped with two vibration transmitters (one for X-axis, one for Y-axis) to alert the Operator of any high vibration conditions. If vibration levels continue to rise to the threshold (as defined by the pump manufacturer), the hydrant pump will automatically be shut down and the alarm sent to the Operator. A combination flow and temperature sensors exist downstream of each hydrant pump. If the flow sensor fails to detect flow, or a loss of flow is detected, the hydrant pump will be automatically shut down and an alarm sent to the Operator. The sensor will also detect fluid temperatures, and automatically shut down the hydrant pump and alert the Operator if the fluid temperature reaches the set point.

Safe Shutdown Procedures:

As noted, the Fuel Facility is manned 24/7. In the event of an accidental spill or emergency such as an earthquake, an emergency fuel shut-off (EFSO) button will be activated by the Operator. Activation of the EFSO system will shut down all delivery pumps at the Fuel Facility, stopping the flow of fuel within the facility and across the entirety of the Airport Hydrant System. Activation of an EFSO at the Fuel Facility will also trigger the tank motor operated valves (receipt and issue) to automatically close.

These EFSO buttons are located throughout the Fuel Facility at all points of ingress and egress, and at each Airport gate at the Airport terminal buildings.

Potential Spills:

All fuel storage tanks are located within secondary containment. All flanged and threaded connections (mechanical joints) for fuel piping and equipment are located over curbed concrete containment pads or within concrete vaults. Fuel piping located outside of secondary containment is all buttwelded without mechanical joints. In the event of an accidental spill, sections of the system can be isolated from other portions to prevent further discharge of system contents. All isolation points are equipped with double block-and-bleed plug valves which provide verifiable positive isolation.

Pumping systems are located on a curbed containment pad. The loading area is provided with sized containment for the largest potential container. An Integrated Contingency Plan (ICP) prepared by Advanced Remediation Technologies, Inc. was developed for the PDX Fuel Facility and is updated in accordance with regulatory requirements. This ICP (Appendix 2) combines the required planning elements from the following regulating agencies:

Resource Conservation and Recovery Act (RCRA) Contingency Planning requirements (40 CFR 264 and 265)

Spill Prevention Control and Countermeasures Plan (SPCCP) (40 CFR 112)

Facility Response Plan (FRP) (40 CFR 112)

Oil & Hazardous Materials Emergency Response Requirement (OAR Div 142, ORS 468B)

The ICP provides clear direction for responding to a spill, including stopping the product flow, shut off of ignition sources, warning personnel/supervisor, initiating containment and notifying agencies such as ORES, NRC, Airport Comms Center, response contractor, and PFC. The ICP will be followed and utilized by the Operator in the event of a spill to see that emergency incidents are responded to quickly, safely and effectively, and are properly reported and documented. The emergency incidents in the plan include pollutant release to the environment resulting from spills, as well as explosions, fires, and other dangerous incidents. All Operator personnel are trained and familiar with the ICP and the process for contacting the Oil Spill Response Organization as required by the FRP. In addition, any emergency related to the PDX Fuel Facility requires the Operator to contact PDX Airport Operations, who in turn engage emergency responders to assist.

In addition to the ICP, an Airlines for America (formerly known as Air Transport Association of American) [A4A] Fuel Facility Disruption Plan was developed and implemented in 2019. This plan provides guidance to the Fuel Consortium and Operator during a fuel disruption. The emergency incidents in the plan include natural disasters such as earthquakes. The A4A is a trade association and lobbying group that works collaboratively with the airlines and government to see that all policies promote a safe, secure and healthy U.S. airline industry.

A copy of the Operator's IPC can be found as an attachment to this report as:

Appendix 2 – ASIG PDX ICP 2023.

A copy of the A4A can be found as an attachment to this report as:

Appendix 3 – PDX – A4A Facility Disruption Plan.

Electrical Systems That Isolate Fuel:

When activated, the Emergency Fuel Shut Off (EFSO) system stops hydrant pumps, sends close commands to electrically operated valves (including the ones located on operating tanks) and causes hydraulic valves (fail-safe, Cla-val) to close. The hydraulic valves can close by one of the following means:

1. Removing power from the electric solenoid.
2. Pressure in the pipe decreases because of the pumps turning off.
3. The EFSO system is activated manually by pressing EFSO pushbuttons which are located at paths of egress and major fueling operations.
4. If power is removed from the electrical distribution system at site, the hydraulic valves (Cla-val) will close because of loss of pressure due to the hydrant pumps not running.
5. If power is removed from the EFSO system (which is fed by the electrical distribution system) the EFSO system will recover in a faulted state. This means that valves will be driven closed, and pumps will be unable to restart until active EFSO alarms are cleared and reset is pressed on the EFSO panel.

Overall Control System:

The control system at the Fuel Facility is a programmable logic controller (PLC) based system. The control system allows operators to monitor and control the fueling system. The control system will also report alarms to the operators.

The control system has redundant logic controllers so that a failure on one controller allows seamless transition to the backup controller. The control system has a dedicated uninterruptible power supply (UPS). During a utility power outage, the UPS will continue to provide power to the EFSO Panel/System and the Control System for a minimum of 15 minutes. This UPS will provide power until the standby generator is running, which may take 30-60 seconds to come up to speed and become available to the system.

Systems in Place for Environmental and Personnel Protection:

Hydraulic valves (fail-safe, Cla-Val) are located at each hydrant pump train. (FC-HPX). Valves close on loss of pressure or loss of power to its solenoid.

Electrically operated valves are located at each operating tank. These valves are "fail in place." While the electric actuator is powered (480v), the valve can be closed remotely by removing an electrical input. The valves are closed locally by using a handwheel located on the actuator or if actuator is powered (480v) the valve can be closed with a selector switch located on the actuator.

It takes approximately 45 seconds to fully close the valve from a close command. The site has a standby generator (seismic rating identified below) which will restore 480v if utility is down.

The electrically operated valves are located at the tank shell. If there is a spill, the electrically operated valves will be in containment with the fuel. If they still have power, they will be able to be remotely closed.

Major Electrical Equipment

1. Standby Generator

   Manufacturer: Kohler – KD1500

   Supports overall electrical distribution system.

   Seismic rating: Qualified. Products are rated to perform successfully during and after seismic activity.

   Sub-base tank, fuel volume, is sized to operate generator for 24 hours.

2. Panelboards within new Power Distribution Center (PDC)

   Manufacturer: ABB – ReliaGear neXT power panel

   Supports smaller loads (lighting, Electric operated valves, PLC)

   Seismic rating: Qualified. Products are rated to perform successfully during and after seismic activity.

   Manufacturer: ABB – RE/RS Lighting Panel

   Supports smaller loads (lighting, Electric operated valves, PLC)

   Seismic rating: Qualified. Products are rated to perform successfully during and after seismic activity.

3. Switchgear (Within new PDC)

   Manufacturer: ABB – AKD-20 Entellisys

   Supports overall electrical distribution system.

   Seismic rating: Qualified. Products are rated to perform successfully during and after seismic activity.

4. Switchboard (Within new PDC)

   Manufacturer: ABB – ReliaGear AV1

   Supports overall electrical distribution system.

   Seismic rating: Qualified. Products are rated to perform successfully during and after seismic activity.

5. Motor Control Center (MCC1) (Within new PDC)

   Manufacturer: Rockwell Automation – Allen Bradley - Centerline 2100

   Supports overall electrical distribution system.

   Seismic rating: Qualified. Products are rated to perform successfully during and after seismic activity.

Schedule to Complete All Proposed Mitigation

It is estimated that construction of the facility per the mitigation drawings will take four (4) years from receipt of all required construction and environmental permits.

Closing Remarks

Comparing the planned replacement structures to those currently in place, one can ascertain an immense improvement to the expected performance and structural integrity of the new and to-remain engineered structures, which meet the requirements of ASCE 7 Risk Category IV in compliance with Fuel Tank Seismic Stability Rules.

Based on the design as proposed, the improved fuel storage facility meets or exceeds Oregon Law, Multnomah County, City of Portland and Port of Portland design requirements. This concludes the Risk Mitigation Implementation Plan for the PDX Fuel Facility.

This document and all attachments were prepared under direction or supervision in accordance with a system designed to provide qualified personnel to properly gather and evaluate the information submitted. Based on the inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the extent of our knowledge and belief, true, accurate and complete.

Sincerely,

Kaylea Michaelis

Kaylea Michaelis – Structural Engineer of Record

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Attachments:

Appendix 1 – PDX Facility Improvements Stormwater Design Narrative
Appendix 2 – Integrated Contingency Plan
Appendix 3 – A4A Fuel Facility Disruption Plan Guidelines
Figure 1 – PDX Fuel Facility Pipe Supports Being Demolished
Figure 2 – PDX Fuel Facility MD101, Mechanical Demolition Overall Site Plan
Figure 3 – PDX Fuel Facility MD401, Enlarged Demolition Plan Hydrant Pump Pad

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