Assessment Summary Report

Hillsboro Airport Seismic Resilience Assessment

Hillsboro, Oregon

Prepared for

Port of Portland

February 4, 2019

154-035-006

www.hartcrowser.com

Assessment Summary Report

Hillsboro Airport Seismic Resilience Assessment

Hillsboro, Oregon

Prepared for

Port of Portland

February 4, 2019
154-035-006

Prepared by

Hart Crowser, Inc., Salus Resilience, and WHPacific/DOWL

REGISTERED PROFESSIONAL ENGINEER
69452PE
OREGON
Nov. 14, 2006
ALLISON MARIE PYRCH
EXPIRES: 12/31/20

Allison M. Pyrch, PE, GE
Associate, Geotechnical Engineer

Janice Marsters, PE (WA), PhD
Principal

David Nafie, AICP
Senior Aviation Planner

6420 SW Macadam Avenue, Suite 100
Portland, OR 97239
Tel 503.620.7284

Contents

TABLES

FIGURES

APPENDIX A

APPENDIX B

Assessment Summary Report

Hillsboro Airport Seismic Resilience Assessment

Hillsboro, Oregon

1.0 INTRODUCTION

Salus Resilience (Salus), represented by Hart Crowser, Inc. (study team) is pleased to submit this summary report of our resilience inventory and assessment for the Hillsboro Airport (HIO) for the Port of Portland (Port). Our work was conducted in general accordance with our subconsultant agreement with WHPacific, dated March 17, 2017.

In the Pacific Northwest, seismic risk is generated by the Cascadia Subduction Zone (CSZ) located within a few miles off the Oregon and Washington coast. This subduction zone results in three types of earthquake risks in Hillsboro: interface earthquakes along the plate boundary, intraslab earthquakes within the North American Plate, and crustal quakes generated by crustal faults. Interface earthquakes on the CSZ are generally large, on the order of magnitude 8 to 9. Based on the most recent scientific data from Oregon State University, the potential risk for a magnitude 8 or greater earthquake along the CSZ ranges between 10 and 35 percent in the next 50 years, depending on rupture location and area. In order to address this hazard, the Oregon State legislature commissioned the completion of the Oregon Resilience Plan (ORP) in 2012. The final report was accepted by the legislature in 2013. The ORP is an assessment of our current infrastructure seismic resilience and a guidance for building a resilient infrastructure system over a 50-year timeframe. A status update was completed in 2018 that highlighted work that has been completed since the original report, including this assessment. This update recommends that a mitigation policy and retrofit plan be developed for the 29 airports highlighted in the original plan, including HIO.

Based on the information presented in the ORP, shaking due to the seismic event will result in large-scale damage and a resulting tsunami is expected along the entire Oregon coast (hereafter referred to as the “design event”). Large-scale shaking damage is expected west of the Cascade Range, including in Hillsboro and Washington County. As part of the response planning for a Cascadia event, the ORP identified HIO as a Category II, Urban General Aviation Airport and also as Tier II, Emergency Response, which is defined as a regional airport that provides access to rural areas needed to restore major commercial operations. Further, the ORP indicates that in order to support a robust multimodal transportation system after a Cascadia event, either the Scappoose or Hillsboro airport should be operational. Based on information from the Oregon Office of Emergency Management (OEM), it is also considered an Incident Staging Base by Federal Emergency management Agency (FEMA) and a State Staging Area (SSA) that will be used to provide distribution to the local communities.

In addition to the ORP, plans and emergency management documents from Washington County (County), the City of Hillsboro (City), the Oregon Department of Aviation (ODA), Oregon Military Department (OMD), and the OEM were reviewed to understand the potential role of HIO in response and recovery plans. Further, a stakeholder group that included members of the 2017 Oregon State Airport Resiliency Workgroup (OEM, ODA, State Resilience Officer), as well as other state, County, City, and Port representatives met February 15, 2018, to discuss the status of state and federal response and recovery plans and HIO's role in these plans. Meeting minutes are attached in Appendix A. This meeting was the first step in developing a more comprehensive approach to state response and recovery plans. Based on this meeting, no clear role has been developed for HIO; however, as the state plans develop, the Port is committed to continuing the conversation with stakeholders to develop the preferred role in response and recovery.

The Port commissioned this seismic resilience assessment to inventory and assess existing facilities at HIO, review existing emergency response plans, and understand the stated roles for the airport with the goal of evaluating the seismic resilience of HIO. This assessment will be used as part of the master planning process to incorporate appropriate resilience goals for HIO into the master plan. As a part of our work, structural assessments of two key buildings were completed, which included a background review of provided information and a site reconnaissance. These reports are discussed in *Section 6.2 Structures* of this report and are included in full as Appendix B.

The Port is also undertaking its own Seismic Resilience Plan. The plan identifies infrastructure critical to Port operations in response to and recovery from a destructive seismic event. The role of the Port's aviation facilities will be to support emergency operations and response efforts and to support long-term recovery efforts. The plan will prioritize investment in critical response and recovery infrastructure and deliver a set of recommendations for capital investment. The Portland International Airport (PDX), being the state's major airport, is the focus and number one priority of resiliency investments by the Port. HIO will play a support role in recovery efforts, as described herein, and as a Tier 2 airport it is a moderate to low priority for Port seismic resiliency investments.

Based on this assessment and our understanding of the region's vulnerabilities to a CSZ earthquake, HIO has the potential to be included in regional plans to have a support role in the emergency response and recovery operations for the region after a CSZ event. Oregon and Washington County communities, infrastructure, and ground transportation systems are projected to suffer severe damage from ground shaking, ground deformation, and landslides. Due to the expected damage to the ground transportation network, Hillsboro and other communities will be separated into "islands" following the event. Smaller, resilient airports will become critical infrastructure essential to the facilitation of the planned air response; supply distribution; and rescue, evacuation, and recovery efforts. Based on our understanding of the emergency recovery needs of the area, HIO will be a valuable asset to the City, the County, the region, and the state for both emergency response operations in an area isolated by damage to ground transportation, as well as for long-term recovery of the local economy. The more resilient HIO becomes, the more quickly facilities at the airport can be returned to service to aid in the regional recovery, although resiliency investments at HIO need to be planned and prioritized in light of broader Port resiliency priorities.

2.0 SCOPE OF SERVICES

The purpose of our work was to conduct a resilience assessment of HIO in support of the master planning effort. Our scope of work for this report meets the portions of the seismic considerations scope between WHPacific and the Port and is summarized below.

- Review Port's Seismic Risk Assessment and Existing Conditions:
  - Review Port's Seismic Risk Assessment Study;
  - Review available geotechnical information in Port records; and
  - Reviewed geologic and geotechnical hazards at the site and assessed soil vulnerabilities at the site.
- Conduct a site reconnaissance including the following:
  - On-site inventory of buildings, materials, and equipment;
  - Review of available emergency plans;
  - Participation in meetings with WHPacific, Port personnel to evaluate existing resilience measures, including long-term resilience goals and timelines to meeting those goals;
  - Perform American Society of Civil Engineers (ASCE) 41-13 structural evaluations of the main terminal building and the maintenance building; and
  - Review material and equipment resources and capacities.
- Provide a summary table of the resilience assessment of airport facilities.
- Identify the role for HIO based on an understanding of Port objectives and outside obligations. Develop goals that support any identified role.
- Develop recommended facility requirements for the stated emergency response and recovery goals that will be incorporated into the 2018 HIO Airport Master Plan Update. Estimated costs and funding scenarios for recommended facilities will be reflected in the Master Plan Capital Improvement Program, as appropriate.
- Prepare summary report outlining study team findings (this report).

3.0 ROLE DISCUSSION

Based on our review of the ORP and the February 15, 2018 meeting, HIO will have a role as a facility for emergency response and recovery operations after a large seismic event. As described in the introduction, due to the expected damage to other infrastructure, it is unlikely that there will be a ground transportation option between PDX and other potential distribution points in Washington County. Emergency plans are not yet specific in calling out facilities for response; however, based on the discussions in our stakeholder meeting, HIO and the adjacent fairgrounds may be needed to facilitate air operations in support of supply distribution, rescue and evacuation efforts, and long-term recovery. Based on our discussions with the Port, the goals for HIO are as follows:

- Protect the life safety of employees and personnel present at HIO during an event.
- Develop resilient storage for airport equipment and supplies.
- Support emergency response as possible.
- Continue to work with stakeholders to define a role and plan for HIO.

4.0 RECORDS REVIEW

4.1 Geologic Hazard Mapping

The study team reviewed mapped geologic hazards including: discrete landslides, landslide susceptibility, earthquake shaking, and relative liquefaction. Landslide mapping is provided by the Statewide Landslide Information Database for Oregon (SLIDO). No mapped or historically active landslides are recorded within the airport boundaries; however, a debris flow estimated to be over 150 years old is mapped southeast of the airport, south of NE Cornell Road (SLIDO 2016). The immediate area of HIO is mapped as predominately low risk for landslides, with a few areas of moderate landslide susceptibility. It is also mapped to be at risk for “very strong” expected earthquake and expected Cascadia earthquake shaking, and low to high liquefaction potential (HAZVU 2016). Additionally, the U.S. Geologic Survey (USGS) maps a low slip rate Quaternary active fault approximately 1 to 1.5 miles northeast of the site (USGS 2006). SLIDO mapped landslides are shown on Figure 1. Liquefaction hazard is shown on Figure 2 .

4.2 Emergency, Response, and Resilience Plans

The study team reviewed the ORP and the Cascadia Playbook and discussed emergency protocols with Port maintenance personnel. The assessment team also reached out to the OEM and OMD, the County, and the City in the February 15, 2018 stakeholder meeting to assess their expectations for HIO’s role following a disaster event. Based on our reviews and discussions, the airport is likely to be tasked with serving a significant role in recovery for the County and the region, if able. However, the designations in the ORP have not been incorporated specifically into current state, regional, or FEMA plans.

Current airport emergency plans cover typical airport events related to air traffic and accidents and do not specifically address a design level earthquake event. We understand that the protocols rely upon on-site airport personnel to facilitate response for an aircraft event and do not include specific protocols for mobilizing outside backup, either Port staff or non-Port resources. A City fire station located adjacent to the airport serves both the airport and the community. Based on our understanding, no specific earthquake plan exists at this facility and, under current operations, there is a possibility that the resources at this facility may not be available for CSZ event response activities if off-airport services are considered a higher priority.

A review of existing documents show that current emergency plans have not been updated to include a large earthquake scenario and education programs have yet to be developed for on-site personnel, both Port employees and private tenants.

4.3 Existing Airport Plans and Reports

To facilitate the seismic assessment of airport facilities, our team reviewed the Port's records library to assess existing airport facility plans and relevant technical reports. The library was extensive, and many documents were downloaded and reviewed. A general list of documents reviewed for this study is included in *Section 10.0 References* of this report. The most relevant documents reviewed are:

- 2010 Plans for the most recent terminal building upgrades;
- The 2016 geotechnical report completed by GRI for the Runway 13R-31L improvement project proposed for construction in 2019/2020; and
- The 2015 Seismic Risk Assessment and Existing Conditions for the Port of Portland.

5.0 SEISMIC CONSIDERATIONS

5.1 Earthquake Mechanisms

The seismicity of the region is controlled by the CSZ. Plate tectonics cause the oceanic Juan de Fuca Plate to subduct beneath the continental North American Plate. Three types of earthquakes are associated with subduction zones: intraslab, interface, and crustal earthquakes. Contributions from each of these sources to the total site seismic hazard was evaluated using the USGS 2008 Interactive Deaggregations (USGS 2013).

Intraslab and Interface Sources. Subduction zones are characterized by the interaction of the oceanic Juan de Fuca Plate and continental North American Plate. As the oceanic plate subducts beneath the continental plate, the two plates lock together. As the plates move together, stresses similar to a spring build in the overlying continental plate. When the magnitude of the *spring* stresses become large enough to overcome the stresses locking the plates together, the plates will suddenly rupture causing an interface earthquake. Interface earthquakes (such as the 2011 magnitude 9 Tohoku earthquake in northern Japan) are some of the largest magnitude earthquakes on record.

Intraslab earthquakes originate from a deeper zone of seismicity that is associated with bending and breaking of the subducting Juan de Fuca Plate. Intraslab earthquakes (such as the 2001 magnitude 7 Nisqually earthquake in west central Washington) occur at depths of 40 to 70 kilometers (km) and can produce earthquakes with magnitudes up to and greater than magnitude 7.

Our review of the interactive deaggregation indicates that interface and intraslab earthquakes contribute over 70 percent of the total seismic hazard to the project area.

Crustal Sources. Shallow crustal faults are caused by cracking of the continental crust resulting from the stress that builds as the subduction zone plates remain locked together. Many small crustal faults that are a part of the greater Cascadia Fold and Thrust Belt are mapped near the project area. Crustal sources contribute approximately 30 percent of the total seismic hazard to the site.

For the purpose of this analysis, the design level seismic events for HIO can be defined as the magnitude 8 and above CSZ events as well as local crustal events (approximate magnitude 6.0 to 6.5).

5.2 Liquefaction

When cyclic loading occurs during an earthquake, the shaking can increase the pore pressure in loose to medium dense saturated sands and cause liquefaction. The rapid increase in pore water pressure reduces the effective normal stress between soil particles, resulting in the sudden loss of shear strength in the soil. Granular soils, which rely on interparticle friction for strength, are susceptible to liquefaction until the excess pore pressures can dissipate. Sand boils and flows observed at the ground surface after an earthquake are the result of excess pore pressures dissipating upwards, carrying soil particles with the draining water. In general, loose, saturated sand soils with low silt and clay contents are the most susceptible to liquefaction. Silty soils with low plasticity are moderately susceptible to liquefaction under relatively higher levels of ground shaking. For any soil type, the soil must be saturated for liquefaction to occur.

Liquefaction potential under the main runway was evaluated by others as part of the design effort for the upcoming runway 13R-31L improvements project. Based on the 2016 GRI study, between 1 and 4 inches of liquefaction settlement is expected over the southern half of the runway and between 2 and 7 inches of liquefaction settlement is anticipated over the northern half of the runway in design level events (CSZ and crustal quakes). We understand that planned runway improvements will not include liquefaction mitigation and thus the runway will be vulnerable to damage during the design event, especially due to differential settlement. Based on the information reviewed and hazard mapping, the liquefaction hazard extends beyond the runway as shown on Figure 2. Liquefaction settlement and soil strength loss may also cause problems with on-site structures. Differential settlement can result in foundation failures, utility disruptions and damage, and problems with building access, such as doors not functioning.

6.0 INVENTORY AND ASSESSMENT

6.1 General

The study team prepared this inventory and assessment using both existing information provided by the Port and data collected during site reconnaissance with airport management on March 28, 2017. The goal of the inventory was to collect data on the existing facilities and resources at the airport related to resilience and disaster response. Non-essential equipment and property not owned by the airport, including Federal Aviation Administration (FAA) owned facilities, privately owned hangars, and adjacent fire facilities, were not included in this assessment, unless otherwise noted. Following the inventory, selected facilities were assessed for a generalized resilience risk assigned a risk rating of low, medium, or high. Elements rated “Low Risk” are anticipated to be mostly functional and useable after a design level event and may require relatively simple pre-disaster preparation. Elements rated “Medium Risk” will need repairs to be used in conjunction with response and recovery activities and could require more extensive pre-disaster preparation. Elements rated “High Risk” will need significant repair or are expected to be damaged beyond repair after a large earthquake. Evaluation of requirements to return elements to the pre-disaster state are not a component of this evaluation or risk ratings. Assessment details are included in the sections below.

6.2 Structures

We collected information on site structures from existing site plans and documents, as well as during our site tour. Port-owned and -operated structures were assessed for resilience. ASCE 41-13 structural assessments were conducted for the terminal building and the maintenance building. These reports are included in Appendix A. A summary of the assessment is included in Table 1.

Table 1 – Structure Assessment Summary

Structure	Airport Owned	Estimated Resilience Risk			Additional Notes
		Low	Med	High	
Terminal Building	Yes		X		Not expected to be operable – see Assessment in Appendix A.
Maintenance Building	Yes			X	Not expected to be operable, likely extensive damage will limit access to supplies – see Assessment in Appendix A.
Former Fuel Station (Mushroom)	Yes			X	Expected to be severely damaged in a design level seismic event and will likely need to be demolished and/or removed to provide access to runways.
Airfield Lighting Building	Yes		X		Concrete block building, equipment and structure not bolted and anchored against lateral forces. Structure could be damaged by lateral movement off foundations.
Hangars (various)	Both Airport-owned and private		X		Based on age and construction type, these structures are often vulnerable to shaking damage including racking, roof connection failures, and lateral displacement. Some are at risk of differential settlement from liquefaction. Rolling doors are unlikely to be operable. Newer hangars like the Nike and Hillsboro Aviation structures will likely perform well.
Navigation Structures	Airport and FAA- owned structures present			X	Equipment is not secured and/or braced against lateral loading, and sensitive equipment will likely need to be repaired or recalibrated after a seismic event. Given FAA requirements for frangibility (breakaway) for equipment located near aircraft operations, some structures will be especially susceptible to damage.

In general, structures at the site are vulnerable to lateral loading during an earthquake. To have an operational airport during response and recovery, bracing and anchoring against shaking and/or retrofits would be required for the majority of the structures at the airport.

6.3 Utility Services

Utilities at the site include electrical, water, wastewater, natural gas, communications, and fuel. Based on the information in the ORP, these services may be out for weeks, months, or longer after a design level event. According to Port maintenance staff, during large winter storms or other localized events, electrical and fuel supplies could be temporarily cut off, requiring the need for on-site generation and fuel storage. The inventory and assessment summary of off-site and on-site services is below in Table 2.

Table 2 – Service Assessment Summary

Service	System Details	Backup Systems	Assessed Resilience Risk			Vulnerabilities	Additional Notes
			Low	Med	High		
Electrical	Electrical service from local provider. Comes into site as overhead then goes underground.	Diesel generators on-site for airfield lighting and FAA tower. No back-up for terminal building.			X	Backup generators and related equipment observed was not anchored against shaking and lateral forces. See Section 6.3.1 for fuel discussion.	
Water	Water comes into site from City system. Hydrant system is also fed by City system.	No emergency water is stored in bulk for emergency operations or personnel.			X	City water supply and shortages are expected from City water system for weeks to months*.	*ORP
Wastewater/Stormwater	Sewer and storm systems flow to City systems. No septic tanks on-site.	1 portable toilet located at NE T-hangar. Others potentially on-site at other facilities.			X	City systems are expected to be off-line for months to years*. Portable toilets will only be functional a short time without service and may leak during shaking.	*ORP

Service	System Details	Backup Systems	Assessed Resilience Risk			Vulnerabilities	Additional Notes
			Low	Med	High		
Natural Gas	NW Natural system feeds the terminal building as well as several buildings near the terminal. All are retrofitted with seismic valves; however, connections may not be flexible.	No backup systems on-site.		X		NW Natural distribution system is vulnerable to outages lasting months after a design event. Connections to buildings and structures may not be flexible and may not be able to withstand differential movement.	
Communications	Airport server room located in the terminal building and services the maintenance building. Telecom and internet provided by Frontier and fed from the terminal building. On-site Port radio communication system includes vehicle radios and handhelds.	Emergency back-up communication system with PDX through port radio system (battery operated). On-site portable generators to charge radios. Batteries good for 8-10 hours.			X	Off-site backup power supporting communications is vulnerable if equipment is not anchored and fuel systems are not robust. Local phone and internet service are vulnerable to outages lasting weeks to months.	

6.3.1 Fuel

Fuel is important for post-event response and recovery because it is required to fuel backup generators and emergency and maintenance equipment. Based on our understanding of the ORP, fuel import will be severely diminished in the event of a large earthquake. Fuel will have to be delivered by air and will be scarce for weeks to months, if not longer. On-site fuel capacity and storage will be imperative to return the airport to a serviceable condition after a design level earthquake event and to support service associated with recovery activities. The inventory and assessment of the on-site liquid fuel are outlined below in Table 3. FAA facility information was not available.

Table 3 – On-Site Liquid Fuel Assessment Summary

Location	Approximate Capacity	Fuel Type	Assessed Resilience Risk			Vulnerabilities	Additional Notes
			Low	Med	High		
Maintenance Building	500 gal	Diesel			X	Fuel capacities are limited and observed tanks were not anchored and/or hardware connections are not flexible. (see note below table) Further, it is likely that many tanks will experience releases due to shaking damage to tanks and/or equipment or adjacent structures. Tank spills could result in hazardous health conditions, environmental contamination, or fires.	Current protocol is to fill only when empty.
Airfield Lighting Building	unknown	Assumed diesel			X		
4 Portable Tanks (on runway closing crosses, but can be moved)	25 gal each	Diesel		X			
Maintenance Truck	50 gal	Unleaded gasoline		X			
Private tanks at several facilities around the airport	Likely as much as 50,000 gal total	Jet A Av. Gas	Not specifically assessed				Fuel in existing aircraft that are on-site and accessible could also be available.

Based on observations and discussions, the on-site fuel tanks are not anchored to resist seismic shaking. FAA, private tanks, and underground tanks were not assessed. Further, many of the connections and pumping mechanisms associated with fueling systems do not use flexible connections and are vulnerable to damage and potential release during an earthquake. In addition, pumps should be connected to generators or alternative power sources. We understand that current procedures and the limited capacity of the on-site storage require significant drawdown of the on-site supplies before fuel orders for refilling are placed. Due to the limited capacity, tank and structural vulnerabilities, and standard maintenance practices, the overall risk assessment for the fuel system is high.

6.4 Equipment and Materials

Emergency response and recovery requires both supplies to respond to an emergency to repair and restart airport functions, as well as supplies to sustain those who are working to complete these tasks. Based on our understanding of the ORP Cascadia Event Scenario, airport personnel and possibly their families could need to shelter on-site for days to weeks. During our reconnaissance and meetings with airport personnel, we understand that certain emergency supplies and materials are available on-site for response and recovery. These supplies are outlined below in Table 4.

Table 4 – On-Site Emergency Supplies and Materials Assessment Summary

Description	Location	Assessed Resilience Risk			Vulnerabilities	Additional Notes
		Low	Med	High		
Emergency Food Supplies	No emergency food supplies on-site. Nearby restaurants are used in emergencies.			X	Staff and possibly members of the public may be on-site for days to weeks and current supplies are inadequate.	
Emergency Shelter	Current practice is to use hotels near airport.			X	Staff and possibly members of the public may be on-site for days to weeks. Hotels may be damaged and not safe.	
First Aid	Basic supplies are located at several locations around the airport. Fire station adjacent has general supplies for emergencies.			X	Potential for injuries is high. Port staff, and terminal tenant personnel as well as passengers and pilots are at risk.	
Medical Equipment	The adjacent fire station has typical emergency medical equipment on hand as expected for their functions.	Unknown			In the event of a design level earthquake, significant needs for medical equipment are likely for staff and others at the airport.	

Description	Location	Assessed Resilience Risk			Vulnerabilities	Additional Notes
		Low	Med	High		
Fire Suppression Equipment	Hydrant system, fire station adjacent to airport. Two large wheeled fire extinguishers are on-site.			X	Hydrant system vulnerable to city outages. No on-site storage is present.	Port likely has more wheeled fire extinguishers that are unused at other facilities that could be re-located to Hillsboro.
Construction Repair Equipment	Loader and dump truck are stored in maintenance building. City of Hillsboro constructed a new public works operations facility in 2016 to the north of HIO with equipment and materials storage close to airport.			X	On-site repairs will likely be necessary. Limited equipment available and stored in vulnerable maintenance building which is not expected to be accessible.	Feasibility of getting equipment from City public works facility to the site was not assessed, but they will likely be needed for other repairs and recovery work.
Material for pavement, roadway, or other structural repairs	Small supplies, mostly in the maintenance building. Landscape supply yard close to airport.			X	Limited and stored in maintenance building which is not expected to be accessible.	
Vehicles	Operations trucks and vehicles. Rental cars on-site.		X		Fuel for on-site vehicles will be limited.	No ability to service or repair vehicles is available on-site. Vehicles are repaired off-site.

6.5 Personnel Resources

Personnel are an important resource for emergency response and recovery after an event. Time and day that the event occurs will affect which personnel are on-site during the event. Specific circumstances will affect the number of personnel available to meet any defined response or recovery role. It is natural to expect that personnel would want to return to their homes to ensure the safety and security of family, if logistically possible. Once personal responsibilities are accomplished, personnel would have to be prepared and able to return to work. Implementing plans for staff training, support, and awareness would be crucial to ensure that staff and their families are prepared to survive the anticipated emergency events as well as to return to work during the response and recovery periods. Non-Port staff that could be at the airport during a CSZ event are also identified below.

Personnel on-site are detailed below.

- **Port Airport Staff** – Three to five Port personnel are on-site at HIO weekdays between 8 a.m. and 5 p.m. These staff generally reside in the Washington County area; however, some personnel live east of the Willamette River. We understand that typical training associated with airport operations and maintenance duties has been completed; however, design level earthquake-focused training and planning has not been conducted.

- **FAA Staff** – The air traffic control tower is manned between 6 a.m. and 10 p.m. 7 days a week.

- **Adjacent Fire Station** – The adjacent fire station is manned 24 hours a day.

- **Tenant Personnel** – An estimated fifty to seventy tenant employees as well as their passengers and clients may be on-site during normal working hours. We understand that no formal communication on emergency protocols has been conducted with tenants.

6.6 Airport Compatibility with Planned Response Aircraft

Plans may call for HIO to fulfil a role to support response and/or recovery as soon as possible following a design level event by accommodating significantly larger and heavier aircraft than most of the aircraft currently operating at the airport. Discussions with the ODA indicate that Lockheed Martin C-130 and Boeing C-17 aircraft are the fixed wing aircraft typically used to support response and recovery activities. Given the primary response role that these fixed wing aircraft will serve, they will be the focus of analysis for airport compatibility in this assessment. In addition to the fixed wing response, the military will also use rotary wing (helicopter) aircraft, including Sikorsky UH-60 Blackhawks and Boeing CH-47 Chinooks. Though helicopters may operate on all airport facilities, including runway and taxiway pavements, it is anticipated that most of their ground base operations will be focused on ramp areas adjacent to airfield pavements.

6.6.1 Pavement Geometry

HIO encompasses approximately 963 acres of land. Of this total, approximately 243 acres are disconnected from the main airport property by roads. There are three runways at the airport. Primary Runway 13R-31L is 6,600 feet long and capable of accommodating most general aviation aircraft. Crosswind Runway 2-20 is 3,821 feet long and is designed to accommodate smaller single- and multi-engine piston-powered aircraft, which are more susceptible to crosswinds that would make landing on the primary runway more difficult. Runway 13L-31R is 3,600 feet long and is intended to accommodate local training activity with small aircraft. HIO has a taxiway system providing for aircraft circulation to and from the runways. HIO is considered an all-weather facility, because it has published instrument approach procedures that allow for continued operations in poor weather/visibility conditions. The most sophisticated of these procedures is the instrument landing system (ILS) approach to Runway 13R, which allows for operations when visibility is as low as 1/2 mile. HIO has an FAA-owned and -operated air traffic control tower.

The primary role for HIO is to accommodate general aviation operations, including nearly all business jet types. The design aircraft is the Gulfstream G650, a jet with a wingspan of just under 100 feet, weighing just under 100,000 pounds, and configured with dual-wheel main landing gear. The FAA Runway Design Code that describes the family of aircraft with these specifications is RDC C-III and the Taxiway Design Group is TDG-2. For that reason, the airfield has been designed with these design criteria. The ability to accommodate aircraft exceeding these criteria may be possible for brief periods, however, damage from overweight or over-width aircraft operations would likely result.

Existing pavement widths were evaluated for compatibility with the C-130 and C-17 Critical Response Aircraft. The Lockheed C-130 Hercules is a workhorse of the military and is capable of landing on more constrained and relatively unimproved airfields. The C-130 has a maximum takeoff weight of 155,000 pounds and a wingspan of 132.6 feet. The Runway Design Code is RDC C-IV and the Taxiway Design Group is TDG-2. Therefore, normal operations of the C-130 could be accommodated easily with a bit of extra care with taxiway operations due to the extra wingspan.

The Boeing C-17 Globemaster is a much larger aircraft with heavy airlift capabilities. The airfield characteristics needed are significantly more demanding than the C-130. The C-17 has a maximum takeoff weight of 585,000 pounds on a complex main landing gear array of wheels. The wingspan is just under 170 feet. The Runway Design Code is RDC C-V and the Taxiway Design Group is TDG-5. The existing airfield facilities are too small in every way to safely accommodate C-17 operations. Therefore, operations of the C-17 would be logistically problematic and quickly cause damage to existing infrastructure. Even if airfield operational concerns are mitigated, current ramp areas would be much too small to stage the aircraft and maneuver the ground service equipment needed to move cargo off the aircraft to other staging areas for further handling. Because of these shortfalls in capability, many millions of dollars in airport improvements would be needed in advance of the CSZ event to consider the C-17 for operations at HIO. However, if critical, the C-17 could operate at lighter loads and stage on temporary apron areas established with portable mat components that could be brought in on helicopters and quickly set up with smaller equipment.

6.6.2 Pavement Strength

The large aircraft needed to airlift the needed volume of personnel and supplies to HIO in conjunction with response and recovery activities for a design level earthquake will exceed the capacity of most of the existing pavements. To evaluate existing pavement strength compatibility with the anticipated fixed wing response aircraft at the planning level, an analysis is provided in Table 5.

Table 5 – Airport Compatibility with Planned Response Aircraft General Summary

Facility	Dimensions (Runways – Length x Width) (Taxiways – Width)	Surfacing/ Pavement Classification Number (PCN)	Does Facility Support Military Response Aircraft	Notes
RW 13R-31L	150 x 6,600	Published strength of 110,000 DTG	C-130 Hercules and smaller plus	Wingspan exceeds design criteria and is slightly overweight.
RW 13L-31R	60 x 3600	PCN 10	No	Used for small aircraft only. May be used for staging.
RW 02-20	75 x 3821	PCN 20	No	Used for small aircraft only. May be used for helicopter operations.
Taxiway A	50 feet wide	110,000 LBS Dual Wheel Gear (DWG)	Limited to Taxiway A	Taxiway Design Group TDG-2 or smaller.
Open Apron Areas	Small, variable in size	12,500 Single Wheel Gear (SWG), small aircraft only.	Limited	C-130 near terminal building or on temporary reinforced mats.

Table 6 – Airfield Facilities Assessment Summary – Main Runway

Service	Facility Details	Backup Systems	Vulnerabilities	Notes
Airfield lighting	High intensity edge lights on RW 13R-31L.	Backup diesel generator at airfield lighting building.	CSZ damage to building and/or conduit that interrupts circuit. Alignment of lighting.	
Visual Approach Aids	PAPI on both ends.	Backup diesel generator at Airfield Lighting building.	CSZ damage to lighting causing misalignment or failure.	Would render inoperative and be disconnected.
Rotating Beacon	Located on tower near Cornell Road.	None	CSZ damage to lighting causing misalignment or failure.	Would render inoperative and be disconnected.
Automated Weather Observation System (AWOS)	Located on airfield.	None	CSZ damage to lighting causing misalignment or failure.	Would render inoperative and be disconnected.

Service	Facility Details	Backup Systems	Vulnerabilities	Notes
Wind Sock and Segmented Circle	Located on airfield.	None	Not critical, would likely not be affected.	
Instrument approach equipment	The localizer and glideslope facilities are located on the airfield.	None.	CSZ damage to equipment causing misalignment or failure.	Would render inoperative and be disconnected.
Other FAA Owned Equipment	Approach lighting towers (MALSR) from 200 to 1400 feet NW from RW 13R end.	None.	CSZ damage to equipment causing misalignment or failure.	

Generally, navigation aids and equipment are not secured and/or braced against lateral loading and sensitive equipment will likely need to be repaired or recalibrated after shaking. The resilience risk rating for this equipment is medium to high. Given FAA requirements for frangibility (breakaway) for equipment located near aircraft runways, some structures will be especially susceptible to damage. FAA technicians would very likely not be on-site unless coincidentally present to maintain FAA equipment. Therefore, if the earthquake happens while FAA personnel are off-site, their ability to assess and repair FAA equipment will be hampered by damage to communication and surface transportation infrastructure. Although lighting and navigation aids provide important nighttime and all-weather capability to the airport, daytime Visual Flight Rule (VFR) operations could likely continue (assuming operable runways) if this equipment is out of service.

7.0 ASSESSMENT SUMMARY

7.1 Geotechnical Considerations

Based on our review of the existing data, the risk for landslide and fault rupture at HIO is minimal. However, very strong shaking and liquefaction are expected at the site. Between 1 and 7 inches of liquefaction settlement should be expected across the site. Differential settlement will damage pavements and structures. This is specifically true for the runways and aprons. Pavement cracking and settlement could damage runways preventing fixed wing air traffic from using the runways until extensive repairs can be made. If desired to maintain normal operations after an earthquake, liquefaction mitigation under runways and critical aprons would be required.

7.2 On-Site Facilities

On-site facilities including structures, utilities, fuel facilities, and navigational equipment are moderately to highly vulnerable during a seismic event. The structures at the site will be minimally operational and the maintenance building is likely to be inoperable, thus any equipment and materials stored inside will be unavailable for response and recovery.

Based on our understanding of airport operations, critical structures would include the airfield electrical control building, the maintenance building, and the terminal building. These structures would need to be retrofitted or replaced to not hinder response efforts and provide service after a design level earthquake.

7.3 On-Site Resources

The airport has minimal emergency supplies to support staff, on-site personnel, and emergency responders during and after an emergency. Therefore, if required to remain on-site for an extended period of time without the ability to replenish supplies, personnel will be vulnerable after a design earthquake.

Materials and equipment available to repair and restore airport functions are also minimal. The airport will be relying on outside materials from local partners and state or national emergency responders to regain functionality because support from PDX will be limited by ground transportation damage.

Above ground tanks observed were not anchored against lateral earthquake forces and are likely to be damaged during a design level earthquake. Fueling connections are often rigid and require power. Further, minimal fuel is available on-site for vehicles and other equipment that will be needed to restore airport functions. Limited access to fuel and damage to fuel storage and equipment will significantly impact airport operations and long-term recovery.

Port personnel often are not available or on-site and will likely not be able to reach the airport after a large earthquake. This is true for FAA personnel as well. Training and emergency planning for Port personnel and other airport staff and tenant personnel has not included a large earthquake scenario. Contingency plans for repair of the navigation equipment are not available.

8.0 RECOMMENDATIONS

What follows are the recommendations of the consultant team based on our understanding of the role HIO will play in response and recovery, our understanding of Port priorities, our analysis of facility conditions, and our assessment of what might be done to increase seismic resiliency at HIO. These recommendations have not been prioritized by Port staff.

In its current state, the airport will be minimally functional after a design level earthquake. As noted above, for HIO to be available for use by fixed wing aircraft and emergency response immediately following the earthquake, ground improvement will be required below runway areas and sufficient apron area for aircraft mobility and seismic retrofit or replacement of critical structures will be required. Further, Port and FAA employees, airport customers, and tenants on-site during a design level earthquake are vulnerable after the event.

After a design level event, HIO will be assessed and repairs will be prioritized based on available resources and needs of the Port and the community. Based on the expected damage, emergency repairs will likely be completed to serve military rotary and fixed wing aircraft. Civilian aircraft and tenant operations may be restored after emergency response operations. However, employee and tenant personnel safety, during and after an event, is necessary. Prior to undertaking any capital project, the Port should weigh the benefits to increasing the resilience of the asset or improvement against the costs of doing so. Hart Crowser and Salus have provided the following recommendations based on the evaluation of Port assets in this study to meet the goal of life safety and availability of critical assets for the recovery.

8.1.1 Continued Engagement with Stakeholders

Federal, state, and local emergency response and recovery plans are still in development. HIO and the Port will continue to work with stakeholders to develop these plans and a more clearly defined role for HIO.

8.1.2 Runway and Navigation

Based on the study completed for the current runway project, between 1 and 7 inches of liquefaction settlement is anticipated across the runway length. In order to support military fixed wing aircraft, liquefaction mitigation or immediate repairs will be required. We understand that grant funding for the runway liquefaction mitigation is not available for the current project. If the mitigation is not completed, HIO should develop a plan to restore the damaged runway to allow military aircraft operations within an appropriate timeframe after an event. This could include developing a plan to house materials and equipment needed for repairs on-site or develop agreements with local suppliers and contractors to perform the work. As an alternative, mechanical stabilization measures (such as perforated steel planking) could be brought in to allow the operation and staging of heavy transport aircraft like the C-130 where runway damage has occurred. Further, as mentioned above, the navigation aids will be damaged and will require repair. The plan should include repair or replacement of critical navigation aids to support military fixed wing aircraft.

8.1.3 Maintenance Facility

The Port understands the need to access equipment within the building for emergency response and recovery efforts. We recommend the Port prioritize adding resilient design features in the existing or future maintenance facility. This will allow for stored equipment to be secure and accessible following a design level event. For a new facility, the building will be constructed to meet current life/safety code levels, while the storage and maintenance area should be hardened to a higher performance level to ensure that equipment can be accessed and used for emergency response and recovery.

8.1.4 Airfield Lighting Building

Based on our observations, the airfield lighting equipment building is not anchored to its foundation and inside equipment is not anchored against lateral loading. Retrofit to secure the building and its equipment, including backup power equipment, should be considered.

8.1.5 Fuel Supply

On-site fuel storage for aircraft and repair equipment is vulnerable because tanks are not anchored to resist lateral loads, nor are connections and hardware designed to be flexible to resist/reduce shaking damage. On-site above ground tanks should be anchored, and the pumps and hardware should be retrofitted so that spills are prevented, and fuel is immediately available for response. Fuel storage and filling practices should also be evaluated and potentially changed so that tanks are kept above a minimum level to ensure that fuel is available in the event of an earthquake. In the long term, additional fuel capacity can also be added to increase the capacity of HIO to aid in recovery efforts.

8.1.6 Emergency Planning and Preparation

Our assessment highlighted several areas where emergency planning and preparation would significantly increase the resilience of HIO and its ability to serve the Port, City, the region, and the public. Our specific recommendations for HIO are outlined below.

Emergency Supplies for Staff and Public

- Develop a storage site for emergency supplies that will be readily available and accessible after a design level event.
- Increase emergency food stuffs to provide food and water for all on-site staff as well as additional personnel or public expected. HIO, on-site, and emergency personnel should have supplies for at least 2 to 4 weeks.
- Increase the potable water storage availability and/or filtration capacity on site to make sure sufficient supplies are available for on-site personnel as well as others expected to be at HIO after an event.
- Consider shelter for all personnel that will be on site as well as a plan for those that may come from outside. Structure vulnerabilities should be included in this consideration.
- Evaluate on-site medical and first aid supplies and update as necessary.

We understand that a current project is underway that will develop and emergency cache for all Port operating areas that will include water, food, shelter, and first aid supplies by the end of 2018. This project will meet some of the recommendations above.

Emergency Planning and Training

- Initiate a program to encourage home preparation for personnel and families.
- Work with all airport users and agencies to develop a more detailed emergency plan and protocols for a design level event and make sure all on-site personnel are trained. This can include the following actions:

- Develop a plan for personnel to reach the site or reach home after an event. Include a discussion of impediments to employee travel. Consider shelter capacity for employee families and other members of the public.

- Develop an alternative communication plan with employees, the City, County, FAA, other response agencies, and entities on site.

- Develop a plan for post-disaster assessments of structures, runways, and equipment to assess status and necessary repairs to support recovery activities.

- Develop protocols for public interaction and coordination with expected users (military, airport owners, City/County), coordination with the FAA, and personnel organization and duties.

- Develop protocols for FAA repairs of FAA owned navigational equipment to be completed by on-site personnel if possible and develop a communication method with the offsite maintenance and repair personnel. Develop an interim plan for temporary VFR-only operations.

- Develop a business continuity plan that provides for both HIO emergency response and long-term recovery at the Airport. This plan should address airport goals for providing private and public service to existing and potential future airport users, including emergency response providers, after a design level event.

- Consider needed training for HIO personnel (e.g., CERT, First Aid, Emergency Management protocols with State and City).

- Consider regularly scheduling planning meetings with agencies and stakeholders to encourage participation and updates to plans and procedures.

Materials and Equipment

- Evaluate material and equipment needs to perform pavement settlement fixes. Consider pavement needs for military aircraft as well as outside help and where supplies are available near HIO. Consider contracts with other agencies, local municipalities and suitably located private contractors to respond after an earthquake to more rapidly assess and repair airport operations.

- Replace/repair the maintenance building and facility storage areas to allow for secure material and equipment storage and to provide access to materials post event. The current structure is very vulnerable to shaking damage. Safe storage for equipment and supplies is important to build resilience.

- Assess communication hardware needs for communication with the Port, City, County, and other entities. Consider a satellite phone on-site.

9.0 LIMITATIONS

We have prepared this report for the exclusive use of the Port of Portland and their authorized agents for the Hillsboro Airport Resilience Assessment in Hillsboro, Oregon in accordance with our agreement dated March 17, 2017. Our report is intended to provide our initial assessment of the site based on the field reconnaissance and records review described herein.

Within the limitations of scope, schedule, and budget, our services have been executed in accordance with generally accepted practices in the fields of civil and geotechnical engineering in this area at the time this report was prepared. No warranty, express or implied, should be understood.

Any electronic form, facsimile, or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by Hart Crowser and will serve as the official document of record.

10.0 REFERENCES

Geotechnical Exploration: Terminal Apron Rehabilitation Hillsboro Airport. GeoEngineers. July 10, 2013.

Geotechnical Engineering Services West Perimeter Road, Hillsboro Airport (HIO) Draft Letter. GRI Geotechnical & Environmental Consultants. February 21, 2006.

Geotechnical Investigation Report HIO Runway 12L-30R & Taxiway D. Kleinfelder. January 6, 2010.

Geotechnical Consultation Memo – Runway 13R-31L Seismic Resiliency Evaluation, GRI. October 17, 2016.

HAZVU 2016. Oregon Statewide Geohazards Viewer. Oregon Department of Geology and Mineral Industries (DOGAMI). http://www.oregongeology.org/hazvu/.

Ma, L., Madin, I.P., Duplantis, S., and Williams, K.J., 2012, *Lidar-based surficial geologic map and database of the greater Portland, Oregon area:* Oregon Department of Geology and Mineral Industries, Open-File Report 0-2012-02, scale 1:8,000. http://www.oregongeology.org/pubs/ofr/p-O-12-02.htm.

ODOT 2014. Oregon Department of Transportation, Geotechnical Design Manual.

Oregon Seismic Safety Policy Advisory Commission, February 2013. The Oregon Resilience Plan – Reducing Risk and Improving Recovery for eth Next Cascadia Earthquake and Tsunami. .

Oregon Resilience Officer, 2018. Status Report – The Oregon Resilience Plan. https://www.oregon.gov/gov/policy/orr/pages/index.aspx

Oregon Department of Geology and Mineral Industries (DOGAMI), Statewide Landslide Information Database for Oregon (SLIDO) 3.2, accessed at http://www.oregongeology.org/sub/slido.

Oregon Office of Emergency Management. Cascadia Playbook, version 2015.

Oregon (State of) 2013. Oregon Resilience Plan, 2013.

Oregon Statewide Geohazards Viewer (HAZVU), 2016. Oregon Department of Geology and Mineral Industries (DOGAMI). http://www.oregongeology.org/hazvu/. Accessed 8/16/17.

Oregon Water Resources Department (OWRD) 2016. Well Log Query, accessed at http://apps.wrd.state.or.us/apps/gw/well_log.

Pavement Evaluation & Design Report Runway 2-20 & Taxiway C (South) Hillsboro Airport. Kleinfelder. October 17, 2011.

Port of Portland Corporate Seismic Risk Assessment Study. HNTB Corporation, Berger ABAM, etc. May 2015.

SLIDO: Statewide Landslide Information Layer for Oregon 2015. Oregon Department of Geology and Mineral Industries (DOGAMI), accessed at http://www.oregongeology.org/slido/index.html.

Spill Prevention Control and Countermeasure Plan Enlarged Plans of Backup Generator & Maintenance Building. HIO 2010-3093. October 2010.

State Landslide Inventory Database for Oregon (SLIDO), 2016. Oregon Department of Geology and Mineral Industries (DOGAMI). http://www.oregongeology.org/sub/slido/. Accessed 8/16/17.

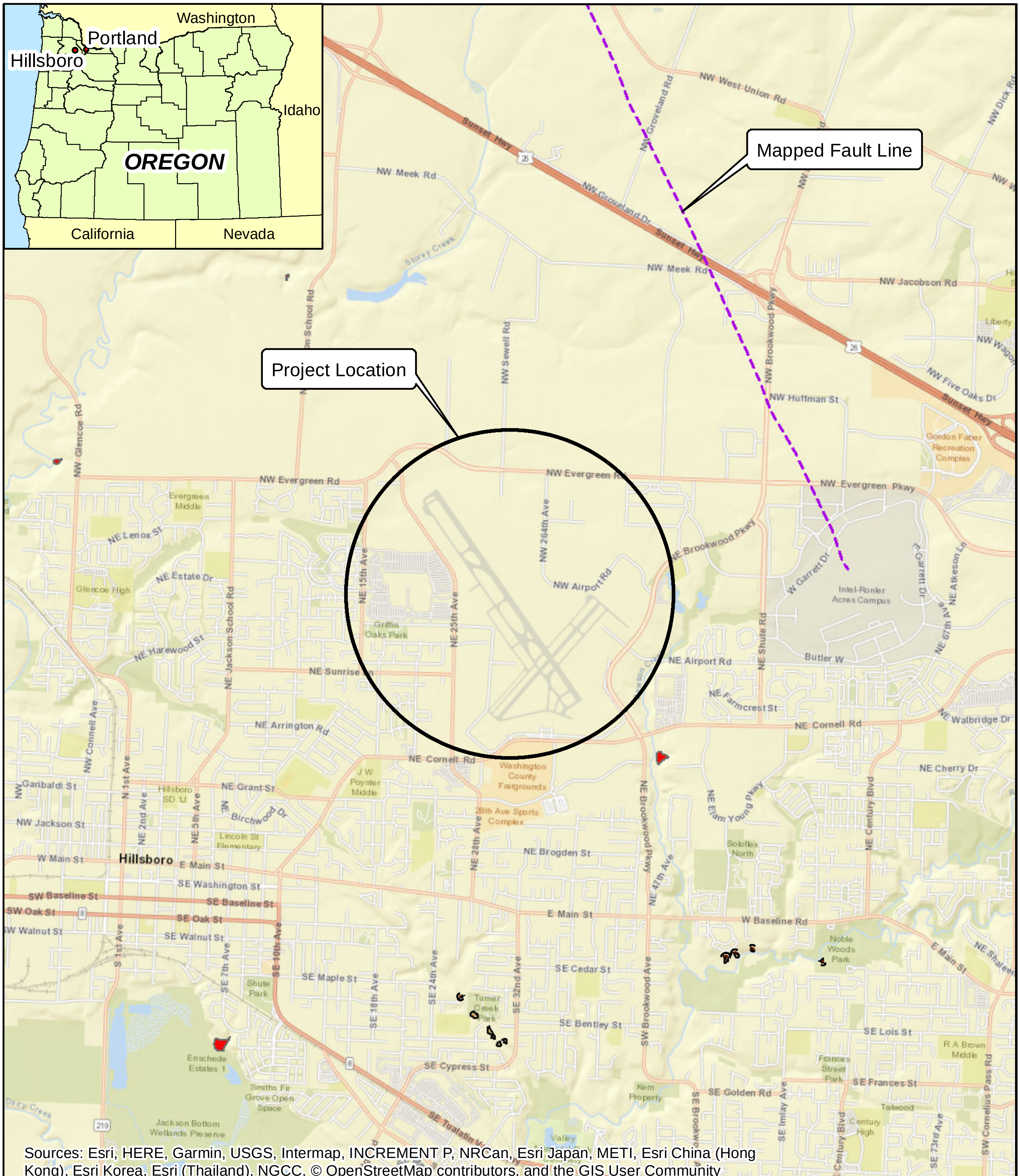
U.S. Department of Agriculture (USDA) 2016. National Resources Conservation Service. *Web Soil Survey.* http://websoilsurvey.nrcs.usda.gov/. Accessed 8/16/2017.

U.S. Geologic Survey (USGS) 2014. National Seismic Hazard Mapping Project – U.S. Seismic Design Maps website: http://earthquake.usgs.gov/designmaps/us/application.php.

U.S. Geological Survey, 2006, Quaternary fault and fold database for the United States, accessed 8/17/2017, from USGS web site: http//earthquake.usgs.gov/hazards/faults/.

USGS 2013. Geologic Hazards Science Center – 2008 Interactive Deaggregations website: http://geohazards.usgs.gov/deaggint/2008/.

\\pdxsrv\data\Notebooks\154035006_Salus-2018 Hillsboro Airport Master Plan\Deliverables\Report-Assessment-FINAL_02-04-19\HIO Resilience Assessment.docx



LEGEND

SLIDO

Scarps

Head Scarp

Deposits

Fan

Landslide

0 1,750 3,500 7,000 Feet

N

Hillsboro Airport Resilience Assessment
Hillsboro, Oregon

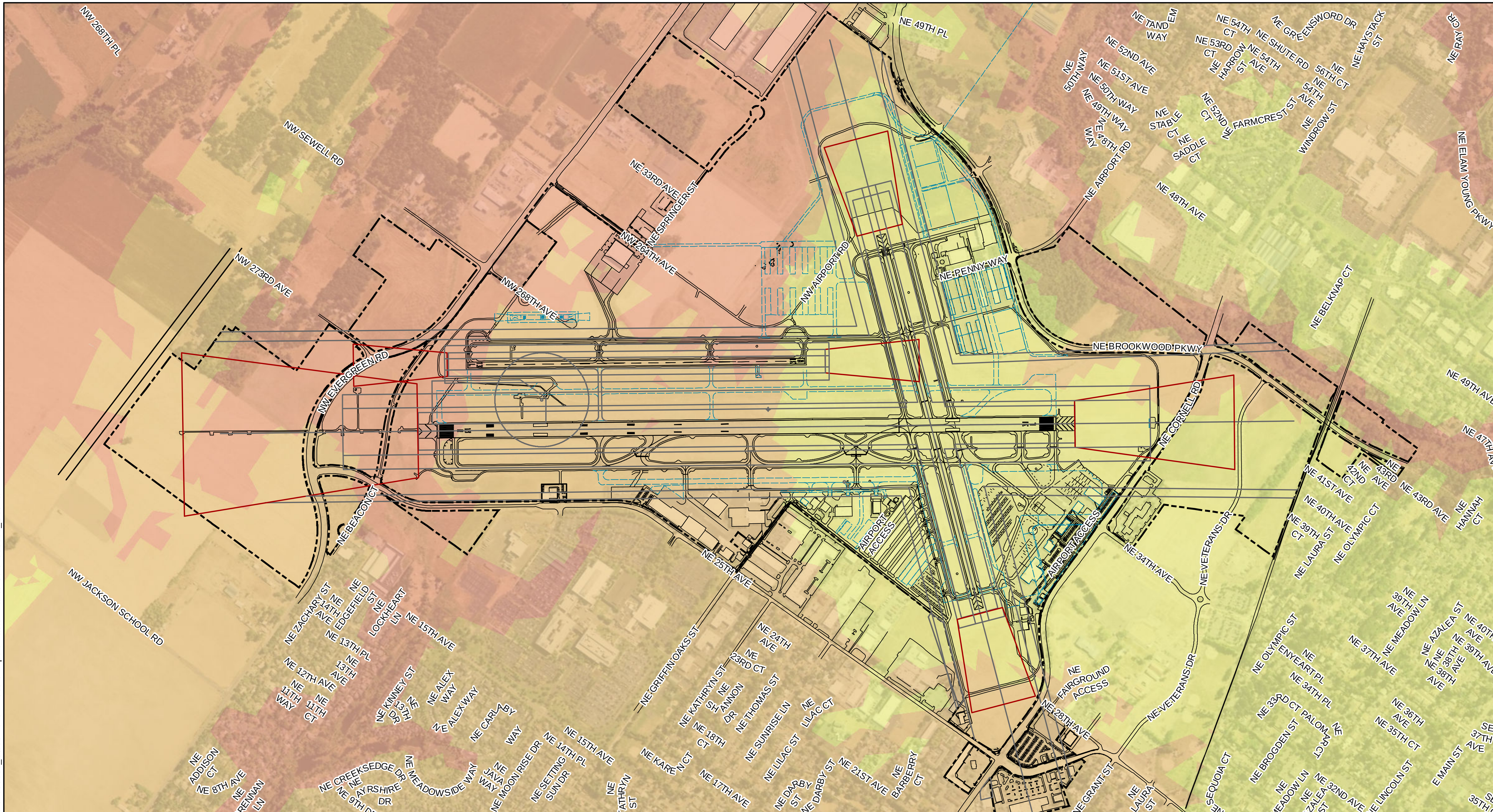
Vicinity Map with
Geologic Hazard Mapping

154-035-006 2/19

HARTCROWSER

Figure **1**

Document Path: \\pdxsrv\data\Notebooks\154035006_Salus-2018 Hillsboro Airport Master Plan\GIS\154035006_Vmap.mxd Date: 2/4/2019 User Name: melissaschweitzer



LEGEND

Oregon Liquefaction Susceptibility

- Low
- Moderate
- High

0 500 1,000 2,000 Feet

N

Sources: Aerial photograph provided by Hexagon Imagery Program Data. Oregon Liquefaction Susceptibility by Oregon Department of Geology and Mineral Industries Open-File Report O-13-06. Project features provided by Port Of Portland on May 3, 2018.

Hillsboro Airport Resilience Assessment
Hillsboro, Oregon

Site Plan and Liquefaction Hazard Map

154-035-006 2/19

HARTCROWSER

Figure **2**

Document Path: \\pdxsrv\data\Notebooks\154035006_Salus-2018 Hillsboro Airport Master Plan\GIS\154035006_GeoHaz2.mxd Date: 2/4/2019 User Name: melissaschweitzer

APPENDIX A
Meeting Minutes:
Hillsboro Airport Master Plan Update – Seismic Response and Recovery Plan Discussion, February 15, 2018
Compiled by Enviroissues

Hillsboro Airport Master Plan Update
Seismic Response and Recovery Plan Discussion

Thursday, February 15 | 1:30 – 3:30 p.m.
Port of Portland Offices | Columbia Gorge Conference Room
Portland International Airport (PDX)

Meeting Objectives

- Understand each agency's roles and responsibilities within the Oregon Resilience Plan and how it relates to Hillsboro Airport
- Understand actions taken in coordination between agencies and challenges with the plan
- Generate public information to be communicated to stakeholders and community members through the Hillsboro Airport Master Plan Update process

Participant Information

Meeting participants introduced themselves and their role relative to seismic resilience planning and/or Hillsboro Airport.

Greg Theisen Port of Portland	Resilience planner for the Port of Portland; planning to use the Oregon Resilience Plan to inform a Port of Portland Capital Improvement Plan in preparation for a Cascadia seismic event; the Capital Improvement Plan is for the Port's aviation and marine assets.
Kori Nobel Port of Portland	Emergency Manager for the Port of Portland;
Steve Nagy Port of Portland	General Aviation Manager for the Port of Portland and sponsor of the Hillsboro Airport Master Plan Update; Hillsboro community members and the master plan's Planning Advisory Committee want to know there is a plan in place to use Hillsboro Airport following a Cascadia seismic event; the Port of Portland wants to understand how other agencies plan to use Hillsboro Airport in this scenario, so the Port can plan appropriate facility investments during the master plan process.
Ryan Parker Port of Portland	Project Manager for the Hillsboro Airport Master Plan Update
Sean Loughran Port of Portland	Long Range Planning Manager for aviation; considering how to make strategic investments in the Port of Portland's system of three airports.
Aaron Ray Port of Portland	Senior Aviation Planner for the Port of Portland.
Tammy Bain City of Hillsboro	Emergency Manager for the City of Hillsboro.
Scott Porter Washington County	Emergency Management Manager for Washington County; considering how Hillsboro Airport could be used in collaboration with nearby Washington County facilities such as fuel delivery.
Mitch Swecker Oregon Department of Aviation	Supporting Governor Brown's office of emergency preparedness as it relates to aviation.
John Wilson Oregon Department of Aviation	Coordinates with the military; contributed to the Oregon Resilience Plan.

Capt. Robert Zorn Oregon Military Department	Creating military continuity plans for Region 10.
Andrew Phelps Oregon Office of Emergency Management	Interested in helping coordinate emergency planning related to Hillsboro Airport.
Mike Harryman Office of Governor Brown	Resilience Manager for the Office of Governor Brown.
Ed Flick Marion County Emergency Manager	Beginning planning for Salem Municipal Airport resilience; participating in the meeting to learn and apply findings in Salem.
Neal White Oregon Pilots Association	Member of Salem Airport Advisory Commission.
Dave Nafie WHPacific	Prime consultant for the Hillsboro Airport Master Plan Update.
Allison Pyrch WHPacific	Supporting resilience planning for the Hillsboro Airport Master Plan Update.

Agenda Items and Results

Overview of Hillsboro Airport Master Plan Update

Steve Nagy shared facts about Hillsboro Airport (HIO):

- Largest general aviation airport in Oregon
- Includes Federal Aviation Administration (FAA) air traffic control tower
- Does not offer commercial passenger service, but private passenger activity occurs such as Intel shuttle to campuses in bay area and southwest
- Houses about 40 based business jets and 30 helicopters used for flight training
- Hosts about 200,000 operations per year, making it the second busiest airport in Oregon
- Hosts three privately owned Fixed Base Operators (FBOs), which store and sell fuel
- Hosts local corporate flight departments
- Hosts two flight schools
- One of two full-time international aviation gateways in Oregon

Steve Nagy shared progress on the HIO Master Plan Update process:

- Completed investigation phase accounting for inventory, 20-year forecast and airport role analysis
- Airport role is expected to remain the same
- Nearing the end of the analysis phase with 20-year facility requirements
- Conducting alternatives analysis
- Next phase will develop a capital improvement plan and funding plan
- Continually considering community interest topics including seismic resilience
- Critical design aircraft is Gulfstream G650 - does not trigger significant airfield changes

Seismic resilience activities related to the master plan update may include:

- Inventory infrastructure and identify assets and liabilities
- Inform facility investments
- Coordination with other agencies

Port Resilience Work

The Port of Portland described its approach to seismic planning:

- Portland International Airport (PDX) will be a vital transportation link within the region and outside the region
- The level of resilience achieved will depend on regional priorities and investments
- The Port's main priority is PDX
- The Port will make commitments in HIO depending on inputs given to the Port from partners and consistent with the Oregon Resilience Plan
- HIO is not planning to grow in size, but it could accommodate larger aircraft activity in an emergency for a limited time
- Plan is in place to reconstruct HIO main runway; cannot wait for master plan process to finish
- Reconstruction will provide a uniform thickness of subbase
- FAA will only pay for the reconstruction that meets facility requirements; Port will pay to maintain additional reconstruction area - HIO tenants have pressed to retain all runway capabilities
- HIO runway reconstruction will occur in 2019
- Reconstruction will not add strength or new capabilities to HIO
- FAA does not fund major capital replacements based on potential emergency needs
- Completed seismic study for runway reconstruction; estimated pavement settlements based on substructure could be 1 – 5 inches; some level of runway damage is expected but not as bad as PDX
- Options to stabilize two-thirds of the main runway would require $15 million to install concrete pillars that limit settlement to an inch or less
- The Port considered adding excess pavement that could be rotomilled off to level out pavement settlements; this would add $3 million to project cost
- The Port does not have funding to add seismic consideration to HIO runway reconstruction now; will reconsider in 10-12 years for next rehabilitation
- Current plan is to develop a mechanism to initiate immediate runway repairs
- Runway will be under construction June 2019

Port staff answered questions about seismic resilience plans

- The Port is also completing a seismic study of PDX runways within the next two years
- PDX north runway will be rehabilitated between 2020 – 2025
- The Port is considering partnership opportunities to raise funds for seismic resilience, including public and private partnerships; there are not many resources for seismic upgrades now
- FAA will fund recovery following seismic events but not resilience projects

Steve Nagy said the Port of Portland wants to know how the City of Hillsboro, Washington County and State of Oregon plan to use HIO following a Cascadia seismic event, so they can plan accordingly.

Agency assessment, response or recovery plans

Mike Harryman shared information about the Oregon Resilience Plan:

- The Oregon Resilience Plan is 5 years old
- Oregon was selected for an 18-month resilience assessment by Department of Homeland Security (DHS), to begin in March 2018 at Redmond Airport
- DHS will work with Oregon Department of Transportation (ODOT) and Oregon Department of Aviation (ODA) considering Cascadia subduction zone event
- The DHS assessment will consider Redmond's ability to handle medical transportation and Federal Emergency Management Agency (FEMA) transportation needs
- If Redmond cannot handle both needs, PDX may be needed to handle medical transportation
- HIO role in resilience plan may develop on situation; HIO may be the only airport available in northern Oregon
- Need to determine location of new fuel hub if long-term temporary fuel storage is needed
- Fuel is important to store but Aviation Gasoline has a short shelf life
- The Port of Portland would like to know if emergency managers prefer larger centralized fuel storage or smaller more distributed storage
- The Port of Portland has emergency power generators at HIO, but they are not connected to the FAA air traffic control tower

Andrew Phelps shared information about the Cascadia Playbook Plan:

- The plan identifies critical needs for two weeks following a Cascadia seismic event
- Objectives are time-based to consider what will be needed for the first two hours, six hours and so on
- Objectives are also spatial such as 95% of population is within 1 mile of food and water
- HIO has not been discussed specifically, but need to coordinate with City, County and Port so all agencies don't expect to use HIO differently

Capt. Zorn explained the military's role in disaster planning and response:

- The military has collected information on resource capacity in Oregon but everything west of the Cascades would be situationally dependent on reconnaissance following a Cascadia seismic event.
- HIO has not been identified specifically.
- The military is always in support of local authorities; everything needs to be initiated at the local level
- Portland is the only area required to identify threats and hazards and communicate
- Agencies should ask for capabilities, not necessarily specific equipment; the military will determine which tools are available to fulfill the capability need

Kori Nobel shared outcomes from the Cascadia exercise:

- Status reports need to be standardized so they can be communicated quickly

- Military aid will come more quickly to sites that can effectively communicate status updates
- The Port of Portland has few staff that work on site at HIO; HIO staff will need expert assistance to conduct assessment of facilities immediately following an event.
- Port of Portland is identifying staff/experts who live near assets and could conduct assessment in emergency

John Wilson explained the Oregon Department of Aviation's needs for seismic planning:

- The Department of Aviation will not have the resources to assess the 28 airports it manages
- Needs to know what plan consultants have in place so contractor engineers can fill assessment needs
- Federal assistance will first go to agencies with plans in place
- Note: the term "open" has different meanings for airports and air space

Scott Porter shared Washington County's seismic preparedness assumptions:

- HIO is not identified specifically in Washington County's emergency plans, but it is referenced in assumptions
- Washington County plans to move fuel through HIO
- HIO is identified as a potential emergency staging area in a report prepared by the National Guard
- Washington County plans to use existing state emergency plans, but it is not clear if the plans have been updated
- Washington County would like the state to communicate how it plans to use HIO in the event of an emergency
- HIO is a significant resource to the Washington County community, especially considering that surface transportation may not be functioning.

Tammy Bain shared the City of Hillsboro's seismic preparedness assumptions:

- Similar assumptions as Washington County – HIO will be very important to the local community if surface roads are impassable
- The Hillsboro Fire Station at the airport could provide status update or support assessment after a seismic event

Kori Nobel opened a discussion of how the Port of Portland requests resources after a seismic event:

- Requests for resources will be funneled through the counties to the state - The Port of Portland should request resources through Multnomah County, per headquarter location (Scott Porter, Mike Harryman)
- Resources will be provided depending on availability (Capt. Zorn)
- FEMA now has aviation assets they can bring in (Mike Harryman)
- Aerial Port of Deparkation (APOD) will probably be located at PDX (Scott Porter)
- Military will assess possible locations of APODs – one likely in Redmond, and a second one in Portland or Willamette Valley (Mike Harryman)
- Salem Airport is a potential APOD candidate after PDX and HIO (John Wilson)

- Remember that surface roads will need to be cleared to distribute resources from the airport (Ed Flick)
- The state is assuming neither PDX nor HIO will be operational following a Cascadia seismic event; it would be very helpful if one of these airports was operational (Andrew Phelps)
- The Portland metro region is challenged because it is separated by rivers – supplies that fly into HIO would not be able to reach the east side of the Willamette river

State Resilience Plan Discussion

- The Oregon Office of Emergency Management has much work ahead, but is striving to work quickly (Andrew Phelps)
- Talk to state congress about funding seismic projects every legislative session (Mike Harryman)
- There is little federal support for seismic preparedness at the moment (Mike Harryman)
- Washington County would like a state emergency plan to identify key areas so a Washington County emergency plan can decide where to make investments (Scott Porter)
- Suggest the HIO master plan include plans for power resilience through backup generators, additional power lines, solar panels (Scott Porter)
- Government support may be needed to make private sector participation in emergency planning financially feasible, i.e., it is expensive to keep fuel tanks full at all times, but government could help pay for it
- It will be important to share information among emergency managers at different agencies to form a cohesive plan (Neal White)

Ongoing engagement and communication

- The Port of Portland will share more information as it becomes available about the runway reconstruction and master plan update (Steve Nagy)
- Continuity plans will continually be reviewed and can adapt to ongoing changes and capabilities of HIO (Greg Theisen)

APPENDIX B
ASCE 41-13 Structural Seismic Hazard Evaluations

STRUCTURAL & EARTHQUAKE ENGINEERING
215 w. 12th street suite 202 ◦ vancouver, washington ◦ 98660

Seismic Hazard Evaluation

Port of Portland
Hillsboro Airport Maintenance Building

1040 NE 25th Avenue
Hillsboro, Oregon

May 5, 2017
17028.00

phone: 360.695.9731
www.wrkengrs.com

TABLE OF CONTENTS

APPENDICES

1. Project Background

The evaluation of the Maintenance Building located in Hillsboro, Oregon is to determine the expected performance during a design basis earthquake. The purpose of our seismic evaluation is to identify the structural and nonstructural deficiencies that exist at the Maintenance Building. The evaluation, if requested, can then be used as the basis for developing a suitable strengthening scheme for the structural system. In addition, the evaluation will assist us in identifying the nonstructural components requiring seismic hardening (i.e. anchorage and/or bracing).

Our work is based on the following:

1. A review of a single building floor plan drawing prepared by the Port of Portland dated 2008.
2. A site visit by Brian Knight, P.E., S.E. of WRK Engineers on March 28, 2017 to briefly review as-built conditions and to briefly review the existing nonstructural components.

2. Evaluation Criteria and Methodology

For our evaluation of the Maintenance Building, we used ASCE Standard 41-13, "Seismic Evaluation and Retrofit of Existing Buildings" published by the American Society of Civil Engineers. ASCE 41 is the nationally recognized Standard for seismic assessment and evaluation of existing buildings. The goal of ASCE 41 is to identify the "weak links" in a building's lateral force resisting system that can lead to significant failure and/or collapse. In addition, ASCE 41 will identify typical nonstructural hazards that may pose a life-safety risk to occupants or a business interruption (i.e. operations) risk to the building.

The methodology utilizes a series of checklists that address possible seismic hazards. Checklists are included in the Standard for all of the major structural systems, nonstructural elements, and geologic and site hazards. The evaluating engineer addresses each statement and determines whether it is compliant or non-compliant. Compliant statements identify conditions that are acceptable. Non-compliant statements identify conditions that are in need of further investigation. In some cases, the Standard specifies additional calculations that may be performed to address a non-compliant statement. In other cases, a detailed analysis of the building must be performed.

Our evaluation of the Maintenance Building is based on an Immediate Occupancy (IO) Performance Level as defined in ASCE 41. The intent of the IO performance level is:

> *After a design earthquake, the basic vertical and lateral force resisting systems retain nearly all of their pre-earthquake strength, and very limited damage to both structural and nonstructural components is anticipated during the design earthquake which require some minor repairs, but the critical parts of the building are habitable.*

In other words, the IO performance level objective is meant to ensure that a building will continue to remain in operation immediately following a major earthquake.

3. Building Description

The Maintenance Building is located in Hillsboro, Oregon. The building was originally constructed in 1976 as a single-story and two-story structure. The original structural system does not appear to have been substantially altered since the time of original construction, but there is what appears to be an addition that was added to one end of the building. This addition does not appear to be part of the original construction, but looks like it was built relatively soon after 1976. The building has a current total area just over 7,000 sq. ft. There are no structures immediately adjacent to the Maintenance Building.

The main portion of the Maintenance Building is a single-story tilt-up with perimeter concrete panel walls and a wood roof with full span trusses. The main portion is a rectangle with overall plan dimensions of about 100 feet by about 50 feet. The addition appears to consist of a wood roof and a wood floor with perimeter wood walls. The addition has two portions: a single-story section with rough plan dimensions of 20 feet by 70 feet along the end wall of the original building and a two-story section with rough plan dimensions of 25 feet by 25 feet located at the corner of the original building. The original roof is approximately 18 feet above grade with roughly four feet of tilt-up wall parapet around the full perimeter. The addition has a story height of approximately nine feet with the low wood roof roughly matching the upper wood floor and the upper wood roof roughly matching the tilt-up roof. While the main tilt-up structure is one-story, the end adjacent to the wood framed addition has an in-fill second-story portion that connects to the two-story addition. For this review, it is assumed this in-fill area was not part of the original construction.

The main roof structure consists of built-up roofing over wood sheathing over open web trusses that span between concrete wall panels. The floor for the addition is assumed to consist of wood sheathing over wood joists. The addition's roof structure is assumed to consist of wood sheathing over wood rafters (or trusses). The bearing walls supporting the addition's roofs and floor are assumed to be at the perimeter only. The perimeter walls at the main structure are assumed to be supported by below-grade continuous concrete footings. The perimeter walls at the addition are assumed to be supported by concrete stem walls with continuous below-grade strip footings.

The original building's lateral force resisting system consists of five-inch-thick concrete tilt-up wall panels. The ASCE 41 Model Building Type is PC1. The perimeter concrete walls are generally solid, but there are some openings spread around the full perimeter (three overhead doors, about seven man-doors, and about four small windows). The concrete walls transfer lateral loads to the foundation. The roof diaphragm is a nailed sheathing system that spans between the perimeter walls. The diaphragm is considered flexible relative to the shear walls which support it.

The addition's lateral force resisting system is assumed to consist of sheathed wood perimeter walls. The ASCE 41 Model Building Type is W2. Most of the perimeter walls have some combination of solid wall sections and window/door openings. The one exception is the long one-story wall which consists only of openings and intermediate studs/columns. The walls transfer lateral loads to the foundation. The floor and roof diaphragms are nailed sheathing systems that span between the perimeter walls. The diaphragms are considered flexible.

4. Site Description and Seismicity

The building is located on a level site with the ground floor at the level of the exterior grade.

The building is assumed to be founded on relatively stiff soils of varying depths. The seismic soil coefficients used for evaluation are based on the current classifications from the ASCE 7-10 provisions. The site soil classification is assumed to be Class "D".

The amplification factors used to account for the soil conditions of the site are F_V equal to 1.565 and F_A equal to 2.352. The short period spectral acceleration, S_{XS}, using the 2008 USGS maps is 0.459g. The long period spectral acceleration, S_{X1}, is 0.263g. The building is located in an area of high seismicity according to the categories defined in ASCE 41.

The susceptibility of the site to significant settlement due to earthquake-induced liquefaction is assumed to be low.

5. Discussion of Building Deficiencies

Using the procedures of ASCE 41, we have identified a number of deficiencies in the lateral force resisting system.

5.1 Structural Deficiencies

Numerous structural deficiencies have been identified at the Maintenance Building. These include the following:

- Wall Anchorage: Exterior concrete walls that are dependent on the diaphragm for lateral support are not anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm.

- Wood Ledgers: The connection between the concrete wall panels and the diaphragm induces cross-grain bending or tension in the wood ledgers.

- Transfer to Shear Walls: Diaphragm connections are not able to develop the lesser of the shear strength of the concrete walls or diaphragms.

- Wall Thickness: Thicknesses of concrete bearing walls are less than 1/25 the unsupported height.

- Cross Ties for Flexible Diaphragms: There are not continuous cross ties between diaphragm chords in the tilt-up portion of the building.

- Precast Wall Panels: Precast wall panel connections with the foundation are not able to develop the strength of the walls.

- Redundancy: The number of lines of wood shear walls for the one-story wood framed addition is less than two in at least one principal direction.

- Shear Stress Check: The shear stress in some of the wood shear walls for the wood framed addition, calculated using the Quick Check procedure, is greater than 1,000 lbs./ft.

- Narrow Wood Shear Walls: Narrow wood shear walls with an aspect ratio greater than 1.5-to-1are used to resist seismic forces.

- Openings: Wood walls with openings greater than 80% of the length are not braced with wood structural panel shear walls with aspect ratios of not more than 1.5-to-1 or are not supported by adjacent construction through positive ties capable of transferring the seismic forces.

- Unblocked Diaphragms: Not all unblocked wood structural panel diaphragms have horizontal spans less than 30 feet and aspect ratios less than or equal to 3-to-1.

5.2 Nonstructural Deficiencies

A nonstructural seismic evaluation for the Maintenance Building was conducted for the Immediate Occupancy performance level. Table 1 below shows various nonstructural systems found in the building where mitigation is required. Additional nonstructural systems that are compliant or that required additional investigation are not included in this table.

TABLE 1 – Nonstructural Seismic Evaluation/Mitigation Criteria (Immediate Occupancy Performance Level)

Nonstructural Component Type	Mitigation Required
Ceilings	
Suspended Integrated Ceiling	Yes
Parapets and Appendages	Yes
Mechanical Equipment	Yes
Storage Vessels	Yes
Fluid Piping	
Hazardous Materials	Yes

Nonhazardous Materials	Yes
Light Fixtures	
Recessed	Yes
Surface-Mounted	Yes
Integrated Ceiling	Yes
Lens Covers and Light Diffusers	Yes
Furnishings and Interior Equipment	
Storage Racks	Yes
Bookcases	Yes
Hazardous Materials Storage	Yes
Rolling Carts	Yes[1]

Table 1 Notes:
1 Storage furnishing with locking or non-locking casters which may damage nearby essential equipment.

6. Adjacency Hazards

There are no immediately adjacent buildings to the Maintenance Building.

7. Geologic and Site Hazards

The potential for significant failure of the foundations and the soil surrounding the site are assumed to be minimal.

The ASCE 41 checklists that we used to identify the structural and nonstructural deficiencies are attached as Appendix B.

8. Expected Building Performance

8.1 Structural

The Maintenance Building has been assigned expected building damage levels for the structural and nonstructural systems. The structural damage levels are "Slight Damage", "Moderate Damage", "Extensive Damage", and "Complete Damage". Structural damage levels for buildings and brief descriptions of each damage level and expected performance are as follows:

- Slight Damage – The building structural systems will sustain slight damage. The building may be occupied during repairs. The structure substantially retains original strength and stiffness. There is no permanent story drift. All systems important to normal operations are functional.

- Moderate Damage – The building will sustain structural damage during a design basis earthquake and may need to be repaired before occupancy is restored. The gravity and lateral force resisting systems may require shoring or bracing if temporary occupancy is needed. There may be some permanent story drift. The structure retains some residual strength and stiffness. Gravity load bearing systems are still functional.

- Extensive Damage – During the design basis earthquake, the gravity and lateral force resisting systems may experience significant damage or partial collapse. The structure has little residual strength and stiffness, and there are permanent story drifts.

- Complete Damage – The structure partially or totally collapses and is nonfunctional.

8.2 Nonstructural

Nonstructural damage levels for buildings and brief descriptions of each damage level and expected performance are as follows:

- 0% Damaged – The nonstructural components are anchored or braced with no damage to interior equipment expected. All nonstructural systems are fully functional.

- 25% Damaged – The nonstructural components are anchored or braced, but not adequately. Minor damage to interior equipment occurs, but a majority of nonstructural systems are functional.

- 50% Damaged – Some nonstructural components are not anchored or are braced inadequately in order to prevent damage during an earthquake. The majority of all nonstructural systems sustain some damage. It is unlikely complete functionality of nonstructural systems is maintained.

- 75% Damaged – Extensive damage to the nonstructural system is expected and may result in loss of component function. Only a small portion of nonstructural systems are functional.

- 100% Damaged – Extensive damage to the nonstructural system is expected and results in total loss of component function.

The Maintenance Building's structural systems have been assigned an expected building damage level of **Extensive Damage** and nonstructural systems have been assigned an expected building damage level of **75% Damaged**. We recommend the building be strengthened/hardened to an Immediate Occupancy performance level in accordance with ASCE Standard 41, "Seismic Evaluation and Retrofit of Existing Buildings".

9. Limitations

The opinions and recommendations presented in this report were developed with the care commonly used as the state of practice of the profession. No other warranties are included, either expressed or implied, as to the professional advice included in this report. This report has been prepared for Port of Portland to be used solely in its evaluation of the seismic safety of the building included herein. This report has not been prepared for use by other parties and may not contain sufficient information for purposes of other parties or uses.

If you have any comments or questions regarding this evaluation, please call.

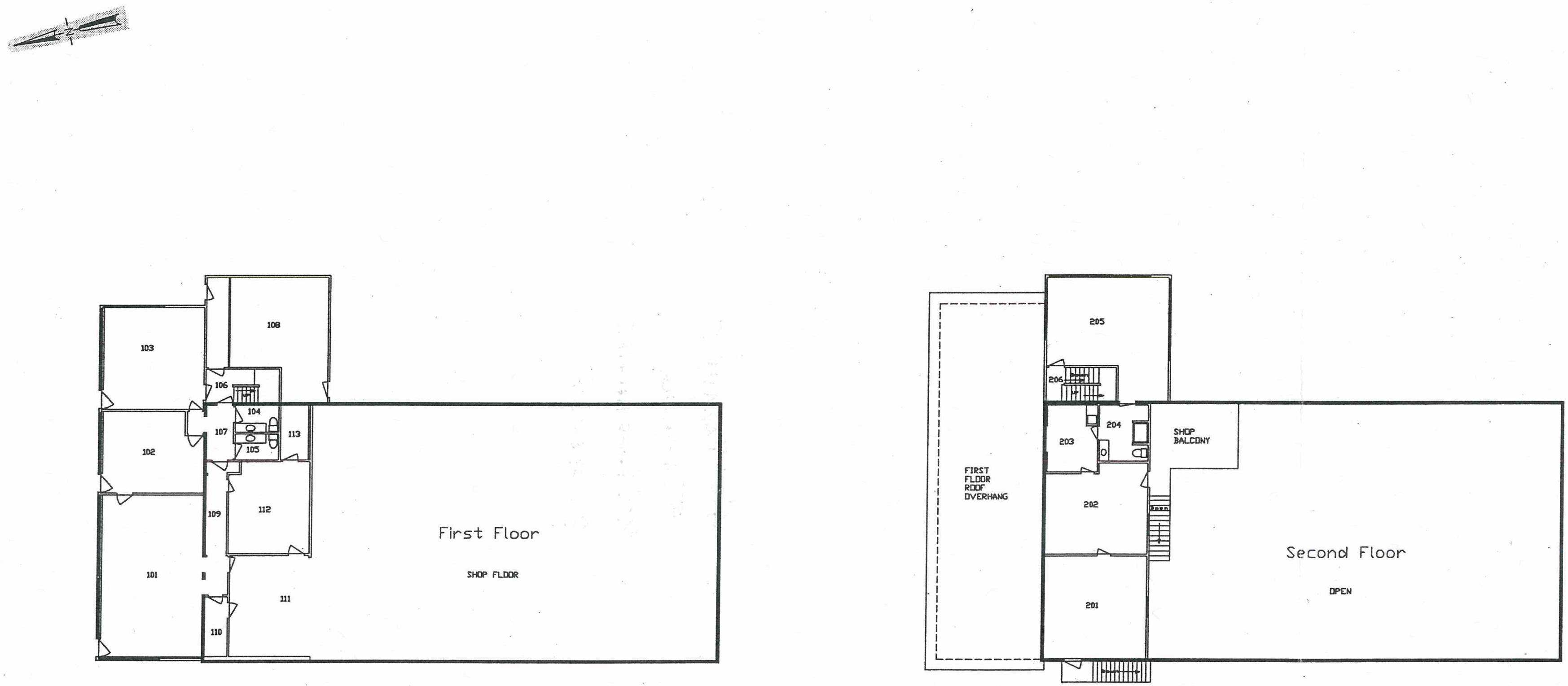
Very truly yours,
WRK Engineers

Jacob Christensen, P.E., S.E.
Project Engineer

Brian Knight, P.E., S.E.
Principal

Appendix A

AVAILABLE BUILDING DRAWINGS



NO.	DATE	BY	REVISIONS	CK'D	APP'VD	NO.	DATE	BY	REVISIONS	CK'D	APP'VD

PORT OF PORTLAND
PORTLAND, OREGON

DESIGNED BY

DRAWN BY Anthony Beach

CHECKED BY CHECKER

DATE 4-3-2008

GRAPHICAL SCALE BAR 0 1/4" 1/2" 1" 2"

HILLSBORO AIRPORT

Port Maintenance Facility
Hillsboro Oregon

SUBMITTED BY

TYPE ######

DRAWING NO. ####/##(D####)

Appendix B

ASCE 41 STRUCTURAL AND NONSTRUCTURAL CHECKLISTS

APPENDIX C
SUMMARY DATA SHEET

BUILDING DATA

Building Name: Hillsboro Airport Maintenance Building — Date: May 5, 2017
Building Address: 1040 NE 25th Avenue, Hillsboro, Oregon 97124
Latitude: 45.532 — Longitude: -122.956 — By: Jacob Christensen
Year Built: 1976 — Year(s) Remodeled: Unknown — Original Design Code: Unknown
Area (sf): 7,025 — Length (ft): ~120 — Width (ft): ~50
No. of Stories: 1 and 2 — Story Height: ~9 ft. and 18 ft. — Total Height: 18 ft.

USE ☒ Industrial ☐ Office ☐ Warehouse ☐ Hospital ☐ Residential ☐ Educational ☐ Other: ______

CONSTRUCTION DATA

Gravity Load Structural System: O.W. Roof Trusses to Concrete Walls / Wood Rafters and Joists to Wood Walls
Exterior Transverse Walls: Concrete Tilt-Up / Wood Stud Wall — Openings? Yes
Exterior Longitudinal Walls: Concrete Tilt-Up / Wood Stud Wall — Openings? Yes
Roof Materials/Framing: Built-Up Roofing and Wood Sheathing Over O.W. Joists or Wood Rafters
Intermediate Floors/Framing: Sheathing Over Wood Joists
Ground Floor: Slab on Grade
Columns: N/A — Foundation: Concrete
General Condition of Structure: Functional with expected aging for its construction date
Levels Below Grade? 0
Special Features and Comments: 100 ft. x 50 ft. Tilt-Up Building with Wood Framed Addition (70 ft. x 20 ft. and 25 ft. x 25 ft.) to Northeast End

LATERAL-FORCE-RESISTING SYSTEM

	Longitudinal	Transverse
System:	PC1 / W2	PC1 / W2
Vertical Elements:	Tilt-Up Panels / Wood Shear Walls	Tilt-Up Panels / Wood Shear Walls
Diaphragms:	Wood Sheathing - Roof and Floor	Wood Sheathing - Roof and Floor
Connections:	Nails and Bolts	Nails and Bolts

EVALUATION DATA

BSE-1N Spectral Response Accelerations: S_{Ds} = 0.732 — S_{D1} = 0.462
Soil Factors: Class = D — F_a = 1.565 — F_v = 2.352
BSE-1E Spectral Response Accelerations: S_{XS} = 0.459 — S_{X1} = 0.263
Level of Seismicity: High — Performance Level: IO
Building Period: T = 0.175
Spectral Acceleration: S_a = 0.459
Modification Factor: $C_mC_1C_2$ = PC1 - 1.0 / W2 - 1.1 — Building Weight: W = PC1 - 243^k / W2 - 48^k
Pseudo Lateral Force: $V = C_mC_1C_2S_aW$ = PC1 - 112^k / W2 - 24^k

BUILDING CLASSIFICATION: IV

REQUIRED TIER 1 CHECKLISTS	Yes	No
Basic Configuration Checklist	☒	☐
Building Type PC1/W2 Structural Checklist	☒	☐
Nonstructural Component Checklist	☒	☐

FURTHER EVALUATION REQUIREMENT: Not compliant with Tier 1 for BPOE. Further evaluation as directed by client.

16.1.2IO IMMEDIATE OCCUPANCY BASIC CONFIGURATION CHECKLIST

Very Low Seismicity

Building System

General

(C) NC N/A U LOAD PATH: The structure shall contain a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)

(C) NC N/A U ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 4% of the height of the shorter building. This statement need not apply for the following building types: W1, W1a, and W2. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2)

C NC (N/A) U MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3)

Building Configuration

C NC (N/A) U WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction shall not be less than 80% of the strength in the adjacent story above. (Commentary: Sec. A.2.2.2. Tier 2: Sec. 5.4.2.1)

C NC (N/A) U SOFT STORY: The stiffness of the seismic-force-resisting system in any story shall not be less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffnessof the three stories above. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2)

C NC (N/A) U VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3)

C NC (N/A) U GEOMETRY: There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4)

C NC (N/A) U MASS: There is no change in effective mass more than 50% from one story to the next. Light roofs, penthouses, and mezzanines need not be considered. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5)

(C) NC N/A U TORSION: The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6)

Low Seismicity: Complete the Following Items in Additionto the Items for Very Low Seismicity.

Geologic Site Hazards

(C) NC N/A U LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance shall not exist in the foundation soils at depths within 50 ft under the building. (Commentary: Sec. A.6.1.1. Tier 2: 5.4.3.1)

(C) NC N/A U SLOPE FAILURE: The building site is sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or is capable of accommodating any predicted movements without failure. (Commentary: Sec. A.6.1.2. Tier 2: 5.4.3.1)

(C) NC N/A U SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: 5.4.3.1)

Moderate and High Seismicity: Complete the Following Items in Addition to the Items for Low Seismicity.

Foundation Configuration

(C) NC N/A U OVERTURNING: The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is greater than $0.6S_a$. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3)

C NC N/A (U) TIES BETWEEN FOUNDATION ELEMENTS: The foundation has ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Site Class A, B, or C. (Commentary: Sec. A.6.2.2. Tier 2: Sec. 5.4.3.4)

16.12IO IMMEDIATE OCCUPANCY STRUCTURAL CHECKLIST FOR BUILDING TYPES PC1: PRECAST OR TILT-UP CONCRETE SHEAR WALLS WITH FLEXIBLE DIAPHRAGMS AND PC1A: PRECAST OR TILT-UP CONCRETE SHEAR WALLS WITH STIFF DIAPHRAGMS

Very Low Seismicity

Foundation System

C NC (N/A) U DEEP FOUNDATIONS: Piles and piers are capable of transferring the lateral forces between the structure and the soil. (Commentary: Sec. A.6.2.3.)

C NC (N/A) U SLOPING SITES: The difference in foundation embedment depth from one side of the building to another shall not exceed one story high. (Commentary: Sec. A.6.2.4)

Connections

C (NC) N/A U WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.5.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)

Seismic-Force-Resisting System

(C) NC N/A U REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1)

(C) NC N/A U WALL SHEAR STRESS CHECK: The shear stress in the precast panels, calculated using the Quick Check procedure of Section 4.5.3.3, is less than the greater of 100 lb/in.^{2} or $2\sqrt{f_c'}$. (Commentary: Sec. A.3.2.3.1. Tier 2: Sec. 5.5.3.1.1)

C NC N/A (U) REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area is not less than 0.0012 in the vertical direction and 0.0020 in the horizontal direction. The spacing of reinforcing steel is equal to or less than 18 in. (Commentary: Sec. A.3.2.3.2. Tier 2: Sec. 5.5.3.1.3)

Diaphragms

C NC (N/A) U TOPPING SLAB: Precast concrete diaphragm elements are interconnected by a continuous reinforced concrete topping slab with a minimum thickness of 2 in. (Commentary: Sec. A.4.5.1. Tier 2: Sec. 5.6.4)

Connections

C (NC) N/A U WOOD LEDGERS: The connection between the wall panels and the diaphragm does not induce cross-grain bending or tension in the wood ledgers. (Commentary: Sec. A.5.1.2. Tier 2: Sec. 5.7.1.4)

C (NC) N/A U TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls, and the connections are able to develop the lesser of the shear strength of the walls or diaphragms. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2)

C NC (N/A) U TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements are doweled for transfer of forces into the shear wall or frame elements, and the dowels are able to develop the least of the shear strength of the walls, frames, or slabs. (Commentary: Sec. A.5.2.3. Tier 2: Sec. 5.7.2)

C NC (N/A) U GIRDER–COLUMN CONNECTION: There is a positive connection using plates, connection hardware, or straps between the girder and the column support. (Commentary: Sec. A.5.4.1. Tier 2: Sec. 5.7.4.1)

Low, Moderate, and High Seismicity: Complete the Following Items in Addition to the Items for Very Low Seismicity.

Seismic-Force-Resisting System

C NC (N/A) U DEFLECTION COMPATIBILITY FOR RIGID DIAPHRAGMS: Secondary components shall have the shear capacity to develop the flexural strength of the components. (Commentary: Sec. A.3.1.6.2. Tier 2: Sec. 5.5.2.5.2)

(C) NC N/A U WALL OPENINGS: The total width of openings along any perimeter wall line constitutes less than 50% of the length of any perimeter wall when the wall piers have aspect ratios of less than 2-to-1. (Commentary: Sec. A.3.2.3.3. Tier 2: Sec. 5.5.3.3.1)

C NC N/A (U) PANEL-TO-PANEL CONNECTIONS: Adjacent wall panels are interconnected to transfer overturning forces between panels by methods other than welded steel inserts. (Commentary: Sec. A.3.2.3.4. Tier 2: Sec. 5.5.3.3.3)

C (NC) N/A U WALL THICKNESS: Thicknesses of bearing walls shall not be less than 1/25 the unsupported height or length, whichever is shorter, nor less than 4 in. (Commentary: Sec. A.3.2.3.5. Tier 2: Sec. 5.5.3.1.2)

Diaphragms

C (NC) N/A U CROSS TIES FOR FLEXIBLE DIAPHRAGMS: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)

C NC (N/A) U PLAN IRREGULARITIES: There is tensile capacity to develop the strength of the diaphragm at reentrant corners or other locations of plan irregularities. (Commentary: Sec. A.4.1.7. Tier 2: Sec. 5.6.1.4)

C NC (N/A) U DIAPHRAGM REINFORCEMENT AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. (Commentary: Sec. A.4.1.8. Tier 2: Sec. 5.6.1.5)

C NC N/A (U) STRAIGHT SHEATHING: All straight sheathed diaphragms have aspect ratios less than 1-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2)

C NC N/A (U) SPANS: All wood diaphragms with spans greater than 12 ft consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)

C NC N/A (U) DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 30 ft and aspect ratios less than or equal to 3-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2)

(C) NC N/A U OTHER DIAPHRAGMS: The diaphragm does not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)

Connections

(C) NC N/A U MINIMUM NUMBER OF WALL ANCHORS PER PANEL: There are at least two anchors from each precast wall panel into the diaphragm elements. (Commentary: Sec. A.5.1.3. Tier 2: Sec. 5.7.1.4)

C (NC) N/A U PRECAST WALL PANELS: Precast wall panels are connected to the foundation, and the connections are able to develop the strength of the walls. (Commentary: Sec. A.5.3.6. Tier 2: Sec. 5.7.3.4)

C NC (N/A) U UPLIFT AT PILE CAPS: Pile caps shall have top reinforcement, and piles are anchored to the pile caps; the pile cap reinforcement and pile anchorage are able to develop the tensile capacity of the piles. (Commentary: Sec. A.5.3.8. Tier 2: Sec. 5.7.3.5)

C NC (N/A) U GIRDERS: Girders supported by walls or pilasters have at least two ties securing the anchor bolts unless provided with independent stiff wall anchors with adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.5.3.7. (Commentary: Sec. A.5.4.2. Tier 2: Sec. 5.7.4.2)

16.3IO IMMEDIATE OCCUPANCY STRUCTURAL CHECKLIST FOR BUILDING TYPE W2: WOOD FRAMES, COMMERCIAL AND INDUSTRIAL

Very Low Seismicity

Seismic-Force-Resisting System

C (NC) N/A U REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1)

C (NC) N/A U SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure of Section 4.5.3.3, is less than the following values (Commentary: Sec. A.3.2.7.1. Tier 2: Sec. 5.5.3.1.1):

Structural panel sheathing	1,000 lb/ft
Diagonal sheathing	700 lb/ft
Straight sheathing	100 lb/ft
All other conditions	100 lb/ft

C NC (N/A) U STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multi-story buildings do not rely on exterior stucco walls as the primary seismic-force-resisting system. (Commentary: Sec. A.3.2.7.2. Tier 2: Sec. 5.5.3.6.1)

C NC N/A (U) GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard is not used as shear walls on buildings more than one story high with the exception of the uppermost level of a multi-story building. (Commentary: Sec. A.3.2.7.3. Tier 2: Sec. 5.5.3.6.1)

C (NC) N/A U NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 2-to-1 are not used to resist seismic forces. (Commentary: Sec. A.3.2.7.4. Tier 2: Sec. 5.5.3.6.1)

C NC N/A (U) WALLS CONNECTED THROUGH FLOORS: Shear walls have an interconnection between stories to transfer overturning and shear forces through the floor. (Commentary: Sec. A.3.2.7.5. Tier 2: Sec. 5.5.3.6.2)

C NC (N/A) U HILLSIDE SITE: For structures that are taller on at least one side by more than one-half story because of a sloping site, all shear walls on the downhill slope have an aspect ratio less than 1-to-2. (Commentary: Sec. A.3.2.7.6. Tier 2: Sec. 5.5.3.6.3)

C NC (N/A) U CRIPPLE WALLS: Cripple walls below first-floor-level shear walls are braced to the foundation with wood structural panels. (Commentary: Sec. A.3.2.7.7. Tier 2: Sec. 5.5.3.6.4)

C (NC) N/A U OPENINGS: Walls with openings greater than 80% of the length are braced with wood structural panel shear walls with aspect ratios of not more than 1.5-to-1 or are supported by adjacent construction through positive ties capable of transferring the seismic forces. (Commentary: Sec. A.3.2.7.8. Tier 2: Sec. 5.5.3.6.5)

C NC N/A (U) HOLD-DOWN ANCHORS: All shear walls have hold-down anchors, constructed per acceptable construction practices, attached to the end studs. (Commentary: Sec. A.3.2.7.9. Tier 2: Sec. 5.5.3.6.6)

Connections

C NC N/A (U) WOOD POSTS: There is a positive connection of wood posts to the foundation. (Commentary: Sec. A.5.3.3. Tier 2: Sec. 5.7.3.3)

C NC N/A (U) WOOD SILLS: All wood sills are bolted to the foundation. (Commentary: Sec. A.5.3.4. Tier 2: Sec. 5.7.3.3)

C NC N/A (U) GIRDER/COLUMN CONNECTION: There is a positive connection using plates, connection hardware, or straps between the girder and the column support. (Commentary: Sec. A.5.4.1. Tier 2: Sec. 5.7.4.1)

Foundation System

C NC (N/A) U DEEP FOUNDATIONS: Piles and piers are capable of transferring the lateral forces between the structure and the soil. (Commentary: Sec. A.6.2.3.)

C NC (N/A) U SLOPING SITES: The difference in foundation embedment depth from one side of the building to another shall not exceed one story high. (Commentary: Sec. A.6.2.4)

Low, Moderate, and High Seismicity: Complete the Following Items in Addition to the Items for Very Low Seismicity.

Seismic-Force-Resisting System

C (NC) N/A U NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 1.5-to-1 are not used to resist seismic forces. (Commentary: Sec. A.3.2.7.4. Tier 2: Sec. 5.5.3.6.1)

Diaphragms

(C) NC N/A U DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1)

C NC N/A (U) ROOF CHORD CONTINUITY: All chord elements are continuous, regardless of changes in roof elevation. (Commentary: Sec. A.4.1.3. Tier 2: Sec. 5.6.1.1)

C NC (N/A) U PLAN IRREGULARITIES: There is tensile capacity to develop the strength of the diaphragm at reentrant corners or other locations of plan irregularities. (Commentary: Sec. A.4.1.7. Tier 2: Sec. 5.6.1.4)

C NC (N/A) U DIAPHRAGM REINFORCEMENT AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. (Commentary: Sec. A.4.1.8. Tier 2: Sec. 5.6.1.5)

C NC (N/A) U STRAIGHT SHEATHING: All straight sheathed diaphragms have aspect ratios less than 1-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2)

(C) NC N/A U SPANS: All wood diaphragms with spans greater than 12 ft consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)

C (NC) N/A U DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 30 ft and aspect ratios less than or equal to 3-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2)

(C) NC N/A U OTHER DIAPHRAGMS: The diaphragm does not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)

Connections

C NC N/A (U) WOOD SILL BOLTS: Sill bolts are spaced at 4 ft or less, with proper edge and end distance provided for wood and concrete. (Commentary: Sec. A.5.3.7. Tier 2: Sec. 5.7.3.3)

16.17 NONSTRUCTURAL CHECKLIST

Life Safety Systems

C NC (N/A) U LS-LMH; PR-LMH. FIRE SUPPRESSION PIPING: Fire suppression piping is anchored and braced in accordance with NFPA-13. (Commentary: Sec. A.7.13.1. Tier 2: Sec. 13.7.4)

C NC (N/A) U LS-LMH; PR-LMH. FLEXIBLE COUPLINGS: Fire suppression piping has flexible couplings in accordance with NFPA-13. (Commentary: Sec. A.7.13.2. Tier 2: Sec. 13.7.4)

C NC (N/A) U LS-LMH; PR-LMH. EMERGENCY POWER: Equipment used to power or control life safety systems is anchored or braced. (Commentary: Sec. A.7.12.1. Tier 2: Sec. 13.7.7)

C NC N/A (U) LS-LMH; PR-LMH. STAIR AND SMOKE DUCTS: Stair pressurization and smoke control ducts are braced and have flexible connections at seismic joints. (Commentary: Sec. A.7.14.1. Tier 2: Sec. 13.7.6)

C NC (N/A) U LS-MH; PR-MH. SPRINKLER CEILING CLEARANCE: Penetrations through panelized ceilings for fire suppression devices provide clearances in accordance with NFPA-13. (Commentary: Sec. A.7.13.3. Tier 2: Sec. 13.7.4)

C NC (N/A) U LS-not required; PR-LMH. EMERGENCY LIGHTING: Emergency and egress lighting equipment is anchored or braced. (Commentary: Sec. A.7.3.1. Tier 2: Sec. 13.7.9)

Hazardous Materials

C (NC) N/A U LS-LMH; PR-LMH. HAZARDOUS MATERIAL EQUIPMENT: Equipment mounted on vibration isolators and containing hazardous material is equipped with restraints or snubbers. (Commentary: Sec. A.7.12.2. Tier 2: 13.7.1)

C (NC) N/A U LS-LMH; PR-LMH. HAZARDOUS MATERIAL STORAGE: Breakable containers that hold hazardous material, including gas cylinders, are restrained by latched doors, shelf lips, wires, or other methods. (Commentary: Sec. A.7.15.1. Tier 2: Sec. 13.8.4)

C (NC) N/A U LS-MH; PR-MH. HAZARDOUS MATERIAL DISTRIBUTION: Piping or ductwork conveying hazardous materials is braced or otherwise protected from damage that would allow hazardous material release. (Commentary: Sec. A.7.13.4. Tier 2: Sec. 13.7.3 and 13.7.5)

C (NC) N/A U LS-MH; PR-MH. SHUT-OFF VALVES: Piping containing hazardous material, including natural gas, has shut-off valves or other devices to limit spills or leaks. (Commentary: Sec. A.7.13.3. Tier 2: Sec. 13.7.3 and 13.7.5)

C (NC) N/A U LS-LMH; PR-LMH. FLEXIBLE COUPLINGS: Hazardous material ductwork and piping, including natural gas piping, has flexible couplings. (Commentary: Sec. A.7.15.4, Tier 2: Sec.13.7.3 and 13.7.5)

C NC (N/A) U LS-MH; PR-MH. PIPING OR DUCTS CROSSING SEISMIC JOINTS: Piping or ductwork carrying hazardous material that either crosses seismic joints or isolation planes or is connected to independent structures has couplings or other details to accommodate the relative seismic displacements. (Commentary: Sec. A.7.13.6. Tier 2: Sec.13.7.3, 13.7.5, and 13.7.6)

Partitions

C NC (N/A) U LS-LMH; PR-LMH. UNREINFORCED MASONRY: Unreinforced masonry or hollow-clay tile partitions are braced at a spacing of at most 10 ft in Low or Moderate Seismicity, or at most 6 ft in High Seismicity. (Commentary: Sec. A.7.1.1. Tier 2: Sec. 13.6.2)

C NC (N/A) U LS-LMH; PR-LMH. HEAVY PARTITIONS SUPPORTED BY CEILINGS: The tops of masonry or hollow-clay tile partitions are not laterally supported by an integrated ceiling system. (Commentary: Sec. A.7.2.1. Tier 2: Sec. 13.6.2)

C NC (N/A) U LS-MH; PR-MH. DRIFT: Rigid cementitious partitions are detailed to accommodate the following drift ratios: in steel moment frame, concrete moment frame, and wood frame buildings, 0.02; in other buildings, 0.005. (Commentary A.7.1.2 Tier 2: Sec. 13.6.2)

C NC N/A **(U)** LS-not required; PR-MH. LIGHT PARTITIONS SUPPORTED BY CEILINGS: The tops of gypsum board partitions are not laterally supported by an integrated ceiling system. (Commentary: Sec. A.7.2.1. Tier 2: Sec. 13.6.2)

C NC **(N/A)** U LS-not required; PR-MH. STRUCTURAL SEPARATIONS: Partitions that cross structural separations have seismic or control joints. (Commentary: Sec. A.7.1.3. Tier 2. Sec. 13.6.2)

C NC N/A **(U)** LS-not required; PR-MH. TOPS: The tops of ceiling-high framed or panelized partitions have lateral bracing to the structure at a spacing equal to or less than 6 ft. (Commentary: Sec. A.7.1.4. Tier 2. Sec. 13.6.2)

Ceilings

C NC **(N/A)** U LS-MH; PR-LMH. SUSPENDED LATH AND PLASTER: Suspended lath and plaster ceilings have attachments that resist seismic forces for every 12 ft^2 of area. (Commentary: Sec. A.7.2.3. Tier 2: Sec. 13.6.4)

C NC **(N/A)** U LS-MH; PR-LMH. SUSPENDED GYPSUM BOARD: Suspended gypsum board ceilings have attachments that resist seismic forces for every 12 ft^2 of area. (Commentary: Sec. A.7.2.3. Tier 2: Sec. 13.6.4)

C **(NC)** N/A U LS-not required; PR-MH. INTEGRATED CEILINGS: Integrated suspended ceilings with continuous areas greater than 144 ft^2, and ceilings of smaller areas that are not surrounded by restraining partitions, are laterally restrained at a spacing no greater than 12 ft with members attached to the structure above. Each restraint location has a minimum of four diagonal wires and compression struts, or diagonal members capable of resisting compression. (Commentary: Sec. A.7.2.2. Tier 2: Sec. 13.6.4)

C **(NC)** N/A U LS-not required; PR-MH. EDGE CLEARANCE: The free edges of integrated suspended ceilings with continuous areas greater than 144 ft^2 have clearances from the enclosing wall or partition of at least the following: in Moderate Seismicity, 1/2 in.; in High Seismicity, 3/4 in. (Commentary: Sec. A.7.2.4. Tier 2: Sec. 13.6.4)

C NC **(N/A)** U LS-not required; PR-MH. CONTINUITY ACROSS STRUCTURE JOINTS: The ceiling system does not cross any seismic joint and is not attached to multiple independent structures. (Commentary: Sec. A.7.2.5. Tier 2: Sec. 13.6.4)

C **(NC)** N/A U LS-not required; PR-H. EDGE SUPPORT: The free edges of integrated suspended ceilings with continuous areas greater than 144 ft^2 are supported by closure angles or channels not less than 2 in. wide. (Commentary: Sec. A.7.2.6. Tier 2: Sec. 13.6.4)

C NC **(N/A)** U LS-not required; PR-H. SEISMIC JOINTS: Acoustical tile or lay-in panel ceilings have seismic separation joints such that each continuous portion of the ceiling is no more than 2500 ft^2 and has a ratio of long-to-short dimension no more than 4-to-1. (Commentary: Sec. A.7.2.7. Tier 2: 13.6.4)

Light Fixtures

C **(NC)** N/A U LS-MH; PR-MH. INDEPENDENT SUPPORT: Light fixtures that weigh more per square foot than the ceiling they penetrate are supported independent of the grid ceiling suspension system by a minimum of two wires at diagonally opposite corners of each fixture. (Commentary: Sec. A.7.3.2. Tier 2: Sec. 13.6.4 and 13.7.9)

C NC **(N/A)** U LS-not required; PR-H. PENDANT SUPPORTS: Light fixtures on pendant supports are attached at a spacing equal to or less than 6 ft and, if rigidly supported, are free to move with the structure to which they are attached without damaging adjoining components. (Commentary: A.7.3.3. Tier 2: Sec. 13.7.9)

C **(NC)** N/A U LS-not required; PR-H. LENS COVERS: Lens covers on light fixtures are attached with safety devices. (Commentary: Sec. A.7.3.4. Tier 2: Sec. 13.7.9)

Cladding and Glazing

C NC **(N/A)** U LS-MH; PR-MH. CLADDING ANCHORS: Cladding components weighing more than 10 lb/ft^2 are mechanically anchored to the structure at a spacing equal to or less than the following: for Life Safety in Moderate Seismicity, 6 ft; for Life Safety in High Seismicity and for Position Retention in any seismicity, 4 ft. (Commentary: Sec. A.7.4.1. Tier 2: Sec. 13.6.1)

C NC **(N/A)** U LS-MH; PR-MH. CLADDING ISOLATION: For steel or concrete moment frame buildings, panel connections are detailed to accommodate a story drift ratio of at least the following: for Life Safety in Moderate Seismicity, 0.01; for Life Safety in High Seismicity and for Position Retention in any seismicity, 0.02. (Commentary: Sec. A.7.4.3. Tier 2: Section 13.6.1)

C NC (N/A) U LS-MH; PR-MH. MULTI-STORY PANELS: For multi-story panels attached at more than one floor level, panel connections are detailed to accommodate a story drift ratio of at least the following: for Life Safety in Moderate Seismicity, 0.01; for Life Safety in High Seismicity and for Position Retention in any seismicty, 0.02. (Commentary: Sec. A.7.4.4. Tier 2: Sec. 13.6.1)

C NC (N/A) U LS-MH; PR-MH. PANEL CONNECTIONS: Cladding panels are anchored out-of-plane with a minimum number of connections for each wall panel, as follows: for Life Safety in Moderate Seismicity, 2 connections; for Life Safety in High Seismicity and for Position Retention in any seismicity, 4 connections. (Commentary: Sec. A.7.4.5. Tier 2: Sec. 13.6.1.4)

C NC (N/A) U LS-MH; PR-MH. BEARING CONNECTIONS: Where bearing connections are used, there is a minimum of two bearing connections for each cladding panel. (Commentary: Sec. A.7.4.6. Tier 2: Sec. 13.6.1.4)

C NC (N/A) U LS-MH; PR-MH. INSERTS: Where concrete cladding components use inserts, the inserts have positive anchorage or are anchored to reinforcing steel. (Commentary: Sec. A.7.4.7. Tier 2: Sec. 13.6.1.4)

C NC (N/A) U LS-MH; PR-MH. OVERHEAD GLAZING: Glazing panes of any size in curtain walls and individual interior or exterior panes over 16 ft^2 in area are laminated annealed or laminated heat-strengthened glass and are detailed to remain in the frame when cracked. (Commentary: Sec. A.7.4.8: Tier 2: Sec. 13.6.1.5)

Masonry Veneer

C NC (N/A) U LS-LMH; PR-LMH. TIES: Masonry veneer is connected to the backup with corrosion-resistant ties. There is a minimum of one tie for every 2-2/3 ft^2, and the ties have spacing no greater than the following: for Life Safety in Low or Moderate Seismicity, 36 in.; for Life Safety in High Seismicity and for Position Retention in any seismicity, 24 in. (Commentary: Sec. A.7.5.1. Tier 2: Sec. 13.6.1.2)

C NC (N/A) U LS-LMH; PR-LMH. SHELF ANGLES: Masonry veneer is supported by shelf angles or other elements at each floor above the ground floor. (Commentary: Sec. A.7.5.2. Tier 2: Sec. 13.6.1.2)

C NC (N/A) U LS-LMH; PR-LMH. WEAKENED PLANES: Masonry veneer is anchored to the backup adjacent to weakened planes, such as at the locations of flashing. (Commentary: Sec. A.7.5.3. Tier 2: Sec. 13.6.1.2)

C NC (N/A) U LS-LMH; PR-LMH. UNREINFORCED MASONRY BACKUP: There is no unreinforced masonry backup. (Commentary: Sec. A.7.7.2. Tier 2: Section 13.6.1.1 and 13.6.1.2)

C NC (N/A) U LS-MH; PR-MH. STUD TRACKS: For veneer with metal stud backup, stud tracks are fastened to the structure at a spacing equal to or less than 24 in. on center. (Commentary: Sec. A.7.6.1. Tier 2: Section 13.6.1.1 and 13.6.1.2)

C NC (N/A) U LS-MH; PR-MH. ANCHORAGE: For veneer with concrete block or masonry backup, the backup is positively anchored to the structure at a horizontal spacing equal to or less than 4 ft along the floors and roof. (Commentary: Sec. A.7.7.1. Tier 2: Section 13.6.1.1 and 13.6.1.2)

C NC (N/A) U LS-not required; PR-MH. WEEP HOLES: In veneer anchored to stud walls, the veneer has functioning weep holes and base flashing. (Commentary: Sec. A.7.5.6. Tier 2: Section 13.6.1.2)

C NC (N/A) U LS-not required; PR-MH. OPENINGS: For veneer with metal stud backup, steel studs frame window and door openings. (Commentary: Sec. A.7.6.2. Tier 2: Sec. 13.6.1.1 and 13.6.1.2)

Parapets, Cornices, Ornamentation, and Appendages

C NC (N/A) U LS-LMH; PR-LMH. URM PARAPETS OR CORNICES: Laterally unsupported unreinforced masonry parapets or cornices have height-to-thickness ratios no greater than the following: for Life Safety in Low or Moderate Seismicity, 2.5; for Life Safety in High Seismicity and for Position Retention in any seismicity, 1.5. (Commentary: Sec. A.7.8.1. Tier 2: Sec. 13.6.5)

C NC (N/A) U LS-LMH; PR-LMH. CANOPIES: Canopies at building exits are anchored to the structure at a spacing no greater than the following: for Life Safety in Low or Moderate Seismicity, 10 ft; for Life Safety in High Seismicity and for Position Retention in any seismicity, 6 ft. (Commentary: Sec. A.7.8.2. Tier 2: Sec. 13.6.6)

(C) NC N/A U LS-MH; PR-LMH. CONCRETE PARAPETS: Concrete parapets with height-to-thickness ratios greater than 2.5 have vertical reinforcement. (Commentary: Sec. A.7.8.3. Tier 2: Sec. 13.6.5)

C (NC) N/A U LS-MH; PR-LMH. APPENDAGES: Cornices, parapets, signs, and other ornamentation or appendages that extend above the highest point of anchorage to the structure or cantilever from components are reinforced and anchored to the structural system at a spacing equal to or less than 6 ft. This checklist item does not apply to parapets or cornices covered by other checklist items. (Commentary: Sec. A.7.8.4. Tier 2: Sec. 13.6.6)

Masonry Chimneys

C NC **(N/A)** U LS-LMH; PR-LMH. URM CHIMNEYS: Unreinforced masonry chimneys extend above the roof surface no more than the following: for Life Safety in Low or Moderate Seismicity, 3 times the least dimension of the chimney; for Life Safety in High Seismicity and for Position Retention in any seismicity, 2 times the least dimension of the chimney. (Commentary: Sec. A.7.9.1. Tier 2: 13.6.7)

C NC **(N/A)** U LS-LMH; PR-LMH. ANCHORAGE: Masonry chimneys are anchored at each floor level, at the topmost ceiling level, and at the roof. (Commentary: Sec. A.7.9.2. Tier 2: 13.6.7)

Stairs

C NC **(N/A)** U LS-LMH; PR-LMH. STAIR ENCLOSURES: Hollow-clay tile or unreinforced masonry walls around stair enclosures are restrained out-of-plane and have height-to-thickness ratios not greater than the following: for Life Safety in Low or Moderate Seismicity, 15-to-1; for Life Safety in High Seismicity and for Position Retention in any seismicity, 12-to-1. (Commentary: Sec. A.7.10.1. Tier 2: Sec. 13.6.2 and 13.6.8)

C NC **(N/A)** U LS-LMH; PR-LMH. STAIR DETAILS: In moment frame structures, the connection between the stairs and the structure does not rely on shallow anchors in concrete. Alternatively, the stair details are capable of accommodating the drift calculated using the Quick Check procedure of Section 4.5.3.1 without including any lateral stiffness contribution from the stairs. (Commentary: Sec. A.7.10.2. Tier 2: 13.6.8)

Contents and Furnishings

C **(NC)** N/A U LS-MH; PR-MH. INDUSTRIAL STORAGE RACKS: Industrial storage racks or pallet racks more than 12 ft high meet the requirements of ANSI/MH 16.1 as modified by ASCE 7 Chapter 15. (Commentary: Sec. A.7.11.1. Tier 2: Sec. 13.8.1)

C **(NC)** N/A U LS-H; PR-MH. TALL NARROW CONTENTS: Contents more than 6 ft high with a height-to-depth or height-to-width ratio greater than 3-to-1 are anchored to the structure or to each other. (Commentary: Sec. A.7.11.2. Tier 2: Sec. 13.8.2)

C **(NC)** N/A U LS-H; PR-H. FALL-PRONE CONTENTS: Equipment, stored items, or other contents weighing more than 20 lb whose center of mass is more than 4 ft above the adjacent floor level are braced or otherwise restrained. (Commentary: Sec. A.7.11.3. Tier 2: Sec. 13.8.2)

C NC **(N/A)** U LS-not required; PR-MH. ACCESS FLOORS: Access floors more than 9 in. high are braced. (Commentary: Sec. A.7.11.4. Tier 2: Sec. 13.8.3)

C NC **(N/A)** U LS-not required; PR-MH. EQUIPMENT ON ACCESS FLOORS: Equipment and other contents supported by access floor systems are anchored or braced to the structure independent of the access floor. (Commentary: Sec. A.7.11.5. Tier 2: Sec. 13.7.7 and 13.8.3)

C NC N/A **(U)** LS-not required; PR-H. SUSPENDED CONTENTS: Items suspended without lateral bracing are free to swing from or move with the structure from which they are suspended without damaging themselves or adjoining components. (Commentary. A.7.11.6. Tier 2: Sec. 13.8.2)

Mechanical and Electrical Equipment

C **(NC)** N/A U LS-H; PR-H. FALL-PRONE EQUIPMENT: Equipment weighing more than 20 lb whose center of mass is more than 4 ft above the adjacent floor level, and which is not in-line equipment, is braced. (Commentary: A.7.12.4. Tier 2: 13.7.1 and 13.7.7)

C NC N/A **(U)** LS-H; PR-H. IN-LINE EQUIPMENT: Equipment installed in-line with a duct or piping system, with an operating weight more than 75 lb, is supported and laterally braced independent of the duct or piping system. (Commentary: Sec. A.7.12.5. Tier 2: Sec. 13.7.1)

C NC **(N/A)** U LS-H; PR-MH. TALL NARROW EQUIPMENT: Equipment more than 6 ft high with a height-to-depth or height-to-width ratio greater than 3-to-1 is anchored to the floor slab or adjacent structural walls. (Commentary: Sec. A.7.12.6. Tier 2: Sec. 13.7.1 and 13.7.7)

C NC **(N/A)** U LS-not required; PR-MH. MECHANICAL DOORS: Mechanically operated doors are detailed to operate at a story drift ratio of 0.01. (Commentary: Sec. A.7.12.7. Tier 2: Sec. 13.6.9)

C NC (N/A) U LS-not required; PR-H. SUSPENDED EQUIPMENT: Equipment suspended without lateral bracing is free to swing from or move with the structure from which it is suspended without damaging itself or adjoining components. (Commentary: Sec. A.7.12.8. Tier 2: Sec. 13.7.1 and 13.7.7)

C NC (N/A) U LS-not required; PR-H. VIBRATION ISOLATORS: Equipment mounted on vibration isolators is equipped with horizontal restraints or snubbers and with vertical restraints to resist overturning. (Commentary: Sec. A.7.12.9. Tier 2: Sec. 13.7.1)

C (NC) N/A U LS-not required; PR-H. HEAVY EQUIPMENT: Floor-supported or platform-supported equipment weighing more than 400 lb is anchored to the structure. (Commentary: Sec. A.7.12.10. Tier 2: 13.7.1 and 13.7.7)

C NC N/A (U) LS-not required; PR-H. ELECTRICAL EQUIPMENT: Electrical equipment is laterally braced to the structure. (Commentary: Sec. A.7.12.11. Tier 2: 13.7.7)

C NC (N/A) U LS-not required; PR-H. CONDUIT COUPLINGS: Conduit greater than 2.5 in. trade size that is attached to panels, cabinets, or other equipment and is subject to relative seismic displacement has flexible couplings or connections. (Commentary: Sec. A.7.12.12. Tier 2: 13.7.8)

Piping

C NC N/A (U) LS-not required; PR-H. FLEXIBLE COUPLINGS: Fluid and gas piping has flexible couplings. (Commentary: Sec. A.7.13.2. Tier 2: Sec. 13.7.3 and 13.7.5)

C NC N/A (U) LS-not required; PR-H. FLUID AND GAS PIPING: Fluid and gas piping is anchored and braced to the structure to limit spills or leaks. (Commentary: Sec. A.7.13.4. Tier 2: Sec. 13.7.3 and 13.7.5)

C NC N/A (U) LS-not required; PR-H. C-CLAMPS: One-sided C-clamps that support piping larger than 2.5 in. in diameter are restrained. (Commentary: Sec. A.7.13.5. Tier 2: Sec. 13.7.3 and 13.7.5)

C NC (N/A) U LS-not required; PR-H. PIPING CROSSING SEISMIC JOINTS: Piping that crosses seismic joints or isolation planes or is connected to independent structures has couplings or other details to accommodate the relative seismic displacements. (Commentary: Sec. A7.13.6. Tier 2: Sec.13.7.3 and Sec. 13.7.5)

Ducts

C NC (N/A) U LS-not required; PR-H. DUCT BRACING: Rectangular ductwork larger than 6 ft^2 in cross-sectional area and round ducts larger than 28 in. in diameter are braced. The maximum spacing of transverse bracing does not exceed 30 ft. The maximum spacing of longitudinal bracing does not exceed 60 ft. (Commentary: Sec. A.7.14.2. Tier 2: Sec. 13.7.6)

C NC N/A (U) LS-not required; PR-H. DUCT SUPPORT: Ducts are not supported by piping or electrical conduit. (Commentary: Sec. A.7.14.3. Tier 2: Sec. 13.7.6)

C NC (N/A) U LS-not required; PR-H. DUCTS CROSSING SEISMIC JOINTS: Ducts that cross seismic joints or isolation planes or are connected to independent structures have couplings or other details to accommodate the relative seismic displacements. (Commentary: Sec. A.7.14.5. Tier 2: Sec. 13.7.6)

Elevators

C NC (N/A) U LS-H; PR-H. RETAINER GUARDS: Sheaves and drums have cable retainer guards. (Commentary: Sec. A.7.16.1. Tier 2: 13.8.6)

C NC (N/A) U LS-H; PR-H. RETAINER PLATE: A retainer plate is present at the top and bottom of both car and counterweight. (Commentary: Sec. A.7.16.2. Tier 2: 13.8.6)

C NC (N/A) U LS-not required; PR-H. ELEVATOR EQUIPMENT: Equipment, piping, and other components that are part of the elevator system are anchored. (Commentary: Sec. A.7.16.3. Tier 2: 13.8.6)

C NC (N/A) U LS-not required; PR-H. SEISMIC SWITCH: Elevators capable of operating at speeds of 150 ft/min or faster are equipped with seismic switches that meet the requirements of ASME A17.1 or have trigger levels set to 20% of the acceleration of gravity at the base of the structure and 50% of the acceleration of gravity in other locations. (Commentary: Sec. A.7.16.4. Tier 2: 13.8.6)

C NC (N/A) U LS-not required; PR-H. SHAFT WALLS: Elevator shaft walls are anchored and reinforced to prevent toppling into the shaft during strong shaking. (Commentary: Sec. A.7.16.5. Tier 2: 13.8.6)

C NC (N/A) U LS-not required; PR-H. COUNTERWEIGHT RAILS: All counterweight rails and divider beams are sized in accordance with ASME A17.1. (Commentary: Sec. A.7.16.6. Tier 2: 13.8.6)

C NC (N/A) U LS-not required; PR-H. BRACKETS: The brackets that tie the car rails and the counterweight rail to the structure are sized in accordance with ASME A17.1. (Commentary: Sec. A.7.16.7. Tier 2: 13.8.6)

C NC (N/A) U LS-not required; PR-H. SPREADER BRACKET: Spreader brackets are not used to resist seismic forces. (Commentary: Sec. A.7.16.8. Tier 2: 13.8.6)

C NC (N/A) U LS-not required; PR-H. GO-SLOW ELEVATORS: The building has a go-slow elevator system. (Commentary: Sec. A.7.16.9. Tier 2: 13.8.6)

ASCE 41-13 TIER 1 RELATED CALCULATIONS

CHECK FOR IMMEDIATE OCCUPANCY PER DISCUSSIONS W/ CLIENT

S_{DS} = 0.732 (SEE FOLLOWING USGS PGS)

0.732 > 0.5 ⇒ HIGH LEVEL OF SEISMICITY

SITE SOIL CLASS – D ASSUMED, BY INSPECTION

BLDG TYPES PC1 CONC TILT-UP W/ FLEX. DIAP.
& W2 WOOD FRAMED (COMM. & INDUS.)
PER SITE VISIT

CONST DATE = 1976± ⇒ NOT BENCHMARK BLDG

FOLLOWING CALCS SUPPLEMENT FOLLOWING CHECKLISTS:
- BASIC CONFIGURATION
- I.O. CHECKLISTS FOR PC1 & W2
- POSITIVE RETENSION NON STRUCTURAL

$S_{XS} = 0.459 \quad S_{X1} = 0.263$ (BSE-1E)

$T = C_t h^{\beta} = 0.02 \cdot (18)^{0.75} = 0.175$

$S_a = S_{X1}/T = \frac{0.263}{0.175} = 1.5 \quad (\le S_{XS})$

$1.5 > 0.459$

$S_a = 0.459$

BLDG WT (PC1) – WORST CASE DIR, ASSUME 15 PSF ROOF

$WT_{BLDG} = 15\text{PSF} \cdot 100' \cdot 50' + 150\text{PCF} \cdot \frac{5}{12} \cdot 100' \cdot 2 \cdot \frac{22^2}{2 \cdot 18} = 243^k$

$C = 1.0$ (TABLE 4-8)

$V = 1.0 \cdot 0.459 \cdot 243^k = \underline{112^k}$

USGS Design Maps Summary Report

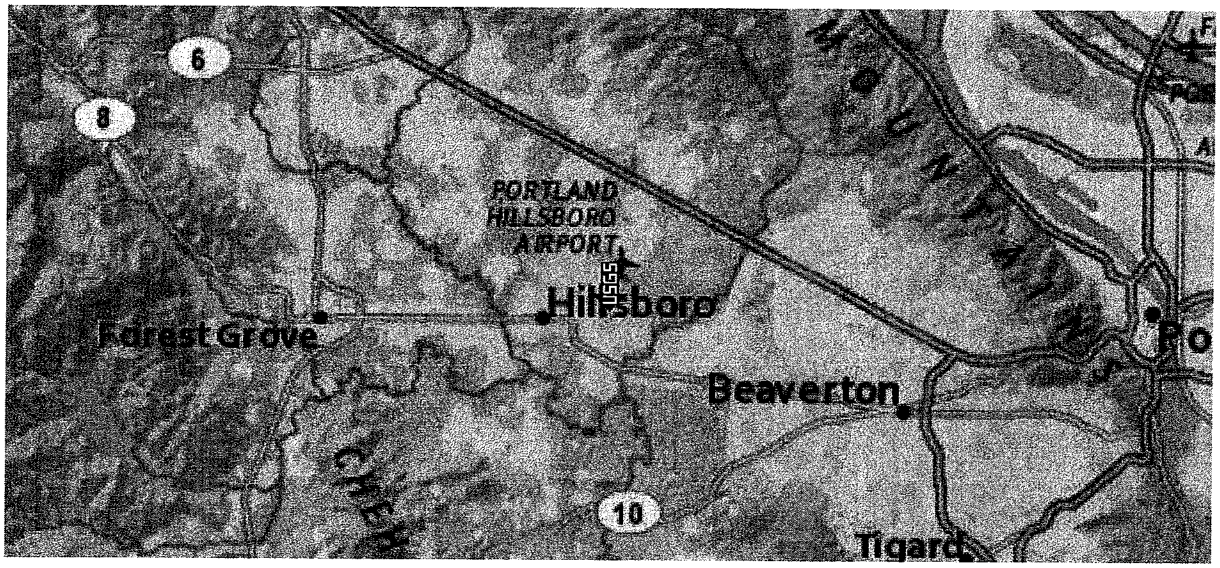
- MAINTENANCE BLDG - 17028.00
- HILLSBORO AIRPORT SEISMIC EVALUATION - 5/5/17

User–Specified Input

Building Code Reference Document ASCE 41-13 Retrofit Standard, BSE-1E
(which utilizes USGS hazard data available in 2008)

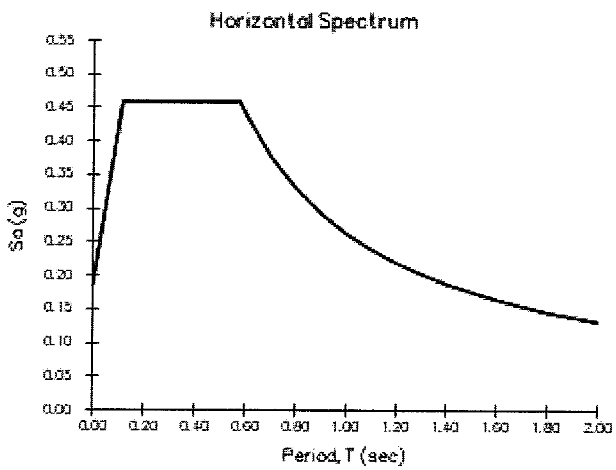
Site Coordinates 45.5322°N, 122.956°W

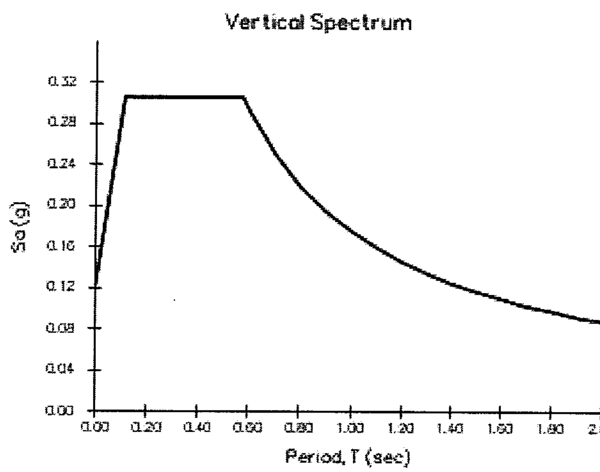
Site Soil Classification Site Class D – "Stiff Soil"



USGS–Provided Output

$S_{S,20/50}$	0.293 g	$S_{XS,BSE-1E}$	0.459 g
$S_{1,20/50}$	0.112 g	$S_{X1,BSE-1E}$	0.263 g





USGS Design Maps Summary Report

- MIANTENANCE BLDG - 17028.00
- HILLSBORO AIRPORT SEISMIC EVALUATION - 5/5/17

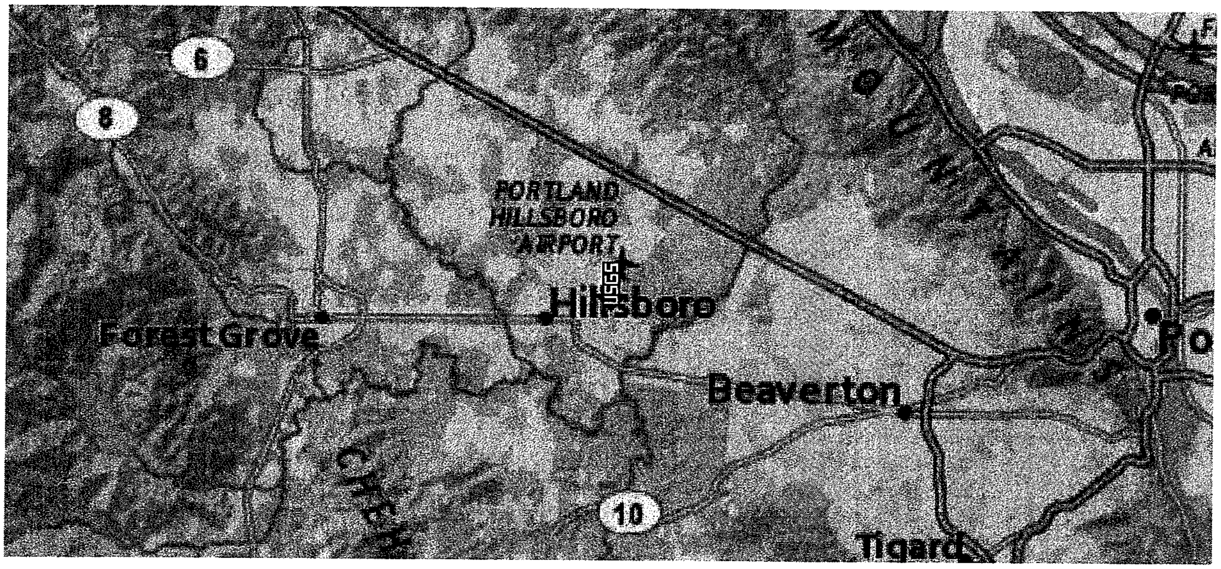
User–Specified Input

Building Code Reference Document ASCE 7-10 Standard
(which utilizes USGS hazard data available in 2008)

Site Coordinates 45.5322°N, 122.956°W

Site Soil Classification Site Class D – "Stiff Soil"

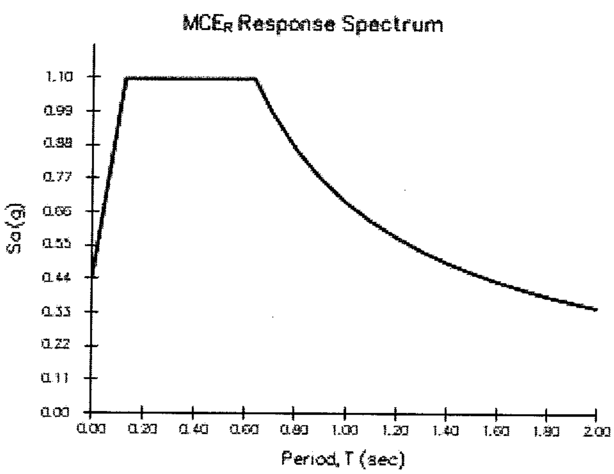
Risk Category I/II/III

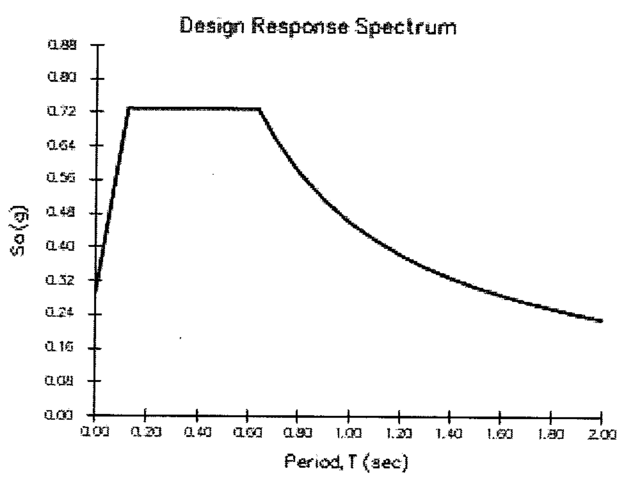


USGS–Provided Output

S_S =	0.995 g	S_{MS} =	1.097 g	S_{DS} =	0.731 g
S_1 =	0.446 g	S_{M1} =	0.693 g	S_{D1} =	0.462 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





For PGA_M, T_L, C_{RS}, and C_{R1} values, please view the detailed report.

TIER 1 CHECKLIST CALCS (CONT.)

BLDG WT (W2) - WORST CASE DIR, 15 PSF ROOF & FLR & 8 PSF WALLS

$WT_{ROOF} = 15\,PSF \cdot 25^2 + 8\,PSF \cdot 25' \cdot 2 \cdot 9'/2 = 11.2^k$

$WT_2 = 15 \cdot 25^2 + 8 \cdot 25' \cdot 2 \cdot 9' + 15\,PSF \cdot 70' \cdot 20' + 8\,PSF \cdot 70' \cdot 9'/2 = 36.5^k$

$WT_{BLDG} = 48^k$

$C = 1.1$ (TABLE 4-8)

$V = 1.1 \cdot 0.459 \cdot 48^k = \underline{24^k}$

BOTH • A.6.2.1 OVERTURNING $\frac{l_{MIN}}{h_+} > 0.6\,S_a$?

PC1 $7'\pm/18' = 0.39$ > $0.276 = 0.6 \cdot 0.456$ ⟹ C.

W2 $4'/9' = 0.44$

PC1 • A.5.1.1 WALL ANCHORAGE

→ CROSS GRAIN BENDING WOOD LEDGER FAILURE BY INSPECTION ⟹ N.C.

$T = \psi\, S_{XS}\, w_p\, A_p$ (EQ 4-13)

$\psi = 1.8 \quad S_{XS} = 0.459$

$w_p = 150\,PCF \cdot 5/12$

$A_p = (22^2/2 \cdot 18)$

$T = 1.8 \cdot 0.459 \cdot 150 \cdot \frac{5}{12} \cdot \frac{22^2}{2 \cdot 18} = 694\,PLF$

TIER 1 CHECKLIST CALCS (CONT.)

PC1 • A3.2.3.1 SHEAR STRESS CHECK $v_j^{AVG} < (100\ PSI \text{ OR } 2\sqrt{f'_c})$

$f'_c = 3000$ PSI (TABLE 4-2) $2\sqrt{3000} = 110$ PSI

$$v_j^{avg} = \frac{1}{M_s}\left(\frac{V_j'}{A_w}\right) \text{ (EQ 4-9)}$$

$M_s = 2.0$ (TABLE 4-9)

- CHECK BLDG IN TRANSV DIR $V_j' = 112^k$

5" WALL LENGTH = 50' + 7' + 10' + 12' = 79'

$A_w = 5'' \cdot 79' \cdot 12''/'$

$$v_j^{avg} = \frac{1}{2.0} \cdot \frac{112000}{5 \cdot 79 \cdot 12} = 12\ PSI << 110\ PSI$$ ✓ ⇒ C.

PC1 • A.3.2.3.5 WALL THICKNESS MIN THICKNESS = $\frac{H_{BRACED}}{25}$

5" WALLS 17' ± (BOTTOM OF TRUSS - CONSERVATIVE)

17'/25 = 8.2" > 5" ⇒ N.C.

W2 • A.3.2.7.1 SHEAR STRESS CHECK

$$v_j^{avg} = \frac{1}{M_s}\left(\frac{V_j}{A_w}\right) \text{ (EQ 4-9)}$$ ⇒ PLF FOR WOOD

A_w ⇒ FT FOR WOOD SHEATHING 1000 PLF MAX

★ IN LONGITUDINAL DIR FOR 1 STORY WOOD SECTION
70' WALL IS "ALL" WINDOWS
∴ $A_w = \emptyset$ → FAILS BY INSPECTION ⇒ N.C.

W2 • A.3.2.7.4 NARROW SHEAR WALLS

1.5 Ht - 1.0 L MAX

SHORTEST WALL ≈ 9'/4' = 2.25 > 1.5 ⇒ N.C.

wrk engineers
STRUCTURAL & EARTHQUAKE ENGINEERING
215 w. 12th street suite 202 ◦ vancouver, washington ◦ 98660

Seismic Hazard Evaluation

Port of Portland
Hillsboro Airport Terminal Building

3555 NE Cornell Road
Hillsboro, Oregon

May 5, 2017
17028.00

phone: 360.695.9731
www.wrkengrs.com

TABLE OF CONTENTS

APPENDICES

1. Project Background

The evaluation of the Terminal Building located in Hillsboro, Oregon is to determine the expected performance during a design basis earthquake. The purpose of our seismic evaluation is to identify the structural and nonstructural deficiencies that exist at the Terminal Building. The evaluation, if requested, can then be used as the basis for developing a suitable strengthening scheme for the structural system. In addition, the evaluation will assist us in identifying the nonstructural components requiring seismic hardening (i.e. anchorage and/or bracing).

Our work is based on the following:

1. A review of available original construction documents for the building prepared by Rose & Breedlove, Inc. (engineers) and Koch & Sax Architects dated 1974.

2. A site visit by Brian Knight, P.E., S.E. of WRK Engineers on March 28, 2017 to verify original construction details, to briefly review as-built conditions, and to briefly review the existing nonstructural components.

2. Evaluation Criteria and Methodology

For our evaluation of the Terminal Building, we used ASCE Standard 41-13, "Seismic Evaluation and Retrofit of Existing Buildings" published by the American Society of Civil Engineers. ASCE 41 is the nationally recognized Standard for seismic assessment and evaluation of existing buildings. The goal of ASCE 41 is to identify the "weak links" in a building's lateral force resisting system that can lead to significant failure and/or collapse. In addition, ASCE 41 will identify typical nonstructural hazards that may pose a life-safety risk to occupants or a business interruption (i.e. operations) risk to the building.

The methodology utilizes a series of checklists that address possible seismic hazards. Checklists are included in the Standard for all of the major structural systems, nonstructural elements, and geologic and site hazards. The evaluating engineer addresses each statement and determines whether it is compliant or non-compliant. Compliant statements identify conditions that are acceptable. Non-compliant statements identify conditions that are in need of further investigation. In some cases, the Standard specifies additional calculations that may be performed to address a non-compliant statement. In other cases, a detailed analysis of the building must be performed.

Our evaluation of the Terminal Building is based on an Immediate Occupancy (IO) Performance Level as defined in ASCE 41. The intent of the IO performance level is:

> *After a design earthquake, the basic vertical and lateral force resisting systems retain nearly all of their pre-earthquake strength, and very limited damage to both structural and nonstructural components is anticipated during the design earthquake which require some minor repairs, but the critical parts of the building are habitable.*

In other words, the IO performance level objective is meant to ensure that a building will continue to remain in operation immediately following a major earthquake.

3. Building Description

The Terminal Building is located in Hillsboro, Oregon. The building was originally constructed in 1974 as a two-story structure. The building has a total area of approximately 24,500 sq. ft. and the structural system does not appear to have been substantially altered since the time of original construction.

The Terminal Building is constructed with a combination of concrete, wood, and steel with exterior bearing walls and a combination of interior bearing walls and columns. The building is generally a rectangle with overall plan dimensions of approximately 175 feet by 70 feet. There are some small offsets around the perimeter between the first and second floors, but no major irregularities. The story heights are 13.5 feet with an overall roof height of 27 feet. There are no structures immediately adjacent to the Terminal Building.

The floor consists of wood sheathing over wood tongue and groove decking over wood beams. Similarly, the roof structure consists of sheathing over tongue and groove decking over wood beams. The roof and floor are both supported by a combination of walls (concrete and wood) and columns (steel and wood). The exterior wood walls are supported by below-grade concrete stem walls with continuous strip footings. The interior and perimeter concrete walls are supported by below-grade continuous concrete footings. The interior columns (and the few exterior columns) are supported by individual concrete spread footings.

The building's lateral force resisting system consists of reinforced concrete walls that vary in thickness from six inches to seven inches. The ASCE 41 Model Building Type is C2A. The perimeter and interior concrete walls do not have any openings, except for at the elevator door locations. The upper level concrete walls, where they exist, are continuations of the lower level walls with no horizontal offsets between levels. The concrete walls transfer lateral loads to the foundation.

The floor and roof diaphragms are nailed sheathing and decking systems that span between the various concrete walls. The diaphragm is considered flexible relative to the shear walls which support it.

There is a partial parapet around a few rooftop mechanical units and a relatively small canopy along the front of the building. The framing for both of these are integrated into the overall building construction. There is no exterior cladding or heavy veneer attached to the outside of the building.

4. Site Description and Seismicity

The building is located on a level site with the ground floor at the level of the exterior grade.

The building is assumed to be founded on relatively stiff soils of varying depths. The seismic soil coefficients used for evaluation are based on the current classifications from the ASCE 7-10 provisions. The site soil classification is assumed to be Class “D”.

The amplification factors used to account for the soil conditions of the site are F_V equal to 1.565 and F_A equal to 2.352. The short period spectral acceleration, S_{XS}, using the 2008 USGS maps is 0.459g. The long period spectral acceleration, S_{X1}, is 0.263g. The building is located in an area of high seismicity according to the categories defined in ASCE 41.

The susceptibility of the site to significant settlement due to earthquake-induced liquefaction is assumed to be low.

5. Discussion of Building Deficiencies

Using the procedures of ASCE 41, we have identified a number of deficiencies in the lateral force resisting system.

5.1 Structural Deficiencies

Numerous structural deficiencies have been identified at the Terminal Building. These include the following:

- Load Path: The structure does not contain a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation.
- Overturning: The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is less than $0.6S_a$.
- Wall Anchorage at Flexible Diaphragms: Exterior concrete walls that are dependent on flexible diaphragms for lateral support are not anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm.
- Transfer to Shear Walls: Diaphragms connections are not able to develop the lesser of the shear strength of the walls or diaphragms.
- Foundation Dowels: Wall reinforcement is doweled into the foundation, but the dowels are not able to develop the lesser of the strength of the walls or the uplift capacity of the foundation.

- Confinement Reinforcing: For shear walls with aspect ratios greater than 2-to-1, the boundary elements are not confined with spirals or ties with spacing less than $8d_b$.

- Wall Thickness: Thicknesses of bearing walls are less than 1/25 the unsupported height.

- Openings at Shear Walls: Diaphragm openings immediately adjacent to some of the shear walls are greater than 15% of the wall length.

- Cross Ties: There are not continuous cross ties between diaphragm chords.

5.2 Nonstructural Deficiencies

A nonstructural seismic evaluation for the Terminal Building was conducted for the Immediate Occupancy performance level. Table 1 below shows various nonstructural systems found in the building where mitigation is required. Additional nonstructural systems that are compliant or that required additional investigation are not included in this table.

TABLE 1 – Nonstructural Seismic Evaluation/Mitigation Criteria (Immediate Occupancy Performance Level)

Nonstructural Component Type	Mitigation Required
Ceilings	
Dropped Furred Gypsum Board	Yes
Suspended Integrated Ceiling	Yes
Fluid Piping	
Hazardous Materials	Yes
Nonhazardous Materials	Yes
Ductwork	Yes
Light Fixtures	
Recessed	Yes
Surface-Mounted	Yes
Integrated Ceiling	Yes
Pendant	Yes
Lens Covers and Light Diffusers	Yes

6. Adjacency Hazards

There are no immediately adjacent buildings to the Terminal Building.

7. Geologic and Site Hazards

The potential for significant failure of the foundations and the soil surrounding the site is assumed to be minimal.

The ASCE 41 checklists that we used to identify the structural and nonstructural deficiencies are attached as Appendix B.

8. Expected Building Performance

8.1 Structural

The Terminal Building has been assigned expected building damage levels for the structural and nonstructural systems. The structural damage levels are "Slight Damage", "Moderate Damage", "Extensive Damage", and "Complete Damage". Structural damage levels for buildings and brief descriptions of each damage level and expected performance are as follows:

- Slight Damage – The building structural systems will sustain slight damage. The building may be occupied during repairs. The structure substantially retains original strength and stiffness. There is no permanent story drift. All systems important to normal operations are functional.

- Moderate Damage – The building will sustain structural damage during a design basis earthquake and may need to be repaired before occupancy is restored. The gravity and lateral force resisting systems may require shoring or bracing if temporary occupancy is needed. There may be some permanent story drift. The structure retains some residual strength and stiffness. Gravity load bearing systems are still functional.

- Extensive Damage – During the design basis earthquake, the gravity and lateral force resisting systems may experience significant damage or partial collapse. The structure has little residual strength and stiffness, and there are permanent story drifts.

- Complete Damage – The structure partially or totally collapses and is nonfunctional.

8.2 Nonstructural

Nonstructural damage levels for buildings and brief descriptions of each damage level and expected performance are as follows:

- 0% Damaged – The nonstructural components are anchored or braced with no damage to interior equipment expected. All nonstructural systems are fully functional.

- 25% Damaged – The nonstructural components are anchored or braced, but not adequately. Minor damage to interior equipment occurs, but a majority of nonstructural systems are functional.

- 50% Damaged – Some nonstructural components are not anchored or are braced inadequately in order to prevent damage during an earthquake. The majority of all nonstructural systems sustain some damage. It is unlikely complete functionality of nonstructural systems is maintained.

- 75% Damaged – Extensive damage to the nonstructural system is expected and may result in loss of component function. Only a small portion of nonstructural systems are functional.

- 100% Damaged – Extensive damage to the nonstructural system is expected and results in total loss of component function.

The Terminal Building's structural systems have been assigned an expected building damage level of **Extensive Damage** and nonstructural systems have been assigned an expected building damage level of **50% Damaged**. We recommend the building be strengthened/hardened to an Immediate Occupancy performance level in accordance with ASCE Standard 41, "Seismic Evaluation and Retrofit of Existing Buildings".

9. Limitations

The opinions and recommendations presented in this report were developed with the care commonly used as the state of practice of the profession. No other warranties are included, either expressed or implied, as to the professional advice included in this report. This report has been prepared for Port of Portland to be used solely in its evaluation of the seismic safety of the building included herein. This report has not been prepared for use by other parties and may not contain sufficient information for purposes of other parties or uses.

If you have any comments or questions regarding this evaluation, please call.

Very truly yours,
WRK Engineers

Jacob Christensen, P.E., S.E.
Project Engineer

Brian Knight, P.E., S.E.
Principal

Appendix A

ORIGINAL BUILDING DRAWINGS

Port of Portland

THE PORT OF PORTLAND COMMISSION

ALAN GREEN JR. – PRESIDENT
RAYMOND M. KELL – VICE PRESIDENT
WALTER GADSBY JR. – SECRETARY
JOSEPH M. EDGAR – TREASURER
F. GLEN ODELL
ROBERT J. RICKETT
JAMES B. THAYER
ROBERT F. WALLACE

EDWARD G. WESTERDAHL II, EXECUTIVE DIRECTOR
ALFRED M. ESCHBACH, DIRECTOR, DEVELOPMENT SERVICES
I. JAMES CHURCH, DIRECTOR, AVIATION

SHEET NO. DESCRIPTION

SHEET NO. 1		DESCRIPTION
ARCHITECTURAL		
PHA 74 - 501 -	A - 1	SITE PLAN
	A - 2	FIRST FLOOR PLAN
	A - 3	SECOND FLOOR PLAN
	A - 4	SCHEDULES & DOOR DETAILS
	A - 5	BUILDING SECTIONS & INTERIOR ELEVATIONS
	A - 6	EXTERIOR ELEVATIONS
	A - 7	ENTRY DETAILS
	A - 8	1/4" CORE PLAN & STAIR DETAILS
	A - 9	1/2" EXTERIOR WALL SECTIONS
	A - 10	DETAILS
	A - 11	MISC. DETAILS
STRUCTURAL		
PHA 74 - 501 -	S - 1	FOUNDATION & FIRST FLOOR PLAN
	S - 2	SECOND FLOOR PLAN
	S - 3	ROOF PLAN
	S - 4	BUILDING CROSS-SECTIONS
	S - 5	STRUCTURAL DETAILS - I
	S - 6	STRUCTURAL DETAILS - II
MECHANICAL		
PHA 74 - 501 -	M - 1	FIRST FLOOR PLAN AND LEGENDS
	M - 2	SECOND FLOOR PLAN AND SCHEDULES
	M - 3	ROOF PLAN AND MECHANICAL ROOM L
	M - 4	DETAILS AND DIAGRAMS
PLUMBING		
PHA 74 - 501 -	P - 1	SITE PLAN AND DETAILS
	P - 2	FIRST FLOOR PLAN AND DETAILS
	P - 3	SECOND FLOOR PLAN AND DETAILS
ELECTRICAL		
PHA 74 - 501 -	E - 1	SITE PLAN
	E - 2	FIRST FLOOR LIGHTING
	E - 3	FIRST FLOOR POWER
	E - 4	SECOND FLOOR LIGHTING
	E - 5	SECOND FLOOR POWER
	E - 6	AIRPORT ALARM PLAN
LANDSCAPING		
PHA 74 - 501 -	L - 1	OFFICE PLANTING PLAN
	L - 2	OFFICE IRRIGATION PLAN
	L - 3	PARKING PLANTING PLAN
	L - 4	PARKING IRRIGATION PLAN

NOT IN CONTRACT

PROJECT MANAGER

DIRECTOR, AVIATION

AS CONSTRUCTED

DRAWING NO. PHA 74-501-1

GENERAL STRUCTURAL NOTES

GENERAL:

1. Soil pressure assumed 2000 psf L.L. and D.L. per Soil Report by F.M. Fox & Associates, Inc. Consulting Soil Engineers & Geologists dated January 30, 1974.
2. Elevations shown on foundation plan are maximum elevation to bottom of footings. Footings to rest on firm natural undisturbed soil, notify Engineer if other conditions are found.
3. Verify all openings in floors on architectural, mechanical, and electrical plans.
4. See architectural plans for general details and dimensions not shown.
5. Contractor to verify and check all dimensions.
6. Design loads: Roof L.L. = 25 psf, Second Floor L.L. = 100 psf, Wind per 1971 U. B. C. Table 23-F, Seismic per 1971 U. B. C. Zone 2.
7. No excavation shall be made below any footing closer than a one to one slope to the bottom of same.
8. Backfill all pipe trench excavations below footings with lean concrete to bottom of footing.
9. Where reference is made to ASTM, AISC, ACI or other standards and specifications, the latest revision or adoption is intended unless specifically designated otherwise.

CONCRETE:

1. The ACI Standard Specifications for structural concrete for buildings ACI-301 shall be followed except items specifically stated otherwise in the project specifications. Contractor shall obtain a copy of this standard for ready reference on the job.
2. Stone concrete to be f_c' = 3000 psi with Laboratory cured test cylinders equal to 3500 psi at 28 days. Minimum cement content equals 5 sacks per yard.

REINFORCING:

1. All reinforcing steel to be ASTM A - 615 60,000 psi yield point.
2. Set main reinforcing steel 2" from forms for columns or surfaces exposed to weather, 1-1/2" for beams and girders, 3" for footings and other concrete poured against earth, 3/4" for walls and slabs not exposed to weather.
3. Provide 2'-0" x 2'-0" corner bars for all horizontal wall steel at all corners and intersections.
4. Splices shall be lapped 27 diameter or 2'-0" minimum unless detailed otherwise.
5. Unless noted otherwise, place 2 - #6 over, 2 - #5 under and 2 - #5 each side all wall openings; vertical bars story height plus 2'-0", horizontal bars opening plus 3'-6" each end (minimum). Place 2 - #6 in bottom all walls. Place 2 - #5 vertical at all discontinuous wall ends.

STEEL:

1. All structural steel ASTM A36, (fy36,000), detail, fabricate and weld to AISC Specifications.
2. Install secondary structural members around openings in floor after primary structure is erected.
3. All tube columns shall conform to ASTM A501.

TIMBER:

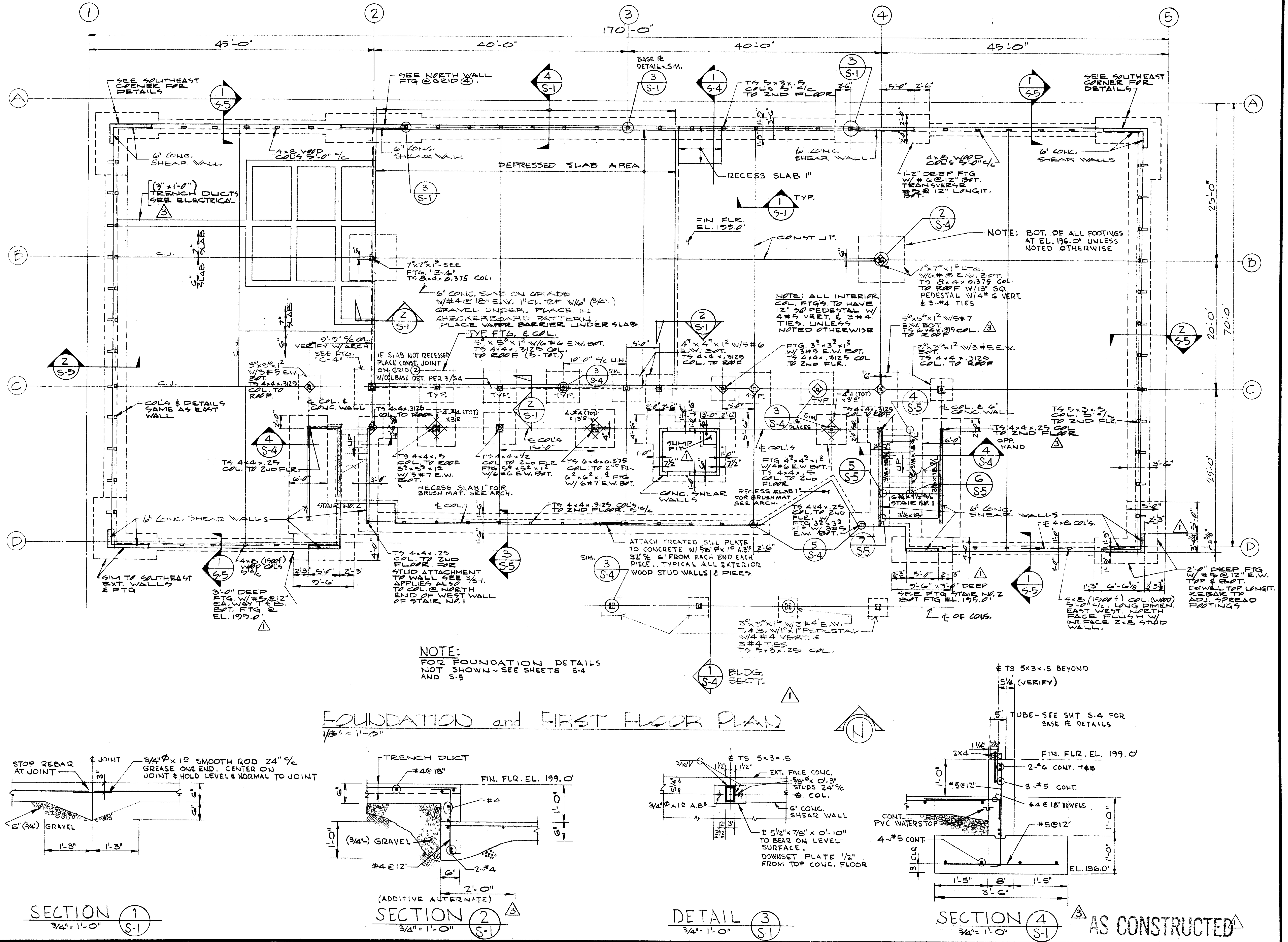
1. All laminated beams to be f = 2400 in accordance with WCLIB Specifications, unless noted otherwise. Use casin glue unless marked waterproof (WP). See Architect for finish details.
2. △ All sawn lumber to be construction grade 1500 f (DF) per WCLIB Grading Rules (latest edition). unless noted otherwise.
3. All Plywood sheathing or sub-flooring shall be DFPA CD Grade with exterior glue. Each panel shall bear the DFPA Grade Trademark of the American Plywood Association.
4. All boltheads and nuts bearing on wood to be provided with standard washers, unless noted otherwise.
5. Stud walls to be No. 2, F_b = 1450 psi (repetitive use).

△

NAILING SCHEDULE

This schedule shall apply unless noted otherwise on the plans.

2-inch subfloor to joist or girder	See plans
Plate to joist or blocking	16d - 16" o.c.
Stud to plate - end nail	2-16d
Stud to plate - toe nail	3-16d or 4-8d
Top plates - spike together	16d - 24" o.c.
- laps and intersections	2-16d
Continuous 1-inch brace to stud	2-8d
2-inch cut-in bracing to stud	2-16d
Corner studs and angles	16d - 30" o.c.
Double joists and headers - face nail to each other	20d @ 16" o.c. Stagger between top & Bottom edge - clinch points
1/2" Plywood roof, floor & wall sheathing	See plans



NO	DATE	BY	REVISIONS	CK'D	APP'V'D	NO	DATE	BY	REVISIONS	CK'D	APP'V'D
3	7/31/75	RG	△ AS BUILTS								
2	5-29-74	EB	CONSTRUCTION DWGS.								
1	5/13/74	RG	△ GENERAL REVISIONS								

THE PORT OF PORTLAND
PORTLAND, OREGON

ROSE' & BREEDLOVE, INC. - ENGINEERS
KOCH & SAX ARCHITECTS
615 OREGON PIONEER BUILDING, PORTLAND, 97204

REGISTERED PROFESSIONAL ENGINEER 2707 OREGON ELDEN E. BREEDLOVE

DESIGNED BY	R.G.
DRAWN BY	B.L., R.G.
CHECKED BY	E.B.
DATE	3/18/74
SCALE	VARIES

PORTLAND-HILLSBORO AIRPORT
OFFICE/RESTAURANT BUILDING

FOUNDATION & FIRST FLOOR PLAN

SUBMITTED BY R.W. Finley

DRAWING NO. PHA 74-501 S-1

NO	DATE	BY	REVISIONS	CK'D	APP'V'D
	5-29-74	EB	CONSTRUCTION DWGS.		
1	5/13/74	RG	GENERAL REVISIONS		

NO	DATE	BY	REVISIONS	CK'D	APP'V'D

THE PORT OF PORTLAND
PORTLAND, OREGON

ROSE' & BREEDLOVE, INC. - ENGINEERS
KOCH & SAX ARCHITECTS
618 OREGON PIONEER BUILDING, PORTLAND, 97204

REGISTERED PROFESSIONAL ENGINEER 3797 OREGON MAY 8, 1958 ELDEN E. BREEDLOVE

DESIGNED BY	RG, SR
DRAWN BY	SR, BL
CHECKED BY	E.B.
DATE	3/18/74
SCALE	VARIES

PORTLAND-HILLSBORO AIRPORT
OFFICE/RESTAURANT BUILDING

SECOND FLOOR PLAN AS CONSTRUCTED

SUBMITTED BY R.W. Finley

DRAWING NO. PHA 74-501 S-2

CHARLES BRUNING CO.

MICROFILMED 30/34

GENERAL NOTE !!! DAP CONNECTORS FLUSH W/TOP OF BEAMS

AS CONSTRUCTED

NO	DATE	BY	REVISIONS	CK'D	APP'V'D
3	7/31/75	RG	3 AS BUILTS		
2	5-29-74	EB	CONSTRUCTION DWGS.		
1	5/13/74	RG	1 GENERAL REVISIONS		

THE PORT OF PORTLAND
PORTLAND, OREGON

ROSE' & BREEDLOVE, INC. - ENGINEERS
KOCH & SAX ARCHITECTS
615 OREGON PIONEER BUILDING, PORTLAND, 97204

REGISTERED PROFESSIONAL ENGINEER 3797 OREGON MAY 6, 1955 ELDEN E. BREEDLOVE

DESIGNED BY	R.G., S.R.
DRAWN BY	S.R., V.O.
CHECKED BY	E.B.
DATE	3/18/74
SCALE	VARIES

PORTLAND - HILLSBORO AIRPORT
OFFICE/RESTAURANT BUILDING

ROOF PLAN

SUBMITTED BY R.W. Finley

DRAWING NO. PHA 74-501 S-3

MICROFILMED 3/34

CHARLES BRUNING CO.

AS CONSTRUCTED

NO	DATE	BY	REVISIONS	CK'D	APP'V'D
	5-29-74	EB	CONSTRUCTION DWGS.		
1	7/13/74	RG	△ GENERAL REVISIONS		

THE PORT OF PORTLAND
PORTLAND, OREGON

ROSE' & BREEDLOVE, INC - ENGINEERS
KOCH & SAX ARCHITECTS
619 OREGON PIONEER BUILDING PORTLAND, 97204

REGISTERED PROFESSIONAL ENGINEER 3702 OREGON MAY 6, 1955 ELDEN E. BREEDLOVE

DESIGNED BY	R. G., S.R.
DRAWN BY	B.S.
CHECKED BY	E.B.
DATE	3/18/74
SCALE	VARIES

PORTLAND-HILLSBORO AIRPORT
OFFICE/RESTAURANT BUILDING

BUILDING CROSS SECTION

SUBMITTED BY R. W. Finley

DRAWING NO. PHA 74-501 S-4

CHARLES BRUNING CO.

MICROFILMED 32/34

AS CONSTRUCTED

NO	DATE	BY	REVISIONS	CK'D	APP'V'D	NO	DATE	BY	REVISIONS	CK'D	APP'V'D
	5-29-74	EB	CONSTRUCTION DWGS.								

THE PORT OF PORTLAND
PORTLAND, OREGON

ROSE' & BREEDLOVE, INC - ENGINEERS
KOCH & SAX ARCHITECTS
615 OREGON PIONEER BUILDING, PORTLAND, 97204

REGISTERED PROFESSIONAL ENGINEER 3797 OREGON MAY 6, 1955 ELDEN E. BREEDLOVE

DESIGNED BY: R.G., S.R.
DRAWN BY: B.L.
CHECKED BY: E.B.
DATE: 3/18/74
SCALE: VARIES

PORTLAND-HILLSBORO AIRPORT
OFFICE/RESTAURANT BUILDING

STRUCTURAL DETAILS I

SUBMITTED BY: R.W. Finley
DRAWING NO. PHA 74-501 S-5

CHARLES BRUNING CO.

MICROFILMED 33/34

AS CONSTRUCTED

NO	DATE	BY	REVISIONS	CK'D	APP'V'D	NO	DATE	BY	REVISIONS	CK'D	APP'V'D
	5-29-74	EB	CONSTRUCTION DWGS.								

THE PORT OF PORTLAND
PORTLAND, OREGON

ROSE' & BREEDLOVE, INC - ENGINEERS
KOCH & SAX ARCHITECTS
615 OREGON PIONEER BUILDING, PORTLAND, 97204

REGISTERED PROFESSIONAL ENGINEER 3707 OREGON — ELDEN E. BREEDLOVE

DESIGNED BY	K.G.
DRAWN BY	J.S., V.O.
CHECKED BY	E.B.
DATE	3/18/74
SCALE	3/4" = 1'-0"

PORTLAND - HILLSBORO AIRPORT
OFFICE/RESTAURANT BUILDING

STRUCTURAL DETAILS II

SUBMITTED BY R.W. Finley

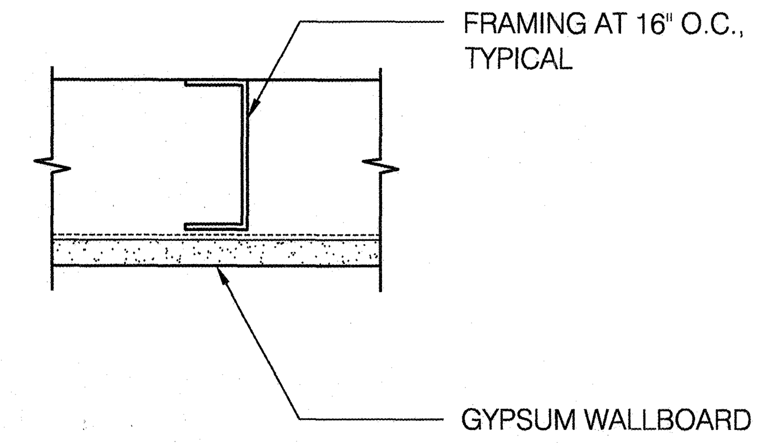
DRAWING NO. HK 74-501 S-6

34/34

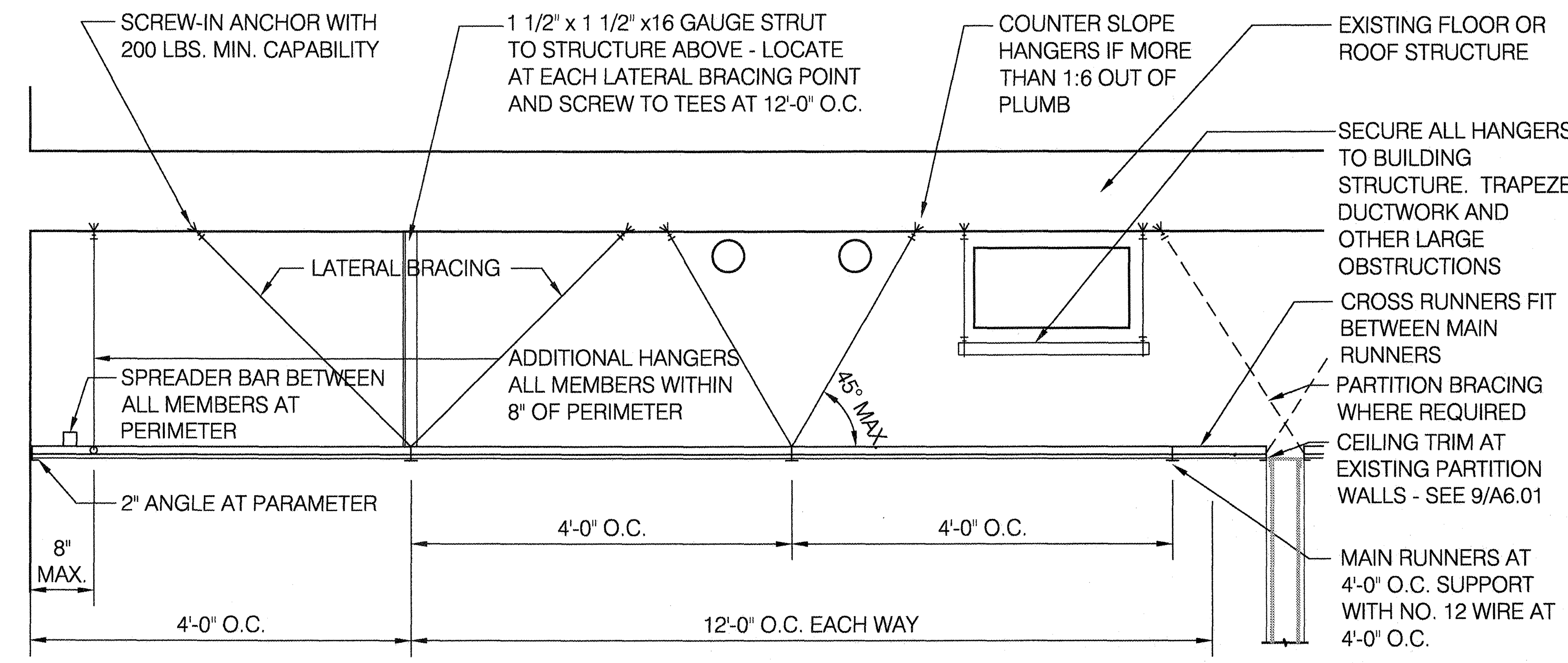
CHARLES BRUNING CO.

NOTES:
1. SUPPORT OF SUSPENDED CEILING TO COMPLY WITH ALL REQUIREMENTS OF NORTHWEST WALL AND CEILING BUREAU - FIELDTECHNICAL AND INFORMATION DOCUMENT #401 - SUSPENSION SYSTEMS FOR ACOUSTICAL LAY-IN CEILINGS.
2. PROVIDE LATERAL BRACING AT 12'-0" O.C. EACH WAY, MAIN RUNNER TO STRUCTURE. BEGIN BRACING WITHIN 6'-0" OF PERIMETER AND 2" FROM CROSS MEMBER.
3. ATTACH WIRES WITH 3 TURNS - TOP AND BOTTOM TYPICAL.
4. SUPPORT LIGHT FIXTURES WITH 12-GAUGE WIRE WITHIN 3" OF EACH FIXTURE CORNER AND 2 ADDED 12-GAUGE SLACK WIRES FROM HOUSING TO SUPPORT ABOVE.
5. PROVIDE A 'T'-BAR STRUT FROM MAIN RUNNERS TO STRUCTURE ABOVE AT 12'-0" O.C. FOR UPLIFT, SECURE AT 'T'-GRID WITH NO. 12 WIRE AND AT STRUCTURE WITH 100LB. CAPACITY SCREW-IN ANCHOR AND NO. 12 WIRE.
6. PROVIDE 1" ANNULAR SPACE AT ALL CEILING PENETRATIONS, TYPICAL.

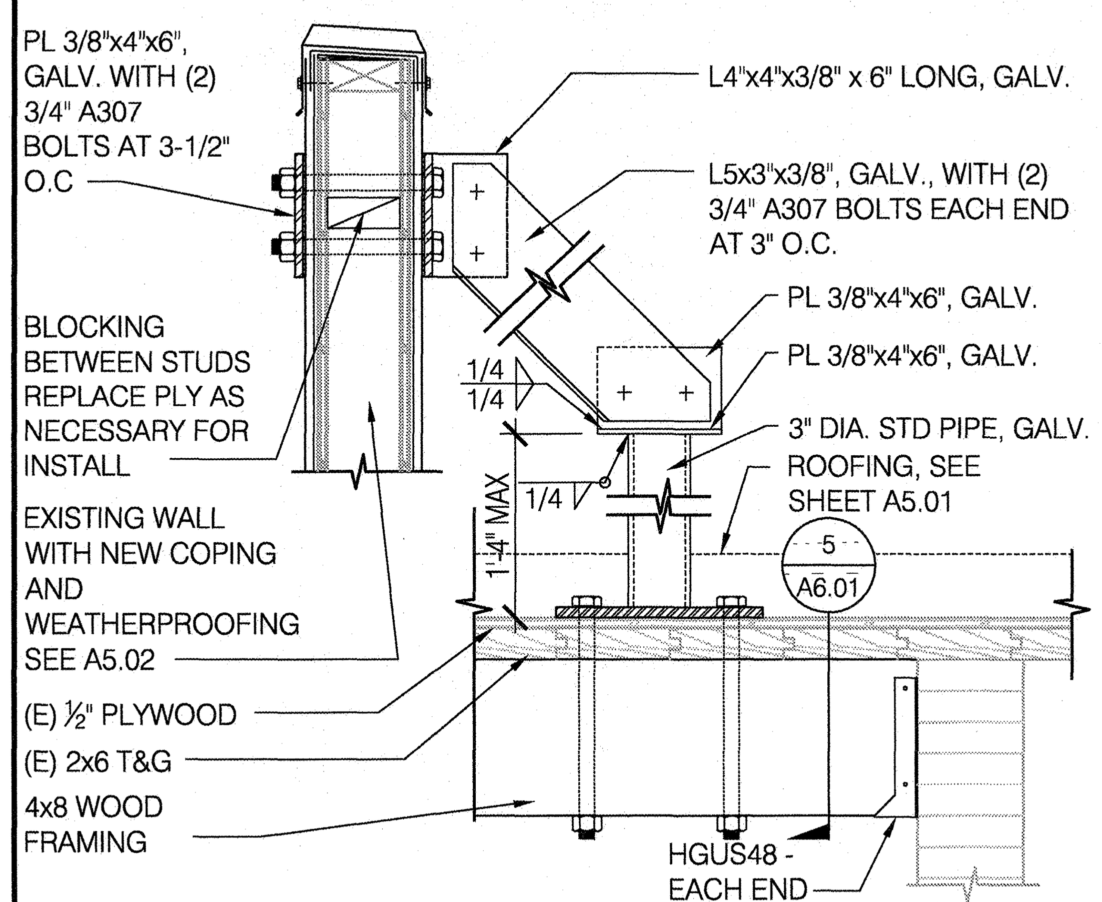
NOT USED
SCALE: 3" = 1'-0"
1 / A6.01



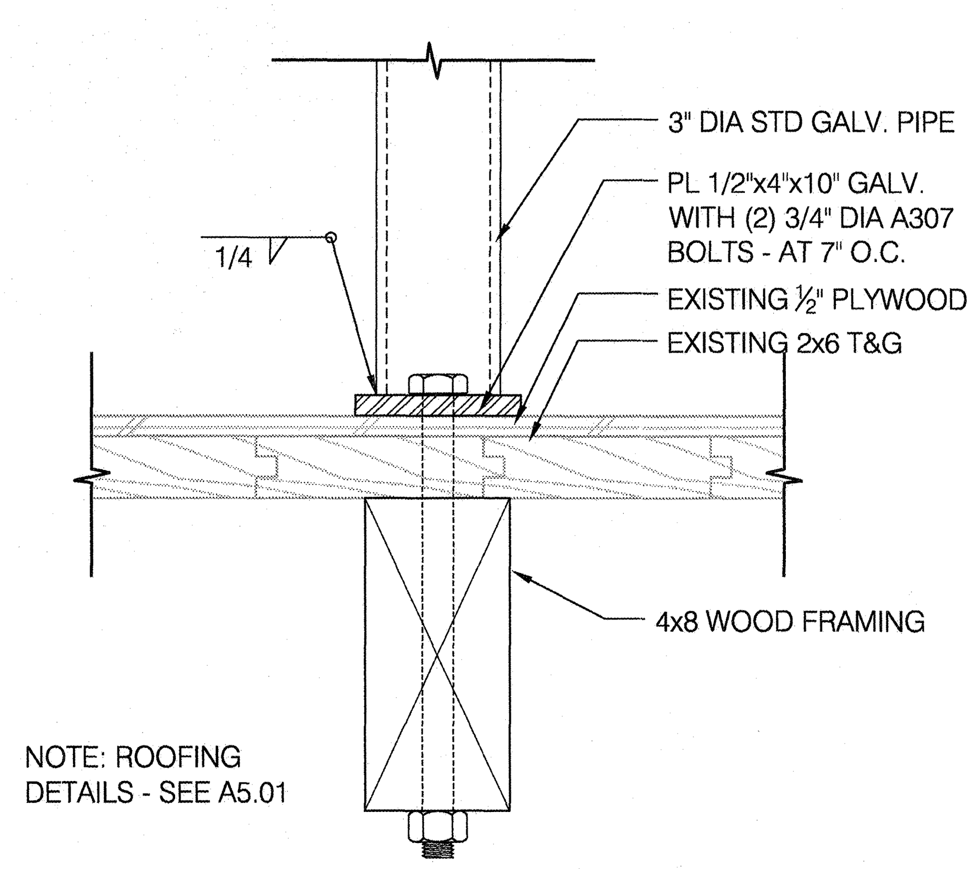
CEILING TYPE C2
SCALE: 3" = 1'-0"
2 / A6.01



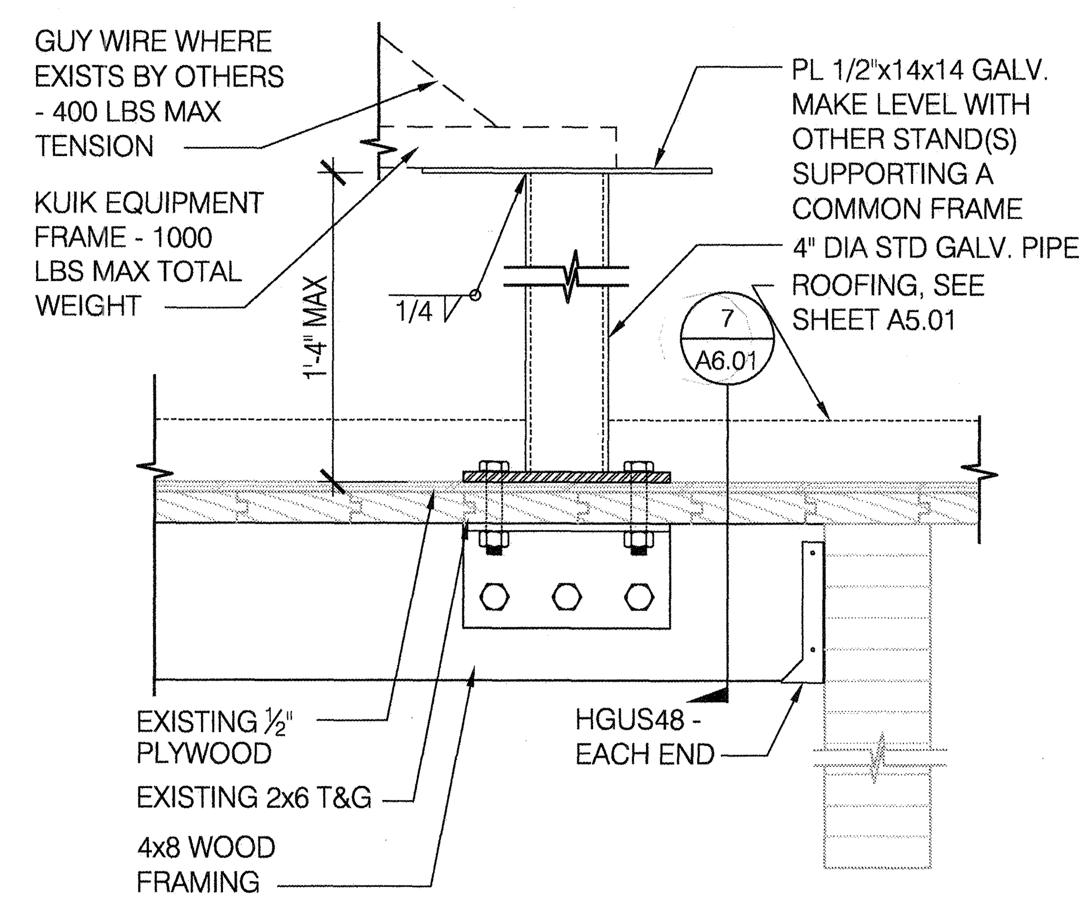
LATERAL BRACING FOR SUSPENDED CEILING
SCALE: 3/4" = 1'-0"
3 / A6.01



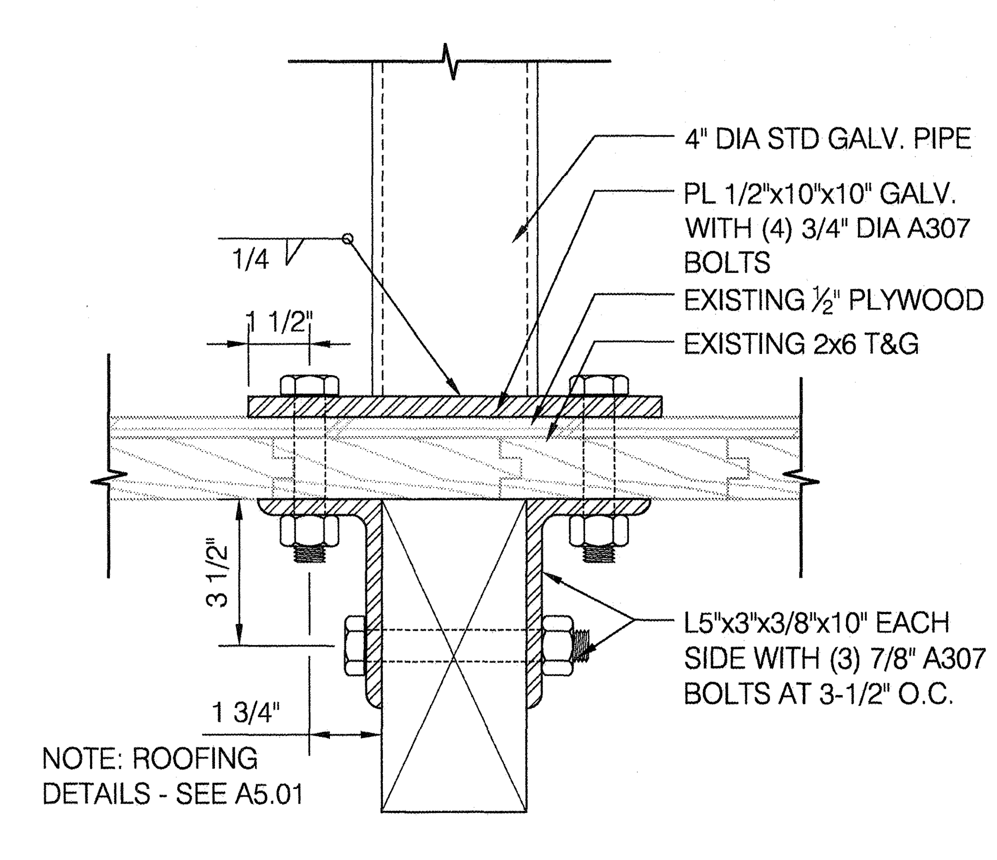
PARAPET SUPPORT STAND
SCALE: 1 1/2" = 1'-0"
4 / A6.01



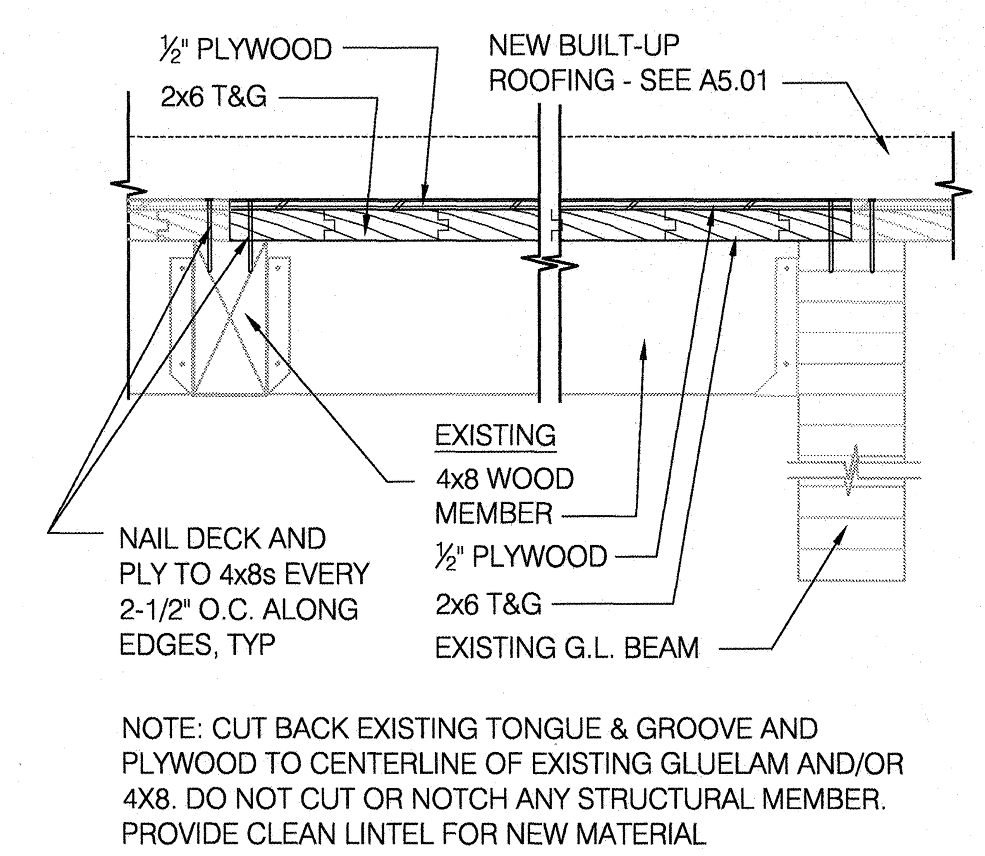
FRAMING DETAIL
SCALE: 3" = 1'-0"
5 / A6.01



EQUIPMENT SUPPORT STAND
SCALE: 1 1/2" = 1'-0"
6 / A6.01

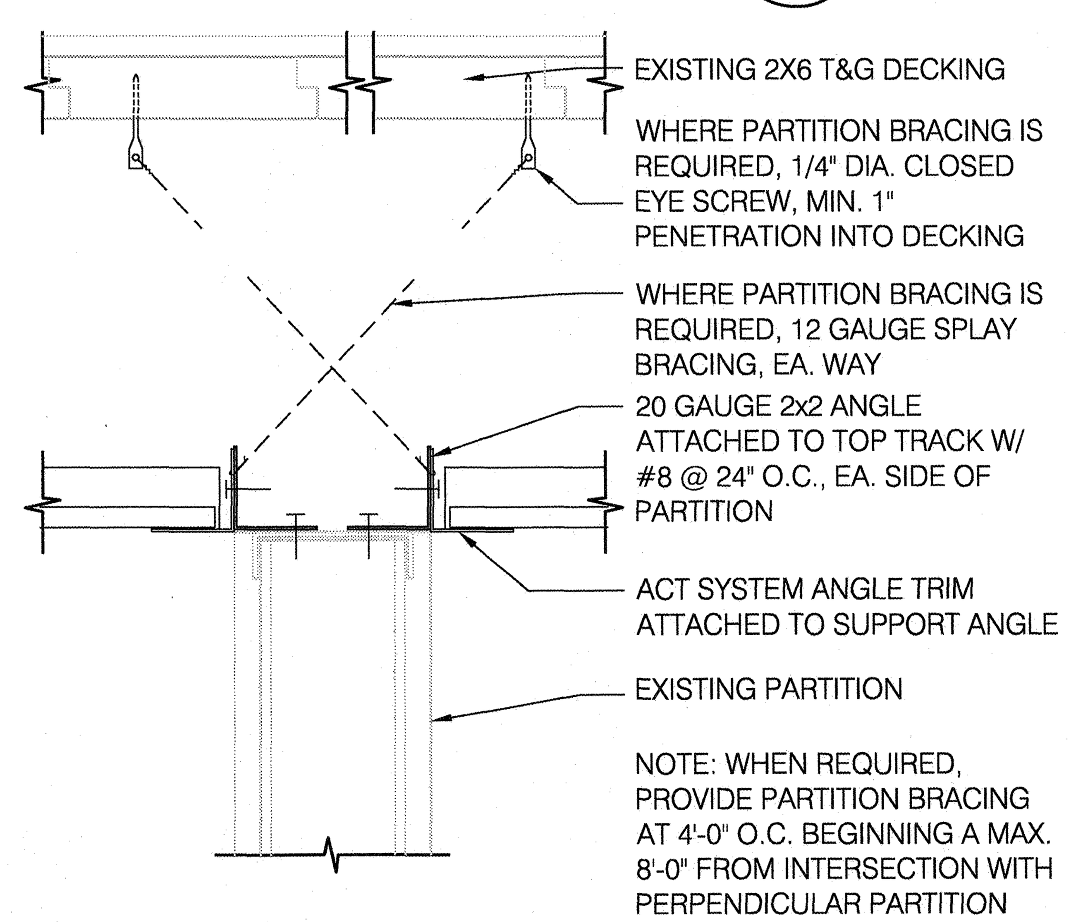


FRAMING DETAIL
SCALE: 3" = 1'-0"
7 / A6.01



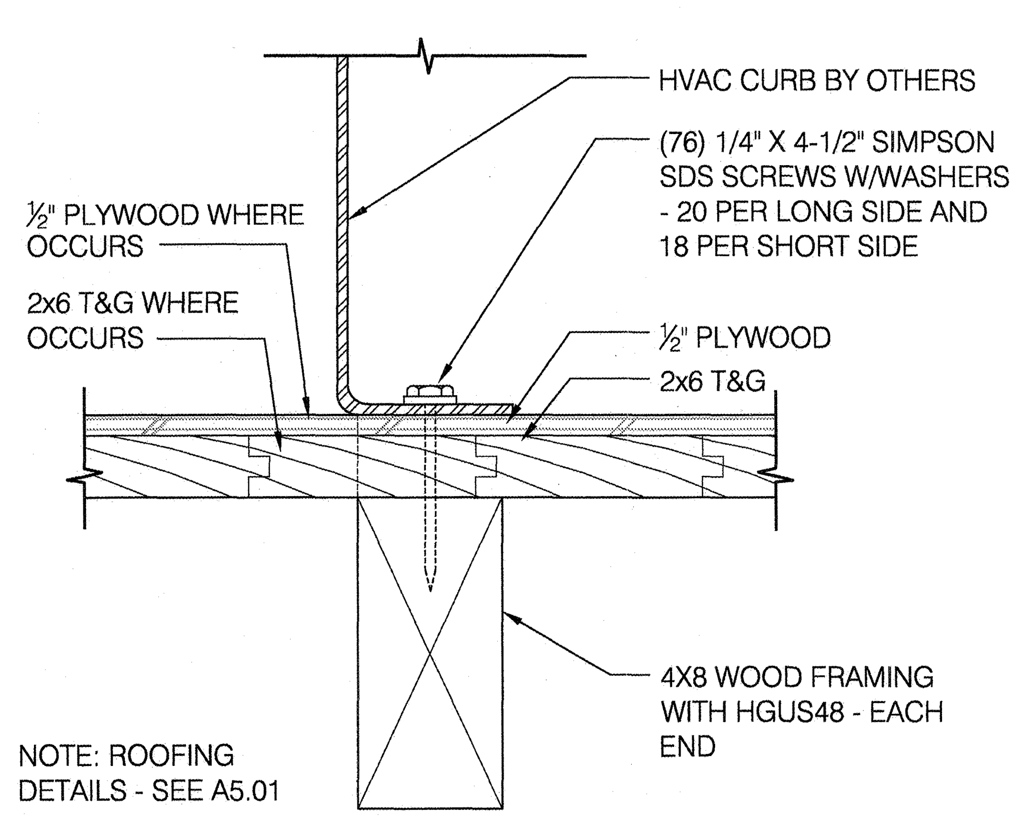
NOTE: CUT BACK EXISTING TONGUE & GROOVE AND PLYWOOD TO CENTERLINE OF EXISTING GLUELAM AND/OR 4X8. DO NOT CUT OR NOTCH ANY STRUCTURAL MEMBER. PROVIDE CLEAN LINTEL FOR NEW MATERIAL

ROOF INFILL DETAIL
SCALE: 1 1/2" = 1'-0"
8 / A6.01

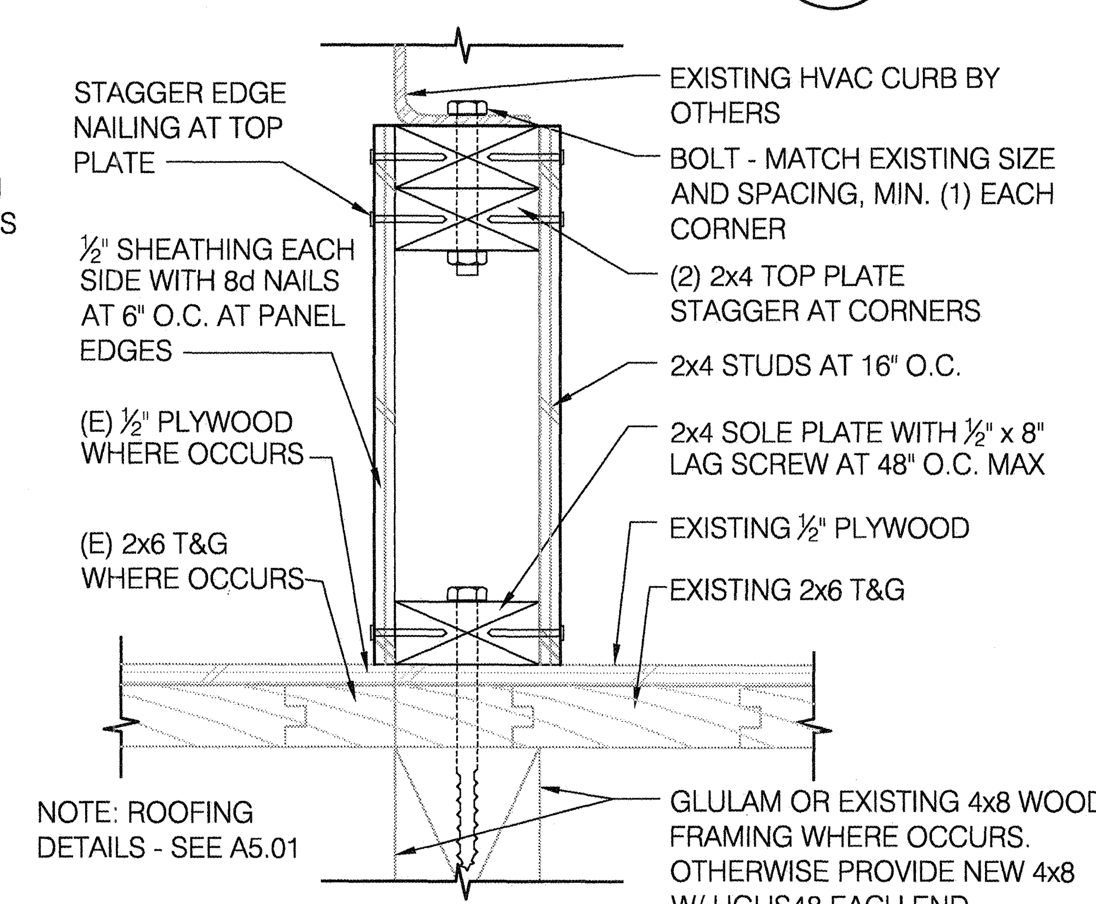


NOTE: WHEN REQUIRED, PROVIDE PARTITION BRACING AT 4'-0" O.C. BEGINNING A MAX. 8'-0" FROM INTERSECTION WITH PERPENDICULAR PARTITION

ACT TRIM AT PARTITIONS
SCALE: 3" = 1'-0"
9 / A6.01



NEW AHU - ATTACHMENT DETAIL
SCALE: 3" = 1'-0"
10 / A6.01



EXISTING AHU - ATTACHMENT DETAIL
SCALE: 3" = 1'-0"
11 / A6.01

RECORD DRAWING

RECORD DRAWINGS
DOCUMENTS HAVE BEEN REVISED BASED SOLELY ON RECORD WORKING DRAWINGS SUPPLIED BY THE CONTRACTOR AND MAY NOT BE ACCURATE IN ALL LOCATIONS. FIELD VERIFY EXISTING AND/OR HIDDEN CONDITIONS PRIOR TO COMMENCEMENT OF NEW WORK. THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION.
09-03-10

NO.	DATE	BY	REVISIONS	CKD	APPVD
4	09/03/10	JHE	RECORD DRAWINGS		
3	12/21/09	JHE	RFI 30		
2	09/21/09	JHE	RFI 15		
1	07/17/09	JHE	AS-BID		

PORT OF PORTLAND
PORTLAND, OREGON

CARLETON HART ARCHITECTURE
322 nw 8th avenue portland, oregon 97209
t 503 243 2252 | f 503 243 3261 | carletonhart.com

2008D042 — DESIGN NUMBER
100546 — PROJECT NUMBER

DESIGNED BY	J. EISNER
DRAWN BY	M. WOEHR
CHECKED BY	D. CALEM
DATE	MAY 2009
GRAPHICAL SCALE BAR	0 1/4" 1/2" 1" 2"

HILLSBORO AIRPORT
TERMINAL BUILDING AND HVAC REHABILITATION
DETAILS - INTERIOR AND EXTERIOR

SUBMITTED BY: JIM McGINNIS, PROJECT ENGINEER

TYPE: CD | DRAWING NO.: HIO 2009-501 | 17/36 | A6.01

Appendix B

ASCE 41 STRUCTURAL AND NONSTRUCTURAL CHECKLISTS

APPENDIX C
SUMMARY DATA SHEET

BUILDING DATA

Building Name: Hillsboro Airport Terminal Building Date: May 5, 2017
Building Address: 3355 NE Cornell Road, Hillsboro, Oregon 97124
Latitude: 45.533 Longitude: -122.948 By: Jacob Christensen
Year Built: 1974 Year(s) Remodeled: 2003, 2010 Original Design Code: 1971 UBC
Area (sf): 24,500 Length (ft): 175 Width (ft): 70
No. of Stories: 2 Story Height: 13.5 ft. Total Height: 27 ft.

USE ☒ Industrial ☐ Office ☐ Warehouse ☐ Hospital ☐ Residential ☐ Educational ☐ Other:

CONSTRUCTION DATA

Gravity Load Structural System: Wood Decking and Beams to Columns (Steel & Wood) and Walls (Wood & Concrete)
Exterior Transverse Walls: Concrete Shear Walls Openings? Yes
Exterior Longitudinal Walls: Concrete Shear Walls Openings? Yes
Roof Materials/Framing: Wood Framing, Decking, and Plywood with Built-Up Roof
Intermediate Floors/Framing: Wood Framing, Decking, and Plywood
Ground Floor: Slab on Grade
Columns: Majority Steel with Some Wood Foundation: Full Concrete Foundation
General Condition of Structure: Functional with expected aging for its construction date
Levels Below Grade? 0
Special Features and Comments: Minimal Perimeter Upper Floor Shear Walls

LATERAL-FORCE-RESISTING SYSTEM

	Longitudinal	Transverse
System:	C2A	C2A
Vertical Elements:	Concrete Shear Walls	Concrete Shear Walls
Diaphragms:	Decking and Sheathing	Decking and Sheathing
Connections:	Nails and Bolts	Nails and Bolts

EVALUATION DATA

BSE-1N Spectral Response Accelerations: S_{Ds} = 0.732 S_{D1} = 0.462
Soil Factors: Class = D F_a = 1.565 F_v = 2.352
BSE-1E Spectral Response Accelerations: S_{XS} = 0.459 S_{X1} = 0.263
Level of Seismicity: High Performance Level: IO
Building Period: T = 0.237
Spectral Acceleration: S_a = 0.459
Modification Factor: $C_mC_1C_2$ = 1.0 Building Weight: W = 440^K
Pseudo Lateral Force: $V = C_mC_1C_2S_aW$ = 202^K

BUILDING CLASSIFICATION: IV

REQUIRED TIER 1 CHECKLISTS	**Yes**	**No**
Basic Configuration Checklist	☒	☐
Building Type C2A **Structural Checklist**	☒	☐
Nonstructural Component Checklist	☒	☐

FURTHER EVALUATION REQUIREMENT: Not compliant with Tier 1 for BPOE. Further evaluation as directed by client.

16.1.2IO IMMEDIATE OCCUPANCY BASIC CONFIGURATION CHECKLIST

Very Low Seismicity

Building System

General

C (NC) N/A U LOAD PATH: The structure shall contain a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)

C NC (N/A) U ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 4% of the height of the shorter building. This statement need not apply for the following building types: W1, W1a, and W2. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2)

C NC (N/A) U MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3)

Building Configuration

(C) NC N/A U WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction shall not be less than 80% of the strength in the adjacent story above. (Commentary: Sec. A.2.2.2. Tier 2: Sec. 5.4.2.1)

(C) NC N/A U SOFT STORY: The stiffness of the seismic-force-resisting system in any story shall not be less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffnessof the three stories above. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2)

(C) NC N/A U VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3)

(C) NC N/A U GEOMETRY: There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4)

(C) NC N/A U MASS: There is no change in effective mass more than 50% from one story to the next. Light roofs, penthouses, and mezzanines need not be considered. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5)

(C) NC N/A U TORSION: The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6)

Low Seismicity: Complete the Following Items in Additionto the Items for Very Low Seismicity.

Geologic Site Hazards

(C) NC N/A U LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance shall not exist in the foundation soils at depths within 50 ft under the building. (Commentary: Sec. A.6.1.1. Tier 2: 5.4.3.1)

(C) NC N/A U SLOPE FAILURE: The building site is sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or is capable of accommodating any predicted movements without failure. (Commentary: Sec. A.6.1.2. Tier 2: 5.4.3.1)

(C) NC N/A U SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: 5.4.3.1)

Moderate and High Seismicity: Complete the Following Items in Addition to the Items for Low Seismicity.

Foundation Configuration

C (NC) N/A U OVERTURNING: The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is greater than $0.6S_a$. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3)

C NC (N/A) U TIES BETWEEN FOUNDATION ELEMENTS: The foundation has ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Site Class A, B, or C. (Commentary: Sec. A.6.2.2. Tier 2: Sec. 5.4.3.4)

16.10IO IMMEDIATE OCCUPANCY STRUCTURAL CHECKLIST FOR BUILDING TYPES C2: CONCRETE SHEAR WALLS WITH STIFF DIAPHRAGMS AND C2A: CONCRETE SHEAR WALLS WITH FLEXIBLE DIAPHRAGMS

Very Low Seismicity

Seismic-Force-Resisting System

C NC (N/A) U COMPLETE FRAMES: Steel or concrete frames classified as secondary components form a complete vertical-load-carrying system. (Commentary: Sec. A.3.1.6.1. Tier 2: Sec. 5.5.2.5.1)

(C) NC N/A U REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1)

(C) NC N/A U SHEAR STRESS CHECK: The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 4.5.3.3, is less than the greater of 100 lb/in.^{2} or $2\sqrt{f'_c}$. (Commentary: Sec. A.3.2.2.1. Tier 2: Sec. 5.5.3.1.1)

(C) NC N/A U REINFORCING STEEL: The ratio of reinforcing steel area to gross concrete area is not less than 0.0012 in the vertical direction and 0.0020 in the horizontal direction. The spacing of reinforcing steel is equal to or less than 18 in. (Commentary: Sec. A.3.2.2.2. Tier 2: Sec. 5.5.3.1.3)

Connections

C (NC) N/A U WALL ANCHORAGE AT FLEXIBLE DIAPHRAGMS: Exterior concrete or masonry walls that are dependent on flexible diaphragms for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.5.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)

C (NC) N/A U TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of loads to the shear walls, and the connections are able to develop the lesser of the shear strength of the walls or diaphragms. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2)

C (NC) N/A U FOUNDATION DOWELS: Wall reinforcement is doweled into the foundation, and the dowels are able to develop the lesser of the strength of the walls or the uplift capacity of the foundation. (Commentary: Sec. A.5.3.5. Tier 2: Sec. 5.7.3.4)

Foundation System

C NC (N/A) U DEEP FOUNDATIONS: Piles and piers are capable of transferring the lateral forces between the structure and the soil. (Commentary: Sec. A.6.2.3)

C NC (N/A) U SLOPING SITES: The difference in foundation embedment depth from one side of the building to another shall not exceed one story high. (Commentary: Sec. A.6.2.4)

Low, Moderate, and High Seismicity: Complete the Following Items in Addition to the Items for Very Low Seismicity.

Seismic-Force-Resisting System

C NC (N/A) U DEFLECTION COMPATIBILITY: Secondary components have the shear capacity to develop the flexural strength of the components and are compliant with the following items: COLUMN-BAR SPLICES, BEAM-BAR SPLICES, COLUMN-TIE SPACING, STIRRUP SPACING, and STIRRUP AND TIE HOOK in the Immediate Occupancy Structural Checklist for Building Type C1. (Commentary: Sec. A.3.1.6.2. Tier 2: Sec. 5.5.2.5.2)

C NC (N/A) U FLAT SLABS: Flat slabs or plates not part of seismic-force-resisting system have continuous bottom steel through the column joints. (Commentary: Sec. A.3.1.6.3. Tier 2: Sec. 5.5.2.5.3)

C NC (N/A) U COUPLING BEAMS: The stirrups in coupling beams over means of egress are spaced at or less than $d/2$ and are anchored into the confined core of the beam with hooks of 135 degrees or more. The ends of both walls to which the coupling beam is attached are supported at each end to resist vertical loads caused by overturning. Coupling beams have the capacity in shear to develop the uplift capacity of the adjacent wall. (Commentary: Sec.A.3.2.2.3. Tier 2: Sec. 5.5.3.2.1)

(C) NC N/A U OVERTURNING: All shear walls have aspect ratios less than 4-to-1. Wall piers need not be considered. (Commentary: Sec. A.3.2.2.4. Tier 2: Sec. 5.5.3.1.4)

C **(NC)** N/A U CONFINEMENT REINFORCING: For shear walls with aspect ratios greater than 2-to-1, the boundary elements are confined with spirals or ties with spacing less than $8d_b$. (Commentary: Sec. A.3.2.2.5. Tier 2: Sec. 5.5.3.2.2)

C NC **(N/A)** U WALL REINFORCING AT OPENINGS: There is added trim reinforcement around all wall openings with a dimension greater than three times the thickness of the wall. (Commentary: Sec. A.3.2.2.6. Tier 2: Sec. 5.5.3.1.5)

C **(NC)** N/A U WALL THICKNESS: Thicknesses of bearing walls are not less than 1/25 the unsupported height or length, whichever is shorter, nor less than 4 in. (Commentary: Sec. A.3.2.2.7. Tier 2: Sec. 5.5.3.1.2)

Connections

C NC **(N/A)** U UPLIFT AT PILE CAPS: Pile caps shall have top reinforcement, and piles are anchored to the pile caps; the pile cap reinforcement and pile anchorage are able to develop the tensile capacity of the piles. (Commentary: Sec. A.5.3.8.Tier 2: Sec. 5.7.3.5)

Diaphragms (Flexible or Stiff)

(C) NC N/A U DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1)

C **(NC)** N/A U OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 15% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3)

C NC **(N/A)** U PLAN IRREGULARITIES: There is tensile capacity to develop the strength of the diaphragm at reentrant corners or other locations of plan irregularities. (Commentary: Sec. A.4.1.7. Tier 2: Sec. 5.6.1.4)

C NC **(N/A)** U DIAPHRAGM REINFORCEMENT AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. (Commentary: Sec. A.4.1.8. Tier 2: Sec. 5.6.1.5)

Flexible Diaphragms

C **(NC)** N/A U CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)

C NC **(N/A)** U STRAIGHT SHEATHING: All straight sheathed diaphragms have aspect ratios less than 1-to-1 in the direction being considered. (Commentary: Sec.A.4.2.1. Tier 2: Sec. 5.6.2)

(C) NC N/A U SPANS: All wood diaphragms with spans greater than 12 ft consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)

C NC **(N/A)** U DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 30 ft and aspect ratios less than or equal to 3-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2)

C NC **(N/A)** U NONCONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete consist of horizontal spans of less than 40 ft and have aspect ratios less than 4-to-1. (Commentary: Sec. A.4.3.1. Tier 2: Sec. 5.6.3)

(C) NC N/A U OTHER DIAPHRAGMS: The diaphragm does not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)

16.17 NONSTRUCTURAL CHECKLIST

Life Safety Systems

(C) NC N/A U LS-LMH; PR-LMH. FIRE SUPPRESSION PIPING: Fire suppression piping is anchored and braced in accordance with NFPA-13. (Commentary: Sec. A.7.13.1. Tier 2: Sec. 13.7.4)

C NC N/A (U) LS-LMH; PR-LMH. FLEXIBLE COUPLINGS: Fire suppression piping has flexible couplings in accordance with NFPA-13. (Commentary: Sec. A.7.13.2. Tier 2: Sec. 13.7.4)

C NC N/A (U) LS-LMH; PR-LMH. EMERGENCY POWER: Equipment used to power or control life safety systems is anchored or braced. (Commentary: Sec. A.7.12.1. Tier 2: Sec. 13.7.7)

C NC N/A (U) LS-LMH; PR-LMH. STAIR AND SMOKE DUCTS: Stair pressurization and smoke control ducts are braced and have flexible connections at seismic joints. (Commentary: Sec. A.7.14.1. Tier 2: Sec. 13.7.6)

C NC N/A (U) LS-MH; PR-MH. SPRINKLER CEILING CLEARANCE: Penetrations through panelized ceilings for fire suppression devices provide clearances in accordance with NFPA-13. (Commentary: Sec. A.7.13.3. Tier 2: Sec. 13.7.4)

C NC N/A (U) LS-not required; PR-LMH. EMERGENCY LIGHTING: Emergency and egress lighting equipment is anchored or braced. (Commentary: Sec. A.7.3.1. Tier 2: Sec. 13.7.9)

Hazardous Materials

C NC N/A (U) LS-LMH; PR-LMH. HAZARDOUS MATERIAL EQUIPMENT: Equipment mounted on vibration isolators and containing hazardous material is equipped with restraints or snubbers. (Commentary: Sec. A.7.12.2. Tier 2: 13.7.1)

C NC N/A (U) LS-LMH; PR-LMH. HAZARDOUS MATERIAL STORAGE: Breakable containers that hold hazardous material, including gas cylinders, are restrained by latched doors, shelf lips, wires, or other methods. (Commentary: Sec. A.7.15.1. Tier 2: Sec. 13.8.4)

C NC N/A (U) LS-MH; PR-MH. HAZARDOUS MATERIAL DISTRIBUTION: Piping or ductwork conveying hazardous materials is braced or otherwise protected from damage that would allow hazardous material release. (Commentary: Sec. A.7.13.4. Tier 2: Sec. 13.7.3 and 13.7.5)

C (NC) N/A U LS-MH; PR-MH. SHUT-OFF VALVES: Piping containing hazardous material, including natural gas, has shut-off valves or other devices to limit spills or leaks. (Commentary: Sec. A.7.13.3. Tier 2: Sec. 13.7.3 and 13.7.5)

C NC N/A (U) LS-LMH; PR-LMH. FLEXIBLE COUPLINGS: Hazardous material ductwork and piping, including natural gas piping, has flexible couplings. (Commentary: Sec. A.7.15.4, Tier 2: Sec.13.7.3 and 13.7.5)

C NC (N/A) U LS-MH; PR-MH. PIPING OR DUCTS CROSSING SEISMIC JOINTS: Piping or ductwork carrying hazardous material that either crosses seismic joints or isolation planes or is connected to independent structures has couplings or other details to accommodate the relative seismic displacements. (Commentary: Sec. A.7.13.6. Tier 2: Sec.13.7.3, 13.7.5, and 13.7.6)

Partitions

C NC (N/A) U LS-LMH; PR-LMH. UNREINFORCED MASONRY: Unreinforced masonry or hollow-clay tile partitions are braced at a spacing of at most 10 ft in Low or Moderate Seismicity, or at most 6 ft in High Seismicity. (Commentary: Sec. A.7.1.1. Tier 2: Sec. 13.6.2)

C NC (N/A) U LS-LMH; PR-LMH. HEAVY PARTITIONS SUPPORTED BY CEILINGS: The tops of masonry or hollow-clay tile partitions are not laterally supported by an integrated ceiling system. (Commentary: Sec. A.7.2.1. Tier 2: Sec. 13.6.2)

C NC N/A (U) LS-MH; PR-MH. DRIFT: Rigid cementitious partitions are detailed to accommodate the following drift ratios: in steel moment frame, concrete moment frame, and wood frame buildings, 0.02; in other buildings, 0.005. (Commentary A.7.1.2 Tier 2: Sec. 13.6.2)

C NC N/A **(U)** LS-not required; PR-MH. LIGHT PARTITIONS SUPPORTED BY CEILINGS: The tops of gypsum board partitions are not laterally supported by an integrated ceiling system. (Commentary: Sec. A.7.2.1. Tier 2: Sec. 13.6.2)

C NC **(N/A)** U LS-not required; PR-MH. STRUCTURAL SEPARATIONS: Partitions that cross structural separations have seismic or control joints. (Commentary: Sec. A.7.1.3. Tier 2. Sec. 13.6.2)

C NC N/A **(U)** LS-not required; PR-MH. TOPS: The tops of ceiling-high framed or panelized partitions have lateral bracing to the structure at a spacing equal to or less than 6 ft. (Commentary: Sec. A.7.1.4. Tier 2. Sec. 13.6.2)

Ceilings

C NC **(N/A)** U LS-MH; PR-LMH. SUSPENDED LATH AND PLASTER: Suspended lath and plaster ceilings have attachments that resist seismic forces for every 12 ft^2 of area. (Commentary: Sec. A.7.2.3. Tier 2: Sec. 13.6.4)

C **(NC)** N/A U LS-MH; PR-LMH. SUSPENDED GYPSUM BOARD: Suspended gypsum board ceilings have attachments that resist seismic forces for every 12 ft^2 of area. (Commentary: Sec. A.7.2.3. Tier 2: Sec. 13.6.4)

C **(NC)** N/A U LS-not required; PR-MH. INTEGRATED CEILINGS: Integrated suspended ceilings with continuous areas greater than 144 ft^2, and ceilings of smaller areas that are not surrounded by restraining partitions, are laterally restrained at a spacing no greater than 12 ft with members attached to the structure above. Each restraint location has a minimum of four diagonal wires and compression struts, or diagonal members capable of resisting compression. (Commentary: Sec. A.7.2.2. Tier 2: Sec. 13.6.4)

(C) NC N/A U LS-not required; PR-MH. EDGE CLEARANCE: The free edges of integrated suspended ceilings with continuous areas greater than 144 ft^2 have clearances from the enclosing wall or partition of at least the following: in Moderate Seismicity, 1/2 in.; in High Seismicity, 3/4 in. (Commentary: Sec. A.7.2.4. Tier 2: Sec. 13.6.4)

C NC **(N/A)** U LS-not required; PR-MH. CONTINUITY ACROSS STRUCTURE JOINTS: The ceiling system does not cross any seismic joint and is not attached to multiple independent structures. (Commentary: Sec. A.7.2.5. Tier 2: Sec. 13.6.4)

(C) NC N/A U LS-not required; PR-H. EDGE SUPPORT: The free edges of integrated suspended ceilings with continuous areas greater than 144 ft^2 are supported by closure angles or channels not less than 2 in. wide. (Commentary: Sec. A.7.2.6. Tier 2: Sec. 13.6.4)

C NC **(N/A)** U LS-not required; PR-H. SEISMIC JOINTS: Acoustical tile or lay-in panel ceilings have seismic separation joints such that each continuous portion of the ceiling is no more than 2500 ft^2 and has a ratio of long-to-short dimension no more than 4-to-1. (Commentary: Sec. A.7.2.7. Tier 2: 13.6.4)

Light Fixtures

C **(NC)** N/A U LS-MH; PR-MH. INDEPENDENT SUPPORT: Light fixtures that weigh more per square foot than the ceiling they penetrate are supported independent of the grid ceiling suspension system by a minimum of two wires at diagonally opposite corners of each fixture. (Commentary: Sec. A.7.3.2. Tier 2: Sec. 13.6.4 and 13.7.9)

C **(NC)** N/A U LS-not required; PR-H. PENDANT SUPPORTS: Light fixtures on pendant supports are attached at a spacing equal to or less than 6 ft and, if rigidly supported, are free to move with the structure to which they are attached without damaging adjoining components. (Commentary: A.7.3.3. Tier 2: Sec. 13.7.9)

C **(NC)** N/A U LS-not required; PR-H. LENS COVERS: Lens covers on light fixtures are attached with safety devices. (Commentary: Sec. A.7.3.4. Tier 2: Sec. 13.7.9)

Cladding and Glazing

C NC **(N/A)** U LS-MH; PR-MH. CLADDING ANCHORS: Cladding components weighing more than 10 lb/ft^2 are mechanically anchored to the structure at a spacing equal to or less than the following: for Life Safety in Moderate Seismicity, 6 ft; for Life Safety in High Seismicity and for Position Retention in any seismicity, 4 ft. (Commentary: Sec. A.7.4.1. Tier 2: Sec. 13.6.1)

C NC **(N/A)** U LS-MH; PR-MH. CLADDING ISOLATION: For steel or concrete moment frame buildings, panel connections are detailed to accommodate a story drift ratio of at least the following: for Life Safety in Moderate Seismicity, 0.01; for Life Safety in High Seismicity and for Position Retention in any seismicity, 0.02. (Commentary: Sec. A.7.4.3. Tier 2: Section 13.6.1)

C NC (N/A) U LS-MH; PR-MH. MULTI-STORY PANELS: For multi-story panels attached at more than one floor level, panel connections are detailed to accommodate a story drift ratio of at least the following: for Life Safety in Moderate Seismicity, 0.01; for Life Safety in High Seismicity and for Position Retention in any seismicty, 0.02. (Commentary: Sec. A.7.4.4. Tier 2: Sec. 13.6.1)

C NC (N/A) U LS-MH; PR-MH. PANEL CONNECTIONS: Cladding panels are anchored out-of-plane with a minimum number of connections for each wall panel, as follows: for Life Safety in Moderate Seismicity, 2 connections; for Life Safety in High Seismicity and for Position Retention in any seismicity, 4 connections. (Commentary: Sec. A.7.4.5. Tier 2: Sec. 13.6.1.4)

C NC (N/A) U LS-MH; PR-MH. BEARING CONNECTIONS: Where bearing connections are used, there is a minimum of two bearing connections for each cladding panel. (Commentary: Sec. A.7.4.6. Tier 2: Sec. 13.6.1.4)

C NC (N/A) U LS-MH; PR-MH. INSERTS: Where concrete cladding components use inserts, the inserts have positive anchorage or are anchored to reinforcing steel. (Commentary: Sec. A.7.4.7. Tier 2: Sec. 13.6.1.4)

C NC (N/A) U LS-MH; PR-MH. OVERHEAD GLAZING: Glazing panes of any size in curtain walls and individual interior or exterior panes over 16 ft^2 in area are laminated annealed or laminated heat-strengthened glass and are detailed to remain in the frame when cracked. (Commentary: Sec. A.7.4.8: Tier 2: Sec. 13.6.1.5)

Masonry Veneer

C NC (N/A) U LS-LMH; PR-LMH. TIES: Masonry veneer is connected to the backup with corrosion-resistant ties. There is a minimum of one tie for every 2-2/3 ft^2, and the ties have spacing no greater than the following: for Life Safety in Low or Moderate Seismicity, 36 in.; for Life Safety in High Seismicity and for Position Retention in any seismicity, 24 in. (Commentary: Sec. A.7.5.1. Tier 2: Sec. 13.6.1.2)

C NC (N/A) U LS-LMH; PR-LMH. SHELF ANGLES: Masonry veneer is supported by shelf angles or other elements at each floor above the ground floor. (Commentary: Sec. A.7.5.2. Tier 2: Sec. 13.6.1.2)

C NC (N/A) U LS-LMH; PR-LMH. WEAKENED PLANES: Masonry veneer is anchored to the backup adjacent to weakened planes, such as at the locations of flashing. (Commentary: Sec. A.7.5.3. Tier 2: Sec. 13.6.1.2)

C NC (N/A) U LS-LMH; PR-LMH. UNREINFORCED MASONRY BACKUP: There is no unreinforced masonry backup. (Commentary: Sec. A.7.7.2. Tier 2: Section 13.6.1.1 and 13.6.1.2)

C NC (N/A) U LS-MH; PR-MH. STUD TRACKS: For veneer with metal stud backup, stud tracks are fastened to the structure at a spacing equal to or less than 24 in. on center. (Commentary: Sec. A.7.6.1. Tier 2: Section 13.6.1.1 and 13.6.1.2)

C NC (N/A) U LS-MH; PR-MH. ANCHORAGE: For veneer with concrete block or masonry backup, the backup is positively anchored to the structure at a horizontal spacing equal to or less than 4 ft along the floors and roof. (Commentary: Sec. A.7.7.1. Tier 2: Section 13.6.1.1 and 13.6.1.2)

C NC (N/A) U LS-not required; PR-MH. WEEP HOLES: In veneer anchored to stud walls, the veneer has functioning weep holes and base flashing. (Commentary: Sec. A.7.5.6. Tier 2: Section 13.6.1.2)

C NC (N/A) U LS-not required; PR-MH. OPENINGS: For veneer with metal stud backup, steel studs frame window and door openings. (Commentary: Sec. A.7.6.2. Tier 2: Sec. 13.6.1.1 and 13.6.1.2)

Parapets, Cornices, Ornamentation, and Appendages

C NC (N/A) U LS-LMH; PR-LMH. URM PARAPETS OR CORNICES: Laterally unsupported unreinforced masonry parapets or cornices have height-to-thickness ratios no greater than the following: for Life Safety in Low or Moderate Seismicity, 2.5; for Life Safety in High Seismicity and for Position Retention in any seismicity, 1.5. (Commentary: Sec. A.7.8.1. Tier 2: Sec. 13.6.5)

(C) NC N/A U LS-LMH; PR-LMH. CANOPIES: Canopies at building exits are anchored to the structure at a spacing no greater than the following: for Life Safety in Low or Moderate Seismicity, 10 ft; for Life Safety in High Seismicity and for Position Retention in any seismicity, 6 ft. (Commentary: Sec. A.7.8.2. Tier 2: Sec. 13.6.6)

C NC (N/A) U LS-MH; PR-LMH. CONCRETE PARAPETS: Concrete parapets with height-to-thickness ratios greater than 2.5 have vertical reinforcement. (Commentary: Sec. A.7.8.3. Tier 2: Sec. 13.6.5)

(C) NC N/A U LS-MH; PR-LMH. APPENDAGES: Cornices, parapets, signs, and other ornamentation or appendages that extend above the highest point of anchorage to the structure or cantilever from components are reinforced and anchored to the structural system at a spacing equal to or less than 6 ft. This checklist item does not apply to parapets or cornices covered by other checklist items. (Commentary: Sec. A.7.8.4. Tier 2: Sec. 13.6.6)

Masonry Chimneys

C NC (N/A) U LS-LMH; PR-LMH. URM CHIMNEYS: Unreinforced masonry chimneys extend above the roof surface no more than the following: for Life Safety in Low or Moderate Seismicity, 3 times the least dimension of the chimney; for Life Safety in High Seismicity and for Position Retention in any seismicity, 2 times the least dimension of the chimney. (Commentary: Sec. A.7.9.1. Tier 2: 13.6.7)

C NC (N/A) U LS-LMH; PR-LMH. ANCHORAGE: Masonry chimneys are anchored at each floor level, at the topmost ceiling level, and at the roof. (Commentary: Sec. A.7.9.2. Tier 2: 13.6.7)

Stairs

C NC (N/A) U LS-LMH; PR-LMH. STAIR ENCLOSURES: Hollow-clay tile or unreinforced masonry walls around stair enclosures are restrained out-of-plane and have height-to-thickness ratios not greater than the following: for Life Safety in Low or Moderate Seismicity, 15-to-1; for Life Safety in High Seismicity and for Position Retention in any seismicity, 12-to-1. (Commentary: Sec. A.7.10.1. Tier 2: Sec. 13.6.2 and 13.6.8)

C NC (N/A) U LS-LMH; PR-LMH. STAIR DETAILS: In moment frame structures, the connection between the stairs and the structure does not rely on shallow anchors in concrete. Alternatively, the stair details are capable of accommodating the drift calculated using the Quick Check procedure of Section 4.5.3.1 without including any lateral stiffness contribution from the stairs. (Commentary: Sec. A.7.10.2. Tier 2: 13.6.8)

Contents and Furnishings

C NC (N/A) U LS-MH; PR-MH. INDUSTRIAL STORAGE RACKS: Industrial storage racks or pallet racks more than 12 ft high meet the requirements of ANSI/MH 16.1 as modified by ASCE 7 Chapter 15. (Commentary: Sec. A.7.11.1. Tier 2: Sec. 13.8.1)

C NC N/A (U) LS-H; PR-MH. TALL NARROW CONTENTS: Contents more than 6 ft high with a height-to-depth or height-to-width ratio greater than 3-to-1 are anchored to the structure or to each other. (Commentary: Sec. A.7.11.2. Tier 2: Sec. 13.8.2)

C NC (N/A) U LS-H; PR-H. FALL-PRONE CONTENTS: Equipment, stored items, or other contents weighing more than 20 lb whose center of mass is more than 4 ft above the adjacent floor level are braced or otherwise restrained. (Commentary: Sec. A.7.11.3. Tier 2: Sec. 13.8.2)

C NC (N/A) U LS-not required; PR-MH. ACCESS FLOORS: Access floors more than 9 in. high are braced. (Commentary: Sec. A.7.11.4. Tier 2: Sec. 13.8.3)

C NC (N/A) U LS-not required; PR-MH. EQUIPMENT ON ACCESS FLOORS: Equipment and other contents supported by access floor systems are anchored or braced to the structure independent of the access floor. (Commentary: Sec. A.7.11.5. Tier 2: Sec. 13.7.7 and 13.8.3)

C NC N/A (U) LS-not required; PR-H. SUSPENDED CONTENTS: Items suspended without lateral bracing are free to swing from or move with the structure from which they are suspended without damaging themselves or adjoining components. (Commentary. A.7.11.6. Tier 2: Sec. 13.8.2)

Mechanical and Electrical Equipment

C NC N/A (U) LS-H; PR-H. FALL-PRONE EQUIPMENT: Equipment weighing more than 20 lb whose center of mass is more than 4 ft above the adjacent floor level, and which is not in-line equipment, is braced. (Commentary: A.7.12.4. Tier 2: 13.7.1 and 13.7.7)

C NC N/A (U) LS-H; PR-H. IN-LINE EQUIPMENT: Equipment installed in-line with a duct or piping system, with an operating weight more than 75 lb, is supported and laterally braced independent of the duct or piping system. (Commentary: Sec. A.7.12.5. Tier 2: Sec. 13.7.1)

C NC N/A (U) LS-H; PR-MH. TALL NARROW EQUIPMENT: Equipment more than 6 ft high with a height-to-depth or height-to-width ratio greater than 3-to-1 is anchored to the floor slab or adjacent structural walls. (Commentary: Sec. A.7.12.6. Tier 2: Sec. 13.7.1 and 13.7.7)

C NC N/A (U) LS-not required; PR-MH. MECHANICAL DOORS: Mechanically operated doors are detailed to operate at a story drift ratio of 0.01. (Commentary: Sec. A.7.12.7. Tier 2: Sec. 13.6.9)

C NC N/A (U) LS-not required; PR-H. SUSPENDED EQUIPMENT: Equipment suspended without lateral bracing is free to swing from or move with the structure from which it is suspended without damaging itself or adjoining components. (Commentary: Sec. A.7.12.8. Tier 2: Sec. 13.7.1 and 13.7.7)

C NC (N/A) U LS-not required; PR-H. VIBRATION ISOLATORS: Equipment mounted on vibration isolators is equipped with horizontal restraints or snubbers and with vertical restraints to resist overturning. (Commentary: Sec. A.7.12.9. Tier 2: Sec. 13.7.1)

C NC N/A (U) LS-not required; PR-H. HEAVY EQUIPMENT: Floor-supported or platform-supported equipment weighing more than 400 lb is anchored to the structure. (Commentary: Sec. A.7.12.10. Tier 2: 13.7.1 and 13.7.7)

C NC N/A (U) LS-not required; PR-H. ELECTRICAL EQUIPMENT: Electrical equipment is laterally braced to the structure. (Commentary: Sec. A.7.12.11. Tier 2: 13.7.7)

C NC N/A (U) LS-not required; PR-H. CONDUIT COUPLINGS: Conduit greater than 2.5 in. trade size that is attached to panels, cabinets, or other equipment and is subject to relative seismic displacement has flexible couplings or connections. (Commentary: Sec. A.7.12.12. Tier 2: 13.7.8)

Piping

C NC N/A (U) LS-not required; PR-H. FLEXIBLE COUPLINGS: Fluid and gas piping has flexible couplings. (Commentary: Sec. A.7.13.2. Tier 2: Sec. 13.7.3 and 13.7.5)

C NC N/A (U) LS-not required; PR-H. FLUID AND GAS PIPING: Fluid and gas piping is anchored and braced to the structure to limit spills or leaks. (Commentary: Sec. A.7.13.4. Tier 2: Sec. 13.7.3 and 13.7.5)

C NC N/A (U) LS-not required; PR-H. C-CLAMPS: One-sided C-clamps that support piping larger than 2.5 in. in diameter are restrained. (Commentary: Sec. A.7.13.5. Tier 2: Sec. 13.7.3 and 13.7.5)

C NC (N/A) U LS-not required; PR-H. PIPING CROSSING SEISMIC JOINTS: Piping that crosses seismic joints or isolation planes or is connected to independent structures has couplings or other details to accommodate the relative seismic displacements. (Commentary: Sec. A7.13.6. Tier 2: Sec.13.7.3 and Sec. 13.7.5)

Ducts

C (NC) N/A U LS-not required; PR-H. DUCT BRACING: Rectangular ductwork larger than 6 ft^2 in cross-sectional area and round ducts larger than 28 in. in diameter are braced. The maximum spacing of transverse bracing does not exceed 30 ft. The maximum spacing of longitudinal bracing does not exceed 60 ft. (Commentary: Sec. A.7.14.2. Tier 2: Sec. 13.7.6)

C NC N/A (U) LS-not required; PR-H. DUCT SUPPORT: Ducts are not supported by piping or electrical conduit. (Commentary: Sec. A.7.14.3. Tier 2: Sec. 13.7.6)

C NC (N/A) U LS-not required; PR-H. DUCTS CROSSING SEISMIC JOINTS: Ducts that cross seismic joints or isolation planes or are connected to independent structures have couplings or other details to accommodate the relative seismic displacements. (Commentary: Sec. A.7.14.5. Tier 2: Sec. 13.7.6)

Elevators

C NC N/A (U) LS-H; PR-H. RETAINER GUARDS: Sheaves and drums have cable retainer guards. (Commentary: Sec. A.7.16.1. Tier 2: 13.8.6)

C NC N/A (U) LS-H; PR-H. RETAINER PLATE: A retainer plate is present at the top and bottom of both car and counterweight. (Commentary: Sec. A.7.16.2. Tier 2: 13.8.6)

C NC N/A (U) LS-not required; PR-H. ELEVATOR EQUIPMENT: Equipment, piping, and other components that are part of the elevator system are anchored. (Commentary: Sec. A.7.16.3. Tier 2: 13.8.6)

C NC N/A (U) LS-not required; PR-H. SEISMIC SWITCH: Elevators capable of operating at speeds of 150 ft/min or faster are equipped with seismic switches that meet the requirements of ASME A17.1 or have trigger levels set to 20% of the acceleration of gravity at the base of the structure and 50% of the acceleration of gravity in other locations. (Commentary: Sec. A.7.16.4. Tier 2: 13.8.6)

C NC N/A (U) LS-not required; PR-H. SHAFT WALLS: Elevator shaft walls are anchored and reinforced to prevent toppling into the shaft during strong shaking. (Commentary: Sec. A.7.16.5. Tier 2: 13.8.6)

C NC N/A (U) LS-not required; PR-H. COUNTERWEIGHT RAILS: All counterweight rails and divider beams are sized in accordance with ASME A17.1. (Commentary: Sec. A.7.16.6. Tier 2: 13.8.6)

C NC N/A (U) LS-not required; PR-H. BRACKETS: The brackets that tie the car rails and the counterweight rail to the structure are sized in accordance with ASME A17.1. (Commentary: Sec. A.7.16.7. Tier 2: 13.8.6)

C NC N/A (U) LS-not required; PR-H. SPREADER BRACKET: Spreader brackets are not used to resist seismic forces. (Commentary: Sec. A.7.16.8. Tier 2: 13.8.6)

C NC N/A (U) LS-not required; PR-H. GO-SLOW ELEVATORS: The building has a go-slow elevator system. (Commentary: Sec. A.7.16.9. Tier 2: 13.8.6)

ASCE 41-13 TIER 1 RELATED CALCULATIONS

CHECK FOR IMMEDIATE OCCUPANCY PER DISCUSSIONS W/ CLIENT

$S_{DS} = 0.732$ (SEE FOLLOWING USGS PGS)

$0.732 > 0.5 \Rightarrow$ HIGH LEVEL OF SEISMICITY

SITE SOIL CLASS — D ASSUMED, BY INSPECTION

BLDG TYPE — C2A CONC SHEAR WALLS (PER DWGS) W/ FLEX DIAPHRAGM

DESIGN CODE 1971 UBC ⟹ NOT BENCHMARK BLDG

FOLLOWING CALCS SUPPLEMENT FOLLOWING CHECKLISTS:

BASIC CONFIGURATION

I.O. CHECKLIST FOR C2A

POSITIVE RETENSION NONSTRUCTURAL

$S_{XS} = 0.459 \quad S_{X1} = 0.263$ (BSE-1E)

$T = C_t h_n^{\beta} = 0.02 \cdot (27)^{0.75} = 0.237$

$S_a = S_{X1}/T = \frac{0.263}{0.237} = 1.11 \ (\leq S_{XS})$

$1.11 > 0.459$

$S_a = 0.459$

BLDG WT — ASSUME 15 PSF FLOOR & ROOF WT

(WORST CASE DIR) ASSUME CONC WALL WT (SMALL % OF LENGTHS) ADDS MINIMAL % WT, USE 10 PSF FOR EXT WALLS

$WT_{ROOF} = 15PSF \cdot 175' \cdot 70' + 10PSF \cdot 175' \cdot 2 \cdot 13.5'/2 = 208^k$

$WT_{FLR} = 15 \cdot 175 \cdot 70 + 10 \cdot 175 \cdot 2 \cdot 13.5 = 232^k$

$WT_{BLDG} = 440^k$

$C = 1.0$ (TABLE 4-8)

$V = 1.0 \cdot 0.459 \cdot 440^k = \underline{202^k}$

USGS Design Maps Summary Report

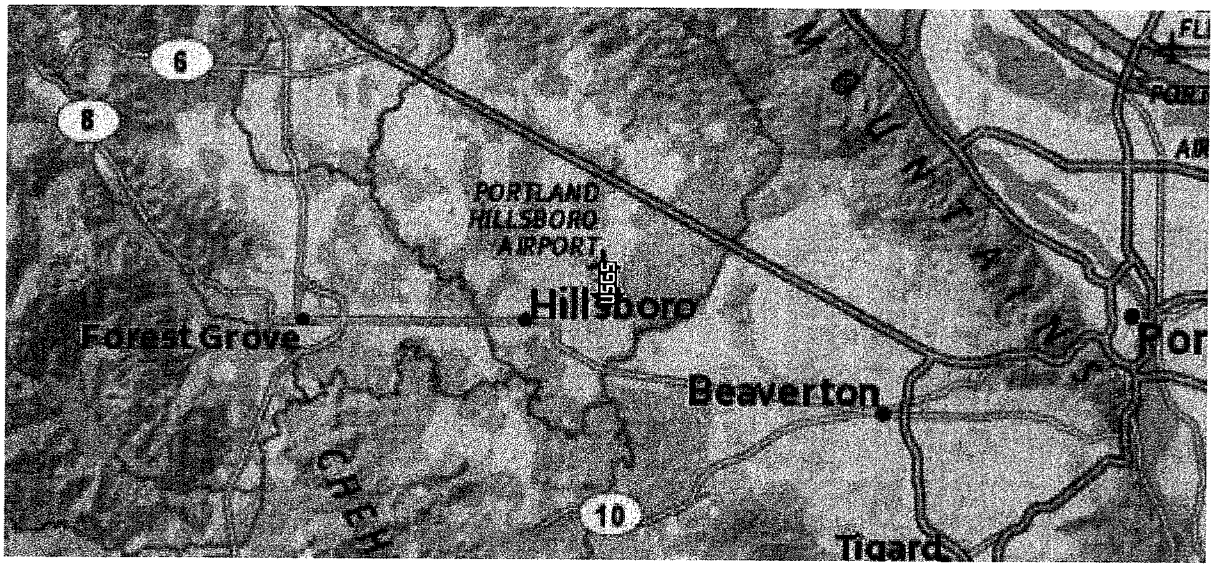
- TERMINAL BUILDING - 17028.00
- HILLSBORO AIRPORT - 5/5/17
SEISMIC EVALUATION

User–Specified Input

Building Code Reference Document ASCE 41-13 Retrofit Standard, BSE-1E
(which utilizes USGS hazard data available in 2008)

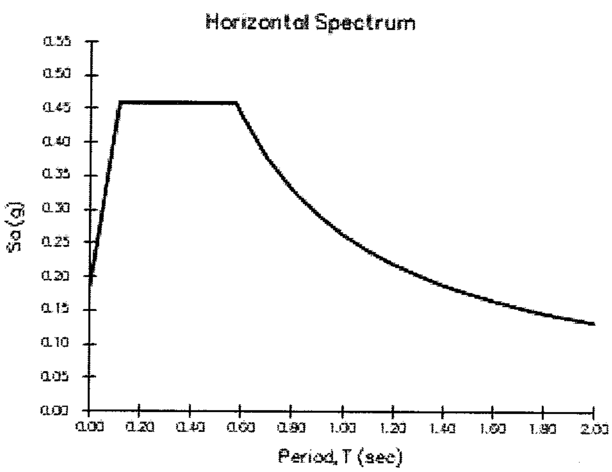
Site Coordinates 45.5331°N, 122.948°W

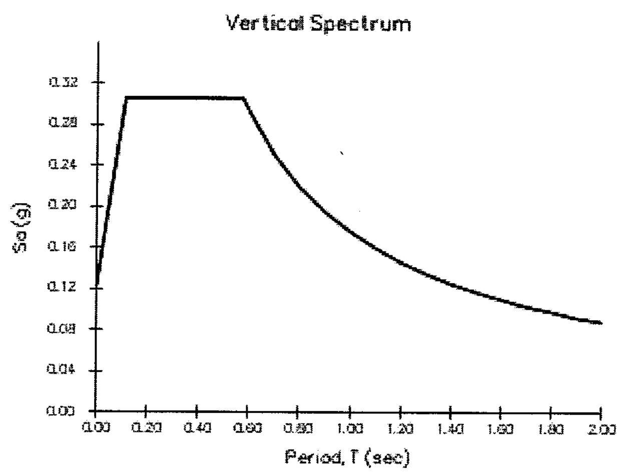
Site Soil Classification Site Class D – "Stiff Soil"



USGS–Provided Output

$S_{S,20/50}$	0.293 g	$S_{XS,BSE\text{-}1E}$	0.459 g
$S_{1,20/50}$	0.112 g	$S_{X1,BSE\text{-}1E}$	0.263 g





USGS Design Maps Summary Report

- TERMINAL BUILDING - 17028.00
- HILLSBORO AIRPORT SEISMIC EVALUATION - 5/5/17

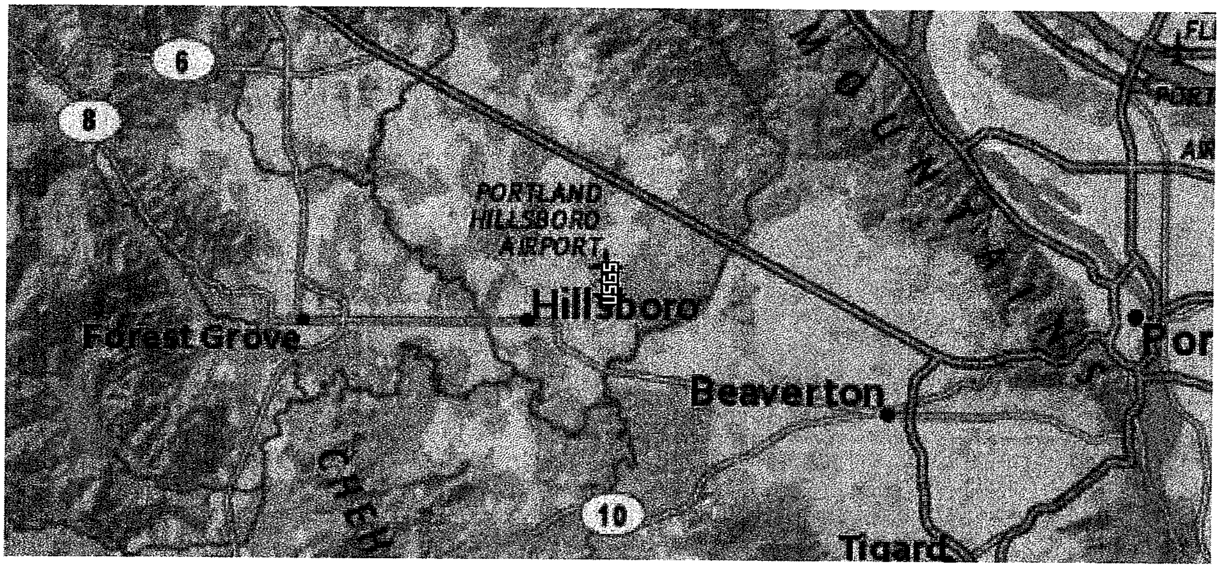
User–Specified Input

Building Code Reference Document ASCE 7-10 Standard
(which utilizes USGS hazard data available in 2008)

Site Coordinates 45.5331°N, 122.948°W

Site Soil Classification Site Class D – "Stiff Soil"

Risk Category I/II/III

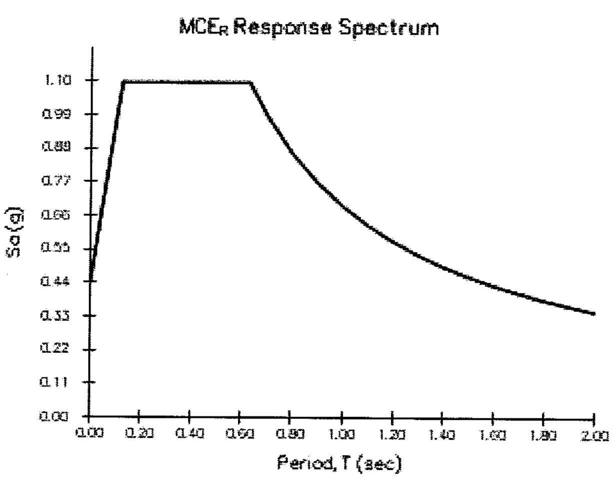


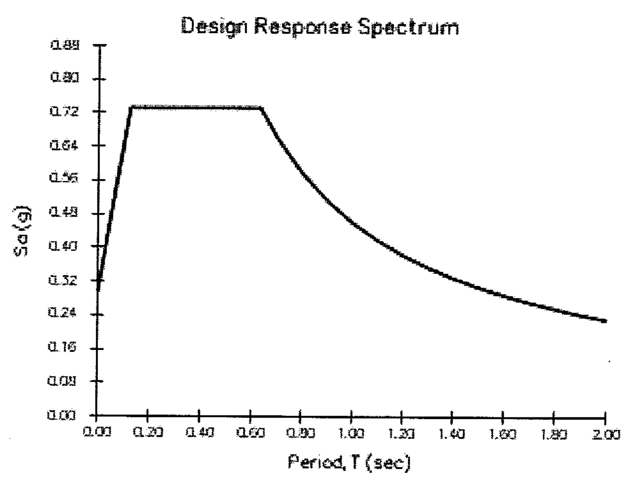
USGS–Provided Output

$S_S =$ 0.996 g $S_{MS} =$ 1.097 g $S_{DS} =$ 0.732 g

$S_1 =$ 0.446 g $S_{M1} =$ 0.693 g $S_{D1} =$ 0.462 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





For PGA_M, T_L, C_{RS}, and C_{R1} values, please view the detailed report.

TIER 1 CHECKLIST CALCS (CONT.)

- A.6.2.1 OVERTURNING $\frac{l_{min}}{ht} > 0.6 S_a$?

  $3.5'/13.5' = \underline{0.259} < \underline{0.276} = 0.6 \cdot 0.456 \Rightarrow$ <u>N.C.</u>

- A.3.2.2.1 SHEAR STRESS CHECK $v_j^{avg} < (100\text{ psi OR } 2\sqrt{f'_c})$

  $f'_c = 3000$ PSI (PER DWG) $2\sqrt{3000} = \underline{110 \text{ PSI}}$

  $v_j^{avg} = \frac{1}{m_s} \cdot \left(\frac{V_j}{A_w} \right)$ (EQ 4-9)

  $m_s = 2.0$ (TABLE 4-9)

  - CHECK 1ST FLOOR IN TRANSVERSE DIR. $V_j = 202^k$

  6" WALL LENGTH $= (15' \cdot 4) + (7.5' \times 2) + (3.5' \cdot 4) = 89'$

  $A_w = 89' \cdot 12''/' \cdot 6''$

  $v_j^{avg} = \frac{1}{2.0} \cdot \frac{202{,}000}{89' \cdot 12''/' \cdot 6''} = 15 \text{ PSI} << 110 \text{ PSI}$ ✓

  BY INSPECTION, TRANS (UPPER) & LONG (UPPER & FULL) RELATIVELY CLOSE TO 15 PSI ± $\Rightarrow$ THEREFORE $\Rightarrow$ <u>C.</u>

- A.3.2.2.2 REINF STEEL

  PER DWG WALLS w/ #5 @ 12 & #4 @ 12

  #4 @ 12 RATIO/FT $= 0.20 in^2 / 6'' \cdot 12'' = 0.003$

  $0.003 > 0.002 > 0.0012$ $\Rightarrow$ <u>C.</u>

  (0.002 = horiz min; 0.0012 = vert min)

TIER 1 CHECKLIST CALCS (CONT.)

- A.5.1.1 WALL ANCH. @ FLEX. DIA.

→ CROSS GRAIN BENDING WOOD LEDGER FAILURE BY INSPECTION ⇒ N.C.

$T = \psi S_{XS} w_p A_p$ (EQ 4-13)

$\psi = 1.8$ $S_{XS} = 0.459$

$w_p = 150\ PCF \cdot 0.5'$

$A_p = 13.5'$ (@ 2ND FLR) PER

$T_2 = 1.8 \cdot 0.459 \cdot \frac{150}{2} \cdot 13.5 = 837\ PLF$

- A.3.2.2.4 OVERTURNING

MAX SW RATIO 4:1

LARGEST RATIO = $13.5'/3.5' = 3.9 < 4$ ✓ C.

- A.3.2.2.7 WALL THICKNESS

MIN THICKNESS = $\frac{H_{BRACED}}{25}$

6" & 7" WALLS ⇒ N.C.

$13.5'/25 = 6.5''$ MIN