Memorandum

Date: 12/21/2023

To: Development Services Center
1900 SW Fourth Avenue
Portland, OR 97201

From: Kaylea A. Michaelis, S.E.

Subject: PDX Seismic Design

Re: PDX Fuel Facility – Structural Analysis Write-Up

Project Background

The PDX Fuel Facility is leased 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 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.

PFC has hired Burns & McDonnell to provide a comprehensive Seismic Vulnerability Assessment (SVA) and Mitigation plan on their behalf.

As a result of the SVA, certain existing features at the current facility are being removed:

- Existing above ground storage tanks 1, 2 and 3.
- Existing concrete dike walls and geomembrane liner.
- Existing Operations Trailer.
- Existing Hydrant Cart Test Stand (HCTS).

The PDX Fuel Facility has been designed in accordance with the following Design Standards:

A. 2022 Oregon Structural Specialty Code (OSSC) based on the International Building Code (IBC) 2021
B. State of Oregon Department of Environmental Quality Fuel Tank Seismic Stability Rules Adopted September 14, 2023
C. ASCE 7-16 – Minimum Design Loads and Associated Criteria for Buildings and Other Structures
D. ACI 318-19 – Building Code Requirements for Structural Concrete

E. ACI 350-20 – Code Requirements for Environmental Engineering Concrete Structures
F. AISC 325-17 – Steel Construction Manual
G. AISC 360-16 – Specification for Structural Steel Buildings
H. AWS-D1.1 – Structural Welding Code

Further information pertaining to design assumptions, design loads and material selections may be found in the design drawings, specifications, supplemental calculations, and appendices.

Geotechnical

A third-party geotechnical investigation was performed by Haley and Aldrich (H&A) in early 2023. Findings of said investigation were provided to Burns & McDonnell as three separate sealed reports. Those reports have been listed as Appendices and are for reference only:

- Appendix A – Report of Geotechnical Engineering Services
- Appendix B – Report of Enhanced Seismic Design Considerations
- Appendix C – Geotechnical Data Report on PDX Fuel Project Tank Design

Based on the report from Haley and Aldrich (H&A) and because of a site-specific analysis the site is classified as follows:

- Site Class E
- S_{ds} = 0.590
- S_{d1} = 0.739
- Seismic Design Category D

Per ASCE 7-16 – 11.4.8 – Site Specific Ground Motion Procedures – a site response analysis must be performed for Site Class F, unless exempted in 20.3.1.

a. For structures with a fundamental period of 0.5 seconds or less, a site-specific analysis is not required.
b. The fundamental period of each 110-foot diameter x 32-foot-tall tank is 0.191 seconds. Which is less than 0.5 seconds, therefore a stie class analysis is not required.

Although not required by ASCE 7, it is permitted to perform a site analysis to determine ground motions for any structure. A site-specific analysis was ordered for this project.

Project Main Structures

This project consists of the following structural features, which have been summarized here to provide the reviewer(s) with an overview of the project:

- (3) 110 ft diameter x 36-foot-tall field fabricated above ground storage (AST) tanks.
  - S-402 – Tank 5

  - S-403 – Tank 6
  - S-404 – Tank 7
  - S-511
- Combined Hydrant Cart Test Stand (HCTS) and Truck Offload with overhead Canopy
  - S-404
  - S-405
  - S-201
  - Canopy design was performed by a hired third-party and has been provided as reference only in Appendix D - Calculations and Plans from Canopy Vendor. This structure has also been submitted for Permit to the City of Portland under a separate permit number.
- Light-pole, Security-pole and Card-Reader and Intercom Foundations
  - Electrical Drawings for location reference
  - Locations are also shown on S-400 series drawings.
  - S-531
- (4) Shop fabricated utility truss modules.
  - S-406
  - S-532
  - S-533
  - S-534
  - S-535
  - S-536
- Electrical Rack and Miscellaneous Cable Tray Supports
  - S-537
- (3) Fire loop support racks
  - S-538
- (1) Utility Expansion Loop Support Steel
  - S-539
- (3) Crossover stairs
  - S-401
  - S-402
  - S-403
  - S-541, S-542
- Pipe Supports
  - Mechanical Drawings
  - S-551
  - S-552
  - S-553

Above Ground Storage Tanks (AST)

The foundation loads as a result of the primary tank and secondary containment shell were developed utilizing API 650 and ASCE 7-16 loading. Further detailed loading information can be found in the structural calculations. The primary tank and secondary containment shell will be designed by an above ground storage tank manufacturer and is a deferred submittal. However, design loads from the tank were incorporated into the foundation as previously indicated.

Both the primary tank and secondary containment shell will be founded on a concrete pile cap that is supported by concrete filled steel pipe piles. The loads that will be applied to the secondary containment shell because of ASCE 7-16 – 15.6.5 – Secondary Containment Systems and 15.6.5.1 Freeboard have been incorporated into the design loading that the foundation will need to resist. It should be noted that the Primary containment has not been designed with a reduction in the structure category.

As shown in the calculations, the interstitial space and the height of the secondary containment wall were not based on the actual liquid within the primary tank, but instead are based on the nominal gallon capacity of the storage tank as required by the Source Control Manual.

The base shear of the pile supported mat was determined by following ASCE 7-16 15.4.2 Rigid Non-Building Structures.

A finite element analysis model that includes all applicable tank loading, including seismic weight from the tank mat itself, was analyzed to determine pile loads. These loads were run through L-pile analysis, and it has been determined that these loads on the concrete filled steel pipe piles are acceptable and within code requirements.

Combined Hydrant Cart Test Stand (HCTS) & Truck Offload with overhead Canopy

This structure consists of a concrete beam system that is integrated with the grids of the overhead canopy structure (designed by others). The concrete beams are supported on a system of concrete filled steel pipe piles. The overhead canopy is 85'-0" x 77'-6" and extends a minimum of 5 feet from the perimeter of the fueling pad as required by the Portland Source Control Manual.

The structure consists of the following components.

- Central island with Reclaim Tank
- (2) two offload drive lanes
- (1) one fueling island

The central island consists of an 8" structural slab that spans across the pile supported concrete grid system. A 20,000 gallon double walled jet fuel reclaim tank is supported on this structural slab and is locally thickened to accommodate anchorage of the tank.

Miscellaneous pipe supports and pump equipment are also supported on this slab.

The two offload drive lanes consist of a 9" structural slab that spans between the pile supported concrete central island and the adjacent pile supported concrete beams systems. Because this drive slab area acts as secondary containment, at all construction joints and concrete interfaces, 6-inch ribbed style flexible water-stops are provided in addition to jet-fuel resistant sealant.

The secondary containment drive lane is sized for a 10,000-gallon tanker truck, however a single drive lane alone is not adequate for containment. Thus, a trench that crosses the central island has been provided to meet minimum containment volume. This trench has been locally thickened to help maintain the structural integrity of the 8" central island structural slab.

On the plan west side of the canopy is a fueling island. This consists of a 30" thick pile supported mat foundation that is tied back into the pile supported concrete beam support system.

The base shear of the pile supported mat was determined by following ASCE 7-16 15.4.2 Rigid Non-Building Structures.

Light pole, Security Pole and Card-Reader and Intercom Foundations

Miscellaneous shallow supporting foundations have been designed to meet the design bearing pressure as provided by H&A. Because of their proximity away from adjacent structures and because they are not an occupied structure nor a threat to creating a potential spill, these structures have not been laterally tied back to adjacent structures.

Pile Caps

All pile caps on this project follow ASCE 7-16 – 12.13.9.3.5 – Foundation Ties requirements. Individual pile caps must be interconnected by ties in accordance with Section 12.13.8.2, where the geotechnical investigation report indicates permanent ground displacement induced by lateral spreading.

ASCE 7-16 – 12.13.8.2 – All ties shall have a design strength in tension or compression at least equal to a force equal to 10% of S_{DS} times the larger pile cap or column factored dead plus factored live load.

In the instance of the Utility Truss pile caps, these pile caps have piping networks that are supported on the trusses and go to the individual AST. As a result, the Utility Truss pile caps have been tied back to the AST Pile Caps. See AST calculations and interconnecting pile cap beams within the calculations for further information.

Utility Truss Modules

To reduce the overall number of piles on this project, a rack system has been provided for the long runs of piping that go from the tanks back to the existing pump pad. These modules are intended to be shop fabricated and assembled as a unit complete with piping and cable tray installed and then shipped to the site for installment. All piping and cable trays on the utility truss have been designed with an R value of 1 assuming moment frames following chapter 15 and a redundancy factor of 1.3. Tributary lengths of all utilities were accounted for and their fully loaded dead and cable or water load was multiplied by the corresponding R value of their supporting steel structure, not of the non-building component seismic value determined by Chapter 13. This approach is conservative and follows the provisions as outlined in ASCE 7-16 – 15.3.2 and results in a higher seismic design force that must be resisted by both the truss and the supporting foundation.

Electrical Rack and Miscellaneous Cable Tray Supports

The Electrical Rack and Miscellaneous Cable Tray Supports are all supported on a steel frame system that consists of moment frames and concentrically braced steel frames. These structures are supported on concrete mat foundations with lateral ties back to an adjacent AST tank pile cap.

Utility Expansion Loop Support Steel

The utilities in this area are all supported on a steel frame system that consists of moment frames and concentrically braced steel frames. These structures are supported on concrete mat foundations with lateral ties back to an adjacent AST tank pile cap.

Crossover Stairs

Personnel access stairs that allow the Fuel Facility Operators to easily cross piping and avoid the need of walking completely around an entire tank to access valves and appurtenances are provided at each tank. These stairs are not primary egress because in the event of an emergency personnel could find alternative means of exiting the vicinity.

The tank vendor stairs however are considered egress stairs; nevertheless, this design will be provided later by the tank manufacturer and should be considered a deferred submittal.

Pipe Supports

Piping design loads, wind and seismic and thermal design cases were run by our internal Burns & McDonnell Mechanical group utilizing Autopipe. The stress outputs as a result of this model were provided to Structural and incorporated into the design of all pipe supports and pile supported concrete mat foundations / pile caps. The seismic coefficient for the piping and their anchorage was determined utilizing Chapter 13 of ASCE 7-16 and input into the pipe stress model.

Seismic Transition Pad

An eighteen-inch concrete shallow mat foundation has been provided adjacent to the first utility truss module on the north end of the facility. This seismic transition pad is an area where the new facility piping transitions from pile supported foundation systems back to shallow foundation systems. The new facility must tie into an existing pump pad that was constructed in the 1970's. The existing facility is not on deep foundation supported structures, thus flexibility in both the piping and the supporting structure has been designed to handle the anticipated vertical and lateral spread resulting from a design level seismic event.

Sincerely,
Kaylea A. Michaelis, S.E.

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