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Engineering Standards Aid Spill Prevention at Marine Oil Terminals

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CALIFORNIA'S MARINE OIL TERMINAL ENGINEERING AND Maintenance Standards (MOTEMS) were adopted by the Building Standards Commission in 2005 and revised in 2013. During the past eight years, implementation of this comprehensive standard has engendered major facility upgrades at many marine oil terminals, enabling prevention of oil spills in state waters.

MOTEMS BACKGROUND

The Marine Facilities Division (MFD) of the California State Lands Commission regulates marine oil terminals (MOTs) within the state. MFD inspections during the mid-nineties found MOTs to be in decrepit condition, with extensive physical deterioration of structures, oil transfer pipelines, electrical/mechanical equipment and mooring/berthing infrastructure, from exposure to extreme environmental conditions and lack of maintenance. These MOTs did not meet modern structural, seismic, fire protection, process safety, electrical/mechanical equipment and electrical system standards. When MOTs were built, seismic design standards were practically non-existent and sea level rise or tsunamis were not major concerns. Also, sizes of vessels calling in at MOTs had increased notably from their original design intent. It was concluded that these perilous infrastructure conditions posed a threat to the safety of oil transfer operations with potential for causing large oil spills.

After extensive review of worldwide regulatory and industry standards, MFD determined that no single all-inclusive guide was available for MOT evaluations and worked toward developing a comprehensive standard for the design, operation and maintenance of Existing and New MOTs, incorporating as many industry standards as possible, while providing guidance for topics not covered elsewhere. The Marine Oil Terminal Engineering and Maintenance Standards or MOTEMS became enforceable as part of the California Building Code in 2006, and the revised second edition recently became effective on January 1, 2014. Thus, it is opportune to take a look back at the impact this standard had in advancing spill prevention at California's MOTs.

TERMINAL RISK CLASSIFICATION

Typical coastal MOT comprises a docking structure to moor tankers and barges to the wharf and includes handling equipment, safety systems and pipelines to transfer petroleum and petroleum products to storage tanks. MOTEMS classifies the state's MOTs into three Consequence-Based risk categories (High, Medium and Low) determined from the volume of oil exposed to spillage, number of transfer operations per year and the largest vessel allowed to berth. The oil exposed to spillage is established by aggregating all stored and flowing oil volumes during transfer at the MOT, prior to activation of the emergency shutdown system (ESD) stopping the flow of oil (within either 30 or 60 seconds, depending upon ESD's installation date). MOTEMS permits risk reduction strategies (e.g. adding new valves) to reduce risk to a lower category. This strategy has economic benefits since MOTEMS becomes more stringent with increase in risk category.

Existing MOT Risk Classification

RISK CLASS	EXPOSED OIL (BBL)	TRANSFERS/YEAR	VESSEL SIZE (DWT)
High	≥1200	N/A	N/A
Medium	<1200	≥90	≥30,000
Low	<1200	<90	<30,000

AUDITING MARINE OIL TERMINALS

MOTEMS requires all existing MOTs to perform periodic audits and inspections (both above and below the waterline) for each "berthing system", involving structural, seismic, geotechnical, mooring, berthing, fire protection, piping/pipeline, mechanical, electrical and corrosion evaluations. The aim is to assess structural and non-structural system integrity and confirm berthing systems' continued "fitness-for-purpose". Berthing systems are the complete set of structural, mechanical and electrical components for the transfer of product to or from a vessel, extending to first valve onshore. However, if a component outside this realm affects the oil transfer process or engineered system being evaluated, it is included in audit assessment.

MOT's risk category determines the schedule (30, 48 or 60 months from February 6, 2006) for MOTEMS Initial Audit submittal, return period of design earthquake ground motion parameters used in seismic assessment, and the level of sophistication for such analysis. Thereafter, Subsequent Audits for all risk categories are due every four years. However, the frequency of subsequent underwater inspections varies with berthing system condition and may range from 1-6 years, depending on construction materials (wrapped or unwrapped timber, protected or unprotected steel, composites, plastic), environmental conditions (benign or aggressive, based on fresh or brackish water and current velocity) and channel bottom or mud line scour. New berthing systems are considered High Risk and must complete the Initial Audit of "as-built" system before commencing oil transfer operations at the berth.

Audits comprise both the fieldwork and engineering analyses and are performed by California registered professional engineers. The scope includes above and under water inspections, structural loading and hazards assessment, seismic analysis and design, mooring and berthing evaluation, mooring hardware assessment, geotechnical investigations, structural design and drawings, process hazards and

instrumentation diagrams, electrical hazard classification diagrams, fire suppression system design, oil pipeline stress analyses, electrical and mechanical equipment, corrosion and electrical supply systems. MOTEMS requires MOTs to address hazards that may affect public health, safety and environment, including sea level rise, tsunamis and passing vessels.

For each MOT berthing system, Global Operational Structural Assessment Rating (OSAR), Global Seismic Structural Assessment Rating (SSAR), and Global Inspection Condition Assessment Rating (ICAR) are assigned as - Critical, Serious, Poor, Fair, Satisfactory, or Good - to grade the berthing system's "fitness-for-purpose". Additionally, Remedial Action Priority (RAP) ratings, ranging from the highest P1 to the lowest P4, are assigned for deficiencies of individual components.

For conducting audits, MFD has developed an Audit Manual that provides a structured format to comprehend MOTEMS regulations and facilitate complete presentation of all design and "as-built" documentation necessary to corroborate compliance. The audit process requires a comprehensive, time-consuming, in-depth effort and culminates with a final audit report. The final audit report documents and drawings often run into many volumes.

MFD Engineers review and independently validate these terminal audits, inspection, analyses, designs and upgrades to ascertain code compliance and monitor upgrade projects from scheduling through commissioning. MFD also reviews MOT Operations Manuals to verify that Terminal Operating Limits (TOLs) are consistent with those identified in the MOTEMS Audits. However, primary responsibility for MOTEMS compliance rests with the MOT operator, and the signature/seal of their California registered engineers authenticates the validity of audit conclusions. If serious life threatening or oil spill safety issues are identified during the audit process, the said registered engineers are obligated to inform MFD, even before submittal of their formal audit report.

DEFICIENCY CORRECTIONS

With submittal of a MOTEMS Audit, an MOT operator acknowledges the deficiencies identified at their facility, and is responsible for taking corrective actions. Deficiencies identified during an audit are cataloged in Executive Summary (ES) tables, with ratings and a recommended schedule for corrective actions. MOTEMS requires that deficiencies be corrected via repair or rehabilitation within a time period mutually agreed upon between the MFD and MOT operator. While there is no specified timeline for achieving compliance and MFD recognizes budgetary cycle constraints, the general aim is for the existing MOTs to be fully MOTEMS compliant within 5 years of their Initial Audit submittal, with exceptions for delays due to permitting, lease or environmental issues. However, if an MOT has structural global rating of Critical/Serious or a component deficiency with P1/ P2 rating, MFD can require immediate/urgent remedial actions.

Note that MOTEMS non-compliance does not necessarily imply that a MOT is unsafe. An MOT that is non-compliant with design standards formulated for extreme environmental conditions may still be operable with restrictive operating conditions. While restrictions pertaining to seismic, mechanical or electrical systems may be imposed, mooring or berthing restrictions are more common. For example, during the time required to achieve compliance with berthing and mooring standards, interim operational or demand restrictions can be imposed or more stringent Terminal Operating Limits (TOLs) based on degraded structural capacity may be specified. Some typical limitations that were applied include:

- Berthing systems not compliant with MOTEMS specified vessel impact velocities were restricted to berthing at reduced speed; MOT

operator was required to monitor vessel approach velocity via deck-mounted lasers.

- MOTs that did not meet the MOTEMS berthing angle requirements, special berthing procedures were specified.
- When mooring hooks, bollards, bitts, or the structure itself could not comply with MOTEMS wind criteria, either their usage was prohibited or reduced wind speed was allowed subject to monitoring with anemometer.
- For passing vessel effects, MOTs were required to inform MFD of vessel surge or sway greater than the specified level; minimum under keel clearance was also required.
- Operators were sometimes restricted from using specified breasting or mooring dolphins. At some MOTs, berths were limited to barges until compliance upgrades were completed.
- Vessel DWT, arrival draft or displacements were limited at certain berths.
- Due to a number of damaged fender piles, berthing between certain specified bents was prohibited at some MOTs.
- Based on the observed wharf piles deterioration, live load restrictions were placed on portions of some wharves and approach ramps, including restrictions on vehicle access to the wharf.
- Some deficient berths were downgraded or declared out-of-service.

The compliance effort has often resulted in initiation of major construction projects, requiring budget planning, and permits from local governments and port districts. To keep MOTs functioning during repairs and construction, complex operational arrangements were often devised. MOTEMS implementation at California MOTs is in various stages and some MOTs have opted for a complete tear down of their facility and replacement with entirely new berthing systems. Some smaller facilities have opted to shut down since compliance with MOTEMS standards was not considered economically feasible.

There have also been proposals to re-activate previously abandoned terminals (oil or non-oil). As these terminals are often in poor shape from lack of maintenance, their re-activation requires the application of "new" MOT standards. To establish baseline condition, a complete audit of the facility is required, and deficiencies are addressed by either retrofit/modification of "existing" components or via complete refurbishment or replacement with "new" components. MOTEMS provides guidance regarding the applicability of "new" vs. "existing" provisions. Such decisions require complex engineering reviews, sophisticated knowledge, subject matter expertise, and nuanced professional judgment.

As an example, one MOT opted to idle their berth for oil transfer to avoid complying with MOTEMS requirements. MFD determined that since the pipelines and structures associated with that berth were capable of being used for oil transfer, MOTEMS would still be applicable to those devices and associated structures capable of transferring oil. However, if pipelines were physically segregated from a source of oil making it impossible to transfer oil without additional construction and engineering, MOTEMS would no longer apply. If this berth is to be brought back into oil service after being "out-of-service", it will be required to comply with the MOTEMS requirements for "new" MOTs.

MFD engineers track the progress of each MOTEMS compliance project, in addition to cyclical inspections and audits, schedule delays, design reviews, permitting, etc. Whenever necessary, engineers conduct a field visit to verify deficiency resolutions and communicate the urgency of upgrade, rehabilitation, or modification to MOT operators that don't meet the code. Also, coordination of MOTEMS provisions with local authority requirements is a major challenge, requiring substantial efforts to resolve conflicting regulatory conditions.

POST EVENT INSPECTIONS

MOTEMS requires a focused inspection following occurrence of a significant, potentially damage-causing event such as an earthquake, storm, vessel impact, fire, explosion or tsunami. The goal of Post Event Inspection is to determine whether the facility is safe to continue operations and if any remedial action is necessary. After review of a damage-causing event at MOT, MFD engineers determine whether to limit or stop facility operations.

CURRENT STATUS OF MOTEMS IMPLEMENTATION

Two cycles of MOTEMS audits have been completed at 35+ California MOTs, and terminals are in various stages of upgrades to address deficiencies identified during MOTEMS audit. MOT operators in Northern California have taken a more proactive approach to MOTEMS compliance, with several facilities inching closer to full compliance. However, progress in Southern California MOTs is slow. The US Navy MOTs in the state have voluntarily agreed to comply with MOTEMS requirements, and one terminal is planning complete replacement with a new MOT. PMM

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