INITIAL EXPRESS TERMS

FOR
PROPOSED BUILDING STANDARDS
OF THE
CALIFORNIA STATE LANDS COMMISSION

REGARDING PROPOSED CHANGES TO
THE 2019 CALIFORNIA BUILDING CODE,
CALIFORNIA CODE OF REGULATIONS, TITLE 24, PART 2

CHAPTER 31F – MARINE OIL TERMINALS
CHAPTER 35 – REFERENCED STANDARDS

LEGEND FOR EXPRESS TERMS

1. Existing California amendments or code language being modified are in italics when they appear in the model code text: All such language appears in *italics*, modified language is underlined.
2. New California amendments: All such language appears *underlined and in italics*.
3. Repealed text: All such language appears in ~~strikeout~~.

INITIAL EXPRESS TERMS

[Note: These Express Terms have been assigned item numbers where the first number represents the Division (e.g. “1.1.” for Division “1”, Item “1”).]

DIVISION 1
SECTION 3101F [SLC]
INTRODUCTION

1.1. ***3101F.2 Purpose.*** *The purpose of this code is to establish minimum engineering, inspection and maintenance criteria for MOTs in order to prevent oil spills and to protect public health, safety and the environment. This code does not specifically address terminal siting, systems onboard vessels, processing facilities, or operational requirements. Relevant provisions from existing codes, industry standards, recommended practices, regulations and guidelines have been incorporated directly or through reference, as part of this code.*

Where there are differing requirements between this code and/or references cited herein, the choice of application shall be subject to Division approval ~~of the Division~~.

In circumstances where ~~new~~ technologies ~~are~~ proposed for use are not covered by this code and/or references cited herein, ~~equivalent~~ prevention of oil spills and equivalent or better protection of ~~to~~ the public health, safety and the environment must be demonstrated, and the choice of application shall be subject to Division approval.

1.2. ***3101F.3 Applicability.*** *…*

Existing (E) requirements apply to MOTs that were ~~are~~ in operation on the date this code became effective (February 6, 2006) ~~is adopted~~.…

1.3. ***3101F.6 Oil spill exposure classification.*** *…*

…

V_F = *Flowing v~~V~~olume of potential exposed oil [bbl]*

Q_C = *Maximum c~~C~~argo t~~T~~ransfer r~~R~~ate [bbl/hr]*

…

1.4. ***3101F.10 Symbols.***

DWT = Dead weight tons

Q_C = *Maximum cargo transfer rate [bbl/hr]*

V_F = *Flowing volume of potential exposed oil [bbl]*

V_S = *Stored volume of potential exposed oil [bbl]*

V_T = *Total volume of potential exposed oil [bbl]*

Δt = *ESD closure and activation time (if applicable) [sec]*

1.5. ***3101F.11~~0~~ References.*** *…*

Notation
Authority: Sections 8750 through 8760, Public Resources Code.
References: Sections 8750, 8751, 8755 and 8757, Public Resources Code. Section 8670.28(a)(7), Government Code.

DIVISION 2
SECTION 3102F
AUDIT AND INSPECTION

2.1. ***3102F.1.5 Baseline assessment.*** *…*

All fire, piping, mechanical and electrical systems shall be documented as to location, capacity, operating limits and physical conditions in the equipment layout diagram(s).

2.2. ***3102F.3.2 Overview.*** *…*

…

An audit is not considered complete until the audit report is received (in electronic and hard copy formats) by the Division.

2.3. ***TABLE 31F-2-3 SCOPE OF UNDERWATER INSPECTION ~~LEVELS OF EFFORT~~ [2.2]***

2.4. Update footnote for "***TABLE 31F-2-4 ASSESSMENT RATINGS***" as follows:

1. …

2. …

3. ICAR = Inspection Condition Assessment Ratings [2.2]; Ratings shall be assigned comparing the observed condition to the as-built ~~original~~ condition.

4. …

2.5. Update footnote for "***TABLE 31F-2-7C***" as follows:

…

9. Ratings shall be assigned comparing the observed condition to the as-built ~~original~~ condition.

10. …

2.6. ***3102F.3.6.1 Terminal operating limits.*** *The physical boundaries of the facility shall be defined by the berthing system operating limits, along with the vessel size limits and environmental conditions.*

The audit shall include ~~a~~ "~~Statement of~~ Terminal Operating Limits~~,~~" (TOLs) diagrams, which ~~must~~ provide a concise statement of the purpose of each berthing system in terms of operating limits for representative vessel size ranges and mooring configurations approved to call and/or conduct transfer operations at the MOT. This description shall ~~must at least~~ include, the minimum and maximum vessel sizes, including Length Overall (LOA), beam, and maximum draft with associated displacement (see Figure~~.~~ 31F-2-1).

In establishing limits for both the minimum and maximum vessel sizes, due consideration shall be given to water depths, dolphin spacing, fender system limitations, manifold height and hose/loading arm reach, with allowances for tidal fluctuations, surge and drift.

Maximum wind, current or wave conditions, or combinations thereof, shall be clearly defined as limiting conditions for vessels at each berth, both with and without active product transfer.

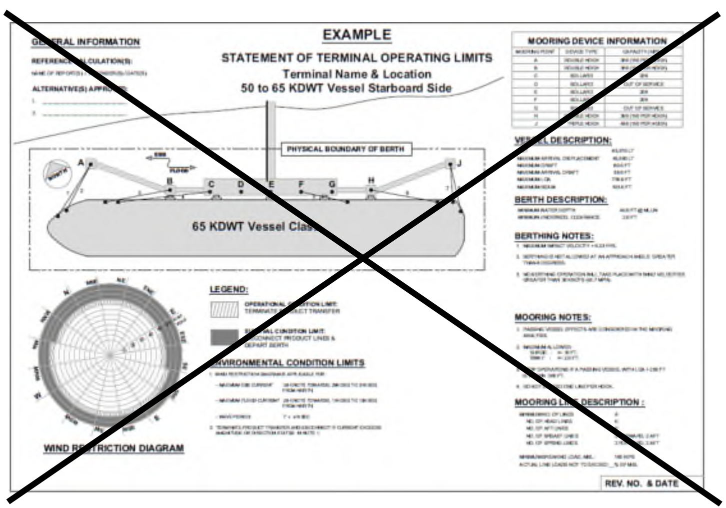
The TOLs shall be explicitly presented to facilitate implementation by the MOT operator, such as through incorporation in the MOT's Operations Manual (2 CCR 2385 [2.1]). The TOLs shall allow for direct comparison of operating limits and output from monitoring systems and instrumentation (i.e., anemometers, current meters, tension monitoring systems, velocity monitoring systems). Design and implementation considerations shall include, but not be limited to:

1. *Units of measurement (i.e., English vs. System International units)*

2. *Directionality (i.e., current restrictions "to", wind restrictions "from", true or magnetic north)*

3. *Parameters of monitoring systems and instrumentation (i.e., duration/averaging of readings, elevation/depth of readings, distance/location of readings)*

2.7. Remove entirely Figure 31F-2-1:



~~FIGURE 31F-2-1~~

2.8. Replace Figure 31F-2-1:

EXAMPLE

TERMINAL OPERATING LIMITS
Terminal Name & Location
50 to 75 KDWT Vessel Starboard Side

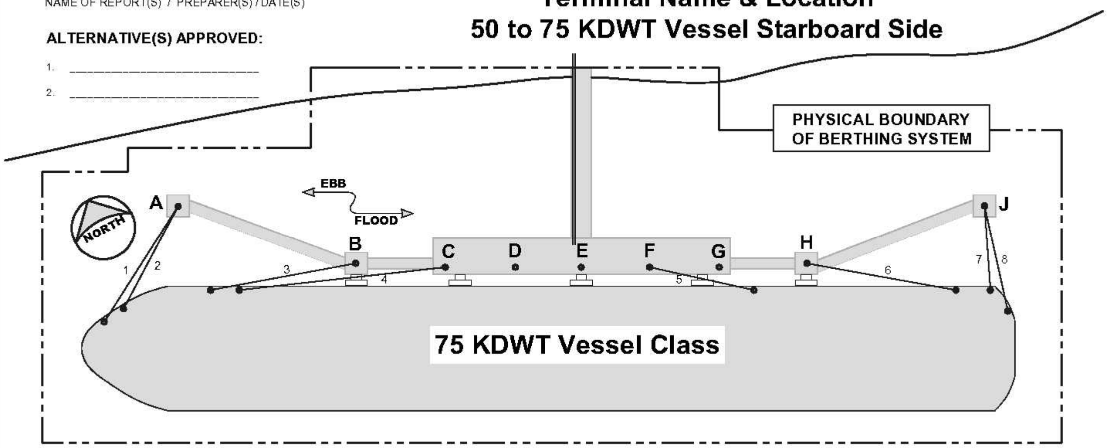
GENERAL INFORMATION

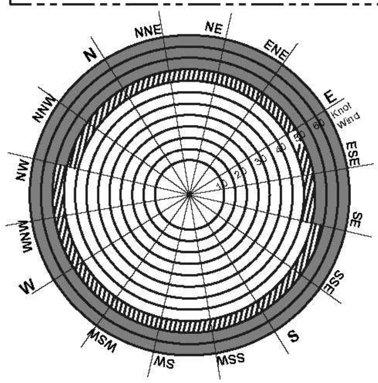
REFERENCE CALCULATION(S):

NAME OF REPORT(S) / PREPARER(S) / DATE(S)

ALTERNATIVE(S) APPROVED:

1. ____________________________
2. ____________________________





WIND RESTRICTION DIAGRAM
(WIND DIRECTION FROM)

LEGEND:

- **OPERATIONAL CONDITION** — TERMINATE PRODUCT TRANSFER
- **SURVIVAL CONDITION** — DISCONNECT PRODUCT LINES
- **DEPARTURE CONDITION** — DEPART BERTH

ENVIRONMENTAL CONDITION LIMITS

1. WIND RESTRICTION DIAGRAM IS APPLICABLE FOR:
   - MAXIMUM EBB CURRENT — 3.9 KNOTS TOWARDS, 290 DEG TO 310 DEG FROM NORTH
   - MAXIMUM FLOOD CURRENT — 2.6 KNOTS TOWARDS, 110 DEG TO 130 DEG FROM NORTH
   - WAVE PERIOD: — T < 4.0 SEC
2. TERMINATE PRODUCT TRANSFER AND DISCONNECT IF CURRENT EXCEEDS MAGNITUDE OR DIRECTION STATED IN NOTE 1.

MOORING DEVICE INFORMATION

MOORING POINT	DEVICE TYPE	CAPACITY (KIPS)
A	DOUBLE HOOK	300 (150 PER HOOK)
B	DOUBLE HOOK	300 (150 PER HOOK)
C	BOLLARD	200
D	BOLLARD	OUT OF SERVICE
E	BOLLARD	200
F	BOLLARD	200
G	BOLLARD	OUT OF SERVICE
H	DOUBLE HOOK	300 (150 PER HOOK)
J	TRIPLE HOOK	450 (150 PER HOOK)

VESSEL DESCRIPTION:

DWT	74,900 LT
MAXIMUM ARRIVAL DISPLACEMENT	75,700 LT
MAXIMUM DRAFT	47.0 FT
MAXIMUM ARRIVAL DRAFT	38.0 FT
MAXIMUM LOA	750.0 FT
MAXIMUM BEAM	105.0 FT

BERTH DESCRIPTION:

MINIMUM WATER DEPTH	40.0 FT @ MLLW
MINIMUM UNDERKEEL CLEARANCE	2.0 FT

BERTHING NOTES:

1. MAXIMUM IMPACT VELOCITY = 0.33 FPS.
2. BERTHING IS NOT ALLOWED AT AN APPROACH ANGLE GREATER THAN 6 DEGREES.
3. NO BERTHING OPERATION WILL TAKE PLACE WITH WIND VELOCITIES GREATER THAN 38 KNOTS (43.7 MPH).

MOORING NOTES:

1. PASSING VESSEL EFFECTS ARE CONSIDERED IN THE MOORING ANALYSIS.
2. MAXIMUM ALLOWED:
   SURGE : +/- 10 FT.
   SWAY : +/- 2.0 FT.
3. STOP OPERATIONS IF A PASSING VESSEL WITH LOA > 250 FT IS WITHIN 300 FT.
4. DO NOT EXCEED ONE LINE PER HOOK.

MOORING LINE DESCRIPTION :

MINIMUM NO. OF LINES	8
NO. OF HEAD LINES	0
NO. OF AFT LINES	0
NO. OF BREAST LINES	2 FORWARD, 2 AFT
NO. OF SPRING LINES	2 FORWARD, 2 AFT
MINIMUM BREAKING LOAD, MBL:	165 KIPS
ACTUAL LINE LOADS NOT TO EXCEED __% OF MBL	

REV. NO. & DATE

FIGURE 31F-2-1

2.9. ***3102F.3.6.4 Mechanical and electrical systems.*** *An evaluation of all mechanical and electrical systems and components shall be performed in accordance with Sections 3108F through 3111F of these standards.~~ If a pipeline stress analysis is required (see Section 3109F.3), f~~Forces and imposed seismic displacements resulting from the structural analysis shall be considered in the pipeline stress analyses (Section 3109F.3), and the piping/pipelines shall be assigned SSARs in Table 31F-2-7B. Mechanical and electrical component deficiencies shall be assigned ratings from Table 31F-2-5.*

2.10. ***3102F.3.8 Documentation and reporting.*** *…* [Correct font style to bold for *"**Table of contents**"*]

2.11. ***3102F.4 Post-event notification and inspection.*** *A post-event inspection is a focused inspection following a significant, potentially damage-causing event such as an earthquake, storm, vessel impact, fire, explosion, construction incident, or tsunami. The primary purpose is to assess the integrity of structural, mechanical and electrical systems. This assessment will determine the operational status and/or any remedial measures required.*

Notation
Authority: Sections 8750 through 8760, Public Resources Code.
References: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

DIVISION 3
SECTION 3103F
STRUCTURAL LOADING CRITERIA

3.1. ***3103F.4.2 Design earthquake motion parameters.*** *The earthquake ground motion parameters of peak ground acceleration, spectral acceleration and earthquake magnitude are modified for site amplification and near fault directivity effects. The resulting values are the Design Peak Ground Acceleration (DPGA), Design Spectral Acceleration (DSA) and Design Earthquake Magnitude (DEM).*

For Site Classes A through E (Section 3103F.4.2.1), peak ground and design spectral accelerations shall ~~may~~ be obtained from:

1. *U.S. Geological Survey (USGS) published data as discussed in Section 3103F.4.2.2, or*
2. *A site-specific probabilistic seismic hazard analysis (PSHA) as discussed in Section 3103F.4.2.3.*

Site-specific PSHA is required for Site Class F.

…

The appropriate probability levels associated with DPGA and DSA for different seismic performance levels are provided in Table 31F-4-1. Deterministic earthquake motions, which are used only for comparison to the probabilistic results, are addressed in Section 3103F.4.2.7 ~~3103F.4.2. 7~~.

…

[Note: Double underline denotes language which is underlined in the existing code.]

3.2. ***3103F.4.2.1 Site classes.*** *The following Site Classes, defined in Section 3106F.2.1, shall be used in developing values of DSA and DPGA: …*

3.3. ***3103F.4.2.2 Earthquake motions from USGS maps.*** *Earthquake ground motion parameters can be obtained directly from the US Seismic Design Maps tool available at the USGS website (http://earthquake.usgs.gov~~/designmaps/us/application.php~~) for the site condition(s) appropriate for the MOT site and the selected probability of exceedance. For this purpose, select the ASCE/SEI 41 [3.1] ~~"2013 ASCE 41"~~ as the design code reference document ~~(based on 2008 USGS hazard data available), "Custom" under the Earthquake Hazard Level option~~, and specify the appropriate custom parameters, including but not limited to, location, required Probability of Exceedance (in 50 years), and appropriate Site Soil Classification(s) for the MOT site. The USGS tool directly provides the peak ground and spectral accelerations for the selected hazard level and site condition(s).*

… If needed, the data for appropriate probability of exceedance may be obtained using the procedure described in Chapter 1 of FEMA 356 [3.2]~~[3.1]~~, and corrected for the MOT site as discussed in Section 3103F.4.2.4 or Section 3103F.4.2.5.

3.4. ***3103F.4.2.4 Simplified evaluation of site amplification effects.*** *…*

For a given site class, the following procedure from Chapter 1 of FEMA 356 [3.2]~~[3.1]~~ presents…

3.5. ***3103F.4.2.5 Site-specific evaluation of amplification effects.*** *…*

In general, an equivalent linear analysis using, for example, SHAKE91 [3.3]~~[3.2]~~ is acceptable when…

…

3.6. ***3103F.4.2.6 Directivity effects.*** *…*

1. *Directivity effects may be reflected in the spectral acceleration values in a deterministic manner by using well established procedures such as that described in Somerville, et al. [3.4]~~[3.3]~~. …*

…

3.7. ***3103F.4.2.7 Deterministic earthquake motions.*** *…*

For comparison, the values of peak ground accelerations and spectral accelerations may be obtained from the USGS maps ~~[3.1]~~, corresponding to the Maximum Considered Earthquake (MCE). In this case, the median values of peak ground acceleration and spectral acceleration values shall be 2/3 (see Section 1.6 of FEMA 356 [3.2]~~[3.1]~~) of the values shown on the USGS maps.

3.8. ***3103F.4.2.9 Design Spectral Acceleration for various damping values.*** *Design Spectral Acceleration (DSA) values at damping other than 5 percent shall be obtained by using a procedure given in Chapter 1 of FEMA 356 [3.2]~~[3.1]~~, …*

3.9. ***TABLE 31F-3-5 VALUES OF B_S AND B_1 [3.2]~~[3.1]~~***

3.10. ***3103F.5.1 General.*** *…*

The vessel's moorings shall be strong enough to hold during all expected environmental and passing vessel conditions ~~of surge, current and weather and long enough~~ to adequately accommodate ~~allow adjustment for~~ changes in draft, surge, sway, yaw ~~drift~~ and tide ~~(2 CCR 2340) [3.4]~~.

3.11. ***3103F.5.2 Wind loads.*** *Wind loads on a vessel, moored at a MOT, shall be determined using procedures described in this section. Wind speed measured at an elevation of 33 feet (10 meters) above the water surface, with duration of 30 seconds shall be used to determine the design wind speed and wind limits for moored vessels. If these conditions are not met, adjustment factors shall be applied per Sections 3103F.5.2.2. ~~Wind loads shall be calculated for each of the load cases identified in Section 3105F.2.~~*

3.12. ***3103F.5.2.1 Design wind speed.*** *For new MOTs, the 25-year return period shall be used to establish the design wind speed for each direction. The design wind speed is the maximum wind speed of 30-second duration used in the mooring analysis (see Section 3105F). The 30-second duration wind speed shall be determined from the annual maximum wind data. Average annual summaries cannot be used. Maximum wind speed data for a minimum of eight directions (45-degree increments) shall be obtained. If other duration wind data is available, it shall be adjusted to a 30-second duration, in accordance with Equation (3-12).*

3.13. ***3103F.5.2.2 Wind limits for moored vessels.*** *Wind loads shall be calculated for each of the load cases identified in Section 3105F.2. Wind velocity limits for moored vessels shall be presented in the Terminal Operating Limits (see Section 3102F.3.6.1 and Figure 31F-2-1) for each of the conditions given below.*

3.14. ***3103F.5.2.2~~1~~.1 Operational ~~Operating~~ condition.*** *The operational ~~operating~~ condition is defined as the wind envelope in which a vessel may conduct transfer operations~~. It is~~, as determined from the mooring analysis (Section 3105F). Transfer operations shall cease~~, at an existing MOT,~~ when the wind exceeds the maximum velocity of the envelope.*

3.15. ***3103F.5.2.2~~1~~.2 Survival condition.*** *The survival condition is defined as the state wherein a vessel can remain safely moored at the berth during severe winds; however, loading arms and hoses shall be disconnected (see Sections 3110F.2 and 3110F.3 regarding movement limits of loading arms and hoses, respectfully). The survival condition is the wind zone between the operational condition and the departure condition (defined in Section 3103F.5.1.3). In this wind zone, the vessel must prepare to depart the berth.*

3.16. ***3103F.5.2.2.3 Departure condition.*** *The departure condition is defined as the wind state above which a vessel can no longer remain safely moored at the berth during severe winds, as determined from the mooring analysis (Section 3105F). For a new MOT~~s~~, the departure ~~survival~~ condition threshold is the maximum wind velocity, for a 30-second gust and a 25-year return period, obtained from historical data. ~~For an existing MOT, a reduced survival condition threshold is acceptable (see Figure 31F-2-1).~~ If the wind rises above these levels, the vessel must depart the berth~~; it shall be able to depart within 30 minutes (see 2 CCR 2340) [3.4]~~.*

~~The 30-second duration wind speed shall be determined from the annual maximum wind data. Average annual summaries cannot be used. Maximum wind speed data for eight directions (45-degree increments) shall be obtained. If other duration wind data is available, it shall be adjusted to a 30-second duration, in accordance with Equation (3-21). The 25-year return period shall be used to establish the design wind speed for each direction. In order to simplify the analysis for barges (or other small vessels), they may be considered to be solid free-standing walls (Chapter 29 of ASCE/SEI 7 [3.5]). This will eliminate the need to perform a computer assisted mooring analysis.~~

3.17. ***3103F.5.2.3~~2~~ Wind speed corrections.*** *…*

…

If wind data is available over land only, the following equation shall be used to convert the wind speed from over-land to over-water conditions [3.5]~~[3.6]~~: …

3.18. ***FIGURE 31F-3-1 WIND SPEED CONVERSION FACTOR [3.5]~~[3.6]~~***

3.19. ***3103F.5.2.4~~3~~ Static wind loads on vessels.*** *The OCIMF MEG3 [3.6]~~[3.7]~~ shall be used to determine the wind loads for all tank vessels.*

Alternatively, wind loads for any type of vessel may be calculated using the guidelines in Ferritto et al. [3.7]~~[3.8]~~.

3.20. ***3103F.5.3 Current loads.*** *~~Environmental loads induced by currents at MOTs shall be calculated as specified in this subsection.~~*

3.21. ***3103F.5.3.1 Design current velocity.*** *Maximum ebb and flood currents, annual river runoffs and controlled releases shall be considered when establishing the design current velocities for both existing and new MOTs.*

Local current velocities may be obtained from NOAA [3.8]~~[3.9]~~ or other sources, but must be supplemented by site-specific data, if the current velocity is higher than 1.5 knots.

Site-specific data shall be obtained by real time measurements over a one-year period. If this information is not available, a safety factor of 1.25 shall be applied to the best available data until real time measurements are obtained.

If the facility is not in operation during annual river runoffs and controlled releases, the current loads may be adjusted.

Operational dates need to be clearly stated in the definition of the ~~t~~Terminal ~~o~~Operating ~~l~~Limits (see Section 3102F.3.6.1 and Figure 31F-2-1).

3.22. ***FIGURE 31F-3-2 CURRENT VELOCITY CORRECTION FACTOR (p. 23 [3.6]~~[3.7]~~)***

3.23. ***3103F.5.3.3 Static current loads.*** *The OCIMF MEG3 [3.6]~~[3.7]~~ or the UFC 4-159-03 [3.9]~~[3.10]~~ procedures shall be used to determine current loads for moored tank vessels.*

3.24. ***3103F.5.4 Wave loads.*** *…*

… The Froude-Krylov method discussed in Chakrabarti's Chapter 7 [3.10]~~[3.11]~~ may be used to calculate the wave excitation forces, …

3.25. ***3103F.5.5 Passing vessels.*** *…*

…Either method of Kriebel [3.11]~~[3.12]~~ or Wang [3.12]~~[3.13]~~ may be used to determine forces on a moored vessel. Kriebel's recent wave tank study improves on an earlier work of Seelig [3.13]~~[3.14]~~.

3.26. ***3103F.5.7 Tsunamis.*** *…*

… For the Ports of Los Angeles and Long Beach, one of these recent studies focused on near field tsunamis with predicted return periods of 5,000 to 10,000 years [3.14]~~[3.15]~~. …

The run-up value for Port Hueneme was obtained from an earlier study by Synolakis et al. [3.15]~~[3.16]~~.

…These results are deterministic and are based on the most severe seismic sources that could reasonably impact MOTs in the San Francisco Bay [3.16]~~[3.17]~~.… Further details are available in [3.16]~~[3.17]~~.

… Loads from tsunami-induced waves can be calculated for various structural configurations [3.17]~~[3.18]~~.

3.27. ***TABLE 31F-3-6 TSUNAMI RUN-UP VALUES (ft) AND CURRENT SPEEDS (ft/sec) IN THE SAN FRANCISCO BAY AREA (AFTER [3.16]~~[3.17]~~)***

3.28. ***3103F.6.1 General.*** *…The terms and equations below are based on those in UFC 4-152-01 [3.18]~~[3.19]~~ and PIANC [3.19]~~[3.20]~~.*

...

W = Total weight of vessel and cargo in pounds [long tons × 2240] ~~[long tons H 2240]~~

…

F_A = ... For new berthing systems, F_A shall be determined in accordance with Section 5-1.5.3 of UFC 4-152-01 [3.18]~~[3.19]~~ or PIANC Section 4.2.8 [3.19]~~[3.20]~~.

…

The approximate displacement of the vessel (when only partially loaded) at impact, DT, can be determined from an extension of an equation from Gaythwaite [3.20]~~[3.21]~~:

…

3.29. ***3103F.6.3 Geometric coefficient (C_g).*** *… Generally, 0.95 is recommended for the impact point at or beyond the quarter points of the ship, and 1.0 for broadside berthing in which contact is made along the straight side [3.18]~~[3.19]~~.*

3.30. ***3103F.6.5 Configuration coefficient (C_c).*** *…*

…

For berths with different conditions, C_c may be interpolated between these values [3.18]~~[3.19]~~.

3.31. ***3103F.6.6 Effective mass or virtual mass coefficient (C_m).*** *…*

…

The value of C_m for use in design should be a minimum of 1.5 and need not exceed 2.0 [3.18]~~[3.19]~~.

3.32. ***3103F.7.2 Wind loads.*** *Chapter 29 of the ASCE/SEI 7 [3.21]~~[3.5]~~ shall be used to establish minimum wind loads on the structure. …*

3.33. ***3103F.8 Load combinations.*** *As a minimum, each component of the structure shall be analyzed for all applicable load combinations given in Table 31F-3-10 or Table 31F-3-11, depending on component type. For additional load combinations, see UFC 4-152-01 [3.18]~~[3.19]~~.*

…

3.34. ***TABLE 31F-3-10 LRFD LOAD FACTORS FOR LOAD COMBINATIONS [3.18]~~[3.19]~~***

3.35. ***TABLE 31F-3-11 SERVICE OR ASD LOAD FACTORS FOR LOAD COMBINATIONS [3.18]~~[3.19]~~***

…

2. Increase in allowable stress shall not be used with these load combinations unless it can be demonstrated that such increase is justified by structural behavior caused by rate or duration of load. See ASCE/SEI 7 [3.21]~~[3.5]~~

3.36. ~~***3103F.9 Safety factors for mooring lines.*** *Safety factors for different material types of mooring lines are given in Table 31F-3-12. The safety factors should be applied to the minimum number of lines specified by the mooring analysis, using the highest loads calculated for the environmental conditions. The minimum breaking load (MBL) of new ropes is obtained from the certificate issued by the manufacturer. If nylon tails are used in combination with steel wire ropes, the safety factor shall be based on the weaker of the two ropes.*~~

3.37. Remove entirely:

~~TABLE 31F-3-12~~
~~SAFETY FACTORS FOR ROPES [3.7]~~

Steel Wire Rope	*1.82*
Polyamide	*2.22*
Other Synthetic	*2.00*
Polyamide Tail for Wire Mooring Lines	*2.50*
Other Synthetic Tail for Wire Mooring Lines	*2.28*
Polyamide Tail for Synthetic Mooring Lines	*2.75*
Other Synthetic Tail for Synthetic Mooring Lines	*2.50*
Joining Shackles	*2.00*

3.38. ***~~3103F.10 Mooring hardware (N/E).~~*** *~~Mooring hardware shall include but not be limited to bollards, quick release hooks, other mooring fittings and base bolts. All mooring hardware shall be clearly marked with their safe working loads (or allowable working loads) [3.7]. The certificate issued by the manufacturer normally defines the safe working loads of this hardware.~~*

3.39. ***~~3103F.10.1 Quick release hooks.~~*** *~~For new MOTs or berthing systems, a minimum of three quick-release hooks are required for each breasting line location for tankers greater than or equal to 50,000 DWT. At least two hooks at each location shall be provided for breasting lines for tankers less than 50,000 DWT. Remote release may be considered for emergency situations.~~*

~~All hooks and supporting structures shall withstand the minimum breaking load (MBL) of the strongest line with a safety factor of 1.2 or greater. Only one mooring line shall be placed on each quick release hook (N/E).~~

~~For multiple quick release hooks, the minimum horizontal load for the design of the tie-down shall be:~~

$$\cancel{F_d = 1.2 \times MBL \times [1+0.75\,(n-1)]} \qquad \cancel{(3\text{-}21)}$$

$\cancel{F_d}$ *~~= Minimum factored demand for assembly tie-down.~~*

$\cancel{n}$ *~~= Number of hooks on the assembly.~~*

~~The capacity of the supporting structures must be larger than~~ $\cancel{F_d}$ *~~(See Section 3107F.5.3).~~*

3.40. ~~***3103F.10.2 Other fittings.*** *Other fittings include cleats, bitts and bollards.*~~

~~*If the allowable working loads for existing fittings are not available, the values listed in Table 31F-3-13 may be used for typical sizes, bolt patterns and layout. The allowable working loads are defined for mooring line angles up to 60 degrees from the horizontal. The combination of vertical and horizontal loads must be considered.*~~

3.41. Remove entirely:

~~***TABLE 31F-3-13***~~

~~***ALLOWABLE WORKING LOADS***~~

TYPE OF FITTINGS	***NO. OF BOLTS***	***BOLT SIZE (in)***	***WORKING LOAD (kips)***
30 in. Cleat	*4*	*1 1/8*	*20*
42 in. Cleat	*6*	*1 1/8*	*40*
Low Bitt	*10*	*1 5/8*	*60 per column*
High Bitt	*10*	*1 ¾*	*75 per column*
44 ½ in. Fit. Bollard	*4*	*1 ¾*	*70*
44 ½ in. Fit. Bollard	*8*	*2 ¼*	*200*
48 in. Fit. Bollard	*12*	*2 ¾*	*450*

~~*Note: This table is modified from Table 6-11 of UFC 4-159-03 [3.10]*~~

3.42. ~~***3103F.10.3 Base bolts.*** *Base bolts are subjected to both shear and uplift. Forces on bolts shall be determined using the following factors:*~~

1. ~~*Height of load application on bitts or bollards.*~~
2. ~~*Actual vertical angles of mooring lines for the highest and lowest tide and vessel draft conditions, for all sizes of vessels at each particular berth.*~~
3. ~~*Actual horizontal angles from the mooring line configurations, for all vessel sizes and positions at each particular berth.*~~
4. ~~*Simultaneous loads from more than one vessel.*~~

~~*For existing MOTs, the deteriorated condition of the base bolts and supporting members shall be considered in determining the capacity of the fitting.*~~

3.43. ***3103F.9~~11~~ Miscellaneous loads.*** …

3.44. ***3103F.10~~2~~ Symbols.*** *…*

3.45. ***3103F.11~~3~~ References.*** *…*

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Authority: Sections 8750 through 8760, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

Notation
Authority: Sections 8750 through 8760, Public Resources Code.
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DIVISION 4
SECTION 3104F
SEISMIC ANALYSIS AND STRUCTURAL PERFORMANCE

4.1. ***3104F.1.1 Purpose.*** *The purpose of this section is to establish minimum standards for seismic analysis and structural performance. Seismic performance is evaluated at two criteria levels. Level 1 requirements define a performance criterion to ensure MOT functionality. Level 2 requirements safeguard against major ~~structural~~ damage, ~~or~~ collapse or major oil spill.*

4.2. ***3104F.1.2 Applicability.*** *Section 3104F applies to all new and existing MOTs ~~structures~~. Structures supporting loading arms, pipelines, oil transfer and storage equipment, critical ~~nonstructural~~ systems and vessel mooring structures, such as mooring and breasting dolphins are included. Catwalks and similar components that are not part of the lateral load carrying system and do not support oil transfer equipment may be excluded.*

4.3. ***3104F.1.3 Configuration classification of MOT structure.*** *Each MOT structure shall be designated as regular or irregular based on torsional irregularity criteria presented in ASCE/SEI 7 [4.1]. An MOT structure is defined to be irregular when maximum displacement at one end of the MOT structure transverse to an axis is more than 1.2 times the average of the displacement at the two ends of the MOT structure, as described in Figure 31F-4-1. For MOTs with multiple segments separated by expansion joints, each segment shall be designated as regular or irregular using criteria in this section. Expansion joints in this context are defined as joints that separate each structural segment in such a manner that each segment will move independently during an earthquake.*

~~*If a MOT is divided into seismically isolated sections, an evaluation of the relative movement of pipelines and supports shall be considered, including phase differences (Section 3109F.3).*~~

4.4. ***3104F.2.1 Seismic Performance Criteria ~~Design earthquake motions~~.*** *Two levels of ~~design~~ seismic performance shall be considered, except for critical systems (Section 3104F.5.1). These levels are defined as follows:*

Level 1 Seismic P~~p~~erformance: *…*

Level 2 Seismic P~~p~~erformance:

- *Controlled inelastic ~~structural~~ behavior with repairable damage*
- *Prevention of ~~structural~~ collapse*
- *Temporary loss of operations, restorable within months*
- *Prevention of major spill (≥ 1200 bbls)*

The Level 1 and Level 2 seismic performance criteria are defined in Table 31F-4-1.

4.5. ***3104F.2.3.2 Nonlinear static demand procedure.*** *...*

...

The target displacement demand of the structure, Δ_d, shall be calculated from: ~~by multiplying the spectral response acceleration, S_A, corresponding to the effective elastic structural period, T_e (see Equation (4-2) or Equation (4-8)), by $T_e^2/4\pi^2$.~~

$$\Delta_d = S_A\left(T_e^2 / 4\pi^2\right) \qquad \text{(4-1)}$$

where:

T_e = effective elastic structural period defined in Equation (4-3) or Equation (4-9)

S_A = spectral response acceleration corresponding to T_e

If T_e<T_0, where T_0 is the period corresponding to the peak of the acceleration response spectrum, a refined analysis (see Section 3104F.2.3.2.1 or 3104F.2.3.2.2) shall be used to calculate the displacement demand. In the refined analysis, the target node displacement demand may be computed from the Coefficient Method (Section 3104F.2.3.2.1) ~~of ASCE/SEI 41 [4.3] that is based on the procedure presented in FEMA 440 [4.6],~~ or the Substitute Structure Method (Section 3104F.2.3.2.2) ~~presented in Priestley et al. [4.4]~~. Both of these methods utilize the pushover curve developed in Section 3104F.2.3.1.

4.6. ***3104F.2.3.2.1 Coefficient Method.*** *The Coefficient Method is based on the procedures presented in ASCE/SEI 41 [4.3] and FEMA 440 [4.4] ~~procedure~~.*

…

The target displacement shall be calculated from:

$$\Delta_d = C_1 C_2 S_A \frac{T_e^2}{4\pi^2} \qquad \text{(4-2)}\cancel{\text{(4-1)}}$$

…

$$T_e = 2\pi\sqrt{\frac{m}{k_e}} \qquad \text{(4-3)}\cancel{\text{(4-2)}}$$

…

$$C_1 = 1 + \frac{\mu_{strength} - 1}{aT_e^2} \qquad \text{(4-4)}$$

$$\cancel{C_1 = 1 + \frac{\mu_{strenght} - 1}{\alpha T_e^2}} \qquad \cancel{\text{(4-3)}}$$

where:

a ~~α~~ = *Site class factor*

…

$\mu_{strength}$ = *ratio of elastic strength demand to yield strength coefficient calculated in accordance with Equation (4-6)~~(4-5)~~. The Coefficient Method is not applicable where* $\mu_{strength}$ *exceeds* $\mu_{\max}$ *computed from Equation (4-7)~~(4-6)~~. $\mu_{strength}$ shall not be taken as less than 1.0.*

…

$$C_2 = 1 + \frac{1}{800}\left(\frac{\mu_{strength} - 1}{T_e}\right)^2 \qquad (4\text{-}5)\cancel{(4\text{-}4)}$$

…

$$\mu_{strength} = \frac{mS_A}{F_y} \qquad (4\text{-}6)\cancel{(4\text{-}5)}$$

where:

F_y = *effective yield strength of the structure in the direction under consideration from the idealized pushover curve.*

…

$$\mu_{\max} = \frac{\Delta_d}{\Delta_y} + \frac{|\alpha_e|^{-h}}{4} \qquad (4\text{-}7)\cancel{(4\text{-}6)}$$

…

$$h = 1 + 0.15 \ln T_e \cancel{\text{, and}} \qquad (4\text{-}8)$$

α_e = *effective negative post-yield slope ratio which shall be computed from:*

$$\alpha_e = \alpha_{P-\Delta} + \lambda\left(\alpha_2 - \alpha_{P-\Delta}\right) \qquad (4\text{-}9)\cancel{(4\text{-}7)}$$

…

4.7. ***3104F.2.3.2.2 Substitute Structure Method.*** *The Substitute Structure Method is based on the procedure presented in Priestley et al. [4.5]~~[4.4]~~ and ASCE/COPRI 61 [4.2].~~ and~~ This method is~~ briefly~~ summarized below.*

1. *Idealize the pushover curve from nonlinear pushover analysis, as described in Section 3104F.2.3.2.1, and estimate the effective yield strength ~~force~~, F_y, and yield displacement, Δ_y.*
2. *Compute the effective elastic lateral stiffness, k_e, as the effective yield strength ~~force~~, F_y, divided by the yield displacement, Δ_y.*
3. *Compute the structural period in the direction under consideration from:*

$$T_e = 2\pi\sqrt{\frac{m}{k_e}}$$ (4-10)~~(4-8)~~

where:

m = seismic mass as defined in Section 3104F.2.3

k_e = effective elastic lateral stiffness in direction under consideration

4. *Determine target displacement, Δ_d, of the effective linear elastic system from:*

$$\Delta_d = S_A \frac{T_e^2}{4\pi^2}$$ (4-11)~~(4-9)~~

where:

S_A = the 5% damped spectral displacement corresponding to the linear elastic structural period, T_e

Select the initial estimate of the displacement demand as $\Delta_{d,i} = \Delta_d$.

5. *The ductility level, $\mu_{\Delta,i}$ ~~μ_Δ~~, is found from $\Delta_{d,i}/\Delta_y$ ~~Δ_d/Δ_y~~. Use the appropriate relationship between ductility and damping, for the component undergoing inelastic deformation, to estimate the effective structural damping, $\xi_{eff,i}$ ~~ξ_{eff}~~. In lieu of more detailed analysis, ~~the relationship shown in Figure 31F-4-5 or~~ Equation (4-12)~~(4-10)~~ may be used for concrete and steel piles connected to the deck through dowels embedded in the concrete. Note that the idealized pushover curves in Figure 31F-4-4 shall be utilized in Figure 31F-4-5, which illustrates the iterative procedure.*

$$\xi_{eff,i} = 0.05 + \frac{1}{\pi}\left(1 - \frac{1-\alpha_1}{\sqrt{\mu_{\Delta,i}}} - \alpha_1\sqrt{\mu_{\Delta,i}}\right)$$ (4-12)

$$\cancel{\xi_{eff} = 0.05 + \frac{1}{\pi}\left(1 - \frac{1-r}{\sqrt{\mu_\Delta}} - r\sqrt{\mu_\Delta}\right)}$$ ~~(4-10)~~

where:

α_1 ~~r~~ = ratio of second slope over elastic slope (see Figures 31F-4-4 and 31F-4-5 ~~31F-4-7~~)

Equation (4-12)~~(4-10)~~ for effective damping was developed by Kowalsky et al. [4.6]~~[4.5]~~ for the Takeda hysteresis model of system's force-displacement relationship.

6. *Compute the force, $F_{d,i}$, on the force-deformation relationship associated with the estimated displacement, $\Delta_{d,i}$ (see Figure 31F-4-5).*

7. *Compute the effective stiffness, $k_{eff,i}$, as the secant stiffness from:*

$$k_{eff,i} = \frac{F_{d,i}}{\Delta_{d,i}}$$ (4-13)

8. Compute the effective period, $T_{eff,i}$, from:

$$T_{eff,i} = 2\pi\sqrt{\frac{m}{k_{eff,i}}} \quad (4\text{-}14)$$

where:

m = seismic mass as defined in Section 3104F.2.3

9. For the effective structural period, $T_{eff,i}$, and the effective structural damping, $\xi_{eff,i}$, compute the spectral acceleration $S_A(T_{eff,i}\xi_{eff,i})$ from an appropriately damped design acceleration response spectrum.

10. Compute the new estimate of the displacement, $\Delta_{d,j}$, from:

$$\Delta_{d,j} = \frac{T_{eff,i}^2}{4\pi^2} S_A\left(T_{eff,i}, \xi_{eff,i}\right) \quad (4\text{-}15)$$

11. Repeat steps 5 to 10 with $\Delta_{d,i} = \Delta_{d,j}$ until displacement, $\Delta_{d,j}$, computed in step 10 is sufficiently close to the starting displacement, $\Delta_{d,i}$, in step 5 (Figure 31F-4-5).

~~6. From the acceleration response spectra, create elastic displacement spectra, S_D, using Equation (4-11) for various levels of damping.~~

$$\cancel{S_D = \frac{T^2}{4\pi^2} S_A} \quad \cancel{(4\text{-}11)}$$

~~7. Using the curve applicable to the effective structural damping, ξ_{eff}, find the effective period, T_d (see Figure 31F-4-6).~~

~~8. In order to convert from a design displacement response spectra to another spectra for a different damping level, the adjustment factors in Section 3103F.4.2.9 shall be used.~~

~~9. The effective secant stiffness, k_{eff}, can then be found from:~~

$$\cancel{k_{eff} = \frac{4\pi^2}{T_d^2} m} \quad \cancel{(4\text{-}12)}$$

~~where:~~

~~m = seismic mass as defined in Section 3104F.2.3~~

~~T_d = effective structural period~~

~~10. The required strength, F_u, can now be estimated by:~~

$$F_u = k_{eff}\Delta_d \quad (4\text{-}13)$$

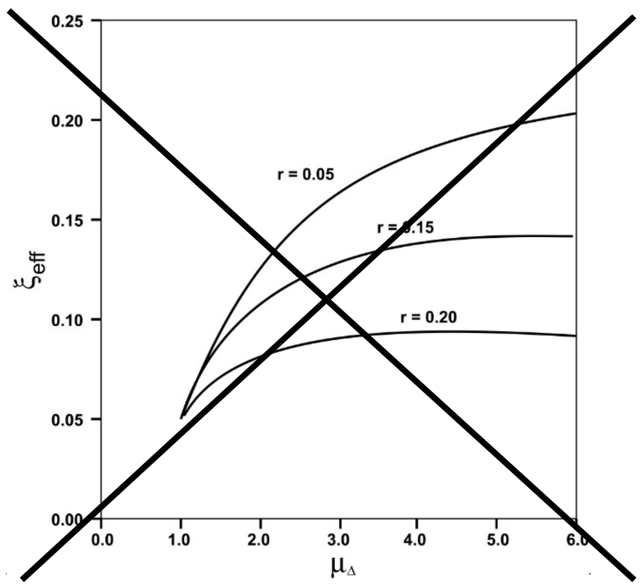
~~11. F_u and Δ_d can be plotted on the force-displacement curve established by the pushover analysis. Since this is an iterative process, the intersection of F_u and Δ_d most likely will not fall on the force-displacement curve and a second iteration will be required. An adjusted value of Δ_d, taken as~~

~~*the intersection between the force-displacement curve and a line between the origin and F_u and Δ_d, can be used to find μ_Δ.*~~

~~*12. Repeat the process until a satisfactory solution is obtained (see Figure 31F-4-7).*~~

~~*13. From pushover data, calculate the displacement components of an element along the two axis of the system.*~~

4.8. Remove entirely:



~~***FIGURE 31F-4-5***~~

~~***RELATION BETWEEN DUCTILITY, μ_Δ, AND EFFECTIVE DAMPING, ξ_{eff} [4.5]***~~

4.9. Add new Figure 31F-4-5:

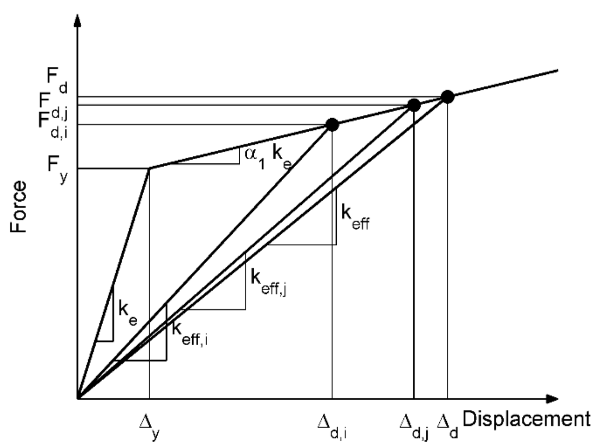
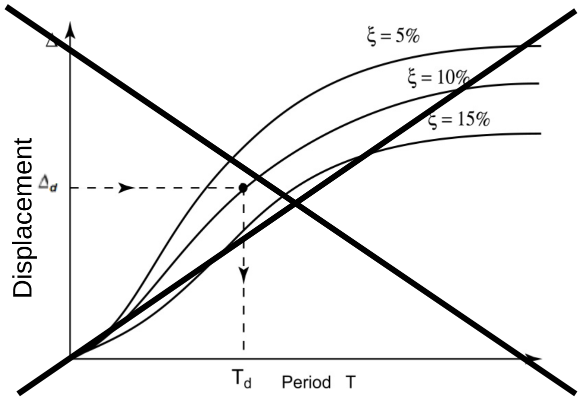


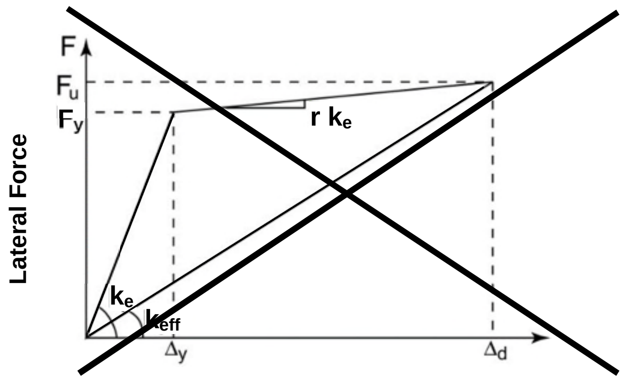
FIGURE 31F-4-5
EFFECTIVE STIFFNESS FOR SUBSTITUTE STRUCTURE METHOD

4.10. Remove entirely:



~~***FIGURE 31F-4-6***~~
~~***DESIGN DISPLACEMENT RESPONSE SPECTRA***~~

4.11. Remove entirely:



~~***FIGURE 31F-4-7***~~
~~***EFFECTIVE LATERAL STIFFNESS (ADAPTED FROM [4.4])***~~

4.12. ***3104F.2.3.3 Linear modal demand procedure.*** *…*

…

The lateral stiffness of the linear elastic response model shall be based on the initial stiffness of the nonlinear pushover curve as shown in Figure 31F-4-6 ~~31F-4-8~~ (also see Section 3106F.9). The p-y springs shall be adjusted based on the secant method approach. Most of the p-y springs will typically be based on their initial stiffness; no iteration is required.

If the fundamental period is $T<T_0$, where T_0 is the period corresponding to the peak of the acceleration response spectrum, the displacement demand from the linear modal analysis shall be amplified to account for nonlinear system behavior by an amplification factor. The amplification factor shall be equal to either $C_1 \times C_2$ per Section 3104F.2.3.2.1, or the ratio of the final target displacement and the initial elastic displacement of Equation (4-11)~~(4-9)~~ per Section 3104F.2.3.2.2.

4.13. *FIGURE 31F-4-6 ~~31F-4-8~~ STIFFNESS FOR LINEAR MODAL ANALYSIS*

4.14. ***3104F.4.2 Combination of orthogonal seismic effects.*** *The design displacement demand at an element, δ_d, shall be calculated by combining the longitudinal, δ_x, and transverse, δ_y, displacements in the horizontal plane (Figure 31F-4-7 ~~31F-4-9~~):*

$$\delta_d = \sqrt{\delta_x^2 + \delta_y^2} \qquad \text{(4-16)}\cancel{\text{(4-14)}}$$

where:

$$\delta_x = \delta_{xy} + 0.3\delta_{xx} \qquad \text{(4-17)}\cancel{\text{(4-15)}}$$

and

$$\delta_y = 0.3\delta_{yx} + \delta_{yy} \qquad \text{(4-18)}\cancel{\text{(4-16)}}$$

OR

$$\delta_y = \delta_{yx} + 0.3\delta_{yy} \qquad \text{(4-19)}\cancel{\text{(4-17)}}$$

and

$$\delta_x = 0.3\delta_{xy} + \delta_{xx} \qquad \text{(4-20)}\cancel{\text{(4-18)}}$$

whichever results in the greater design displacement demand.

4.15. ***FIGURE 31F-4-7 ~~31F-4-9~~ PLAN VIEW OF WHARF SEGMENT UNDER X AND Y SEISMIC EXCITATIONS***

4.16. ***3104F.4.3 P-Δ Effects.*** *The P-Δ effect (i.e., the additional moment induced by the total vertical load multiplied by the lateral deck deflection) shall be considered unless the following relationship is satisfied (see Figure 31F-4-8 ~~31F-4-10~~):*

$$\frac{V}{W} \geq 4\frac{\Delta_d}{H} \qquad \text{(4-21)}\cancel{\text{(4-19)}}$$

…

4.17. ***FIGURE 31F-4-8 ~~31F-4-10~~ P-Δ EFFECT***

4.18. ***3104F.4.5 Shear key forces.*** *…*

$$V_{sk} = 1.5(e/L_l)V_{\Delta T} \qquad \text{(4-22)}\cancel{\text{(4-20)}}$$

…

4.19. ***3104F.5 Nonstructural components, nonbuilding structures and building structures.*** *Nonstructural components, nonbuilding structures and building structures at MOTs shall be assessed for Level 2 seismic performance (see Section 3104F.2.1). Consideration shall be given to the adequacy and condition of supports and attachments (or anchorage), strength, flexibility, relative displacement, P-delta effects, and seismically-induced interaction with other components and structures.*

4.20. ***3104F.5.1 General.*** *Nonstructural components are mechanical, electrical and architectural components that may be required to resist the effects of earthquake, such as piping/pipelines, loading arms, lifting equipment (winches and cranes), spill prevention equipment, pumps, instrumentation and storage cabinets, and lighting fixtures.*

Nonbuilding structures are self-supporting structures that carry gravity loads and that may be required to resist the effects of earthquake (with the exception of building structures, such as control rooms), including but not limited to, gangways, hose towers and racks.

Critical systems are nonstructural components, nonbuilding structures or building structures that shall remain operational or whose failure could impair emergency operations following an earthquake, to prevent major oil spills and to protect public health, safety and the environment. A seismic assessment of the survivability and continued operation (related to personnel safety, oil spill prevention or response) during a Level 2 earthquake (see Table 31F-4-1) shall be performed for critical systems, including but not limited to, fire protection, emergency shutdown and electrical power systems.

4.21. ***3104F.5.2 Seismic assessment.*** *For existing (E) nonstructural components, nonbuilding structures and building structures and their supports and attachments, seismic assessment shall be performed in accordance with CalARP [4.8] or ASCE Guidelines [4.9], except for piping/pipelines which shall be evaluated per Section 3109F. If required, seismic evaluation and strengthening shall be performed in accordance with this section.*

For new (N) nonstructural components, nonbuilding structures and building structures and their supports and attachments, seismic evaluation and design shall be performed in accordance with this section, except for piping/pipelines which shall be evaluated per Section 3109F.

For evaluation, strengthening and design, seismic forces (demands) shall be obtained from Section 3104F.5. The seismic adequacy of nonstructural components shall be demonstrated through submission of design documentation reviewed and accepted by a registered design professional, or manufacturer's certification that the nonstructural component is seismically qualified by analysis or testing or experience data as specified in ASCE/SEI 7 [4.1]. Structures shall be analyzed in accordance with Section 3107F.5. Supports and attachments shall be assessed in accordance with Sections 3107F.7.

4.22. ***3104F.5.3 Contribution to global response of MOT structures.*** *Nonstructural components, nonbuilding structures and building structures permanently attached to MOT structures, including, but not limited to, pipelines, loading arms, hose towers/racks, raised platforms, control rooms and vapor control equipment, may affect the global structural response. In such cases, the seismic characteristics (mass and/or stiffness) of the nonstructural components, nonbuilding structures and building structures shall be considered in computing global seismic response of the MOT structures. If the seismic response of nonstructural components is determined to be out of phase (e.g. pipelines) with the global structural response, then the mass contribution can be neglected in the seismic structural analysis.*

4.23. ***3104F.5.4 Nonstructural components and nonbuilding structures permanently attached to MOT structures.*** *This section covers nonstructural components and nonbuilding structures having a significant mass and/or ~~a critical~~ importance to the operability and safety of the MOT, and that are permanently attached to MOT structures (e.g., wharves, trestles, dolphins). The weight of nonstructural components and nonbuilding structures shall be included in the dead load of the structure per Section 3103F.2.*

Computation of seismic effects shall consider:

1. Amplification of acceleration from ground to location of attachment of the nonstructural component or nonbuilding structure to the deck due to flexibility of the MOT structure, and

2. Amplification of acceleration due to flexibility of the nonstructural component or nonbuilding structure.

The following are not covered in this section and shall be assessed using rational approach that includes consideration of strength, stiffness, ductility, and seismic interaction with all other connected components and with the supporting structures or systems, subject to Division approval:

1. Nonstructural component supported by other nonstructural system permanently attached to MOT structure;

2. Nonstructural component or nonbuilding structure supported by other structure permanently attached to MOT structure;

3. Nonstructural component or nonbuilding structure attached to multiple MOT structures;

4. Nonstructural component or nonbuilding structure attached to structure and ground.

4.24. ~~***3104F.5.1 Contribution to global response.*** *Nonstructural components including, but not limited to pipelines, loading arms, raised platforms, control rooms and vapor control equipment, may affect the global structural response. In such cases, the seismic characteristics (mass and/or stiffness) of the nonstructural components shall be considered. If the seismic response of nonstructural components is out of phase with the global structural response, then the mass contribution can be neglected in the seismic structural analysis.*~~

4.25. ~~***3104F.5.2 Seismic assessment.*** *In general, for nonstructural components, the evaluation procedures of Section 3110F.8 apply.*~~

~~*For pipelines, the seismic analysis shall be performed in accordance with Section 3109F.3, in lieu of Section 3110F.8. If a pipeline analysis has been performed and support reactions are available, they may be used to determine the forces on the support structure.*~~

4.26. ~~***3104F.6 Nonstructural critical systems assessment.*** *A seismic assessment of the survivability and continued operation during a Level 2 earthquake (see Table 31F-4-1) shall be performed for critical systems such as fire protection, emergency shutdown and electrical power systems. The assessment shall consider the adequacy and condition of anchorage, flexibility and seismically-induced interaction. For existing systems, seismic adequacy may be assessed per CalARP [4.8].*~~

4.27. ***3104F.5.4.1 Seismic loads.*** *This section specifies the procedure to compute seismic loads on nonstructural components and nonbuilding structures permanently attached to a MOT structure.*

The following nonstructural components are exempt from the requirements of this section:

1. *Temporary or movable equipment unless part of a critical system (Section 3104F.5.1);*
2. *Mechanical and electrical components that are attached to the MOT structure and have flexible connections to associated piping and conduit; and either:*
   (a) *The component weighs 400 lb or less, the center of mass is located 4 ft or less above the MOT deck, and the component Importance Factor,* I_p *, is equal to 1.0; or*
   (b) *The component weighs 20 lb or less, or in the case of a distributed system, 5 lb/ft or less.*

4.28. ***3104F.5.4.1.1 Simplified Procedure****. The Simplified Procedure may be used to estimate seismic loads on nonstructural components and nonbuilding structures permanently attached to a MOT structure. The Simplified Procedure shall not be used if any of the following apply:*

1. *Mass of the nonstructural component or nonbuilding structure exceeds 25% of the combined mass of the MOT structure plus nonstructural component or nonbuilding structure;*
2. *Multiple nonstructural components or nonbuilding structures of similar type (or natural period) when their combined mass exceeds 25% of the total mass of the MOT structure plus nonstructural components or nonbuilding structures;*
3. *Concrete/Steel MOT structure with irregular configuration (Section 3104F.1.3 and Table 31F-4-2) and high or medium spill exposure classification.*

The horizontal seismic force, F_p*, shall be computed as follows [4.10]:*

$$F_p = \frac{1.2 S_{XS} a_p I_p W_p}{R_p} \qquad (4\text{-}23)$$

$$0.3 S_{XS} I_p W_p \le F_p \le 1.6 S_{XS} I_p W_p$$

where:

S_{XS} *= spectral acceleration in Section 3103F.4.2.4 or Section 3103F.4.2.5, at 0.2 seconds*

a_p *= amplification factor for nonstructural component or nonbuilding structure (Table 31F-4-3)*

I_p *= importance factor for nonstructural component or nonbuilding structure (Table 31F-4-4)*

W_p *= weight of the nonstructural component or nonbuilding structure*

R_p = *response modification factor for nonstructural component or nonbuilding structure (Table 31F-4-5)*

Alternatively, when dynamic properties of the MOT structure are available, the horizontal seismic force, F_p, may be computed from [4.10]:

$$F_p = \frac{a_p S_A I_p A_x W_p}{R_p} \quad (4\text{-}24)$$

$$0.3 S_{XS} I_p W_p \le F_p \le 1.6 S_{XS} I_p W_p$$

where:

S_A = *spectral acceleration in Section 3103F.4.2.4 or Section 3103F.4.2.5, at the period equal to the fundamental period of the MOT structure, T, in direction under consideration*

A_x = *torsional amplification factor given by:*

$$A_x = \left(\frac{\Delta_m}{1.2 \Delta_{avg}} \right)^2 \quad (4\text{-}25)$$

$$1 \le A_x \le 3$$

where:

Δ_m = *maximum displacement at one end of the MOT structure transverse to an axis*

Δ_{avg} = *average of the displacements at the extreme points of the MOT structure (see Figure 31F-4-1)*

The horizontal seismic force, F_p, in the direction under consideration shall be applied at the center of gravity and distributed relative to the mass distribution of the nonstructural component or nonbuilding structure.

The horizontal seismic force, F_p, shall be applied independently in at least two orthogonal horizontal directions in combination with service or operating loads associated with the nonstructural component or nonbuilding structure, as appropriate. For vertically cantilevered systems, however, F_p shall be assumed to act in any horizontal direction.

The concurrent vertical seismic force, F_v, shall be applied at the center of gravity and distributed relative to the mass distribution of the nonstructural component or nonbuilding structure, as follows:

$$F_v = \pm 0.2 S_{XS} W_p \quad (4\text{-}26)$$

4.29. Add new Table 31F-4-3:

TABLE 31F-4-3
AMPLIFICATION FACTORS FOR
NONSTRUCTURAL COMPONENTS AND NONBUILDING STRUCTURES

COMPONENT OR STRUCTURE	a_p[1,2]
Rigid components or structures (period less than 0.06 seconds)	*1.0*
Rigidly attached components or structures	*1.0*
Flexible components or structures (period longer than 0.06 seconds)	*2.5*
Flexibly attached components or structures	*2.5*

1. A lower value shall not be used unless justified by detailed dynamic analysis, and shall in no case be less than 1.0.

2. If the fundamental period of the MOT structure, T, and the period of the flexible nonstructural component or nonbuilding structure, T_p, is known, a_p may be estimated 24) from Figure 31F-4-9.

4.30. Add new Figure 31F-4-9:

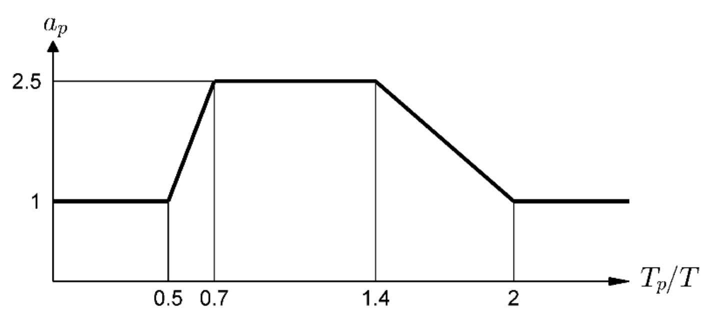


FIGURE 31F-4-9
AMPLIFICATION FACTOR, a_p [4.10]

4.31. Add new Table 31F-4-4:

TABLE 31F-4-4
IMPORTANCE FACTORS FOR
NONSTRUCTURAL COMPONENTS AND NONBUILDING STRUCTURES

COMPONENT OR STRUCTURE	I_p
Critical[1]	*1.5*
Other	*1.0*

1. See Section 3104F.5.1 for definition of critical system.

4.32. Add new Table 31F-4-5:

TABLE 31F-4-5
RESPONSE MODIFICATION FACTORS FOR
NONSTRUCTURAL COMPONENTS AND NONBUILDING STRUCTURES

COMPONENT OR STRUCTURE	R_p
Critical[1]	*1.0*
Loading arms	*3.0*
Piping/pipelines (welded)	*12.0*
Piping/pipelines (threaded or flanged)	*6.0*
Pumps	*2.5*
Skids	*2.5*
Tanks and totes	*2.5*
Light fixtures (or luminaires)	*1.5*
Electrical conduits and cable trays	*6.0*
Mooring hardware	*2.5*
Velocity monitoring equipment	*2.5*
Instrumentation or storage cabinets	*6.0*
Cranes	*2.5*
Gangway (column systems)	*3.0*
Gangways (truss systems)	*Use* R_p *from frame systems*
Hose towers and racks	*Use* R_p *from frame systems*
Frame systems:	
Steel special concentrically braced frames	*6.0*
Steel ordinary concentrically braced frames	*3.5*
Steel special moment frames	*8.0*
Steel intermediate moment frames	*4.5*
Steel ordinary moment frames	*3.5*
Lightframe wood sheathed with wood structural panels	*6.5*
Lightframe cold-formed steel sheathed with wood structural panels	*6.5*
Lightframe walls with shear panels of other materials	*2.0*
Other	*Subject to Division approval*

1. See Section 3104F.5.1 for definition of critical system.

4.33. ***3104F.5.4.1.2 Linear modal demand procedure.*** *The linear modal demand procedure (Section 3104F.2.3.3) may always be used and shall be used to estimate seismic forces when the Simplified Procedure (Section 3104F.5.4.1.1) is not permitted. The MOT structure and nonstructural components and/or nonbuilding structures shall be modeled explicitly. The seismic forces obtained from the linear modal demand procedure shall be adjusted for appropriate importance factors and response modification factors as specified in Table 31F-4-4 and Table 31F-4-5.*

4.34. ***3104F.5.5 Nonstructural components and nonbuilding structures permanently attached to the ground.*** *The seismic load shall be computed using the procedures in ASCE/SEI 7 [4.1], except that Level 2 design earthquake motion parameters defined in Section 3103F.4 shall be used in lieu of those specified in ASCE/SEI 7 [4.1].*

4.35. ***3104F.5.6 Building structures.*** *For buildings permanently attached to MOT structure, Section 3104F.5.4.1 shall be used to compute seismic loads. Computation of seismic effects shall consider:*

1. *Amplification of acceleration from ground to location of attachment of the building to the deck due to flexibility of the MOT structure, and*

2. *Amplification of acceleration due to flexibility of the building.*

For buildings permanently attached to the ground, seismic loads shall be computed using the procedures in ASCE/SEI 7 [4.1], as amended by the local enforcing agency requirements, subject to Division approval.

4.36. ***3104F.6~~7~~ Symbols.***

a ~~α~~	=	*Site class factor*
a_p	=	*Amplification factor for nonstructural component or nonbuilding structure*
A_x	=	*Torsional amplification factor*
…		
e	=	…
$F_{d,i}$	=	*Force at step i of iteration*
$F_{d,j}$	=	*Force at step j of iteration*
F_p	=	*Horizontal seismic force on nonstructural component, nonbuilding structure or building structure supported on MOT*
~~F_u~~	~~=~~	~~*Required strength at maximum response*~~
F_v	=	*Vertical seismic force on nonstructural component, nonbuilding structure or building structure supported on MOT*
…		
H	=	…
I_p	=	*Importance factor for nonstructural component or nonbuilding structure*
k_e	=	…
~~k_{eff}~~	~~=~~	~~*Effective secant lateral stiffness*~~
$k_{eff,i}$	=	*Effective secant lateral stiffness at step i of iteration*
$k_{eff,j}$	=	*Effective secant lateral stiffness at step j of iteration*
…		
~~r~~	~~=~~	~~*Ratio of second slope over elastic slope*~~

R_p	=	*Response modification factor for nonstructural component or nonbuilding structure*
S_A	=	…
~~S_D~~	~~=~~	~~*Displacement response spectrum at T*~~
S_{SX}	=	*Spectral acceleration in Section 3103F.4.2.4 or Section 3103F.4.2.5, at 0.2 seconds*
…		
~~T_d~~	~~=~~	~~*Effective structural period*~~
T_e	=	…
$T_{eff,i}$	=	*Effective structural period at step i of iteration*
T_p	=	*Period of flexible nonstructural component or nonbuilding structure*
T_0	=	*Period at peak of the acceleration response spectrum*
…		
W	=	…
W_p	=	*Weight of the nonstructural component or nonbuilding structure*
...		
Δ_d	=	*Target displacement demand*
$\Delta_{d,i}$	=	*Target displacement demand at step i of iteration*
$\Delta_{d,j}$	=	*Target displacement demand at step j of iteration*
...		
~~μ_Δ~~	~~=~~	~~*Ductility level*~~
$\mu_{\Delta,i}$	=	*Initial ductility level*
...		
~~ξ_{eff} or ξ~~	~~=~~	~~*Effective structural damping*~~
$\xi_{eff,i}$	=	*Effective structural damping at step i of iteration*

4.37. *3104F.7 References.*

[4.1] American Society of Civil Engineers (ASCE), 2016 ~~2010~~, ASCE/SEI 7-16~~0~~ (ASCE/SEI 7), "Minimum Design Loads and Associated Criteria for Buildings and Other Structures," Reston, VA.

[4.2] American Society of Civil Engineers (ASCE), 2014, ASCE/COPRI 61-14 (ASCE/COPRI 61), "Seismic Design of Piers and Wharves," Reston, VA.

[4.3] American Society of Civil Engineers (ASCE), 2017 ~~2014~~, ASCE/SEI 41-17~~3~~ (ASCE/SEI 41), "Seismic Evaluation and Retrofit of Existing Buildings," Reston, VA.

[4.4] Federal Emergency Management Agency (FEMA), June 2005, FEMA 440, "Improvement of Nonlinear Static Seismic Analysis Procedures," Redwood City, CA.

[4.5~~4~~] Priestley, M.J.N., Seible, F., Calvi, G.M., 1996, "Seismic Design and Retrofit of Bridges," John Wiley & Sons, Inc., New York.

[4.6~~5~~] Kowalsky, M.J., Priestley, M.J.N, MacRae, G.A., 1994, "Displacement-Based Design – A Methodology for Seismic Design Applied to Single Degree of Freedom Reinforced Concrete Structures," Report No. SSRP – 94/16, University of California, San Diego.

~~[4.6] Federal Emergency Management Agency (FEMA), June 2005, FEMA 440, "Improvement of Nonlinear Static Seismic Analysis Procedures," Redwood City, CA.~~

[4.7] Ferritto, J., Dickenson, S., Priestley N., Werner, S., Taylor, C., Burke, D., Seelig, W., and Kelly, S., 1999, "Seismic Criteria for California Marine Oil Terminals," Vol.1 and Vol.2, Technical Report TR-2103-SHR, Naval Facilities Engineering Service Center, Port Hueneme, CA.

[4.8] CalARP Program Seismic Guidance Committee, December 2013, "Guidance for California Accidental Release Prevention (CalARP) Program Seismic Assessments," Sacramento, CA.

[4.9] American Society of Civil Engineers, 2011, "Guidelines for Seismic Evaluation and Design of Petrochemical Facilities," 2nd ed., New York.

[4.10] Goel, R. K., 2017, "Estimating Seismic Forces in Ancillary Components and Nonbuilding Structures Supported on Piers, Wharves, and Marine Oil Terminals," Earthquake Spectra, https://doi.org/10.1193/041017EQS068M.

Authority: Sections 8750 through 8760, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

Notation
Authority: Sections 8750 through 8760, Public Resources Code.
References: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

DIVISION 5
SECTION 3105F
MOORING AND BERTHING ANALYSIS AND DESIGN

5.1. ***3105F.1.3 Mooring/berthing requirements.*** *Multiple berth MOTs shall use the same environmental input conditions for each berth unless it can be demonstrated that there are significant differences.*

MOTs shall have the following equipment in operation:

1. *An anemometer (N/E).*
2. *A current meter in high velocity current (>1.5 knots) areas (N/E).*
3. *Remote reading tension load devices in high velocity current (>1.5 knots) areas and/or with passing vessel effects for new MOTs.*
4. *Mooring hardware in accordance with Section 3105F.8 ~~3103F.10~~ (N/E).*

Berthing systems shall be in accordance with Section 3105F.4 (N/E).

Monitoring systems and instrumentation shall be implemented considering the parameters in Section 3102F.3.6.1, and shall be installed, maintained and calibrated in accordance with Section 3111F.9.3.

5.2. ***3105F.1.4 New MOTs.*** *… Quick release hooks shall be sized in accordance with Section 3105F.8 ~~3103F.10~~. …*

5.3. ***3105F.1.5 Analysis and design of mooring components.*** *… Structural characteristics of the MOT, including type and configuration of mooring fittings such as bollards, bitts, hooks and capstans and material properties and condition, shall be determined in accordance with Sections 3107F.7 ~~3107F.4~~ and 3105F.8 ~~3103F.10~~.*

The analysis and design of mooring components shall be based on the loading combinations and safety factors defined in Sections 3103F.8, 3105F.7 and 3105F.8 ~~through 3103F.10~~, and in accordance with ACI 318 [5.1], AISC 325 [5.2] and ANSI/ AWC NDS [5.3], as applicable.

5.4. ***3105F.2 Mooring analyses.*** *A mooring analysis shall be performed for each berthing system, to justify the safe berthing of the various ~~deadweight capacities of~~ vessels ~~expected~~ at the MOT. Review of vessels calling at the MOT shall be performed to identify representative vessel size ranges and mooring configurations. Vessels analyzed shall be representative of the upper bound of each vessel size range defined. The Terminal Operating Limits (TOLs) shall be generated based on the mooring analyses (see Section 3102F.3.6.1 and Figure 31F-2-1).*

The forces acting on a moored vessel shall be determined in accordance with Section 3103F.5. Mooring line and breasting load combinations shall be in accordance with Section 3103F.8.

Two procedures, manual and numerical, are available for performing mooring analyses. These procedures shall conform to either the OCIMF (MEG 3) [5.4] or UFC 4-159-03 [5.5]. The manual procedure (Section 3105F.2.1) may be used for barges. In order to simplify the analysis for barges (or other small vessels), they may be considered to be solid free-standing walls (Chapter 29 of ASCE/SEI 7 [5.6]). This will eliminate the need to perform a computer assisted mooring analysis.

A new mooring assessment shall be performed when conditions change, such as any modification in the mooring configuration, vessel size or new information indicating greater wind, current or other environmental loads.

~~In general, vessels shall remain in contact with the breasting or fendering system. Vessel motion (sway) of up to 2 feet off the breasting structure may be allowed under the most severe environmental loads, unless greater movement can be justified by an appropriate mooring analysis that accounts for potential dynamic effects. The allowable movement shall be consistent with mooring analysis results, indicating that forces in the mooring lines and their supports are within the allowable safety factors. Also, a check shall be made as to whether the movement is within the limitations of the cargo transfer equipment.~~

The most severe combination of the environmental loads and limiting conditions shall be justified based on site-specific evaluation, and considered in the mooring analyses ~~has to be identified for each mooring component~~. At a minimum, the following ~~conditions~~ shall be considered and documented:

1. *Two current directions (maximum ebb and flood; See Section 3103F.5.3)*
2. *Two tide levels (highest high and lowest low)*
3. *Two vessel loading conditions (ballast and maximum draft at the terminal)*
4. *Eight wind directions (45 degree increments)*
5. *Vessel motion limits (as applicable) ~~The maximum allowable extension limits of the loading arms and/or hoses.~~*
6. *Fender properties ~~The maximum allowable compression/deflection of the fender system.~~*
7. *Mooring hardware capacities*
8. *Minimum mooring line properties (such as MBL of the weakest line permitted for vessel size range)*
9. *Passing vessel forces*

In general, vessels shall remain in contact with the breasting or fendering system. Vessel motion (sway) of up to 2 feet off the breasting structure may be allowed under the most severe environmental loads, unless greater movement can be justified by an appropriate mooring analysis that accounts for potential dynamic effects. The allowable movement shall be consistent with mooring analysis results, indicating that forces in the mooring lines and their supports are within the allowable safety factors. Also, a check shall be made as to whether the movement is within the limitations of the cargo transfer equipment.

The mooring analyses outputs define the wind load and other limitations.

Upon completion of the mooring analyses, the following shall be checked, as applicable:

1. *The fender system compression/deflection performance.*

2. *Anchorage capacity of each mooring hardware component.*

3. *Capacity of supporting structure(s) exceed each mooring line demand.*

4. *Maximum allowable capacities for mooring lines.*

5. *Vessel motion does not exceed the maximum allowable extension limits of the loading arms and/or hoses.*

5.5. ***3105F.3.2 Passing vessels.*** *…*

…The guidelines established in ~~the Department of Defense, UFC 4-150-06,~~ Figure 5-17 of UFC 4-150-06 [5.7]~~[5.6]~~ for interior channels may be used. The "vertical bank" in Figure 5-17 of UFC 4-150-06 [5.7]~~[5.6]~~ shall be replaced by the side of the moored vessel when establishing the distance, "L."

…

5.6. ***3105F.3.3 Seiche.*** *…*

…Seiche typically has wave periods ranging from 20 seconds up to several hours, with wave heights in the range of 0.1 to 0.4 ft [5.7]~~[5.6]~~.

…

1. *… Use Chapter 2 of UFC 4-150-06 [5.7]~~[5.6]~~ to calculate the wave period and length for different modes. …*

2. *…*

3. *… Methods outlined in a paper by F.A. Kilner [5.8]~~[5.7]~~ can be used to calculate the vessel motion.*

4. *…*

5.7. ***3105F.4 Berthing analysis and design.*** *The analysis and design of berthing components shall be based on the loading combinations and safety factors defined in Sections 3103F.8 and 3105F.7 ~~3103F.9~~, and in accordance with ACI 318 [5.1], AISC 325 [5.2], and ANSI/AWC NDS [5.3], as applicable.*

5.8. ***3105F.4.5 Design and selection of new fender systems.*** *For guidelines on new fender designs, refer to UFC 4-152-01 [5.9]~~[5.8]~~ and PIANC [5.10]~~[5.9]~~. Velocity and temperature factors, contact angle effects and manufacturing tolerances shall be considered (see Appendices A and B of PIANC [5.10]~~[5.9]~~). Also, see Section 3103F.6.*

5.9. ***3105F.6 Offshore moorings.*** *Offshore MOT moorings shall be designed and analyzed considering the site water depth, metocean environment and class of vessels calling per OCIMF MEG3 [5.4] or UFC 4-159-03 [5.5] ~~UFC 4-152-01 [5.8].~~*

5.10. ***3105F.6.2 Design of mooring components.*** *Design of mooring components shall be based on loading combinations and safety factors defined in Sections 3103F.8, 3105F.7 and 3105F.8 ~~through 3103F.10~~ and follow the guidelines provided in either the OCIMF MEG3 [5.4] or UFC 4-159-03 [5.5].*

5.11. ***3105F.7 Safety factors for mooring lines.*** *Safety factors for different material types of mooring lines are given in Table 31F-5-3. The safety factors should be applied to the minimum number of lines specified by the mooring analysis, using the highest loads calculated for the environmental conditions. The minimum breaking load (MBL) of new ropes is obtained from the certificate issued by the manufacturer. If nylon tails are used in combination with steel wire ropes, the safety factor shall be based on the weaker of the two ropes.*

5.12. Add Table 31F-5-3:

TABLE 31F-5-3
SAFETY FACTORS FOR ROPES [5.4]

Steel Wire Rope	*1.82*
Polyamide	*2.22*
Other Synthetic	*2.00*
Polyamide Tail for Wire Mooring Lines	*2.50*
Other Synthetic Tail for Wire Mooring Lines	*2.28*
Polyamide Tail for Synthetic Mooring Lines	*2.75*
Other Synthetic Tail for Synthetic Mooring Lines	*2.50*
Joining Shackles	*2.00*

5.13. ***3105F.8 Mooring hardware (N/E).*** *Mooring hardware shall include but not be limited to bollards, quick release hooks, other mooring fittings and base bolts. All mooring hardware shall be clearly marked with their safe working loads (or allowable working loads) [5.4]. The certificate issued by the manufacturer normally defines the safe working loads of this hardware.*

5.14. ***3105F.8.1 Quick release hooks.*** *For new MOTs or berthing systems, a minimum of three quick-release hooks are required for each breasting line location for tankers greater than or equal to 50,000 DWT. At least two hooks at each location shall be provided for breasting lines for tankers less than 50,000 DWT. Remote release may be considered for emergency situations.*

All hooks and supporting structures shall withstand the minimum breaking load (MBL) of the strongest line with a safety factor of 1.2 or greater. Only one mooring line shall be placed on each quick release hook (N/E).

For multiple quick release hooks, the minimum horizontal load for the design of the tie-down shall be:

$$F_d = 1.2 \times MBL \times [1+0.75\,(n-1)] \qquad (5\text{-}4)$$

where:

F_d = *Minimum factored demand for assembly tie-down.*

n = *Number of hooks on the assembly.*

The capacity of the supporting structures must be larger than F_d (See Section 3107F.6).

5.15. ***3105F.8.2 Other fittings.*** *Other fittings include cleats, bitts and bollards.*

If the allowable working loads for existing fittings are not available, the values listed in Table 31F-5-4 may be used for typical sizes, bolt patterns and layout. The allowable working loads are defined for mooring line angles up to 60 degrees from the horizontal. The combination of vertical and horizontal loads shall be considered.

5.16. Add new Table 31F-5-4:

TABLE 31F-5-4
ALLOWABLE WORKING LOADS

TYPE OF FITTINGS	***NO. OF BOLTS***	***BOLT SIZE (in)***	***WORKING LOAD (kips)***
30 in. Cleat	*4*	*1 1/8*	*20*
42 in. Cleat	*6*	*1 1/8*	*40*
Low Bitt	*10*	*1 5/8*	*60 per column*
High Bitt	*10*	*1 ¾*	*75 per column*
44 ½ in. Fit. Bollard	*4*	*1 ¾*	*70*
44 ½ in. Fit. Bollard	*8*	*2 ¼*	*200*
48 in. Fit. Bollard	*12*	*2 ¾*	*450*

Note: This table is modified from Table 6-11 of UFC 4-159-03 [5.5]

5.17. ***3105F.8.3 Base bolts.*** *Base bolts are subjected to both shear and uplift. Forces on bolts shall be determined using the following factors:*

1. *Height of load application on bitts or bollards.*
2. *Actual vertical angles of mooring lines for the highest and lowest tide and vessel draft conditions, for all sizes of vessels at each particular berth.*
3. *Actual horizontal angles from the mooring line configurations, for all vessel sizes and positions at each particular berth.*
4. *Simultaneous loads from more than one vessel.*

For existing MOTs, the deteriorated condition of the base bolts and supporting members shall be considered in determining the capacity of the fitting.

5.18. ***3105F.9~~7~~ Symbols.***

…

F	=	…
F_d	=	*Minimum factored demand for assembly tie-down*
L	=	…
MBL	=	*Minimum breaking load*
n	=	*Number of hooks on the assembly*

…

5.19. ***3105F.10~~8~~ References.***

...

[5.2] American Institute of Steel Construction, Inc. (AISC), 2017 ~~2011~~, AISC 325-17~~11~~ (AISC 325), "Steel Construction Manual," 15th ~~14th~~ ed., Chicago, IL.

[5.3] American Wood Council (AWC), 2017 ~~2014~~, ANSI/AWC NDS-2018~~15~~ (ANSI/AWC NDS), "National Design Specification (NDS) for Wood Construction," Washington, D.C.

…

[5.5] Department of Defense, 3 October 2005 (Change 2, 23 June 2016) ~~(Revised 1 September 2012)~~, Unified Facilities Criteria (UFC) 4-159-03, "Design: Moorings," Washington, D.C.

[5.6] American Society of Civil Engineers (ASCE), 2016, ASCE/SEI 7-16 (ASCE/SEI 7), "Minimum Design Loads and Associated Criteria for Buildings and Other Structures," Reston, VA.

[5.7~~6~~] Department of Defense, 12 December 2001 (Change 1, ~~Revised~~ 19 October 2010), Unified Facilities Criteria (UFC) 4-150-06, "Military Harbors and Coastal Facilities" Washington D.C.

[5.8~~7~~] ...

[5.9~~8~~] *Department of Defense, 24 January 2017 ~~28 July 2005 (Revised 1 September 2012)~~, Unified Facilities Criteria (UFC) 4-152-01, "Design: Piers and Wharves," Washington, D.C.*

[5.10~~9~~] …

Authority: Sections 8750 through 8760, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

Notation
Authority: Sections 8750 through 8760, Public Resources Code.
References: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

DIVISION 6
SECTION 3106F
GEOTECHNICAL HAZARDS AND FOUNDATIONS

6.1. ***3106F.10.2 Kinematic loading from lateral spreading.*** *Kinematic pile loading from permanent lateral spread ground deformation in deep seated levels of slope/embankment/dike foundation soils shall be evaluated. The lateral deformations shall be restricted such that the structural performance of foundation piles is not compromised.*

The lateral deformation of the embankment or dike and associated piles and foundation soils shall be determined using analytical methods as follows:

1. *…*
2. *For the pushover analysis, the estimated displacements may be uniformly distributed within the thickness of the weak soil layer (i.e., zero at and below the bottom of the layer to the maximum value at and above the top of the weak layer)~~, or as appropriate~~. <u>The thickness of the weak soil layer shall not be more than five times the pile diameter or 10 feet, whichever is smaller.</u>*
3. *...*

Notation
Authority: Sections 8750 through 8760, Public Resources Code.
References: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

DIVISION 7
SECTION 3107F
STRUCTURAL ANALYSIS AND DESIGN OF COMPONENTS

7.1. ***3107F.1.1 Purpose.*** *This section establishes the minimum performance standards for structural and nonstructural components. Evaluation procedures for seismic performance, strength and deformation characteristics of concrete, steel and timber components are prescribed herein. Analytical procedures for seismic assessment ~~structural systems~~ are presented in Section 3104F.*

7.2. ***3107F.1.2 Applicability.*** *This section addresses MOT~~s~~ structures constructed using the following structural components:*

1. *Reinforced concrete decks supported by batter and/or vertical concrete piles*
2. *Reinforced concrete decks supported by batter and/or vertical steel piles, including pipe piles filled with concrete*
3. *Reinforced concrete decks supported by batter and/or vertical timber piles*
4. *Timber decks supported by batter or vertical timber, concrete or steel pipe piles*
5. *Retaining structures constructed of steel, concrete sheet piles or reinforced concrete*

Additionally, this section addresses structural and nonstructural components, nonbuilding structures and building structures comprised of steel, concrete or timber.

7.3. ***3107F.2.1 Component strength.*** *…* [Correct indentation of paragraph beginning with *"In addition…"*]

7.4. ***3107F.2.1.1 Material properties.*** *…*

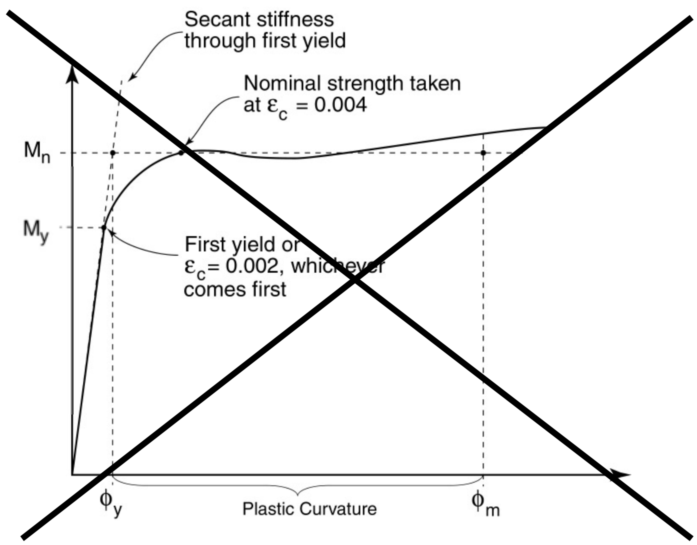
Based on a historical review of the building materials used in the twentieth century, guidelines for tensile and yield properties of concrete reinforcing bars and the compressive strength of structural concrete have been established (see Tables 10-2 to 10-4 of ASCE/SEI 41 [7.3]) ~~(see Tables 6-1 to 6-3 of FEMA 356 [7.3]~~. … The values in Tables 31F-7-1 and 31F-7-2, are adjusted according to ~~e~~Equations (7-1) through (7-3).

7.5. ***3107F.2.1.2 Knowledge factor (k).*** *…*

The knowledge factor, k, is 1.0 when comprehensive knowledge as specified above is utilized. Otherwise, the knowledge factor shall be 0.75 (see Section 5.2.6 of ASCE/SEI 41 [7.3]) ~~(see Table 2-1 of FEMA 356 [7.3])~~.

7.6. ***3107F.2.2 Component stiffness.*** *…However, in lieu of using nonlinear methods to establish the stiffness and moment curvature relation of structural components, the equations of Table 31F-7-3 may be used to approximate the effective elastic stiffness, EI_e, for lateral analyses (see Section 3107F.8~~5~~ for definition of symbols).*

7.7. Remove entirely:



~~FIGURE 31F-7-4~~
~~METHOD A – MOMENT CURVATURE ANALYSIS~~

7.8. Add new Figure 31F-7-4:

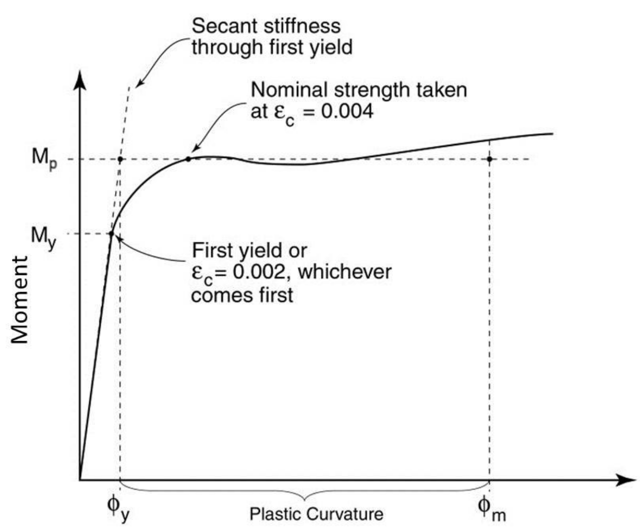


FIGURE 31F-7-4
METHOD A – MOMENT CURVATURE ANALYSIS

7.9. ***3107F.2.5.6 Component acceptance/damage criteria.*** *…The ~~following~~ limiting values (Table 31F-7-5) apply for each performance level for both existing and new structures…*

7.10. ***3107F.2.7.1 Joint shear capacity.*** *…*

…

$$\boldsymbol{\nu_j = \frac{0.9\, M_o}{\sqrt{2}\; l_{dv}\, D_p^2}} \qquad \textit{(7-23)}$$

$$\cancel{\boldsymbol{\nu_j = \frac{0.9\, M_p}{\sqrt{2}\; l_{dv}\, D_p^2}}} \qquad \textit{~~(7-23)~~}$$

where:

…

M_o ~~M_p~~= Overstrength ~~Over strength~~ moment demand of the plastic hinge (the maximum possible moment in the pile) as determined from the procedure of Section 3107F.2.5.7

…

… Note, if the pile is subjected to axial tension under seismic load, the value of N, and f_a ~~fa~~ will be negative.

…

$$\boldsymbol{M_c = \left(\frac{1}{0.9}\right)\sqrt{2}\;\nu_j\, l_{dv}\, D_p^2 \;\le\; M_o} \qquad \textit{(7-27)}$$

$$\cancel{\boldsymbol{M_c = \left(\frac{1}{.90}\right)\sqrt{2}\;\nu_j\, l_{dv}\, D_p^2 \;\le\; M_p}} \qquad \textit{~~(7-27)~~}$$

…

$$\boldsymbol{M_{c,r} = 2A_s f_y(h_d - d_c) + N\left(\frac{D_p}{2} - d_c\right)} \qquad \textit{(7-28)}$$

where:

…

In addition, the bottom deck steel ($A_{s,\,deckbottom}$) ~~(A_s, deckbottom)~~ area within h_d/2 of the face of the pile shall satisfy: …

$$\phi'_y = \frac{\phi_y M_c}{M_p} \qquad \textit{(7-30)}$$

$$\cancel{\phi'_y = \frac{\phi_y M_c}{M_n}}$$ ~~*(7-30)*~~

where:

M_p = Idealized plastic moment capacity from Method A or B (see Figure 31F-7-4 or 31F-7-5, respectively)

~~*M_n is defined in Figure 31F-7-4.*~~

…

where:

L_p = Plastic hinge length as determined from Equation (7-5)

~~*Where L_p is given by Equation (7-5).*~~

…

$$\phi'_u = \phi_p + \frac{\phi_y M_{c,r}}{M_p}$$ *(7-32)*

$$\cancel{\phi'_u = \phi_p + \frac{\phi_y M_{c,r}}{M_n}}$$ ~~*(7-32)*~~

where:

M_p = Idealized plastic moment capacity from Method A or B (see Figure 31F-7-4 or 31F-7-5, respectively)

~~*Note that*~~ *$M_{c,r}$ = 0, unless deck stirrups are present as discussed above. Examples of adjusted moment curvature relationships are shown in Figure 31F-7-13.*

7.11. ***FIGURE 31F-7-12~~1~~ JOINT ROTATION***

7.12. ***3107F.2.8.1 Existing ordinary batter piles.*** *…* [Correct indentation of paragraph beginning with *"As an example, …"*]

7.13. ***3107F.2.8.2 Nonordinary batter piles.*** *…*

For fused and seismic release mechanism batter pile systems, a nonlinear modeling procedure shall be used and peer reviewed (Section 3101F.8.2 ~~3108F.8.2~~).

7.14. ***3107F.3.3.2 Displacement capacity.*** *…For pier-type (long unsupported length) vertical piles, three simplified procedures to determine fixity or displacement capacity are described in UFC 4-151-10 [7.12], UFC 3-220-01~~01A~~ [7.13] and Chai [7.14]. …*

7.15. ***3107F.5 Nonbuilding structures and building structures.*** *The analysis of nonbuilding structures and building structures shall be based on the load combinations defined in Section 3103F.8 with seismic assessment per Section 3104F.5. The component strength in nonbuilding structures and building structures shall be established in accordance with AISC [7.10], ACI-318 [7.7], ANSI/AWC NDS [7.11], accounting for existing condition with knowledge factors applied, as appropriate. For strength evaluation of supports and attachments, see Section 3107F.7.*

7.16. ***3107F.6~~5~~ Mooring and berthing components.*** *Mooring components include bitts, bollards, cleats, pelican hooks, capstans, mooring dolphins and quick release hooks. The maximum mooring line forces (demand) shall be established per Section 3105F. Applicable safety factors to be applied to the demand are provided in Section 3105F.8. Multiple lines may be attached to the mooring component at varying horizontal and vertical angles. Mooring components shall therefore be checked for all mooring analysis load cases.*

Berthing components include fender piles and fenders, which may be camels, fender panels or wales. The maximum berthing forces (demand) on breasting dolphins and fender piles shall be established according to Section 3105F.

Mooring and berthing components analyses shall be based on the load combinations defined in Section 3103F.8 with seismic assessment per Section 3104F.5. The component strength shall account for existing condition with knowledge factors applied, as appropriate. For strength evaluation of supports and attachments, see Section 3107F.7.

Mooring and berthing component capacities may be governed by the strength of the deck, structure and/or soil. Therefore, a check of the deck, structural and geotechnical capacities to withstand component loads shall be performed, as appropriate.

~~Applicable safety factors to be applied to the demand are provided in Section 3103F.10.~~

7.17. ***3107F.7~~5.1~~ Supports and attachments (or anchorage) ~~Component strength~~.*** *The evaluation of supports and attachments for nonstructural components, nonbuilding structures and building structures shall be based on the load combinations defined in Section 3103F.8 with seismic assessment per Section 3104F.5. The strength of supports and attachments for nonstructural components, nonbuilding structures and building structures shall be assessed in accordance with AISC [7.10], ACI-318 [7.7], ANSI/AWC NDS [7.11], accounting for existing condition with knowledge factors applied, as appropriate. The following parameters shall be established ~~in order~~ to calculate ~~component~~ strength:*

New and existing components:

1. *Yield and tensile strength of structural steel*
2. *Structural steel modulus of elasticity*
3. *Yield and tensile strength of bolts*
4. *Concrete infill compressive strength*
5. *Concrete infill modulus of elasticity*

Additional parameters for existing components:

1. *Condition of steel including corrosion*
2. *Effective cross-sectional areas*
3. *Condition of embedment material such as concrete slab or timber deck*

The analysis and design shall include the load transfer to supporting deck/pile structures or foundation elements. A check of the deck capacity to withstand support and attachment loads shall be performed for all nonstructural components, nonbuilding structures and building structures.

7.18. ~~***3107F.5.2 Mooring and berthing component demand.*** *The maximum mooring line forces (demand) shall be established per Section 3105F. Multiple lines may be attached to the mooring component at varying horizontal and vertical angles. Mooring components shall therefore be checked for all the mooring analysis load cases. The maximum demand on breasting dolphins and fender piles shall be established according to Sections 3103F.6 and 3105F.*~~

7.19. ~~***3107F.5.3 Capacity of mooring and berthing components.*** *The structural and connection capacity of mooring components bolted to the deck shall be established in accordance with AISC [7.10], ACI-318 [7.7], ANSI/AWC NDS [7.11], as appropriate. The mooring component capacity may be governed by the strength of the deck material. Therefore, a check of the deck capacity to withstand mooring component loads shall be performed.*~~

7.20. *3107F.8~~6~~ Symbols.*

…

~~M_n~~ = ~~*Moment at secant stiffness*~~

M_o = *Overstrength moment demand of the plastic hinge (Section 3107F.2.7)*

M_p = ~~*Overstrength moment demand of the plastic hinge (Section 3107F.2.7), or i*~~ *Idealized plastic moment capacity from Method A or B (Section 3107F.2.5.4~~.2~~)*

…

7.21. *3107F.9~~7~~ References.*

…

[7.3] American Society of Civil Engineers (ASCE), 2017, ASCE/SEI 41-17 (ASCE/SEI 41), "Seismic Evaluation and Retrofit of Existing Buildings," Reston, VA.

~~*[7.3] Federal Emergency Management Agency, FEMA - 356, Nov. 2000, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings," Washington, D.C.*~~

…

[7.10] American Institute of Steel Construction Inc. (AISC), 2017 ~~2011~~, AISC 325-17~~11~~ (AISC 325), "Steel Construction Manual," 15th ~~14th~~ ed., Chicago, IL.

[7.11] American Wood Council (AWC), 2017 ~~2014~~, ANSI/AWC NDS-2018~~15~~ (ANSI/AWC NDS), "National Design Specification (NDS) for Wood Construction," Washington, D.C.

…

[7.13] Department of Defense, 01 November 2012 ~~16 January 2004~~, Unified Facilities Criteria (UFC) 3-220-01~~A~~, "Geotechnical Engineering," ~~"Deep Foundations,"~~ Washington, D.C.

…

Notation
Authority: Sections 8750 through 8760, Public Resources Code.
References: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

DIVISION 8
SECTION 3108F
FIRE PREVENTION, DETECTION AND SUPPRESSION

8.1.

TABLE 31F-8-2
FIRE HAZARD CLASSIFICATIONS

FIRE HAZARD CLASSIFICATION	*STORED VOLUME (bbls)*			*FLOWING VOLUME (bbls)*		*CRITERIA (bbls)**
	Stripped	V_{SL}	V_{SH}	V_{FL}	V_{FH}	
LOW	*y*	*n*	*n*	*y*	*y*	$V_{FL} \geq V_{FH}$, and $V_T \leq 1200$
LOW	*n*	*y*	*n*	*y*	*n*	$V_{SL} + V_{FL} \leq 1200$
MEDIUM	*n*	*n*	*y*	*n*	*y*	$V_{SH} + V_{FH} \leq 1200$
MEDIUM	*y*	*n*	*n*	*y*	*y*	$V_{FH} > V_{FL}$, and $V_T \leq 1200$
HIGH	*y*	*n*	*n*	*y*	*y*	$V_T > 1200$
HIGH	*n*	*y*	*y*	*y*	*y*	$V_T > 1200$
HIGH	*n*	*y*	*n*	*y*	*n*	$V_{SL} + V_{FL} > 1200$
HIGH	*n*	*n*	*y*	*n*	*y*	$V_{SH} + V_{FH} > 1200$

y ≡ yes
n ≡ no
Stripped = product purged from pipeline following product transfer event.
V_{SL} *= stored volume of low volatility product*
V_{SH} *= stored volume of high volatility product*
V_{FL} *= volume of low volatility product flowing through transfer line during ESD.*
V_{FH} *= volume of high volatility product flowing through transfer line during ESD.*
$V_T = V_{SL} + V_{SH} + V_{FL} + V_{FH}$ *= Total Volume (stored and flowing)*

** Quantities are based on maximum flow rate, including simultaneous transfers.*

8.2.

TABLE 31F-8-3
MINIMUM FIRE SUPPRESSION PROVISIONS PER BERTH (N/E)

FIRE HAZARD CLASSIFICATION (From Table 31F-8-2)	*VESSEL AND CARGO LIQUID VOLATILITY RATING (From Table 31F-8-1)*	*MINIMUM PROVISIONS*
LOW	*Barge with L_C (including drums)*	***500 gpm of water*** *2 x 20 lb portable dry chemical extinguishers or the equivalent.* *~~and~~* *2 x 110 lb wheeled dry chemical extinguishers or the equivalent.*
	Barge with H_C (including drums) *Tankers < 50 KDWT, handling L_C or H_C*	***1,500 gpm of water*** *2 x 20 lb portable dry chemical extinguishers or the equivalent.* *~~and~~* *2 x 165 lb wheeled dry chemical extinguishers or the equivalent.*
MEDIUM	*Tankers < 50 KDWT, handling L_C*	***1,500 gpm of water*** *2 x 20 lb portable dry chemical extinguishers or the equivalent.* *~~and~~* *2 x 165 lb wheeled dry chemical extinguishers or the equivalent.*
	Tankers < 50 KDWT, handling H_C	***2,000 gpm of water*** *4 x 20 lb portable dry chemical extinguishers or the equivalent.* *~~and~~* *2 x 165 lb wheeled dry chemical extinguishers or the equivalent.*
HIGH	*Tankers < 50 KDWT, handling L_C or H_C*	***3,000 gpm of water*** *4 x 20 lb portable dry chemical extinguishers or the equivalent.* *~~and~~* *2 x 165 lb wheeled dry chemical extinguishers or the equivalent.*
LOW, MEDIUM, HIGH	*Tankers > 50 KDWT, handling L_C or H_C*	***3,000 gpm of water*** *6 x 20 lb portable dry chemical extinguishers or the equivalent.* *~~and~~* *4 x 165 lb wheeled dry chemical extinguishers or the equivalent.*

Notes: L_C and H_C are defined in Table 31F-8-1. KDWT= Dead Weight Tons (Thousands)

8.3. ***3108F.6.3 Fire water.*** *The source of fire water shall be reliable and provide sufficient rated capacity as determined in the Fire Protection Assessment. Water-based fire protection systems shall be tested and maintained per California NFPA 25 [8.9], as adopted and amended by the State Fire Marshal, or the local enforcing agency requirements. Specifications shall be retained. The latest testing and maintenance records shall be readily accessible to the Division (N/E). …*

8.4. ***3108F.7 Fire ~~Critical~~ systems seismic assessment (N/E).*** *Fire detection and protection systems, and emergency shutdown systems shall have a seismic assessment per Section 3104F.5~~6~~. For strength evaluation of supports and attachments, see Section 3107F.7.*

For firewater piping and pipeline systems, see Section 3109F.7. ~~For anchors and supports, see Section 3109F.4.~~

~~For equipment anchorages and supports, see Section 3110F.8.~~

Notation
Authority: Sections 8750 through 8760, Public Resources Code.
References: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

DIVISION 9
SECTION 3109F
PIPING AND PIPELINES

9.1. ***3109F.2 Oil piping and pipeline systems.*** *All pressure piping and pipelines for oil service shall conform to the provisions of API Standard 2610 [9.1], ASME B31.3 [9.2] or B31.4 [9.3] as appropriate, including the following:*

1. All piping/pipelines shall be documented on current ~~P&ID's~~ <u>P&IDs</u> (N/E).

…

9.2. ***3109F.3 Pipeline stress analysis (N/E).*** *Pipeline stress analysis shall be performed for:*

1. New piping and pipelines

2. Significant rerouting/relocation of existing piping

3. Any replacement of "not-in-kind" piping

4. Any significant rearrangement or replacement of "not in-kind" anchors and/or supports

5. Significant seismic displacements calculated from the structural <u>and/or geotechnical</u> assessment<u>s</u>

Pipeline stress analysis shall be performed in accordance with ASME B31.4 [9.3], considering all relevant loads and corresponding displacements determined from the structural analysis <u>and/or geotechnical analysis</u> described in Section<u>s</u> 3104F <u>and 3106F, respectively</u>. Seismic loading of above-grade pipelines may be analyzed in accordance with ASME B31.E [9.5] <u>with seismic loads computed from Section 3104F.5.4.1</u>.

<u>For pipelines spanning between seismically isolated sections (Section 3104F.1.3) and/or varying geotechnical conditions, evaluation of the relative movement of pipelines and supports and varying seismic accelerations shall be considered, including phase differences.</u>

Flexibility analysis for piping, considering supports, shall be performed in accordance with ASME B31.4 [9.3] by using the largest temperature differential imposed by normal operation, start-up, shutdown or abnormal conditions. Thermal loads shall be based upon maximum and minimum local temperatures; heat traced piping shall use the maximum attainable temperature of the heat tracing system.

<u>Section 3106F.12 provides additional considerations for underwater seafloor pipelines.</u>

To determine forces at sliding surfaces, the coefficients of static friction shown in Table 31F-9-1 shall be used.

9.3. ***3109F.4 Piping and pipelines ~~Anchors and~~ supports and attachments (or anchorage).*** *~~Anchors and s~~ Supports and attachments shall conform to ASME B31.3 [9.2], ASME B31.4 [9.3], API Standard 2610 [9.1] and the ASCE Guidelines [9.6] (N).*

A seismic assessment shall be performed for existing ~~anchors and~~ supports and attachments using recommendations in Section 7 of CalARP [9.7] ~~or Chapter 11 of FEMA 356 [9.8]~~, as appropriate (E).

For strength evaluation of supports and attachments, see Section 3107F.7. If a pipeline analysis has been performed and support reactions are available, they may be used to determine the forces on the support structure.

9.4. ***3109F.5.1 Valves and fittings.*** *…*

1. *Conform to ASME B31.3 [9.2], ASME B31.4 [9.3], API Standard 609 [9.8]~~[9.9]~~ and ASME B16.34 [9.9]~~[9.10]~~, as appropriate, based on their service (N).*
2. *…*
3. *…*
4. *…*
5. *…*
6. *Isolation valves shall be fire-safe in accordance with API Standard 607 [9.10]~~[9.11]~~ (N).*
7. *…*
8. *…*
9. *…*
10. *Pressure relief devices shall be sized in accordance with API RP 520 [9.11]~~[9.12]~~ (N). Set pressures and accumulating pressures shall be in accordance with API RP 520 [9.11]~~[9.12]~~ (N/E).*
11. *…*
12. *…*
13. *…*

9.5. ***3109F.6 Utility and auxiliary piping and pipeline systems.*** *…*

Vapor return lines and VOC vapor inerting and enriching (natural gas) piping shall conform to 33 CFR 154.2100(b) [9.12]~~[9.13]~~ (N/E).

…

9.6. ***3109F.7 Fire piping and pipeline systems.*** *Firewater and foam piping and fittings shall meet the following requirements:*

1. *Conform to NFPA 11 [9.13]~~[9.14]~~, NFPA 24 [9.14]~~[9.15]~~, and ASME B16.5 [9.15]~~[9.16]~~ (N/E).*

2. *…*

3. *…*

4. *Piping and appurtenances shall be color-coded per local jurisdiction requirements or per ASME A13.1 [9.16]~~[9.17]~~ (N/E).*

5. *Pipeline stress analysis shall be performed for firewater piping and pipelines per Section 3109F.3 (N/E).*

6. *Firewater piping and pipelines supports and attachments shall be assessed per Section 3109F.4.*

7~~6~~. *External visual inspection shall be performed for per Section 3102F.3.5.5 (N/E).*

9.7. ***3109F.8 References.***

…

~~[9.8] Federal Emergency Management Agency, Nov. 2000, FEMA 356, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings," Washington, D.C.~~

[9.8~~9~~] American Petroleum Institute (API), 2009, API Standard 609, "Butterfly Valves: Double Flanged, Lug- and Wafer-Type," 7th ed., Washington, D.C.

[9.9~~10~~] American Society of Mechanical Engineers (ASME), 2013, ASME B16.34-2013 (ASME B16.34), "Valves Flanged Threaded and Welding End," New York.

[9.10~~1~~] American Petroleum Institute (API), 2010, API Standard 607, "Fire Test for Quarter-Turn Valves and Valves Equipped with Nonmetallic Seats," 6th ed., Washington, D.C.

[9.11~~2~~] American Petroleum Institute (API), API Recommended Practice 520 P1 and P2 (API 520), "Sizing, Selection, and Installation of Pressure-relieving Devices, Part 1 – Sizing and Selection," 2014, 9th ed., and "Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries – Part 2 – Installation," 2015, 6th ed., Washington, D.C.

[9.12~~3~~] Code of Federal Regulations (CFR), Title 33, Section 154.2100 – Vapor Control System, General (33 CFR 154.2100)

[9.13~~4~~] National Fire Protection Association (NFPA), NFPA 11, "Standard for Low-, Medium-, and High-Expansion Foam," Quincy, MA. For edition, see California Code of Regulations (CCR), Title 24, Part 2, Chapter 35 – Referenced Standards.

[9.14~~5~~] National Fire Protection Association (NFPA), NFPA 24, "Standard for the Installation of Private Fire Service Mains and Their Appurtenances," Quincy, MA. For edition, see California Code of Regulations (CCR), Title 24, Part 2, Chapter 35 – Referenced Standards.

[9.15~~6~~] American Society of Mechanical Engineers (ASME), 2013, ASME B16.5-2013 (ASME B16.5), "Pipe Flanges and Flanged Fittings," New York.

[9.16~~7~~] *American Society of Mechanical Engineers (ASME), 2007, ASME A13.1-2007 (R2013) (ASME A13.1), "Scheme for the Identification of Piping Systems," New York.*

Authority: Sections 8750 through 8760, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

Notation
Authority: Sections 8750 through 8760, Public Resources Code.
References: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

DIVISION 10
SECTION 3110F
MECHANICAL AND ELECTRICAL EQUIPMENT

10.1. ***3110F.2.1 General criteria.*** *Marine loading arms and ancillary systems shall conform to ASME B31.3 [10.1], 33 CFR 154.510 [10.2] and OCIMF ~~CCIMF~~ "Design and Construction Specification for Marine Loading Arms" [10.3]. Each loading arm used for transferring oil shall have a means of being drained or closed before being disconnected.*

…

Loading arms and ancillary systems shall have a seismic assessment in accordance with Section 3104F.5. For seismic evaluation, design and strengthening of loading arms and ancillary equipment, seismic loads shall be computed per Section 3104F.5.4.1 ~~shall meet the seismic criteria defined in Section 3104F.2.1~~ and the procedure in Section 8.5.3 of ASCE/COPRI 61 [10.5] ~~(N)~~. For strength evaluation of supports and attachments, see Section 3107F.7.

10.2. ***3110F.6 Oil sumps and ancillary equipment.*** *…*

…

3. *Sumps shall be located at least ~~25ft~~ 25 ft from the manifolds, base of the loading arms or hose towers (N).*

…

10.3. ***3110F.7 Vapor control systems.*** *Vapor control systems shall conform to 33 CFR 154.2000 through 154.2181 [10.21] and API Standard 2610 [10.22]. The effects of seismic, wind, dead, live and other loads shall be considered in the analysis and design of individual tie-downs of components, such as of steel skirts, vessels, controls and detonation arresters. ~~The analysis and design shall include the load transfer to supporting deck/pile structures or foundation elements.~~*

10.4. ~~***3110F.8 Equipment anchors and supports.*** *For new (N) electrical and mechanical equipment, the seismic lateral loads (demand) shall be calculated using the methods of Section 6.4 of FEMA 450 [10.23]. The design for load transfer to the wharf deck shall use the same procedures as for mooring and berthing components (see Section 3107F.5.3).*~~

~~*For existing (E) equipment, the seismic assessment shall be performed in accordance with CalARP [10.24], FEMA 356 [10.25] or ASCE Guidelines [10.26].*~~

10.5. ***3110F.10~~9~~ Spill prevention equipment and systems maintenance (N/E).*** *…*

10.6. *3110F.11~~0~~ Pumps (N/E).* *…*

…Firewater pumps providing the wharf fire protection shall be maintained in accordance with Section 3108F.6.3 ~~per California NFPA 25 [10.27], as adopted and amended by the State Fire Marshal, or local enforcing agency requirements~~.

10.7. *3110F.12~~1~~ Mechanical and electrical equipment ~~Critical systems~~ seismic assessment (N/E).* *~~Critical m~~ Mechanical and electrical equipment ~~related to personnel safety, oil spill prevention or response,~~ shall have a seismic assessment per Section 3104F.5~~.3~~. For strength evaluation of ~~equipment anchorages and~~ supports and attachments, see Section 3107F.7 ~~3110F.8~~.*

10.8. *3110F.13~~2~~ References.*

…

[10.7] National Fluid Power Association (NFPA), 2009, NFPA T3.6.7 R3-2009 (R2017~~2~~) (NFPA T3.6.7 R3), "Fluid Power Systems and Products – Square Head Industrial Cylinders – Mounting Dimensions," Milwaukee, WI.

…

~~[10.23] Federal Emergency Management Agency, 2003, FEMA 450, "NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures," Washington, D.C.~~

~~[10.24] CalARP Program Seismic Guidance Committee, December 2013, "Guidance for California Accidental Release Prevention (CalARP) Program Seismic Assessments," Sacramento, CA.~~

~~[10.25] Federal Emergency Management Agency (FEMA), Nov. 2000, FEMA 356, "Prestandard and Commentary for the Seismic Rehabilitation of Buildings," Washington, D.C.~~

~~[10.26] American Society of Civil Engineers (ASCE), 2011, 1997, "Guidelines for Seismic Evaluation and Design of Petrochemical Facilities," 2nd ed., New York.~~

~~[10.27] National Fire Protection Association (NFPA), California NFPA 25, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems," California ed. For edition, see California Code of Regulations (CCR), Title 24, Part 2, Chapter 35 – Referenced Standards.~~

Authority: Sections 8750 through 8760, Public Resources Code.

Reference: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

Notation
Authority: Sections 8750 through 8760, Public Resources Code.
References: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

DIVISION 11
SECTION 3111F
ELECTRICAL SYSTEMS

11.1. ***3111F.3 Identification and tagging.*** *All electrical equipment, cables and conductors shall be clearly identified by means of tags ~~oftags~~, plates, color coding or other effective means to facilitate troubleshooting and improve safety, …*

11.2. ***3111F.5 Electrical service.*** *…*

1. *Electrical, instrument and control systems used to activate ~~activiate~~ equipment needed to control a fire or mitigate its consequences shall …*

11.3. ***3111F.6 Grounding and bonding (N/E).***

…

3. *Bonding of vessels to the MOT structure is not permitted ~~(2 CCR 2341) [11.7]~~.*

…

11.4. ***3111F.8 Illumination (N/E).*** *~~Lighting shall conform to 2 CCR 2365 [11.7] and 33 CFR 154.570 (d) [11.8].~~*

11.5. ***3111F.8.1 Illumination Locations.*** *At a minimum, MOTs shall have fixed lighting (or luminaires) that illuminate the following areas:*

1. *Transfer connection points on the MOT*
2. *Transfer connection points for any barge that may transfer oil at the MOT*
3. *Transfer operations work areas on the MOT*
4. *Transfer operations work areas for any barge that may transfer oil at the MOT*
5. *Areas defined in Sections 17.4 and 24.6.4 of ISGOTT [11.7], as applicable*

Lighting shall be located or shielded so as not to mislead or otherwise interfere with off-site areas as governed by federal, state and local agency requirements.

11.6. ***3111F.8.2 Illumination Levels.*** *After subtraction of the ambient lighting level, the minimum illumination levels at the locations defined in Section 3111F.8.1 shall be as follows:*

1. 5.0 footcandles (54 lux) at transfer connection points

2. 1.0 footcandle (11 lux) in transfer operations work and other areas

The illumination levels shall be verified by measurement at the locations defined in Section 3111F.8.1. All measurements shall be taken on a horizontal plane, 3 feet above the MOT and barge deck or walking surface (33 CFR 154.570 (b) [11.8]). Background measurement of ambient lighting (e.g., moonlight, sky glow) shall be recorded in an area shielded from site lighting.

11.7. ***3111F.8.3 Emergency Power for Illumination (N).*** *In the event of power supply failure, the emergency power system (Section 3111F.5.1) shall automatically illuminate all of the areas defined in Section 3111F.8.1, and fire pump, hydrant, monitor, foam, and hose connection points on the MOT. The emergency power system shall provide power for a duration of not less than 60 minutes at a level of not less than an average of 0.5 footcandle (5.5 lux).*

11.8. ***3111F.10 Cathodic Protection Systems (CPS) (N/E).*** *CPS operating, testing, and maintenance criteria for underwater structures shall conform to UFC 3-570-01 ~~UFC 3-570-02N~~ [11.12] …*

11.9. ***3111F.11 Electrical ~~Critical~~ systems seismic assessment (N/E).*** *Electrical ~~power~~ systems shall have a seismic assessment per Section 3104F.5~~.3~~. For strength evaluation of ~~equipment anchorages and~~ supports and attachments, see Section 3107F.7 ~~3110F.8~~.*

11.10. ***3111F.12 References.***

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[11.7] International Chamber of Shipping (ICS), Oil Companies International Marine Forum (OCIMF), International Association of Ports and Harbors (IAPH), 2006, "International Safety Guide for Oil Tankers and Terminals (ISGOTT)," 5th ed., Witherby, London.

~~[11.7] California Code of Regulations (CCR), Title 2, Division 3, Chapter 1, Article 5 – Marine Terminals Inspection and Monitoring (2 CCR 2300 et seq.)~~

…

[11.12] Department of Defense, 28 November 2016, Unified ~~United~~ Facilities Criteria (UFC) 3-570-01, ~~2004 January 16 UFC 3-570-02N,~~ "~~Electrical Engineering~~ Cathodic Protection," Washington, D.C.

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Notation
Authority: Sections 8750 through 8760, Public Resources Code.
References: Sections 8750, 8751, 8755 and 8757, Public Resources Code.

CHAPTER 35
REFERENCED STANDARDS

The California State Lands Commission (Commission) references the following reference standards in Chapter 35:

1. ACI 318-14 (unamended)
2. ASCE/SEI 7-16 (unamended)
3. ASME B31.3-2014 (unamended)
4. ASTM D4318-10 (unamended)
5. ANSI/AWC NDS-2018 (unamended)

Note that the Commission has opted not to adopt the 2018 International Building Code references and/or latest editions of ASME B31.3 and ASTM D4318. Therefore, the following obelisks are proposed:

ASME

B31.3—2014 Process Piping……………………………………………………………3109F, 3110F, 3112F

ASTM

D4318—10 Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils…...3106F

Notation
Authority: Sections 8750 through 8760, Public Resources Code.
References: Sections 8750, 8751, 8755 and 8757, Public Resources Code.