

American Lifelines Alliance Matrix of Standards and Guidelines for Natural Hazards

OIL PRODUCTS SYSTEMS		NATURAL HAZARD PROVISIONS ⁸		
COMPONENT	GUIDE/STANDARD ¹	LOADING	DESIGN	EXISTING ⁷
System Reliability ⁶				
Buried Pipelines	ASME/ANSI B31.4 ASCE TCLEE 1984	none ² earthquake	none earthquake	●
Aboveground Piping	ASME/ANSI B31.4 ASME/ANSI B31.3 API 2510 API 2508 ASCE TCLEE 1984	none ² none ² earthquake	none earthquake, wind, ice	●
Pumping Station Piping	ASME/ANSI B31.3 ASME/ANSI B31.4 API 2510 ASCE TCLEE 1984	none ² none ² earthquake	earthquake, wind, ice none	●
Well Facilities	ASME/ANSI B31.4 ASME/ANSI B31.3 API RP 14E	none ² none ²	none earthquake, wind, ice	
Refineries	API 2508 ASCE Petrochem ASME/ANSI B31.3 ASME BPV ³	earthquake, wind none ² none ²	earthquake, wind earthquake, wind, ice earthquake, wind, ice	●
Storage Tanks	API 620 API 650 NFPA 59 API 2508 ASCE TCLEE 1984	earthquake, wind earthquake, wind earthquake	earthquake, wind earthquake, wind	● ● ● ●

NATURAL GAS SYSTEMS		NATURAL HAZARD PROVISIONS ⁸		
COMPONENT	GUIDE/STANDARD ¹	LOADING	DESIGN	EXISTING ⁷
System Reliability ⁶				
Buried Pipelines	ASME/ANSI B31.8 PRCI (2000) ASCE TCLEE 1984	none ² earthquake earthquake	none earthquake earthquake	● ●
Aboveground Piping	ASME/ANSI B31.3 ASME/ANSI B31.8 ANSI Z223.1 NFPA 54, SGC, IFGC ASCE TCLEE 1984	none ² none ² none ² none ² earthquake	earthquake, wind, ice none	●
Compressor Station Piping	ASME/ANSI B31.3 ASME/ANSI B31.8 ASCE TCLEE 1984	none ² none ² earthquake	earthquake, wind, ice none none	●
Well Facilities	ASME/ANSI B31.8 API RP 14E	none ²	none	
LNG Facilities				
System Reliability ⁶	NFPA 59A NFPA 59A	earthquake earthquake	earthquake earthquake	
Piping	API 620	earthquake, wind	earthquake, wind	
Storage Tanks	API 650 ASME BPV ³ NFPA 59A ASCE 1984	earthquake, wind earthquake, wind earthquake, ref. ANSI A58.1 for wind and snow earthquake	earthquake, wind earthquake, wind, ice earthquake, ref. ANSI A58.1 for wind and snow earthquake	● ● ● ●

WATER SYSTEMS (Potable & Raw)		NATURAL HAZARD PROVISIONS ⁸		
COMPONENT	GUIDE/STANDARD ¹	LOADING	DESIGN	EXISTING ⁷
System Reliability ⁶				
Buried Pipelines	AWWA M11 ASCE TCLEE 15	none ² earthquake	none earthquake	●
Aboveground Pipelines	ASME/ANSI B31.3	none ²	earthquake, wind, ice	
Pumping Plants	ASME B31.3	none ²	earthquake, wind, ice	
Storage Tanks	ACI 350 AWWA D ⁵ ASCE 1984	earthquake earthquake, wind, snow earthquake	earthquake earthquake, wind, snow earthquake	● ● ●
Well Facilities				
Canals				

WASTE WATER SYSTEMS		NATURAL HAZARD PROVISIONS ⁸		
COMPONENT	GUIDE/STANDARD ¹	LOADING	DESIGN	EXISTING ⁷
System Reliability ⁶				
Buried Pipelines	AWWA M11 ASCE TCLEE 15	none ² earthquake	none earthquake	●
Aboveground Pipelines	ASME/ANSI B31.3	none ²	earthquake, wind, ice	
Treatment Plants	ASME B31.3 WEF	none ² earthquake, flood	earthquake, wind, ice	● ●
Storage Tanks	ACI 350 AWWA D ⁵ ASCE 1984	earthquake earthquake, wind, snow earthquake	earthquake earthquake, wind, snow earthquake	● ● ●

ELECTRIC POWER SYSTEMS		NATURAL HAZARD PROVISIONS ⁸		
COMPONENT	GUIDE/STANDARD ¹	LOADING	DESIGN	EXISTING ⁷
System Reliability ⁶				
Substations	IEEE-693 RUS 1724e ⁴ ASCE Manual 96	earthquake wind, ice, earthquake earthquake	earthquake wind, ice, earthquake earthquake	● ● ●
Transmission Towers & Poles	ASCE-10* ASCE Manual 72* ASCE Manual 74 ASCE Manual 91* ASCE Concrete Poles* PCI Prest. Conc. Poles ¹ RUS 1724e ⁴ IEEE 605 ³ IEEE 691 ¹ IEEE 693 NESC	wind, ice, earthquake wind, ice, earthquake wind, ice, earthquake ² wind, ice, earthquake wind, ice, earthquake wind, ice, earthquake wind, ice, earthquake wind, ice, earthquake none earthquake wind, ice, earthquake	wind, ice, earthquake wind, ice wind, ice wind, ice, earthquake wind, ice, earthquake wind, ice, earthquake wind, ice, earthquake wind, ice, earthquake none none earthquake wind, ice	● ● ● ● ● ● ● ● ● ● ● ● ● ● ●
Distribution Poles	NESC RUS 160-2 ¹	wind, ice, earthquake wind, ice, earthquake	wind, ice wind, ice, earthquake	● ●
Buried Conduits				

TELECOMMUNICATION SYSTEMS		NATURAL HAZARD PROVISIONS ⁸		
COMPONENT	GUIDE/STANDARD ¹	LOADING	DESIGN	EXISTING ⁷
System Reliability ⁶				
Towers, Masts and Poles	TIA/EIA 222G (2003) TIA/EIA 222F	earthquake, wind, ice wind, ice	earthquake, wind, ice wind, ice	● ●
Buried Cables	Bell Core	earthquake, flood	earthquake, flood	
Underwater Cables				
Aboveground Cables	Bell Core	earthquake, wind, ice, snow	Earthquake, wind, ice, snow	
Switching Equipment	Bell Core	earthquake, fire	earthquake, fire	
Cable Trays	SMACNA BSP (Bell System Practices) ASCE 7	none none	earthquake earthquake	
		earthquake, wind, ice, snow	earthquake, wind, ice, snow	

PORTS AND INLAND WATERWAYS		NATURAL HAZARD PROVISIONS ⁸		
COMPONENT	GUIDE/STANDARD ¹	LOADING	DESIGN	EXISTING ⁷
System Reliability ⁶				
Piers/Wharves	ASCE TCLEE 12 NCEL R-939 NAVFAC DM-25.1 ASCE TCLEE 12 NFESC TR-2069SHR	earthquake earthquake earthquake earthquake	earthquake	● ●
Breakwaters/Jetties	NCEL R-939 ASCE TCLEE 12	earthquake earthquake	earthquake earthquake	● ●
Sea Walls	NCEL R-939 ASCE TCLEE 12	earthquake earthquake	earthquake earthquake	● ●
Container Handling	ASCE-7 IBC, SBC, UBC ASCE TCLEE 12 AISC	earthquake, wind, snow, ice earthquake, wind, snow, ice earthquake none ²	earthquake, wind, snow, ice earthquake, wind, snow, ice earthquake earthquake, wind, snow, ice	●
Cargo Movement	ASCE-7 IBC, SBC, UBC ASCE-ASCE TCLEE 12	earthquake, wind, snow, ice earthquake, wind, snow, ice earthquake	earthquake, wind, snow, ice earthquake, wind, snow, ice earthquake	●
Marine Oil Terminals	CSLC NFESC, TR-2103-SHR ASCE-7 NFPA ⁴	earthquake earthquake earthquake, wind, snow, ice earthquake	earthquake earthquake earthquake, wind, snow, ice earthquake	

HIGHWAYS AND ROADS		NATURAL HAZARD PROVISIONS ⁸		
COMPONENT	GUIDE/STANDARD ¹	LOADING	DESIGN	EXISTING ⁷
System Reliability ⁶				
Bridges	FHWA 106 AASHTO CALTRANS FHWA-RD-94-052 FHWA 106	earthquake earthquake, wind, snow, ice, flood earthquake, wind, snow, ice, flood earthquake earthquake	earthquake, wind, snow, ice, flood earthquake earthquake	● ● ● ● ●
Embankments	CALTRANS	earthquake	earthquake	●
Road Beds				
Culverts	AASHTO CALTRANS	none ² none ²	none none	
Tunnels	AASHTO CALTRANS	none ² none ²	none none	
Retaining Walls	FHWA 106	earthquake	earthquake	
Signs	ASCE-7 IBC, SBC, UBC	earthquake, wind, snow, ice earthquake, wind, snow, ice	earthquake, wind, snow, ice earthquake, wind, snow, ice	

RAILROAD		NATURAL HAZARD PROVISIONS ⁸		
COMPONENT	GUIDE/STANDARD ¹	LOADING	DESIGN	EXISTING ⁷
System Reliability ⁶				
Bridges	AREMA Ch. 9 AREMA Ch. 7 AREMA Ch. 8 AREMA Ch. 9 AREMA Ch. 15	wind wind, ice earthquake wind	wind wind, ice earthquake wind	● ● ● ●
Embankments	AREMA Ch. 9	earthquake	earthquake	earthquake
Rails, Ties, and Ballast	AREMA Ch. 9	earthquake	earthquake	earthquake
Culverts	AREMA Ch. 9	earthquake	earthquake	earthquake
Tunnels	AREMA Ch. 9	earthquake	earthquake	earthquake
Signs	ASCE-7 IBC, SBC, UBC	earthquake, wind, snow, ice earthquake, wind, snow, ice	earthquake, wind, snow, ice earthquake, wind, snow, ice	

ELECTRICAL, MECHANICAL, AND ARCHITECTURAL COMPONENTS		NATURAL HAZARD PROVISIONS		
COMPONENT	GUIDE/STANDARD ¹	LOADING	DESIGN	EXISTING ⁷
Elect./Mech. Equip	ASCE-7 ASCE TCLEE 1984 ASME BPV ³ NFPA ¹ IBC, SBC, UBC SMACNA	earthquake, wind, ice earthquake none ² earthquake earthquake, wind earthquake	earthquake, wind, ice earthquake earthquake, wind earthquake earthquake, wind earthquake	● ● ● ●
Suspended Ceilings	IBC, SBC, UBC	earthquake	earthquake	●
Elevated Floors				

NOTES

- Documents in **bold italics** indicate that the guidelines were not produced by a consensus process as defined for SDO's approved by the American National Standards Institute
- "none" applies if a guideline or standard does not specifically identify how loads are to be obtained; if a group of standards is referenced, the natural hazard listed may be only covered in one document
- ASME BPV refers to the ASME Boiler and Pressure Vessel Code that typically governs the design of all pressurized containers
- NFPA refers to various NFPA standards governing fire protection systems
- AWWA D refers to various AWWA standards governing water storage tanks
- "System Reliability" is a component of design referring to practices that are specifically developed to provide reasonable assurance that consequences of a natural hazard on system service will meet the goals established by stakeholders (owners, operators, regulators, insurers, customers, and users). Consequences are defined by multiple performance requirements but typically include impact on public safety, duration of service interruption, and costs to repair damage.
- Existing** indicates that analysis or design procedures (NOT LOADS) could be applied for existing components
- Loading** refers to whether or not specific loads for various natural hazards are defined; "Design" refers to the existence of design and/or analysis procedures that account for loads arising from natural hazards

ALA Manmade Hazards Matrix Summary

ELECTRIC POWER		MANMADE HAZARD PROVISIONS		
COMPONENT	GUIDE/STANDARD	LOADING	DESIGN	EXISTING
System Reliability	§ Ø	Radiological, Blast, Cyber	Biological, Blast, Cyber	
Transmission Towers	Ø	Blast	Blast	
Distribution Poles	Ø	Blast	Blast	
Buried Conduits	Ø	Radiological	Radiological	
Substations	IEEE (1) §	Chemical	Radiological	
	Ø	Radiological		
Elect./Mechanical Equipment	Ø	Radiological, Cyber	Radiological, Cyber	

WASTEWATER SYSTEMS		MANMADE HAZARD PROVISIONS		
COMPONENT	GUIDE/STANDARD	LOADING	DESIGN	EXISTING
System Reliability				
Buried Pipelines				
Aboveground Pipelines				
Pumping Plants	NFPA (17) §	Chemical, Blast		
Storage Tanks	§			

NATURAL GAS		MANMADE HAZARD PROVISIONS		
COMPONENT	GUIDE/STANDARD	LOADING	DESIGN	EXISTING
System Reliability	NPC (2) Ø	Radiological, Blast	Cyber Radiological	
Buried Pipelines	DOT (3)	Blast	Chemical Blast	
	DOT (4)			
	DOT (5)			
	DOT (6)			
Aboveground Piping	DOT (7)	Blast	Chemical Blast	
	DOT (8)			
	DOT (9)			
	DOT (10)			
Compressor Station Piping				
Well Facilities				
Offshore Production Installations	ISO (11) §	Chemical, Blast		
Elect./Mechanical Equipment	§ Ø	Radiological	Radiological	

TELECOMMUNICATIONS SYSTEMS		MANMADE HAZARD PROVISIONS		
COMPONENT	GUIDE/STANDARD	LOADING	DESIGN	EXISTING
System Reliability	SEI (18) § Ø	Cyber	Cyber	
Towers, Masts and Poles	Ø	Radiological, Blast	Radiological, Blast	
Buried Cables		Biological	Biological	
Underwater Cables				
Aboveground Cables				
Switching Equipment	Ø	Radiological, Cyber	Radiological, Cyber	
Cable Trays				

OIL PRODUCTS		MANMADE HAZARD PROVISIONS		
COMPONENT	GUIDE/STANDARD	LOADING	DESIGN	EXISTING
System Reliability	NPC (12) § Ø	Cyber	Cyber	
Buried Pipelines	Ø	Radiological, Blast	Radiological, Blast	
Aboveground Piping	Ø	Blast	Blast	
Pumping Station Piping	Ø	Blast	Blast	
Well Facilities	Ø	Blast	Blast	
Refineries	Ø	Blast	Blast	
Storage Tanks	§ Ø	Blast		
Elect./Mechanical Equipment	Ø	Radiological, Blast, Cyber		

PORTS AND INLAND WATERWAYS		MANMADE HAZARD PROVISIONS		
COMPONENT	GUIDE/STANDARD	LOADING	DESIGN	EXISTING
System Reliability	§ Ø		Blast	
Piers/Wharves	§ Ø		Blast	
Breakwaters/Jetties	Ø		Blast	
Sea Walls	Ø		Blast	
Container Handling				
Cargo Movement				
Marine Oil Terminals	§ Ø		Blast	

LNG SYSTEMS		MANMADE HAZARD PROVISIONS		
COMPONENT	GUIDE/STANDARD	LOADING	DESIGN	EXISTING
System Reliability	§ Ø	Radiological, Blast, Cyber	Radiological, Blast, Cyber	
Piping	Ø	Blast	Blast	
Storage Tanks	Ø	Blast	Blast	
Elect./Mechanical Equipment	Ø	Radiological, Blast, Cyber	Radiological, Blast, Cyber	

HIGHWAYS AND ROADS		MANMADE HAZARD PROVISIONS		
COMPONENT	GUIDE/STANDARD	LOADING	DESIGN	EXISTING
System Reliability				
Bridges	§			
Embankments				
Road Beds				
Culverts				
Tunnels				
Retaining Walls				
Signs				

WATER SYSTEMS (POTABLE & RAW)		MANMADE HAZARD PROVISIONS		
COMPONENT	GUIDE/STANDARD	LOADING	DESIGN	EXISTING
Treatment Units	(13) USACHPPM (14)		Chemical, Biological Biological	
System Reliability	(15)		Chemical, Biological, Radiological, Cyber	
	(16)		Chemical, Biological	
Buried Pipelines				
Aboveground Pipelines				
Pumping Plants	§			
Storage Tanks	§			
Well Facilities				

RAILROAD		MANMADE HAZARD PROVISIONS		
COMPONENT	GUIDE/STANDARD	LOADING	DESIGN	EXISTING
System Reliability				
Bridges	§			
Embankments				
Rails, Ties, and Ballast	§			
Culverts				
Tunnels				
Signs				

INFRASTRUCTURE INTERDEPENDENCIES		MANMADE HAZARD PROVISIONS		
COMPONENT	GUIDE/STANDARD	LOADING	DESIGN	EXISTING
System Reliability	Ø	Chemical, Biological, Radiological, Blast, Cyber	Chemical, Biological, Radiological, Blast, Cyber	

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KEY TO TABLE

* = Guidelines & Standards **not** produced by an ANSI approved standard developing organization.
A = Guidelines & Standards produced by an ANSI approved standard developing organization.
§ = Empty box indicates guidelines and standards related to the specified hazards are not available.
Ø = Standards have been identified, but must be purchased for review. See appendices B-M.
 Ø = Government standards exist, but are issued from a controlled or sensitive source.
 Loading: Whether or not specific loads for various identified hazards are defined.
 Design: Existence of design and/or analysis that account for loads arising specified hazards.
 Existing: Analysis or design procedures (not loads) could be applied for existing components.
 IEEE (1): Guide for Containment and Control of Oil Spills in Substations.
 NPC (2): Securing Oil and Natural Gas Infrastructures in the New Economy.
 DOT (3): CFR 49, 195.8, Transportation of Hazardous Liquids or CO₂ in Pipelines Constructed with other than Steel Pipe.
 DOT (4): CFR 49, 192.755, Transportation of Natural Gas by Pipeline, Minimum Federal Safety Standards, Protecting Cast Iron Pipelines.
 DOT (5): CFR 49, 192.614, Damage Prevention Program.
 DOT (6): CFR 49, 149.442, Damage Prevention Program.

DOT (7): CFR 49, 195.8, Transportation of Hazardous Liquids or CO₂ in Pipelines Constructed with other than Steel Pipe.
 DOT (8): CFR 49, 195.55 Protecting Cast Iron Pipelines.
 DOT (9): CFR 49, 192.614, Damage Prevention Program.
 DOT (10): CFR 49, 149.442, Damage Prevention Program.
 ISO (11): Petroleum and Gas industries- Control and mitigation of fires and explosions on offshore production installations.
 NPC (12): Securing Oil & Natural Gas Infrastructures in the New Economy.
 US Congress (13): Safe Drinking Water Act.
 USACHPPM (14): Biological Warfare Agents as Threats to Potable Water, Environ Health Perspectives 107:975-984.
 US Congress (15): Water Infrastructure Security and Research Development Act.
 US Congress (16): HR 3178 and the Development of Anti-Terrorism Tools for Water Infrastructure.
 NFPA (17): Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
 SEI (18): The CERT Guide to System and Network Security Practices.