



Seismic Vulnerability Assessment Forms

Form 9: Control Equipment OAR 340-300-0003 (f) (F)

General steps for assessment of all control systems at all facilities based on ASCE7, Section 13:

1. Verify that the anchorage for all control equipment meets the requirements of ASCE7, Section 13.4. **(CON1)**
2. All electrical/control equipment must have latches so that they stay closed (ASCE7, Section 13.6.3). **(CON2)**
3. All cables connected to the control systems must facilitate all possible seismic displacement (ASCE7 Section 13.6.4). **(CON3)**

Steps based on *Seismic Evaluation and Design of Petrochemical and other Industrial Facilities*, ASCE, 3rd edition, 2020, Section 6.5:

4. Control panels and systems relays and other trip-sensitive equipment should be qualified to function during or after an earthquake. **(CON4)**
5. Analyze control systems for susceptibility to impact or excessive displacements. **(CON5)**
6. If control equipment is required to function during or after the SSE (DE), it should be inspected and any vulnerabilities assessed. Verify that there would be no pounding between adjacent control boxes and systems. **(CON6)**
7. Within internal control systems, verify that the individual components are firmly anchored and will not displace during the earthquake. **(CON7)**
8. Battery racks that support control equipment should be structurally sound and be able to resist transverse and lateral loads. **(CON8)**
9. Control panels often contain components on rollers or slides. Verify that these have stops or restraints to remain in place during and after an earthquake. **(CON9)**
10. Design control equipment should be designed for anchorage for resistance to the DE (SSE). **(CON10)**
11. Batteries should be restrained from falling off racks and should have a spacer so that there is no sliding. **(CON11)**
12. Overhead equipment should be clear of batteries and control equipment to minimize the potential for falling damage. **(CON12)**
13. Control panels should be inspected for trip-sensitive devices, such as relays. Their functionality and requirements to operate during and after the SSE(DE) should be verified. **(CON13)**

Assessment of LNG Tanks and Pipeline Control Systems (some of these are applicable to all control systems) based on NFPA 59A, Section 12.2 thru 12.9 unless noted otherwise:

14. Emergency Shutdown Systems shall comply with API RP 14C and Section 12.3 to shut down the flow of LNG to or from the tank and shut down equipment whose continued operation could add or prolong an emergency event. The system must be failsafe, and protected or located to prevent the possibility that it becomes inoperable in an emergency. If exposed to fire, control systems must be evaluated to remain operational. **(CON14)**
15. Critical supports/equipment within the cryogenically exposed areas shall be provided with cryogenic insulation and passive fire protection, sufficient for the incident duration (NFPA 59A, Section 10.6). **(CON15)**
16. If the shutdown system may create an additional hazard or mechanical problem, that portion of the system may be omitted from the automated ESD, but this should not affect the controlled shutdown of LNG or flammable fluids (CSA Z276-22, Section 12.2.2). **(CON16)**
17. Buildings housing process or control equipment must have a protective enclosure enclosing all control equipment (NFPA 59A 12.9.3). **(CON17)**
18. Operating instructions identifying the location of emergency controls shall be posted conspicuously (NFPA 59A 13.2.4). **(CON18)**
19. From NFPA 59A, Section 9.4.2 – Valve controls under icing conditions – must be able to maintain operability, storage, and vaporization facilities shall be designed so that, in the event that power or instrument air failure occurs, the system will proceed to a fail-safe condition that is maintained until the operators can act either to reactivate or to secure the system. **(CON19)**
20. 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 to shut down equipment whose continued operation could add to or sustain an emergency. **(CON20)**
21. 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. **(CON21)**
22. 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. **(CON22)**
23. 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. **(CON23)**
24. 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: **(CON24)**
 - i. Installed or located where they cannot be exposed to a fire
 - ii. Protected against failure due to a fire exposure of at least 10 minutes.
25. 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. **(CON25)**
26. At LNG facilities, there shall be a protective enclosure including a peripheral fence, building wall, or natural barrier enclosing major facility components, such as the following: **(CON26)**
 - i. LNG storage containers
 - ii. Flammable refrigerant storage tanks
 - iii. Flammable liquid storage tanks
 - iv. Other hazardous materials storage areas
 - v. Outdoor process equipment areas
 - vi. Buildings housing process or control equipment
 - vii. Onshore loading and unloading facilities
27. From Section 13.15 Container Instrumentation - Instrumentation for LNG facilities shall be designed so

that, in the event of power or instrument air failure, the system will go into a fail-safe condition that can be maintained until the operators can take action to reactivate or secure the system. **(CON27)**

28. From Section 13.18.4.5 Each facility operator shall ensure that a control system that is out of service for 30 days or more is tested prior to its return to service, to ensure that it is in proper working order. **(CON28)**

- i. Each facility operator shall ensure that the inspections and tests in this section are carried out at the intervals specified.
- ii. Control systems that are used seasonally shall be inspected and tested before use each season.
- iii. Control systems that are used as part of the fire protection system at the facility shall be inspected and tested in accordance with the applicable fire codes and standards.

29. From Section 14.8.10.4 - Control systems that are used as part of the fire protection system at the LNG plant shall be inspected and tested in accordance with the applicable local fire code and conform to four items listed with various NFPA references. **(CON29)**

From 49 CFR 193

30. **From 49 CFR 193.2441 - the facility** must have a control center from which operations and warning devices are monitored as required by this part. A control center must have the following capabilities and characteristics: **(CON30)**

- i. It must be located apart or protected from other LNG facilities so that it is operational during a controllable emergency.
- ii. Each remotely actuated control system and each automatic shutdown control system required by this part must be operable from the control center.
- iii. Each control center must have personnel in continuous attendance while any of the components under its control are in operation unless the control is being performed from another control center that has personnel in continuous attendance.
- iv. If more than one control center is located at an LNG Plant, each control center must have more than one means of communication with each other center.
- v. Each control center must have a means of communicating a warning of hazardous conditions to other locations within the plant frequented by personnel.

31. From CFR 49 193.2445 Sources of power **(CON31)**

- i. Electrical control systems, means of communication, emergency lighting, and firefighting systems must have at least two sources of power which function so that failure of one source does not affect the capability of the other source.
- ii. Where auxiliary generators are used as a second source of electrical power, they must be located apart or protected from components so that they are not unusable during a controllable emergency and fuel supply must be protected from hazards.

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