Prevention First 2002

Marine Oil Terminal Engineering & Maintenance Standards (MOTEMS)

Audit and Inspection Criteria

Overview and Discussion of Controversial Provisions

September 10, 2002

Ron Heffron, P.E.

Agenda

- *Overview of Annual Inspections*
- *Overview of Audits*
- *Overview of Post-Event Inspections*
- *Discussion of Some Controversial Issues*

Audits and Inspections - Flowchart

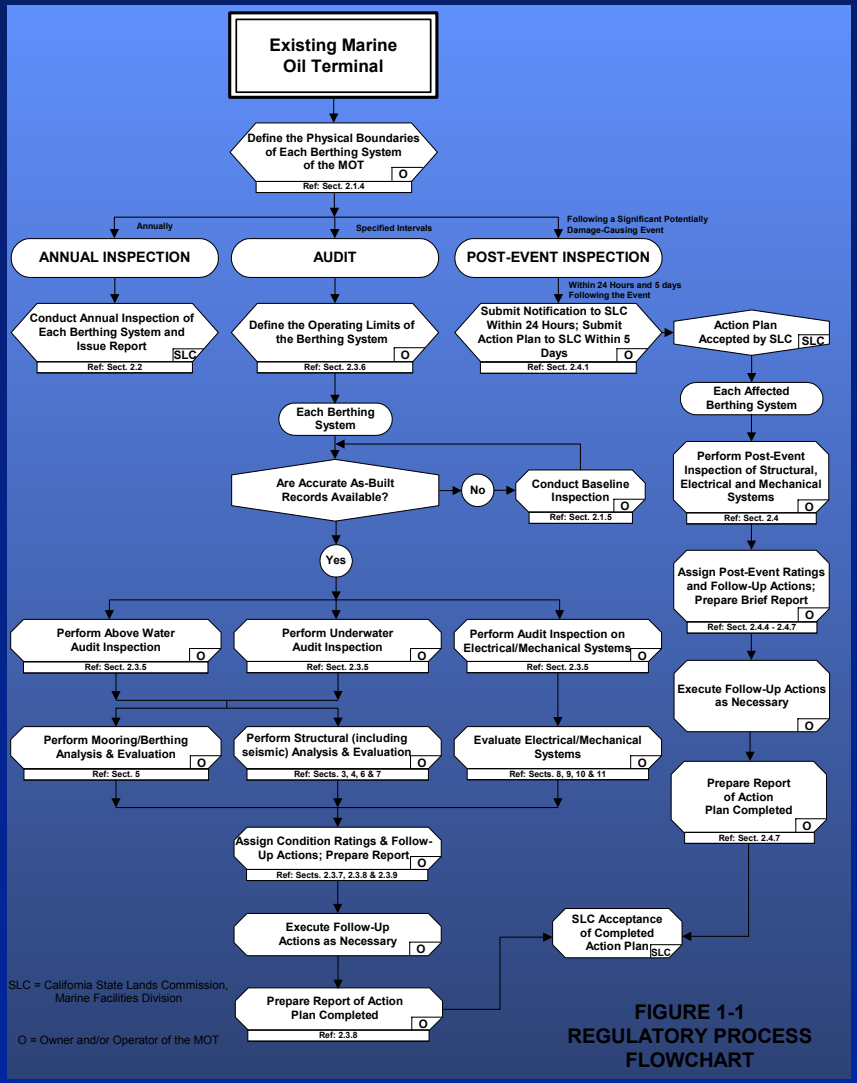
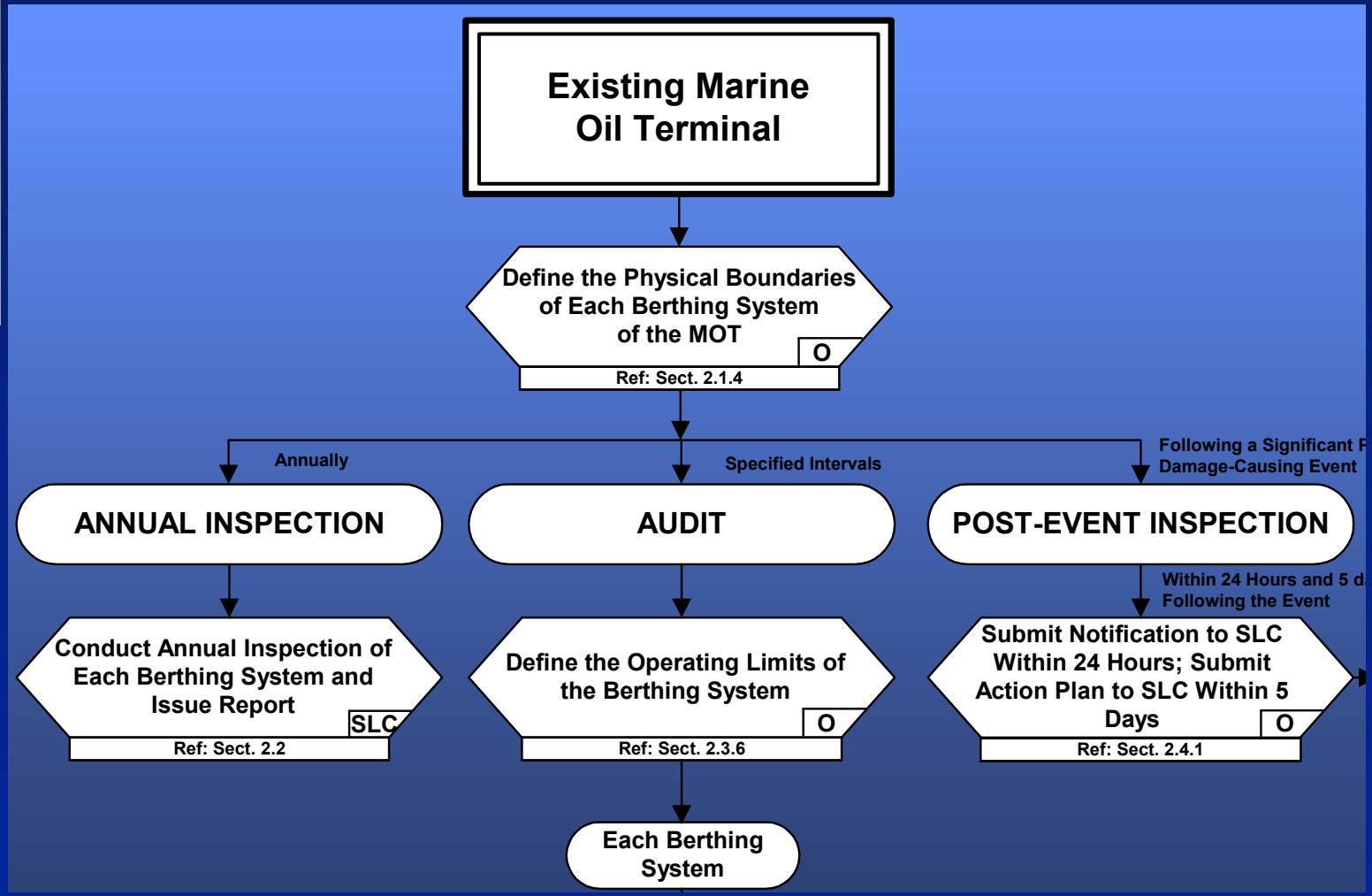
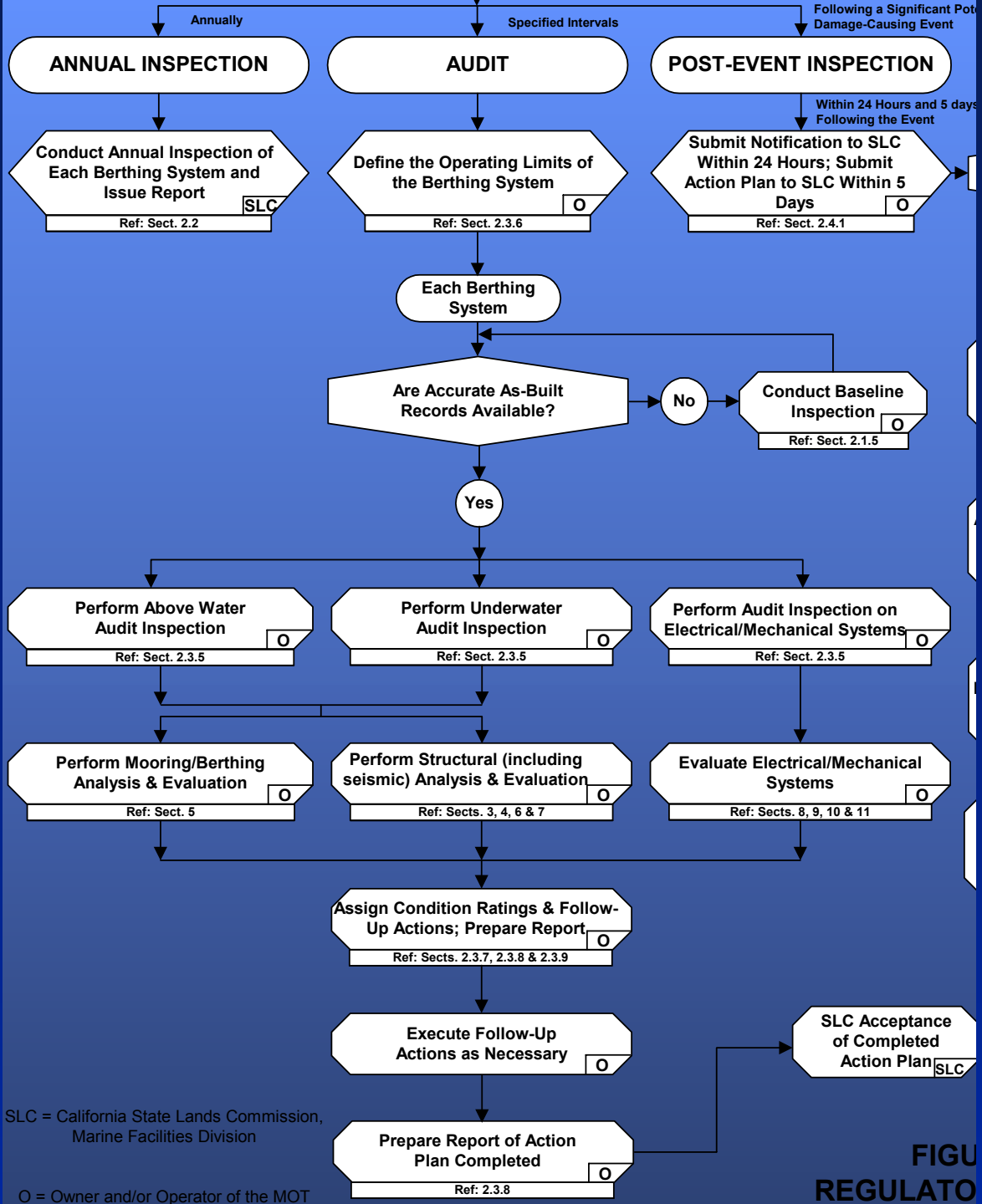


FIGURE 1-1
REGULATORY PROCESS FLOWCHART

Regulatory Process Flowchart





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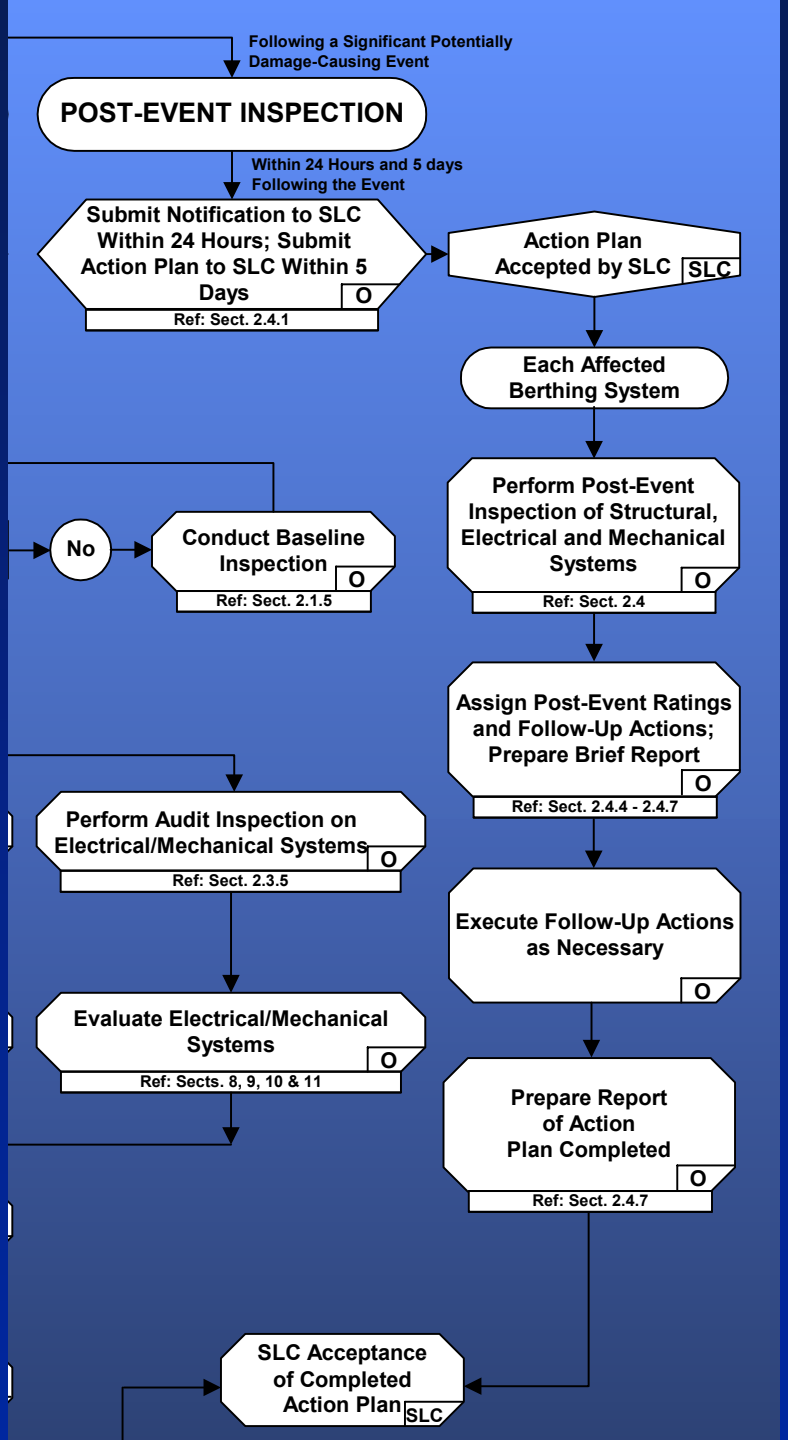
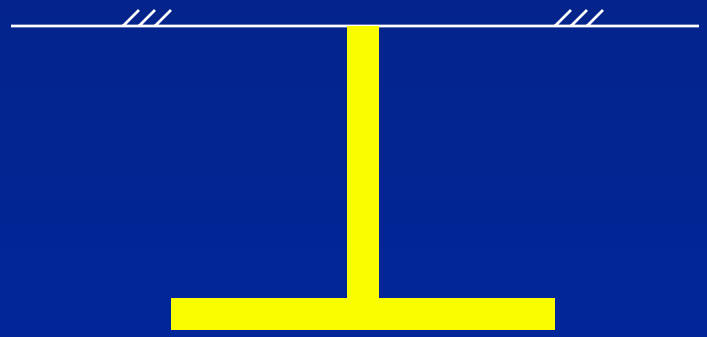

Following a Significant Potentially Damage-Causing Event
POST-EVENT INSPECTION
Within 24 Hours and 5 days Following the Event
Submit Notification to SLC Within 24 Hours; Submit Action Plan to SLC Within 5 Days
O
Ref: Sect. 2.4.1
Action Plan Accepted by SLC
SLC
Each Affected Berthing System
Perform Post-Event Inspection of Structural, Electrical and Mechanical Systems
O
Ref: Sect. 2.4
No
Conduct Baseline Inspection
O
Ref: Sect. 2.1.5
Assign Post-Event Ratings and Follow-Up Actions; Prepare Brief Report
O
Ref: Sect. 2.4.4 - 2.4.7
Perform Audit Inspection on Electrical/Mechanical Systems
O
Ref: Sect. 2.3.5
Execute Follow-Up Actions as Necessary
O
Evaluate Electrical/Mechanical Systems
O
Ref: Sects. 8, 9, 10 & 11
Prepare Report of Action Plan Completed
O
Ref: Sect. 2.4.7
SLC Acceptance of Completed Action Plan
SLC

Physical Boundaries of "Berthing Systems"

Berthing System: ***A complete set of structural, electrical and mechanical components for the transfer of product to or from the vessel to the first valve onshore***

Two Berthing Systems



One Berthing System

Audit / Inspection Types

- ***Annual Inspection***
- ***Audit***
- ***Post-Event Inspection***

Annual Inspection

- *Conducted by SLC*
- *2 CCR 2320*
- *Walkdown Inspection - Primarily Topside*

Audit Overview

- Objective
- Frequency - Issue 1
- Baseline Inspection - Issue 2
- Qualifications - Issue 3
- Scope
- Evaluation - Issue 4
- Ratings
- Follow-up
- Reporting

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

Audit Frequency - Initial

TABLE 2-1

INITIAL AUDIT REPORT SUBMISSION DEADLINE FOR EXISTING BERTHING SYSTEMS

MOT Classification[1]	Submission Deadline[2]
High	30 Months
Medium	48 Months
Low	60 Months

1 As defined in Sections 4 and 5, Tables 4-1 and 5-1
2 From the effective date of this standard

TABLE 4-1

MOT RISK CLASSIFICATION

Risk Classification	Exposed Oil (bbls)	Transfers per Year per Berthing System	Maximum Vessel Size (DWTx1000)
High	≥1200	N.A.	N.A.
Moderate	<1200	≥90	≥30
Low	<1200	<90	<30

TABLE 5-1

MOT MOORING/BERTHING CLASSIFICATION

Risk Classification	Wind, (V_W) (knots)	Current, (V_c) (knots)	Passing Vessel Effects	Change in Draft (ft.)
High	>50	>1.5	Yes	>8
Moderate	30 to 50	1.0 to 1.5	No	6 to 8
Low	<30	<1.0	No	<6

Audit Frequency - Subsequent - Issue 1

- *Above Water - 3 years*
- *Underwater - Table 2-2*

TABLE 2-2

MAXIMUM INTERVAL BETWEEN UNDERWATER AUDIT INSPECTIONS (YEARS)[1]

Condition Rating From Previous Inspection	CONSTRUCTION MATERIAL				Channel Bottom or Mudline – Scour[4]	
	Unwrapped Timber or Unprotected Steel (no coating or cathodic protection)[4]		Concrete, Wrapped Timber, Protected Steel or Composite Materials (FRP, plastic, etc.)[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	5
2 (Serious)	2	1	2	2	2	2
1 (Critical)	N/A[5]	N/A[5]	N/A[5]	N/A[5]	N/A[5]	N/A[5]

1. The maximum interval between Underwater Audit Inspections shall 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 and maximum current velocities less than 1.5 knots for the majority of the days in a calendar year
3. Aggressive environments include brackish or salt water, polluted water, or waters with current velocities greater than 1.5 knots for the majority of the days in the calendar year.
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.
5. MOTs rated “Critical” will not be operational; and Emergency Action shall be required in accordance with Table 2-7.

Audit Frequency - Subsequent - Issue 1

- ***Above Water - 3 years***
- ***Justification:***
  - **Consistent with other agencies**

Agency	Above Water Inspection Frequency	Comment
US Navy	Annual	Subject to change
Federal Highway Administration	Every Two Years	All US Bridges
Port of Los Angeles	Every Two Years	Over 200 WF Structures
New York City EDC	Every Two Years	Over 12 miles of Waterfront

Audit Frequency - Subsequent - Issue 1

- ***Underwater - 1 to 6 years***
- ***Justification:***
  - Consistent with ASCE UW Investigations Manual

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

Condition Rating From Previous Inspection	CONSTRUCTION MATERIAL				Channel Bottom or Mudline – Scour[4, 5] (Soundings[6] / Direct Observation)	
	Unwrapped Wood or Unprotected Steel (no coating or cathodic protection)[4]		Concrete, Wrapped Wood, Protected Steel or Composite Materials (FRP, plastic, etc.)[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 / 6	2 / 5
5 (Satisfactory)	6	4	6	5	6 / 6	2 / 5
4 (Fair)	5	3	5	4	6 / 6	2 / 5
3 (Poor)	4	3	5	4	6 / 6	2 / 5
2 (Serious)	2	1	2	2	2 / 2	2 / 2
1 (Critical)	0.5	0.5	0.5	0.5	1 / 1	0.5 / 1

1. The recommended maximum interval between Routine Inspections should be reduced as appropriate based on the extent of deterioration observed on a structure, the rate of further anticipated deterioration, the importance of the structure, or other factors. The intervals may likewise be increased as appropriate for non-typical cases such as alternative deterioration-resistance construction materials (i.e., special hardwoods), or other factors. Regulatory jurisdictions may also dictate the maximum inspection interval.
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. The intervals indicate requirements for soundings and direct observation, respectively.
5. For most structures, two maximum intervals will be shown in this table, one for the assessment of construction material (wood, concrete, steel, etc) and one for scour (last 2 columns). The shorter interval of the two should dictate the maximum interval used.
6. Soundings may be performed at the time of the above water inspection.

Baseline Inspection - Issue 2

- *Must be conducted if drawings are not available*
- *Level of detail must support what is needed to conduct the structural analysis*
- *Strength / ductility characteristics must be determined*
- *Non-destructive testing, partially-destructive testing and/or laboratory testing may be required*
- *Electrical and mechanical systems must be determined as to location, capacity, operating limits and physical condition*

Minimum Qualifications - Issue 3

Project Manager:	***In-depth knowledge of systems under audit***
Team Leader:	***Registered civil/structural engineer; commercially trained diver (or equal) for u/w inspections***
Team Members: ***(Structural)***	***Graduate civil/structural engineer or certified technician; commercially trained diver (or equal) for u/w inspections***
Lead Engineer: ***(Seismic Structural)***	***Registered civil/structural engineer***
Lead Engineer: ***(Electrical)***	***Registered electrical engineer***
Lead Engineer: ***(Mechanical)***	***Registered mechanical engineer***

Minimum Qualifications - Issue 3

Team Leader: ***Registered civil/structural engineer; commercially trained diver (or equal) for u/w inspections***

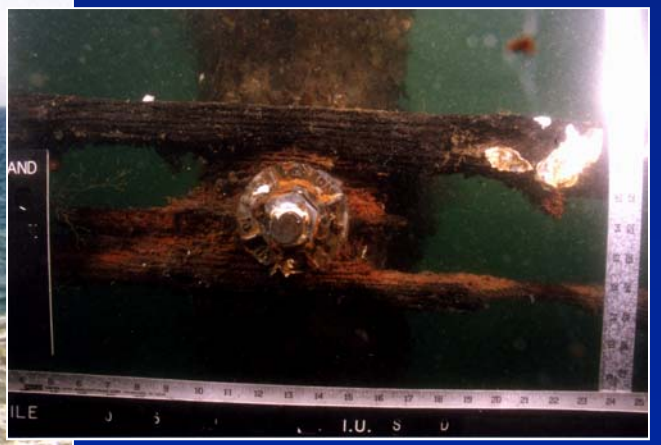
Why Engineers?

Why Engineers?

Because Professional Judgement is Required Throughout the Inspection Process

Examples:

- **Assigning Condition Ratings**
- **Understanding Load Paths**
- **Understanding the Structural Significance of Damage**

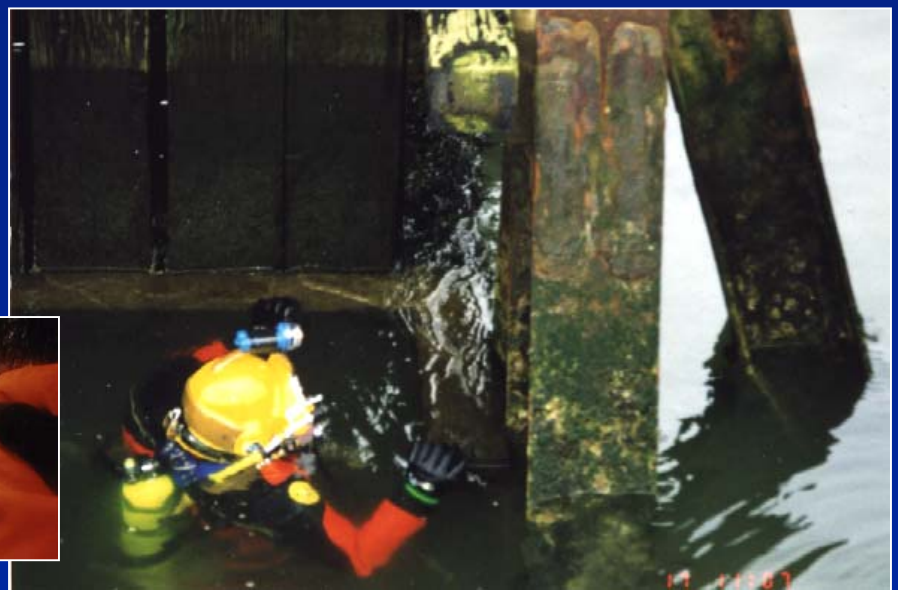


Why Engineers?

Because Professional Judgement is Required Throughout the Inspection Process

Examples:

- Quantifying Damage for Structural Analysis
- Requires first-hand knowledge of the deterioration
- Requires judgement to know what data to collect



Why Engineers?

Because Professional Judgement is Required Throughout the Inspection Process

Examples:

- **Estimating the Remaining Useful Life of a Structure**
- **Requires understanding of deterioration mechanisms and rates**

Why Engineers? - Anecdote A

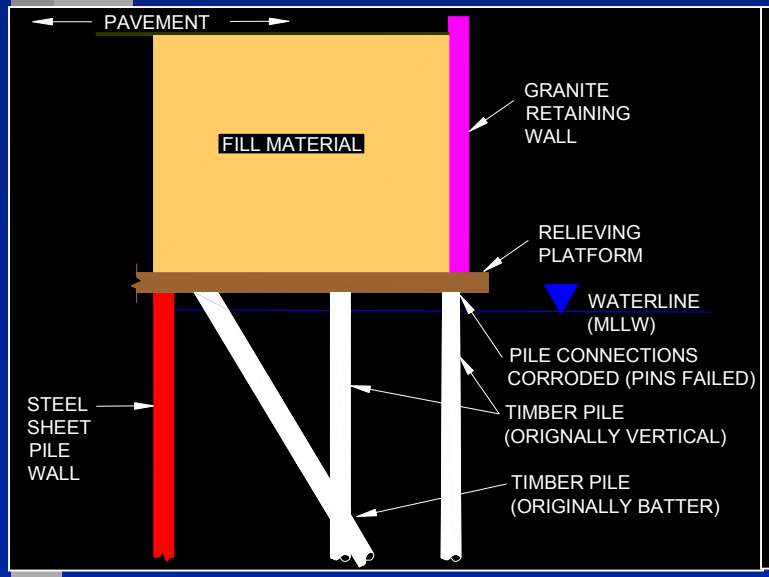
Example:

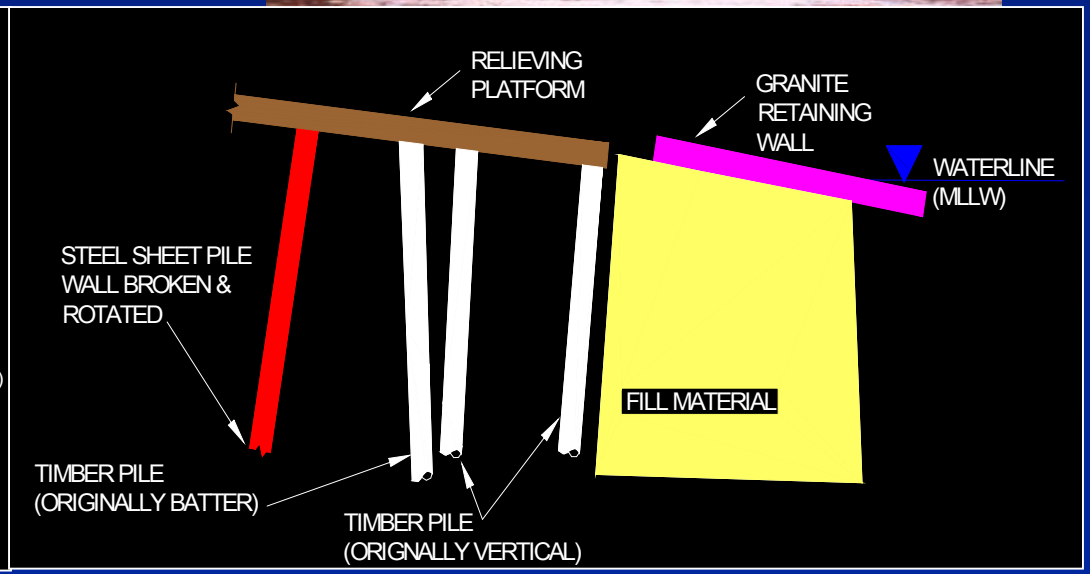
"The timber piles were wrapped, so we just assumed they were adequately protected…besides, it's expensive to remove and replace wraps and the owner had no rational basis for spending the extra money"

Solution: ***Engineers must be aware of the industry issues and help develop the scope of work - educating Owners to understand that recent research has found timber pile wraps to often be woefully inadequate. Removal of a representative sample of wraps may be essential to understanding the structure's condition.***

Why Engineers? - Anecdote B

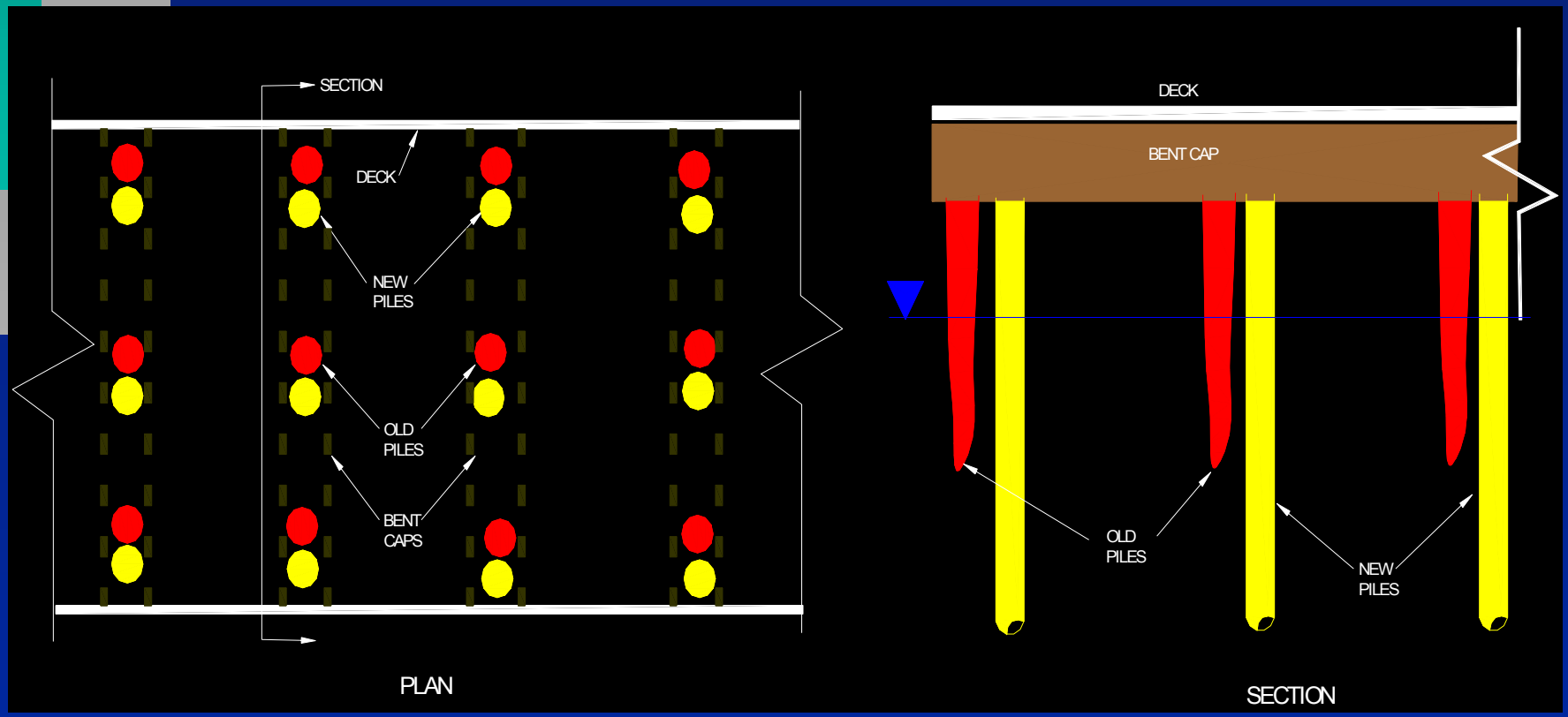
Failure of Timber Marginal Wharf in Boston





Why Engineers? - Anecdote C

Timber Pier in Boston Harbor



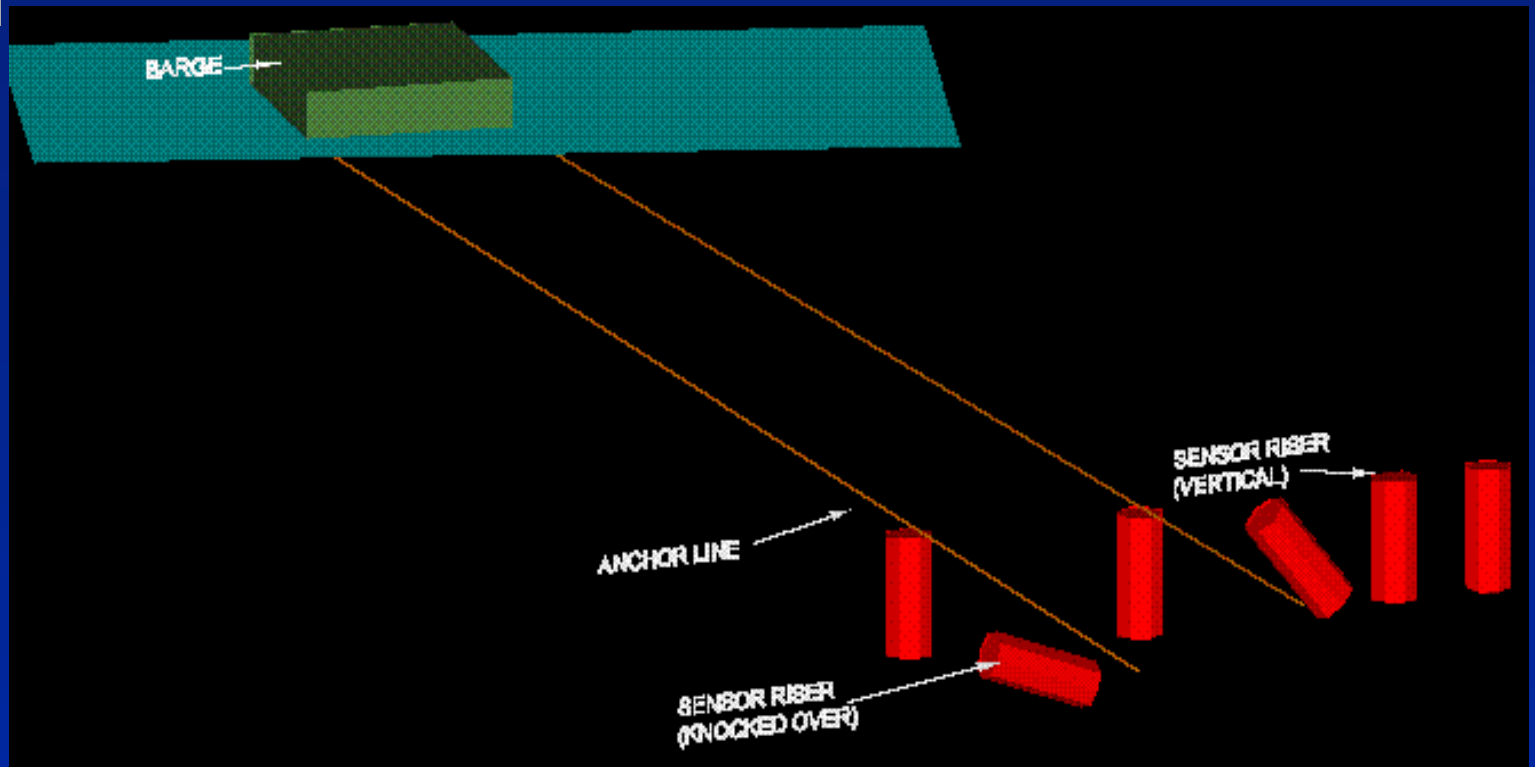
Why Engineers? - Anecdote D

Bridge in Tidal Washington State

"The badly deteriorated column above the footing was ignored (it was more difficult to inspect), while all the remedial attention was focused on footing 'deterioration' that was primarily voids from formwork"

Why Engineers? - Anecdote E

Navy Construction Project in Virginia - "The current knocked the risers over so we need a change order to reconstruct them and install protection so it won't happen again"



Why Engineers? - Anecdote E

Recent Pier Collapse in Philadelphia - Killing Several People

Facts:

- ***Pier had just been inspected the day before collapse***
- ***Pier collapsed due to extensive deterioration***
- ***Owner may have no recourse since he hired a non-engineer-diver with no Professional Liability Insurance***

Why Commercially Trained Divers?

Justification:

- *OSHA has ruled that recreational SCUBA training is inadequate for this type of work*
- *PADI, NAUI and YMCA have all written letters to OSHA stating that their training does NOT qualify individuals for this type of work*
- *Owners may ultimately be liable, if anything happens, for hiring unqualified divers*
- *Unqualified divers may have inadequate insurance*

Scope

TABLE 2-4

SCOPE OF UNDERWATER INSPECTIONS

Level		Sample Size and Methodology[1, 2]							
		Steel		Concrete		Timber		Composite	Slope Protection/ Channel Bottom or Mudline-Scour
		Piles	Bulkheads/ Retaining Walls	Piles	Bulkheads/ Retaining Walls	Piles	Bulkheads/ Retaining Walls	Piles	
I	**Sample Size:**	100%	100%	100%	100%	100%	100%	100%	100%
	Method:	Visual/ Tactile	Visual/ Tactile	Visual/ Tactile	Visual/ Tactile	Visual/ Tactile	Visual/ Tactile	Visual/ Tactile	Visual/ Tactile
II	**Sample Size:**	10%	Every 100 LF	10%	Every 100 LF	10%	Every 50 LF	10%	0%
	Method:	Visual: Removal of marine growth in 3 bands	Visual: Removal of marine growth in 1 SF areas	Visual: Removal of marine growth in 3 bands	Visual: Removal of marine growth in 1 SF areas	Visual: Removal of marine growth on 3 bands Measurement: Remaining diameter	Visual: Removal of marine growth in 1 SF areas	Visual: Removal of marine growth in 3 bands	
III	**Sample Size:**	5%	Every 200 LF	0%	0%	5%	Every 100 LF	0%	0%
	Method:	Remaining thickness measurement; electrical potential measurement; corrosion profiling as necessary	Remaining thickness measurement; electrical potential measurement; corrosion profiling as necessary	N/A	N/A	Internal marine borer infestation evaluation	Internal marine borer infestation evaluation		

1. The stated sample size may be reduced in the case of large structures where statistically representative sampling can be demonstrated to the Division in accordance with these standards. The sampling plan must be representative of all areas and component types (i.e. approach trestles, pier/wharf, dolphins, inboard, outboard, batter, vertical, concrete, steel, timber, etc.). Any reduced sampling plan proposed to the Division must include the Level I inspection of all piles around the perimeter of the facility where vessels may berth or where debris may impact or accumulate. If the reduced sampling plan proposes to conduct less than 100 percent Level I effort, then the results of the inspection must be carefully monitored. If significant deterioration is observed on any component, which could reasonably be expected to be present on additional components, and which could have a detrimental effect on the load bearing capacity of the structure either locally or globally, then the inspection scope shall be increased to include a 100 percent Level I effort. See reference [2.1].
2. The minimum inspection sampling size for small structures shall include at least two components.

LF = Linear Feet; SF = Square Feet, N/A = Not Applicable

Audit Evaluation - Issue 4

- *Terminal Operating Limits (Statement of Purpose)*
  - *Physical Limits*
  - *Minimum / Maximum Vessel Sizes - LOA / Beam / Max. Arrival Draft with Associated Displacement*
  - *Must Consider Water Depths, Dolphin Spacing, Fender System Limitations, Manifold Height and Hose / Loading Arm Reach, Tidal Fluctuations, Surge, & Drift*
- *Mooring and Berthing Analysis*
- *Structural Evaluation (including seismic)*
- *Electrical / Mechanical Systems Evaluation*

Audit Evaluation - Issue 4

- *Structural Evaluation (including seismic)*
  - Grandfathering is over
  - All terminals must meet minimum standards
  - Seismic, mooring, berthing, etc.
- *Electrical / Mechanical Systems Evaluation*
  - A pipeline stress analysis may be required
  - Piping and structural analyses must be co-dependant

Condition Assessment Ratings

TABLE 2-5

CONDITION ASSESSMENT RATINGS (CAR)

Rating		Description of Structural Systems Above and Below Water Line
6	Good	No problems or only minor problems noted. Structural elements may show very minor deterioration, but no overstressing observed. The capacity of the structure meets the requirements of this standard. The structure should be considered fit-for-purpose. No repairs or upgrades are required.
5	Satisfactory	Limited minor to moderate defects or deterioration observed, but no overstressing observed. The capacity of the structure meets the requirements of this standard. The structure should be considered fit-for-purpose. No repairs or upgrades are required.
4	Fair	All primary structural elements are sound; but minor to moderate defects or deterioration observed. Localized areas of moderate to advanced deterioration may be present, but do not significantly reduce the load bearing capacity of the structure. The capacity of the structure is no more than 15 percent below the structural requirements of this standard, as determined from an engineering evaluation. The structure 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.

Condition Assessment Ratings

3	**Poor**	Advanced deterioration or overstressing observed on widespread portions of the structure, but does not significantly reduce the load bearing capacity of the structure. The capacity of the structure is no more than 25 percent below the structural requirements of this standard, as determined from an engineering evaluation. The structure 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**	Advanced deterioration, overstressing or breakage may have significantly affected the load bearing capacity of primary structural components. Local failures are possible and loading restrictions may be necessary. The capacity of the structure is more than 25 percent below than the structural requirements of this standard, as determined from an engineering evaluation. The structure 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**	Very advanced deterioration, overstressing or breakage has resulted in localized failure(s) of primary structural components. More widespread failures are possible or likely to occur and load restrictions should be implemented as necessary. The capacity of the structure is critically deficient relative to the structural requirements of this standard. The structure is not fit-for-purpose. The facility shall cease operations until deficiencies are corrected and accepted by the Division.

Remedial Action Priorities

TABLE 2-6

REMEDIAL ACTION PRIORITIES (RAP) FOR ELECTRICAL AND MECHANICAL DEFICIENCIES

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 berthing system is not fit-for-purpose. 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.

Follow-Up Actions

TABLE 2-7

STRUCTURAL FOLLOW-UP ACTIONS

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 structural 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 structural 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 non-typical deterioration, usually prior to designing repairs. Special testing, laboratory analysis, monitoring or investigation using non-standard 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.

Documentation and Reporting

Example

EXECUTIVE SUMMARY TABLE (ES-1)
STRUCTURAL CONDITION ASSESSMENT RATINGS (CAR)

Berthing System	System	Condition Assessment Rating	From this Audit[1]	From Previous Audit[1]	Next Audit Due (Mo/Yr)	Assigned Follow-Up Actions	Fit-for-Purpose?
North Wharf	Above Water Structure	4 (Fair)	(date)		6/2004	Upgrade Design and Implementation	No
	Underwater Structure	5 (Satisfactory)		(date)	10/2006		Yes
South Wharf	Above Water Structure	4 (Fair)	(date)		6/2004	Repair Design Inspection	No
	Underwater Structure	3 (Poor)		(date)	10/2006	Special Inspection; Repair Design Inspection	No

Example

EXECUTIVE SUMMARY TABLE (ES-2)
ELECTRICAL AND MECHANICAL SYSTEM REMEDIAL ACTION PRIORITIES (RAP)

Berthing System	Deficiency	Remedial Action Priority (RAP) (P1-P4)	From this Audit	From Previous Audit	Next Audit Due (Mo/Yr)	Description of Planned Remedial Action	Fit-For-Purpose?
North Wharf	Fire main leaking	**P3**		(date)	6/2004	Repair	No
	Pipeline badly corroded	**P2**	(date)			Investigate; urgent action required	
	Electrical (Class I, Div 2 violation)	**P1**	(date)			Immediate remedial action required	

Post-Event Audit

- *Initial notification to SLC within 24 hours*
- *Action Plan to SLC within 5 working days*

Post-Event Ratings

TABLE 2-8

POST-EVENT RATINGS AND ACTIONS

Rating	Summary of Damage	Remedial Actions
A	No significant event-induced damage observed.	No further action required. The berthing system may continue operations.
B	Minor to moderate event-induced damage observed but all primary structural elements and electrical/mechanical systems are sound.	Repairs or mitigation may be required to remain operational. The berthing system may continue operations.
C	Moderate to major event-induced damage observed which may have significantly affected the load bearing capacity of primary structural elements or the functionality of key electrical/mechanical systems.	Repairs or mitigation may be necessary to resume or remain operational. The berthing system may be allowed to resume limited operations. (See 2 CCR 2385 (f)).
D	Major event-induced damage has resulted in localized or widespread failure of primary structural components; or the functionality of key electrical/mechanical systems has been significantly affected. Additional failures are possible or likely to occur.	The berthing system may not resume operations until the deficiencies are corrected (See 2 CCR 2385 (f)).


Bad Day at the Office