PREVENTION FIRST 2002

Engineering Standards for Marine Oil Terminal Design and Maintenance (MOTEMS)

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Overview of the Presentation

- Background of the Project and the Current State of Practice
- Overview of the Solution
- The Project Team
- The Standards
- Issues and Costs
- Regulations and Application

Background
Statutory Authority

- **From the Lempert-Keene-Seastrand Oil Spill Prevention and Response Act of 1990:**

  "The commission shall adopt rules, regulations, guidelines and commission leasing policies for reviewing the location, type, character, performance standards, size and operation of all existing and proposed marine terminals within the state, whether or not on lands leased from the commission, and all other marine facilities on land under lease from the commission to minimize the possibilities of a discharge of oil." (Sect. 8755 (a))

  "The commission shall periodically review and accordingly modify its rules, regulations, guidelines and commission leasing policies to ensure that all operators of marine terminals within the state and marine facilities under the commission's jurisdiction always provide the best achievable protection of the public health and safety, and the environment…" (Pub. Res. Code Sect. 8756)

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Current Practice for Existing Terminals

- **Historic Precedent**
  - *Maximum Size of Vessels Calling at Terminals Are Often Not Restricted By Structural Constraints, But Rather by Historic Precedent*
  - *If the Vessel Has Called on the Facility in the Past, A Grandfather Clause Was Adopted to Allow Them to Continue This Practice into the Future*
  - *The Design Capacity of the Facility Is Not Considered Unless The Operator Wants to Upgrade*
- **Facilities In California Are Aging**
  - *Many Facilities Were Constructed in the 1901 to 1925 Period*
  - *Newest Facility Was Constructed in 1987*
  - *Average Age of MOTs Waterfront Facilities in CA is 50 Years - This is Typically Considered Past the Design Life of a Marine Facility*
  - *Seismic Standards Did Not Exist When Most of the Facilities Were Built*

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Background
Examples of Current Practice

Large Tanker Berthing at an Old, Deteriorated Timber Wharf

Background
Examples of Current Practice

Broken Loading Arm At Terminal Located in High Current Area

Other Examples of Current Practices

- Mooring Dolphins With 3 Out of 10 Piles Broken
- Designing Structural Upgrades Without Inspecting Piles First
- Conducting Sophisticated Mooring Analysis to Determine Loads, But Never Comparing Them to the Structural Capacity
- Not Inspecting Under The Wharf (pile/cap interface) After Major Earthquake

Other Examples of Current Practices

- Upgrade to Larger Tanker Ignored Cleat Capacity - Resulting in Downgrade from 73 mph Wind to 25 mph
- Ignoring Shifting Sand Bars That Cause Potential Problems With Passing Vessel Motion
- Posted Wind Rose But No Anemometer To Monitor Wind Speed
- Posted Mooring Arrangement in Control Room But Lines Not Used As Posted
- No Underwater Inspection for 30-40 Years

Background
What Can Happen?

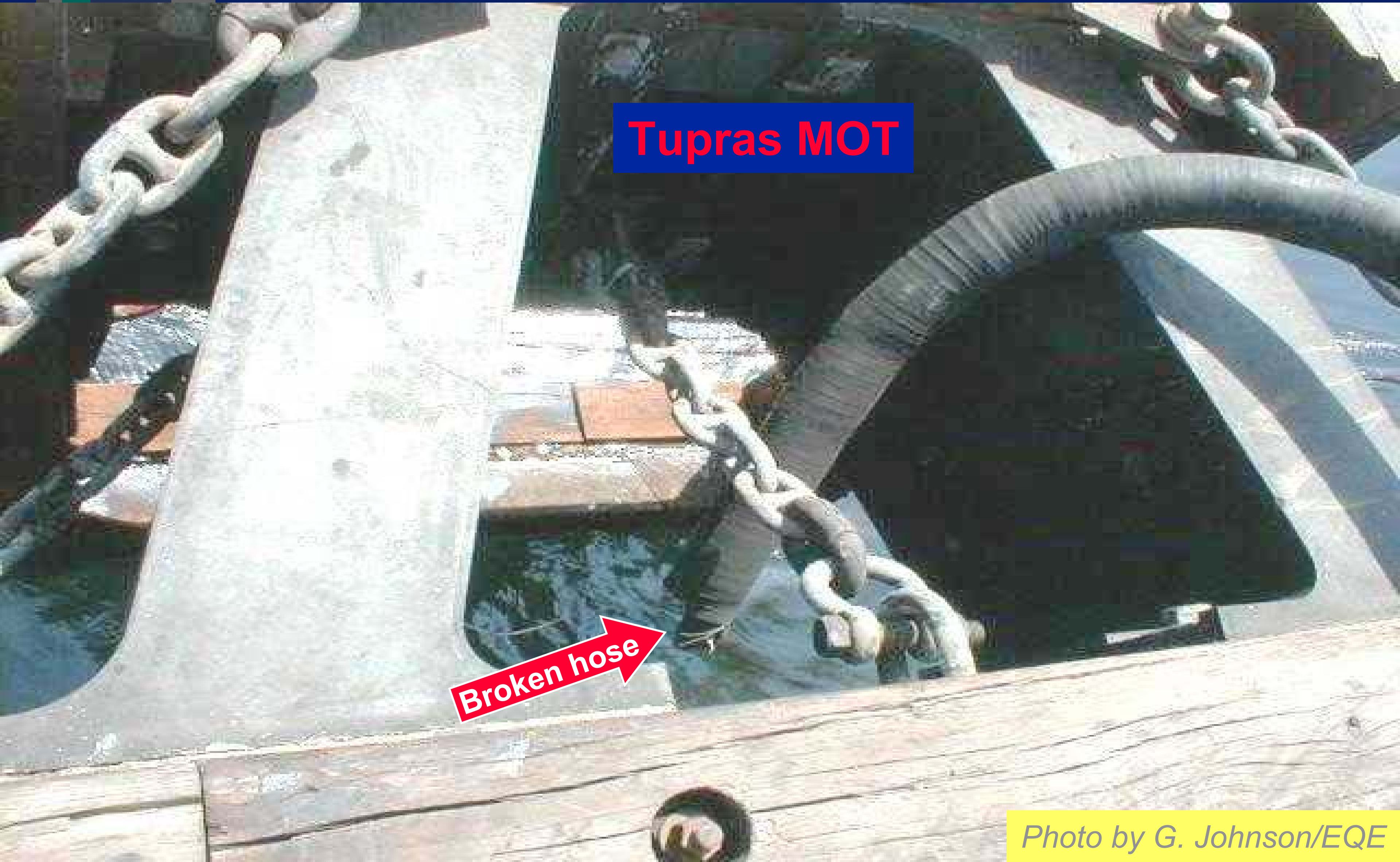
Background
What Can Happen?

Wharf - Tupras Marine Oil Terminal, Turkey

August 24, 1999

Background
What Can Happen?

Background
What Can Happen?



Background
What Can Happen?

Ulashi Harbor: *Accumulation of oil from the Tupras Refinery*

August 24, 1999

Background
What Can Happen?

Background

What Can Happen?

February 28, 2001

Port of Seattle Terminal 37

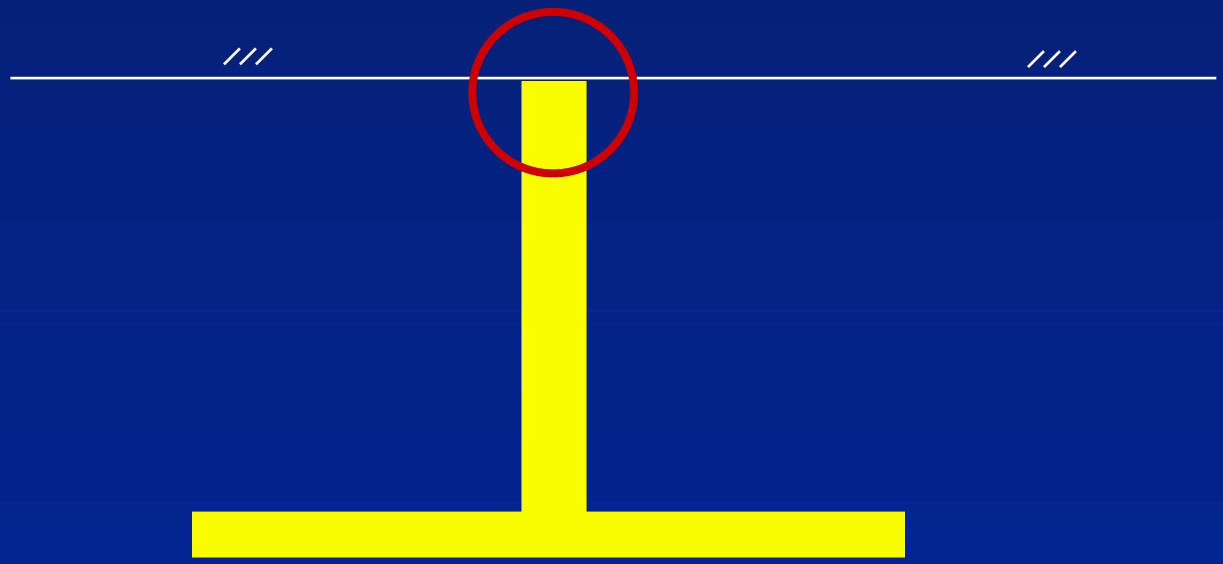
Background
What Can Happen?

Port of Seattle

February 28, 2001

Background
What Can Happen?

Major Marine Oil Terminal in Puget Sound



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The Solution: MOTEMS

- Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS)
  - *Standards Completed*
  - *Will Define Specific Engineering Criteria for Both Existing and New MOTs*
  - *Will Allow the SLC to Accomplish Their Goal of Protecting the Environment and Ensuring Safe Operations Through the Enforcement of the Standards*
- Schedule
  - *Engineering Standards Completed May 2002*
  - *Regulations to Follow (mid 2003)*

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MOTEMS
Scope of the Standards

- Audit and Inspection Criteria
- Structural Loading Criteria
- Seismic Analysis and Design Criteria
- Mooring and Berthing Analysis and Design Criteria
- Geotechnical Hazards Criteria
- Structural Analysis and Design of Components
- Piping and Pipeline Criteria
- Electrical and Mechanical Equipment Criteria

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The Team

- **U.S. Naval Facilities Engineering Service Center**
  - *Cooperative Research & Development Agreement*
  - *Seismic, Mooring and Structural Inspection Input*
- **University of Southern California**
  - *Tsunami and Seismic Risk Assessment*
- **University of California - San Diego**
  - *Seismic Analysis and Limit States Definition*
- **Han-Padron Associates / Ben C. Gerwick, JV**
  - *Assimilate Input From All Sources and References*
  - *Develop the Actual Standards*
  - *Facilitate the Workshops*

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The Standards
Overview

- Audit and Inspection Criteria
- Structural Criteria
- Electrical / Mechanical Criteria

The Standards
Audit Overview

- *Objective*
- *Frequency*
- *Baseline Inspection*
- *Qualifications*
- *Scope*
- *Evaluation*
- *Ratings*
- *Follow-up*
- *Reporting*

The Standards
Audit Objective

- Review of All Structural, Electrical and Mechanical Systems on a Prescribed Periodic Basis
- Relative to a Specific, Defined Purpose
- Standards Define the Criteria
- Audit Manual Defines the Execution Requirements

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FACILITY CLASSIFICATIONS (E)
(INITIAL AUDIT DEADLINES)

HIGH : *>1200 Bbls at risk*
(30 Months)

MEDIUM: *<1200 Bbls at risk or*
> 90 transfers/year
(48 Months)

LOW: *< 1200 Bbls at risk,*
< 90 transfers/year
< 30,000 DWT
(60 Months)

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The Standards

Subsequent Audit Frequencies

TABLE 2-2
RECOMMENDED MAXIMUM INTERVAL BETWEEN UNDERWATER AUDIT INSPECTIONS
(YEARS)[1]

Condition Rating From Previous Inspection	CONSTRUCTION MATERIAL: Unwrapped Timber or Unprotected Steel (no coating or cathodic protection)[4]		CONSTRUCTION MATERIAL: Concrete, Wrapped Timber, Protected Steel or Composite Materials (FRP, plastic, etc.)[4]		Channel Bottom or Mudline – Scour[4]	
	Benign[2] Environment	Aggressive[3] Environment	Benign[2] Environment	Aggressive[3] Environment	Benign[2] Environment	Aggressive[3] Environment
6 (Good)	6	4	6	5	6	5
5 (Satisfactory)	6	4	6	5	6	5
4 (Fair)	5	3	5	4	6	5
3 (Poor)	4	3	5	4	6	3
2 (Serious)	2	1	2	1	2	1
1 (Critical)	.5	.5	.5	.5	.5	.5

1. The recommended maximum interval between Underwater Audit Inspections should be reduced as appropriate based on the extent of deterioration observed on a structure, the rate of further anticipated deterioration, or other factors.
2. Benign environments include fresh water with low to moderate currents (maximum current always < .75 kts)
3. Aggressive environments include brackish or salt water, polluted water, or waters with moderate to swift currents (maximum current ≥ .75 kts)
4. For most structures, two maximum intervals will be shown in this table, one for the assessment of construction material (timber, concrete, steel, etc) and one for scour (last 2 columns). The shorter interval of the two should dictate the maximum interval used.

The Standards

Structural Criteria

- *Dead Loads*
- *Live Loads*
- *Seismic Loads*
- *Mooring and Berthing Loads*

The Standards

Structural Criteria: Seismic

Risk Classification:

TABLE 2 EXISTING FACILITY CLASSIFICATION			
Classification Level	**Exposed Oil (bbl)**	**Transfers per Year/Facility**	**Vessel Size (DWTx1000)**
High	$\geq$ 1200	N.A.	N.A.
Moderate	< 1200	$\geq$ 90	$\geq$ 30
Low	< 1200	< 90	< 30

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The Standards

Structural Criteria: Seismic

Performance Criteria:

- ***Level 1 Earthquake:*** **No or minor structural damage without interruption in service or with minor temporary interruption in service.**

- ***Level 2 Earthquake:*** **Controlled inelastic behavior with repairable damage resulting in temporary closure in service restorable within months. Prevention of major spill. Prevention of collapse.**

The Standards

Structural Criteria: Seismic

Design Earthquake Motions:

TABLE 3
DESIGN EARTHQUAKE MOTIONS

Classification		Probability of Exceedance	Return Time
High	Level 1	50% in 50 years	72 years
	Level 2	10% in 50 years	475 years
Moderate	Level 1	64% in 50 years	50 years
	Level 2	14% in 50 years	333 years
Low	Level 1	75% in 50 years	36 years
	Level 2	19% in 50 years	238 years

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Structural Criteria: Mooring & Berthing

Risk Classification:

TABLE 5 FACILITY RISK CLASSIFICATION				
Risk Level	**Wind, (V_w)**	**Current, (V_c)**	**Passing Vessels**	**Tidal Variation**
High	> 50 knots	> 1.5 knots	Yes	> 8 feet
Moderate	30 to 50	0.75 to 1.5 knots	No	6 to 8
Low	< 30 knots	< 0.75 knot	No	< 6 feet

Classification determines the level of sophistication of the analysis required

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Electrical / Mechanical Standards

- *Fire Prevention*
- *Fire Detection*
- *Fire Suppression*
- *Piping and Pipelines*
- *Marine Loading Arms*
- *Dock Hoses and Hose Towers*
- *Lifting Equipment*
- *Personnel Vessel Access Equipment*

Electrical / Mechanical Standards

- *Sumps*
- *Vapor Control Systems*
- *Electrical Power*
- *Illumination*
- *Communication Systems*
- *Control Systems*
- *Supervision Systems*

MOTEMS - ISSUES

- Will Require a Registered Engineer to be a member of the dive team, at a minimum of 25% of the total dive time.
- Grandfathering of terminals will end - require an engineering justification for vessels.
- A seismic analysis will be required, with possible structural upgrades/rehabilitation.
- A pipeline analysis may be required, pending the global displacements from the seismic analysis.
- The fire water volumes are specified in MOTEMS, and may cause some terminals to upgrade fire water or foam systems. A comprehensive fire plan is required.

MOTEMS ISSUES (Cont.)

- A Baseline Inspection may be required, to provide minimum engineering design details, if drawings, P&ID's are not available.

- A geotechnical review of the facility is required - evaluating the potential for liquefaction, slope instability, etc.

- The Audit may reveal other deficiencies that will need to be corrected. A schedule for rehabilitation must be jointly agreed upon by the operator and MFD.

- Subsequent audits are required at intervals from 1 to 6 years, pending the condition assessment ratings.

MOTs in California
INITIAL AUDIT

- Number of MOTs Considered “HIGH” = 14 (Audit within 30 months)
- Number of MOTs Considered “MEDIUM” = 12 (Audit within 48 months)
- Number of MOTs Considered “LOW” = 15 (Audit within 60 months)
- After the Audit, rehabilitation is scheduled and agreed upon by operator and MFD.

Costs Associated with MOTEMS Implementation

- EXAMPLE MOT (Maximum in parentheses):
- Cost of the on-site audit: $26K (40)
- Cost of the u/w inspection: $21K (25)
- Cost of the structural assessment: $20K (50)
- Cost of the mooring analyses (if required): $20K (30)
- Cost of the pipeline analysis (if required): None (10)
- Cost to update/analyze geotechnical data: None (20)
- **TOTAL MOTEMS COSTS: $87K (175)**

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MOTEMS COSTS (Cont.)

- EXAMPLE MOT:
- COST TO REHABILITATE: $750K (Other MOTs could range up to $10 Million)
- (Note: Cost can be spread out over a number of years, as scheduled/agreed upon by operator and MFD)
- COST TO CLEAN-UP (NOT INCLUDING BUSINESS LOSSES):
- 1200 Bbls @ $20,000/Bbl = $24 Million

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Regulations - 2003

- Will “Incorporate” the MOTEMS
- Will Require Existing Facilities to Evaluate Current Practices and Facilities, Regardless of Whether or Not They Are Upgrading
- Will Provide Timeline for Compliance - With Tighter Requirements for Higher Risk Facilities
- Will Require Periodic (Future) Inspections
- May Require Upgrades For Some / Many Facilities

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Related Activities

- *Port of Oakland - Wharf & Embankment Strengthening Project*
- *Strong Motion Instrumentation Program - Port of Oakland & 1 MOT in Bay Area (POLA and POLB planned)*
- *Full Scale Wharf Test Program - Port of Long Beach (early 2003)*
- *NEHRP (National Earthquake Hazard Reduction Program, FEMA 368, 2003)*

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The Impact

- **Anticipate Impact Far Beyond the State of CA**
  - ***This Will Be the First Document of Its Kind***
  - ***Seismic criteria is being proposed for NEHRP (FEMA 368) as recommended seismic provisions for new wharf and pier structures.***
- **Those Potentially Affected**
  - ***Owners, Operators, and Landlords of Liquid Bulk Terminals and other port facilities, throughout the world (PIANC Working Group #34)***

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