

**Seismic Water System References**  
**Compiled by Yumei Wang**  
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**TECHNICAL REFERENCES**

American Lifelines Alliance (ALA) (downloadable for free)  
[Guideline for the Seismic Design and Retrofit of Piping Systems, 2002](#)

ALA Design Guideline for Seismic Resistant Water Pipeline Installations (downloadable for free)  
[http://americanlifelinesalliance.com/Products\\_new3.htm#WaterPipelines](http://americanlifelinesalliance.com/Products_new3.htm#WaterPipelines)

ALA Seismic Fragility Formulations for Water Systems (2 parts), 2001 (downloadable for free)  
[http://americanlifelinesalliance.com/Products\\_new3.htm#WaterSystems](http://americanlifelinesalliance.com/Products_new3.htm#WaterSystems)  
[http://americanlifelinesalliance.com/pdf/Part\\_1\\_Guideline.pdf](http://americanlifelinesalliance.com/pdf/Part_1_Guideline.pdf)

American Lifelines Alliance (downloadable for free)  
[Design Guideline for Buried Steel Pipe](#)

American Society of Civil Engineers (ASCE) TCLEE monograph 15 (must purchase)  
Guidelines for the Seismic Evaluation and upgrade of Water Transmission Facilities  
Eidinger and Avila, 1999

American Society of Civil Engineers (ASCE) TCLEE monograph 22 (must purchase)  
Seismic Screening Checklists for Water and Waste water Facilities  
Heubach, 2002

FEMA guidebook for securing mechanical equipment (downloadable for free)  
<http://www.fema.gov/media-library/assets/documents/2142?id=1557>

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[Additional references listed by Don Ballantyne](#)

American Concrete Institute, *Code Requirements for Environmental Concrete Structures, ACI-350*. Available for sale from ACI. Includes seismic design.

AWWA *Risk and Reliance Management of Water and Wastewater Systems, AWWA J100-10*. Version 1. Currently being updated to version 2 including revised seismic appendix. Available for sale from AWWA.

AWWA Tank Design Standards – *AWWA D-100 (Steel), D-110 – Wire and Strand Wound; D-115 – Tendons Prestressed*. All have seismic provisions. Available for sale from AWWA.

Ballantyne, Donald B, and CB Crouse, *Reliability and Restoration of Water Supply Systems for Fire Suppression and Drinking Water Following Earthquakes*, National Institute of Standards and Technology, 1997. Available electronically for free from NIST.

Ballantyne, Donald; *Minimizing Earthquake Damage, A Guide for Water Utilities*, AWWA 1994. Out of print, available electronically from Don Ballantyne

Chung, Riley, DB Ballantyne, E Comeau, T L. Holzer; Daniel Madrzykowski; A J. Schiff; William C. Stone; J Wilcoski; R. D. Borchardt; J D. Cooper; Hai S. Lew; Jack P. Moehle; L H. Sheng; A W. Taylor; I Bucker; John R. Hayes; E V. Leyendecker; T O'Rourke; M P. Singh; M Whitney; *January 17, 1995 Hyogoken-Nanbu (Kobe) Earthquake: Performance of Structures, Lifelines, and Fire Protection Systems (NIST SP 901. NIST 1996*. Available electronically from NIST online.

Eidinger, John, and Craig Davis, *Recent Earthquakes, Implications for US Water Utilities*, Water Research Foundation, 2012. Available for free from WRF.

FEMA/NIBS, *HAZUS-MH, Multi-Hazard Loss Estimation Methodology Technical Guide and Software*. Free from FEMA, Requires ARCGIS platform. Technical manual provides excellent resource for loss estimation methodology – Chapter 8 is for Lifelines.

Honegger, DG and DJ Nyman, *Guidelines for the Seismic Design and Assessment of Natural Gas and Liquid Hydrocarbon Pipelines*, Pipeline Research Council International, 2004. For sale from PRCI. Provides excellent design approach for steel pipe.

Japan Water Works Association, *Seismic Design and Construction Guidelines for Water Supply Facilities*, 1997. English Translated Edition. Available electronically from Don Ballantyne. (Similar document in Japanese for wastewater systems also available from Don Ballantyne. Must be translated.)

O'Rourke, MJ, and X Liu, *Response of Buried Pipelines Subject to Earthquakes*, MCEER Monograph Series No. 3, 1999. Available free in electronic format from MCEER

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## **OREGON RESOURCES**

Oregon W/WW agency response network  
<http://orwarn.org/>

2013 Oregon Resilience Plan Final by the Oregon Seismic Safety Policy Advisory Commission. There is a water/waste water chapter.  
[http://www.oregon.gov/OMD/OEM/osspace/docs/Oregon\\_Resilience\\_Plan\\_Final.pdf](http://www.oregon.gov/OMD/OEM/osspace/docs/Oregon_Resilience_Plan_Final.pdf)

Crew Scenario of magnitude 9 earthquake (2013) (downloadable for free)  
[http://www.crew.org/sites/default/files/cascadia\\_subduction\\_scenario\\_2013.pdf](http://www.crew.org/sites/default/files/cascadia_subduction_scenario_2013.pdf)

Citizen earthquake preparedness guidebook by the Oregon Emergency Management (downloadable for free)  
[http://www.oregon.gov/OMD/OEM/plans\\_train/earthquake/shakygroundmagazine\\_final.pdf](http://www.oregon.gov/OMD/OEM/plans_train/earthquake/shakygroundmagazine_final.pdf)

Interactive web map called “Oregon HazVu” that presents natural hazard information for Oregon at <http://www.oregongeology.org/hazvu>. Users can browse to a site or navigate by entering an address, and then request hazard information for flooding, landslides, faults, seismicity, earthquake shaking and liquefaction, volcanic hazards, coastal erosion and tsunami inundation.

## **WATER SYSTEM SEISMIC ANALYSES**

EPA's epanet network analyses  
<http://www.epa.gov/nrmrl/wswrd/dw/epanet.html>

MCEER giraffe water system analyses for consumption and essential care activities  
<http://mceer.buffalo.edu/publications/catalog/reports/Seismic-Response-Modeling-of-Water-Supply-Systems-MCEER-08-0016.html>

## **ENERGY SECTOR TECHNICAL REFERENCES**

Department of Energy (ODOE), Public Utility Commission of Oregon (OPUC), and DOGAMI completed the Oregon Energy Assurance Project, including the 2013 DOGAMI earthquake risk study in Oregon’s Critical Energy Infrastructure (CEI) Hub. Here’s the Oregonian article (9-22-13 front page)  
[http://www.oregonlive.com/environment/index.ssf/2013/09/oregons\\_energy\\_hub\\_on\\_the\\_wil.html#incart\\_m-rpt-1](http://www.oregonlive.com/environment/index.ssf/2013/09/oregons_energy_hub_on_the_wil.html#incart_m-rpt-1) and includes a link to the state report from the ODOE webpage. Table 5 from this report is clipped below.

### **TABLE 5: SEISMIC ENGINEERING REFERENCE LIST**

This Reference List was developed by DOGAMI staff for this EAP study in March 2010. It includes current and useful references for seismic vulnerability studies and mitigation efforts at energy facilities. Companies should consult with facility engineers to determine appropriate references and guidelines to conduct seismic assessment and mitigation. This will depend on each facility and their proposed or existing structures. Companies should consider the ground conditions at their facility, in particular, site-specific liquefaction and lateral spreading potential. We have listed websites where available. Some references need to be purchased.

#### **Acronyms:**

ALA - American Lifelines Alliance [www.americanlifelinesalliance.org](http://www.americanlifelinesalliance.org)  
ASCE - American Society of Civil Engineers  
IBC - International Building Code  
IEEE - Institute of Electrical and Electronics Engineers  
MOTEMS – Marine Oil Terminal Engineering and Maintenance Standards, State of California  
PRCI - Pipeline Research Council International  
TCLEE - Technical Council on Lifeline Earthquake Engineering (under ASCE)

## **Buildings**

Current IBC (for new buildings)

New IBC seismic provisions adopt ASCE 7 and only provide a few exceptions or alternatives to ASCE 7 (ref. ASCE 7-2005: Minimum Design Loads for Buildings and Other Structures, newest edition ASCE 7-10)

ASCE 31 and ASCE 41 (31 for evaluation of existing buildings; 41 for mitigation)

Seismic Evaluation of Existing Buildings, SEI/ASCE 31-03

[Seismic Rehabilitation Of Existing Buildings ASCE/SEI 41/06](#)

NOTE: Neither of these specify explicit retrofit requirements. The user needs to determine goals.

## **Electrical**

IEEE 693 RECOMMENDED PRACTICE FOR SEISMIC DESIGN OF SUBSTATIONS (2005)

ALA [Electric Power Systems Guidelines and Commentary](#) (for scoping studies). April 2005

ASCE 113, Substation Structure Design Guide, Manuals of Practice, Editor: Leon Kempner Jr., 2008, 164 pp

ASCE Manual No 96. Guide to Improved Earthquake Performance of Electrical Power Systems. TCLEE. Editor: Anshel Schiff. 1999 <http://fire.nist.gov/bfrlpubs/build98/PDF/b98069.pdf>

## **Petroleum and Natural Gas Facilities, including Waterfront Structures, Tank Farms, and Telecommunications**

ASCE Petrochemical facilities seismic guidelines (1997 and forthcoming 2011)

Guidelines for the Seismic Evaluation and Design of Petrochemical Facilities (task committee of Petrochemical Committee of Energy Division of ASCE)

## **Waterfront**

ASCE TCLEE monograph 12. Seismic Guidelines for Ports. March 1998. Editor: Stuart Werner

MOTEMS The most current version of MOTEMS (Rev. 0) is at:

[http://www.slc.ca.gov/Division\\_Pages/MFD/MOTEMS/MOTEMS\\_Home\\_Page.html](http://www.slc.ca.gov/Division_Pages/MFD/MOTEMS/MOTEMS_Home_Page.html)

MOTEMS Rev. 1 is expected to become law around Q4 2010, and has already been accepted by the CA Building Standards Committee. You can view all of the changes that will be adopted (the Express Terms) at: [http://www.slc.ca.gov/Division\\_Pages/MFD/MFD\\_Home\\_Page.html](http://www.slc.ca.gov/Division_Pages/MFD/MFD_Home_Page.html)

## **Tanks, Piping and Control Equipment, incl. Natural Gas Piping and Well Facilities**

ASME/ANSI B31E-2008, Standard for the Seismic Design and Retrofit of Above-Ground Piping Systems

ASME Piping Codes:

ASME B31.4 (2006) Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids

ASME B31.8 (2007) Gas Transmission and Distribution Piping Systems

ASME B31.3 (2006) Process Piping

Honegger, D.G. and D.J. Nyman (2004), Guidelines for the Seismic Design and Assessment of Natural Gas and Liquid Hydrocarbon Pipelines, PRCI catalog no. L51927.

[http://prci.org/index.php/pm/pubs\\_details/](http://prci.org/index.php/pm/pubs_details/)

API 620 (2008), Design and Construction of Large, Welded, Low-pressure Storage Tanks

ALA (2002) Guideline for the Design of Buried Steel Pipe

API 650 (2007) Welded Tanks for Oil Storage, 11th Edition, Addendum 1 (2008) and Addendum 2 (2009), American Petroleum Institute

California Accidental Release Prevention (*CalARP*)

<http://www.oes.ca.gov/Operational/OESHome.nsf/978596171691962788256b350061870e/452A4B2AF244158788256CFE00778375?OpenDocument>

ALA Guide for Seismic Evaluation of Active Mechanical Equipment, 2008 (for walk through assessments)

ALA [Oil and Natural Gas Pipeline Systems Guidelines and Commentary](#) (for scoping studies)

ALA [Guideline for the Seismic Design and Retrofit of Piping Systems](#) (for scoping study purposes; used to develop B31E)