Oregon Department of Environmental Quality

Seismic Vulnerability Assessment Forms

Form 8: Fire Detection and Suppression

1. A site-specific Fire Protection Assessment shall be prepared by a registered engineer or a competent fire protection professional. The assessment shall consider all of the hazards and risks associated with the facility, and shall include but not be limited to, the elements of pre-fire planning, goals, resources, organization, strategy and tactics, including the following: **(FDS1)**
2. The characteristics of the entire facility (e.g. tanks, marine terminals, pipeline systems, etc.)
3. Product types, and any other flammables, corrosive or toxic chemicals at the facility and fire scenarios
4. Possible collateral fire damage to adjacent facilities
5. Fire-fighting capabilities, including the availability of water (flow rates and pressure), foam type and associated shelf life, proportioning equipment, and vehicular access.
6. Justify the selection of appropriate extinguishing agents.
7. Calculation of water and foam capacities, as applicable, consistent with area coverage requirements.
8. Coordination of emergency efforts (company and external fire departments)
9. Emergency escape routes for both personnel safety and required external fire department vehicles.
10. Requirements for fire drills, training of all personnel, and the use of non-fixed equipment.
11. Life safety, safe egress, and denoted safety zone areas available to all personnel.
12. Rescue for personnel (if an oil terminal includes vessel personnel).
13. Sufficient cooling water for pipelines and valves exposed to the heat (internal to the facility or outside).
14. Contingency planning when supplemental fire support is not available. What are the mutual aid agreements and are they sufficient.
15. Consideration of adverse conditions, such as electrical power failure, steam failure, fire pump failure, an earthquake or other damage to the fire water system.
16. Provide the date of the assessment and schedule to review/update. This assessment must be updated in accordance with OAE 340-300-0003.

For Marine Oil Terminals

	QUESTION	RESPONSE	
FDS2	Is there a common or separate fire system for each berthing system? Are there any firewalls?		
FDS3	Is all existing fire protection equipment shown on an equipment layout drawing? Identify by drawing number(s).		
FDS4	Are fire water pipelines shown on P&IDs or "as-built" drawings? Identify diagram or drawing number(s)		
HAZARD ASSESSMENT AND RISK ANALYSIS			
FDS5	Have the following items been field verified (location and condition) to ensure operability: a) Water supply? b) Fire pumps? c) Fire water jockey pumps? d) Hydrant locations? e) Foam supply? f) Wheeled extinguishers? g) Portable extinguishers? h) Hose connections? i) Hose storage stations? j) Fire alarm pull stations? k) Fire Detector(s) l) Fire monitors? m) Fire boat connections? n) International Shore Connection? Note leakage, physical damage, or corrosion. Summarize any deficiencies or recommendations.	a) b) c) d) e) f) g) h) i) j) k) l) m) n)	
FDS6	Are all fire water pumps inspected, maintained, and tested per NFPA-25?		
FIRE PREVENTION			
Ignition source control			
FDS7	Describe how the terminal protected from static electricity, lightning, and stray currents (API 2003)		
FDS8	Verify that cargo manifolds and loading arms conform to electrical isolation requirements. Provide brief details		
FDS9	If the wharf structure is steel, is there an insulating flange that electrically isolates the pipeline on wharf from the first pipeline support on-shore? Are pipeline(s) electrically bonded to the wharf? [API 2003, Section 6.3]		
FDS10	If the wharf is concrete or timber, is the pipeline grounded either to the water or on shore? [API 2003, Section 6.3]		

	QUESTION	RESPONSE	
FDS11	If a multi-berth terminal, what is the distance between adjacent manifolds?		
EMERGENCY SHUTDOWN (ESD) SYSTEMS			
FDS12	Fill out the table below for ESD valves		
FDS13	What is the ESD effective time to stop the flow of oil after initiating closure action?		
FDS14	For ESD systems, are actuation stations located such that ESD can be initiated within 30 seconds of a shutdown order received on the wharf?		
FDS15	Are communications or control circuits synchronized for the simultaneous closure of the SIVs and the shutdown of the loading pumps?		
FDS16	Is there an alarm to indicate failure of the primary power source? Describe location.		
FDS17	Is there a secondary power source should the primary power source fail?		
FDS18	Is the automated ESD system tested periodically? Date of last test?		
FDS19	Are electrical, instrument, and control systems (i.e. ESD system), located within hazardous classified areas, protected from fire damage, if such equipment is used to activate equipment needed to control a fire or mitigate its consequences. Have API Pub 2218 guidelines been followed and the Oregon state electrical code?		
Emergency Shutdown (ESD) Valves			
FDS20	Are all ESD valves located near the dock manifold connection or loading arm? Describe location(s)?		
Shore Isolation Valves (SIVs)			
FDS21	Fill out the table below for SIVs.		
FDS22	Are all SIVs for each cargo line located on shore and clustered together?		
FDS23	Are SIVs clearly marked with the identification of each associated pipeline?		
FDS24	Is there adequate lighting to identify and manually operate the SIVs?		
FDS25	Is there a manual reset to restore the SIV system after shutdown?		

	QUESTION	RESPONSE	
FDS26	Are thermal expansion relief valves installed to relieve pressure from a blocked-in offshore segment of the pipeline when the SIV is in the closed position?		
AUTOMATED FIRE DETECTION SYSTEM			
FDS27	Does the MOT have a permanently installed automated fire detection or sensing system?		
FDS28	Are fire (flame, heat, or smoke) sensors installed in all enclosed spaces within classified areas?		
FDS29	Is each fire detection system of the manual reset type?		
FDS30	Is each fire-detection system capable of continuous monitoring?		
FDS31	Do detection devices automatically initiate ESD?		
FDS32	Is there periodic testing of the detection system? When last tested?		
FDS33	Are fire detection system specifications available and have these been verified by the audit team?		
FIRE ALARMS			
FDS34	Are there automatic and manual fire alarm-initiating devices at strategic locations?		
FDS35	Are triggered alarms visible and audible by all MOT and vessel personnel involved in transfer operations?		
FDS36	During a triggered MOT fire alarm, is the alarm also visually and audibly displayed at the facility's control center?		
FDS37	Is the fire alarm system integrated with the ESD system?		
FDS38	Is the alarm system tested per NFPA-72? When last tested?		
FDS39	Are fire alarm system manufacturer maintenance and testing requirements available and have these been complied with and verified by the audit team?		
FIRE SUPPRESSION			
FDS40	Is the firewater flow rate consistent with the requirements of Table 19.1 of ISGOTT (International Safety Guide for Oil Tankers and Terminals)? (Table repeated in PIANC WG 253B, “Recommendations for the Design and Assessment of Marine Oil, Gas and Petrochemical Terminals”, 2022)		

	QUESTION	RESPONSE	
FDS41	Field verify fire pump capacity and pressure ratings and compare to the latest pump flow test results. Do pump ratings and test results match? Any recommendations? Provide the latest flow test results in audit report and reference here.		
FDS42	Verify that water-based fire protection systems have been maintained by the MOT operator per NFPA-25.		
FDS43	For diesel-powered pumps, field verify the following: a) Fuel tank at least 2/3 full. b) Battery electrolyte level is within acceptable range. c) Crankcase oil is within acceptable range. Coolant level is within acceptable range. Note observation results. [NFPA-25]	a) b) c) d)	
FDS44	For seawater drafting pumps, field verify that pump suction is free from marine growth and other obstructions. Note observation results.		
FDS45	Is a standby fire pump available? If so, describe.		
	COVERAGE		
FDS46	Does the fire suppression include coverage for: a) Marine structures (pier, wharf, or approach trestle)? b) Terminal cargo manifold? c) Vessel manifold? d) Cargo transfer systems? e) Sumps? f) Pipelines? g) Control stations? Summarize any deficiencies or recommendations.	a) b) c) d) e) f) g)	
	FIRE HYDRANTS		
FDS47	What is the maximum separation distance between hydrants?		
FDS48	Is the facility currently accessible to fire trucks and mutual aid equipment? Are firewater connections accessible to fire trucks or mutual aid equipment? Describe access locations.		
FDS49	Do hoses and monitors have the capability of applying two independent water streams to cover the cargo manifold, transfer system, vessel manifold and sumps?		

	QUESTION	RESPONSE	
FIREWATER			
FDS50	If there is a wet system, is it pressurized?		
FDS51	Does the terminal have a pump-in point for firefighting vessels and trucks to augment the fire water supply to the shore fire main grid?		
FDS52	Are pump-in-points located at a safe distance from high-risk areas, such as sumps, manifolds, loading arms, etc.?		
FOAM SUPPLY			
FDS53	Have calculations as to aqueous film forming foam (AFFF) type, flow rates, and application duration been verified by the audit team?		
FDS54	Record AFFF type, quantity, and location.		
FDS55	Is AFFF proportioning equipment located at least 100 feet from sumps, manifolds and loading arms?		
FDS56	Is a facility program/procedure in place to ensure that AFFF is replaced consistent with the manufacturer's recommendations? Date of last AFFF replacement?		
FIRE MONITOR SYSTEMS			
FDS57	Can all monitors be oscillated and moved throughout their full range? [NFPA-25]		
FDS58	Is AFFF educator tubing and its connection to monitors, free from obstructions and in good serviceable condition?		
FDS59	Are monitors located to provide an unobstructed path between the monitor and the target area?		
FDS60	What is the maximum vessel manifold height (ballast draft, high tide) above the MOT deck?		
FDS61	If the maximum vessel manifold height is greater than 30 feet above the wharf deck, are the monitors raised?		
FDS62	Are there sprinklers and/or remotely controlled water/foam monitors to protect personnel, escape routes, shelter locations and the fire water system?		
FDS63	Are there isolation valves in the firewater and foam lines, and are the isolation valves at least 150 feet from the manifold and loading arm/hose area?		

	QUESTION	RESPONSE	
SUPPLEMENTAL FIRE SUPPRESSION SYSTEMS			
FDS64	Is supplemental fire suppression necessary to meet minimum suppression requirements?		
FDS65	If yes, does it provide less than 25% of the fire water/foam requirements of the Fire Protection Assessment?		
FDS66	How much time from the activation of the fire alarm does it take for supplementary resources to arrive?		
FDS67	Is there a contingency wherein the supplemental fire/foam resource is not available? Is this considered in the Fire Protection Assessment?		

For LNG Facilities (NFPA 59A, Chapter 12 “Fire Protection, Safety and Security”)

(FD68) The extent of such protection shall be determined by an evaluation based on fire protection engineering principles, analysis of local conditions, hazards within the facility, and exposure to or from other property. The evaluation shall determine the following (Section 12.2.1):

1. The type, quantity, and location of equipment necessary for the detection and control of fires, leaks, and spills of LNG, flammable refrigerants, or flammable gases,

2. The type, quantity, and location of equipment necessary for the detection and control of potential non-process and electrical fires,

3. The methods necessary for the protection of the equipment and structures from the effects of fire exposure,

4. Requirements for fire protection water systems,

5. Requirements for fire-extinguishing and other fire control Equipment,

6. The equipment and processes to be incorporated within the ESD system, including analysis of subsystems, if any, and the need for depressurizing specific vessels or equipment
    a. during a fire emergency,

7. The type and location of sensors necessary to initiate the automatic operation of the ESD system or its subsystems,

8. The availability and duties of individual plant personnel and the availability of external response personnel during an emergency,

9. The protective equipment, special training, and qualification needed by individual plant personnel as specified by NFPA 600, Standard on Industrial Fire Brigades, for their respective emergency duties,

10. Requirements for other fire protection equipment and systems,

Fire and Leak Detection (Section 12.4) Areas, including enclosed buildings, that can have the presence of flammable gas, LNG or flammable refrigerant spills, and fire shall be monitored as required by the evaluation in Section 12.2.1. **(FDS69)**

Gas Detection (Section 12.4.2.1,2) Continuously monitored low-temperature sensors or flammable gas detection systems shall sound an alarm at the plant site and at a constantly attended location if the plant site is not attended continuously. Flammable gas detection systems shall activate an audible and a visual alarm at not more than 25 percent of the lower flammable limit of the gas or vapor being monitored. **(FDS70)**

Fire Detection (Section 12.4.3.1,2,4) Fire detectors shall activate an alarm at the plant site and at a constantly attended location if the plant site is not attended continuously. If so, determined by an evaluation in accordance with 12.2.1, fire detectors shall be permitted to activate portions of the ESD system. The detection systems shall be designed, installed, and maintained in accordance with NFPA 72, National Fire Alarm and Signaling Code. **(FDS71)**

Fire Protection Water Systems. (Section 12.5) A water supply and a system for distributing and applying water shall be provided for protection of exposures; for cooling containers, equipment, and piping; and for controlling unignited leaks and spills, unless an evaluation in accordance with 12.2.1 determines that the use of water is unnecessary or impractical. The fire water supply and distribution systems, if provided, shall simultaneously supply water to fixed fire protection systems, including

monitor nozzles, at their design flow and pressure, involved in the maximum single incident expected in the plant plus an allowance of 1000 gpm (63 L/sec) for hand hose streams for at least 2 hours. **(FDS72)**

Fire Extinguishing and Other Fire Control Equipment. (Section 12.6) Portable or wheeled fire extinguishers shall be recommended for gas fires by their manufacturer. Portable or wheeled fire extinguishers shall be available at strategic locations, as determined in accordance with 12.2.1, within an LNG facility and on tank vehicles. Portable and wheeled fire extinguishers shall conform to the requirements of NFPA 10, Standard for Portable Fire Extinguishers. Handheld portable dry chemical extinguishers shall contain minimum nominal agent capacities of 20 lb. (9 kg) or greater and shall have a minimum 1 lb./sec (0.45 kg/sec) agent discharge rate. For facility hazard areas where minimal class “A” fire hazards are present, the selection of potassium bicarbonate–based dry chemical extinguishers is recommended. Wheeled portable dry chemical extinguishers shall contain minimum nominal agent capacities of 125 lb. (56.7 kg) or greater and shall have a minimum 2 lb./sec (0.90 kg/sec) agent discharge rate. If provided, automotive and trailer-mounted fire apparatus shall not be used for any other purpose. Fire trucks shall conform to NFPA 1901, Standard for Automotive Fire Apparatus. Automotive vehicles

assigned to the plant shall be provided with a minimum of one portable dry chemical extinguisher having a capacity of not less than 18 lb. (8.2 kg). **(FDS73)**

Maintenance of Fire Protection Equipment. (Section 12.7) Facility operators shall prepare and implement a maintenance program for all plant fire protection equipment. **(FDS74)**

Personnel Safety. (Section 12.8) Protective clothing that will provide protection against the effects of exposure to LNG shall be available and readily accessible at the facility. Employees who are involved in emergency response activities shall be equipped with protective clothing and equipment and trained in accordance with NFPA 600, Standard on Industrial Fire Brigades. Written practices and procedures shall be developed to protect employees from the hazards of entry into confined or hazardous spaces. At least three portable flammable gas indicators shall be readily available. **(FDS75)**

From 49 CFR 193 for LNG facilities

Fire Protection (49 CFR 193.2611) (FDS76)

a. Maintenance activities on fire control equipment must be scheduled so that a minimum of equipment is taken out of service at any one time and is returned to service in a reasonable period of

b. Access routes for movement of fire control equipment within each LNG plant must be maintained to reasonably provide for use in all weather conditions.

Protective enclosures (49 CFR 193.2905)(FDS77)

The following facilities must be surrounded by a protective enclosure:

1. Storage tanks
2. Impounding systems
3. Vapor barriers
4. Cargo transfer systems
5. Control rooms and stations
6. Control systems
7. Fire control equipment
8. Security communications systems
9. Alternative power sources

The protective enclosure may be one or more separate enclosures surrounding a single facility or multiple facilities.

Ground elevations outside a protective enclosure must be graded in a manner that does not impair the effectiveness of the enclosure.

Protective enclosures may not be located near features outside of the facility, such as trees, poles, or buildings, which could be used to breach the security.

At least two accesses must be provided in each protective enclosure and be located to minimize the escape distance in the event of emergency.

Each access must be locked unless it is continuously guarded. During normal operations, an access may be unlocked only by persons designated in writing by the operator. During an emergency, a means must be readily available to all facility personnel within the protective enclosure to open each access.

The ESD System (NFPA 59A, Section 12.3) (FDS78)

1. Each LNG facility shall have an ESD system(s) to isolate or shut off a source of LNG, flammable liquids, flammable refrigerant, or flammable gases, and shut down equipment whose continued operation could add to or sustain an emergency.
2. Valves, control systems, and equipment required by the ESD system shall not be required to duplicate valves, control systems, and equipment installed to meet other requirements of the standard where multiple functions are incorporated in the valves, control systems, and equipment. The valves, control systems, and equipment shall meet the requirements for ESD systems.
3. If equipment shutdown will introduce a hazard or result in mechanical damage to equipment, the shutdown of any equipment or its auxiliaries shall be omitted from the ESD system if the effects of the continued release of flammable or combustible fluids are controlled.
4. The ESD system(s) shall be of a fail-safe design or shall be otherwise installed, located, or protected to minimize the possibility that it will become inoperative in the event of an emergency or a failure at the normal control system.
5. ESD systems that are not of a fail-safe design shall have all components that are located within 50 ft (15 m) of the equipment controlled in either of the following ways:
    a. Installed or located where they cannot be exposed to a fire
    b. Protected against failure due to a fire exposure/heat for at least 10 minutes duration
    c. Operating instructions identifying the location and operation of emergency controls shall be posted in the facility area.
    d. Manual actuators shall be located in an area accessible in an emergency, shall be at least 50 ft (15 m) from the equipment they serve and shall be marked with their designated function.

The ESD System shall be automatically activated when any of the following occur: **(FDS79)**

1. The detection of an abnormal operating condition by pressure sensors in the inlet and outlet systems or in the process systems. The detection of fire on the terminal
2. The detection of flammable gas concentration at 60% of the lower explosive limit

ESD system components that are exposed to fire or cryogenic effects shall be evaluated to confirm that the actuators will not be impaired by the potential exposures thereby preventing the components to fail to a safe position. **(FDS80)**

For Tank Farms

Verify that the following types of fires are addressed in the fire assessment plan: **(FDS81)**

1. Rim seal fires: Rim seal fires frequently occur in tanks with a floating roof and can be quickly extinguished using stationary systems, provided they are promptly detected. If a fire persists longer, the seal may be damaged and cause an oil spill, posing the risk of an extensive fire. This damage or excess use of water may sink the floating roof and create a full-surface fire.
2. Fires caused by vapors: Vapors may leak during the storage of petrochemical liquids and are at risk of catching fire (e.g., lightning).
3. Embankment: Tank farms are usually encompassed by a sealed embankment, dike or bund area or stand inside a pond to contain leaking fluids. Leaks from valves and associated equipment can catch fire within the bund area. Likewise, liquids may catch fire if they unexpectedly leak from the tank.
4. Explosion: Since explosions can damage stationary extinguishing systems, mobile backup solutions should be incorporated in the fire protection plan.
5. Boilover: A boilover is a result of prolonged crude oil tank fires where trapped water quickly evaporates, resulting in a fireball.
6. Full-surface tank fire: In extreme cases, the floating roof can sink and catch fire, causing a full-surface tank fire to quickly develop, which requires fixed foam monitors and mobile solutions to extinguish.
7. The fire plan and specifics must comply with the Oregon State Fire Marshall regulations and NFPA 15 “Standard for Spray Fixed Systems for Fire Protection”, 2017.

For all tanks, including but not limited to petroleum products, LNG, and firewater, check each connecting pipeline, stairways or other attachments for DE level seismic displacement. If seismic displacement as a result of required analyses exceeds the capacity of the connection/pipeline, then this condition must be addressed. **(FDS82)**

For buildings or building-like structures:

For building or building-like structures, the fire protection system must satisfy local building codes (ASCE7, Section 1.3.7). All piping/tubing sections for fire suppression/sprinkler systems must satisfy the seismic relative displacements (ASCE7 Section 13.6.8). Support of the systems must conform to NFPA 13. If the structure is within the hazardous area and not

pressurized, components must comply with intrinsically safe specifications (e.g. microwaves, heaters, etc.) **(FDS83)**

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