Institute for Sustainable Solutions
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Review of Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS)

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The Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS) is Title 24 Part 2 of the California Building Code which serves to fulfill the requirements of the Lempert-Keen-Seastrand oil spill prevention and response act of 1990. The code established "minimum engineering, inspection and maintenance criteria" for Marine Oil Terminal (MOTs) to prevent oil spills and to protect public health, safety and the environment. Potential oil spills and consequences "shall be mitigated by implementing appropriate designs using the best achievable technologies," and "residual risks are addressed by operational and administrative means." The code applies to both existing and new MOTs in California, with some reduced requirements for existing facilities.

This summary focuses on the expectations placed on MOTs by MOTEMS and briefly outlines the seismic analyses and design requirements, however much of this code consists of technical engineering requirements which are outside of the expertise of ISS. Further review by technical experts is advised.

MOTs regulated by MOTEMS must undergo inspections (conducted annually), audits (conducted every 4 years unless otherwise recommended), and post-event inspections to ensure compliance with this code. These audits and inspections are a form of **vulnerability analysis** which then set forward **mitigation requirements** to which facilities must respond with a **mitigation plan**. Audits and post-even inspections must be performed by a multidisciplinary team consisting of a: project manager, on-site team leader, structural inspection team, structural analyst, electrical inspection team, mechanical inspection team, corrosion specialist, geotechnical analyst, and representative(s) from the regulatory authority. Detailed instructions for each of these teams can be found on pages 8-11. The findings of the inspection team are then reviewed by a qualified professional to ensure quality assurance, and the regulatory authority may require peer review for advanced

engineering analyses and design "by an external independent source to maintain the integrity of the process."

Audits and post-event inspections assign the facility, and each component berthing system, with a rating under three different criteria: a Global Operational Structural Assessment Rating, a Global Seismic Structural Assessment Rating (SSAR; see Figure 1), and a Global Inspection Condition Assessment Rating. Based on the assigned score in each rating system, remedial action priorities (see Figure 2) are assigned for deficiencies with additional recommendations for remediation and/or upgrading along with required follow-up actions (see Figure 3) prescribed in priority order.

Audits and post-event inspections (**vulnerability analysis**) will result in a final report that contains an executive summary, introduction, a description and summary of the observed conditions of the facility, the assigned assessment ratings with supporting calculations and results from the engineering analysis with noted deficiencies and corresponding remedial action priorities, required follow-up actions and schedules for remedial actions, and appendices including data and calculations. Based on the prescribed remedial actions and follow-up items, facility operators must develop an action plan implementation (**Mitigation plan**) and are responsible for correcting deficiencies prior to the next audit. Prior to implementation of the action plan, projects will be reviewed by the regulatory authority. Following the implementation of the action plan, updated "as-built" documentation will be submitted to the regulatory authority.

Seismic Design Requirements

MOTEMS defines the methodology for determining the seismic requirements at a given facility based on Design Peak Ground Acceleration (DPGA), Design Spectral Acceleration, and Design Magnitude, which will include site amplification effects and site liquefaction assessments. DPGA and Design Spectral Acceleration will be obtained from either the USGS US Seismic Design Maps tool using ASCE/SEI 41 with the probability of exceedance in 50 years and appropriate site soil classifications. Or, DPGA and Design Spectral Acceleration will be determined by a site-specific probabilistic seismic hazard analysis conducted by a qualified California

registered civil engineer with a California authorization as a geotechnical engineer. The design earthquake is determined by the recurrence rate probability as seen in Figure 4, **or** the design earthquake may be selected as the largest earthquake magnitude associated with a critical seismic source, taken as the closest distance from the source to the facility site. If the largest earthquake magnitude is selected, it "shall be associated with all DPGA values for the site, irrespective of probability levels."

The minimum seismic performance for facilities is evaluated at two criteria levels. Level 1 defines a performance criteria to ensure MOT functionality following an earthquake and requires minor or no structural damage and temporary or no interruption in operations. Level 2 defines a performance criteria to safeguard against major damage, collapse, or major oil spill. Level 2 includes controlled inelastic behavior with reparable damage, the prevention of collapse, a temporary loss of operations that is restorable within months, and the prevention of major spills. Major spills are defined as greater than 1200 barrels—it is worth noting here that MOTEMS applies to berthings and marine oil terminals so this metric for major spills may not be transferable to the CEI Hub.

The capacity for a facility to meet these seismic performance requirements is based on the existing conditions of the facility "calculated as 'best estimates,' taking into account the mean material strengths, strain hardening and degradation over time. The capacity of components with little or no ductility which may lead to brittle failure scenarios, shall be calculated based on lower bound material strengths." The objective of the seismic analysis is to "verify that the displacement capacity of the structure is greater than the displacement demand." Pages 33-43 provide information on seismic analysis methodologies, pages 50-54 define minimum standards for analysis and evaluation of geotechnical hazards and foundations, and pages 55-69 establish the minimum performance standards for nonstructural components and evaluation procedures for different components.

Figure 1: Description of Seismic Structural Assessment Rating

RATING		DESCRIPTION OF STR OSAR[1] and SSAR[2]
6	Good	The capacity of the structure or system meets the requirements of this standard. The structure or system should be considered fit-for-purpose. No repairs or upgrades are required.
5	Satisfactory	The capacity of the structure or system meets the requirements of this standard. The structure or system should be considered fit-for-purpose. No repairs or upgrades are required.
4	Fair	The capacity of the structure or system is no more than 15 percent below the requirements of this standard, as determined from an engineering evaluation. The structure or system should be considered as marginal. Repair and/or upgrade measures may be required to remain operational. Facility may remain operational, provided a plan and schedule for remedial action is presented to and accepted by the Division.
3	Poor	The capacity of the structure or system is no more than 25 percent below the requirements of this standard, as determined from an engineering evaluation. The structure or system is not fit-for-purpose. Repair and/or upgrade measures may be required to remain operational. The facility may be allowed to remain operational on a restricted or contingency basis until the deficiencies are corrected, provided a plan and schedule for such work is presented to and accepted by the Division.
2	Serious	The capacity of the structure or system is more than 25 percent below the requirements of this standard, as determined from an engineering evaluation. The structure or system is not fit-for-purpose. Repairs and/or upgrade measures may be required to remain operational. The facility may be allowed to remain operational on a restricted basis until the deficiencies are corrected, provided a plan and schedule for such work is presented to and accepted by the Division.
1	Critical	The capacity of the structure or system is critically deficient relative to the requirements of this standard. The structure or system is not fit-for-purpose. The facility shall cease operations until deficiencies are corrected and accepted by the Division.

Figure 2: Description of Remedial Action Priorities

COMPONENT DEFICIENCY REMEDIAL ACTION PRIORITIES (RAP)

REMEDIAL PRIORITIES	DESCRIPTION AND REMEDIAL ACTIONS
P1	*Specified whenever a condition that poses an immediate threat to public health, safety or the environment is observed. Emergency Actions may consist of barricading or closing all or portions of the berthing system, evacuating product lines and ceasing transfer operations.* *The berthing system is not fit-for-purpose. Immediate remedial actions are required prior to the continuance of normal operations.*
P2	*Specified whenever defects or deficiencies pose a potential threat to public health, safety and the environment. Actions may consist of limiting or restricting operations until remedial measures have been completed.* *The berthing system is not fit-for-purpose. This priority requires investigation, evaluation and urgent action.*
P3	*Specified whenever systems require upgrading in order to comply with the requirement of these standards or current applicable codes. These deficiencies do not require emergency or urgent actions.* *The MOT may have limitations placed on its operational status.*
P4	*Specified whenever damage or defects requiring repair are observed.* *The berthing system is fit-for-purpose. Repair can be performed during normal maintenance cycles, but not to exceed one year.*
R	*Recommended action is a good engineering/maintenance practice, but not required by these standards.* *The berthing system is fit-for-purpose.*

Figure 3: Description of Follow-Up Actions

FOLLOW-UP ACTIONS [2.2]

FOLLOW-UP ACTION	DESCRIPTION
Emergency Action	*Specified whenever a condition which poses an immediate threat to public health, safety or the environment is observed. Emergency Actions may consist of barricading or closing all or portions of the berthing system, limiting vessel size, placing load restrictions, evacuating product lines, ceasing transfer operations, etc.*
Engineering Evaluation	*Specified whenever damage or deficiencies are observed which require further investigation or evaluation to determine appropriate follow-up actions.*
Repair Design Inspection	*Specified whenever damage or defects requiring repair are observed. The repair design inspection is performed to the level of detail necessary to prepare appropriate repair plans, specifications and estimates.*
Upgrade Design and Implementation	*Specified whenever the system requires upgrading in order to comply with the requirements of these standards and current applicable codes.*
Special Inspection	*Typically specified to determine the cause or significance of nontypical deterioration, usually prior to designing repairs. Special testing, laboratory analysis, monitoring or investigation using nonstandard equipment or techniques are typically required.*
Develop and Implement Repair Plans	*Specified when the Repair Design Inspection and required Special Inspections have been completed. Indicates that the structure is ready to have repair plans prepared and implemented.*
No Action	*Specified when no further action is necessary until the next scheduled audit or inspection.*

Figure 4: Description of Seismic Performance Criteria

TABLE 31F-4-1
SEISMIC PERFORMANCE CRITERIA[1, 2]

SPILL CLASSIFICATION[3]	SEISMIC PERFORMANCE LEVEL	PROBABILITY OF EXCEEDANCE	RETURN PERIOD
High	*Level 1*	*50% in 50 years*	*72 years*
	Level 2	*10% in 50 years*	*475 years*
Medium	*Level 1*	*65% in 50 years*	*48 years*
	Level 2	*15% in 50 years*	*308 years*
Low	*Level 1*	*75% in 50 years*	*36 years*
	Level 2	*20% in 50 years*	*224 years*