Safe Operation and Maintenance of Dry Dock Facilities

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Safe Operation and Maintenance of Dry Dock Facilities

Prepared by
the Dry Dock Asset Management Task Committee of
the Ports and Harbors Committee of
the Coasts, Oceans, Ports, and Rivers Institute of
the American Society of Civil Engineers

Edited by
Paul A. Harren

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PREFACE

Prior to the publication of this manual of practice, there was no documentation available to commercial facilities that provides guidance for the operators of the four types of dry dock facilities: floating dry docks, graving docks, marine railways, and vertical lifts. As a result, some facilities have been operated and maintained without a thorough understanding of the design of the dry dock and, therefore, the features that are vital to the safe operation of the facility.

Several dry dock failures in recent years have underscored the need for understanding and vigilance when operating and maintaining dry docks. The most vivid example occurred on March 27, 2002, at Dubai Dry Dock No. 2, one of the world's largest ship repair facilities. With five vessels in dock, a section of the gate failed, causing uncontrolled flooding of the dock.

This manual is intended for commercial entities that inspect, maintain, or operate the types of dry docks addressed in this manual, with a capacity of 400 long tons or greater. This manual is not applicable to facilities that are certified to MIL-STD-1625 (D)SH (2009) for the drydocking of U.S. Navy ships. Personnel safety requirements are outside the scope of this manual.

Four activities are vital to maintaining and operating a dry dock safely. These activities include:

Condition Assessment: The condition assessment evaluates the physical condition of the dry dock, reviews design documentation, and performs calculations to determine the capacity of the dry dock in its current condition.

Maintenance: Maintenance includes scheduled preventive maintenance tasks as well as maintenance to correct deficiencies that are identified through a condition assessment, a preventive maintenance task, a control inspection, or during dock operations.

Control Inspection: The control inspection is a comprehensive but qualitative review of the dry dock facility to evaluate the effectiveness of the maintenance program in keeping the dry dock in a condition to support operating at the rated capacity as determined in the condition assessment. This is effectively an audit of the maintenance program.

Dock Operations: Dock operations encompass all tasks associated with the act of docking a vessel in a dry dock. This includes, but is not limited to, calculations to ensure the stability of the vessel and dock throughout the evolution; proper blocking to ensure proper loading of both the vessel and dock; and procedure requirements.

Sections of this manual are dedicated to each of these activities. The goal is to provide a cost-effective program that provides guidance to maintain and operate a dry dock in a safe manner.

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1
BACKGROUND

This section will provide basic information about the different types of dry docks. Knowledge of the types of dry docks and their design features is useful for understanding the structural and operational limitations of a dry dock. Additionally, an explanation of basic terms used in the following sections will be provided.

1.1 TYPES OF DRY DOCKS

1.1.1 Floating Dry Docks

Floating dry docks, often referred to as "floaters," are structures with sufficient size, strength, displacement, and stability to lift a vessel from the water using buoyancy. Figure 1-1 shows a floating dry dock. These docks can be operated with list and trim to reduce block loading and reduce or eliminate vessel stability problems when docking or undocking. Some shipyards are equipped to transfer vessels to shore from a floating dry dock, which enables concurrent work on multiple vessels. Floating dry docks are comprised of a pontoon and wing walls.

The pontoon is the main structural component (Fig. 1-2) that must be designed to distribute the concentrated blocking loads from the vessel to the dock and ultimately to the uniform buoyant force on the hull. The pontoon provides the transverse strength for the dock as well as contributing to the longitudinal strength. Additionally, the pontoon must have sufficient volume to provide the displacement to lift the vessel and dock out of the water using buoyancy.

The wing walls provide stability when the pontoon is submerged, and longitudinal strength to distribute the ship's weight to the uniform

Figure 1-1. Floating dry dock. Source: U.S. Navy photo by Mass Communication Specialist Seaman Kelly E. Barnes.

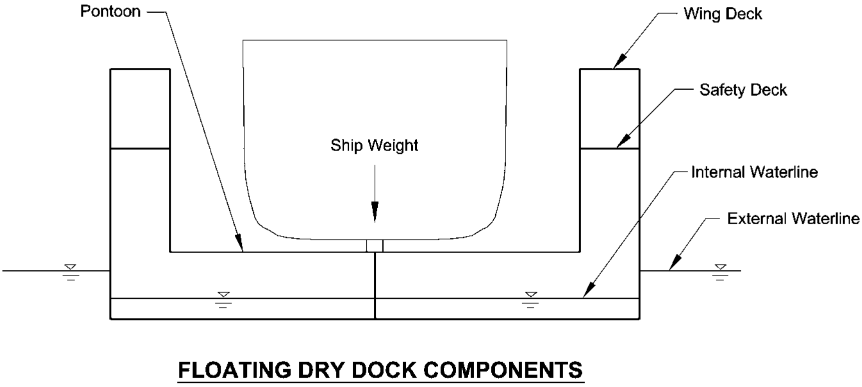


Figure 1-2. Floating dry dock components.

buoyant support. Stability can be critical in floating docks with small wing walls or those that have walls that are not continuous over the full length of the dock.

Categories of floating dry docks are discussed in 1.1.1.1 through 1.1.1.3.

1.1.1.1 Pontoon Dock. Pontoon or "Rennie" type docks have continuous wing walls with sectional pontoons. Typically, the pontoon sections are designed to be self-docking. To do this, a section of the pontoon is disconnected from the wing walls, rotated 90 degrees to align its long dimension (normally transverse) to the longitudinal direction of the dock, and docked on the remaining sections of the pontoon. The discontinuous pontoon deck results in reduced longitudinal stiffness because the wing walls provide the only longitudinal strength.

1.1.1.2 Caisson Dock. A caisson dock, also referred to as a box or one-piece dock, is constructed with continuous wing walls and pontoon. Caisson docks are not self-docking and require being drydocked in a larger facility for maintenance or inspection. This type of dock can be lighter and stronger than other types of floating dry docks because the full lengths of both the pontoon and wing walls are effective for longitudinal strength.

1.1.1.3 Sectional Dock. Sectional docks are comprised of a series of sections, each containing a pontoon and wing walls. The sections are joined with locking logs, hinge pins, or moment connections. Locking logs loosely align the sections but cannot take much force. Hinge pins can provide shear strength but have no moment capacity. Sectional docks with moment connections at the top and bottom of the wing walls act like pontoon docks. It is very important that the pins or plates that comprise the moment connection be inspected and maintained. Sectional docks are usually self-docking.

1.1.2 Graving Docks

Graving docks, or basin dry docks as they are sometimes called, are a type of dry dock that is distinguished by the fact that the floor upon which the blocks bear is below the level of the adjacent water. Figure 1-3 is a graving dock being flooded for a docking evolution. The basic structure of a graving dock consists of a floor, sidewalls, headwall, and a gate (Fig. 1-4). Alters (stepwise changes in the wall thickness) may be incorporated into the walls for structural stability. Graving docks can be further subdivided into the following three categories that relate to the means used to resist the buoyant force on the dock resulting from the displacement of the water volume of the dock.

1.1.2.1 Full Hydrostatic Graving Dock. A full hydrostatic graving dock relies on its own weight or an anchorage system to resist the hydrostatic forces acting on the dock. Regardless of the surrounding geology (even "solid" rock), it must be presumed that the dock structure will be exposed to the full hydraulic pressure. Therefore, in a full hydrostatic dock the full buoyant force of the dry dock at the highest water table

Figure 1-3. Graving dock. Courtesy of General Dynamics Electric Boat, Groton, CT.

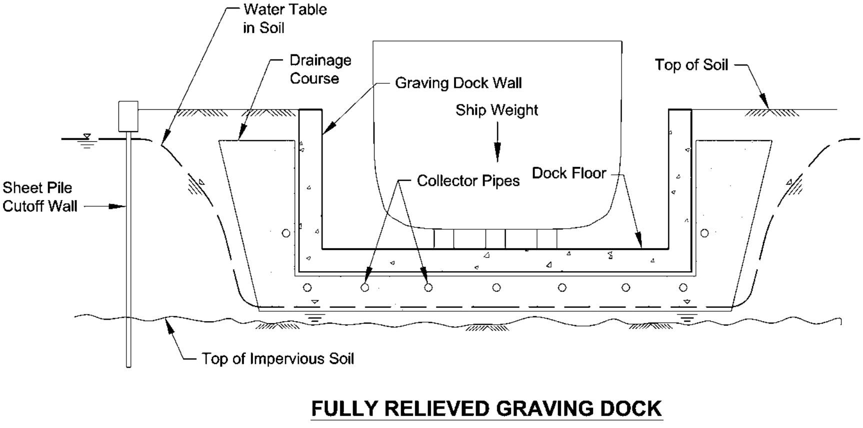


Figure 1-4. Graving dock components.

elevation must be resisted by either the weight of the structure, the combined weight of the structure and foundation material (rock, soil, etc.) engaged by hold-down devices such as anchors or piles, the weight of soil resting on the ledge formed by projections of the floor beyond the side walls, or friction created by the soil on the sidewalls.

1.1.2.2 Fully Relieved Graving Dock. A fully relieved graving dock does not have sufficient weight to resist the hydrostatic forces acting on the dock. This type of dock relies on a drainage system to remove the surrounding water behind the walls and beneath the slab to alleviate the hydrostatic pressure. This type of dock is less expensive to construct because it is lighter and does not require as much material; however, it does require the continual cost of operating and maintaining the drainage system throughout the life of the dock.

1.1.2.3 Partially Relieved Graving Dock. A partially relieved graving dock requires relief of the hydrostatic force under the floor slab only. The walls are designed for a full hydrostatic head of water. A sheet-pile cutoff wall is typically driven at the perimeter of the floor slab to reduce seepage under the slab. This type of dock also requires the continual cost of operating and maintaining the drainage system throughout the life of the dock.

1.1.2.4 Closure Gates. All graving docks have a closure gate that is removed from its seat to allow a vessel to enter or exit the dock and is put in place to dewater the dock. The two major types of gates are caisson gates and hinged gates, each with various implementations.

1.1.2.4.1 Caisson Gates. Caisson gates are structures that are either floated or rolled to be removed from the entrance to a graving dock. The floating caisson gate is probably the most widely used closure gate for graving docks. Floating caisson gates contain trim tanks to ballast the gate. Controlling the ballast water requires pumps, typically located on the machinery deck inside the gate.

1.1.2.4.2 Hinged Gates. Hinged gates have been implemented with either side or bottom hinges. This type of gate is fast operating. However, major repairs require removal of the gate, which is typically difficult and costly.

1.1.3 Marine Railway

A marine railway is a mechanical means of hoisting a ship out of the water along an inclined track (Fig. 1-5). This type of dry dock consists of a cradle that rides on inclined rails that extend from shore into the water. The cradle is moved by a hauling chain driven by a winch (Fig. 1-6). A marine railway is fast operating and has relatively low initial cost. However, the mechanical system requires periodic replacement of some moving parts such as the hauling chain and cradle rollers. Additionally, underwater maintenance of the tracks is required. The tracks are also

Figure 1-5. Marine railway. U.S. Coast Guard photo by PA2 Kyle Niemi.

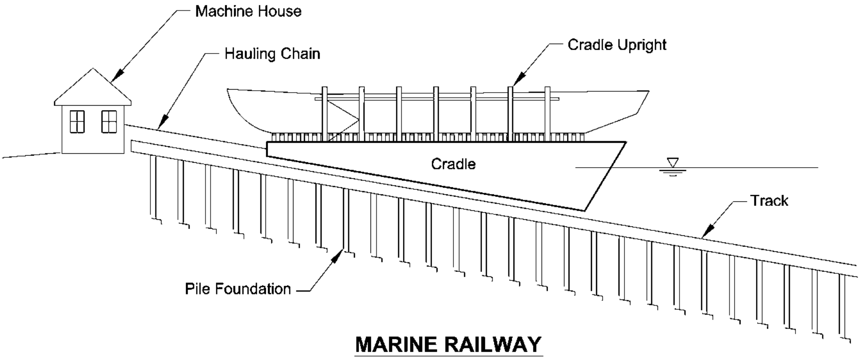


Figure 1-6. Marine railway components.

prone to damage, particularly in the tidal zone where debris can impact the tracks.

1.1.4 Vertical Lift

A vertical lift is a mechanical device for hoisting a ship out of the water vertically (Fig. 1-7). It consists of a platform, a series of synchronous hoists, and hoist support piers (Fig. 1-8). The platform is lowered into the water. The vessel is then floated over the platform and the synchronized

Figure 1-7. Vertical lift. Courtesy of Heger Dry Dock, Holliston, MA.

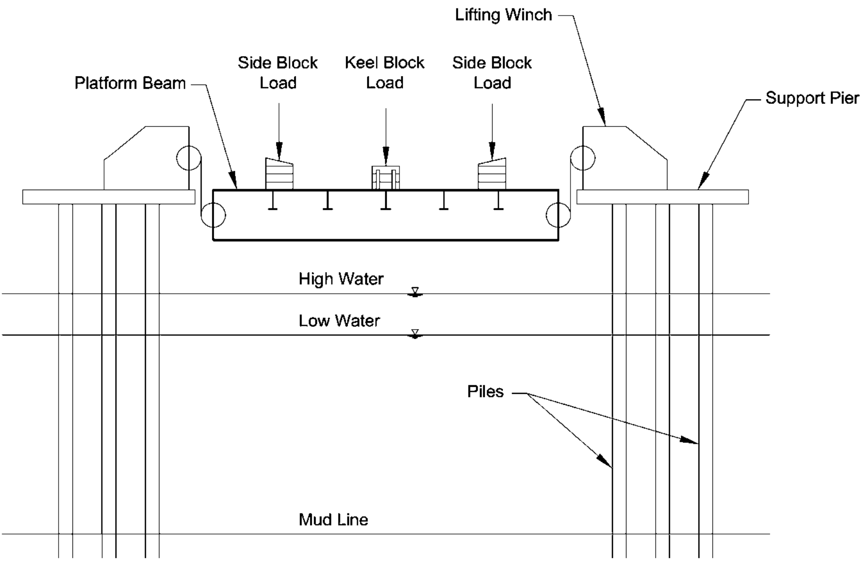


Figure 1-8. Vertical lift components.

hoists raise the platform and vessel out of the water. A vertical lift is a fast operating dry dock and can be equipped with a rail system to transfer vessels from the platform onto shore. However, the maintenance costs are relatively high.

1.2 TERMS USED IN THIS MANUAL

Altar	A stepwise change in the wall thickness of a graving dock. This allows a greater wall thickness at the base to resist overturning while reducing the volume of construction materials.
Anode	A sacrificial zinc or aluminum ingot attached to a hull or other steel element to help prevent corrosion of the steel.
Ballast	Liquid or solid mass loaded on a vessel, dry dock closure gate, or floating dry dock to improve stability and trim. Temporary ballast is usually water stored in dedicated tanks. Permanent ballast is usually solid lead castings or concrete.
Block Load	The force on a keel or side block due to gravity and seismic and wind forces acting on a vessel.
Bollard	A mooring bit, usually located alongside the top of a dry dock wall.
Breasthook	Horizontal plate brackets connecting opposite sides of hull plating at the ends of a caisson gate.
Bulkhead	(1) A vertical *structural* partition dividing a vessel's interior into various compartments for strength and safety purposes. (2) Term applied to vertical partition walls subdividing the interior of a vessel, closure gate, or floating dry dock into separate compartments.
Capstan	Steel warping drum that rotates on a vertical axis for the handling of mooring lines.
Cathodic Protection	A sacrificial or impressed current system of corrosion protection of hull, tanks, piping, or other steel members.
Center of Buoyancy	The centroid of the submerged volume of a vessel or dock.
Center of Gravity	The location at which an object's weight could be replaced by a concentrated force without changing its behavior.
Cradle	The movable structure of a marine railway that supports the vessel.

Deflection Monitoring System	Typically an optical (sight or laser) arrangement of targets measured from a reference point to determine the relative displacement along a dock.
Displacement	All-inclusive weight of a vessel or floating structure equal to the weight of the water displaced.
Dock Draft	The vertical distance from the lowest point on a dock, typically the keel, to the waterline.
Dock Master	Individual responsible for the operation of a dry dock.
Docking Evolution	The act of bringing a vessel into a dry dock from preparation through the final condition in which work will be performed.
Docking Reference Point	A point on the vessel being docked that aligns with a known point on the dock used to position the vessel on the blocks.
Docking Plan	Detailed structural plan and profile of the lower hull structure required for correct location of the vessel and blocking in a dry dock.
Draft	The vertical distance from the keel to the waterline.
Dry Dock	General term for a graving dock, floating dry dock, vertical lift, marine railway, and marine travelift used for the maintenance and repair of vessels.
Drydock	The action of bringing a vessel into a dry dock.
Dry Dock Translation System	A mechanism used to change the location of a floating dry dock.
Fair-Lead	A fitting through which a line may be passed so as to preserve or change its direction without inducing excessive friction.
Fairwater	An external shroud projecting the hull of a vessel in way of an underwater intake or sea chest. The fairwater has an open face on the downstream edge. The purpose is to reduce turbulent intake.
Fendering Timber	An intermediate member that is used to transfer load between a vessel and dock or pier to prevent damage to the vessel or structure. The material is typically wood, plastic, or rubber.

Freeboard	The elevation above the waterline of a floating dry dock's pontoon deck.
GM (measure of stability)	The vertical distance from a vessel's center of gravity (G) to its metacenter (M).
Hauling Side Blocks	Supports used to prevent the overturning of a vessel in dry dock. They can be positioned against the hull during the docking evolution.
Hydrographic Survey	An assessment of a water-covered area to determine the depth of water relative to a reference plane (i.e., mean low water).
Hydrostatic Curves	Also referred to as *curves of form* or *displacement and other curves* (D&O curves). A graphical description of properties of the vessel's form, which are plotted against the draft of the vessel. Properties that are always included in the hydrostatic curves are displacement, longitudinal center of buoyancy (LCB), height of transverse metacenter above keel (KM), tons per inch immersion (TPI), longitudinal center of flotation (LCF), and moment to trim one inch (MT1″).
Hydrostatic Forces	Forces acting on a stationary body by a fluid.
Hydrostatic Head	A pressure caused by the height of fluid above the point of interest.
KB	The vertical distance from the keel of a ship (K) to the center of buoyancy (B).
Keel	The principal bottom structural element of a ship extending along the centerline for the full length of the vessel.
Keel Block(s)	Movable structural supports that are aligned under the hull structure of a vessel to be drydocked and above the dock structure to transfer the deadweight of a vessel to the dock structure.
KM	The vertical distance from the keel of a ship (K) to its metacenter (M). The metacenter is considered to be fixed for small angles of heel.
Knuckle Block	The first keel block upon which the ship bears.
Knuckle Reaction	As the vessel first contacts the blocks, usually the aft-most block, a force develops at the knuckle block which rotates the ship until it makes contact with all the keel blocks. This

	can be eliminated on a floating dry dock by trimming the dock to match the vessel.
Light Dock Condition	The normal, unloaded state of a floating dry dock with all operating equipment on board and the water level in all tanks as low as the dewatering pumps can obtain.
Light Weight	The weight of the complete ship including hull, machinery, outfit, equipment, and liquids in machinery, but not including any variable or movable weights such as ballast water, cargo, fuel, or stores.
List	A measure of the deviation from vertical of a ship's vertical axis in the athwartship direction. Measured as a difference in the port and starboard draft readings.
Longitudinal Center of Buoyancy (LCB)	The longitudinal center of the displaced volume referenced to either the forward reference point or amidships.
Longitudinal Center of Flotation (LCF)	The longitudinal centroid of the waterplane, referenced to either the forward reference point or amidships. It is the point about which the vessel trims as a constant weight is shifted longitudinally aboard the vessel.
Longitudinal Strength	The capacity of a structure to resist global shear and bending due to uneven distribution of loads, such as buoyancy and weights, along its length.
Megger Test	An electrical test performed using a megohmmeter that verifies the integrity of the insulation on an electrical cable or motor windings.
Metacenter	The point through which a vertical line from a ship's center of buoyancy as the ship rolls intersects the original vertical centerline of the ship.
Metacentric Height (GM)	Vertical distance between the center of gravity of a ship (G) and its metacenter (M). A positive value (M higher than G) is required in order for a vessel to have upright stability.
Moment Capacity	The maximum moment that a structural member can transfer.
Moment Connections	An attachment between two structural members that is capable of transferring a moment.

Moment to Trim 1 Inch (MT1″)	A hydrostatic property of the vessel indicating the necessary differential variation of weight acting at a distance required to influence the trim of the vessel by 1 in.
Mooring Dolphin	A structure used to secure a vessel on location. This typically comprises a series of driven piles.
Naval Architect	Company or individual qualified in the design, construction, and repair of marine vessels.
Overturning Moment	The result of a load located or perturbed away from the center of gravity (G) that tends to increase the list of a vessel.
Planner	Representative of the shipyard who coordinates the work to be performed in the dry dock.
Righting Moment	A vessel's ability to right itself, resulting from an offset in location of the center of buoyancy (B) and center of gravity (G).
Safety Deck	An intermediate watertight deck within the wing wall of a floating dry dock, forming the upper boundary of the ballast tanks. In a properly designed dock, the elevation of the safety deck ensures sufficient buoyancy to keep the dock afloat when all ballast tanks are flooded. Graving dock caisson gates are also designed with safety decks.
Sea Chest	An enclosure, attached to the inside of the underwater shell and open to the sea, fitted with a strainer plate. A sea valve and piping connected to the sea chest passes seawater into the vessel for ballasting, cooling, or firefighting purposes.
Ship Owner	Company or designated representative that is responsible for the vessel.
Shipyard	Company or designated representative that is performing the drydocking.
Shore/Shoring	A structural member, such as a strut, used to brace a vessel in the transverse direction in a dock.
Stoplog	A dam consisting of a piece or pieces in slots in the sides of a waterway to shut off flow (usually for temporary use).

Tank Level Indicator (TLI)	A means of measuring the water level within a tank.
Tons Per Inch Immersion (TPI)	A hydrostatic property of the vessel indicating the differential change in displacement for every inch the vessel is submerged.
Transfer	The physical act of moving a vessel from landside to a dry dock or vice versa.
Translate	The physical act of moving a floating dry dock from one position to a second position. For example, moving the floating dry dock from its moored position to a vessel transfer position at a bulkhead.
Transverse Bending Strength	The capacity of a structure to resist a transverse bending moment.
Transverse Center of Gravity (TCG)	The athwartship (port or starboard) location of the center of gravity measured from the longitudinal center line of a vessel.
Transverse Inertia	The moment of inertia of a structural member that would be effective for a transverse bending moment.
Transverse Strength	The capacity of a structure to resist loads that are unevenly distributed across its width, such as block loads or the concentrated weight of a floating dry dock's wing walls.
Trashrack	A grille, usually of vertical metal bars, used to screen out debris from the entrance to the dry dock flood ports or pump well.
Trim	The difference in the forward and aft draft of a ship.
Trim and Stability Booklet (T&S book)	A handbook placed aboard a vessel for use by the vessel operators to assist in calculating the stability of the vessel. The document consists of tables and drawings indicating the essential characteristics of all spaces aboard a vessel where loads may be placed.
Ultrasonic Thickness (UT)	A technique used to measure the thickness of a steel member using sound waves.
Vertical Center of Gravity (VCG or KG)	The vertical location of the center of gravity (G) measured as a distance above the keel (K).
Weather Deck	Uppermost hull, closure gate, or floating dry dock deck exposed to the weather at all times.
Weep Hole	Opening provided in a wall or bulkhead to facilitate drainage of water. It usually serves

	to reduce hydrostatic pressure behind the structure.
Winch	An engine fitted with a rotating drum for hauling ropes, cables, or chains. Some are fitted with multiple drums, a gypsy head for hauling ropes, or a wildcat for hauling chains.
Wing Tank	Ballast tank adjacent to the hull side.

1.3 OVERALL PHILOSOPHY

The effective management of a dry dock facility requires a broad view of the four activities discussed in this manual: condition assessment, maintenance, control inspection, and dock operations. The condition assessment determines the safe capacity of the dry dock. The other three activities are intended to ensure the dry dock remains in a condition to maintain the ability to safely operate at the rated capacity. Information obtained from preventive maintenance tasks, control inspections, failures, and dock operations must be analyzed to determine the root cause of component failures that occur, or deficiencies noted during inspections and potential impacts on the rated capacity. The impact on the condition assessment must be considered with respect to deficiencies observed from any of these sources. Figure 1-9 shows the process of evaluating deficiencies to determine their effects on the facility condition.

Initially, the dry dock owner performs a condition assessment of its dry dock facility to determine asset condition and operational criticality. During this stage, the structural and operations capacities are defined and documented for the dry dock asset. Ideally, condition assessments are performed at initial asset installation or when a significant configuration change occurs. Throughout the asset's life cycle, if the asset is properly maintained and documentation is routinely kept up to date, the rated capacity of the facility should be maintained.

Control inspections are performed on a periodic basis to verify asset performance to requirements set forth during the condition assessment. The dry dock is visually inspected and operationally tested with the results documented. All deficiencies are entered into the maintenance management system for subsequent planning and scheduling of repairs.

Maintenance includes routine, reactive, and preventive maintenance (PM). Routine and preventive maintenance are typically planned and scheduled in advance of the work. Reactive maintenance occurs due to mechanical equipment or structural failure. Reactive repairs are unplanned and the failures can cause unsafe as well as costly conditions. It is imperative to perform causal analysis of all failures in critical systems to deter-

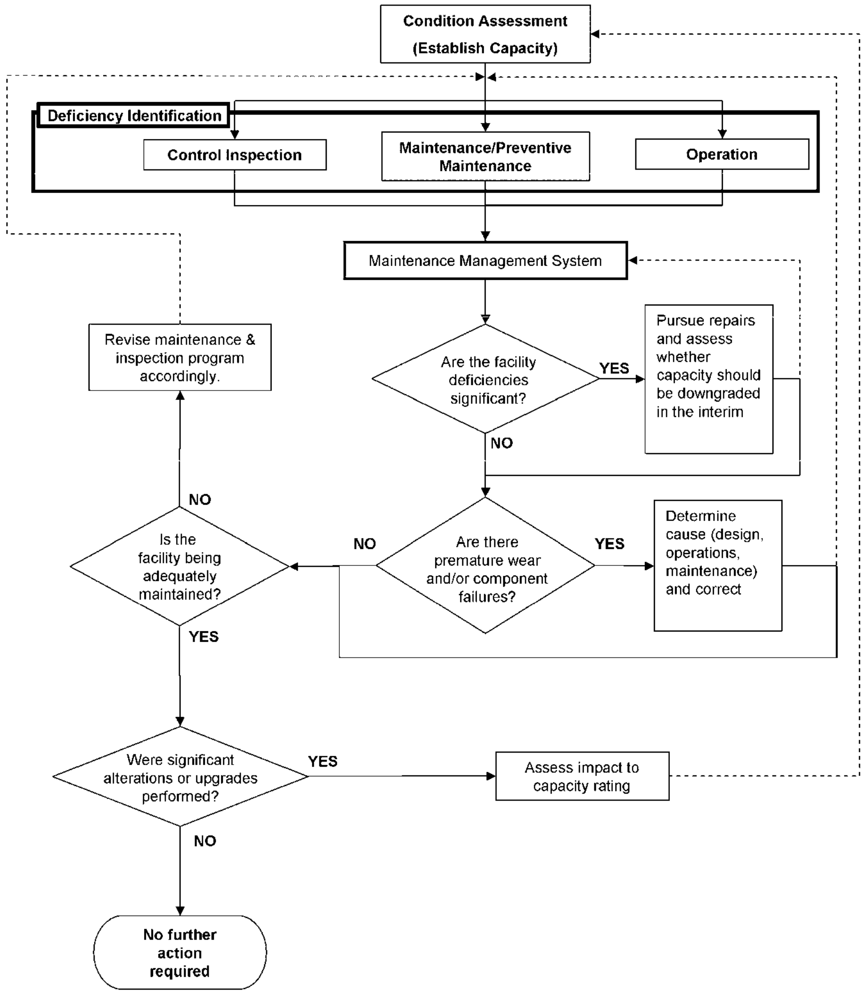


Figure 1-9. Interaction between dry dock management activities.

mine the root cause of the problem so the appropriate corrective actions can be initiated.

Operations personnel are responsible for operating the dry dock equipment within the specified capacities defined during condition assessment. Dry dock operators also provide the first line of defense against unplanned breakdowns because they are most familiar with the asset and are in the ideal position to report early detection of unusual conditions or circumstances.

Regardless of the functional area, all individuals have a responsibility to promptly report and document all deficiencies in the maintenance management system. Historical records should be periodically analyzed to identify systemic problems that may require a change in asset design, configuration, operation, or maintenance program. If a change of design or configuration occurs, a condition assessment is performed to determine its new capacities.

2

DRY DOCK CONDITION ASSESSMENT

2.1 GENERAL

2.1.1 Purpose

The purpose of the dry dock condition assessment is to establish a baseline condition of the structural, mechanical, and electrical components and determine safe operational limitations for the facility. The baseline condition of the facility will be used to develop control inspection procedures and a maintenance schedule. The established operational limitations will be used by the dock operator to ensure the dry dock's operational capabilities are not exceeded.

2.2 ASSESSMENT PROCEDURES

2.2.1 Condition Assessment Process

The condition assessment of a dry dock requires the design review team to gather all pertinent design data on the facility and conduct a material condition survey to establish the present condition of the facility. These data are used in the analysis of the facility.

2.2.2 Design Data: Document Review

Documents governing or prepared for the original design and construction, rehabilitation, alteration, or repair of the facility shall be reviewed if available.

The design data required will vary depending on the type of facility being reviewed. In general, the design data will include:

(A) General arrangement of facility
(B) Structural drawings and specifications
(C) Mechanical drawings and specifications
(D) Electrical drawings and specifications
(E) System descriptions
(F) Operating manual/procedures
(G) Hydrographic data
(H) Geotechnical information
(I) Design calculations
(J) Design ship data

Refer to the individual sections on each type of dry dock for more detailed design data requirements.

2.2.3 Material Condition Survey

A material condition survey is required to establish the existing condition of the facility. The survey must be detailed enough to ascertain the actual condition of all critical components of the facility and verify that the design data are correct.

The material condition survey will vary depending on the type of facility being reviewed. In general, the survey will include:

(A) Visual survey of all structural components
(B) Ultrasonic thickness (UT) or other measurements to establish the extent of corrosion/deterioration
(C) Witness operational test of all critical mechanical and electrical components
(D) Witness operational test of all control systems
(E) Witness of the dock in operation
(F) Underwater inspections
(G) Maintenance records

Refer to the individual sections on each type of dry dock for more detailed survey requirements.

2.2.4 Design Review

The design review consists of calculations to substantiate the operational limitations. The design review is conducted using the "as-is" condition of the facility.

2.2.5 Summary of Findings, Evaluation, and Recommendations

Results of the design review shall be summarized in a written report. The report shall include:

(A) Scope of Investigation
(B) Description of Structure
(C) Dates of Construction, Modifications, and Repairs
(D) History
(E) Design Data
(F) Material Condition Survey Report
(G) Design Review Summary
(H) Recommended Future Surveys
(I) Safe Rated Capacity

2.3 CONDITION ASSESSMENT OF FLOATING DRY DOCKS

2.3.1 Qualifications and Equipment

2.3.1.1 Personnel Qualifications. All personnel involved in the assessment shall possess the technical qualifications, including practical experience, education, and professional judgment, required to perform the individual tasks assigned. Interpretation of results and conclusions shall be performed by a professional engineer or naval architect experienced in the design and inspection of floating dry docks.

2.3.1.2 Equipment. Equipment shall be obtained as appropriate to accomplish or perform the various tests and inspections specified in this manual of practice. All equipment shall be in good working order. For equipment that can be calibrated, calibration shall be current and reports of calibration shall be available for owner review.

2.3.2 Design Data: Document Review

Documents governing or prepared for the original design and construction, rehabilitation, alteration, or repair of the facility shall be reviewed if available.

The design data required will vary depending on the type of floating dock being reviewed. In general, the design data will include:

(A) General arrangement of the floating dock
(B) Structural drawings and specifications
(C) Mechanical drawings and specifications
(D) Electrical drawings and specifications

(E) System descriptions
(F) Operating manual/procedures
(G) Computer-controlled ballast system (where applicable)
(H) Deflection monitoring system (where applicable)
(I) Floating dry dock translation system (where applicable)
(J) Hydrographic data
(K) Stability data
(L) Mooring design
(M) Environmental data
(N) Design calculations
(O) Design ship data

2.3.3 Material Condition Survey

A material condition survey is required to establish the existing condition of the facility. The survey must be detailed enough to ascertain the actual condition of all critical components of the facility and verify that the design data are valid.

In general, the survey will include:

(A) Visual survey of all internal ballast tanks and all sea chests
(B) Visual survey of machinery spaces, safety deck area
(C) Visual survey of wing deck areas
(D) Visual survey of external portions of the dock
(E) Visual survey of blocking
(F) Visual survey of mooring system
(G) Witness operational test of all critical mechanical and electrical components
(H) Witness operational test of all control systems
(I) Underwater inspection of hull
(J) Underwater survey of mooring dolphin/pier pilings
(K) Freeboard readings
(L) Witness of the dock in operation
(M) UT or other measurements to establish the extent of corrosion/deterioration
(N) Hydrographic survey

The condition of the structural steel, concrete, and/or timber shall be assessed in accordance with ASCE/SEI 11-99, *Condition assessment of existing buildings* (2000).

2.3.3.1 Visual Survey of All Internal Ballast Tanks. During the initial condition assessment survey, 100% of all ballast tanks should be visually inspected. The material condition of structural elements can vary greatly from ballast tank to ballast tank or even within a single ballast tank due to varying environmental conditions or past renovation projects that repaired some areas but not others. Therefore, it is imperative to visually inspect all members in every ballast tank. Special actions necessary to remove mud, silt, or debris in the ballast tanks should be performed prior to visual inspection.

All structural members should be inspected for condition of protective coating, extent of corrosion, buckling, cracking, or other signs of distress.

The bottom plate and plate stiffeners should be inspected for signs of dock grounding (pushed-up plate, buckled stiffeners and/or frames).

Each sea chest shall be inspected for condition of protective coating, extent of corrosion, buckling, cracking, or other signs of distress.

The side shell plate and plate stiffeners should be inspected for signs of external impact damage (pushed-in plate, buckled stiffeners and/or frames).

Note size and location of all leaks (external, between tanks, through valves, packing glands, etc.).

Note size, location, and probable cause of all holes and/or cracks (impact, corrosion, stress).

Where corrosion has caused a loss of metal thickness or where as-built member thicknesses are in question, ultrasonic thickness (UT) measurements may be necessary to confirm actual member thicknesses. See 2.3.3.13 for more information on UT measurements.

2.3.3.2 Visual Survey of Machinery Spaces, Safety Deck Area. During the initial condition assessment survey, 100% of all machinery spaces and safety deck areas should be visually inspected.

All structural members should be inspected for condition of protective coating, extent of corrosion, buckling, cracking, or other signs of distress.

The side shell plate and plate stiffeners should be inspected for signs of external impact damage (pushed-in plate, buckled stiffeners and /or frames).

Note size, location, and probable cause of all holes and/or cracks (impact, corrosion, stress).

Where corrosion has caused a loss of metal thickness or where as-built member thicknesses are in question, UT measurements may be necessary to confirm actual member thicknesses. See 2.3.3.13 for more information on UT measurements.

The safety deck should be inspected when the dock is fully submerged. At this time, the air in the ballast tank below the safety deck is pressurized. Any leaks in the safety deck plate or packing glands will be evident by hissing air or leaking water.

Figure 2-1. Washboarding of pontoon deck. Courtesy of Heger Dry Dock, Holliston, MA.

2.3.3.3 Visual Survey of External Portions of Dock. All abovewater external areas of the dry dock should be visually inspected. These areas include the pontoon deck, wing deck, wing side shells, pontoon side shell, end bulkheads, aprons, fenders, stairs, ladders, handrails, and so forth.

2.3.3.3.1 Local Issues. The pontoon deck is usually one of the first areas to show deterioration. Heavy corrosion is not always evident, however, since rust scale is being continuously worn away by high traffic, heavy wear, and so forth. Check for severe "washboarding" of the deck (dishing of the deck plate between stiffeners; Fig. 2-1. This can significantly diminish the transverse bending strength of the pontoon.

2.3.3.3.2 Global Issues. The wing deck is the top structural flange of the dock which provides its longitudinal strength. This is an extremely important structural member and should not have any cracks, buckles, holes, or severe deterioration.

Check the deck for any large buckles that progress across the entire width of the deck (and usually down the wing sides). Check for cracks in plate. Buckling or cracking in the upper portions of the wing wall may be an indication of longitudinal overstress.

The longitudinal strength of the dry dock is severely impaired by buckling or cracking in the upper or lower regions of the wing. If buckling or cracking is found in this portion of the wing, the dry dock should not be used until the situation can be investigated more thoroughly and repairs made, if necessary.

2.3.3.3.3 Miscellaneous Items. Check the condition of foundation plating around all cleats, bollards, winches, capstans, and so forth. Where the item is fastened to the deck is generally a high corrosion area.

Check the condition of fendering timber and attachments to wings. The wood tends to rot and steel tends to corrode where the wood and steel meet.

Check crane rails and fastenings, if any.

2.3.3.4 Visual Survey of Blocks. The condition of the blocking system shall be visually assessed.

Check the timber for excessive crushing, warping, cracking, checking, rot, or wear from fasteners. Check for loss of contact at edges. In general, minor cracking is acceptable unless bearing area has been lost.

If the blocks have concrete bases, check the concrete for cracking, spalling, and exposed rebar.

If the blocks have steel bases, check the steel for loss of metal thickness by corrosion, cracks, cracked welds, and so forth.

Check the condition of fastenings. All timber shall be adequately secured to prevent floating when the dock is submerged.

If the dock is equipped with hauling side blocks, the hauling block hardware shall be inspected. The hauling block hardware includes chains, sheaves, cranks, slides, and pawls.

2.3.3.5 Visual Survey of Mooring System. The dry dock's mooring system shall be inspected for signs of corrosion and wear.

2.3.3.6 Operational Tests. An operational test of all the dry dock's mechanical and electrical components shall be conducted by the shipyard and witnessed by the surveyor. The operational test shall include witnessing the following:

(A) Dewatering pumps: check for proper control from control panel, abnormal vibration
(B) Ballast system valves: check for proper control from control panel, valve position indicator gages or lights working properly
(C) Tank level indicator gages
(D) Draft level indicator gages and draft boards
(E) Primary power source (shore-supplied or onboard generators)

(F) Emergency backup power: demonstrate the maximum number of ballast pumps that are capable of being operated on the backup power system. The backup power system shall be capable of running the dock controls system, alarms, emergency lighting, and a sufficient number of dewatering pumps to maintain safe operation (minimum of two pumps), albeit at a slower rate, simultaneously.
(G) Capstans
(H) Winches
(I) Vessel centering system (if so equipped)
(J) Longitudinal deflection monitoring system (requirement for docks 300 feet and longer)
(K) Alarms
(L) Lighting
(M) Emergency lighting
(N) Fire-fighting system

2.3.3.7 Submergence Test. A submergence test shall be conducted by the shipyard and witnessed by the surveyor. The dock shall be ballasted down to maximum submergence and the dock drafts recorded. In docks designed with a safety deck, the submergence should cease at the maximum design draft with the flood valves open. If the dry dock cannot achieve its design draft, the reason shall be noted (e.g., insufficient water depth at site, incorrect vent tube lengths). The surveyor shall inspect the safety deck areas for leaks when the dock is at maximum submergence.

After a minimum of 30 minutes, the dock drafts should be recorded again just prior to deballasting the dock. Any change in drafts, indicating leakage, shall be noted by the surveyor. If leaks are detected, further testing may be required to isolate the source of the leaks.

The dock shall be deballasted using all the main dewatering pumps. Time to ballast and deballast the dock shall be recorded, with starting and stopping dock drafts noted.

2.3.3.8 Verification of Instrument Calibration. If, during the operational test, the water level indicator gages, ammeter gages, valve position indicators, or other instrumentation do not reflect the actual condition, the errant gages should be recalibrated and checked by comparing the physical measurement to the reading on the gage.

The surveyor shall verify the accuracy of the deflection monitoring system by determining the dock's actual deflection with an independent measuring system and comparing the results with the dry dock's system.

2.3.3.9 Underwater Surveys. An underwater hull survey shall be conducted every 5 years. The surveyor shall inspect for buckled plate, corrosion, condition of sea chest gratings, and marine growth.

Where corrosion has caused a loss of metal thickness or where as-built member thicknesses are in question, UT measurements may be necessary to confirm actual member thicknesses. See 2.3.3.13 for more information on UT measurements.

2.3.3.10 Freeboard Readings. The buoyant capacity of the dock can change over time. The accumulation of mud, sandblast grit, or other items, or the lack of ability of the pumping system to dewater the tanks as low as originally designed, can reduce the buoyant lift capacity. Therefore, the buoyant capacity shall be checked at least once every 3 years.

The buoyancy available to lift the vessel is represented by the volume of the dock's pontoon above the waterline with the dock at its minimum draft. To determine the dock's buoyant capacity, pontoon deck freeboard readings must be taken after the dock has been pumped to its minimum draft (maximum freeboard).

Freeboard is the measurement from the lowest point on the pontoon deck (usually at the inside corner of the wing) to the waterline. The freeboard measurement is used to calculate buoyant capacity of the dock as described in 2.3.4.1.

With no ship on the dock, the dock shall be dewatered by the shipyard using the main deballasting system only. Portable stripping pumps should not be used because they are not permanent dock equipment. With the dock deballasted, the surveyor should take freeboard measurements at each corner of the pontoon and, if possible, at amidships, port, and starboard.

2.3.3.11 Witness of Dock in Operation. The surveyor shall witness one complete cycling of the dock from operating freeboard, to maximum submergence depth, and back to operating freeboard.

2.3.3.12 Light Dock Weight Determination. If the original design documents do not have sufficient information on the light dock condition, a deadweight survey must be conducted. NAVSEA S9086-C6-STM-010/CH096 provides procedures for performing a deadweight survey.

2.3.3.13 Thickness Measurements. Use UT measurements and/or calipers to physically measure steel thickness in areas of high corrosion.

The number and frequency of readings will vary as to the condition of the dock. Steel that still retains all of its protective coating, or steel with many holes through it, may require no readings because the condition is obvious. Steel that is questionable will require readings to establish remaining thickness. Steel that is due for repair may require many readings to establish the zones for replacement.

If UT measurements are required, a grid pattern shall be established and readings taken at those intervals. Examples are taking a reading every 10 feet longitudinally and 5 feet transversely on plate, or three readings on the web and flange of each vertical stiffener (one each in the upper, middle, and lower zones). The engineer or naval architect in charge of the condition assessment shall establish the frequency and locations of measurements.

2.3.3.14 Hydrographic Survey. A hydrographic survey shall be conducted to establish available water depths at the submergence berth and approach channel. The survey datum shall be clearly labeled with its reference elevation (mean low water, mean high water, etc.). The survey shall be conducted every 5 years unless local site conditions justify a longer or shorter frequency. A severe storm may warrant an updated hydrographic survey.

2.3.3.15 Checklists. See Appendix A for sample checklists that shall be used for summarizing the dock's condition. These checklists should be modified to reflect the actual components of the dock being surveyed. Each item shall be rated according to the following:

(A) Satisfactory (S): The condition of the item will not result in system damage and, based on measured or estimated deterioration rate, it may be expected to remain satisfactory until the next control inspection.

(B) Marginal (M): The condition of the item will not result in major damage or, by itself, it will not make the facility unsafe to dock a ship, provided it is corrected, repaired, or replaced in a timely manner. A number of such items as a group can make the facility unsafe. This shall be evaluated by the surveyor.

(C) Unsatisfactory (U): The condition of the item may cause system damage or loss and shall be corrected, repaired, or replaced immediately (if there is a ship in dock) or prior to docking a ship (if there is no ship in dock).

(D) Not Applicable (NA): The item listed in the checklist is not present on the dry dock. Note that as items are added, removed, or replaced from the dry dock, the inspection checklist shall be updated to reflect the configuration changes.

(E) Not Inspected (NI): The item was not inspected as part of the survey. It is not acceptable to mark an item NI unless there is a basis for expecting the item to be in a satisfactory condition.

2.3.3.16 Summary of Results. The surveyor shall prepare a written report summarizing the findings of the survey. The report shall include:

(A) Experience and qualifications of the surveyors
(B) Dates and major milestones of the survey
(C) Scope of the survey
(D) List of items not inspected and reasons why
(E) Condition report
(F) Checklists
(G) Corrective action plan for making any necessary repairs to the facility

2.3.4 Design Review

The purpose of the design review is to establish the operational limitations of the dock in its present condition. If the design calculations and operational limitations from the original designer exist and, in the opinion of the surveyor, the dock has not significantly deteriorated to the point that these operational limitations should be revised, then a new design review need not be performed and the original operational limitations may be used.

If, however, documentation for the original operational limitations does not exist, or the dock's structure or equipment have deteriorated to the point where the original operational limitations are questionable, or the dock has been modified in any way, or the dry dock's operating location has been changed, then a new design review will be required.

The design review consists of calculations to substantiate the operational limitations. The design review is conducted using the "as-is" condition of the facility as determined by the material condition survey described in 2.3.3.

For a floating dry dock, the design review will include:

(A) Calculation of buoyant capacity
(B) Transverse bending calculations
(C) Longitudinal bending calculations and deflection limits
(D) Local strength analyses
(E) Block loading calculations
(F) Hydrostatic properties of the dock
(G) Light dock weight determination
(H) Stability data (KG versus weight curve)
(I) Mooring analyses
(J) Ballast system
(K) Control systems
(L) Ship handling system

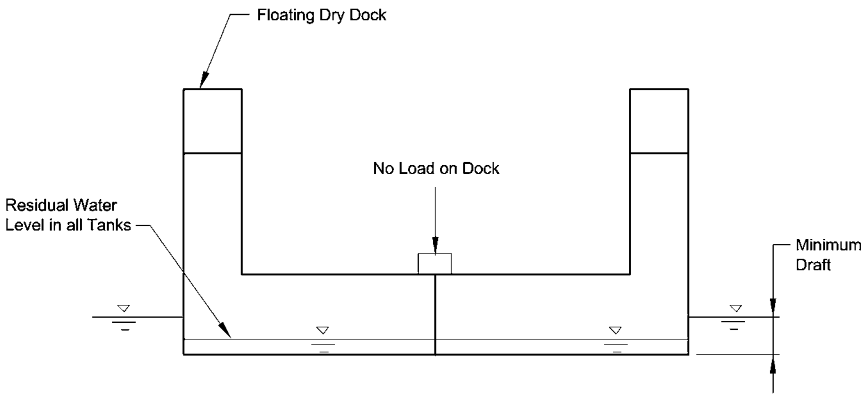


Figure 2-2. Minimum dock draft.

(M) Electrical power system
(N) Fire protection system
(O) Corrosion criteria
(P) Calculation of maximum sill load (for vessel transfer systems)

2.3.4.1 Calculation of Buoyant Capacity. The buoyant capacity of the dry dock is calculated by subtracting the dock's displacement at minimum draft from the dock's displacement at the operating draft.

The minimum draft is measured after pumping as much ballast water as possible out of the ballast tanks, using the main ballast pumps. Portable stripping pumps should not be used to remove the residual ballast water that cannot be removed by the dock's main ballast system (Fig. 2-2).

The operating draft is calculated by subtracting the operating freeboard from the pontoon depth at the location of the freeboard measurement (Fig. 2-3). The operating freeboard shall be a minimum of 12 inches.

2.3.4.2 Transverse Bending Calculations. The transverse strength of the dry dock is provided by the transverse bulkheads (watertight and nonwatertight) and/or transverse trusses in the pontoon.

The pontoon structure must distribute the concentrated load of the ship along the dock's centerline to the buoyant support of the water over its entire width by its transverse strength.

At least four separate loading conditions should be investigated when analyzing transverse strength:

(A) Maximum positive bending
(B) Transverse bending at operating draft

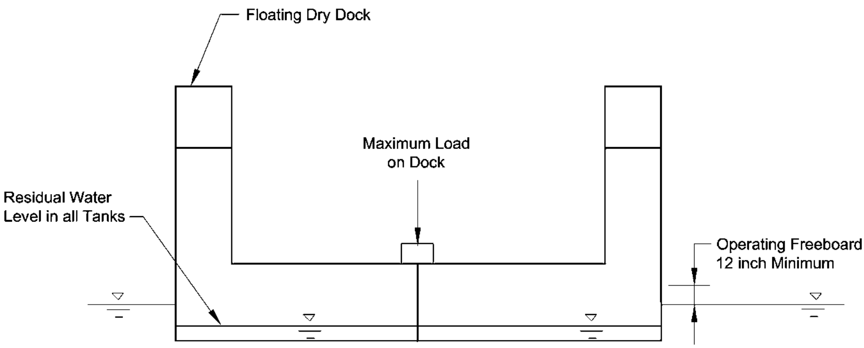


Figure 2-3. Dock operating draft.

(C) Partial load, maximum head condition
(D) Reverse bending

The transverse bending stresses must be combined with stresses caused by local conditions such as hydrostatic pressure on the hull, where applicable.

If the section modulus of the transverse frame varies across the width of the dry dock, the maximum transverse bending stress shall be calculated for each different cross section.

When determining allowable stresses, the buckling strength of the pontoon deck, bottom plate, and other members in compression shall be determined for each different panel size, plate thickness, or member size. The "as-is" condition of the member shall be used.

2.3.4.2.1 Transverse Bending with Water at Top of Keel Blocks. During the docking evolution, the dry dock/ship system passes through a condition at which the water level outside the dry dock is at the top of the keel blocks. This condition produces the maximum transverse bending in the floating dry dock. Therefore, the bending moment at the point when the exterior water is at the top of the keel blocks shall be calculated. At this time, 100% of the vessel weight is on the dock while the pontoon and the submerged section of the wing provide buoyant lift.

The submerged section of the wing provides additional buoyancy farther away from the dock centerline, which increases the bending moment. For this case, 100% of the rated load per foot is assumed to act on the keel blocks at the transverse centerline (Fig. 2-4).

2.3.4.2.2 Transverse Bending at Operating Draft. Transverse bending stresses when the dry dock is at its operating draft shall be calculated. In

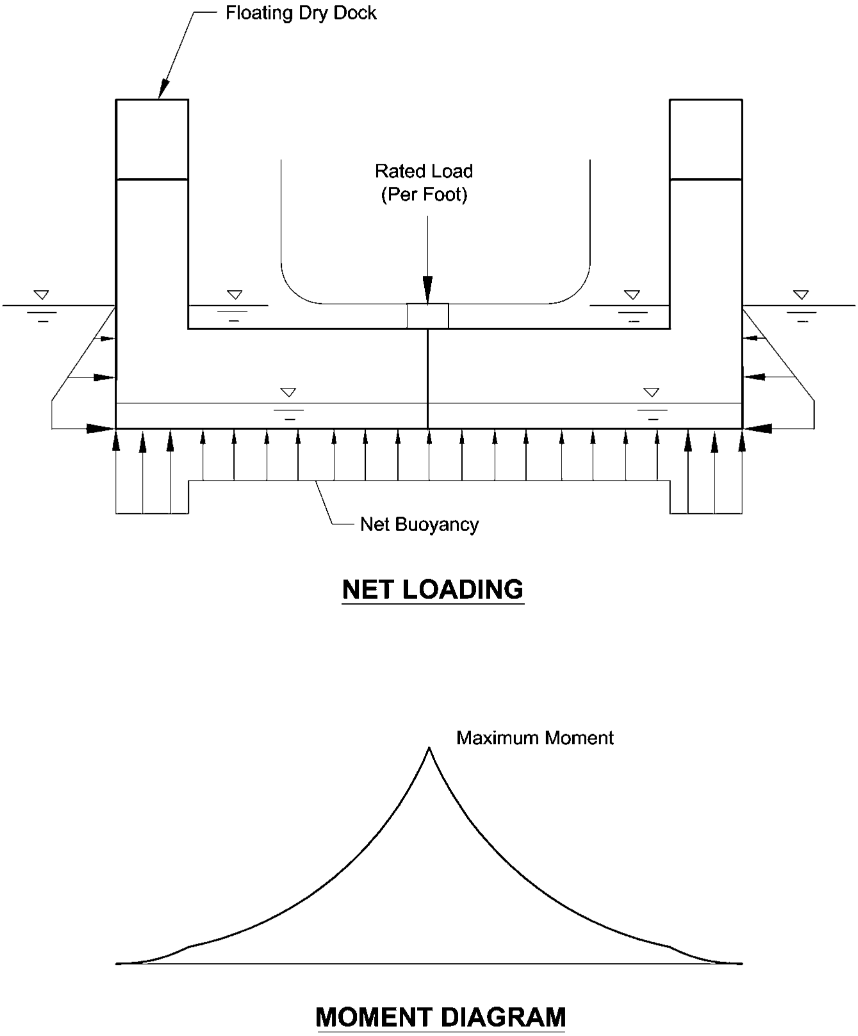


Figure 2-4. Maximum transverse bending condition.

cases where the rated load per foot exceeds the buoyant capacity of the dock at the operating draft, the additional uplift is achieved through shear in the wing walls and longitudinal bulkheads. This increases the transverse bending moment (Fig. 2-5).

2.3.4.2.3 Partial Load, Maximum Head Condition. The partial load, maximum head condition is the point at which the maximum hydrostatic head occurs on the shell of the dry dock.

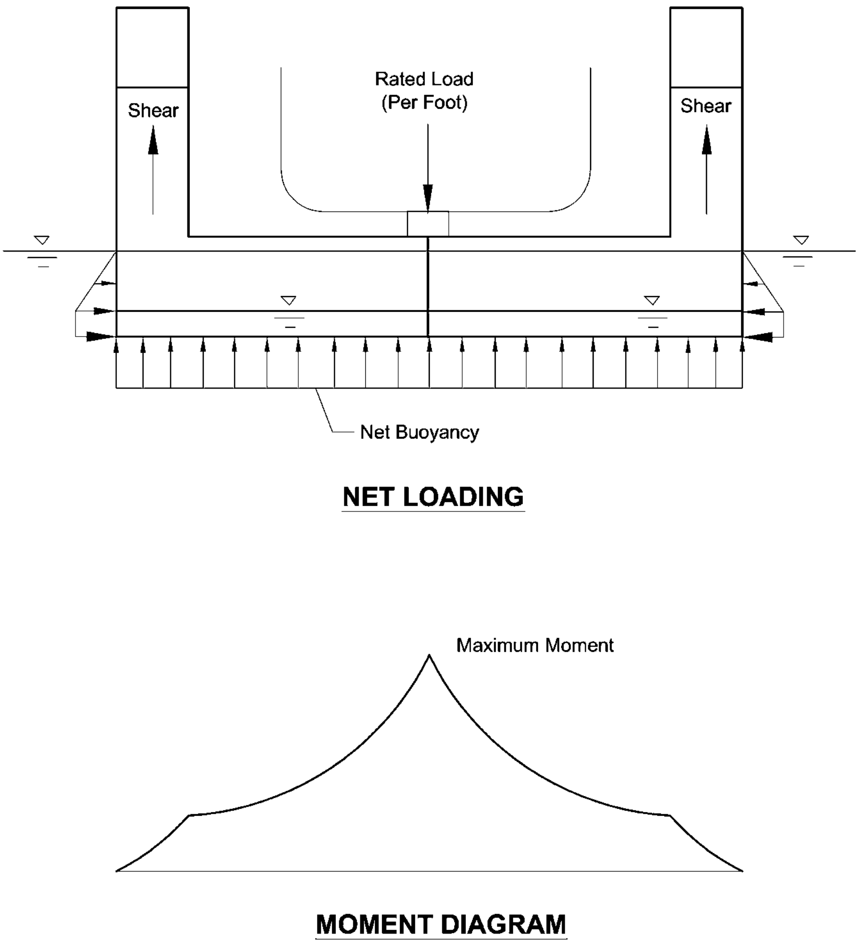


Figure 2-5. Transverse bending at operating draft.

Although the load at the centerline is only a portion of the total vessel load and the bending moment is not as great as in the first case, the bending stresses, when combined with the local stresses caused by hydrostatic head pressure, may control.

The partial load, maximum head condition occurs when the internal water level has reached the base of the wings (Fig. 2-6).

The magnitude of the hydrostatic head, which develops at this point, is a function of the vessel's draft and beam. The deeper the draft and wider the beam of the vessel being docked, the higher the maximum hydrostatic head will be.

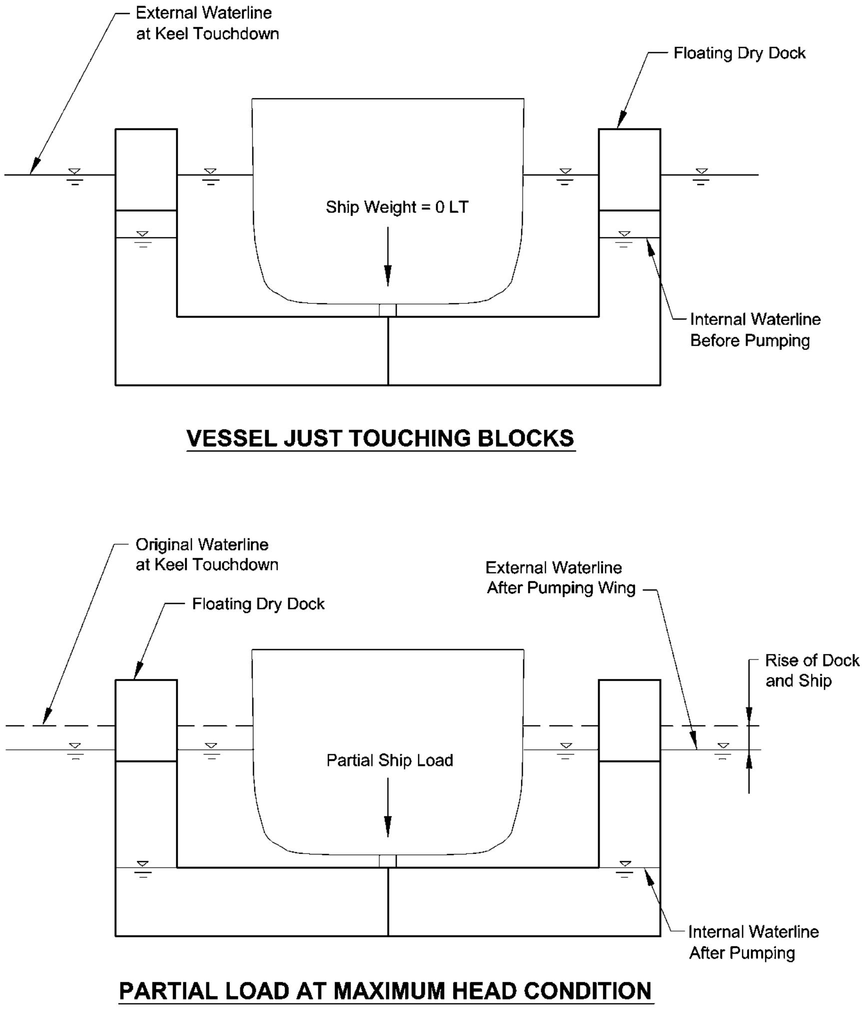


Figure 2-6. Partial load, maximum head condition.

The volume of water that is pumped out of the wing walls (V1) after the vessel's keel contacts the keel blocks is equal to the volume that the vessel and dry dock wings rise out of the water during that pumping (V2). With this volume known, along with the length and beam of the ship and dock wing walls, the rise of the ship and dock can be calculated (Fig. 2-7).

The resulting depth of water over the pontoon deck is the maximum head on the dry dock for that particular vessel.

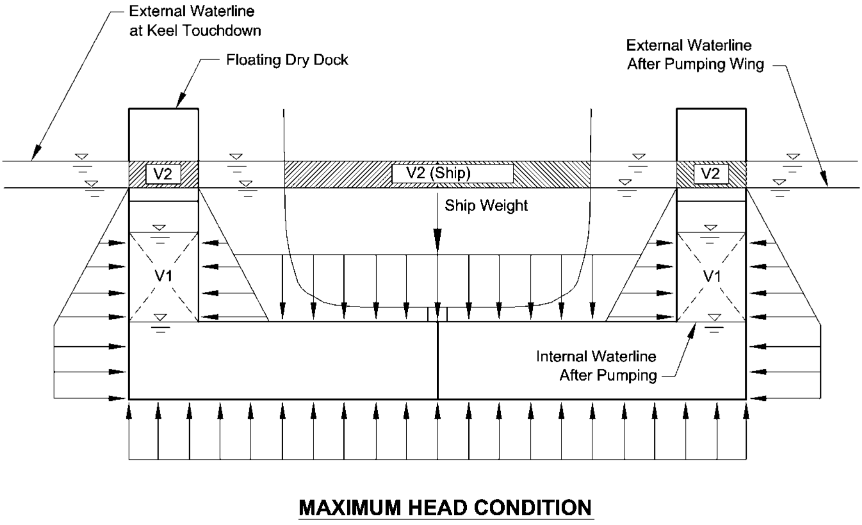


Figure 2-7. Maximum head condition.

The displaced volume of the portion of ship that has been lifted out of the water (V2 Ship) is the weight of the vessel on the keel blocks for this condition.

2.3.4.2.4 Reverse Bending. The reverse transverse bending condition shall be investigated.

This condition occurs wherever there is a dewatered ballast compartment providing uplift in an area where there is no ship weight pushing down, such as an unloaded portion of a partially loaded compartment (Fig. 2-8).

The pontoon is held down at the wings and buoyancy tends to bow it up—the reverse of a typical loading condition.

In this case, the pontoon bottom plate is in compression and must be investigated for plate buckling.

2.3.4.2.5 Transverse Bending Limits. The dry dock should be rated for a maximum allowable load per foot along the keel. With the dry dock supporting the maximum load per foot, transverse bending stresses for each of the above bending cases shall not exceed the established acceptable limits for each member.

2.3.4.3 Longitudinal Bending Calculations and Deflection Limits. The longitudinal bending stresses in the dock shall be calculated

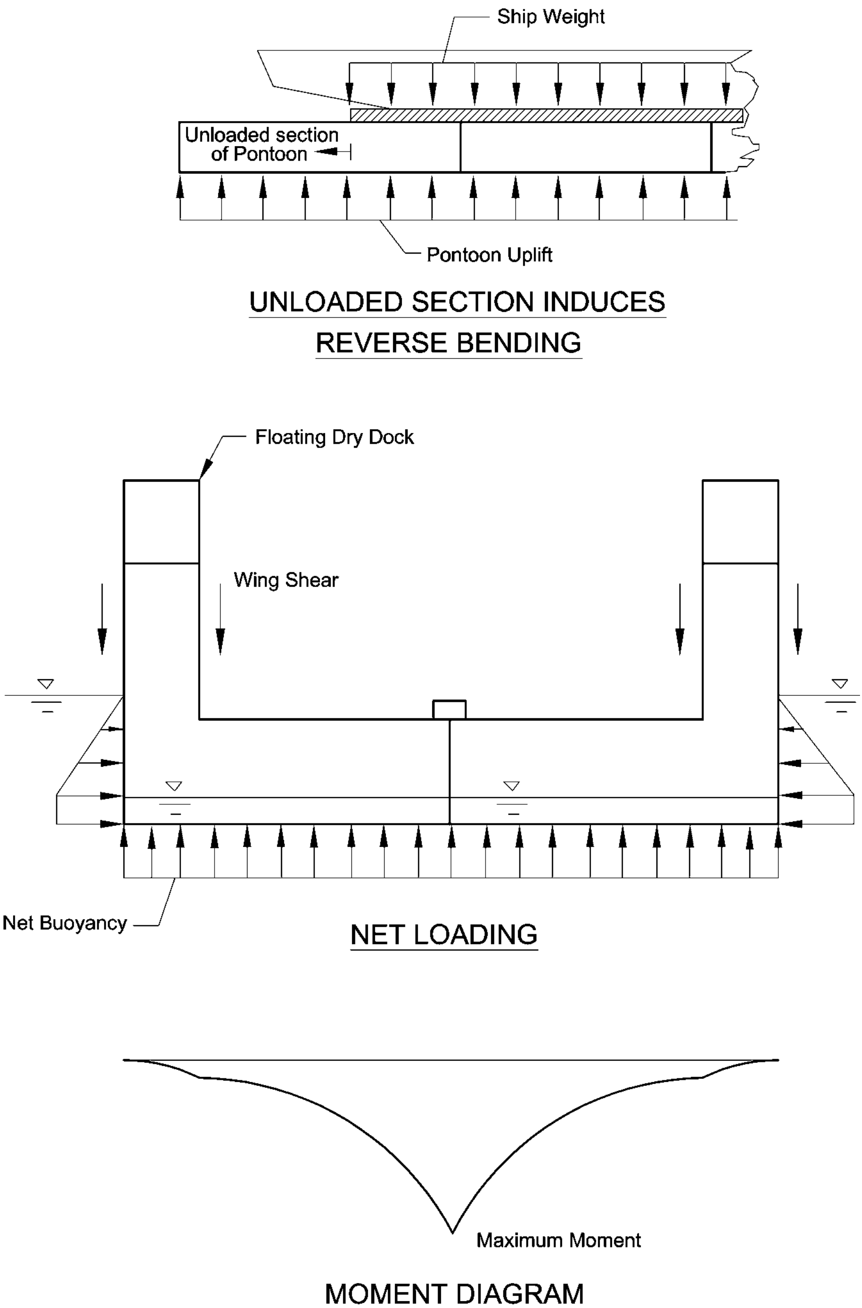


Figure 2-8. Reverse bending at unloaded section.

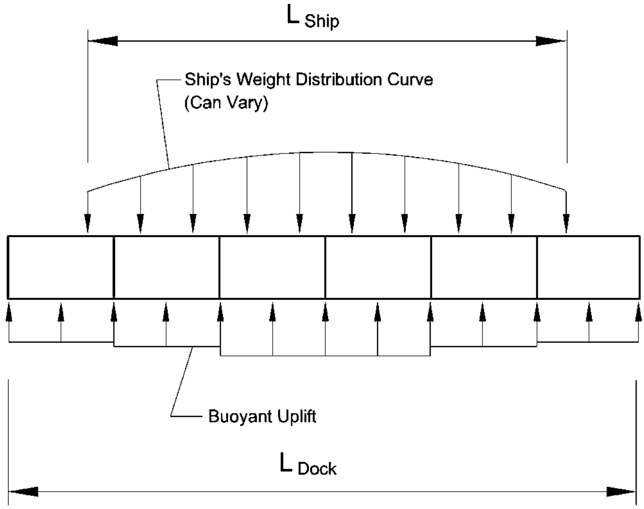


Figure 2-9. Longitudinal bending condition.

for the shortest capacity vessel that will not exceed the dry dock's load per foot limitations. The condition in which a vessel much shorter than the dry dock with a weight per foot at the rated capacity produces an extreme longitudinal bending condition that must be evaluated. This longitudinal bending condition results from the buoyant uplift force on the dry dock forward and aft of the vessel combined with the deadweight force of the vessel.

Longitudinal deflections of the dock shall be calculated for various loading conditions such that the minimum dock deflection that causes the dock to reach working stress limits shall be established. Allowable buckling stresses in the wing deck, upper wing side shell, and pontoon bottom, if lower than normal bending stresses, shall control.

These calculations shall be used to set the operational longitudinal deflection limits described in 2.3.5.6.3.

2.3.4.4 Local Strength Analyses. Calculations shall be performed to determine:

(A) Allowable hydrostatic pressure on hull
(B) Allowable hydrostatic pressure on internal bulkheads and safety deck
(C) Allowable vehicle loading on pontoon deck, aprons, access bridge, etc.

(D) Mooring loads
(E) Foundation loads

2.3.4.5 Block Loading Analyses. A description of the blocking system shall be provided. Calculations shall show that the blocks are stable and structurally adequate to support the rated load per block. Calculations shall include:

(A) Allowable bearing pressure on timber times bearing area
(B) Structural strength of block base unit
(C) Local structural strength of dock structure directly supporting blocks

Calculations shall be done for both keel blocks and side blocks, and a rated block load for each determined.

2.3.4.6 Hydrostatic Properties of the Hull. The following hydrostatic properties of the dry dock hull shall be calculated:

(A) Displacement of dock versus draft
(B) KB of dock versus draft
(C) KM of dock versus draft
(D) Transverse inertia of dock versus draft
(E) Ballast tank tables or lift curves

2.3.4.7 Light Dock Weight Determination. If the original light weight and vertical center of gravity (KG) of the dock are unavailable, or if the dock's weight and/or KG have been modified since the original calculations were performed, a new light dock weight and KG shall be calculated. The light weight and KG can be calculated by a theoretical weight estimate verified by a light dock weight survey.

2.3.4.8 Stability Data: KG versus Weight Curve. To ensure stability, the ship/dock combination must maintain a minimum GM throughout the evolution. GM is the measure of stability. Stability of the ship/dock system is usually investigated for five separate phases of the docking or undocking evolution (Fig. 2-10).

These phases are:

(1) Dry dock at full submergence, no ship
(2) Partial lift of ship, ship has been lifted approximately half its docking draft
(3) External waterline at top of keel blocks

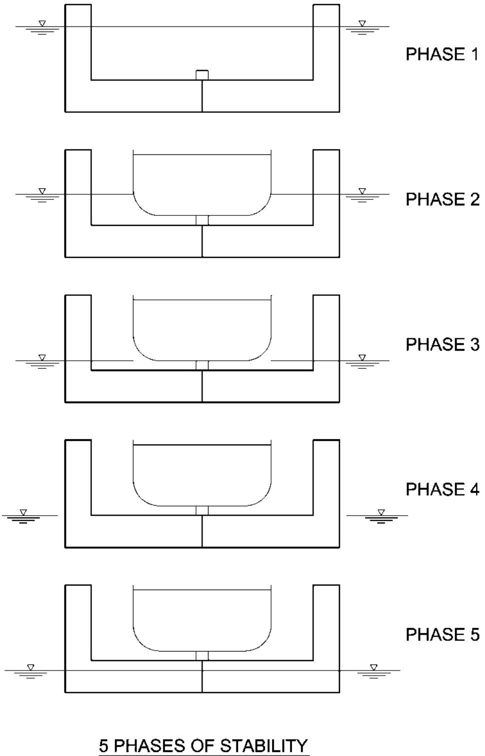


Figure 2-10. Phases of stability.

(4) External waterline just over pontoon deck
(5) Dock at normal operating draft

The minimum stability phase usually occurs at phase 3 or 4.

The required minimum GM varies with the rated lift capacity of the floating dock. Figure 2-11 is the curve of the minimum required GM as a function of the dock's lift capacity. The ship/dock combination must maintain the required GM at all phases of lift.

The minimum stability phase shall be determined and a KG versus weight curve developed for the dry dock for that minimum stability phase. The KG versus weight curve is a plot of the maximum allowable vessel KG (the distance the vessel's center of gravity is above the vessel's keel, adjusted for free liquids onboard the vessel) versus the vessel's docking displacement, which results in the minimum allowable GM for the ship/dock combination. Figure 2-12 shows a sample KG versus weight curve.

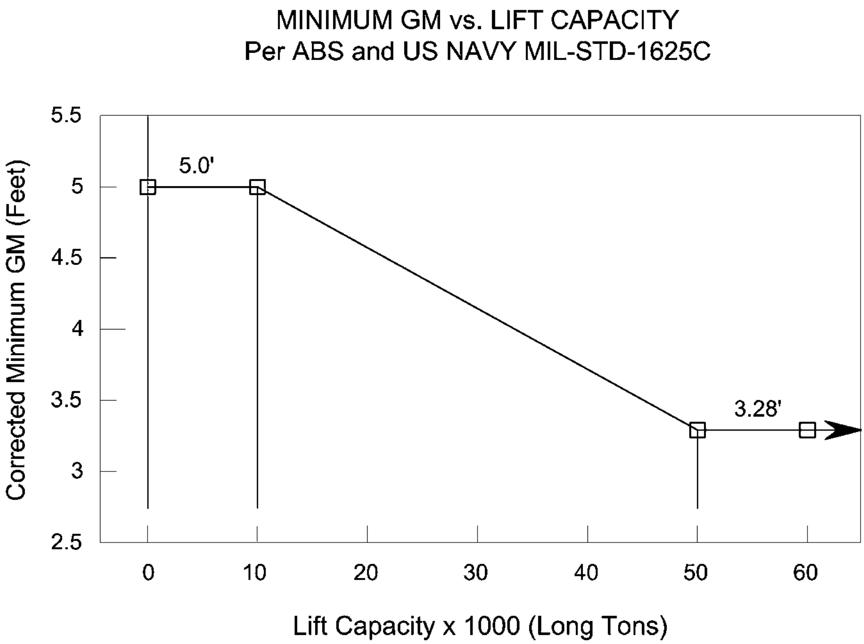


Figure 2-11. Minimum required GM.

This curve is used by the operator to verify adequate stability of the ship/dock combination when docking any vessel. If the plot of the vessel's docking displacement and its KG intersect on or below the line, the dock has sufficient stability to lift the vessel and maintain the minimum GM for the ship/dock system. If the plot of the vessel's docking displacement and its KG intersect above the line, the dock does not have sufficient stability to lift the vessel and the GM for the ship/dock system will be below the minimum required and may possibly be negative, indicating an unstable condition.

2.3.4.9 Mooring Analyses. Analyses of the dock's mooring system shall be conducted. The analyses shall establish:

(A) Maximum wind speed in combination with maximum current speed that the mooring system is capable of resisting
(B) Maximum trim and list that the mooring system is capable of achieving without binding
(C) Maximum and minimum tide elevations

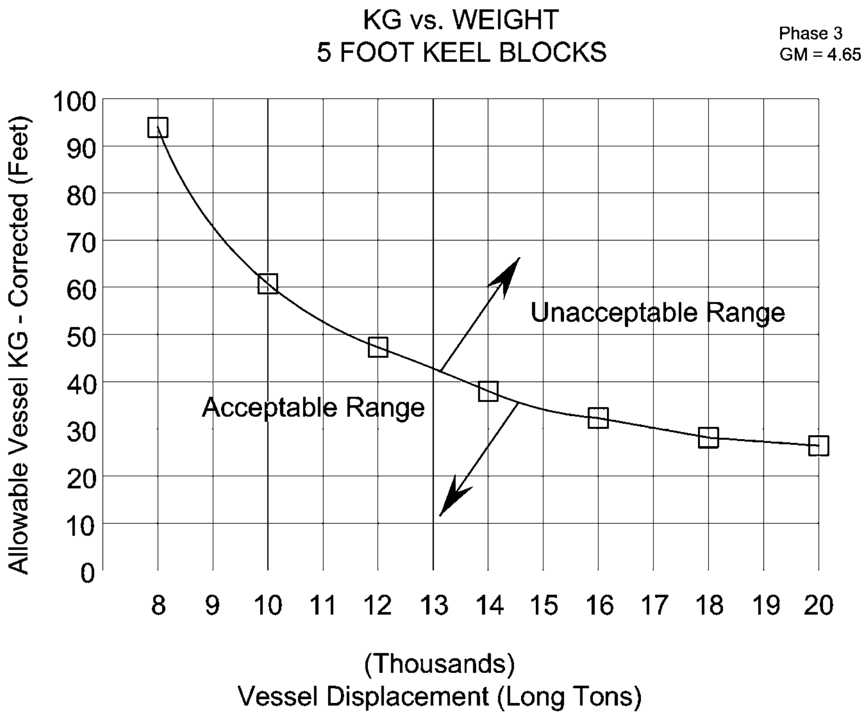


Figure 2-12. KG versus weight curve.

2.3.4.10 Ballast System. A description of the dry dock's ballast system shall be provided. Original design pumping and flooding times shall be noted, if known.

2.3.4.11 Control Systems. A description of the dry dock's control systems shall be provided.

2.3.4.12 Ship Handling System. A description of the dry dock's ship handling system shall be provided.

2.3.4.13 Electrical Power Systems. A description of the electrical power system shall be provided.

2.3.4.14 Fire Protection System. A description of the fire protection system shall be provided.

2.3.4.15 Corrosion Criteria. A description of the corrosion criteria used in analyzing the dock's structure shall be provided.

2.3.5 Summary of Findings, Evaluation, and Recommendations

Results of the design review shall be summarized in a written report.

2.3.5.1 Purpose of Assessment. In general, the purpose of the initial condition assessment is to determine the dry dock's existing condition and establish operational limitations that the dock operators can employ when operating the dock. There may be other reasons for conducting a condition assessment, including evaluation for insurance purposes, appraisal, commercial certification, accident investigation, and so forth.

The purpose of the condition assessment shall be stated in the report.

2.3.5.2 Scope of Investigation. The scope of the investigative work performed for the assessment shall be listed, including:

(A) Names of key people involved
(B) Dates and extent of surveys and tests
(C) Original documents reviewed
(D) Original design calculations reviewed
(E) New calculations performed
(F) New drawings and specifications developed

2.3.5.3 Description of Structure. A general description of the structure shall be given. The description should include type of dry dock, materials of construction, principal dimensions, and location of facility.

2.3.5.3.1 Dates of Construction, Modifications, and Repairs. Any information available on the dates of construction and/or dates and extent of modifications and repairs should be included.

2.3.5.3.2 History. Any pertinent history that is available on the dry dock should be included. This may include name of designer, name of builder, list of vessels drydocked, dock relocations, major dock overhauls or renovations, and a list of major storms, earthquakes, or accidents that the dock has experienced.

2.3.5.3.3 Design Data. Information accumulated and developed during the survey and assessment shall be included in the report. This may include drawings, specifications, descriptions, photographs, design calculations, and so forth.

2.3.5.4 Material Condition Survey. The results of the material condition survey shall be summarized in a written report.

2.3.5.4.1 Scope of Survey. The scope of the material condition survey shall be listed, including:

(A) Names of surveyors
(B) Dates of surveys and tests
(C) Specific items inspected
(D) Tests performed
(E) Data collected, including UT measurements, photographs, videos, etc.

2.3.5.4.2 Qualifications of Survey Team. The qualifications of the surveyors and members of the survey team shall be stated.

Each team member involved in the survey shall possess the technical qualifications, including practical experience, education, and professional judgment, required to perform the individual tasks assigned. A professional engineer or naval architect experienced in the design and inspection of floating dry docks shall be in charge of the survey team.

Résumés of key people shall be included.

2.3.5.4.3 Results of Survey. The results of the material condition survey conducted in accordance with 2.3.3 shall be included. This typically includes the checklist and a discussion of the results.

2.3.5.4.4 Photographs and Video Recordings. Photographs and video recordings may be included in the report.

2.3.5.5 Design Review Summary

2.3.5.5.1 Scope of Design Review. The scope of the design review shall be summarized.

2.3.5.5.2 Calculations. Calculations as required in 2.3.4 shall be included.

2.3.5.6 Recommended Operational Limitations. The report shall clearly summarize the operational limitations of the dry dock.

The operational limitations will be used by the dock operator when operating the dock. It will be his responsibility not to exceed these limitations.

Operational limitations shall be set such that there is no danger to the dock or ship in dock if the operator does not exceed these limitations.

2.3.5.6.1 Overall Lift Capacity. The overall lift capacity of the dock shall be stated.

The overall lift capacity shall be the lesser of:

(A) The buoyant capacity of the dock at the minimum pontoon deck freeboard, or
(B) The rated load per foot capacity times the available keel blocking length, or
(C) Maximum weight ship due to stability requirements.

The pontoon deck freeboard at the operating draft shall be 12 inches or greater.

2.3.5.6.2 Rated Load per Foot Capacity. The rated load per foot capacity of the dock shall be stated.

The rated load per foot capacity shall be the lesser of:

(A) Transverse bending strength of the dock, or
(B) Longitudinal bending strength of the dock, or
(C) Keel block capacity, or
(D) Local strength of the block support structure in pontoon.

2.3.5.6.3 Longitudinal Deflection Limits. For docks longer than 300 feet, the longitudinal deflection limits shall be stated. The method of monitoring longitudinal deflection shall be described.

2.3.5.6.4 Stability Limits. The stability limitations of the dock shall be stated.

A KG versus weight curve shall be included. The KG versus weight curve is a plot of the maximum allowable vessel KG versus the vessel's docking displacement (actual ship's weight at time of docking), which results in the minimum allowable GM for the ship/dock combination.

2.3.5.6.5 Hydrostatic Head Pressures on the Hull. The allowable hydrostatic head pressures on the dock's external shell shall be stated (Fig. 2-13).

2.3.5.6.6 Hydrostatic Head Pressures on Internal Bulkheads. The allowable hydrostatic head pressures of the dock's internal bulkheads shall be stated.

2.3.5.6.7 Block Load Limits. The rated load per keel block shall be stated.

The rated load per keel block shall be the lesser of:

(A) Allowable bearing pressure on timber times bearing area, or
(B) Structural strength of block base unit, or

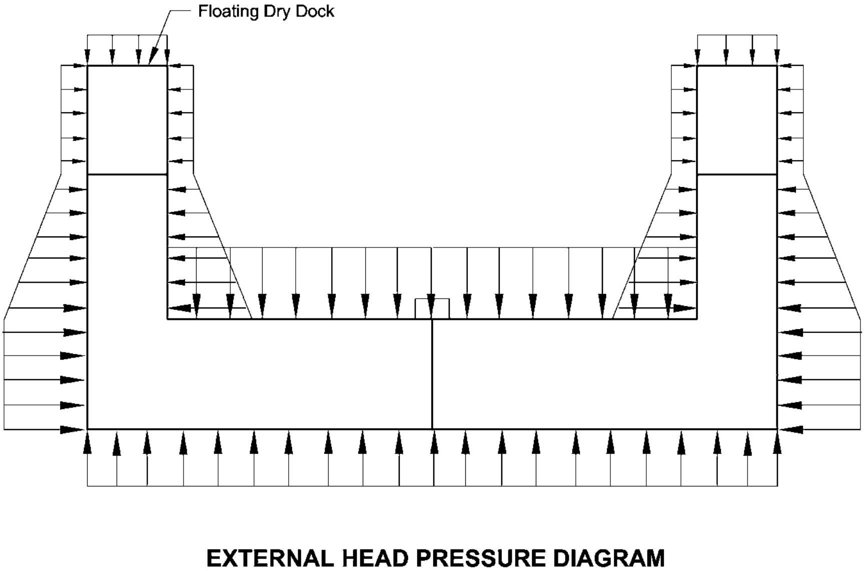


Figure 2-13. External head pressure diagram.

(C) Local structural strength of dock structure directly supporting blocks.

The rated load per side block shall be stated.
The rated load per side block shall be the lesser of:

(A) Allowable bearing pressure on timber times bearing area, or
(B) Structural strength of block base unit, or
(C) Local structural strength of dock structure directly supporting blocks.

2.3.5.6.8 Maximum Water Depth over the Keel Blocks. The maximum water depth over the keel blocks shall be stated. It shall be noted whether this depth limitation is dictated by site limitations. If the maximum water depth achievable is limited by tidal variations, the depth over the blocks shall be correlated with a specific tide level.

2.3.5.6.9 List and Trim Limits. The maximum list and trim angles for the dock shall be stated. The maximum list and trim shall be determined such that the mooring system does not bind; the wing wall cranes or other structures are not in danger of falling or rolling; the dry dock will not contact bulkheads, piles, piers, and so forth; and access bridges are not endangered.

2.3.5.6.10 Allowable Pontoon Deck and Apron Loading. The maximum allowable pontoon deck and apron loadings in pounds, kips, or tons per square foot shall be stated.

The maximum allowable pontoon deck and apron vehicle loadings shall be stated.

2.3.5.7 Recommended Future Surveys. A recommendation on the frequency and scope of future surveys should be made based on the condition of the dry dock and the operating environment. Upon sale or lease of a dry dock, a condition assessment shall be performed.

2.4 CONDITION ASSESSMENT OF GRAVING DOCKS

2.4.1 Qualifications and Equipment

2.4.1.1 Personnel Qualifications. All personnel involved in the condition assessment shall possess the technical qualifications, including practical experience, education, and professional judgment, required to perform the individual tasks assigned. Interpretation of results and conclusions shall be performed by a professional engineer or naval architect experienced in the design and inspection of graving docks.

2.4.1.2 Equipment. Equipment shall be obtained as appropriate to accomplish or perform the various tests and inspections specified in this manual of practice. All equipment shall be in good working order. For equipment that can be calibrated, calibration shall be current and reports of calibration shall be available for owner review.

2.4.2 Design Data: Document Review

Documents governing or prepared for the original design and construction, rehabilitation, alteration, or repair of the facility shall be reviewed, if available.

The design data required will vary depending on the type of graving dock being reviewed. In general, the design data will include:

(A) General arrangement of graving dock
(B) Structural drawings and specifications
(C) Mechanical drawings and specifications
(D) Electrical drawings and specifications

(E) System descriptions
(F) Control and indication systems
(G) Operating manual/procedures
(H) Hydrographic data
(I) Geotechnical report, boring logs, and results from soil testing
(J) Stability data of caisson gate (if applicable)
(K) Environmental data
(L) Design calculations
(M) Concrete material test data, including but not limited to concrete cylinder breaks (compressive strength) and flexural strength tests (modulus of rupture)
(N) Design ship data

2.4.3 Material Condition Survey

A material condition survey is required to establish the existing condition of the facility. The survey must be sufficiently detailed to ascertain the actual condition of all critical components of the facility and verify that the design data are valid.

In general, the survey will include:

(A) Visual survey of graving dock floor
(B) Visual survey of graving dock walls
(C) Visual survey of the pumphouse, dewatering pump well, and underdrain pump wells
(D) Visual survey of area surrounding dock, top of side walls, and head wall
(E) Visual survey of flooding/dewatering tunnels
(F) Visual survey of the gate
(G) Visual survey of gate's machinery
(H) Visual survey of gate lodge, sill, abutment, and gate seal
(I) Visual survey of blocking
(J) Visual survey of mooring hardware (cleats, bollards, chocks, etc.)
(K) Visual survey of dock fenders
(L) Operational test of ship handling equipment such as capstans and winches
(M) Witness operational test of all critical mechanical and electrical components
(N) Witness operational test of backup generator under load
(O) Witness operational test of all control systems
(P) Witness superflooding operation (If applicable)
(Q) Dock floor pressure relief system/floor vents (if applicable)
(R) Graving dock wall pressure relief system/cell drains (if applicable)

(S) Underwater inspection of submerged portions of dock
(T) Witness of the dock in operation
(U) UT or other measurements to establish extent of corrosion/deterioration
(V) Grade survey of graving dock floor to determine settlement/rise
(W) Measurement of wall displacement
(X) Hydrographic survey
(Y) Cathodic protection system

Depending on the results of the visual survey and the availability of design data, the survey may also include:

(A) Coring into the existing floor slab to obtain concrete cylinders for strength testing
(B) Coring into the existing floor slab to investigate the presence of voids
(C) Additional soil sampling and testing
(D) Visual inspection of the underdrain system via remote camera
(E) Mooring hardware load test/anchor bolt pull test

The condition of the structural steel, concrete and/or timber shall be assessed in accordance with ASCE/SEI 11-99, *Condition assessment of existing buildings* (2000).

2.4.3.1 Survey of Graving Dock Floor. The graving dock floor shall be visually inspected for depressions, cracks, spalling, leakage, or other types of degradation. The size and location of major cracks and leaks shall be mapped and recorded for future reference. Evidence of upward displacement or settlement of the floor, or evidence of voids under the floor, shall be noted and investigated further to determine cause.

2.4.3.2 Survey of Graving Dock Walls. The graving dock walls shall be visually inspected. Docks with concrete walls shall be inspected for cracks, spalling, leakage, movement, or other types of degradation. The size and location of major cracks and leaks shall be mapped and recorded for future reference. Docks with steel sheet-pile walls shall be inspected for corrosion, loss of metal thickness, split seams, bulging, buckling, or other types of degradation or failure.

2.4.3.3 Survey of Areas Surrounding Graving Dock. The area surrounding the graving dock shall be visually inspected for signs of settlement indicating loss of material.

2.4.3.4 Visual Survey of Flooding/Dewatering Tunnels. The flooding/dewatering tunnels shall be visually inspected for cracks, spalling, leakage, or other types of degradation. The size and location of major cracks and leaks shall be mapped and recorded for future reference.

2.4.3.5 Visual Survey of the Gate. For gates that have ballast tanks, 100% of all of the ballast tanks and machinery spaces shall be visually inspected. The material condition of structural elements can vary greatly from ballast tank to ballast tank or even within a single ballast tank due to varying environmental conditions or past renovation projects that repaired some areas but not others. Therefore, it is imperative to visually inspect all members in every ballast tank.

For gates without ballast tanks, both sides of the gate should be visually inspected.

All structural members should be inspected for condition of protective coating, condition of cathodic protection system, buckling, cracking, extent of corrosion, condition of fasteners, or other signs of distress. It may be necessary to remove silt or sediment from the ballast tanks prior to the inspection to provide access to 100% of the structure.

The side shell plate and plate stiffeners should be inspected for signs of external impact damage (pushed-in plate, buckled stiffeners and/or frames).

Check the effectiveness of the gate seals and general fit of the gate. Note size and location of all leaks (external, between tanks, through valves, packing glands, etc.)

Note size, location, and probable cause of all holes and/or cracks (impact, corrosion, stress)

Where corrosion has caused a loss of metal thickness or where as-built member thicknesses are in question, UT measurements may be necessary to confirm actual member thicknesses. See 2.4.3.15 for more information on UT measurements.

2.4.3.6 Visual Survey of Gate's Machinery. For gates designed to be ballasted and deballasted, the ballast control equipment shall be visually inspected during the survey and an operational test of the equipment shall be witnessed.

For gates designed to swing in and out of position or lowered on hinges, the operating mechanisms shall be visually inspected and an operational test of the equipment shall be witnessed.

2.4.3.7 Visual Survey of Blocks. The condition of the blocking system shall be visually assessed.

Check the timber for excessive crushing, warping, cracking, checking, rot, or wear from fasteners. Check for loss of contact at edges. In general, minor cracking is acceptable unless bearing area has been lost.

If the blocks have concrete bases, check the concrete for cracking, spalling, and exposed rebar.

If the blocks have steel bases, check the steel for loss of metal thickness by corrosion, cracks, cracked welds, and so forth.

Check the condition of fastenings. All timber shall be adequately secured to prevent floating when the dock is flooded.

If the dock is equipped with hauling side blocks, the hauling block hardware shall be inspected. The hauling block hardware includes chains, sheaves, cranks, slides, and pawls.

2.4.3.8 Operational Tests. An operational test of all the graving dock's mechanical and electrical components shall be conducted by the shipyard and witnessed by the surveyor. The operational test shall include witnessing the following:

(A) Dewatering pumps: check for proper control from control panel, abnormal vibration
(B) Dock flooding and dewatering system valves, stripping system valves and sluice gates: check for proper control from control panel, valve position indicator gages or lights working properly
(C) Gate ballast equipment or lifting mechanism(s)
(D) Stripping/drainage pumps
(E) Water level indicator gages
(F) Emergency backup power: demonstrate maximum number of stripping pumps that are capable of being run off of the backup power system. The backup power system shall be capable of running at least one of the stripping pumps and the dock controls system, alarms, and emergency lighting simultaneously.
(G) Capstans
(H) Winches
(I) Vessel centering system (if so equipped)
(J) Control systems
(K) Water level sensors/high water alarms
(L) Lighting
(M) Emergency lighting
(N) Fire-fighting system
(O) Cathodic protection

2.4.3.9 Pressure Relief System. For docks designed with a system to relieve hydrostatic pressure under the slab and/or behind the walls, it shall be verified that the system is working as designed.

2.4.3.10 Underwater Surveys. An underwater survey of the submerged portion of the gate, gate seating area, waterfront bulkhead, and other areas of the dock that cannot be inspected when the dock is dewatered shall be conducted. The surveyor shall inspect for cracks, spalling, corrosion, or other types of degradation.

Where corrosion of steel structural members has caused a loss of metal thickness or where as-built member thicknesses are in question, UT measurements may be necessary to confirm actual member thicknesses. See 2.4.3.15 for more information on UT measurements.

2.4.3.11 Grade Survey of Graving Dock Floor. The elevation of the floor slab shall be measured and recorded for future reference. This information will be used in future surveys to determine whether the slab is rising or settling.

2.4.3.12 Displacement Survey of Graving Dock Walls. If there are visual indications that the side walls may have moved from their original location, the actual position of the walls should be determined and recorded for future reference. This information will be used in future surveys to determine whether the walls are continuing to move.

2.4.3.13 Witness of Dock in Operation. The surveyor should witness one complete cycling of the dock, including flooding of dock, opening of gate, closing of gate, and dewatering of dock.

2.4.3.14 Verification of Calibration of Instruments. If, during the operational test, the water level indicator gages, ammeter gages, valve position indicators, or other instrumentation do not reflect the actual condition, the errant gages should be recalibrated and checked by comparing the physical measurement to the reading on the gages.

2.4.3.15 Thickness Measurements. Use UT measurements and/or calipers to physically measure steel thickness in areas of high corrosion.

The number and frequency of readings will vary as to the condition of the dock. Steel that still retains all of its protective coating, or steel with many holes through it, may require no readings because the condition is obvious. Steel that is questionable will require readings to establish remaining thickness. Steel that is due for repair may require many readings to establish the extent of replacement.

If UT measurements are required, a grid pattern shall be established and readings taken at those intervals. Examples are a reading every 10 feet longitudinally and 5 feet vertically on plate, or three readings on the web and flange of each vertical stiffener in the gate (one each in the upper, middle, and lower zones). The engineer or naval architect in charge of the condition assessment shall establish the frequency and locations of measurements.

2.4.3.16 Hydrographic Survey. A hydrographic survey shall be conducted to establish available water depths between the dock and open channel. The survey datum shall be clearly labeled with its reference elevation (e.g., mean low water, mean high water). The survey shall be conducted every 5 years unless local site conditions justify a longer or shorter frequency. A severe storm may warrant an updated hydrographic survey.

2.4.3.17 Checklists. See Appendix B for sample checklists that shall be used for summarizing the dock's condition. These checklists should be modified to reflect the actual components of the dock being surveyed. Each item shall be rated according to the following:

(A) Satisfactory (S): The condition of the item will not result in system damage and, based on measured or estimated deterioration rate, it may be expected to remain satisfactory until the next control inspection.
(B) Marginal (M): The condition of the item will not result in major damage or, by itself, it will not make the facility unsafe to dock a ship, provided it is corrected, repaired, or replaced in a timely manner. A number of such items as a group can make the facility unsafe. This shall be evaluated by the surveyor.
(C) Unsatisfactory (U): The condition of the item may cause system damage or loss and shall be corrected, repaired, or replaced immediately (if there is a ship in dock) or prior to docking a ship (if there is no ship in dock).
(D) Not Applicable (NA): The item listed in the checklist is not present on the dry dock. Note that as items are added, removed, or replaced from the graving dock, the inspection checklist shall be updated to reflect the configuration changes.
(E) Not Inspected (NI): The item was not inspected as part of the survey. It is not acceptable to mark an item NI unless there is a basis for expecting the item to be in a satisfactory condition.

2.4.3.18 Summary of Results. The surveyor shall prepare a written report summarizing the findings of the survey. The report shall include:

(A) Experience and qualifications of the surveyors
(B) Dates and major milestones of the survey
(C) Scope of the survey
(D) List of items not inspected and reasons why

(E) Condition report
(F) Checklists
(G) Corrective action plan for making any necessary repairs to the facility

2.4.4 Design Review

The purpose of the design review is to establish the operational limitations of the dock in its present condition. If the design calculations and operational limitations from the original designer exist and, in the opinion of the surveyor, the dock has not significantly deteriorated to the point that these operational limitations should be revised, then a new design review need not be performed and the original operational limitations may be used.

If, however, documentation for the original operational limitations does not exist, the dock's structure or equipment have deteriorated to the point where the original operational limitations are questionable, or the dock has been modified in any way, then a new design review is required.

The design review shall consist of calculations to substantiate the operational limitations. The design review is conducted using the "as-is" condition of the facility as determined by the material condition survey of 2.4.3.

For a graving dock, the design review will include:

(A) Geotechnical data
(B) Loading on floor
(C) Loading on walls
(D) Uplift stability
(E) Structural strength of gate
(F) Stability and hydrostatic properties of gate
(G) Local strength analyses
(H) Block loading calculations
(I) Light weight of gate determination
(J) Ballast system of gate
(K) Superflood system (if applicable)
(L) Electrical power system
(M) Fire protection system
(N) Corrosion criteria

2.4.4.1 Loading on Floor. Critical loading combinations shall be investigated and the resulting stresses and factors of safety determined.

If allowable block loading varies with location or blocking is limited to certain reinforced areas, these locations and load limits shall be noted.

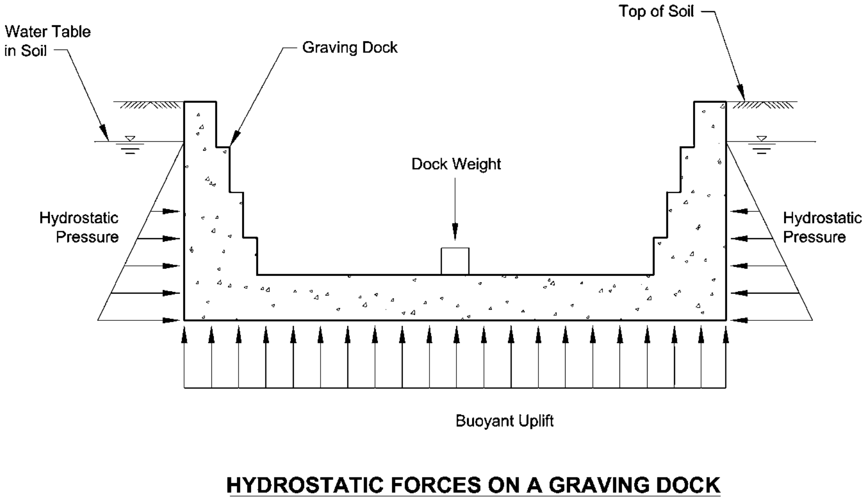


Figure 2-14. Hydrostatic forces on a graving dock.

2.4.4.2 Loading on Walls. Critical loading combinations shall be investigated and the resulting stresses and factors of safety determined.

2.4.4.3 Uplift Stability. Calculations shall be provided that demonstrate that the uplift resistance furnished by the graving dock is greater than the uplift force caused by hydrostatic pressures (Fig. 2-14).

2.4.4.4 Structural Strength of Gate. The structural strength of the gate shall be assessed. As a minimum, the ability of the gate to resist the hydrostatic forces with the graving dock dewatered and the tide level at the maximum anticipated level (e.g., extreme high tide, storm surge) shall be demonstrated.

When determining acceptable stresses, buckling strength of members in compression shall be considered. The “as-is” condition of the member shall be used.

2.4.4.5 Light Weight of Gate Determination. For docks designed with a floating caisson gate, the light weight and center of gravity of the gate must be stated. If the original light weight and vertical center of gravity (KG) of the gate are unavailable, or if the gate’s weight and/or KG have been modified since the original calculations were performed, a new light gate weight and KG shall be calculated. The light weight and KG can be calculated by a theoretical weight estimate verified by a light weight survey.

2.4.4.6 Stability of the Gate. For gates that are designed to be floated in and out of position, the stability of the gate when afloat must be evaluated. The minimum water levels required in the gate's ballast tanks to maintain adequate stability shall be noted.

2.4.4.7 Ballast Required to Seat Gate. For gates that are designed to be floated in and out of position, the minimum amount of ballast water required to keep the gate seated shall be determined. The light weight of the gate combined with the weight of the ballast water must be greater than the buoyant force on the gate during the highest anticipated tide (e.g., storm condition).

2.4.4.8 Block Loading Analyses. A description of the blocking system shall be provided. Calculations shall show that the blocks are stable and structurally adequate to support the rated load per block. Calculations shall include:

(A) Allowable bearing pressure on timber times bearing area
(B) Structural strength of block base unit
(C) Local structural strength of graving dock floor directly supporting blocks

Calculations shall be done for both keel blocks and side blocks, and a rated block load for each determined.

2.4.4.9 Flooding, Dewatering, and Stripping Systems. A description of the dock's flooding, dewatering, and stripping systems shall be provided. Original design pumping and flooding times shall be noted, if known.

2.4.4.10 Ship Handling System. A description of the dock's ship handling system shall be provided.

2.4.4.11 Electrical Power Systems. A description of the electrical power system shall be provided.

2.4.4.12 Fire Protection System. A description of the fire protection system shall be provided.

2.4.4.13 Control and Indication Systems. A description of the control and indication systems shall be provided.

2.4.4.14 Corrosion Criteria. A description of the corrosion criteria used in analyzing the dock's structure shall be provided.

2.4.5 Summary of Findings, Evaluation, and Recommendations

Results of the design review shall be summarized in a written report.

2.4.5.1 Purpose of Assessment. In general, the purpose of the initial condition assessment is to determine the graving dock's existing condition and establish operational limitations that the dock operators can employ when operating the dock. There may be other reasons for conducting a condition assessment, including evaluation for insurance purposes, appraisal, commercial certification, accident investigation, and so forth.

The purpose of the condition assessment shall be stated in the report.

2.4.5.2 Scope of Investigation. The scope of the investigative work performed for the assessment shall be listed, including:

(A) Names of key people involved
(B) Dates and extent of surveys and tests
(C) Original documents reviewed
(D) Original design calculations reviewed
(E) New calculations performed
(F) New drawings and specifications developed

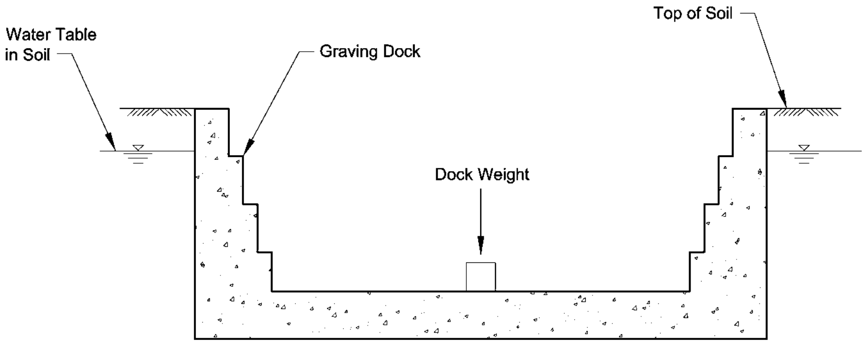
2.4.5.3 Description of Structure. A general description of the structure shall be given. The description should include type of graving dock, materials of construction, principal dimensions, and location of facility. General classifications of graving dock designs are illustrated in Figs. 2-15 and 2-16.

2.4.5.3.1 Dates of Construction, Modifications, and Repairs. Any information available on the dates of construction and/or dates and extent of modifications and repairs should be included.

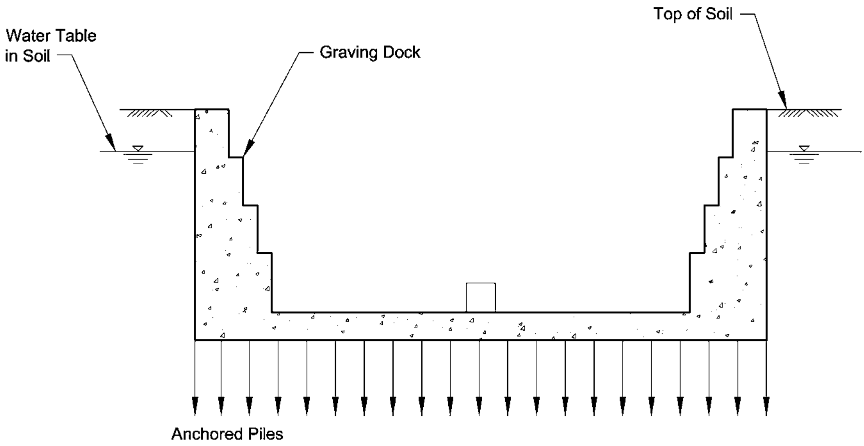
2.4.5.3.2 History. Any pertinent history that is available on the graving dock should be included. This may include name of designer, name of builder, list of vessels drydocked, and a list of major storms, earthquakes, or accidents that the dock has experienced.

2.4.5.3.3 Design Data. Information accumulated and developed during the survey and assessment shall be included in the report. This may include drawings, specifications, descriptions, photographs, design calculations, and so forth.

2.4.5.4 Material Condition Survey. The results of the material condition survey shall be summarized in a written report.



MASS GRAVITY FULL HYDROSTATIC GRAVING DOCK



ANCHORED FULL HYDROSTATIC GRAVING DOCK

Figure 2-15. Full hydrostatic graving dock.

2.4.5.4.1 Scope of Survey. The scope of the material condition survey shall be listed, including:

(A) Names of surveyors
(B) Dates of surveys and tests
(C) Specific items inspected
(D) Tests performed
(E) Data collected, including UT measurements, photographs, videos, etc.

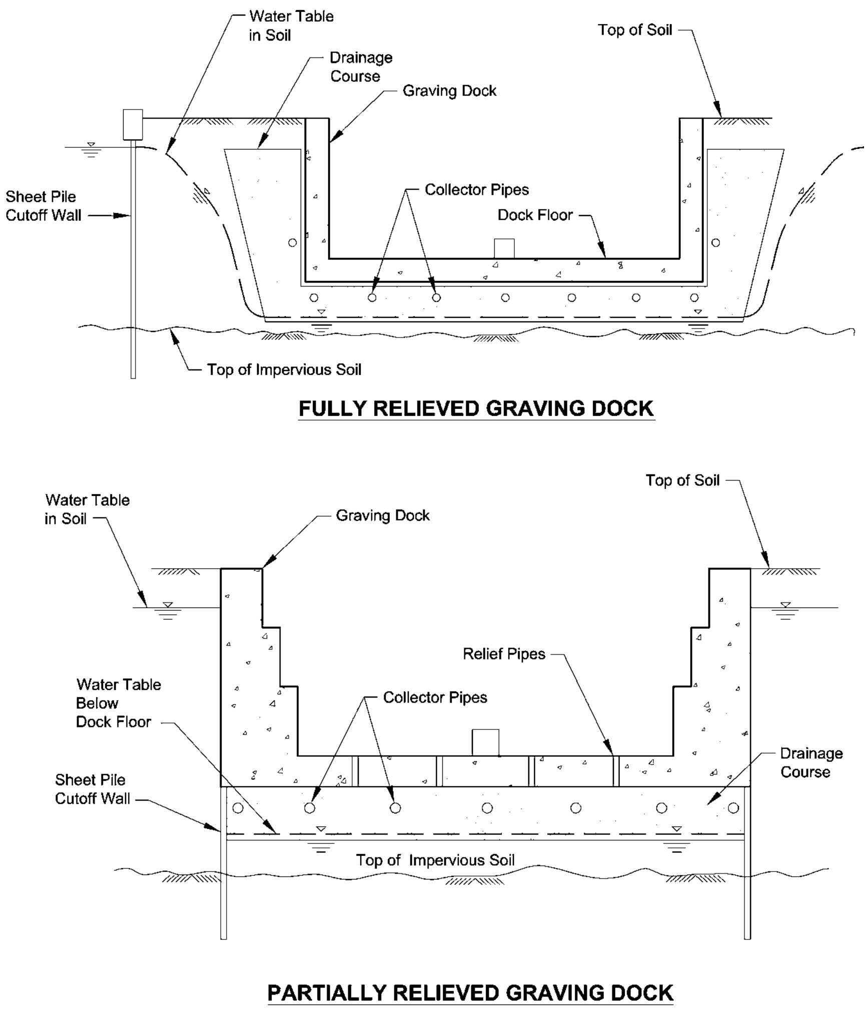


Figure 2-16. Relieved graving docks.

2.4.5.4.2 Qualifications of Survey Team. The qualifications of the surveyors and members of the survey team shall be stated.

Each team member involved in the survey shall possess the technical qualifications, including practical experience, education, and professional judgment, required to perform the individual tasks assigned. A professional engineer or naval architect experienced in the design and inspection of graving docks shall be in charge of the survey team.

Résumés of key people shall be included.

2.4.5.4.3 Results of Survey. The results of the material condition survey conducted in accordance with 2.4.3 shall be included. This typically includes the checklist and a discussion of the results.

2.4.5.4.4 Photographs and Video Recordings. Photographs and video recordings may be included in the report.

2.4.5.5 Design Review

2.4.5.5.1 Scope of Design Review. The scope of the design review shall be summarized.

2.4.5.5.2 Calculations. Calculations as required in 2.4.4 shall be included.

2.4.5.6 Recommended Operational Limitations. The report shall clearly summarize the operational limitations of the graving dock.

The operational limitations will be used by the dock operator when operating the dock. It will be his responsibility not to exceed these limitations.

Operational limitations shall be set such that there is no danger to the dock or ship in dock if the operator does not exceed these limitations.

2.4.5.6.1 Overall Capacity. The overall capacity of the dock shall be stated. The overall capacity shall be the rated load per foot capacity multiplied by the available keel blocking length.

2.4.5.6.2 Load per Foot Capacity. The rated load per foot capacity of the dock shall be stated.

The rated load per foot capacity shall be the lesser of:

(A) Strength of the dock floor slab, or
(B) Strength of the floor slab supporting piles (if applicable), or
(C) Strength of the dock floor subgrade soil, or
(D) Keel block capacity.

2.4.5.6.3 Stability Limits of Gate. For docks with gates that are designed to be floated in and out of position, the stability limitations of the gate shall be stated. Minimum required ballast water levels for gate stability shall be stated.

2.4.5.6.4 Ballast Required to Seat Gate. For docks with gates that are designed to be floated in and out of position, the minimum required ballast water to keep the gate seated at the highest anticipated tide shall be stated.

2.4.5.6.5 Hydrostatic Head Pressures on the Gate. The maximum tide level that the gate with an empty dock can resist shall be stated.

2.4.5.6.6 Hydrostatic Head Pressures on Internal Bulkheads of the Gate. For gates that have internal ballast tanks, the allowable hydrostatic head pressures of the dock's internal bulkheads shall be stated.

2.4.5.6.7 Block Load Limits. The rated load per keel block shall be stated.

The rated load per keel block shall be the lesser of:

(A) Allowable bearing pressure on timber times bearing area, or
(B) Structural strength of block base unit, or
(C) Local structural strength of graving dock floor directly supporting blocks.

The rated load per side block shall be stated.
The rated load per side block shall be the lesser of:

(A) Allowable bearing pressure on timber times bearing area, or
(B) Structural strength of block base unit, or
(C) Local structural strength of graving dock floor directly supporting blocks.

2.4.5.6.8 Maximum Water Depth over the Keel Blocks. The maximum water depth over the keel blocks shall be stated relative to a specific tide level (e.g., mean low water, mean high water).

2.4.5.6.9 Allowable Floor Loading. The maximum allowable floor slab loadings in pounds, kips, or tons per square foot shall be stated. The location of the allowable loads shall be stated.

2.4.5.7 Recommended Future Surveys. A recommendation on the frequency and scope of future surveys should be made based on the condition of the graving dock. Upon sale or lease of a graving dock, a condition assessment shall be performed.

2.5 CONDITION ASSESSMENT OF MARINE RAILWAYS

2.5.1 Qualifications and Equipment

2.5.1.1 Personnel Qualifications. All personnel involved in the condition assessment shall possess the technical qualifications, including practical experience, education, and professional judgment, required to perform the individual tasks assigned. Interpretation of results and conclusions shall be performed by a professional engineer or naval architect experienced in the design and inspection of marine railways.

2.5.1.2 Equipment. Equipment shall be obtained as appropriate to accomplish or perform the various tests and inspections specified in this manual of practice. All equipment shall be in good working order. For equipment that can be calibrated, calibration shall be current and reports of calibration shall be available for owner review.

2.5.2 Design Data: Document Review

Documents governing or prepared for the original design and construction, rehabilitation, alteration, or repair of the facility shall be reviewed, if available.

The design data required will vary depending on the type of marine railway being reviewed. In general, the design data will include:

(A) General arrangement of the marine railway
(B) Structural drawings and specifications
(C) Mechanical drawings and specifications
(D) Electrical drawings and specifications
(E) System descriptions
(F) Operating manual/procedures
(G) Hydrographic data
(H) Soils information
(I) Environmental data
(J) Design calculations
(K) Design ship data

2.5.3 Material Condition Survey

A material condition survey is required to establish the existing condition of the facility. The survey must be detailed enough to ascertain the actual condition of all critical components of the facility and verify that the design data are valid.

In general, the survey will include:

(A) Visual survey of foundation
(B) Visual survey of track
(C) Visual survey of cradle
(D) Inspection of rollers or wheels
(E) Inspection of hauling chains or wire rope

(F) Inspection of hauling machine
(G) Line, grade, and gauge survey of rails
(H) Visual survey of blocking
(I) Witness operational test of all critical mechanical and electrical components
(J) Witness operational test of all control systems
(K) Underwater inspection of submerged portions of dock
(L) Witness of the dock in operation
(M) UT or other measurements to establish extent of corrosion/deterioration
(N) Hydrographic survey
(O) Verify that cathodic protection is operational

The condition of the structural steel, concrete, and/or timber shall be assessed in accordance with ASCE/SEI 11-99, *Condition assessment of existing buildings* (2000).

2.5.3.1 Survey of Foundation. The exposed portions of the foundation shall be inspected for signs of corrosion, deterioration, failure from overload, and other problems. Excavation of the below-grade foundation is usually not required unless foundation failure is suspected.

A foundation failure may be evident by tell-tale signs on the track. These signs can include an out-of-grade track, large gaps between the track and foundation, and/or structural failure of the track beam. If these signs are found, the condition of the foundation should be investigated more thoroughly.

2.5.3.2 Survey of Track. A marine railway track can be constructed of steel, concrete, timber, or some combination of these materials. The modes of deterioration will vary depending on the materials of construction.

Also, a track has three different environmental zones that can affect materials in different ways (Fig. 2-17).

These zones are:

(A) Underwater Zone: The portion of track and foundation that remains submerged at all times.
(B) Splash and Tidal Zone: The portion of track, foundation, and cradle that get wet from tidal variations and wave splash. This is usually the zone of heaviest deterioration.
(C) Above the Splash Zone: The portion of track, foundation, cradle, and hauling house that is above the heavy splash from waves.

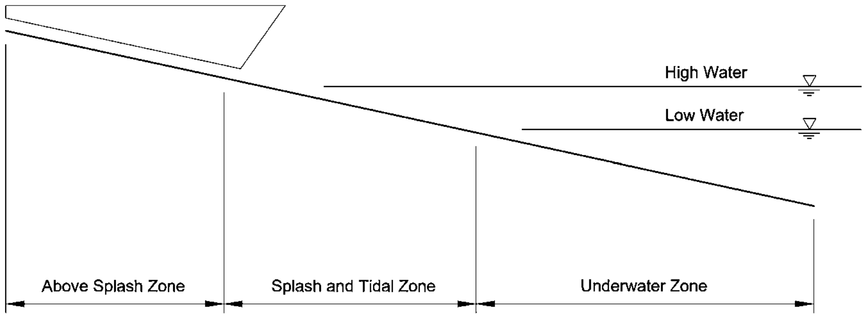


Figure 2-17. Typical deterioration zones.

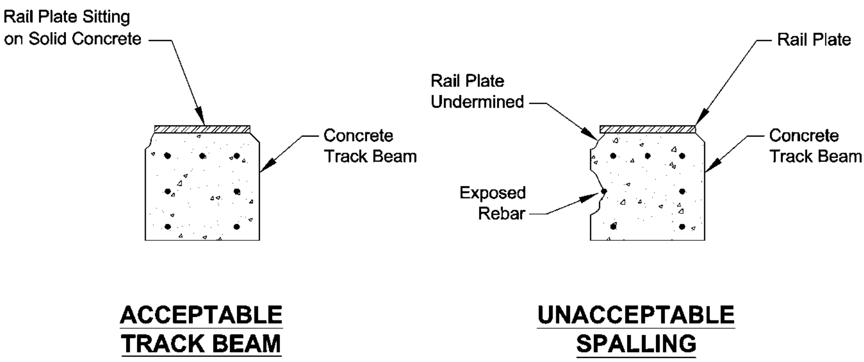


Figure 2-18. Spalling of track beam.

2.5.3.2.1 Concrete Track. A concrete track should be inspected for:

(A) Spalling: Some minor spalling is acceptable, but if spalling has progressed to undermine the rail plate or is exposing the rebar, the damage should be repaired (Fig. 2-18).
(B) Major Cracking: Indicates possible overload, foundation failure, or impact damage.
(C) Deteriorated Fastenings: Rails can pull away from the concrete or become loose, a potential cause of derailment.

2.5.3.2.2 Steel Track. A steel tack deteriorates at varying rates over its length. Some areas of the track may look fine while other areas have heavy corrosion. The entire length of track, above and below water, shall be visually inspected.

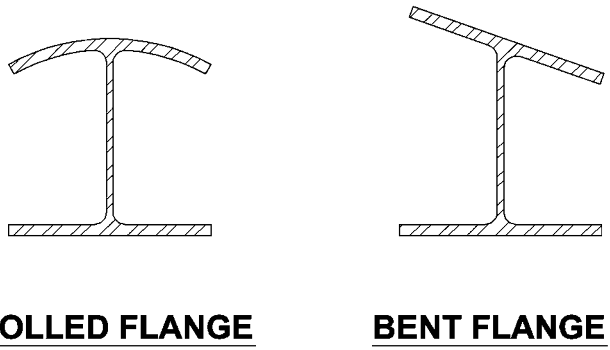


Figure 2-19. Deformed top flange.

In general, the area of worst corrosion is usually the splash and tidal zone.

During the inspection, the condition of steel structural members should be examined.

Note percentages of total area that are corroded.

Note the severity of corrosion.

Defects or damage such as bent or buckled frames, plates, or bulkheads; holes in plates; and cracks in plating, framing, or welds should be noted.

A steel track should be inspected for:

(A) Corroded steel: As described above.
(B) Rolled or bent top flange: Overloading or off-center loading of the rail plate may cause the top flange of the track to roll or bend about the web of the beam (Fig. 2-19).
(C) Missing rubber pads: Some steel tracks on steel piles have rubber pads installed between the track and pile bonnets.

2.5.3.2.3 Wood Track. Inspect timber for rot, marine borers, impact damage, and signs of overload. Use a probe, core borer, and/or hammer to test wood. Marine borers are not always evident from the surface. Determine the depth at which sound wood is found below punky surfaces.

Note the condition of track timber sheathing (if any). Sheathing may need to be removed in representative areas to check condition of tar coating, sheathing felt, and timber beneath.

Check the track for rotted timbers, usually found above the splash zone and in the splash and tidal zone.

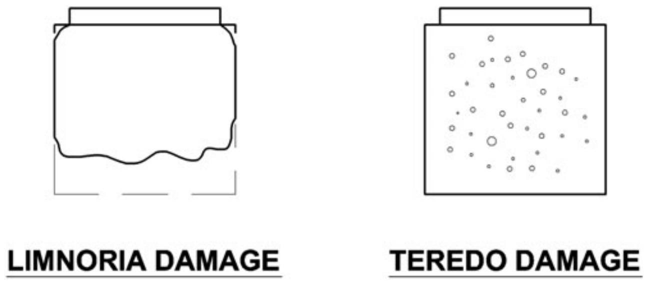


Figure 2-20. Marine borer damage.

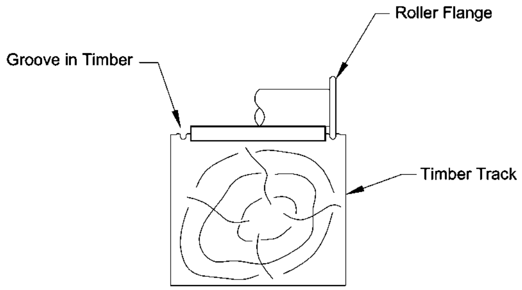


Figure 2-21. Rail plate squeeze.

Check the track for termites or other bugs, usually found above the splash zone.

Check the track for marine borers, usually found in the tidal and underwater zones in salt water only. Two common types of marine borers are the wood gribble (*Limnoria lignorum*) and the shipworm (*Teredo navalis*). Limnoria damage is readily evident with a visual inspection as loss of material occurs on the outside of the timber. *Teredo navalis* is a mollusk, although it looks like a worm. It bores a tiny hole into the wood when young, and as it grows it tunnels along the grain of the wood. Detection of *Teredos navalis* is difficult because most of the damage occurs inside the timber. A member may be riddled with holes but look fine from the outside (Fig. 2-20).

Check the track for rail plate squeeze. The rail plate sometimes squeezes into the wood, reducing the height of the top of plate above the wood. The roller flanges can then contact the wood and will wear grooves in the wood on either side of the rail plate (Fig. 2-21). The roller flanges contacting the wood can create considerable additional friction that the hauling system must overcome. This additional force could overload the hauling system. Also, roller flanges may tend to break more often.

2.5.3.2.4 All Types of Tracks. All types of tracks should be checked for the following:

(A) Ice damage: Check for damage by ice in the tidal zone. Damage may include bent or broken members, derailed roller frames, "jacking" of track up off of piles, or out-of-line or out-of-grade track.
(B) Impact damage: Check for damage by floating debris in tidal zone. Check for damage by anchors and vessel impact in the tidal zone or the underwater zone. Damage may include bent or broken members, derailed roller frames, or out-of-line or out-of-grade track.
(C) Mud or debris on or near track: Check for mud over the rails. Mud covering the track beams is acceptable as long as it does not cover the rails. (Mud may actually protect the track beams from deterioration.) However, mud on the track can cause the rollers or wheels to ride up on the mud and derail, possibly causing a cradle derailment. If mud has built up greater than the level of the rails, the cradle will have to push through this mud when backing down. This will add considerable force to the backing chain or cable and underwater sheaves, possibly overloading them. The mudline over the full width of the cradle should be determined to verify that no part of the cradle will contact the mud during cradle movement.
(D) Gaps between pile and track beam: Gaps between pile and track beam indicate shims have fallen out, pile has sunk, or track has come up. Track grade should be checked and shims inserted to suit. There should be no gaps between pile and track, or the track will deflect when the loaded cradle travels over this area.
(E) Chain or cable slides: Check for worn, loose, or missing chain slides.

All rail plates or rails should be checked for wear, crowning, loose fastenings, and misalignment.

2.5.3.3 Survey of Cradle. All structural elements of the cradle shall be visually inspected for corrosion; cracked, bent, or buckled members; or rotted or broken timbers.

The cradle shoe plate, if so equipped, shall be visually inspected and checked for wear and crowning in the same manner as the track rail plates.

2.5.3.4 Inspection of Rollers or Wheels. For marine railways that operate on a system of rollers, the following shall be checked:

(A) Verify that the number and position of roller frames are adequate to allow the cradle to travel the full length of the track without overrunning the rollers or causing the rollers to run off the end of the track.
(B) Visually inspect the rollers for signs of wear, broken treads, or broken flanges. Measure a representative sample of roller treads to determine the amount of tread wear.
(C) Visually inspect roller pintles and bushings for wear.
(D) Visually inspect roller frames for corrosion, wear, and bent or buckled members.
(E) Verify that roller frames are properly connected together.

For marine railways that operate on a system of wheels, the following shall be checked:

(A) Visually inspect the wheels for signs of wear, broken treads, or broken flanges. Measure a representative sample of wheel diameters to determine wheel wear.
(B) Visually inspect axles for corrosion, wear, or cracks.

2.5.3.5 Inspection of Hauling Chains or Wire Rope. For marine railways that operate with a system of hauling chains, the following shall be inspected:

(A) Visually inspect each chain link for signs of wear or cracks.
(B) If the hauling chain is 5 or more years old, or if the chain shows visible signs of wear, the hauling chain shall be gaged at a maximum of 10-foot intervals. The barrel diameters of each side of the link, the double grip diameter, and the pitch distance over five links shall be measured.
(C) If the backing chain is 5 or more years old, or if the chain shows visible signs of wear, the backing chain shall be gaged at a maximum of 20-foot intervals. The barrel diameters of each side of the link and the double grip diameter shall be measured.
(D) The connection between the backing chain and hauling chain shall be visually inspected.
(E) The connection of the hauling chain to the cradle shall be visually inspected.
(F) The connection of the backing chain to the cradle shall be visually inspected.

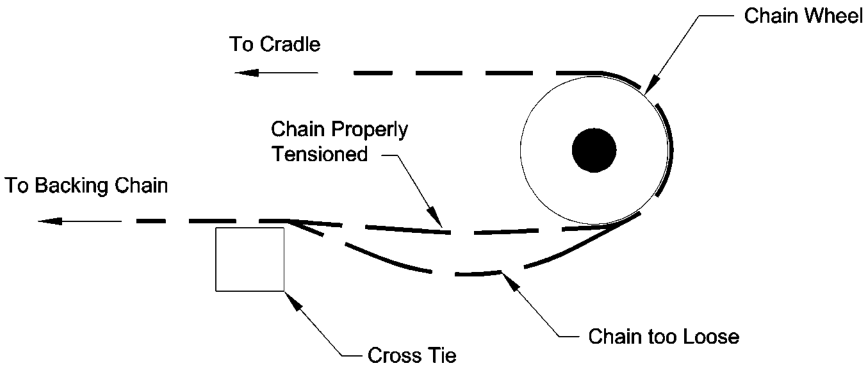


Figure 2-22. Hauling chain tension.

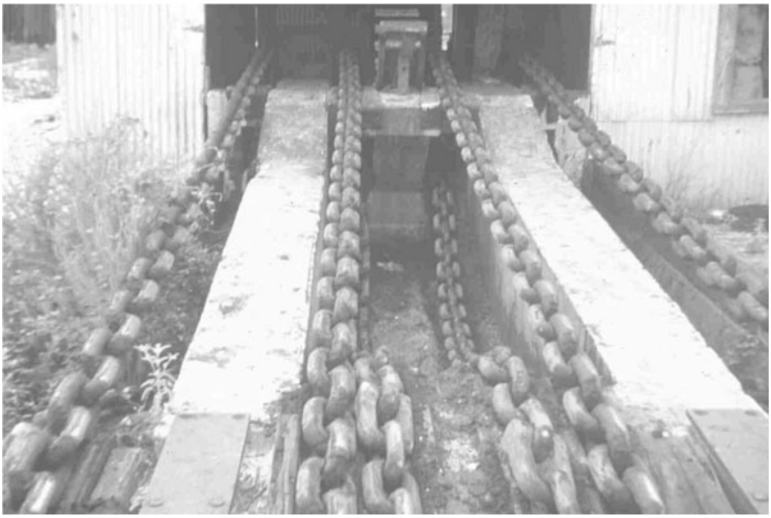


Figure 2-23. Loose hauling chain (right). Courtesy of Heger Dry Dock, Holliston, MA.

(G) The underwater sheave cases, sheaves, and pins shall be visually inspected. If excessive wear of the sheave pins is suspected, the sheave cases should be brought to the surface and disassembled for closer inspection.

(H) Verify that the chain system is properly tensioned (Figs. 2-22 and 2-23).

For marine railways that operate with a wire rope hauling system, the following shall be inspected:

(A) Visually inspect the wire in accordance with ASME B30.5-2007.
(B) If the haul in wire is 10 or more years old, or if it shows visible signs of wear, the wire rope shall be replaced.
(C) If the haul-out wire is 10 or more years old, or if it shows visible signs of wear, the haul-out wire shall be replaced.
(D) The connection of the haul-in wire to the cradle shall be visually inspected.
(E) The connection of the haul-out wire to the cradle shall be visually inspected.
(F) The underwater sheave cases, sheaves, and pins, if so equipped, shall be visually inspected. If excessive wear of the sheaves or sheave pins is suspected, the sheave cases should be brought to the surface and disassembled for closer inspection.

2.5.3.6 Inspection of Hauling Machine. The hauling machine shall be observed in operation throughout an entire cycle of haul-out and haul-in.

2.5.3.7 Line, Grade, and Gauge Survey of Rails. A detailed line, grade, and gauge survey of the track (using surveyor's instruments) shall be taken at least once every 5 years or if unusual wear of rails, plates, wheels, rollers, and so forth is observed.

The top of rail elevation (grade) shall be measured at 10-foot intervals along each rail of the track.

Line shall be measured at 20-foot intervals along each rail of the track.

The distance between rail centerlines (gauge) shall be measured at 20-foot intervals along the track.

The results of the survey shall be presented graphically.

2.5.3.8 Visual Survey of Blocks. The condition of the blocking system should be visually assessed.

Check the timber for excessive crushing, warping, cracking, checking, rot, or wear from fasteners. Check for loss of contact at edges. In general, minor cracking is acceptable unless bearing area has been lost.

If the blocks have concrete bases, check the concrete for cracking, spalling, and exposed rebar.

If the blocks have steel bases, check the steel for loss of metal thickness by corrosion, cracks, cracked welds, and so forth.

Check the condition of fastenings. All timber should be adequately secured to prevent floating when the dock is submerged.

If the marine railway is equipped with hauling side blocks, the hauling block hardware shall be inspected. The hauling block hardware includes chains, sheaves, cranks, slides, and pawls.

2.5.3.9 Operational Tests. An operational test of all the marine railway's mechanical and electrical components shall be conducted by the shipyard and witnessed by the surveyor. The operational test shall include witnessing the following:

(A) Hauling machine
(B) Ammeters
(C) Limit switches
(D) Alarms
(E) Emergency backup power
(F) Winches
(G) Vessel centering system
(H) Lighting
(I) Fire-fighting system
(J) Cradle locks

2.5.3.10 Underwater Surveys. The survey shall include an underwater inspection of the submerged portions of the exposed foundation; track, chain, or wire rope system; and cradle.

2.5.3.11 Witness of Marine Railway in Operation. The surveyor should witness one complete cycling of the marine railway, running the cradle from its parked position to the end of the track and back to the parked position.

2.5.3.12 Thickness Measurements. Use UT measurements and/or calipers to physically measure steel thickness in areas of high corrosion.

The number and frequency of readings will vary as to the condition of the marine railway. Steel that still retains all of its protective coating, or steel with many holes through it, may require no readings because the condition is obvious. Steel that is questionable will require readings to establish remaining thickness. Steel that is due for repair may require many readings to establish the zones for replacement.

If UT measurements are required, a grid pattern shall be established and readings taken at those intervals. Examples are a reading every 10 feet longitudinally and 5 feet transversely on plate, or three readings on the web and flange of each vertical member (one each in the upper, middle, and lower zones). The engineer or naval architect in charge of the condition assessment shall establish the frequency and locations of measurements.

2.5.3.13 Hydrographic Survey. A hydrographic survey shall be conducted to establish available water depths between the cradle and open channel and to ensure that the elevation of the mud or silt is not higher than the track. The survey datum shall be clearly labeled with its reference elevation (e.g., mean low water, mean high water). The survey shall be conducted every 5 years unless local site conditions justify a longer or shorter frequency. A severe storm may warrant an updated hydrographic survey.

2.5.3.14 Checklists. See Appendix C for sample checklists that shall be used for summarizing the marine railway's condition. These checklists should be modified to reflect the actual components of the marine railway being surveyed. Each item shall be rated according to the following:

(A) Satisfactory (S): The condition of the item will not result in system damage and, based on measured or estimated deterioration rate, it may be expected to remain satisfactory until the next control inspection.
(B) Marginal (M): The condition of the item will not result in major damage or, by itself, it will not make the facility unsafe to dock a ship, provided it is corrected, repaired, or replaced in a timely manner. A number of such items as a group can make the facility unsafe. This shall be evaluated by the surveyor.
(C) Unsatisfactory (U): The condition of the item may cause system damage or loss and shall be corrected, repaired, or replaced immediately (if there is a ship in dock) or prior to docking a ship (if there is no ship in dock).
(D) Not Applicable (NA): The item listed in the checklist is not present on the marine railway. Note that as items are added, removed, or replaced from the marine railway, the inspection checklist shall be updated to reflect the configuration changes.
(E) Not Inspected (NI): The item was not inspected as part of the survey. It is not acceptable to mark an item NI unless there is a basis for expecting the item to be in a satisfactory condition.

2.5.3.15 Summary of Results. The surveyor shall prepare a written report summarizing the findings of the survey. The report shall include:

(A) Experience and qualifications of the surveyors
(B) Dates and major milestones of the survey
(C) Scope of the survey
(D) List of items not inspected and reasons why
(E) Condition report
(F) Results of line, grade, and gauge survey

(G) Checklists
(H) Corrective action plan for making any necessary repairs to the facility

2.5.4 Design Review

The purpose of the design review is to establish the operational limitations of the marine railway in its present condition. If the design calculations and operational limitations from the original designer exist and, in the opinion of the surveyor, the marine railway has not significantly deteriorated to the point that these operational limitations should be revised, then a new design review need not be performed and the original operational limitations used.

If, however, documentation for the original operational limitations does not exist, the marine railway's structure or equipment has deteriorated to the point where the original operational limitations are questionable, or the marine railway has been modified in any way, then a new design review may be required.

The design review consists of calculations to substantiate the operational limitations. The design review is conducted using the "as-is" condition of the facility as determined by the material condition survey.

For a marine railway, the design review will include:

(A) Capacity of foundation
(B) Capacity of track
(C) Structural strength of cradle
(D) Stability of cradle
(E) Local strength analyses
(F) Block loading calculations
(G) Capacity of hauling machine
(H) Capacity of wire rope or hauling chain
(I) Line, grade, and gauge tolerances

2.5.4.1 Capacity of Foundation. The maximum allowable wheel or roller loads that the foundation is capable of supporting shall be determined. This shall be checked against the maximum calculated loads induced on the foundation when docking a capacity vessel.

The loading on the foundation varies throughout the length of the track. At the end of the track, only the submerged weight of the cradle needs to be supported. As the cradle moves inshore and comes in contact with the vessel, the vessel's weight is gradually transferred onto the cradle. At the point where the ship's keel breaks the water, its full weight is on the cradle and the remaining portion of the track and foundation must be designed for this condition. The foundation under the cradle in

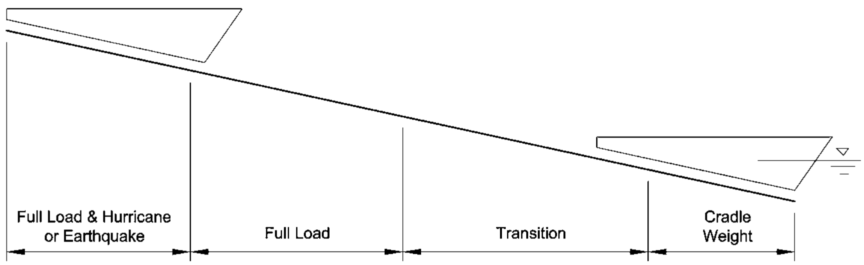


Figure 2-24. Typical zones of foundation and track loads.

the full-up condition shall also be investigated for additional loads induced by extreme winds or earthquakes with a capacity vessel aboard (Fig. 2-24).

2.5.4.2 Capacity of Track. The maximum allowable wheel or roller loads that the track is capable of supporting shall be determined. This shall be checked against the maximum calculated loads induced on the track when docking a capacity vessel.

2.5.4.3 Structural Strength of Cradle. The ability of the cradle to support the maximum rated loads shall be verified by structural analyses of:

(A) Cradle beams
(B) Cradle columns
(C) Bottom chords
(D) Wheels or rollers

An example of a marine railway cradle configuration is shown in Fig. 2-25.

2.5.4.4 Stability of Cradle. The ability of the cradle to resist overturning in high winds or earthquake loading shall be determined.

2.5.4.5 Block Loading Analyses. A description of the blocking system shall be provided. Calculations shall show the blocks are stable and structurally adequate to support the rated load per block. Calculations shall include:

(A) Allowable bearing pressure on timber times bearing area
(B) Structural strength of block base unit

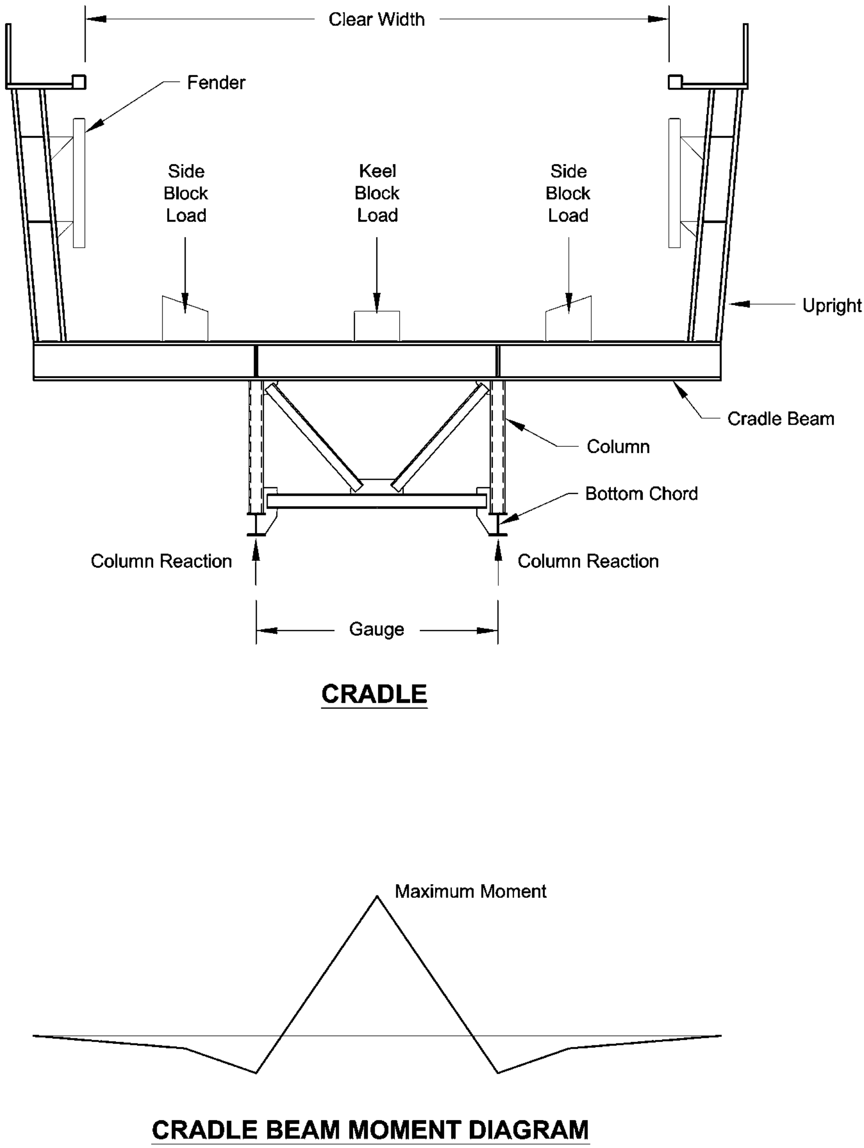


Figure 2-25. Marine railway cradle loading.

(C) Local structural strength of dock structure directly supporting blocks

Calculations shall be done for both keel blocks and side blocks, and a rated block load for each determined.

2.5.4.6 Capacity of Hauling Machine. The maximum allowable line pull on the hauling machine shall be determined.

2.5.4.7 Capacity of Wire Rope or Hauling Chain. For facilities designed with a wire rope hauling system, the allowable line pull on the wire rope shall be determined by the wire rope manufacturer's specified safe working load. Deteriorated wire rope shall be inspected and replaced in accordance with ASME B30.5-2007.

For facilities designed with a chain hauling system, the allowable line pull on the chain shall be calculated using a minimum cross-sectional chain link area as defined by the surveyor. This is the chain link area that is required to haul a capacity vessel. The surveyor shall recommend the periodicity of a maintenance task to inspect the chain to ensure that the chain maintains adequate section.

2.5.5 Summary of Findings, Evaluation, and Recommendations

Results of the design review shall be summarized in a written report.

2.5.5.1 Purpose of Assessment. In general, the purpose of the initial condition assessment is to determine the marine railway's existing condition and establish operational limitations that the dock operators can employ when operating the marine railway. There may be other reasons for conducting a condition assessment, including evaluation for insurance purposes, appraisal, commercial certification, accident investigation, and so forth.

The purpose of the condition assessment shall be stated in the report.

2.5.5.2 Scope of Investigation. The scope of the investigative work performed for the assessment shall be listed, including:

(A) Names of key people involved
(B) Dates and extent of surveys and tests
(C) Original documents reviewed
(D) Original design calculations reviewed
(E) New calculations performed
(F) New drawings and specifications developed

2.5.5.3 Description of Structure. A general description of the structure shall be given. The description shall include type of marine railway, materials of construction, principal dimensions, and location of facility.

2.5.5.3.1 Dates of Construction, Modifications, and Repairs. Any information available on the dates of construction and/or dates and extent of modifications and repairs should be included.

2.5.5.3.2 History. Any pertinent history that is available on the marine railway should be included. This may include name of designer, name of builder, list of vessels drydocked, relocations, and a list of major storms, earthquakes, or accidents that the marine railway has experienced.

2.5.5.3.3 Design Data. Information accumulated and developed during the survey and assessment shall be included in the report. This may include drawings, specifications, descriptions, photographs, design calculations, and so forth.

2.5.5.4 Material Condition Survey

2.5.5.4.1 Scope of Survey. The scope of the material condition survey shall be listed, including:

(A) Names of surveyors
(B) Dates of surveys and tests
(C) Specific items inspected
(D) Tests performed
(E) Data collected, including UT measurements, photographs, videos, etc.

2.5.5.4.2 Qualifications of Survey Team. The qualifications of the surveyors and members of the survey team shall be stated.

Each team member involved in the survey shall possess the technical qualifications, including practical experience, education, and professional judgment, required to perform the individual tasks assigned. A professional engineer experienced in the design and inspection of marine railway dry docks shall be in charge of the survey team.

Résumés of key people shall be included.

2.5.5.4.3 Results of Survey. The results of the material condition survey conducted in accordance with 2.5.3 shall be included. This typically includes the checklist and a discussion of the results.

2.5.5.4.4 Photographs. Photographs and video recordings may be included in the report.

2.5.5.5 Design Review

2.5.5.5.1 Scope of Design Review. The scope of the design review shall be summarized.

2.5.5.5.2 Calculations. Calculations as required in 2.5.4 shall be included.

2.5.5.6 Recommended Operational Limitations. The report shall clearly summarize the operational limitations of the marine railway.

The operational limitations will be used by the dock operator when operating the marine railway. It will be his responsibility not to exceed these limitations.

Operational limitations shall be set such that there is no danger to the dock or ship in dock if the operator does not exceed these limitations.

2.5.5.6.1 Overall Lift Capacity. The overall lift capacity of the dock shall be stated.

The overall lift capacity shall be based on the lesser of:

(A) The capacity of the hauling system, or
(B) The rated load per foot capacity times the available keel blocking length, or
(C) Maximum weight ship due to cradle stability requirements.

When determining the overall capacity of the dock, it is important to establish the maximum coefficient of friction for the wheel or roller system (Fig. 2-26). The coefficient of friction may vary depending on the condition

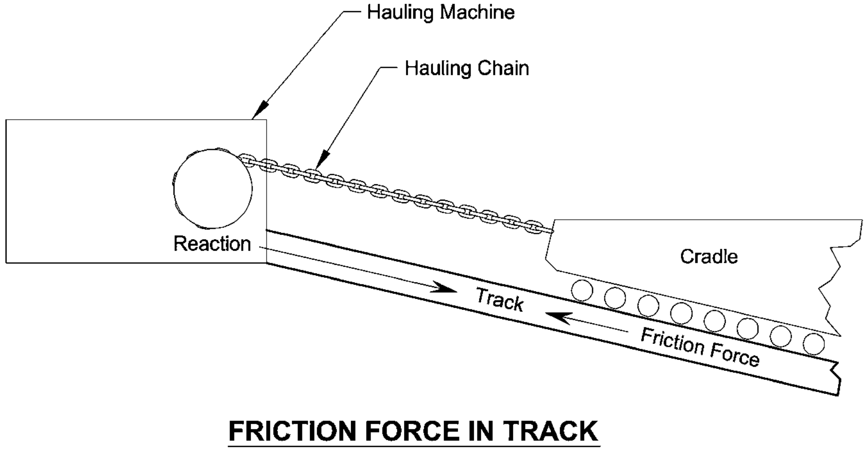


Figure 2-26. Marine railway forces.

of the wheels or rollers, condition of the track, alignment of the track, or mud and debris on track.

2.5.5.6.2 Load per Foot Capacity. The rated load per foot capacity of the dock shall be stated.

The rated load per foot capacity shall be the lesser of:

(A) Capacity of cradle structure to support maximum rated line load, or
(B) Capacity of track structure to support maximum rated line load, or
(C) Capacity of foundation to support maximum rated line load, or
(D) Keel block capacity.

2.5.5.6.3 Block Load Limits. The rated load per keel block shall be stated.

The rated load per keel block shall be the lesser of:

(A) Allowable bearing pressure on timber times bearing area, or
(B) Structural strength of block base unit, or
(C) Local structural strength of dock structure directly supporting blocks.

The rated load per side block shall be stated.

The rated load per side block shall be the lesser of:

(A) Allowable bearing pressure on timber times bearing area, or
(B) Structural strength of block base unit, or
(C) Local structural strength of dock structure directly supporting blocks.

2.5.5.6.4 Maximum Water Depth over the Keel Blocks. The maximum water depth over the keel blocks shall be stated relative to a specific tide level (e.g., mean low water, mean high water).

2.5.5.6.5 Allowable Deck Loading. The maximum allowable cradle deck loadings in pounds, kips, or tons per square foot shall be stated.

The maximum allowable cradle deck vehicle loadings shall be stated if the deck is to be used for vehicles such as material handling equipment or aerial manlifts.

2.5.5.7 Recommended Future Surveys. A recommendation on the frequency and scope of future surveys should be made based on the condition of the marine railway. Upon sale or lease of a marine railway, a condition assessment shall be performed.

2.6 CONDITION ASSESSMENT OF VERTICAL LIFTS

2.6.1 Qualifications and Equipment

2.6.1.1 Personnel Qualifications. All personnel involved in the condition assessment shall possess the technical qualifications, including practical experience, education, and professional judgment, required to perform the individual tasks assigned. Interpretation of results and conclusions shall be performed by a professional engineer or naval architect experienced in the design and inspection of vertical lifts.

2.6.1.2 Equipment. Equipment shall be obtained as appropriate to accomplish or perform the various tests and inspections specified in this manual of practice. All equipment shall be in good working order. For equipment that can be calibrated, calibration shall be current and reports of calibration shall be available for owner review.

2.6.2 Design Data: Document Review

Documents governing or prepared for the original design and construction, rehabilitation, alteration, or repair of the facility shall be reviewed, if available.

The design data required will vary depending on the type of vertical lift being reviewed. In general, the design data will include:

(A) General arrangement of the vertical lift
(B) Structural drawings and specifications
(C) Mechanical drawings and specifications
(D) Electrical drawings and specifications
(E) System descriptions
(F) Operating manual/procedures
(G) Hydrographic data
(H) Soils information
(I) Environmental data
(J) Design calculations
(K) Design ship data

2.6.3 Material Condition Survey

A material condition survey is required to establish the existing condition of the facility. The survey must be detailed enough to ascertain the actual condition of all critical components of the facility and verify that the design data are valid.

In general, the survey will include:

(A) Visual survey of support piers and piles
(B) Visual survey of platform
(C) Inspection of wire ropes or chains
(D) Inspection of lifting hoists
(E) Visual survey of blocking and transfer cradles
(F) Witness operational test of all critical mechanical and electrical components
(G) Witness operational test of all control systems
(H) Underwater inspection of submerged portions of the vertical lift
(I) Witness of the vertical lift in operation
(J) Verify that cathodic protection is operational
(K) UT or other measurements to establish extent of corrosion
(L) Hydrographic survey

The condition of the structural steel, concrete, and/or timber shall be assessed in accordance with ASCE/SEI 11-99, *Condition assessment of existing buildings* (2000).

2.6.3.1 Survey of Support Piers and Piles. The support piers and piles shall be inspected for signs of corrosion, deterioration, failure from overload, and other problems. Excavation of the below-grade foundation is usually not required unless foundation failure is suspected.

2.6.3.2 Survey of Platform. All structural elements of the cradle shall be visually inspected for corrosion; cracked, bent, or buckled members; or rotted or broken timbers.

2.6.3.3 Inspection of Wire Rope Lifting System. For vertical lifts that operate with a wire rope lifting system, the following shall be inspected:

(A) Visually inspect the wire in accordance with ASME B30.5-2007.
(B) If the lifting wire is 10 or more years old, or if it shows visible signs of wear, the wire rope shall be replaced.
(C) The connection of the lifting wire to the platform shall be visually inspected.
(D) The sheave cases, sheaves, and pins, if so equipped, shall be visually inspected. If excessive wear of the sheaves or sheave pins is suspected, the sheave cases should be disassembled for closer inspection.

2.6.3.4 Inspection of Lifting Hoists. The lifting hoist shall be observed in operation throughout an entire cycle of lowering and raising the platform.

2.6.3.5 Visual Survey of Blocks. The condition of the blocking system should be visually assessed.

Check the timber for excessive crushing, warping, cracking, checking, rot, or wear from fasteners. Check for loss of contact at edges. In general, minor cracking is acceptable unless bearing area has been lost.

If the blocks have concrete bases, check the concrete for cracking, spalling, and exposed rebar.

If the blocks have steel bases, check the steel for loss of metal thickness by corrosion, cracks, cracked welds, and so forth.

Check the condition of fastenings. All timber shall be adequately secured to prevent floating when the platform is submerged.

If the vertical lift is equipped with hauling side blocks, the hauling block hardware shall be inspected. The hauling block hardware includes chains, sheaves, cranks, slides, and pawls.

2.6.3.6 Operational Tests. An operational test of all the vertical lift's mechanical and electrical components shall be conducted by the shipyard and witnessed by the surveyor. The operational test shall include witnessing the following:

(A) Lifting hoist
(B) Ammeters
(C) Limit switches
(D) Alarms
(E) Emergency backup power
(F) Vessel handling system
(G) Lighting
(H) Fire-fighting system
(I) Platform locks

2.6.3.7 Underwater Surveys. The survey shall include an underwater inspection of the submerged portions of the facility.

2.6.3.8 Witness of Vertical Lift in Operation. The surveyor should witness one complete cycling of the vertical lift, running the platform from the raised position to its maximum depth and back to the raised position. The synchronization of the hoists is a key characteristic to observe as this is essential for the safe operation of the vertical lift.

2.6.3.9 Thickness Measurements. Use UT measurements and/or calipers to physically measure steel thickness in areas of high corrosion.

The number and frequency of readings will vary as to the condition of the vertical lift. Steel that still retains all of its protective coating or steel with many holes through it may require no readings because the condition is obvious. Steel that is questionable will require readings to establish remaining thickness. Steel that is due for repair may require many readings to establish the zones for replacement.

If UT measurements are required, a grid pattern shall be established and readings taken at those intervals. Examples are a reading every 10 feet longitudinally and 5 feet transversely on plate, or three readings on the web and flange of each vertical member (one each in the upper, middle, and lower zones). The engineer or naval architect in charge of the condition assessment shall establish the frequency and locations of measurements.

2.6.3.10 Hydrographic Survey. A hydrographic survey under the platform shall be conducted to ensure a minimum clearance below and around the platform of at least 12 inches when the platform is fully lowered. The survey datum shall be clearly labeled with its reference elevation (e.g., mean low water, mean high water). The survey shall be conducted every 5 years unless local site conditions justify a longer or shorter frequency. A severe storm may warrant an updated hydrographic survey.

2.6.3.11 Checklists. See Appendix D for sample checklists that shall be used for summarizing the vertical lift's condition. These checklists should be modified to reflect the actual components of the dock being surveyed. Each item shall be rated according to the following:

(A) Satisfactory (S): The condition of the item will not result in system damage and, based on measured or estimated deterioration rate, it may be expected to remain satisfactory until the next control inspection.
(B) Marginal (M): The condition of the item will not result in major damage or, by itself, it will not make the facility unsafe to dock a ship, provided it is corrected, repaired, or replaced in a timely manner. A number of such items as a group can make the facility unsafe. This shall be evaluated by the inspector.
(C) Unsatisfactory (U): The condition of the item may cause system damage or loss and shall be corrected, repaired, or replaced immediately (if there is a ship in dock) or prior to docking a ship (if there is no ship in dock).
(D) Not Applicable (NA): The item listed in the checklist is not present on the vertical lift. Note that as items are added, removed, or replaced from the vertical lift, the inspection checklist shall be updated to reflect the configuration changes.
(E) Not Inspected (NI): The item was not inspected as part of the survey. It is not acceptable to mark an item NI unless there is a basis for expecting the item to be in a satisfactory condition.

2.6.3.12 Summary of Results. The surveyor shall prepare a written report summarizing the findings of the survey. The report shall include:

(A) Experience and qualifications of the surveyors
(B) Dates and major milestones of the survey
(C) Scope of the survey
(D) List of items not inspected and reasons why
(E) Condition report
(F) Results of line, grade, and gauge survey
(G) Checklists
(H) Corrective action plan for making any necessary repairs to the facility.

2.6.4 Design Review

The purpose of the design review is to establish the operational limitation of the vertical lift in its present condition. If the design calculations and operational limitations from the original designer exist and, in the opinion of the surveyor, the vertical lift has not significantly deteriorated to the point that these operational limitations should be revised, then a new design review need not be performed and the original operational limitations may be used.

If, however, documentation for the original operational limitations does not exist, the vertical lift's structure or equipment have deteriorated to the point where the original operational limitations are questionable, the vertical lift has been modified in any way, or the vertical lift's area of operation has been changed, then a new design review may be required.

The design review consists of calculations to substantiate the operational limitations. The design review is conducted using the "as-is" condition of the facility as determined by the material condition survey.

For a vertical lift, the design review will include:

(A) Capacity of foundation
(B) Capacity of support piers
(C) Structural strength of platform
(D) Block loading calculations
(E) Capacity of lifting hoist
(F) Capacity and operational requirements of wire ropes

Figure 2-27 shows the arrangement of a typical vertical lift.

2.6.4.1 Capacity of Foundation. The maximum allowable hoist loads that the foundation is capable of supporting shall be determined. This

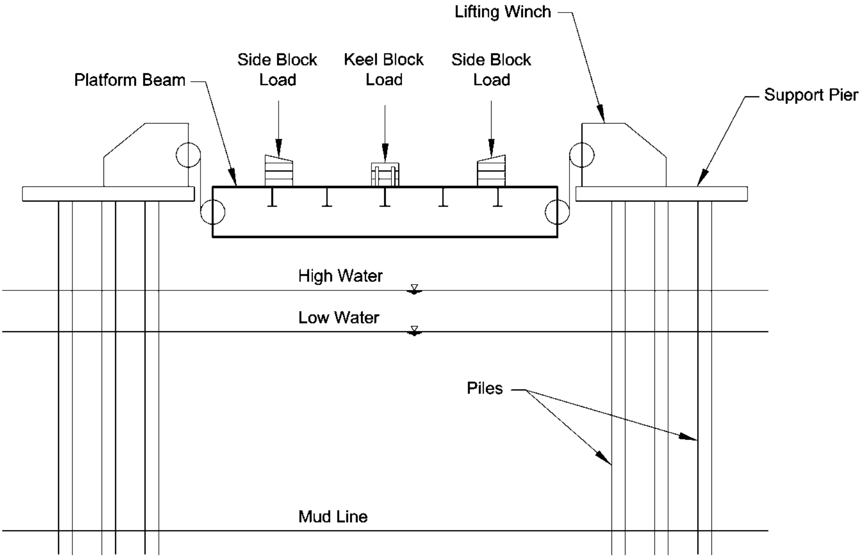


Figure 2-27. Vertical lift cross section.

shall be checked against the maximum calculated loads induced on the foundation when docking a capacity vessel.

2.6.4.2 Capacity of Support Piers. The maximum allowable hoist loads that the support piers are capable of supporting shall be determined. This shall be checked against the maximum calculated loads induced on the foundation when docking a capacity vessel.

2.6.4.3 Structural Strength of Platform. The ability of the platform to support the maximum rated loads shall be verified by structural analyses.

2.6.4.4 Block Loading Analyses. A description of the blocking system shall be provided. Calculations shall show the blocks are stable and structurally adequate to support the rated load per block. Calculations shall include:

(A) Allowable bearing pressure on timber times bearing area
(B) Structural strength of block base unit
(C) Local structural strength of dock structure directly supporting blocks

Calculations shall be done for both keel blocks and side blocks, and a rated block load for each determined.

2.6.4.5 Capacity of Lifting Hoist. The maximum allowable line pull on the lifting hoists shall be determined.

2.6.4.6 Capacity and Operational Requirements of Wire Ropes. The capacity of wire rope lifting system and the allowable line pull on the wire rope shall be determined.

2.6.5 Summary of Findings, Evaluation, and Recommendations

Results of the design review shall be summarized in a written report.

2.6.5.1 Purpose of Assessment. In general, the purpose of the initial condition assessment is to determine the vertical lift's existing condition and establish operational limitations that the dock operators can employ when operating the vertical lift. There may be other reasons for conducting a condition assessment, including evaluation for insurance purposes, appraisal, commercial certification, accident investigation, and so forth.

The purpose of the condition assessment shall be stated in the report.

2.6.5.2 Scope of Investigation. The scope of the investigative work performed for the assessment shall be listed, including:

(A) Names of key people involved
(B) Dates and extent of surveys and tests
(C) Original documents reviewed
(D) Original design calculations reviewed
(E) New calculations performed
(F) New drawings and specifications developed

2.6.5.3 Description of Structure. A general description of the structure shall be given. The description should include type of vertical lift, materials of construction, principal dimensions, and location of facility.

2.6.5.3.1 Dates of Construction, Modifications, and Repairs. Any information available on the dates of construction and/or dates and extent of modifications and repairs should be included.

2.6.5.3.2 History. Any pertinent history that is available on the vertical lift should be included. This may include name of designer, name of builder, list of vessels drydocked, and a list of major storms, earthquakes, or accidents that the vertical lift has experienced.

2.6.5.3.3 Design Data. Information accumulated and developed during the survey and assessment shall be included in the report. This may include drawings, specifications, descriptions, photographs, design calculations, and so forth.

2.6.5.4 Material Condition Survey

2.6.5.4.1 Scope of Survey. The scope of the material condition survey shall be listed, including:

(A) Name of surveyors
(B) Dates of surveys and tests
(C) Specific items inspected
(D) Tests performed
(E) Data collected, including UT measurements, photographs, videos, etc.

2.6.5.4.2 Qualifications of Survey Team. The qualifications of the surveyors and members of the survey team shall be stated.

Each team member involved in the survey shall possess the technical qualifications, including practical experience, education, and professional judgment, required to perform the individual tasks assigned. A professional engineer experienced in the design and inspection of the applicable type of vertical lift shall be in charge of the survey team.

Résumés of key people shall be included.

2.6.5.4.3 Results of Survey: Check-Off Sheet. The results of the material condition survey conducted in accordance with 2.6.3 shall be included.

2.6.5.4.4 Photographs. Photographs and video recordings may be included in the report.

2.6.5.5 Design Review

2.6.5.5.1 Scope of Design Review. The scope of the design review shall be summarized.

2.6.5.5.2 Calculations. Calculations as required in 2.6.4 shall be included.

2.6.5.6 Recommended Operational Limitations. The report shall clearly summarize the operational limitations of the lift.

The operational limitations will be used by the dock operator when operating the vertical lift. It will be his responsibility not to exceed these limitations.

Operational limitations shall be set such that there is no danger to the vertical lift or ship in dock if the operator does not exceed these limitations.

2.6.5.6.1 Maximum Lift Beam Capacity. The maximum allowable live load per lift beam shall be stated. The allowable distribution of the load on the beam shall also be stated.

The maximum allowable live load per lift beam shall be based on the lesser of:

(A) The strength of the lift beam, or
(B) The capacity of the wire rope and sheave system, or
(C) The strength of the connection of the wire rope to the lift beam, or
(D) The capacity of the hoist, or
(E) The capacity of the pier and foundation to support the hoist loads.

2.6.5.6.2 Load per Foot Capacity. The rated load per foot capacity of the dock shall be stated.

The rated load per foot capacity shall be the lesser of:

(A) The maximum allowable live load per lift beam divided by the beam spacing, or
(B) Keel block or transfer car capacity.

2.6.5.6.3 Block Load Limits. The rated load per keel block shall be stated.

The rated load per keel block shall be the lesser of:

(A) Allowable bearing pressure on timber times bearing area, or
(B) Structural strength of block base unit, or
(C) Local structural strength of dock structure directly supporting blocks.

The rated load per side block shall be stated.

The rated load per side block shall be the lesser of:

(A) Allowable bearing pressure on timber times bearing area, or
(B) Structural strength of block base unit, or
(C) Local structural strength of dock structure directly supporting blocks.

2.6.5.6.4 Maximum Water Depth over the Platform, Transfer System, or Keel Blocks. The maximum water depth over the keel blocks shall be stated relative to a specific tide level (e.g., mean low water, mean high water).

2.6.5.6.5 Allowable Deck Loading. The maximum allowable platform deck loadings in pounds, kips, or tons per square foot shall be stated.

The maximum allowable platform deck vehicle loadings shall be stated.

2.6.5.7 Recommended Future Surveys. A recommendation on the frequency and scope of future surveys should be made based on the condition of the vertical lift. Upon sale or lease of a vertical lift, a condition assessment shall be performed.

3

MAINTENANCE

3.1 INTRODUCTION

The dry dock operator shall have an active maintenance program that manages planned, unplanned, and preventive maintenance activities. Adopting a proactive approach in maintenance reinforces safety, reduces downtime, and minimizes costs associated with equipment failures. A sound maintenance program also provides the customer with a high level of confidence that the dry dock operator can safely and cost-effectively support their vessel during its lay period.

The maintenance program for a drydocking facility should be no different than that of a typical manufacturing or industrial facility. In fact, a dry dock maintenance program lends itself well to being an extension of the company's current maintenance program which is typically built around its enterprise. Regardless of whether the equipment is a milling machine, a built-up roof system, or a dry dock dewatering pump, the maintenance process for ensuring equipment reliability is equivalent. Therefore, this manual of practice assumes that the dry dock owner currently has an active maintenance program in place. Furthermore, it is not the intent of this document to dictate a specific maintenance organizational structure or policy. That is a business decision left to the dry dock owner (Narayan et al. 2008; Kelly 2006; Kister and Hawkins 2006). At a minimum, the dry dock owner shall have a maintenance organization complemented by an engineering organization. These functions may be served by either shipyard personnel or contractors.

3.2 MAINTENANCE STRATEGIES

The maintenance strategies for all dry dock components shall be categorized into one of the four maintenance strategies (Wireman 2008):

(A) Preventive maintenance (PM) includes lubrication, regular service, inspections, and minor adjustments.
(B) Predictive maintenance (PdM) techniques include the use of sonics, oil analysis, thermography, and vibration analysis to check the health of a system or equipment.
(C) Condition-based maintenance (CBM) uses real-time technologies or modeling to accomplish the PdM techniques described above.
(D) Run-to-failure (RTF) is only used when the techniques described above are not feasible and failure does not cause detriment to safety, cost, or production.

3.3 CONDITION-BASED MAINTENANCE

Traditionally, time-directed maintenance (TDM) has been the norm where predesigned plans initiate maintenance activities on facilities on a periodic basis. TDM requires securing the system at regular intervals to perform intrusive and often costly component replacement (Sun and Bai 2003). The periodicities are somewhat subjective and are based on failure history, experience, and judgment or vendor recommendation.

Recently, condition-based maintenance (CBM) has gained recognition and wide acceptance in diverse industries as a more favorable maintenance strategy than TDM. The basic CBM model is most commonly a reliability index model (Bengtsson 2004). A preventive maintenance level is set and based on an acceptable risk of failure for the system or component (Frangopol et al. 2004). Over time, the system or component will deteriorate (or wear) and reliability will decrease, approaching the preventive maintenance (PM) level. At the specified PM level, an action event triggers planned maintenance well in advance of the failure level. Similar to TDM, inspection of the system is performed at fixed time intervals. However, the inspections are typically less intrusive and therefore less costly and disruptive to production.

An objective of this manual of practice is to introduce new maintenance technologies that support the migration of maintenance strategies away from TDM and toward CBM. By adopting a reliability-centered maintenance (RCM) culture, the dry dock owner can employ a number of nondestructive predictive maintenance (PdM) tools to optimize dry dock asset performance (Kister and Hawkins 2006). For example, vibration analysis can be used on dewatering pumps to detect abnormalities in pump vibration signatures that could signal abnormal shaft wear or misalignment conditions in advance of failure. Another PdM tool is temperature analysis (or thermography) for electric motors to detect out-of-tolerance operating temperatures that signify the initiation of bushing wear. Oil analysis (or tribology) on gear box greases and oils, such as in capstans, is an effective means of determining the existence of foreign particles in the lubricant, possibly warning of excessive mechanical part wear.

The objective of an effective RCM program is to reduce the number of run-to-failure (RTF) occurrences. RTF maintenance leads to costly repairs and unnecessary asset down time. However, for non-critical, low cost assets where component redundancy exists, RTF may be a viable maintenance strategy. For example, a dry dock area lighting system can be designed using a RTF maintenance strategy where the loss of a single light fixture is not detrimental to dry dock operations. The dry dock owner is responsible for determining the criticality of each dry dock component, asset, or system and assigning the appropriate risk and maintenance strategy.

3.4 MAINTENANCE ORGANIZATION

The maintenance organization shall be either a department of the shipyard or a contractor to the shipyard experienced in maintaining waterfront facilities. It shall have sufficient, trained staff available to carry out all the scheduled maintenance as well as any emerging, unscheduled repairs. Additionally, the maintenance organization shall have access to contractors to assist, as necessary, on certain specialized tasks or labor-intensive tasks. All maintenance and operating personnel are responsible for reporting all breakdowns or unusual occurrences, which will be recorded for use in work package development as well as root cause failure/common mode failure analysis.

3.5 ENGINEERING ORGANIZATION

The engineering organization shall be either a department of the shipyard or a contractor to the shipyard experienced in designing and maintaining waterfront or marine-type facilities. It shall have competency in structural, mechanical, electrical, and controls engineering disciplines. The engineering organization is responsible for all technical aspects such as drawings, specifications, calculations, and equipment operating procedures. It provides technical direction for the maintenance organization as needed, reviews maintenance histories, creates preventive maintenance work packages, sets and monitors periodicities, conducts root cause failure/common mode failure analysis, and oversees major facility repairs and overhauls.

3.6 PLANNING ORGANIZATION

The planning organization is optional, depending on the size of the facility. If it is deemed that a formal planning organization is unnecessary, the engineering organization shall be responsible for planning duties. The planning organization shall be responsible for scoping work, work package development, backlog management, and scheduling all planned (including PMs) and unplanned work. The planning organization also ensures that all material and tools are available before scheduling the work. It is responsible for monitoring the maintenance backlog and reporting when additional resources are needed to maintain a manageable work backlog.

3.7 COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM

Tying the maintenance, engineering, planning, and operational organizations together is critical for program success. All maintenance and repair requirements, including scheduled preventive maintenance, control inspection deficiencies, and operational deficiencies, must be tracked from identification through resolution by the maintenance management system. A computerized maintenance management system (CMMS) is a powerful collaboration tool for the planning and scheduling of planned, unplanned, and PM activities. It also provides a central repository for storing work history, failure history, and cost information (Palmer 1999; Levitt 2008). The CMMS identifies the availability of personnel, parts, and materials to perform each task. When integrated with the shipyard's enterprise system, the CMMS becomes the central focus for managing all maintenance activities. Although this manual of practice does not require the use of a CMMS, it is strongly recommended. A complete CMMS consists of the following system components:

3.7.1 Work Management

(A) Notifications: Documentation of difficiencies and failure codes
(B) Work Orders: The actual work package from which craft personnel receive direction, and provides the charging mechanisim
(C) Maintenance Planning: For managing work backlog and scheduling work

(D) Preventive Maintenance: Contains preplanned work packages that automatically issue prior to the required periodicities

3.7.2 Materials Management

(A) Spare Parts: Both critical and noncritical parts
(B) Stock Models: Management of in-stock and consumable supplies
(C) Inventory Management: Asset management and cost control
(D) Requisition: Purchase mechanism for vendor services and parts not in inventory
(E) Bills of Material: Identify all material (stock and nonstock) associated with a particular work package

3.8 PERIODICITIES

Appendices E through H provide example tables of recommended preventive maintenance periodicities for equipment typically found on floating dry docks, graving docks, marine railways, and vertical lift systems, respectively. The periodicities are only suggested starting points and are to be used only when engineering judgment is unclear or the manufacturer's data or historical information are unavailable.

3.9 MATERIALS MANAGEMENT

The maintenance organization shall be responsible for ensuring that required parts and spares are available prior to carrying out all planned maintenance tasks. A task window shall be the earliest and latest time that any planned task is scheduled. The maintenance organization shall also ensure, within reason, that sufficient parts are available for all emerging repairs (e.g., replacement light bulbs, fuses, shear pins).

Critical Spares: As determined by the common mode failure analysis conducted by engineering, critical spares shall be warehoused for equipment whose failure has a direct impact on safety, production, or cost. Preventive maintenance on critical spares shall be conducted as necessary, such as exercising electric motors in long-term storage by rotating the stators on a periodic basis.

3.10 RECORDS MANAGEMENT

The engineering organization shall be responsible for ensuring that all items are identified with unique identifiers (alpha/numeric) such that a record of all maintenance and repairs are kept for each item through the life of the asset. The engineering organization is responsible for maintaining the maintenance records. In the case of a contract maintenance organization, the maintenance records shall be kept by the contractor but shall remain the property of the shipyard. All organizations (maintenance, engineering, planning, and operations) are responsible for the timely reporting of deficiencies.

3.11 ROOT CAUSE ANALYSIS

For any dry dock system, asset, or operational failure that causes significant cost or delay to dry docking operations, a root cause analysis (RCA) shall be performed to identify and resolve the cause of failure. The definition of "significant cost or delay" is subjective and is ultimately defined by the dry dock owner. A rule of thumb is any accident, incident, or event that involves at least two or more levels management for resolution.

3.12 PERFORMANCE MEASURES

For any successful maintenance program, the dry dock owner must use dependable metrics for gauging its maintenance performance. There are two basic categories of performance measures: leading indicators and lagging indicators. *Leading Indicators* are used to predict how well the current resources allocated to maintenance activities are likely to influence the program. *Lagging Indicators* measure past performance of initiatives to assist in validating the current maintenance strategies (Kister and Hawkins 2006). Examples of common indicators are as follows.

3.12.1 Leading Indicators

3.12.1.1 Schedule Compliance. Schedule compliance is defined as completed scheduled man-hours versus total scheduled man-hours. It is a measure of the ability of the organization to manage scheduled work.

3.12.1.2 Backlog. Backlog is defined as the amount of identified work in the queues of the maintenance organization. For each work center, ready and total backlog are typically measured in man-hours (Kister and Hawkins 2006).

3.12.1.2.1 Ready Backlog. Ready backlog is work planned, material on-site, and ready to work. A healthy ready backlog for each work center should be 2 to 3 weeks.

3.12.1.2.2 Total Backlog. Total backlog is a measurement of all identified work (planned, unplanned, scheduled, and unscheduled). A healthy total backlog for each work center should be 4 to 6 weeks.

3.12.1.3 Age of Backlog. Age of backlog emphasizes those jobs that remain in the backlog for any length of time. The total backlog is typically categorized as under 30 days, 31 to 60 days, 61 to 90 days, 91 to 120 days, and more than 120 days old.

3.12.1.4 Preventive Maintenance On-Time Compliance. PM on-time compliance is defined as the number of PM work orders finished on time versus the number of PM work orders created. It is a measure of the organization's ability to perform PMs within the required periodicities.

3.12.1.5 Predictive Maintenance Monitoring. PdM monitoring identifies possible problems in equipment or a system during operation before a malfunction occurs. PdM monitoring techniques include vibration analysis, thermography, ultrasound, and lubricant analysis.

3.12.2 Lagging Indicators

3.12.2.1 Maintenance Spending. Maintenance spending is a measure of where current funding resources are being allocated. High maintenance spending on assets may indicate systemic issues with the equipment.

3.12.2.2 Training Schedule Compliance. Training schedule compliance measures how well craft personnel and supervisors are adhering to training schedules.

3.12.2.3 Downtime Percentage. Downtime percentage measures equipment downtime due to scheduled and unscheduled maintenance as a percentage of total operating time.

3.12.2.4 Mean Time Between Failure (MTBF). MTBF measures the average life span of equipment between failures.

3.12.2.5 Mean Time To Repair (MTTR). MTTR is the average amount of downtime required to repair broken equipment.

3.13 CONTINUOUS IMPROVEMENT

The PM program shall be evaluated on an annual basis to allow for continuous improvement of processes and to increase the overall effectiveness, detail, and quality of the program. The evaluation is typically accomplished through annual audits of maintenance records and operations, as well as research of repetitive problems encountered in the program.

3.13.1 Audits

3.13.1.1 Purpose of Audits. Audits shall be used to objectively assess and evaluate the PM program for efficiency, and to identify those facility items that are maintenance-delinquent and those items that require a maintenance program.

3.13.1.2 Audit Process. Auditing operations shall be conducted by a third party, independent of the organizations routinely involved in the maintenance program. The third party shall have working knowledge of, and previous experience with, dry docks and drydocking operations. The audits shall, at a minimum, consist of:

(A) Document review of routine maintenance logs for compliance with required maintenance schedules and procedures (i.e., checklist, if used)
(B) Field review of the routine maintenance procedures for a given facility or piece of equipment for compliance with the required maintenance procecedures
(C) Documentation and field review of completed work orders for compliance with recommended repairs, replacements, or special maintenance needs
(D) Documentation review of incomplete work orders, and causal evalution of the incompleteness

The audit shall report the findings of the review and provide recommendations for improving those areas found to be delinquent, noncompliant with the procedures, or incomplete.

3.13.2 Research and Innovation

Research and innovation are two key components for the constant improvement and evolution of any PM program. Research and innnovation can be used to address those items where PM could be beneficial. Examples of these items could include:

(A) Life cycle of subsurface timber piles
(B) Life cycle of soil anchors
(C) Marine corrosion prediction

3.14 RESTRICTIONS

Structural modifications or repairs shall not be performed while a structure is under load. For example, a truss member with material section loss in a floating dry dock pontoon may not be replaced while the dock is burdened with a vessel. There are two reasons for this:

(A) In the process of performing the repair, the structure may be compromised to the point where a failure may occur.
(B) When the structure is unloaded, residual stresses may develop because the new member was installed in the loaded condition.

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4

CONTROL INSPECTIONS

Control inspections shall be performed to record the condition of the facility, identify deficiencies, and to evaluate the effectiveness of preventive maintenance and deficiency correction procedures. Control inspections are intended to be relatively rapid but comprehensive periodic examinations of the entire facility. Control inspections as specified herein shall be performed as defined in this section.

4.1 FREQUENCY

Operators may deviate from the control inspection intervals specified below to accommodate dry dock operations or other significant conflicts that prevent accomplishment on schedule. Deferred control inspections shall be documented immediately and shall be accomplished at the first opportunity.

4.1.1 Structural

Structures shall be inspected annually. Structures include all parts of the facility that carry or transfer loads. Structures are commonly constructed from steel plate or shapes, concrete, or wood.

4.1.2 Visual and Operational (V&O)

Mechanical and electrical systems, equipment, and components shall be inspected and operationally tested at appropriate intervals. Typical intervals are provided in Appendices E through H. Cathodic protection systems shall be inspected where applicable.

4.1.3 Completeness

Structures and equipment that are inaccessible for inspection shall not be assumed to be satisfactory. A basis for acceptance of these areas, such as metrics or historical data, shall be established or the activity shall make them accessible for inspection. For example, structural members in the upper wing wall of a floating dry dock may need to be staged to provide for an effective inspection. Condition assessment and preventive maintenance records shall be reviewed prior to conducting control inspections to identify areas warranting closer attention during the inspection.

4.2 INSPECTION PERSONNEL

Control inspections may be conducted either by the operator's personnel or by contractors, who shall be individually qualified for their respective roles in such inspections. Inspectors shall have an engineering degree or an equivalent amount of relevant experience. Floating dry dock inspectors shall have experience in the design and operation of floating dry docks or in ship surveying. Inspection team members for graving docks, marine railways, and vertical lifts shall have experience in the design, operation, or inspection of that type of facility or similar type of structure. An individual team member for the underwater portion of the inspection shall have experience in at least two of the following areas: underwater salvage work, ship surveying, or underwater maintenance and repair of materials appropriate to the facility. A diver meeting the requirements of a recognized certification society for similar underwater inspection shall be considered to be qualified to perform the underwater portion of the survey. Control inspections shall be performed by personnel who are not accomplishing the routine maintenance of the facility.

4.3 INSPECTIONS RECORDS

Records, schedules, and other associated documentation shall be maintained. The qualifications of personnel conducting control inspections shall be kept on file with the facility operator. Inspection checklists similar to those illustrated in Appendices A through D, as applicable, shall be used to record inspection results. The checklists shall be modified to suit each facility and shall have sufficient detail to ensure representative inspection of all structures and mechanical and electrical equipment.

Structural members such as transverse and longitudinal strength members, and plating and framing for decks, bulkheads, and shells shall be listed individually by ballast tank, compartment, frame number, or other identifier. Mechanical and electrical equipment such as valves, pumps, and sluice gates shall also be listed individually. The grouping of items for an entire facility, such as "pontoon structure," "marine railway cradle structure," or "ballast valves," is insufficient. The necessity or urgency for correcting deficiencies shall be explained on the checklists. The following material condition ratings as shall be utilized:

(A) Satisfactory (S): The condition of the item will not result in system damage and, based on measured or estimated deterioration rate, it may be expected to remain satisfactory until the next control inspection.
(B) Marginal (M): The condition of the item will not result in major damage or, by itself, it will not make the facility unsafe to dock a ship, provided it is corrected, repaired, or replaced in a timely manner. A number of such items as a group can make the facility unsafe. This shall be evaluated by the inspector.
(C) Unsatisfactory (U): The condition of the item may cause system damage or loss and shall be corrected, repaired, or replaced immediately (if there is a ship in dock) or prior to docking a ship (if there is no ship in dock).
(D) Not Applicable (NA): The item listed in the checklist is not present on the dry dock. Note that as items are added, removed, or replaced from the dry dock, the inspection checklist shall be updated to reflect the configuration changes.
(E) Not Inspected (NI): The item was not inspected as part of the survey. It is not acceptable to mark an item NI unless there is a basis for expecting the item to be in a satisfactory condition.

4.4 CORRECTION OF DEFICIENCIES

All significant deficiencies identified during control inspections, including all deficiencies rated Marginal or Unsatisfactory, shall be added to the activity's maintenance management system and tracked in that system until the deficiency is corrected. The results of the control inspection shall be evaluated to determine whether there is a need to repeat the condition assessment.

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5

DOCK OPERATIONS

5.1 SCOPE OF DOCK OPERATIONS

This section of the manual defines the requirements to safely dock and undock vessels in floating dry docks, graving docks, marine railways, and vertical lifts. The requirements include documentation, operating procedures, manning, and personnel qualification procedures.

5.2 DOCUMENTATION

5.2.1 Docking Report

If contractually required, a report documenting the work performed on a vessel in dry dock shall be completed by the shipyard and submitted to the ship owner. The report shall, at a minimum, include the following information:

(A) Docking position of vessel
(B) Shipyard's Docking Plan
(C) Docking condition
  i. Docking drafts
  ii. Docking displacement
(D) Undocking condition
  i. Undocking drafts
  ii. Undocking displacement
(E) Underwater hull work
(F) Structural modifications
(G) Equipment changes

(H) Weight changes
(I) Condition of propulsion system
  i. Shaft alignment
  ii. Propeller condition
  iii. Rudder condition

5.2.2 Instructions for a Docking Facility

A dry dock facility shall develop, maintain, and implement a series of operating procedures for the safe use of the facility. This includes, but is not limited to, the normal operation of the facility as well as emergency procedures.

5.2.3 Emergency Procedures

A dry dock facility shall develop, maintain, and implement a series of emergency procedures for the rapid response to unexpected events. This includes, but is not limited to, heavy weather plans, casualty or damage control, and contingency plans for all docking operations.

5.2.4 Log Book

A dry dock log shall be maintained at the main control station for the purpose of recording all pertinent details regarding the use of the docking facility during all dock operations, including docking evolutions, lay-days, and periods when the dock is being maintained while not in use. The data contained within the log book shall include the following:

(A) Name of dock master
(B) Times for the commencement and completion of critical steps
(C) Tides
(D) Weather, including wind speed and direction and sea state, during docking evolutions
(E) Vessel and dock drafts, if applicable
(F) Type of power employed
(G) Casualties, if any
(H) Inoperable equipment

5.3 PRE-AWARD PROCEDURE

This procedure documents the capability of the shipyard's facility to adequately support and accommodate a specific class or type of vessel for the purpose of drydocking.

5.3.1 Vessel's Information

Request the following information necessary for generating a blocking plan and performing calculations from the ship owner:

(A) Vessel's Docking Plan
(B) Vessel's displacement and other curves of form (Hydrostatic Table)
(C) Vessel's Trim and Stability Booklet, if available
(D) Vessel's service requirements to include:
  i. Electrical shore power
  ii. Steam
  iii. Fresh water
  iv. Seawater cooling
  v. Fire main
(E) Dry dock report from prior drydocking to include:
  i. Place and date of last docking
  ii. Last docking position
  iii. Paint history
  iv. Data on ship alterations which may affect docking but are not shown in the vessel's Docking Plan

5.3.2 Blocking Calculations

Using the vessel's Docking Plan, the shipyard shall calculate the bearing load on the keel and side blocks, and confirm that these loads are within the acceptable limits of the dry dock as developed in the condition assessment. The shipyard shall submit to the ship owner a preliminary pre-award set of calculations to verify the capability of the dry dock to support the docking of a class or type of vessel.

5.3.2.1 Trapezoidal Block Load. The maximum anticipated keel line load in long tons per linear foot shall be verified to not exceed the capacity of the dry dock.

5.3.2.2 Average Block Load. The shipyard shall calculate the side block and keel block pressures. These values shall be compared to ensure the block pressures do not exceed the permissible compressive stress under normal loading conditions for the particular wood type and grade used, as indicated in the *National Design Specification (NDS) for Wood Structures* (ANSI/AF&PA NDS-2005). The proportional limit loads shall be used when calculating the block stress due to the overturning moment caused by extreme wind loads and seismic ground forces. Some typical blocking wood properties are shown in Table 5-1; more precise values for the species and grade of wood can be obtained in the NDS.

Table 5-1. Typical Blocking Wood Properties

Block Material	Permissible Compressive Stress Perpendicular to the Grain (psi)	Proportional Limit Perpendicular to the Grain (psi)
Douglas Fir	400	800
Red Oak	600	1,300
White Oak	600	1,300
Yellow Pine	300	700

5.3.2.3 Maximum Hull Pressure. The maximum hull pressure can be obtained from the ship owner's Docking Plan.

5.3.2.4 Wind and Seismic Side Block Requirements. Additional loading is imparted on the blocks due to extreme wind loads and seismic ground forces based on geographical location, as determined by ASCE/SEI 7-05 (ASCE 2006). The side blocks must be capable of distributing the overturning moment according to *Naval Ships' Technical Manual* (NSTM) S9086-7G-STM-010, Chapter 997, "Docking Instructions and Routine Work in Dry Dock" (NAVSEA 1996).

5.3.3 Overturning Moments

Overturning moments caused by extreme winds and seismic events shall be used to determine the minimum number of side blocks required.

5.3.4 Shipyard's Docking Plan

Using the vessel's Docking Plan, the shipyard shall develop an in-house Docking Plan to be submitted to the ship owner for approval. Based on the vessel–dock configuration, determine whether an alternate blocking plan that differs from the ship owner's Docking Plan is required. Unless otherwise contractually stated, the docking position should account for the previously docked positions to ensure that the vessel can be 100% paint coated. The shipyard's Docking Plan shall contain the information described in the following paragraphs.

5.3.4.1 Alternate Blocking Plan. An alternate blocking plan is required if the dock frame spacing differs from the vessel blocking plan spacing, if work items prevent the use of certain blocks, or if the vessel is damaged.

If an alternative blocking plan requires block placement other than where specified in the ship owner's Docking Plan, interpolation of side block heights may be required and the data shall be presented according to 5.3.4.5.

The new position of the side blocks must be checked to ensure that they fall under a strength point on the vessel (usually a longitudinal girder), and over a strength point on the dock (usually a transverse frame).

The new position of all blocks must be checked to ensure that they do not interfere with any underwater hull openings or protrusions in their new positions. The new position of the blocks should be cross-checked with the "Table of Hull Openings below the Projected Docking Waterline" described in Section 5.3.4.6.

5.3.4.2 Plan View of Dry Dock with Vessel Outline. The following information must be included in the shipyard's Docking Plan:

(A) Vessel outline shall include hull openings, appendages, and protuberances that may affect the docking.
(B) Longitudinal and transverse position of the vessel's docking reference point or stern reference point (SRP) from a fixed reference point on the dry dock.
(C) Blocking arrangement showing the longitudinal and transverse position, as well as spacing of the keel blocks and side blocks, from a fixed reference point on the dry dock.

5.3.4.3 Elevation View of Dry Dock with Vessel Outline. The following information must be included in the shipyard's Docking Plan:

(A) Dock draft at full submergence, showing waterline and freeboard for floating dry docks.
(B) Vessel outline shall include a partial body plan to include the aft perpendicular, forward perpendicular, mid-ship section, and all appendages and protuberances that may affect the docking. This includes but is not limited to ladders, propellers, and rudders.
(C) Afloat clearance from vessel hull or appendages, whichever is lower, to the highest block. A minimum clearance of 12 inches is required between the vessel and dock blocks during the docking evolution. In a floating dock, a minimum of 12 inches of clearance between the hull and harbor bottom shall be maintained. Clearances less than 12 inches are dangerous and should be considered only in emergency situations.
(D) Landed clearances from rudder and propeller(s) to the dock floor and clearances for shaft removal, if such work is to be performed.

5.3.4.4 Cross Section at Propeller(s)

(A) Afloat clearances from propeller(s) to the nearest block and any block the propeller(s) may pass entering or exiting the dock. A minimum clearance of 12 inches is required between the propeller(s), dock blocks, and dock floor during the docking evolution. In a floating dock, a minimum of 12 inches clearance between the hull and harbor bottom shall be maintained. Clearances less than 12 inches are dangerous and should be considered only in emergency situations.
(B) Landed clearances from propeller(s) to the dock floor and clearances for shaft removal, if such work is to be performed. Include details of typical sections showing buildup of keel blocks and side blocks. Details shall include baseline height, width and breadth of the block, and half-breadths.

5.3.4.5 Side Block Table of Offsets. This table is to include the distance to the aft face of each block from a fixed reference point, length (longitudinal) and breadth (transverse) of each block, as well as the heights and half-breadths (transverse location) of the critical points A, B, and C indicated on the docking plan. The slope per length of the block to determine the forward heights or the actual forward heights shall be included.

5.3.4.6 Table of Hull Openings below the Projected Docking Waterline. Using the ship owner's Docking Plan as a reference, a table shall be generated that indicates the following information:

(A) Purpose of opening(s)
(B) Size of opening(s)
(C) Vertical, longitudinal, and transverse location of opening(s)

5.3.4.7 General Notes. All pertinent information shall be documented in the General Notes. This includes:

(A) Purpose and scope
(B) Calculated docking condition including maximum anticipated displacement, drafts, and trapezoidal loads on blocks
(C) Docking position
(D) Keel block information, including baseline height, typical length and breadth, and omitted blocks
(E) Side block information, including typical length and breadth, and omitted blocks

(F) References
(G) Principal characteristics of the dock and vessel, including principal dimensions, displacements, and drafts

5.3.5 Shipyard's Berthing and Approach Plan

A general arrangement of the shipyard's facility shall be generated that includes the following:

(A) Geographic location
(B) Channel features and markers
(C) On-shore arrangement of pertinent facilities and roadways
(D) Crane locations, including reach arms and capacities
(E) Pier locations and mooring capabilities
(F) Service locations and capacities, including:
   i. Shore power voltage and amperage
   ii. Seawater cooling connection size and capacity
   iii. Fire main connection size and capacity
   iv. Potable water connection size and capacity
   v. Steam connection size and capacity
(G) Dry dock location
(H) Hydrographic survey of the facility showing water depths
(I) Approach lines of the vessel to pier-side facilities and dry dock

5.4 MANNING REQUIREMENTS

5.4.1 Docking Personnel

A manning procedure shall be developed for the docking facility. The procedure should be made available to the dock master and ship owner upon request. The procedure shall describe each station to be manned, the functions to be performed, and the qualification criteria for personnel manning those stations during all operational evolutions. The procedure shall include personnel required for casualty or damage control, emergency procedures, heavy weather plans, and contingency plans.

5.4.2 Personnel Qualification Procedure

All personnel shall be qualified through training and experience. Individual qualifications, such as described in 5.4.3.1, shall be documented and retained on file as a matter of individual personnel records. These documents shall be made available to the ship owner upon request. If an individual is qualified, or a station requires qualification through a recognized standard or organization, this qualification may be submitted as an alternative qualification procedure.

5.4.3 Dock Master

Every docking facility shall have at least one designated dock master who is qualified to dock and undock vessels.

5.4.3.1 Qualifications and Certification of the Dock Master. The dock master shall be qualified through training and experience to direct all docking operations in a safe and reliable manner in a similar type of facility in which certification is to be granted. The dock master shall be certified using the criteria in this section and shall be approved by the shipyard's top management, making the certification a matter of record. This certification shall be made available to the ship owner upon request. Additionally, a complete résumé of training and qualifications shall be maintained by the shipyard and submitted to the ship owner upon request.

5.4.3.2 Training. It shall be demonstrated that the designee has received formal schooling in the mathematics of stability calculations within the previous 5 years or has utilized such mathematics within the previous 3 years. As an alternative, evidence shall be provided that the designee has the support of an individual or agent who meets either of the above criteria.

5.4.3.3 Work Experience. It shall be demonstrated that the dock master meets one of the following criteria:

(A) Served as a dock master on the type of facility for which he is qualified and for a period during which a total of at least 10 dockings and 10 undockings were accomplished, one of which shall have been conducted within the previous 6 months. Additionally, supervised or assisted in the docking or undocking of at least two ships with large deadrises and one using high blocking (high block 8 feet or over) if those types of vessels will be docked in the facility.

(B) Served under a dock master as a dock master-in-training, being actively involved in a total of 10 dockings and 10 undockings, 10 of which (5 dockings and 5 undockings) shall have been completed on the type of dock for which he is qualified. One docking or undocking shall have been conducted within the previous 6 months. Additionally, assisted in the docking or undocking of at least two ships with large deadrises and one using high blocking if those types of vessels will be docked in the facility.

5.4.3.4 Retaining Qualification. To remain qualified, the dock master shall participate in at least one docking every year on the type of facility for which he is qualified. This qualification requires the review of Docking Plans and checking corresponding block buildup requirements, as well as active involvement in the actual docking and undocking operation.

5.4.3.5 Operational Experience. The types of ships that the dock master has docked during his career shall be listed. Additionally, the number, types of ships, and approximate displacements of ships docked under the designee's supervision within the past 2 years shall be indicated.

5.5 FLOATING DRY DOCKS

This section describes the requirements for operating a floating dry dock. This includes single-section and multi-section floating dry docks.

5.5.1 Pre-Docking Procedure

Prior to docking, the vessel's docking condition must be assessed for stability and block loading. The blocks must be built and verified, and a docking conference convened.

5.5.1.1 Vessel Displacement and Stability. Within 72 hours prior to docking, the vessel's final docking condition must be determined and evaluated. This shall include liquid loads, cargo, and work items required to be loaded prior to drydocking. The vessel shall be ballasted or loaded such that there is no list, and trim has been minimized. Normally, the vessel's maximum allowable trim is 1 foot per 100 feet of waterline. The dock should be ballasted to match the vessel's trim, thus reducing the potential for a knuckle reaction. The vessel's condition just prior to docking will be used to determine the final block loading and generate the dock's Pumping Plan. The minimum stability of the vessel during all phases of docking must meet the requirements of *Naval Ships' Technical Manual* (NSTM). S9086-7G-STM-010, Chapter 997, "Docking instructions and routine work in drydock" (NAVSEA 1996).

5.5.1.1.1 Soundings. The ship owner shall provide the shipyard with a current set of tank soundings to be used to determine the vessel's docking condition. With the ship owner's permission, the shipyard may alter the vessel's liquid load condition in order to safely drydock the vessel.

5.5.1.1.2 Weights. The ship owner shall provide the shipyard with an itemized list of weights aboard the vessel. This includes, but is not limited to, crew and effects, stores, cargo, and ammunition (if applicable).

5.5.1.1.3 Work Items. Based on contractual work items to be accomplished in dock, the ship owner shall provide the shipyard with a list of items anticipated to be moved prior to docking. This includes, but is not limited to, anchors and anchor chains, hatch covers, and marine equipment.

5.5.1.1.4 Calculation of Vessel Weight and Center of Gravity. Calculate the docking weight and longitudinal center of gravity (LCG) by use of the vessel's Hydrostatic Table in conjunction with the measured drafts. The vertical center of gravity (KG) must be estimated by combining the light ship weight and KG with the itemized list of weights and their KGs from the ship owner. The transverse center of gravity (TCG) can be calculated based on the estimated KG and the difference between the port and starboard drafts. The virtual rise of the center of gravity due to free surface effects of onboard liquids must also be taken into account when performing transverse stability calculations.

5.5.1.1.5 Draft of Instability. The draft of instability occurs when the vertical center of gravity above the keel (KG) equals the metacentric height above the keel (KM), or KG = KM. At this point, GM = 0 and the vessel has an insufficient righting moment, allowing it to roll. The draft of instability is of concern if the blocking arrangement is using hauling side blocks. Vessels with a high KG and/or narrow beams (such as naval combatants) typically experience a higher draft of instability. It is imperative that the side blocks are hauled into position prior to the vessel reaching the draft of instability.

5.5.1.2 Block Loads. Using the docking condition and vessel stability calculation from 5.5.1.1, calculate the trapezoidal block load. This is necessary to verify that the final block load is within the dock capacity, as well as to develop the Pumping Plan.

5.5.1.3 Pumping Plan. The purpose of the Pumping Plan is to provide guidance to the dock master while deballasting the dry dock. It shall include water levels in each tank for at least the following five phases of stability, as well as any intermittent stopping points. Intermittent stopping points include, but are not limited to, hauling side blocks (if applicable), block fit checks by divers, and watertight checks. The five phases of stability are (Fig. 2-10):

(A) Full Submergence
(B) Mid-Point Draft
(C) Top of Keel Blocks
(D) Top of Pontoon Deck
(E) Operating Draft

5.5.2 Block Build

The keel blocks and side blocks shall be built in accordance with the ship owner-approved Docking Plan.

5.5.2.1 Block Building Requirements

5.5.2.1.1 Baseline. A level baseline shall be established for setting the heights of the blocks. The baseline is used to create a level plane of reference to which the blocks shall be built, mitigating any irregularities in the pontoon deck. The baseline shall be established with the dock in an unstressed condition and shall be re-established if the working plane has changed. "Unstressed" shall be defined as an unloaded dock, with all tanks pumped down to low suction and devoid of any potential thermal expansion due to sunlight.

5.5.2.1.2 Block Materials. The material and general construction of the base blocks for the keel and side blocks shall be similar, resulting in a proportional design spring rate.

5.5.2.1.3 Soft Cap Thickness. Softwood (Table 5-1) caps shall form the top of the keel and side blocks. The intent of the softwood is to crush slightly under load and conform to any irregularities in the vessel's hull without damaging the hull. Softwood caps that show signs of excessive crushing should be replaced as necessary. The soft cap design for the keel and side blocks shall retain the proportional design of the block construction. Soft caps on the keel blocks shall be no less than 2 inches in thickness and no greater than 6 inches in thickness. Soft caps on the side blocks shall be no less than 2 inches and no greater than 6 inches on the short corners. There is no maximum on the long corners, to account for a steep rise in the shape of the side blocks.

5.5.2.1.4 Side Blocks. The side blocks shall be built in accordance with the approved docking plan, within ±0.25 inch, unless otherwise indicated on the Docking Plan.

5.5.2.1.5 Line of Action. The line of action of the force normal to the vessel's hull for all blocking must pass through the middle one-third of the block.

5.5.2.1.6 Cribbing. Keel blocks with an aspect ratio greater than 2:1 (longitudinal length: height) shall be cribbed at the ends of the keel block line, typically the forward four and aftermost four keel blocks.

Side blocks with an aspect ratio greater than 2:1 on the narrow side shall be cribbed together in pairs. Side blocks higher than 6 feet, as measured from the bottom of the block to the highest point of the soft cap, shall be tied together in pairs by means of cribbing or bracing. If hauling side blocks are tied together, they must be hauled together.

5.5.2.1.7 Block Foundation. The shipyard shall ensure that no block base rests on gravel, sand, or other nonpermanent foundation.

5.5.2.1.8 Internal Verification. The block build foreman shall inspect all blocks prior to releasing the block build for internal verification. The equipment used to build the blocks shall remain in place until the blocks have been verified to have been built in accordance with the building requirements. Verification shall be provided by a qualified individual who was not involved with the block build, and documented using a Pre-Docking Inspection Checklist such as that provided in Table 5-2.

Table 5-2. Pre-Docking Inspection Checklist

ITEM	SAT	UNSAT
Foundation Block: Timber		
Check timber for excessive crushing, warping, cracking, rot, and degraded material	☐	☐
Note amount of wear from fasteners	☐	☐
Evaluate the condition of the interface between blocks in the stack	☐	☐
Note condition of the fasteners in the blocks	☐	☐
Note arrangements for preventing tripping and floating of blocks	☐	☐
Foundation Block: Concrete		
Structural damage due to overloads?	☐	☐
Corrosion of steel reinforcement?	☐	☐
Check concrete for cracking, spalling, and exposed rebar	☐	☐
Foundation Block: Steel		
Evaluate the loss of steel due to corrosion	☐	☐
Look for cracks in welds	☐	☐
Deformed structure	☐	☐

Table 5-2. *Continued*

ITEM	SAT	UNSAT
Blocks: General		
Soft caps minimum thickness 2 in. and no crush prior to docking	☐	☐
Spacing and location as per blocking arrangement (±0.5 in. transversely, ±1 in. longitudinally, ±0.25 in. height)	☐	☐
Keel Blocks		
Sight keel block line for alignment and fit	☐	☐
Keel block height meets requirement	☐	☐
Keel profile applied to keel block offsets	☐	☐
Bilge Blocks		
Sight bilge block line for alignment and fit	☐	☐
Bilge block construction is within required dimensions	☐	☐
Bilge block construction (force normal to vessel's hull passes through middle one-third of all blocks, no gaps, cribbing if over 6 ft.)	☐	☐
Miscellaneous		
Crane clearance	☐	☐
Check overhead interferences and clearances	☐	☐
Depth of water (tide-dependent)	☐	☐
Condition of the working floor for debris, unevenness, etc.	☐	☐
Check mooring system	☐	☐
Note draft/trim devices in use	☐	☐
Condition of fendering	☐	☐
Condition of lifting straps	☐	☐

5.5.2.1.9 External Verification. The contract may require the ship owner's verification prior to releasing the block build for docking. The equipment used to build the blocks shall remain in place until the blocks have been verified to have been built in accordance with the building requirements.

5.5.3 Docking Conference

A docking conference shall be convened to clarify the docking particulars. Attendees should include the dock master, commanding officer or captain of the vessel, cargo mate or engineering officer, and harbor pilot (if involved in the docking). Proxy individuals are not recommended for this conference. If it is not practical to conduct the docking conference in person, it may be convened via teleconference, e-mail, or another means. The Docking Conference Checklist shall be followed (Table 5-3) to ensure that all parties understand the details of the evolution. Topics for discussion shall include:

(A) Weather
(B) Tides
(C) Line handling
(D) Tug configuration
(E) Communication
(F) Use of divers
(G) Review of ship condition
(H) Docking procedures
(I) Drafts during lift phases

5.5.4 Docking Procedure

The vessel shall be drydocked in accordance with the shipyard's Docking Plan. The docking procedures shall be prepared in a formal manner as a matter of record, and made available at all stations during the docking evolution. Table 5-4 shows a sample Docking Procedure Checklist.

5.5.4.1 General

5.5.4.1.1 Operating Procedures. All dry dock operating procedures shall be prepared sequentially, in step-by-step detail. The documented procedures are a matter of record and shall be strictly followed. Prerequisite procedures are required prior to commencing the docking evolution; they include, but are not limited to, valve line-up, cycling of pump operations, and emergency power.

5.5.4.1.2 Checklists. Sequential checklists shall be developed for all dry dock operating procedures, including prerequisite procedures.

5.5.4.1.3 Communication. Appropriate methods of communication shall be included in the aforementioned procedures. These methods may include two-way radios, push-to-talk phones, cell phones, and/or hand signals.

5.5.4.2 Stationing of Personnel. A safety meeting shall be convened no more than 24 hours prior to docking the vessel to instruct various

Table 5-3. Docking Conference Checklist

ITEM
Documentation to Be Provided
Current dock certification
Operating practices, safety requirements, and yard security plans
Docking calculations
Blocking arrangement (if different from Docking Plan)
Docking procedure
Facility Safety Equipment
Fire alarm locations
Emergency power
Emergency ballast/dewatering pumps
Review
The flooding and pumping plan for the dry dock (allowable trim and deflection)
Specific list, trim, and drafts of the vessel during docking, landing, when are blocks to be hauled. **Critical draft (GM = 0) is ______**
GM of ship/dock system in all phases [floating dry dock only—not less than 5 ft. except on docks of greater than 10,000 long ton (LT) capacity]
Block loading: trapezoidal load, knuckle load
Any special precautions or actions characteristic to the docking facility, the docked vessel, or a combination.
High/low water, currents, weather
Communications plan
Tug plan
Vessel entry plan (line handlers, fenders)
Vessel clearance above keel blocks, side blocks, and other potential obstructions
Docking position
Procedure for positioning vessel in dock
When to secure ship's power, when to provide shore power, when to provide fire protection water
Use of divers, arrange time for block inspection
Plan for primary brow and emergency brow placement
Time and Date of Drydocking ______
Vessel Condition
Verify vessel load condition (tanks, drafts, displacement)
All equipment retracted
Verify temporary services/hookups
Drafts: FWD ______, MID ______, AFT ______

Table 5-4. Docking Procedure Checklist

ITEM	SAT	UNSAT
During Docking Evolution		
Communication check	☐	☐
Time and Date Vessel First Enters the Sill		
______, ______		
Vessel came in smoothly. Could it have hit any underwater obstacles?	☐	☐
Position of the vessel is correct.	☐	☐
Correct draft of dock when vessel first grounds	☐	☐
Correct drafts of dock and vessel when vessel is landed	☐	☐
Check for vessel list and alignment	☐	☐
Correct draft of vessel when bilge blocks are hauled	☐	☐
All bilge blocks were hauled fully	☐	☐
Keel centered on keel blocks	☐	☐
Trim and Docking Plan being followed	☐	☐
Post-Docking Evolution		
Proper contact area (wedges may be required). If inadequate area (less than 80% of the blocks surface area in contact with the vessel), float	☐	☐
Drafts of Dock		
(FWD ______, MID ______, AFT ______)		
Does dock have a hog or sag?	☐	☐
Are any blocks hitting appendages?	☐	☐
Any appendages not shown on Docking Plan or in wrong location?	☐	☐
Excessive crush of blocks?	☐	☐
Location: ___________	☐	☐
Verify correct position of vessel on blocks	☐	☐
Ensure side haul blocks are locked in position	☐	☐
Damage to vessel (describe below)	☐	☐

docking personnel to the docking requirements. The purpose of the meeting is to assign personnel to their respective positions. They should also become familiar with the details of the operation and their specific assignments.

5.5.4.2.1 Dock Master. During the docking evolution, the preferred position for the dock master is on the dry dock, versus being on the vessel being docked.

5.5.4.2.2 Manning. The dock master shall ensure that all positions are properly manned. This includes all line handlers on station with lines laid out, and pump, winch, and crane operators on station.

5.5.4.3 Weather. Heavy weather, including high winds and fast currents, introduce an element of risk into the docking operation. Large sail areas on the floating dock as well as the vessel can cause serious control issues. Ultimately, the dock master must decide whether the risks can be mitigated by altering the line handling arrangement, or to abort. It is recommended to cease all dock operations when sustained wind speeds are in excess of 20 knots.

5.5.4.4 Cranes. All dock cranes shall be secured in their docking positions prior to submerging the dock, and shall remain secured until the vessel has landed on the blocks. They should be positioned such that they will not interfere with dock operations. Shore cranes with reach arms that pose potential interference hazards shall be secured during the docking operation. After landing, cranes may be used (1) as long as they do not interfere with the vessel, and (2) the crane's operating limitations allow their use in order to land gangways, service lines, and grounding cables.

5.5.4.5 Submerging the Dock to Full Submergence. Full submergence shall be considered a depth at which there is at least 12 inches of clearance between the hull of the vessel or projections and the nearest block.

5.5.4.6 Draft Readings. Prior to the vessel entering the dry dock, the vessel and dock draft mark readings should be verified. This is to ensure that the vessel's condition afloat is safe for dry docking in accordance with the specified Docking Plan prior to receiving the vessel.

5.5.4.7 Transition from Ship or Tug Propulsion to Handling by Dock Lines. When the vessel is a safe distance from the dock, heaving lines shall be passed between the dock and the vessel to make up the handling lines fast to the vessel. It may be necessary to stop the vessel to allow the tug boats to cast off their lines.

Tugs may continue to be used to assist with the movement of the vessel into dock after their lines have been cast off. They may position themselves at the entrance to the dock such that they prevent loss of control of the vessel until an adequate number of handling lines have been connected to the vessel.

The use of ship or tug propulsion within the dock should be avoided because the wash could damage the blocks.

5.5.4.8 Exchange of Responsibility and Operational Control. As the leading edge of the vessel to be docked crosses the dock sill and the ship is fair to be docked, the dock master shall assume operational control of the vessel and takes full responsibility for the safety and operation of the vessel being docked. The pilot is also relieved of operational control of the vessel and tugs. The sill time is to be made a matter of record and recorded in the ship and dock logs.

5.5.4.9 Positioning the Ship. The ship shall be hauled into the dock, centered transversely over the keel blocks, and positioned longitudinally in the dock according to the ship owner-approved Docking Plan. The centered position must be maintained as the dock is pumped up because the line may go slack or tighten as the dock rises, depending on the relative height of the mooring hardware on the ship versus the mooring hardware on the dock.

5.5.4.9.1 Transverse Control. Centering devices, such as centering bobs and battens or other means of ensuring position, shall be utilized during the docking of the vessel.

5.5.4.9.2 Longitudinal Control. Longitudinal markers, such as line-of-sight markers, shall be used to align the ship's docking reference point longitudinally within the dock during the docking evolution.

5.5.4.10 Landing the Ship

5.5.4.10.1 Draft Reading. When the vessel has been positioned longitudinally and transversely in the dock and is fair for landing, the dock master shall record the final drafts of the vessel as the "Drafts at Landing." Based on the vessel drafts and the block build base height and prior to lifting, the anticipated landing dock drafts should be calculated. At the time of landing, the dock drafts (bow, mid, and aft) shall also be recorded when the vessel first lands (i.e., just the bow or stern starts to lift) and when it is fully landed (i.e., the other end of the vessel starts to lift). If the actual dock drafts do not accurately match the calculated dock drafts (the vessel landed too early or too late), pumping operations shall stop until the source of the error has been determined. It may be necessary to refloat the ship and send divers down to investigate the vessel's hull or the dry dock's blocking.

5.5.4.10.2 Line Handling. All line handlers shall remain on station and be prepared to handle all lines until the vessel is landed on all blocks. It should be noted that, as the dock is pumped, the lines to the vessel will become slack or taut, and it will require constant working of the lines in order to hold the vessel fast in position.

5.5.4.10.3 Pumping the Dock. When the vessel is fair for landing and all line handlers are on station, the dock master shall instruct the ballast control operator to deballast the dock in accordance with the Pumping Plan.

5.5.4.10.4 Shoring. If shores are used in addition to blocking, they shall be placed after the vessel has fully landed on the blocks. Placement of the shores shall be accomplished prior to the vessel reaching its calculated draft of instability (KM = KG, GM = 0).

5.5.4.10.5 Stopping Operation. The pumping of the dock shall be stopped by the dock master and the vessel refloated as deemed necessary if:

(A) The vessel is misaligned longitudinally greater than 6 inches.
(B) The vessel is misaligned on the keel blocks greater than 3 inches transversely.
(C) A shore buckles, if used.
(D) The vessel takes an unexpected list at landing.
(E) The vessel lands at a dock draft greater than predicted, which may indicate a foreign object on the block line or an unknown protrusion below the vessel.

If the vessel's position at landing on the keel exceeds the allowable centering limits, it is recommended that the operation be stopped, the dock resubmerged to a separation depth of 12 inches, and the vessel be refloated and repositioned.

5.5.4.10.6 Side Blocks. After the vessel has landed fair on the keel blocks and it is determined that its transverse and longitudinal positions are acceptable, the dock shall be deballasted to a calculated stopping draft. At that point, the hauling side blocks, if used instead of fixed blocks, shall be hauled into position.

When hauling blocks are used, they must be hauled prior to the vessel reaching its draft of instability (KM = KG, GM = 0). The draft at which the side blocks will be hauled shall be determined as part of the stability calculations.

It is recommended that, at the time of hauling side blocks, the vessel GM be 1 foot or greater.

5.5.4.10.7 Divers. During docking operations, it is suggested that divers be on stand-by to assist. If divers are to be used during a docking evolution, it is recommended that the divers be briefed. The briefing should include a review of the Docking Plan, noting locations of suction intakes, as well as a walk-through of the dry dock and the block build. Divers should be available to assist with the following operations:

(A) To verify that the ship is in the proper position relative to the block build.
(B) To resolve underwater discrepancies or obstructions.
(C) To swim all of the blocks to ensure the vessel's proper fit and alignment after landing on the blocks.

5.5.4.10.8 Gangways and Service Lines. At the dock master's discretion, gangways and service lines shall be installed after the vessel is adequately controlled by lines or has safely landed on the keel blocks and the side haul blocks, if used, are secured in position.

5.5.4.10.9 Grounding Cables. Grounding cables or straps designed to protect the vessel from the effects of welding and electrical storms shall be attached after the vessel has landed safely on the blocks.

5.5.4.10.10 Final Liquid Load Report. After the dock has reached its final operating draft, the vessel shall report its final liquid loads as the "Liquid Loads at Landing." If the vessel was docked with trim, the liquid load levels as reported by the Tank Level Indicator (TLI) system may change. There is also potential for loss of liquids during transit from the sill into docking position due to events such as fuel burned in the vessel's onboard generator.

5.5.4.11 Examination of the Blocks. The dock master and dock crew shall remain on the dock until it has been deballasted sufficiently to allow a full inspection of the blocks and shores. All blocks shall be visually inspected for full contact or excessive crushing. All corrections to the blocks shall be approved by the dock master and corrected immediately.

If there is excessive strain on the vessel or the vessel has been landed outside of acceptable limits, it may be necessary to refloat the vessel.

5.5.5 In-Dock Procedure

During the lay period, any discrepancies with the ship owner's Docking Plan and/or modifications to the vessel that affect the Docking Plan shall be noted on a redline drawing and submitted to the ship owner. Any modifications to the vessel that affect the subsequent undocking of the vessel shall be recorded and submitted to the dock master prior to undocking.

5.5.5.1 Corrections to the Ship Owner's Docking Plan

5.5.5.1.1 Pre-Existing Conditions. If deficiencies or errors are found on the ship owner's Docking Plan, they shall be properly documented on a redline copy of the ship owner's Docking Plan and submitted to the ship owner.

5.5.5.1.2 Work Performed In Dock. If modifications are made to the vessel that affect the Docking Plan, then the necessary changes to the Docking Plan shall be made by the cognizant planning department in charge of the vessel. All changes made to the vessel that affect its subsequent undocking shall also be submitted to the naval architect responsible for undocking the vessel.

5.5.5.2 Monitoring of Weight Changes. No weight changes shall be made to the vessel while in dry dock without prior written approval from the dock master.

5.5.5.2.1 Effect on Undocking. The cognizant planning department shall monitor and record all work-related weight changes aboard the vessel, including the transfer of weights and liquids. This includes, but is not limited to, structural work, equipment modifications, stores, and liquids aboard the vessel. This information shall be submitted to the dock master prior to undocking for use in performing subsequent undocking stability calculations. Permanent weight changes that affect the light ship condition of the vessel shall be submitted to the ship owner to be used in updating the vessel's Trim and Stability Booklet.

5.5.5.2.2 Effect on Block Loading. Weight changes made to vessel while in dock will immediately affect the block loading on the dock. It is possible that large changes in weights such as ballast could adversely affect the block loading, creating a block overload condition. It is recommended that the naval architect review any planned major weight changes prior to conducting the work so as to predict the block load.

5.5.5.3 Watertight Integrity

5.5.5.3.1 Severe Weather. Unless severe weather calculations demonstrate that the vessel in dock is acceptable without refloating, temporary closure plates shall be provided prior to removing plates or cutting access openings below the waterline. These closure plates shall be available for installation within 48 hours' notice for emergency sealing of temporary access openings. Remove the temporary closures when the potential breach of watertight integrity no longer exists.

5.5.5.3.2 End of Shift. Secure openings at the end of each shift not immediately followed by another shift engaged in dry dock work.

5.5.5.3.3 Watertight Hatches. When an area of shell plating removal makes temporary closure impracticable, secure vulnerable compartments in order to minimize potential damage to the extent permitted by the scope and urgency of work.

5.5.5.3.4 Planning. Schedule underwater hull operations to maintain the vessel's positive stability and maximum hull watertight integrity in the event of flooding.

5.5.6 Pre-Undocking Procedure

No more than 72 hours prior to undocking, the vessel's final undocking condition must be determined and calculated. Starting with the as-docked condition, this shall include liquid loads, cargo, and work items required to be loaded or off-loaded prior to undocking. The calculation shall predict the float-off condition, including the predicted float-off drafts. The vessel shall be ballasted or loaded such that there is no calculated list, and trim has been minimized. The vessel's maximum predicted allowable trim is 1 foot per 100 feet of waterline. The dock should be ballasted to match the vessel's trim, thus reducing the potential for a knuckle reaction upon float-off. The final condition will be used to determine the block load and generate the dock's Pumping Plan for undocking. The minimum stability of the vessel during all phases of undocking must meet the requirements of *Naval Ships' Technical Manual* (NSTM) S9086-7G-STM-010, Chapter 997, "Docking instructions and routine work in drydock" (NAVSEA 1996).

5.5.6.1 Soundings. The planner shall provide the dock master with a current set of tank soundings to be used to determine the vessel's undocking condition. The dock master may alter the vessel's liquid load condition to safely undock the vessel.

5.5.6.2 Weights. The planner shall provide the dock master with an itemized list of weights aboard the vessel. This includes, but is not limited to, crew and effects, stores, cargo, and ammunition (if applicable).

5.5.6.3 Work Items. Based on contractual work items accomplished in dock, the planner shall provide the dock master with an itemized list of weight changes made while in dock, as specified in 5.5.5.2.

5.5.6.4 Calculations. Calculate the vessel's undocking stability by recalculating the vessel's KG, LCG, and TCG, taking into account the difference in the liquid load, free surface, weights, and work items from the as-docked condition.

5.5.6.4.1 Draft of Instability. The draft of instability occurs when the center of gravity equals the metacentric height or KG = KM, GM = 0. This is the point at which the vessel has an insufficient righting moment, allowing it to roll. Draft of instability is most critical when dealing with vessels that have narrow beams, such as naval combatants, and hauling blocks, since the hauling blocks must be hauled out of position after the vessel passes through the draft of instability. It is preferable to haul the side block to the outer position after floating the vessel.

5.5.6.4.2 Block Loads. Using the undocking condition and vessel stability calculation, recalculate the trapezoidal block load. This is necessary to verify that the final block load is within the dock capacity, as well as to develop the Pumping Plan.

5.5.6.5 Pumping Plan. The purpose of the Pumping Plan is to provide guidance to the dock operator while ballasting. The pumping plan consists of at least the following five phases of stability, as well as any intermittent stopping points. Intermittent stopping points include, but are not limited to, hauling side blocks and watertight checks. The five phases of stability are (Fig. 2-10):

(A) Operating Draft
(B) Top of Pontoon Deck
(C) Top of Keel Blocks
(D) Mid-Draft
(E) Full Submergence

5.5.7 Undocking Conference

An undocking conference shall be convened to clarify the undocking particulars. Attendees should include the dock master, commanding officer of the vessel, cargo mate or engineering officer, and harbor pilot. Proxy individuals are not recommended for this conference. If it is not practical to conduct the undocking conference in person, it may be convened via teleconference, e-mail, or another means. The Undocking

Conference Checklist (Table 5-5) shall be followed to ensure that all parties understand the details of the evolution.

5.5.8 Undocking Procedure

The vessel shall be undocked in accordance with the shipyard's Undocking Procedure. The undocking procedure checklists shall be prepared in a formal manner as a matter of record and made available at all stations during the undocking evolution.

5.5.8.1 General

5.5.8.1.1 Operating Procedures. All dry dock operating procedures shall be prepared sequentially, in step-by-step detail. The documented procedures are a matter of record and shall be strictly followed. Prerequisite procedures are required prior to commencing the undocking evolution, which include but are not limited to valve line-up, cycling of pump operations, and emergency power.

5.5.8.1.2 Checklists. Sequential checklists shall be developed for all dry dock operating procedures, including prerequisite procedures. Table 5-6 is an example Undocking Procedure Checklist.

5.5.8.1.3 Communication. Appropriate methods of communication shall be included in the aforementioned procedures. These methods may include two-way radios, push-to-talk phones, cell phones, and/or hand signals.

5.5.8.2 Stationing of Personnel. A safety meeting shall be convened no more than 24 hours prior to undocking the vessel to instruct various docking personnel on the undocking requirements. The purpose of the meeting is to assign personnel to their respective positions. They should also become familiar with the details of the operation and their specific assignments.

5.5.8.2.1 Dock Master. During the undocking evolution, the preferred position for the dock master is on the dry dock, versus being on the vessel.

5.5.8.2.2 Manning. The dock master shall ensure that all positions are properly manned. This includes all line handlers on station with lines laid out, and pump, winch, and crane operators on station.

5.5.8.3 Weather. Heavy weather, including high winds and fast currents, introduce an element of risk into the dock operation. Large sail

Table 5-5. Undocking Conference Checklist

ITEM	SAT	UNSAT
Documentation to Be Provided		
Recorded weight shifts during availability	☐	☐
Undocking calculations	☐	☐
Undocking procedure	☐	☐
Undocking Report		
Transducers uncovered	☐	☐
Sacrificial anodes uncovered and free of paint	☐	☐
Shaft rope guard and fairwaters in place	☐	☐
Hull opening blanks and plugs removed	☐	☐
Sea chest strainers are bolted in place and lock-wired	☐	☐
Sea valves and waster pieces are properly installed and are in the closed position	☐	☐
All underwater body work has been completed	☐	☐
Dock is free of all debris and blasting material	☐	☐
Review		
The flooding and pumping plan for the dry dock (allowable trim and deflection)	☐	☐
Specific list, trim, and drafts of the vessel during undocking (when side blocks are hauled)	☐	☐
GM of ship/dock system for all phases [floating dry dock only—not less than 5 ft except on docks of greater than 10,000 long ton (LT) capacity]	☐	☐
High/low water, currents, weather	☐	☐
Communications plan	☐	☐
Tug plan	☐	☐
Temporary services disconnection	☐	☐
Vessel exit plan (line handlers, fenders)	☐	☐
Vessel clearance above keel blocks, side blocks, and other potential obstructions	☐	☐
Pier location and temporary service hookup	☐	☐
Where personnel will be stationed (all hull openings that were worked on)	☐	☐
Procedure if immediate redocking is required	☐	☐
Is ballast required for undocking?	☐	☐
Time and Date of Undocking ______, ______		
Vessel Condition		
Verify vessel load condition (tanks, drafts, displacement), perform tank sounding within 12 hours of undocking	☐	☐

Table 5-6. Undocking Procedure Checklist

ITEM	SAT	UNSAT
During Undocking Evolution		
Communication check	☐	☐
All equipment retracted	☐	☐
Verify temporary services/disconnection	☐	☐
Personnel at hull openings	☐	☐
Stopped at correct draft for hauling side blocks	☐	☐
Hauled all side blocks fully	☐	☐
Detection of any leaks	☐	☐
Vessel exited smoothly. Could it have hit any underwater obstacles?	☐	☐
Time and Date Vessel Is Completely Clear of the Sill ______, ______		
Drafts: FWD ______, MID ______, AFT ______		
Damage (describe below)	☐	☐

areas on the floating dock as well as the vessel can cause serious control issues. Ultimately, the dock master must decide whether the risks can be mitigated by altering the line handling arrangement, or to abort. It is recommended to cease all dock operations when sustained wind speeds are in excess of 20 knots.

5.5.8.4 Cranes. All dock cranes shall be secured in their undocking positions prior to submerging the dock. They should be positioned such that they will not interfere with undocking operations. Shore cranes with reach arms that pose potential interference hazards shall be secured during the undocking operation. Prior to floating the vessel, cranes may be used to remove gangways, service lines, and grounding cables as long as they do not interfere with the vessel and the crane's operating limitations allow their use.

5.5.8.5 Submerging the Dock to Full Submergence. Full submergence shall be considered a depth at which there is at least 12 inches of clearance between the hull of the vessel or projections and the nearest block.

5.5.8.6 Floating the Ship

5.5.8.6.1 Line Handling. All line handlers shall be on station and prepared to handle all lines. It should be noted that as the dock is ballasted, the lines may go slack or tighten, depending on the relative height of the mooring hardware on the ship versus the mooring hardware on the dock; it may require constant working of the lines to hold the vessel fast in position.

5.5.8.6.2 Ballasting the Dock. When the vessel is safe for float-off and all line handlers are on station, the dock master shall instruct the ballast control operator to ballast the dock in accordance with the ballasting plan.

5.5.8.6.3 Draft Readings. As specified above, the undocking calculations shall include the predicted vessel drafts at float-off. As the vessel floats in the dry dock, the draft mark readings should be read and recorded. This is to confirm the vessel's actual condition and displacement prior to exiting the dock.

5.5.8.6.4 Divers. During undocking operations, it is suggested that divers be on stand-by to assist with the undocking operation. If divers are to be on hand during an undocking evolution, it is recommended that the divers be briefed. The briefing should include a review of the Undocking Plan, noting locations of suction intakes as well as a walk-through of the dry dock and the block build. Divers should be available to resolve underwater discrepancies or obstructions.

5.5.8.7 Exchange of Responsibility and Operational Control. As the aftermost edge of the vessel to be undocked crosses the dock sill, the dock master shall be relieved by the commanding officer of operational control of the vessel. The sill time is to be made a matter of record and recorded in the ship and dock logs.

5.5.9 Post-Undocking Procedure

5.5.9.1 Accounting for the Dock's Blocks. The dock master shall remain on the dock until it has been deballasted sufficiently to account for all of the blocks. It is possible that during paint operations or extremely low temperatures part of the blocks may adhere to the vessel during undocking. If blocks are found to be missing, the vessel must be notified that divers will be required to check the underwater hull in order to remove the adhered portion of the block(s).

5.5.9.2 Docking Report. If specified contractually, a docking report shall be completed at the conclusion of the docking evolution in accordance with 5.2.1.

5.6 GRAVING DOCKS

This section describes the requirements for operating a graving dock.

5.6.1 Pre-Docking Procedure

Prior to docking, the vessel's docking condition must be assessed for stability and block loading. The blocks must be built and verified and a docking conference convened.

5.6.1.1 Vessel Stability. Within 72 hours prior to docking, the vessel's final docking condition must be determined and evaluated. This shall include liquid loads, cargo, and work items required to be loaded prior to drydocking. The vessel shall be ballasted or loaded such that there is no list, and trim has been minimized. In a graving dock, the vessel's maximum allowed trim shall be calculated such that the magnitude of the knuckle reaction does not exceed the load capacity of the knuckle block. The foremost and aftermost blocks may be butted or cribbed to minimize the potential for toppling blocks when landing and floating the vessel. The vessel's condition just prior to docking will be used to determine the final block loading. The minimum stability of the vessel during all phases of docking must meet the requirements of *Naval Ship's Technical Manual* (NSTM) S9086-7G-STM-010, Chapter 997, "Docking Instructions and Routine Work in Dry Dock" (NAVSEA, 1996).

5.6.1.1.1 Soundings. The ship owner shall provide the shipyard with a current set of tank soundings to be used to determine the vessel's docking condition. The shipyard may instruct the vessel to alter its liquid load condition in order to safely drydock the vessel.

5.6.1.1.2 Weights. The ship owner shall provide the shipyard with an itemized list of weights and their locations aboard the vessel. This includes, but is not limited to, crew and effects, stores, cargo, and ammunition (if applicable).

5.6.1.1.3 Work Items. Based on contractual work items to be accomplished in dock, the ship owner shall provide the shipyard with a list of items anticipated to be moved prior to docking. This includes, but is not limited to, anchors and anchor chains, hatch covers, and marine equipment.

5.6.1.1.4 Calculation of Vessel Center of Gravity (KG). Calculate the docking weight and longitudinal center of gravity (LCG) by use of the vessel's Hydrostatic Table in conjunction with the measured drafts. The vertical center of gravity (KG) must be estimated by combining the light ship weight and KG with the itemized list of weights and their KGs from the ship owner. The transverse center of gravity can be calculated based on the estimated KG and the difference between port and starboard drafts. The virtual rise of the center of gravity due to free surface effects of onboard liquids must also be taken into account when performing transverse stability calculations.

5.6.1.1.5 Draft of Instability. The draft of instability occurs when the center of gravity equals the metacentric height or KG = KM, GM = 0. This is the point at which the vessel has an insufficient righting moment, allowing it to roll. The draft of instability is most critical when dealing with vessels that have narrow beams, such as naval combatants, and hauling side blocks, since the hauling side blocks must be hauled into position before the vessel reaches the draft of instability.

5.6.1.2 Block Loads. Using the docking condition and vessel stability calculation from 5.6.1.1, calculate the trapezoidal block load. This is necessary to verify that the final block load is within the dock capacity, as well as to calculate the knuckle reaction.

5.6.2 Block Build

The keel blocks and side blocks shall be built in accordance with the ship owner-approved Docking Plan.

5.6.2.1 Block Building Requirements

5.6.2.1.1 Baseline. A level baseline shall be established for setting the heights of the blocks. The baseline is used to create a level plane of reference to which the blocks shall be built, mitigating any irregularities in the dock floor. The baseline shall be re-established if the working plane has changed.

5.6.2.1.2 Block Materials. The material and general construction of the base blocks for keel and side blocks shall be similar, resulting in a proportional design spring rate.

5.6.2.1.3 Soft Cap Thickness. Softwood (Table 5-1) caps shall form the top of the keel and side blocks. The soft cap design for the keel and side blocks shall retain the proportional design of the block construction. Soft caps on keel blocks shall be no less than 2 inches in thickness, and no greater than 6 inches in thickness. Soft caps on side blocks shall be no less than 2 inches and no greater than 6 inches on the short corners. There is no maximum on the long corners, to account for a steep rise in the shape of the side blocks.

5.6.2.1.4 Side Blocks. The side blocks shall be built in accordance with the approved Docking Plan, within ±0.25 inch.

5.6.2.1.5 Line of Action. The line of action of the force normal to the vessel's hull for all blocking must pass through the middle one-third of the block.

5.6.2.1.6 Cribbing. Side blocks higher than 6 feet, as measured from the bottom of the block to the highest point of the soft cap, shall be tied together in pairs by means of cribbing or bracing. If hauling side blocks are tied together, they must be hauled together.

5.6.2.1.7 Block Foundation. The shipyard shall ensure that no block base rests on gravel, sand, or other nonpermanent foundation.

5.6.2.1.8 Internal Verification. The block build foreman shall inspect all the blocks prior to releasing the block build for internal inspection. The equipment used to build the side blocks shall remain on the dock until the blocks have been verified to have been built in accordance with the building requirements. Verification shall be provided by a qualified individual who was not involved with the block build and documented using a Pre-Docking Inspection Checklist such as that provided in Table 5-2.

5.6.2.1.9 External Verification. The contract may require the ship owner's verification prior to releasing the block build for docking. The equipment used to build the side blocks shall remain on the dock until the blocks have been verified to have been built in accordance with the building requirements.

5.6.3 Docking Conference

A docking conference shall be convened to clarify the docking particulars. Attendees should include the dock master, commanding officer or captain of the vessel, cargo mate or engineering officer, and harbor pilot (if involved in the docking). Proxy individuals are not recommended for this conference. If it is not practical to conduct the docking conference in person, it may be convened via teleconference, e-mail, or another means. The Docking Conference Checklist shall be followed (see Table 5-3 as an example) to ensure that all parties understand the details of the evolution. Topics for discussion shall include:

(A) Weather
(B) Tides
(C) Line handling
(D) Tug configuration
(E) Communication
(F) Use of divers
(G) Review of ship condition
(H) Docking procedures

5.6.4 Docking Procedure

The vessel shall be drydocked in accordance with the shipyard's Docking Plan. The docking procedures shall be prepared in a formal manner as a matter of record and made available at all stations during the docking evolution. Table 5-4 shows a sample Docking Procedure checklist.

5.6.4.1 General

5.6.4.1.1 Operating Procedures. All graving dock operating procedures shall be prepared sequentially, in step-by-step detail. The documented procedures are a matter of record and shall be strictly followed. Prerequisite procedures are required prior to commencing the docking evolution which include, but are not limited to, cycle test of pumps and valves in the gate, if equipped, cycle test of dock flooding and dewatering pumps and valves, and check of emergency back-up power.

5.6.4.1.2 Checklists. Sequential checklists shall be developed for all graving dock operating procedures, including prerequisite procedures.

5.6.4.1.3 Communication. Appropriate methods of communication shall be included in the aforementioned procedures. These methods may include two-way radios, push-to-talk phones, cell phones, and/or hand signals.

5.6.4.2 Stationing of Personnel. A safety meeting shall be convened no more than 24 hours prior to docking the vessel to instruct various docking personnel to the docking requirements. The purpose of the meeting is to assign personnel to their respective positions. They should also become familiar with the details of the operation and their specific assignments.

5.6.4.2.1 Dock Master. During the docking evolution, the preferred position for the dock master is on the graving dock, versus being on the vessel.

5.6.4.2.2 Manning. The dock master shall ensure that all positions are properly manned. This includes all line handlers on station with lines laid out, and pump, winch, and crane operators on station.

5.6.4.3 Weather. Heavy weather, including high winds and fast currents, introduces an element of risk into the dock operation. Sail areas on a vessel can cause serious control issues. Ultimately, the dock master must decide whether the risks can be mitigated by altering the line handling arrangement, or to abort. It is recommended to cease all dock operations when sustained wind speeds are in excess of 20 knots.

5.6.4.4 Cranes. Shore cranes with reach arms that pose potential interference hazards shall be secured during the docking operation. Cranes may be used to land gangways, service lines, and grounding cables as long as they do not interfere with the vessel and the crane's operating limitations allow their use.

5.6.4.5 Flooding the Dock. Flooding the dock is accomplished by allowing water to travel through a sluice gate from a flooding chamber or through flood valves in the gate. With free communication between the outside water and the dock, water will continue to flow into the dock until the water levels equalize. The flooding operation is tide-dependent because the maximum water in the dock is based on the outside water level.

5.6.4.6 Opening the Gate. When the inside and outside water levels have equalized, the flooding valves employed shall remain open to ensure that the water levels remain equalized. There are two predominant types of gates employed: a floating caisson gate or a hinged gate.

5.6.4.6.1 Caisson Gate. When the inside and outside water levels of the dock have equalized, the caisson gate shall be deballasted to allow the gate to float out of the dock's sill. Tugs and/or line handlers ashore control the movement of the gate to a location that does not interfere with the subsequent vessel movement into the dock.

5.6.4.6.2 Hinged Gate. When the inside and outside water levels have equalized, the hinged gate shall be ballasted (if it is fitted with a ballast tank) so that it can submerge until it rests on the river floor or submerged supports. It may be necessary to employ divers to ensure that it is fully down and to ensure clearance for the subsequent operation of the dock.

5.6.4.7 Draft Readings. Prior to the vessel entering the graving dock, the vessel's draft mark readings should be verified. This is to ensure that the vessel's condition afloat is safe for docking in accordance with the specified Docking Plan prior to receiving the vessel.

5.6.4.8 Transition from Ship or Tug Propulsion to Handling by Dock Lines. When the vessel is a safe distance from the dock, heaving lines shall be passed between the dock and the vessel to make up the handling lines fast to the vessel. It may be necessary to stop the vessel to allow the tug boats to cast off their lines.

Tugs may continue to be used to assist with the movement of the vessel into the dock after their lines have been cast off. They may position themselves at the entrance to the dock such that they prevent loss of control of the vessel until an adequate number of handling lines have been connected to the vessel.

The use of ship or tug propulsion within the dock should be avoided because the wash could damage the blocks.

5.6.4.9 Exchange of Responsibility and Operational Control. As the leading edge of the vessel to be docked crosses the dock sill and the ship is fair to be docked, the dock master shall assume operational control of the vessel and takes full responsibility for the safety and operation of the vessel to be docked. The pilot is also relieved of operational control of the vessel and tugs. The sill time is to be made a matter of record and recorded in the ship and dock logs.

5.6.4.10 Securing the Gate. After the ship has been safely hauled into the dock and is secured in the dock, the gate shall be placed back in position and secured before any further operations begin.

5.6.4.10.1 Caisson Gate. With the ship secured, the caisson gate shall be moved back into position in the dock sill. The caisson gate shall be fully ballasted into position.

5.6.4.10.2 Hinged Gate. With the ship secured, the gate shall be deballasted (if fitted with a buoyancy tank) and then hauled by capstan or winch back into position.

5.6.4.11 Securing the Flood Valves. After the gate is secured in position and the vessel has been positioned, the flood valves shall be secured. Consideration must be given to the possibility that the gate may lose its seal if the tide is falling.

5.6.4.12 Positioning the Ship. The ship shall be centered transversely over the keel blocks and positioned longitudinally in the dock according to the ship owner-approved Docking Plan. The centered position must be maintained as the dock is pumped down because the lines may go slack or tighten depending on the relative height of the mooring hardware on the ship versus the mooring hardware on the dock as the water is removed from the dock.

5.6.4.13 Landing the Ship

5.6.4.13.1 Draft Reading. When the vessel has been positioned longitudinally and transversely in dock and is fair for landing, the dock master shall record the final drafts of the vessel as the "Drafts at Landing." Based on the vessel drafts and the block build base height and prior to dewatering, the anticipated water level in the dock at landing should be calculated. At the time of landing, the vessel drafts (bow, mid, and aft) shall be recorded (i.e., just as the bow or stern starts to land) and when it is fully landed (i.e., the other end of the vessel lands). If the actual dock water level does not accurately match the calculated water level (the vessel landed too early or too late), dewatering shall stop until the source of the error has been determined. It may be necessary to float the ship and send divers down to investigate the vessel's hull or the graving dock's blocking.

5.6.4.13.2 Line Handling. All line handlers shall remain on station and be prepared to handle all lines. It should be noted that as the dock is dewatered, the lines may go slack or tighten depending on the relative height of the mooring hardware on the ship versus the mooring hardware on the dock lines.

5.6.4.13.3 Pumping Down the Dock. When the vessel is fair for landing and all line handlers are on station, the dock master shall instruct the pump control operator to commence dewatering the dock. Generally, the gate is not fully sealed until the outside water level is higher than the inside water level. The hydrostatic pressure will force the gate to seat into its final position.

5.6.4.13.4 Shoring. If shores are used in addition to blocking, they shall be placed after the vessel has fully landed on the blocks. Placement of the shores shall be accomplished prior to the vessel reaching its calculated draft of instability (KM = KG, GM = 0).

5.6.4.13.5 Stopping Operation. The dewatering of the dock shall be stopped by the dock master and the vessel refloated as deemed necessary if:

(A) The vessel is misaligned longitudinally greater than 6 inches.
(B) The vessel is misaligned on the keel blocks greater than 3 inches transversely.
(C) A shore buckles, if used.
(D) The vessel takes an unexpected list at landing.
(E) The vessel lands at a water level greater than predicted, which may indicate a foreign object on the block line or an unknown protrusion below the vessel.

If the vessel's position at landing on the keel exceeds the allowable centering limits, it is recommended that the operation be stopped, the dock flooded to a separation depth of 12 inches, and the vessel be refloated and repositioned.

5.6.4.13.6 Side Blocks. After the vessel has landed fair on the keel blocks and it is determined that its transverse and longitudinal positions are acceptable, the dock shall be dewatered to a calculated stopping water level and the hauling side blocks, if used instead of fixed blocks, shall be hauled into position.

When hauling blocks are used, they must be hauled prior to the vessel reaching its draft of instability (KM = KG, GM = 0). The draft at which the side blocks will be hauled shall be determined as part of the stability calculations.

It is recommended that at the time of hauling side blocks, the vessel GM be 1 foot or greater.

5.6.4.13.7 Divers. During docking operations, it is suggested that divers be on stand-by to assist with the docking operation. If divers are to be on hand during a docking evolution, it is recommended that the divers be briefed. The briefing should include a review of the Docking Plan, noting locations of suction intakes as well as a walk-through of the graving dock and the block build. Divers should be available to perform the following operations:

(A) To assist the dock master in emergency dockings if the clearances are less than 12 inches.
(B) To resolve underwater discrepancies or obstructions.
(C) If a hinged gate is utilized, prior to the vessel entering the dock, the divers shall swim the lay-down area to ensure that the gate has been fully lowered prior to allowing the vessel to pass the dock's sill.
(D) To swim all of the blocks to ensure the vessel's proper fit and alignment after landing on the blocks.

5.6.4.13.8 Gangways and Service Lines. At the dock master's discretion, gangways and service lines shall be installed after the vessel is adequately controlled by lines or has safely landed on the keel blocks and the side haul blocks, if used, are secured in position.

5.6.4.13.9 Grounding Cables. Grounding cables or straps designed to protect the vessel from the effects of welding and electrical storms shall be attached after the vessel has been safely landed on the blocks.

5.6.4.13.10 Final Liquid Load Report. After the vessel has landed on the blocks, the vessel shall report its final liquid loads as the "Liquid Loads at Landing." If the vessel was docked with trim, the liquid load levels as reported by the TLI system may change. There is also potential for loss of liquids during transit from the sill into docking position due to events such as fuel burned in the vessel's on-board generator.

5.6.4.14 Examination of the Blocks. The dock master or dock watch shall remain at the dock until it has been pumped down sufficiently to allow a full inspection of the blocks and shores. All blocks shall be visually inspected for full contact or excessive crushing. Any corrections to the blocks shall be assessed by the dock master and corrected immediately.

If it is discovered that there is excessive strain on the vessel or the vessel has been landed outside of acceptable limits, it may be necessary to refloat the vessel.

5.6.5 In-Dock Procedure

During the lay period, any discrepancies with the ship owner's Docking Plan and modifications to the vessel that affect the docking plan shall be noted on a redline drawing and submitted to the ship owner. Any modifications to the vessel that affect the subsequent undocking of the vessel shall be recorded and submitted to the dock master prior to undocking.

5.6.5.1 Corrections to the Ship Owner's Docking Plan

5.6.5.1.1 Pre-Existing Conditions. If deficiencies or errors are found on the ship owner's Docking Plan, they shall be properly documented on a redline copy of the ship owner's Docking Plan and submitted to the ship owner.

5.6.5.1.2 Work Performed In Dock. If modifications are made to the vessel that affect the Docking Plan, then the necessary changes to the Docking Plan shall be made by the cognizant planning department in charge of the vessel.

5.6.5.2 Monitoring of Weight Changes. No weight changes shall be made to the vessel while in dry dock without prior written approval from the dock master.

5.6.5.2.1 Effect on Undocking. The cognizant planning department shall monitor and record all work-related weight changes aboard the vessel, including the transfer of weights and liquids. This includes but is not limited to structural work, equipment modifications, stores, and liquids aboard the vessel. This information shall be submitted to the dock master prior to undocking for use in performing subsequent undocking stability calculations. Permanent weight changes that affect the light ship condition of the vessel shall be submitted to the ship owner to be used in updating the vessel's Trim and Stability Booklet.

5.6.5.2.2 Effect on Block Loading. Weight changes made to vessel while in dock will immediately affect the block loading on the dock. It is possible that large changes in weights such as ballast could adversely affect the block loading, creating a block overload condition. It is recommended that the naval architect review any planned major weight changes prior to conducting the work so as to predict the block load.

5.6.5.3 Watertight Integrity

5.6.5.3.1 Severe Weather. Unless severe weather calculations demonstrate the vessel in dock is acceptable without refloating, temporary closure plates shall be provided prior to removing plates or cutting access openings below the waterline. These closure plates shall be available for installation within 48 hours for emergency sealing of temporary access openings. Remove the temporary closures when the breach of watertight integrity no longer exists.

5.6.5.3.2 End of Shift. Secure openings at the end of each shift not immediately followed by another shift engaged in dry dock work.

5.6.5.3.3 Watertight Hatches. When an area of shell plating removal makes temporary closure impracticable, secure vulnerable compartments to minimize potential damage to the extent permitted by the scope and urgency of work.

5.6.5.3.4 Planning. Schedule underwater hull operations to maintain the vessel's positive stability and maximum hull watertight integrity in the event of flooding.

5.6.6 Pre-Undocking Procedure

No more than 72 hours prior to undocking, the vessel's final undocking condition must be determined and calculated. Starting with the as-docked condition, this shall include liquid loads, cargo, and work items required to be loaded or off-loaded prior to undocking. The calculation shall predict the float-off condition, including the predicted float-off drafts. The vessel shall be ballasted or loaded such that there is no calculated list and trim has been minimized. It shall be verified that the calculated knuckle load does not exceed the load capacity of the knuckle block. The minimum stability of the vessel during all phases of undocking must meet the requirements of *Naval Ship's Technical Manual* (NSTM) S9086-7G-STM-010, Chapter 997, "Docking Instructions and Routine Work in Dry Dock" (NAVSEA, 1996).

5.6.6.1 Soundings. The planner shall provide the dock master with a current set of tank soundings to be used to determine the vessel's undocking condition. The dock master may alter the vessel's liquid load condition to safely undock the vessel.

5.6.6.2 Weights. The planner shall provide the dock master with an itemized list of weights aboard the vessel. This includes, but is not limited to, crew and effects, stores, cargo, and ammunition (if applicable).

5.6.6.3 Work Items. Based on contractual work items accomplished in dock, the planner shall provide the dock master with an itemized list of weight changes made while in dock, as specified in 5.6.5.2.

5.6.6.4 Calculations. Calculate the vessel's undocking stability by recalculating the vessel's KG, LCG, and TCG, taking into account the difference in the liquid load, free surface, weights, and work items from the as-docked condition.

5.6.6.4.1 Draft of Instability. The draft of instability occurs when the center of gravity equals the metacentric height, or KG = KM, GM = 0. This is the point at which the vessel has an insufficient righting moment, allowing it to roll. Draft of instability is most critical when dealing with vessels that have narrow beams, such as naval combatants, and hauling blocks, since the hauling blocks must be hauled out of position after the vessel passes through the draft of instability. It is preferable to haul the side blocks to the out position after floating the vessel.

5.6.6.4.2 Block Loads. Using the undocking condition and vessel stability calculation, recalculate the trapezoidal block load. This is necessary to verify that the final block load is within the dock's rated capacity.

5.6.7 Undocking Conference

An undocking conference shall be convened to clarify the undocking particulars. Attendees should include the dock master, commanding officer of the vessel, cargo mate or engineering officer, and harbor pilot. Proxy individuals are not recommended for this conference. If it is not practical to conduct the undocking conference in person, it may be convened via teleconference, e-mail, or another means. The Undocking Conference Checklist (see Table 5-5 for an example) shall be followed to ensure that all parties understand the details of the evolution.

5.6.8 Undocking Procedure

The vessel shall be undocked in accordance with the shipyard's Undocking Plan. The undocking procedures shall be prepared in a formal manner as a matter of record and made available at all stations during the docking evolution.

5.6.8.1 General

5.6.8.1.1 Operating Procedures. All graving dock operating procedures shall be prepared sequentially, in step-by-step detail. The documented procedures are a matter of record and shall be strictly followed. Prerequisite procedures are required prior to commencing the undocking evolution which include but are not limited to valve line-up, cycling of pump operations and emergency power.

5.6.8.1.2 Checklists. Sequential checklists shall be developed for all dry dock operating procedures, including prerequisite procedures. Table 5-6 is an example Undocking Procedure Checklist.

5.6.8.1.3 Communication. Appropriate methods of communication shall be included in the aforementioned procedures. These methods may include two-way radios, push-to-talk phones, cell phones, and/or hand signals.

5.6.8.2 Stationing of Personnel. A safety meeting shall be convened no more than 24 hours prior to undocking the vessel to instruct various docking personnel to the undocking requirements. The purpose of the meeting is to assign personnel to their respective positions. They should also become familiar with the details of the operation and their specific assignments.

5.6.8.2.1 Dock Master. During the undocking evolution, the preferred position for the dock master is on the graving dock, rather than being on the vessel.

5.6.8.2.2 Manning. The dock master shall ensure that all positions are properly manned. This includes all line handlers on station with lines laid out, and pump, winch, and crane operators on station.

5.6.8.3 Weather. Heavy weather, including high winds and fast currents, introduce an element of risk to the undocking operation. Large sail areas on the vessel can cause serious control issues. Ultimately, the dock master must decide whether the risks can be mitigated by altering the line handling arrangement, or to abort. It is recommended to cease all dock operations when sustained wind speeds are in excess of 20 knots.

5.6.8.4 Cranes. Cranes may be used to remove gangways, service lines, and grounding cables as long as they do not interfere with the vessel.

5.6.8.5 Flooding the Dock. Flooding the dock is accomplished by allowing water to travel through a sluice gate or a closure gate. With free communication between the outside water and the dock, water will continue to flow into the dock until the water levels equalize. The flooding operation is tide-dependent because the maximum water in the dock is based on the outside water level.

5.6.8.6 Floating the Ship

5.6.8.6.1 Line Handling. All line handlers shall be on station and prepared to handle all lines. It should be noted that as the dock is flooded, the lines may go slack or tighten depending on the relative height of the mooring hardware on the ship versus the mooring hardware on the dock and may require constant working of the lines to hold the vessel fast in position.

5.6.8.6.2 Flooding the Dock. When the vessel is safe for float-off and all line handlers are on station, the dock master shall instruct the flooding control operator to flood the dock in accordance with the Flooding Plan.

5.6.8.6.3 Draft Readings. As specified above, the undocking calculations shall include the predicted vessel drafts at float-off. As the vessel floats in the graving dock, the draft mark readings should be read and recorded. This is to confirm the vessel's actual condition and displacement prior to exiting the dock.

5.6.8.6.4 Divers. During undocking operations, it is suggested that divers be on stand-by to assist with the undocking operation. If divers are to be on hand during an undocking evolution, it is recommended that the divers be briefed. The briefing should include a review of the Undocking Plan, noting locations of suction intakes as well as a walk-through of the graving dock and the block build. Divers should be available in order to resolve underwater discrepancies or obstructions.

5.6.8.7 Opening the Gate. When the inside and outside water levels have equalized, the flooding valves employed shall remain open to ensure that the water levels remain equalized.

5.6.8.7.1 Caisson Gate. When the inside and outside water levels have equalized, the caisson gate shall be deballasted so that it can float out of the dock's sill. Tugs and/or line handlers control the movement of the gate into a position that will not interfere with the subsequent operation of the dock.

5.6.8.7.2 Hinged Gate. When the inside and outside water levels have equalized, the hinged gate shall be ballasted (if it is fitted with a ballast tank) so that it can submerge until it rests on the river floor or submerged supports. It may be necessary to employ divers to ensure that it is fully down and to ensure clearance for the subsequent operation of the dock.

5.6.8.8 Exchange of Responsibility and Operational Control. As the aftermost edge of the vessel to be undocked crosses the dock sill, the dock master shall return operational control of the vessel to the captain. The sill time is to be made a matter of record and recorded in the ship and dock logs.

5.6.9 Post-Undocking Procedure

5.6.9.1 Accounting for the Dock's Blocks. The dock master shall remain on the dock until it has been pumped down sufficiently to account for all of the blocks. It is possible that during paint operations or extremely low temperatures that part of the blocks may adhere to the vessel during undocking. If blocks are found to be missing, the vessel must be notified that divers will be required to check the underwater hull to remove the adhered portion of the block(s).

5.6.9.2 Docking Report. If specified contractually, a docking report shall be completed at the conclusion of the undocking evolution in accordance with 5.2.1.

5.7 MARINE RAILWAYS

This section describes the requirements for operating a marine railway.

5.7.1 Pre-Docking Procedure

Prior to docking, the vessel's docking condition must be assessed for stability and block loading. The blocks must be built and verified, and a docking conference convened.

5.7.1.1 Vessel Stability. Within 72 hours prior to docking, the vessel's final docking condition must be determined and evaluated. This shall include liquid loads, cargo, and work items required to be loaded prior to drydocking. The vessel shall be ballasted or loaded such that there is little or no list, and trim relative to the block slope has been minimized such that the magnitude of the knuckle reaction does not exceed the load capacity of the knuckle block. The foremost and aftermost blocks may be cribbed to minimize the potential for toppling blocks when landing and floating the vessel. The vessel's condition just prior to docking will be used to determine the final block loading. The minimum stability of the vessel during all phases of docking must meet the requirements of *Naval Ship's Technical Manual* (NSTM) S9086-7G-STM-010, Chapter 997, "Docking Instructions and Routine Work in Dry Dock" (NAVSEA, 1996).

5.7.1.1.1 Soundings. The ship owner shall provide the shipyard with a current set of tank soundings to be used to determine the vessel's docking condition. The shipyard may instruct the vessel to alter its liquid load condition to safely drydock the vessel.

5.7.1.1.2 Weights. The ship owner shall provide the shipyard with an itemized list of weights and their locations aboard the vessel. This includes, but is not limited to, crew and effects, stores, cargo, and ammunition (if applicable).

5.7.1.1.3 Work Items. Based on contractual work items to be accomplished in dock, the ship owner shall provide the shipyard with a list of items anticipated to be moved prior to docking. This includes, but is not limited to, anchors and anchor chains, hatch covers, and marine equipment.

5.7.1.1.4 Calculation of Vessel's Vertical Center of Gravity (KG). Calculate the docking weight and longitudinal center of gravity (LCG) by use of the vessel's hydrostatic table in conjunction with the measured drafts. The vertical center of gravity (KG) must be estimated by combining the light ship weight and KG with the itemized list of weights and their KGs from the ship owner. The transverse center of gravity (TCG) can be calculated based on the estimated KG and the difference between port and starboard drafts. The virtual rise of the center of gravity due to free surface effects of onboard liquids must also be taken into account when performing transverse stability calculations.

5.7.1.1.5 Draft of Instability. The draft of instability occurs when the vertical center of gravity equals the metacentric height, or KG = KM, GM = 0. This is the point at which the vessel has an insufficient righting moment, allowing it to roll. Draft of instability is most critical when dealing with vessels that have narrow beams, such as naval combatants, and hauling side blocks, since the hauling side blocks must be hauled into position before the vessel reaches the draft of instability.

5.7.1.2 Block Loads. Using the docking condition and vessel stability calculation from 5.7.1.1, calculate the trapezoidal block load. This is necessary to verify that the final block load is within the railway's capacity.

5.7.2 Block Build

The keel blocks and side blocks shall be built in accordance with the ship owner-approved Docking Plan.

5.7.2.1 Block Building Requirements

5.7.2.1.1 Baseline. A straight baseline shall be established for setting the heights of the blocks. The baseline is used to create a straight plane of reference to which the blocks will be built, mitigating any irregularities in the cradle's deck. The baseline shall be established with the cradle in an unstressed condition and shall be reestablished if the working plane has changed. "Unstressed" shall be defined as an unloaded cradle. Bear in mind that if the cradle operates on a curved track, the plane of reference will be at an angle to the horizontal when the cradle is submerged to receive the vessel.

5.7.2.1.2 Block Materials. The general construction of the base blocks for keel and side blocks shall be similar, resulting in a proportional design spring rate.

5.7.2.1.3 Soft Cap Thickness. Softwood (Table 5-1) caps shall form the top of the keel and side blocks. The soft cap design for the keel and side blocks shall retain the proportional design of the block construction. Soft caps on keel blocks shall be no less than 2 inches in thickness and no greater than 6 inches in thickness. Soft caps on side blocks shall be no less than 2 inches and no greater than 6 inches on the short corners. There is no maximum on the long corners, to account for a steep rise in the shape of the side blocks.

5.7.2.1.4 Side Blocks. The side blocks shall be built in accordance with the approved docking plan, within ±0.25 inch.

5.7.2.1.5 Line of Action. The line of action of the force normal to the vessel's hull for all blocking must pass through the middle one-third of the block.

5.7.2.1.6 Cribbing. Side blocks higher than 6 feet, as measured from the bottom of the block to the highest point of the soft cap, shall be tied together in pairs by means of cribbing or bracing. If hauling side blocks are tied together, they must be hauled together.

5.7.2.1.7 Internal Verification. The block build foreman shall inspect all the blocks prior to releasing the block build for internal inspection. The equipment used to build the side blocks shall remain on the cradle until the blocks have been verified to have been built in accordance with the building requirements. Verification shall be provided by a qualified individual who was not involved with the block build and documented using a Pre-Docking Inspection Checklist such as that provided in Table 5-2.

5.7.2.1.8 External Verification. The contract may require the ship owner's verification prior to releasing the block build for docking. The equipment used to build the side blocks shall remain on the cradle until the blocks have been verified to have been built in accordance with the building requirements.

5.7.3 Docking Conference

A docking conference shall be convened to clarify the docking particulars. Attendees should include the dock master, commanding officer or captain of the vessel, cargo mate or engineering officer, and harbor pilot (if involved in the docking). Proxy individuals are not recommended for this conference. If it is not practical to conduct the docking conference in person, it may be convened via teleconference, e-mail, or another means. The Docking Conference Checklist shall be followed (see Table 5-3 as an example) to ensure that all parties understand the details of the evolution. Topics for discussion shall include:

(A) Weather
(B) Tides
(C) Line handling
(D) Tug configuration
(E) Communication
(F) Use of divers
(G) Review of ship condition
(H) Docking procedures

5.7.4 Docking Procedure

The vessel shall be drydocked in accordance with the shipyard's Docking Plan. The docking procedures shall be prepared in a formal manner as a matter of record and made available at all stations during the docking evolution. Table 5-4 shows a sample Docking Procedure Checklist.

5.7.4.1 General

5.7.4.1.1 Operating Procedures. All marine railway operating procedures shall be prepared sequentially, in step-by-step detail. The documented procedures are a matter of record and shall be strictly followed. Prerequisite procedures are required prior to commencing the docking evolution which include, but are not limited to, divers checking for debris on track, clearing of grit from track and rollers/wheels, and checking for proper tension in hauling and backing chains prior to cradle movement.

5.7.4.1.2 Checklists. Sequential checklists shall be developed for all marine railway operating procedures, including prerequisite procedures.

5.7.4.1.3 Communication. Appropriate methods of communication shall be included in the aforementioned procedures. These methods may include two-way radios, push-to-talk phones, cell phones, and/or hand signals.

5.7.4.2 Stationing of Personnel. A safety meeting shall be convened no more than 24 hours prior to docking the vessel in order to instruct various docking personnel to the docking requirements. The purpose of the meeting is to assign personnel to their respective positions. They should also become familiar with the details of the operation and their specific assignments.

5.7.4.2.1 Dock Master. During the docking evolution, the preferred position for the dock master is on the catwalk of the cradle, versus being on the vessel being docked.

5.7.4.2.2 Manning. The dock master shall ensure that all positions are properly manned. This includes all line handlers on station with lines laid out, and winch operators on station.

5.7.4.3 Weather. Heavy weather, including high winds and fast currents, introduce an element of risk into the dock operation. Large sail areas on the vessel can cause serious control issues. Ultimately, the dock master must decide whether the risks can be mitigated by altering the line handling arrangement, or to abort. It is recommended to cease all dock operations when sustained wind speeds are in excess of 20 knots.

5.7.4.4 Lowering the Cradle to Full Depth. Full depth shall be considered a depth at which there is at least 12 inches of clearance between the hull of the vessel or projections and the nearest block.

5.7.4.5 Draft Readings. Prior to the vessel entering the cradle, the draft mark readings should be verified. This is to ensure that the vessel's condition afloat is safe for drydocking in accordance with the specified Docking Plan prior to receiving the vessel. Based on the vessel drafts and the block build base height and prior to hauling, the anticipated cradle draft at landing should be calculated. At the time of hauling, the cradle draft shall be recorded when the vessel first lands (i.e., just as the bow or stern starts to lift) and when it is fully landed (i.e., the other end of the vessel starts to lift). If the actual cradle drafts do not accurately match the calculated cradle drafts, (the vessel landed too early or too late), hauling operations shall stop until the source of the error has been determined. It may be necessary to refloat the ship and send divers down to investigate the vessel's hull or the block build.

5.7.4.6 Transition from Ship or Tug Propulsion to Handling by Lines. When the vessel is a safe distance from the cradle, heaving lines shall be passed between the cradle's catwalk and the vessel to make up the handling lines fast to the vessel. It may be necessary to stop the vessel to allow the tug boats to cast off their lines.

Tugs may continue to be used to assist with the movement of the vessel into the cradle after their lines have been cast off. They may position themselves at the entrance to the cradle such that they prevent loss of control of the vessel until a sufficient number of handling lines have been connected to the vessel.

The use of ship or tug propulsion within the cradle should be avoided because the wash could damage the blocks.

5.7.4.7 Exchange of Responsibility and Operational Control. As the leading edge of the vessel to be docked crosses the cradle's sill and the ship is fair to be docked, the dock master shall assume operational control of the vessel and takes full responsibility for the safety and operation of the vessel to be docked. The pilot is also relieved of operational control of the vessel and tugs. The sill time is to be made a matter of record and recorded in the ship and railway logs.

5.7.4.8 Positioning the Ship. The ship shall be hauled into the cradle, centered transversely over the keel blocks, and positioned longitudinally in the dock according to the ship owner-approved Docking Plan. The centered position must be maintained as the cradle is hauled up because the lines may go slack or tighten depending on the relative height of the mooring hardware on the ship versus the mooring hardware on the cradle.

5.7.4.8.1 Transverse Control. Centering devices such as a transit on shore, or other means of ensuring position shall be utilized during the docking of the vessel.

5.7.4.8.2 Longitudinal Control. Longitudinal markers such as line-of-sight markers shall be used to align the ship's docking reference point longitudinally within the cradle during the docking evolution.

5.7.4.9 Landing the Ship

5.7.4.9.1 Draft Reading. When the vessel has been centered longitudinally and transversely in the cradle and is fair for landing, the dock master shall record the final drafts of the vessel as the "Drafts at Landing."

5.7.4.9.2 Line Handling. All line handlers shall remain on station and be prepared to handle all lines. It should be noted that as the cradle is hauled up, the lines may go slack or tighten depending on the relative height of the mooring hardware on the ship versus the mooring hardware on the cradle.

5.7.4.9.3 Hauling the Cradle. When the vessel is fair for landing and all line handlers are on station, the dock master shall instruct the railway operator to commence hauling the cradle.

5.7.4.9.4 Shoring. If shores are used in addition to blocking, they shall be placed after the vessel has fully landed on the blocks. Placement of the shores shall be accomplished prior to the vessel reaching its calculated draft of instability (KM = KG, GM = 0).

5.7.4.9.5 Stopping Operation. The hauling of the cradle shall be stopped by the dock master and the vessel refloated as deemed necessary if:

(A) The vessel is misaligned longitudinally greater than 6 inches.
(B) The vessel is misaligned on the keel blocks greater than 3 inches transversely.
(C) A shore buckles, if used.
(D) The vessel takes an unexpected list at landing.
(E) The vessel lands at a cradle draft greater than predicted, which may indicate a foreign object on the block line or an unknown protrusion below the vessel.

5.7.4.9.6 Side Blocks. After the vessel has landed fair on the keel blocks and it is determined that its transverse and longitudinal positions are acceptable, the cradle shall be hauled to a calculated stopping draft, and the hauling side blocks, if used instead of fixed blocks, shall be hauled into position.

If the vessel's position at landing on the keel exceeds the allowable centering limits, it is recommended that the operation be stopped, the cradle resubmerged to a separation depth of 12 inches, and the vessel be repositioned.

When hauling blocks are used, they must be hauled prior to the vessel reaching its draft of instability (KM = KG, GM = 0). The draft at which the side blocks will be hauled shall be determined as part of the stability calculations.

It is recommended that at the time of hauling side blocks, the vessel's GM be 1 foot or greater.

5.7.4.9.7 Divers. During docking operations, it is recommended that divers be on stand-by to assist with the docking operation. If divers are to be on hand during a docking evolution, it is recommended that the divers be briefed. The briefing should include a review of the Docking Plan, noting locations of suction intakes as well as a walk-through of the cradle and the block build. Divers should be available to assist with the following operations:

(A) Swim and check the railway prior to commencing the operation.
(B) Investigate underwater discrepancies or obstructions.

(C) Swim all of the blocks to ensure the vessel's proper fit and alignment after landing on the blocks.

5.7.4.9.8 Gangways and Service Lines. At the dock master's discretion, gangways and service lines shall be installed after the vessel has safely landed on the keel blocks and the side haul blocks, if used, are secured in position. Service lines, such as fire main and shore power, shall be installed after the vessel has been landed safely on the blocks.

5.7.4.9.9 Grounding Cables. Grounding cables or straps designed to protect the vessel from the effects of welding and electrical storms shall be attached after the vessel has been safely landed on all the blocks.

5.7.4.9.10 Final Liquid Load Report. After the vessel has landed on the blocks and the cradle has been hauled into the cradle latches, the vessel shall report its final liquid loads as the "Liquid Loads at Landing." If the vessel was docked with trim but rests nearer to level at the full-up position (such as on a curved trackway), the liquid load levels as reported by the TLI system may change. There is also potential for loss of liquids during the docking evolution due to events such as fuel burned in the vessel's on-board generator.

5.7.4.10 Examination of the Blocks. Immediately following the cradle entering into the latches, the dock master shall conduct a full inspection of the blocks and shores. All blocks shall be visually inspected for full contact or excessive crushing. Any corrections to the blocks shall be assessed by the dock master and corrected immediately.

If it is discovered that there is excessive strain on the vessel or the vessel has been landed outside of acceptable limits, it may be necessary to refloat the vessel.

5.7.5 In-Dock Procedure

During the lay period, any discrepancies with the ship owner's Docking Plan and modifications to the vessel that affect the Docking Plan shall be noted on a redline drawing and submitted to the ship owner. Any modifications to the vessel that affect the subsequent undocking of the vessel shall be recorded and submitted to the dock master prior to undocking.

5.7.5.1 Corrections to the Ship Owner's Docking Plan

5.7.5.1.1 Pre-Existing Conditions. If deficiencies or errors are found on the ship owner's Docking Plan, they shall be properly documented on a redline copy of the ship owner's Docking Plan and submitted to the ship owner.

5.7.5.1.2 Work Performed in Dock. If modifications are made to the vessel that affect the Docking Plan, then the necessary changes to the Docking Plan shall be made by the cognizant planning department in charge of the vessel.

5.7.5.2 Monitoring of Weight Changes. No weight changes shall be made to the vessel while in dry dock without prior written approval from the dock master.

5.7.5.2.1 Effect on Undocking. The cognizant planning department shall monitor and record all work related to weight changes aboard the vessel, including the transfer of weights and liquids. This includes, but is not limited to, structural work, equipment modifications, stores, and liquids aboard the vessel. This information shall be submitted to the dock master prior to undocking for use in performing subsequent undocking stability calculations. Permanent weight changes that affect the light ship condition of the vessel shall be submitted to the ship owner to be used in updating the vessel's trim and stability booklet.

5.7.5.2.2 Effect on Block Loading. Weight changes made to the vessel while in dock will immediately affect the block loading on the dock. It is possible that large changes in weights such as ballast could adversely affect the block loading, creating a block overload condition. It is recommended that the naval architect review any planned major weight changes prior to conducting the work so as to predict the block load.

5.7.5.3 Watertight Integrity

5.7.5.3.1 Severe Weather. Unless severe weather calculations demonstrate the vessel in dock is acceptable without refloating, temporary closure plates shall be provided prior to removing plates or cutting access openings below the waterline. These closure plates shall be available for installation within 48 hours for emergency sealing of temporary access openings. Remove the temporary closures when the breach of watertight integrity no longer exists.

5.7.5.3.2 End of Shift. Secure openings at the end of each shift not immediately followed by another shift engaged in dry dock work.

5.7.5.3.3 Watertight Hatches. When an area of shell plating removal makes temporary closure impracticable, secure vulnerable compartments to minimize potential damage to the extent permitted by the scope and urgency of work.

5.7.5.3.4 Planning. Schedule underwater hull operations to maintain the vessel's positive stability and maximum hull watertight integrity in the event of flooding.

5.7.6 Pre-Undocking Procedure

No more than 72 hours prior to undocking, the vessel's final undocking condition must be determined and calculated. Starting with the as-docked condition, this shall include liquid loads, cargo, and work items required to be loaded or off-loaded prior to undocking. The calculation shall predict the float-off condition, including the predicted float-off drafts. The vessel's trim relative to the block slope shall be minimized such that the magnitude of the knuckle reaction does not exceed the load capacity of the knuckle block. The foremost and aftermost blocks may be cribbed to minimize the potential for toppling blocks when floating the vessel. The final condition will be used to determine the block load. The minimum stability of the vessel during all phases of undocking must meet the requirements of *Naval Ship's Technical Manual* (NSTM) S9086-7G-STM-010, Chapter 997, "Docking Instructions and Routine Work in Dry Dock" (NAVSEA, 1996).

5.7.6.1 Soundings. The planner shall provide the dock master with a current set of tank soundings to be used to determine the vessel's undocking condition. The dock master may alter the vessel's liquid load condition to safely undock the vessel.

5.7.6.2 Weights. The planner shall provide the dock master with an itemized list of weights aboard the vessel. This includes, but is not limited to, crew and effects, stores, cargo, and ammunition (if applicable).

5.7.6.3 Work Items. Based on contractual work items accomplished in dock, the planner shall provide the dock master with an itemized list of weight changes made while in dock as specified in 5.7.5.2.

5.7.6.4 Calculations. Calculate the vessel's undocking stability by recalculating the vessel's KG, LCG, and TCG, taking into account the difference in the liquid load, free surface, weights, and work items from the as-docked condition.

5.7.6.4.1 Draft of Instability. The draft of instability occurs when the vertical center of gravity equals the metacentric height, or KG = KM, GM = 0. This is the point at which the vessel has an insufficient righting moment, allowing it to roll. Draft of instability is most critical when dealing with vessels that have narrow beams, such as naval combatants, and hauling blocks, since the hauling blocks must be hauled out of position after the vessel passes through the draft of instability. It is preferable to haul the side blocks to the outer position after floating the vessel.

5.7.6.4.2 Block Loads. Using the undocking condition and vessel stability calculation, recalculate the trapezoidal block load. This is necessary to verify that the final block load is within the cradle's capacity.

5.7.7 Undocking Conference

An undocking conference shall be convened to clarify the undocking particulars. Attendees should include the dock master, commanding officer of the vessel, cargo mate or engineering officer, and harbor pilot. Proxy individuals are not recommended for this conference. If it is not practical to conduct the undocking conference in person, it may be convened via teleconference, e-mail, or another means. The Undocking Conference Checklist (see Table 5-5 for an example) shall be followed to ensure that all parties understand the details of the evolution.

5.7.8 Undocking Procedure

The vessel shall be undocked in accordance with the shipyard's Undocking Plan. The undocking procedures shall be prepared in a formal manner as a matter of record and made available at all stations during the undocking evolution.

5.7.8.1 General

5.7.8.1.1 Operating Procedures. All marine railway operating procedures shall be prepared sequentially, in step-by-step detail. The documented procedures are a matter of record and shall be strictly followed. Prerequisite procedures are required prior to commencing the undocking evolution which include, but are not limited to, divers checking for debris on track, clearing of grit from track and rollers/wheels, and checking for proper tension in hauling and backing chains prior to cradle movement.

5.7.8.1.2 Checklists. Sequential checklists shall be developed for all marine railway operating procedures, including prerequisite procedures. Table 5-6 is an example Undocking Procedure Checklist.

5.7.8.1.3 Communication. Appropriate methods of communication shall be included in the aforementioned procedures. These methods may include two-way radios, push-to-talk phones, cell phones, and/or hand signals.

5.7.8.2 Stationing of Personnel. A safety meeting shall be convened no more than 24 hours prior to undocking the vessel to instruct various docking personnel to the undocking requirements. The purpose of the meeting is to assign personnel to their respective positions. They should also become familiar with the details of the operation and their specific assignments.

5.7.8.2.1 Dock Master. During the undocking evolution, the preferred position for the dock master is on the catwalk of the cradle.

5.7.8.2.2 Manning. The dock master shall ensure that all positions are properly manned. This includes all line handlers on station with lines laid out, and winch operators on station.

5.7.8.3 Weather. Heavy weather, including high winds and fast currents, introduce an element of risk into the dock operation. Large sail areas on the vessel can cause serious control issues. Ultimately, the dock master must decide whether the risks can be mitigated by altering the line handling arrangement, or to abort. It is recommended to cease all dock operations when sustained wind speeds are in excess of 20 knots.

5.7.8.4 Hauling the Cradle to Full Submergence. The cradle shall be hauled out to the full submergence position. Full submergence shall be considered a depth at which there is at least 12 inches of clearance between the hull of the vessel or projections and the nearest block.

5.7.8.5 Floating the Ship

5.7.8.5.1 Line Handling. All line handlers shall be on station and prepared to handle all lines. It should be noted that as the cradle is lowered, the lines may go slack or tighten depending on the relative height of the mooring hardware on the ship versus the mooring hardware on the cradle.

5.7.8.5.2 Lowering the Cradle. When the vessel is safe for float-off and all line handlers are on station, the dock master shall instruct the railway operator to lower the cradle.

5.7.8.5.3 Draft Readings. As specified above, the undocking calculations shall include the predicted vessel drafts at float-off. As the vessel floats in the cradle, the draft mark readings should be read and recorded. This is to confirm the vessel's actual condition and displacement prior to exiting the dock.

5.7.8.5.4 Exchange of Responsibility and Operational Control. As the aftermost edge of the vessel to be undocked crosses the dock sill, the dock master shall be relieved by the commanding officer of operational control of the vessel. The sill time is to be made a matter of record and recorded in the ship and dock logs.

5.7.9 Post-Undocking Procedure

5.7.9.1 Accounting for the Dock's Blocks. The dock master shall remain on the cradle until it has been raised sufficiently to account for all of the blocks. It is possible that during paint operations or extremely low temperatures, part of the blocks may adhere to the vessel during undocking. If blocks are found to be missing, the vessel must be notified that divers will be required to check the underwater hull to remove the adhered portion of the block(s).

5.7.9.2 Docking Report. If specified contractually, a docking report shall be completed at the conclusion of the undocking evolution in accordance with 5.2.1.

5.8 VERTICAL LIFTS

This section describes the requirements for operating a vertical lift docking system. The following assumes that the vertical lift system has a transfer system integrated into the facility. It assumes that cars will be linked together and blocks installed on top of the cars.

5.8.1 Pre-Docking Procedure

Prior to docking, the vessel's docking condition must be assessed for stability and block loading. The blocks must be built and verified, and a docking conference convened.

5.8.1.1 Vessel Stability. Within 72 hours prior to docking, the vessel's final docking condition must be determined and evaluated. This shall include liquid loads, cargo, and work items required to be loaded prior to dry docking. The vessel shall be ballasted or loaded such that there is little or no list, and trim relative to the block slope has been minimized such that the magnitude of the knuckle reaction does not exceed the load capacity of the knuckle block. The foremost and aftermost blocks may be cribbed to minimize the potential for toppling blocks when landing and floating the vessel. The vessel's condition just prior to docking will be used to determine the final block loading. The minimum stability of the vessel during all phases of docking must meet the requirements of *Naval Ship's Technical Manual* (NSTM) S9086-7G-STM-010, Chapter 997, "Docking Instructions and Routine Work in Dry Dock" (NAVSEA, 1996).

5.8.1.1.1 Soundings. The ship owner shall provide the shipyard with a current set of tank and bilge soundings to be used to determine the vessel's docking condition. The shipyard may instruct the vessel to alter its liquid load condition to safely drydock the vessel.

5.8.1.1.2 Weights. The ship owner shall provide the shipyard with an itemized list of weights and their locations aboard the vessel. This includes, but is not limited to, crew and effects, stores, cargo, and ammunition (if applicable).

5.8.1.1.3 Work Items. Based on contractual work items to be accomplished in dock, the ship owner shall provide the shipyard with a list of items anticipated to be moved prior to docking. This includes, but is not limited to, anchors and anchor chains, hatch covers, and marine equipment.

5.8.1.1.4 Calculation of Vessel's Vertical Center of Gravity (KG). Calculate the docking weight and longitudinal center of gravity (LCG) by use of the vessel's hydrostatic table in conjunction with the measured drafts. The vertical center of gravity (KG) must be estimated by combining the light ship weight and KG with the itemized list of weights and their KGs from the ship owner. The transverse center of gravity (TCG) can be calculated based on the estimated KG and the difference between port and starboard drafts. The virtual rise of the center of gravity due to free surface effects of onboard liquids must also be taken into account when performing transverse stability calculations.

5.8.1.1.5 Draft of Instability. The draft of instability occurs when the vertical center of gravity equals the metacentric height, or KG = KM, GM = 0. This is the point at which the vessel has an insufficient righting moment, allowing it to roll. Draft of instability is most critical when dealing with vessels that have narrow beams, such as naval combatants, and hauling side blocks, since the hauling side blocks must be hauled into position before the vessel reaches the draft of instability.

5.8.1.2 Block Loads. Using the docking condition and vessel stability calculation from 5.8.1.1, calculate the trapezoidal block load. This is necessary to verify that the final block load is within the dock's capacity.

5.8.2 Block Build

The keel blocks and side blocks shall be built in accordance with the ship owner-approved Docking Plan.

5.8.2.1 Block Building Requirements

5.8.2.1.1 Baseline. A level baseline shall be established for setting the heights of the blocks. The baseline is used to create a level plane of reference to which the blocks will be built, mitigating any irregularities in the cars or the vertical lift platform. The baseline shall be established with the car and platform in an unstressed condition and shall be re-established if the working plane has changed. "Unstressed" shall be defined as an unloaded car and platform.

5.8.2.1.2 Block Materials. The general construction of the base blocks for keel and side blocks shall be similar, resulting in a proportional design spring rate.

5.8.2.1.3 Soft Cap Thickness. Softwood (Table 5-1) caps shall form the top of the keel and side blocks. The soft cap design for the keel and side blocks shall retain the proportional design of the block construction. Soft caps on keel blocks shall be no less than 2 inches in thickness and no greater than 6 inches in thickness. Soft caps on side blocks shall be no less than 2 inches and no greater than 6 inches on the short corners. There is no maximum on the long corners, to account for a steep rise in the shape of the side blocks.

5.8.2.1.4 Side Blocks. The side blocks shall be built in accordance with the approved Docking Plan, within ±0.25 inch.

5.8.2.1.5 Line of Action. The line of action of the force normal to the vessel's hull for all blocking must pass through the middle one-third of the block.

5.8.2.1.6 Cribbing. Side blocks higher than 6 feet, as measured from the bottom of the block to the highest point of the soft cap, shall be tied together in pairs by means of cribbing or bracing. If hauling side blocks are tied together, they must be hauled together.

5.8.2.1.7 Internal Verification. The dock foreman shall inspect all the blocks prior to releasing the block build for internal inspection. The equipment used to build the side blocks shall remain on the dock until the blocks have been verified to have been built in accordance with the building requirements. Verification shall be provided by a qualified individual who was not involved with the block build and documented using a pre-docking inspection checklist such as that provided in Table 5-2.

5.8.2.1.8 External Verification. The contract may require the ship owner's verification prior to releasing the block build for docking. The equipment used to build the side blocks shall remain on the dock until the blocks have been verified to have been built in accordance with the building requirements.

5.8.3 Docking Conference

A docking conference shall be convened to clarify the docking particulars. Attendees should include the dock master, commanding officer or captain of the vessel, cargo mate or engineering officer, and harbor pilot (if involved in the docking). Proxy individuals are not recommended for this conference. If it is not practical to conduct the docking conference in person, it may be convened via teleconference, e-mail, or another means. The Docking Conference Checklist shall be followed (see Table 5-3 as an example) to ensure that all parties understand the details of the evolution. Topics for discussion shall include:

(A) Weather
(B) Tides
(C) Line handling
(D) Tug configuration
(E) Communication
(F) Use of divers
(G) Review of ship condition
(H) Docking procedures

5.8.4 Docking Procedure

The vessel shall be drydocked in accordance with the shipyard's Docking Plan. The docking procedures shall be prepared in a formal manner as a matter of record and made available at all stations during the docking evolution. Table 5-4 shows a sample Docking Procedures Checklist.

5.8.4.1 General

5.8.4.1.1 Operating Procedures. All vertical lift operating procedures shall be prepared sequentially, in step-by-step detail. The documented procedures are a matter of record and shall be strictly followed. Prerequisite procedures are required prior to commencing the docking evolution which include, but are not limited to, computer program inputs, car securing, track and winch/cable inspection, and transfer procedures.

5.8.4.1.2 Checklists. Sequential checklists shall be developed for all vertical lift operating procedures including prerequisite procedures.

5.8.4.1.3 Communication. Appropriate methods of communication shall be included in the aforementioned procedures. These methods may include two-way radios, push-to-talk phones, cell phones, and/or hand signals.

5.8.4.2 Stationing of Personnel. A safety meeting shall be convened no more than 24 hours prior to docking the vessel in order to instruct various docking personnel to the docking requirements. The purpose of the meeting is to assign personnel to their respective positions. They should also become familiar with the details of the operation and their specific assignments.

5.8.4.2.1 Dock Master. During the docking evolution, the preferred position for the dock master is on shore. The location shall provide the best visibility and ability to communicate and control the lift.

5.8.4.2.2 Manning. The dock master shall ensure that all positions are properly manned. This includes all line handlers on station with lines laid out, and winch operators on station.

5.8.4.3 Weather. Heavy weather, including high winds and fast currents, introduce an element of risk into the dock operation. Large sail areas on the vessel can cause serious control issues. Ultimately, the dock master must decide whether the risks can be mitigated by altering the line handling arrangement, or to abort. It is recommended to cease all dock operations when sustained wind speeds are in excess of 20 knots.

5.8.4.4 Lowering the Platform to Full Depth. Full depth shall be considered a depth at which there is at least 12 inches of clearance between the hull of the vessel or projections and the nearest block.

5.8.4.5 Draft Readings. Prior to the vessel entering the dock, the draft mark readings should be verified. This is to ensure that the vessel's condition afloat is safe for dry docking in accordance with the specified Docking Plan prior to receiving the vessel.

5.8.4.6 Transition from Ship or Tug Propulsion to Handling by Lines. When the vessel is a safe distance from the dock, heaving lines shall be passed between the pier and the vessel to make up the handling lines fast to the vessel. It may be necessary to stop the vessel to allow the tug boats to cast off their lines.

Tugs may continue to be used to assist with the movement of the vessel into the dock after their lines have been cast off. They may position themselves at the entrance to the dock such that they prevent loss of control of the vessel until all handling lines have been connected to the vessel.

The use of ship or tug propulsion over the platform should be avoided because the wash could damage the blocks.

5.8.4.7 Exchange of Responsibility and Operational Control. As the leading edge of the vessel to be docked crosses the platform's sill and the ship is fair to be docked, the dock master shall assume operational control of the vessel and take full responsibility for the safety and operation of the vessel to be docked. The pilot is also relieved of operational control of the vessel and tugs. The sill time is to be made a matter of record and recorded in the ship and dock logs.

5.8.4.8 Positioning the Ship. The ship shall be hauled into the dock, centered transversely over the keel blocks and positioned longitudinally in the dock according to the ship owner-approved Docking Plan. The centered position must be maintained as the platform is lifted up, as the lines may go slack or tighten depending on the relative height of the mooring hardware on the ship versus the mooring hardware on the dock.

5.8.4.8.1 Transverse Control. Centering devices such as a transit on shore, or other means of ensuring position shall be utilized during the docking of the vessel.

5.8.4.8.2 Longitudinal Control. Longitudinal markers such as line-of-sight markers shall be used to align the ship's docking reference point longitudinally within the dock during the docking evolution.

5.8.4.9 Landing the Ship

5.8.4.9.1 Draft Reading. When the vessel has been centered longitudinally and transversely over the blocks and is fair for landing, the dock master shall record the final drafts of the vessel as the "Drafts at Landing." Based on the vessel drafts and the block build base height and prior to lifting, the anticipated dock drafts should be calculated. At the time of landing, the dock drafts shall also be recorded when the vessel first lands (i.e., just as the bow or stern starts to lift) and when it is fully landed (i.e., when the other end of the vessel starts to lift). If the actual dock drafts do not accurately match the calculated dock drafts (the vessel landed too early or too late), lifting operations shall stop until the source of the error has been determined. It may be necessary to refloat the ship and send divers down to investigate the vessel's hull or the dry dock's blocking.

5.8.4.9.2 Line Handling. All line handlers shall remain on station and be prepared to handle all lines. It should be noted that as the platform is lifted up, the lines may go slack or tighten depending on the relative height of the mooring hardware on the ship versus the mooring hardware on the dock.

5.8.4.9.3 Lifting the Platform. When the vessel is fair for landing and all line handlers are on station, the dock master shall instruct the winch operator to commence lifting the platform.

5.8.4.9.4 Stopping Operation. The lifting of the platform shall be stopped by the dock master and the vessel refloated as deemed necessary if:

(A) The vessel is misaligned longitudinally greater than 6 inches.
(B) The vessel is misaligned on the keel blocks greater than 3 inches transversely.
(C) The vessel takes an unexpected list at landing.
(D) The vessel lands at a dock draft greater than predicted, which may indicate a foreign object on the block line or an unknown protrusion below the vessel.

5.8.4.9.5 Side Blocks. After the vessel has landed fair on the keel blocks and it is determined that its transverse and longitudinal position are acceptable, the platform shall be lifted to a calculated stopping draft and the hauling side blocks, if used instead of fixed blocks, shall be hauled into position.

If the vessel's position at landing on the keel exceeds the allowable centering limits, it is recommended that the operation be stopped, the platform resubmerged to a separation depth of 12 inches, and the vessel be repositioned.

When hauling blocks are used, they must be hauled prior to the vessel reaching its draft of instability (KM = KG, GM = 0). The draft at which the side blocks will be hauled shall be determined as part of the stability calculations.

It is recommended that, at the time of hauling side blocks, the vessel GM be one foot or greater.

5.8.4.9.6 Divers. During docking operations, it is recommended that divers be on stand-by to assist with the docking operation. If divers are to be on hand during a docking evolution, it is recommended that the divers be briefed. The briefing should include a review of the docking plan, noting locations of suction intakes as well as a walk-through of the dry dock and the block build. Divers should be available in order to assist with the following operations:

(A) Investigate underwater discrepancies or obstructions.
(B) Swim all of the blocks to ensure a proper fit and alignment after landing on the blocks and prior to completing the lift.

5.8.4.10 After the Vessel Is Fully Up

5.8.4.10.1 Gangways and Service Lines At the dock master's discretion, gangways and service lines shall be installed after the vessel has safely landed on the keel blocks and the side haul blocks, if used, are secured in position. If there is immediate need for a gangway after safely landing the vessel on the blocks, it may be suspended by a crane during dock lifting operations. Service lines, such as fire main and shore power, shall be installed after the vessel has been landed safely on the blocks.

5.8.4.10.2 Grounding Cables. Grounding cables or straps designed to protect the vessel from the effects of welding and electrical storms shall be attached after the vessel has been safely landed on the blocks.

5.8.4.10.3 Final Liquid Load Report. After the vessel has been moved to the final location, the vessel shall report its final liquid loads as the "Liquid Loads at Landing."

5.8.4.10.4 Examination of the Blocks. Immediately following the platform reaching the top of its lift, the dock master shall conduct a full inspection of the blocks. All blocks shall be visually inspected for full contact or excessive crushing. Any corrections to the blocks shall be assessed by the dock master and corrected immediately.

If it is discovered that there is excessive strain on the vessel or the vessel has been landed outside of acceptable limits, it may be necessary to refloat the vessel.

5.8.4.10.5 Securing the Platform. Immediately after the inspection of the blocks and verification that the vessel does not need to be refloated, the dock master shall instruct personnel to secure the platform. The platform shall be secured to transfer the load of the platform to the pier rather than the winches.

5.8.4.9 Transfer. If the vessel is to be moved to another part of the yard, the dock master shall follow the manufacturer's instructions of the transfer cars and execute the transfer. Transfers shall always be done at a slow speed, with personnel off the vessel and clear of the moving system. Personnel shall inspect the track to ensure it is clear and in good condition prior to any movement.

5.8.5 In-Dock Procedure

During the lay period, any discrepancies with the ship owner's Docking Plan and modifications to the vessel that affect the Docking Plan shall be noted on a redline drawing and submitted to the ship owner. Any modifications to the vessel that affect the subsequent undocking of the vessel shall be recorded and submitted to the dock master prior to undocking.

5.8.5.1 Corrections to the Ship Owner's Docking Plan

5.8.5.1.1 Pre-Existing Conditions. If deficiencies or errors are found on the ship owner's Docking Plan, they shall be properly documented on a redline copy of the ship owner's Docking Plan and submitted to the ship owner.

5.8.5.1.2 Work Performed in Dock. If modifications are made to the vessel that affect the Docking Plan, then the necessary changes to the Docking Plan shall be made by the cognizant planning department in charge of the vessel.

5.8.5.2 Monitoring of Weight Changes. No weight changes shall be made to the vessel while in dry dock without prior written approval from the dock master.

5.8.5.2.1 Effect on Undocking. The cognizant planning department shall monitor and record all work related to weight changes aboard the vessel, including the transfer of weights and liquids. This includes, but is not limited to, structural work, equipment modifications, stores, and liquids aboard the vessel. This information shall be submitted to the dock master prior to undocking for use in performing subsequent undocking stability calculations. Permanent weight changes that affect the light ship condition of the vessel shall be submitted to the ship owner to be used in updating the vessel's Trim and Stability Booklet.

5.8.5.2.2 Effect on Block Loading. Weight changes made to the vessel while in dock will immediately affect the block loading on the dock. It is possible that large changes in weights such as ballast could adversely affect the block loading, creating a block overload condition. It is recommended that the naval architect review any planned major weight changes prior to conducting the work so as to predict the block load.

5.8.5.3 Watertight Integrity

5.8.5.3.1 Severe Weather. Unless heavy weather calculations demonstrate the vessel in dock is acceptable without refloating, temporary closure plates shall be provided prior to removing plates or cutting access openings below the waterline. These closure plates shall be available for installation within 48 hours for emergency sealing of temporary access openings. Remove the temporary closures when the breach of watertight integrity no longer exists.

5.8.5.3.2 End of Shift. Secure openings at the end of each shift not immediately followed by another shift engaged in dry dock work.

5.8.5.3.3 Watertight Hatches. When an area of shell plating removal makes temporary closure impracticable, secure vulnerable compartments to minimize potential damage to the extent permitted by the scope and urgency of work.

5.8.5.3.4 Planning. Schedule underwater hull operations to maintain the vessel's positive stability and maximum hull watertight integrity in the event of flooding.

5.8.6 Pre-Undocking Procedure

No more than 72 hours prior to undocking, the vessel's final undocking condition must be determined and calculated. Starting with the as-docked condition, this shall include liquid loads, cargo, and work items required to be loaded or off-loaded prior to undocking. The calculation shall predict the float-off condition, including the predicted float-off drafts. The vessel's trim relative to the block slope shall be minimized such that the magnitude of the knuckle reaction does not exceed the load capacity of the knuckle block. The foremost and aftermost blocks may be cribbed to minimize the potential for toppling blocks when floating the vessel. The final condition will be used to determine the block load. The minimum stability of the vessel during all phases of undocking must meet the requirements of *Naval Ships' Technical Manual* (NSTM) S9086-7G-STM-010, Chapter 997, "Docking Instructions and Routine Work in Dry Dock" (NAVSEA, 1996).

5.8.6.1 Soundings. The planner shall provide the dock master with a current set of tank soundings to be used to determine the vessel's undocking condition. The dock master may alter the vessel's liquid load condition to safely undock the vessel.

5.8.6.2 Weights. The planner shall provide the dock master with an itemized list of weights aboard the vessel. This includes but is not limited to crew and effects, stores, cargo, and ammunition (if applicable).

5.8.6.3 Work Items. Based on contractual work items accomplished in dock, the planner shall provide the dock master with an itemized list of weight changes made while in dock, as specified in 5.8.5.2.

5.8.6.4 Calculations. Calculate the vessels undocking stability by recalculating the vessel's KG, LCG and TCG taking into account the difference in the liquid load, free surface, weights, and work items from the as-docked condition.

5.8.6.4.1 Draft of Instability. The draft of instability occurs when the vertical center of gravity equals the metacentric height, or KG = KM, GM = 0. This is the point at which the vessel has an insufficient righting moment, allowing it to roll. Draft of instability is most critical when dealing with vessels that have narrow beams, such as naval combatants, and hauling blocks, since the hauling blocks must be hauled out of position after the vessel passes through the draft of instability. It is preferable to haul the side blocks to the outer position after floating the vessel.

5.8.6.4.2 Block Loads. Using the undocking condition and vessel stability calculation, recalculate the trapezoidal block load. This is necessary to verify that the final block load is within the cradle's capacity.

5.8.7 Undocking Conference

An undocking conference shall be convened to clarify the undocking particulars. Attendees should include the dock master, commanding officer of the vessel, cargo mate or engineering officer, and harbor pilot. Proxy individuals are not recommended for this conference. If it is not practical to conduct the undocking conference in person, it may be convened via teleconference, e-mail, or another means. The Undocking Conference Checklist (Table 5-5) shall be followed to ensure that all parties understand the details of the evolution.

5.8.8 Undocking Procedure

The vessel shall be undocked in accordance with the shipyard's Undocking Plan. The undocking procedures shall be prepared in a formal manner as a matter of record and made available at all stations during the undocking evolution.

5.8.8.1 General

5.8.8.1.1 Operating Procedures. All vertical lift operating procedures shall be prepared sequentially, in step-by-step detail. The documented procedures are a matter of record and shall be strictly followed. Prerequisite procedures are required prior to commencing the undocking evolution which include, but are not limited to, transfer procedures, track/winch/cable/car inspections, and check for proper blocking support prior to vessel movement.

5.8.8.1.2 Checklists. Sequential checklists shall be developed for all dry dock operating procedures including prerequisite procedures. Table 5-6 is an example of an Undocking Procedure Checklist.

5.8.8.1.3 Communication. Appropriate methods of communication shall be included in the aforementioned procedures. These methods may include two-way radios, push-to-talk phones, cell phones, and/or hand signals.

5.8.8.2 Stationing of Personnel. A safety meeting shall be convened no more than 24 hours prior to undocking the vessel to instruct various docking personnel to the undocking requirements. The purpose of the meeting is to assign personnel to their respective positions. They should also become familiar with the details of the operation and their specific assignments.

5.8.8.2.1 Dock Master. During the undocking evolution, the preferred position for the dock master is on shore. The location shall provide the best visibility and ability to communicate and control the lift.

5.8.8.2.2 Manning. The dock master shall ensure that all positions are properly manned. This includes all line handlers on station with lines laid out, and winch operators on station.

5.8.8.3 Weather. Heavy weather, including high winds and fast currents, introduce an element of risk into the dock operation. Large sail areas on the vessel can cause serious control issues. Ultimately, the dock master must decide whether the risks can be mitigated by altering the line handling arrangement, or to abort. It is recommended to cease all dock operations when sustained wind speeds are in excess of 20 knots.

5.8.8.4 Lowering the Platform to Full Submergence. Full submergence shall be considered a depth at which there is at least 12 inches of clearance between the hull of the vessel or projections and the nearest block.

5.8.8.5 Floating the Ship

5.8.8.5.1 Line Handling. All line handlers shall be on station and prepared to handle all lines. It should be noted that as the platform is lowered, the lines may go slack or tighten depending on the relative height of the mooring hardware on the ship versus the mooring hardware on the dock.

5.8.8.5.2 Lowering the Platform. When the vessel is safe for float-off and all line handlers are on station, the dock master shall instruct the winch operator to lower the platform.

5.8.8.5.3 Draft Readings. As specified above, the undocking calculations shall include the predicted vessel drafts at float-off. As the vessel floats off, the drafts shall be recorded. This is to confirm the vessel's actual condition and displacement prior to exiting the dock.

5.8.8.6 Exchange of Responsibility and Operational Control. As the aftermost edge of the vessel to be undocked crosses the platform's sill, the dock master shall be relieved by the commanding officer of operational control of the vessel. The sill time is to be made a matter of record and recorded in the ship and dock logs.

5.8.9 Post-Undocking Procedure

5.8.9.1 Accounting for the Dock's Blocks. The dock master shall account for all the blocks after the platform has been raised. It is possible that during paint operations or extremely low temperatures, part of the blocks may adhere to the vessel during undocking. If blocks are found to be missing, the vessel must be notified that divers will be required to check the underwater hull in order to remove the adhered portion of the block(s).

5.8.9.2 Docking Report. If specified contractually, a docking report shall be completed at the conclusion of the undocking evolution in accordance with 5.2.1

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APPENDIX A

SAMPLE FLOATING DRY DOCK INSPECTION CHECKLIST

The following pages provide a sample checklist for the condition assessment and control inspection of floating dry docks. This checklist is generic and should be modified to the specific facility. Note that some items included in the sample checklist are specific to steel floating dry docks and others are specific to concrete floating dry docks. The modified checklists should provide sufficient detail to ensure that 100% of the structure and operational components are inspected. For example, flood valves and ballast control pumps should be listed individually. Each item shall be rated according to the following:

(A) Satisfactory (S): The condition of the item will not result in system damage and, based on measured or estimated deterioration rate, it may be expected to remain satisfactory until the next control inspection.

(B) Marginal (M): The condition of the item will not result in major damage nor, by itself, will it make the facility unsafe to dock a ship, provided it is corrected, repaired, or replaced in a timely manner. A number of such items as a group can make the facility unsafe. This shall be evaluated by the inspector.

(C) Unsatisfactory (U): The condition of the item may cause system damage or loss and shall be corrected, repaired, or replaced immediately (if there is a ship in dock) or prior to docking a ship (if there is no ship in dock).

(D) Not Applicable (NA): The item listed in the checklist is not present on the dry dock. Note that as items are added, removed, or replaced from the dry dock, the inspection checklist shall be updated to reflect the configuration changes.

(E) Not Inspected (NI): The item was not inspected as part of the survey. It is not acceptable to mark an item NI unless there is a basis for expecting the item to be in a satisfactory condition.

Inspection Checklist - Floating Dry Docks

Facility Name: ____________________

Dry Dock Designation: ____________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Mechanical & Electrical						
Dewatering/Flooding Systems						
Main Dewatering Pumps						
Motors for Dewatering Pumps						
Motor Controllers						
Lubrication						
Piping						
Drainage Pumps						
Suction Valves & Valve Operators						
Discharge Valves & Valve Operators						
Flood Valves & Valve Operators						
Sluice Valves & Valve Operators						
Crossover Valves & Valve Operators						
Tank Level Indication System						
Draft Indication System						
Deflection Detection System						
Inclinometers						
Power Systems						
Engine Generator Sets						
Shore Power for Main Power Source						
Electrical Power Distribution System						
Shore Power for Backup Power Source						
Communication Systems						
Sound Powered Phones & Radios						
Dial Telephone						
Public Address System						
Fire Alarms						
Fire Protection Systems						
Fire Pump						
Fire Main						
Fire Stations – Hoses, Nozzles etc.						
CO_2 Extinguishers						
Dry Chemical Extinguishers						
Miscellaneous						
Alarms – Flooding etc.						
Lighting for Operations and Security						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ____________________

Of Company: ____________________

Date of Inspection: ____________________

Inspection Checklist - Floating Dry Docks

Facility Name: ______________________________

Dry Dock Designation: ______________________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Deck and Breasting Winches						
Capstans/Winches/Trolleys						
Block Handling Systems						
Crane Stops and Securing Systems						
Stern and Bow Closure Machinery						
Cathodic Protection Systems						
Air Compressors & Distribution Systems						
Steel Hull Structure						
Pontoon						
Pontoon Deck – Plating						
Pontoon Deck – Stiffeners						
Pontoon Deck – Girders						
Pontoon Bottom – Plating						
Pontoon Bottom – Stiffeners						
Pontoon Bottom – Girders						
Pontoon Sides – Plating						
Pontoon Sides – Longitudinals						
Pontoon Sides – Verticals						
Long. CL Bulkheads – Plating						
Long. CL Bulkheads – Longitudinals						
Long. CL Bulkheads – Verticals						
Long. off CL Bulkheads – Plating						
Long. off CL Bulkheads – Longitudinals						
Long. off CL Bulkheads – Verticals						
Trans. End Bulkheads – Plating						
Trans. End Bulkheads – Horizontals						
Trans. End Bulkheads – Verticals						
Trans. Bulkheads – Plating						
Trans. Bulkheads – Horizontals						
Trans. Bulkheads – Verticals						
Framing – Verticals/Columns						
Framing – Diagonals						
Crossover Tunnel – Plating						
Hull Openings						
Protective Coating						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ______________________________

Of Company: ______________________________

Date of Inspection: ______________________________

Inspection Checklist - Floating Dry Docks

Facility Name: ______________________________

Dry Dock Designation: ______________________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Wings						
Inner Shells – Plating						
Inner Shells – Stiffeners						
Inner Shells – Girders						
Outer Shells – Plating						
Outer Shells – Stiffeners						
Outer Shells – Girders						
Trans. End Bulkheads – Plating						
Trans. End Bulkheads – Horizontals						
Trans. End Bulkheads – Verticals						
Trans. Bulkheads Plating						
Trans. Bulkheads – Horizontals						
Trans. Bulkheads – Verticals						
Framing – Horizontals						
Framing – Diagonals						
Crossover Tunnel – Plating						
Sally Ports – Plating						
Safety Deck – Plating						
Safety Deck – Stiffeners						
Safety Deck – Girders						
Top Deck – Plating						
Top Deck – Stiffeners						
Top Deck – Girders						
Reinforcement for Attachments						
Hull Openings						
Protective Coating						
Welds, Rivets, Bolts						
Exterior Portions						
Pontoon Deck						
Pontoon Side Shells						
Wing shells – Inner & Outer						
Access Hatches						
Reinforcements for Attachments						
Attachment Fastenings						
Fendering						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ______________________________

Of Company: ______________________________

Date of Inspection: ______________________________

Inspection Checklist - Floating Dry Docks

Facility Name: ____________________

Dry Dock Designation: ____________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Dock Connections						
Shear Connections						
Alignment Connections						
Rub Plating						
Protective Coating						
Aprons/Outriggers						
Deck Plating						
Framing						
Dock Connections						
Planking						
Communication Bridge						
Decking/Grating						
Framing						
Dock Connections						
Blocking						
Keel Blocks						
Side/Bilge Blocks						
Hauling Blocks						
Miscellaneous						
Mooring Spuds & Connections						
Mooring Chains & Anchors						
Cleats						
Bollards						
Chocks						
Gratings						
Platforms/Handrails						
Watertight Doors, Hatches, Manholes						
Access for Operations & Security						
Draftboards						
Stairways/Ladders						
Ship Grounding Straps						
Welding Machine Grounds						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ____________________

Of Company: ____________________

Date of Inspection: ____________________

Inspection Checklist - Floating Dry Docks

Facility Name: ____________________

Dry Dock Designation: ____________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Concrete Hull Structure						
Pontoon Slab – Above Waterline						
Pontoon Slab – Below Waterline						
Wing Wall – Side Slabs						
Wing Wall – End Slabs						
Trans. WT Bulkhead Slabs						
Compartment Slabs						
Storage Tank Slabs						
Access Trunk Slabs						
Pontoon Framing						
Wing Wall Framing						
Storage Tank Framing						
Access Trunk Framing						
Compartment Framing						
Top Decks – Slab						
Top Decks – Attachment Fastenings						
Top Decks – Crane Rail & Supports						
Top Decks – Covering/Painting						
Safety Decks – Slabs						
Safety Decks – Attachment Fastenings						
Safety Decks – Covering/Painting						
Pontoon Deck – Slab						
Pontoon Deck – Sonar Pit Slab						
Pontoon Deck – Attachment Fastenings						
Pontoon Deck – Hatch Frames						
Pontoon Deck – Rub Plating						
Pontoon Sides – Attachment Fastenings						
Sides – Fill & Discharge Sleeves						
Pontoon Sides – SW Sleeves						
Pontoon Sides – Hawsepipe Fastenings						
Pontoon Sides – Ant. Mast Fastenings						
Pontoon Sides – Fenders						
Miscellaneous WT Sleeves						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ____________________

Of Company: ____________________

Date of Inspection: ____________________

Inspection Checklist - Floating Dry Docks

Facility Name: ______________________________

Dry Dock Designation: ______________________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Blocking						
Keel Blocks						
Side/Bilge Blocks						
Hauling Blocks						
Miscellaneous						
Mooring Spuds & Connections						
Mooring Chains & Anchors						
Cleats						
Bollards						
Chocks						
Gratings						
Platforms/Handrails						
Watertight Doors, Hatches, Manholes						
Access for Operations & Security						
Draftboards						
Stairways/Ladders						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ______________________________

Of Company: ______________________________

Date of Inspection: ______________________________

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APPENDIX B

SAMPLE GRAVING DOCK INSPECTION CHECKLIST

The following pages provide a sample checklist for the condition assessment and control inspection of graving docks. This checklist is generic and should be modified to the specific facility. The modified checklists should provide sufficient detail to ensure that 100% of the structure and operational components are inspected. For example, flood valves and dewatering pumps should be listed individually. Each item shall be rated according to the following:

(A) Satisfactory (S): The condition of the item will not result in system damage and, based on measured or estimated deterioration rate, it may be expected to remain satisfactory until the next control inspection.

(B) Marginal (M): The condition of the item will not result in major damage nor, by itself, will it make the facility unsafe to dock a ship, provided it is corrected, repaired, or replaced in a timely manner. A number of such items as a group can make the facility unsafe. This shall be evaluated by the inspector.

(C) Unsatisfactory (U): The condition of the item may cause system damage or loss and shall be corrected, repaired, or replaced immediately (if there is a ship in dock) or prior to docking a ship (if there is no ship in dock).

(D) Not Applicable (NA): The item listed in the checklist is not present on the dry dock. Note that as items are added, removed, or replaced from the dry dock, the inspection checklist shall be updated to reflect the configuration changes.

(E) Not Inspected (NI): The item was not inspected as part of the survey. It is not acceptable to mark an item NI unless there is a basis for expecting the item to be in a satisfactory condition.

Inspection Checklist - Graving Docks

Facility Name: ____________________

Dry Dock Designation: ____________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Mechanical & Electrical						
Sluice Gates						
Sluice Gate Leaf						
Sluice Gate Guides						
Sluice Gate Operator						
Sluice Gate Controller						
Hydraulic Operating Gear						
Lubrication System						
Preservation						
Check Valves						
Valve Leaves						
Swing Mechanism						
Non-slam Mechanism						
Lubrication System						
Preservation						
Stop Logs or Gates						
Guide Slot						
Log or Gate Body						
Hoisting Equipment						
Intake Screens & Trash Racks						
Preservation						
Fire Protection System						
Fire Pump						
Fire Main						
Fire Stations – Hoses, Nozzles etc.						
CO_2 Extinguishers						
Dry Chemical Extinguishers						
Miscellaneous						
Access for Operations & Security						
Lighting for Operations & Security						
Capstans						
Capstan Motors						
Capstan Motor Controllers						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ____________________

Of Company: ____________________

Date of Inspection: ____________________

Inspection Checklist - Graving Docks

Facility Name:________________________

Dry Dock Designation:________________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Basic Structure						
Coping						
Walls						
Galleries						
Altars						
Service Tunnels						
Floor						
Apron						
Caisson Seats						
Drainage Culverts						
Drainage Tunnels						
Flooding Tunnels						
Discharge Tunnels						
General Appearance						
Pressure Relief System						
Fittings						
Cleats						
Bollards						
Chocks						
Gratings						
Platforms/Handrails						
Draft Gauges						
Blocking						
Keel Blocks						
Side/Bilge Blocks						
Hauling Blocks						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By:________________________

Of Company:________________________

Date of Inspection:________________________

Inspection Checklist - Graving Docks

Facility Name: ______________________

Dry Dock Designation: ______________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Caisson Mechanical & Electrical						
Main Dewatering Pumps						
Pump Motors						
Pump Motor Controllers						
Valves & Valve Operators						
Trimming Pumps						
Pump Motors						
Pump Motor Controllers						
Discharge Valves & Valve Operators						
Flood Valves & Valve Operators						
Equalizing Valves & Valve Operators						
Vent Blower						
Blower Motor						
Motor Operator						
Power Leads (Portable)						
Transformers						
Control Panel						
Alarms						
Caisson Basic Structure						
Shell Plating						
Deck Plating						
Top Deck Covering						
Bulkhead Plating						
Structural Framing						
Fenders						
Backing for Seals						
Seals						
Fixed Ballast						
Exterior Preservation						
Interior Preservation						
Ballast Compartment Preservation						
General Condition						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ______________________

Of Company: ______________________

Date of Inspection: ______________________

Inspection Checklist - Graving Docks

Facility Name: ____________________

Dry Dock Designation: ____________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Caisson Fittings						
Hatches						
Cleats						
Bollards						
Chocks						
Gratings						
Platforms/Handrails						
Air Ports						
Compressed Air Piping						
Compressed Air Control Valves						
Inclinometers						
Water Level Indicators						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ____________________

Of Company: ____________________

Date of Inspection: ____________________

Inspection Checklist - Graving Docks

Facility Name: ______________________________

Dry Dock Designation: ______________________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Pump Room Mechanical Equipment						
Pumps						
Pump Motors						
Motor Controllers						
Shafts & Couplings						
Guide Bearings						
Impellers						
Wearing Rings						
Pump Casings						
Packing Glands						
Lubrication System						
Flanges & Gaskets						
Drainage Pumps						
Sump Pumps						
Pump Motors						
Motor Controllers						
Suction Valves & Operators						
Discharge Valves & Operators						
Check Valves & Operators						
Valve Controllers						
Air Blower Motor						
Blower Controller						
Lubrication System						
Preservation						
Pump Room Electrical Equipment						
Control Panel						
Selector Switches						
Pushbutton Controls						
Indicator Lights						
Feeder Controls						
Valve Indicators						
Water Level Indicators						
Trouble Indicators & Alarms						
Transfer Switches						
Reset Buttons						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ______________________________

Of Company: ______________________________

Date of Inspection: ______________________________

Inspection Checklist - Graving Docks

Facility Name: ______________________________

Dry Dock Designation: ______________________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Relays						
Voltmeters						
Ammeters						
Temperature Indicators						
Transformers						
Circuit Breakers						
Pump Room Services						
Compressed Air Piping & Valves						
Power Distribution Systems						
Communication Systems						
Ventilation Systems						
Dry Chemical Extinguishers						
CO_2 Extinguishers						
Pump Room Basic Structure						
Roof						
Walls						
Floor						
Pump Pits						
Suction Chambers						
Suction Bells						
General Preservation						
Pump Room Fittings						
Hatches						
Gratings						
Platforms/Handrails						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ______________________________

Of Company: ______________________________

Date of Inspection: ______________________________

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APPENDIX C

SAMPLE MARINE RAILWAY INSPECTION CHECKLIST

The following pages provide a sample checklist for the condition assessment and control inspection of marine railways. This checklist is generic and should be modified to the specific facility. The modified checklists should provide sufficient detail to ensure that 100% of the structure and operational components are inspected. For example, cradle rollers should be listed individually. Each item shall be rated according to the following:

(A) Satisfactory (S): The condition of the item will not result in system damage and, based on measured or estimated deterioration rate, it may be expected to remain satisfactory until the next control inspection.
(B) Marginal (M): The condition of the item will not result in major damage nor, by itself, will it make the facility unsafe to dock a ship, provided it is corrected, repaired, or replaced in a timely manner. A number of such items as a group can make the facility unsafe. This shall be evaluated by the inspector.
(C) Unsatisfactory (U): The condition of the item may cause system damage or loss and shall be corrected, repaired, or replaced immediately (if there is a ship in dock) or prior to docking a ship (if there is no ship in dock).
(D) Not Applicable (NA): The item listed in the checklist is not present on the dry dock. Note that as items are added, removed, or replaced from the dry dock, the inspection checklist shall be updated to reflect the configuration changes.
(E) Not Inspected (NI): The item was not inspected as part of the survey. It is not acceptable to mark an item NI unless there is a basis for expecting the item to be in a satisfactory condition.

Inspection Checklist - Marine Railways

Facility Name: ____________________

Dry Dock Designation: ____________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Cradle						
General Condition						
Decking						
Cradle Beams						
Uprights and catwalks						
Columns						
Runners						
Hauling connection						
Hauling Chain equalizer sheave						
Backing chain equalizer sheave						
Wheel Bearing Supports						
Low logs						
Groundways & Rails						
Settlement of Tracks						
Condition of Piles						
Condition of Stringers						
Condition of Cross Bracings						
Track Plates & Fasteners						
Rails & Fasteners						
Condition of Chain Guides						
Preservation						
Rail Alignment						Line and Grade
Mud & Silt Condition						
Wheels						
Wheel Bearings						
Rollers						
Roller Bushings						
Roller Frames						
Spacer Blocks						
Fittings						
Cleats						
Ringbolts						
Draftboards						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ____________________

Of Company: ____________________

Date of Inspection: ____________________

Inspection Checklist - Marine Railways

Facility Name: ____________________

Dry Dock Designation: ____________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Blocking						
Keel Blocks						
Side/Bilge Blocks						
Hauling Blocks						
Hauling Chains						
Locking Pawls						
Chains & Sheaves						
Inhaul Chains/Cable						Gage chains
Outhaul Chains						Gage Chains
Inhaul Sheaves						
Outhaul Sheaves						
Chain Connecting Links						
Sheave Fasteners						
Chain Slack & Fit						
Preservation						
Hauling Machinery						
Gearing, speed reducer						
Shafting						
Bearings						
Sprockets, Chain wheels						
Cable Drum						
Frame						
Anchor Bolts						
Electric Brakes						
Hand Brakes						
Locking Pawls						
Clutch						
Safety Guards						
Lubrication						
Preservation						
Electric Motor						
Diesel/Gas Engine						
Steam/Compressed Air Drives						
Controller						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ____________________

Of Company: ____________________

Date of Inspection: ____________________

Inspection Checklist - Marine Railways

Facility Name: ______________________________

Dry Dock Designation: ______________________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Speed Limit Device						
Electrical						
Control Board						
Switches						
Safety Devices & Alarms						
Communication System						
Public Address System						
Radios						
Fire Alarm						
Mechanical						
Bilge Block Hauling Equipment						
Warping Winches						
Head Capstan						
Fire Protection System						
Fire Pump						
Fire Main						
Fire Stations – Hoses, Nozzles etc.						
CO_2 Extinguishers						
Dry Chemical Extinguishers						
Miscellaneous						
Access for Operations & Security						
Lighting for Operations & Security						
General Condition of Winch House						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ______________________________

Of Company: ______________________________

Date of Inspection: ______________________________

APPENDIX D

SAMPLE VERTICAL LIFT INSPECTION CHECKLIST

The following pages provide a sample checklist for the condition assessment and control inspection of vertical lifts. This checklist is generic and should be modified to the specific facility. The modified checklists should provide sufficient detail to ensure that 100% of the structure and operational components are inspected. For example, hoists should be listed individually. Each item shall be rated according to the following:

(A) Satisfactory (S): The condition of the item will not result in system damage and, based on measured or estimated deterioration rate, it may be expected to remain satisfactory until the next control inspection.

(B) Marginal (M): The condition of the item will not result in major damage nor, by itself, will it make the facility unsafe to dock a ship, provided it is corrected, repaired, or replaced in a timely manner. A number of such items as a group can make the facility unsafe. This shall be evaluated by the inspector.

(C) Unsatisfactory (U): The condition of the item may cause system damage or loss and shall be corrected, repaired, or replaced immediately (if there is a ship in dock) or prior to docking a ship (if there is no ship in dock).

(D) Not Applicable (NA): The item listed in the checklist is not present on the dry dock. Note that as items are added, removed, or replaced from the dry dock, the inspection checklist shall be updated to reflect the configuration changes.

(E) Not Inspected (NI): The item was not inspected as part of the survey. It is not acceptable to mark an item NI unless there is a basis for expecting the item to be in a satisfactory condition.

Inspection Checklist - Vertical Lifts

Facility Name: ____________________

Dry Dock Designation: ____________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Hoists						
Motors						
Gears						
Brakes						
Wire Ropes						
Bearings						
Drums						
Foundation Platforms						
Anchorage						
Piles						
Pawls						
Lubrication						
Preservation						
Wiring						
Platform						
Main Transverse Beams						
Secondary Transverse Beams						
Longitudinal Beams						
Stiffeners						
Decking						
Sheaves						
Bearings						
Sheaves Housing						
Lubrication						
Tracks						
Preservation						
Pins						
Cradles						
Main Transverse Beams						
Secondary Transverse Beams						
Longitudinal Beams						
Stiffeners						
Wheels/Rollers/Roller Plates						
Roller Spindles/Wheel Axles						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ____________________

Of Company: ____________________

Date of Inspection: ____________________

Inspection Checklist - Vertical Lifts

Facility Name: ______________________

Dry Dock Designation: ______________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Block Bearers						
Preservation						
Compressed Air						
Compressors/Receivers						
Air Dryers						
Valves & Piping						
Controls						
Controls						
Circuit Breakers						
Motor Starters						
Disconnect Switches						
Limit Switches						
Load Sensors						
Load Indicators						
Cams						
Ammeters						
Voltmeters						
Push Buttons						
Drum Controllers						
Electrical Interlocks						
Mechanical Interlocks						
Indicating Lights						
Relays						
Alarms						
Transfer System						
Tracks						
Hauling Equipment						
Load Bearers						
Cradles						
Tracks						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ______________________

Of Company: ______________________

Date of Inspection: ______________________

Inspection Checklist - Vertical Lifts

Facility Name: ______________________________

Dry Dock Designation: ______________________________

Items Inspected	Condition					Remarks
	U	M	NA	NI	S	
Blocking						
Keel Blocks						
Side/Bilge Blocks						
Hauling Blocks						
Communication System						
Public Address System						
Radios						
Fire Alarm						
Power System						
Main Power Supply						
Backup Power Supply						
Power Distribution System						
Fire Protection System						
Fire Pump						
Fire Main						
Fire Stations – Hoses, Nozzles etc.						
CO_2 Extinguishers						
Dry Chemical Extinguishers						

U Unsatisfactory
M Marginal
NA Not Applicable
NI Not Inspected
S Satisfactory

Inspected By: ______________________________

Of Company: ______________________________

Date of Inspection: ______________________________

APPENDIX E

SAMPLE FLOATING DRY DOCK MAINTENANCE TASKS

This appendix provides a minimum preventive maintenance program for floating dry docks. This is meant as a starting point. If the operator has historical data to show that an alternative program is providing acceptable results, that program should be continued. Further, this preventive maintenance program is a traditional time-based program. It is suggested that metrics be obtained and studied to develop a condition-based maintenance program. A properly designed and implemented condition-based maintenance program is expected to be more efficient and cost-effective.

5-Year PM

Mooring Arm Components: Disassemble, inspect, replace/rebuild worn parts as deemed necessary, and lubricate.

Capstan Motors: Inspect and lubricate.

Water Depth: Perform hydrographic survey under dock and approaches. Dredge as required.

3-Year PM

Mooring Arm Components: Blast and recoat as needed.

Pumps and Gearboxes: Replace oil.

Biennial PM

Air Compressors: Replace oil.

Motors: Replace motor bearing oil.

Annual PM

Structural: Inspect all structural members.

Valve Operators: Inspect. Lubricate/repair as required.

Capstans: Lubricate.

Motors, Drive Gearboxes, and Drive Chains: Lubricate.

Mooring Arm Components: Inspect. Take micrometer measurements of connection pin to identify any extraordinary wear.

Oily Waste System Piping: Pneumatic pressure test.

Fuel Oil System Piping: Pressure test.

Reduced Pressure Principal Back-Flow Preventers, Pressure Vacuum Breaker Devices, and Double Check Valve Assemblies: Test.

Piping, Valves, Piping Supports, and Pipe Identification: Inspect.

Cathodic Protection: Inspect zinc/aluminum anodes and replace as necessary.

Semi-Annual PM

Phone Systems: Test operations.

Mooring Arm Components: Inspect and lubricate.

Ballast Tank Hatches: Inspect and lubricate.

Freeze Protection Valves: Maintain.

Hydraulic Fluids: Sample.

Quarterly PM

High Water Alarms: Inspect/test.

Equipment with Oil and/or Hydraulic Fluid: Inspect/add as needed.

Capstans: Lubricate.

Pumps and Pump Discharge Flap Valves: Lubricate.

Air Compressors: Inspect oil level and belts, and drain moisture from tanks.

Level Sensor Tubes: Flush.

Fire Pumps and Sprinkler Pumps: Replace snubbers.

2-Month PM

Mooring Arm Components: Lubricate slider rail.

Monthly PM

Egress Lighting Equipment: Inspect and test.

Mooring Arm T-Rails: Lubricate.

Freeze Protection Valves: Test.

Fire Pumps: Operate.

Weekly PM

Ballast System Valves and Pumps: Operate.

APPENDIX F

SAMPLE GRAVING DOCK MAINTENANCE TASKS

This appendix provides a minimum preventive maintenance program for graving docks. This is meant as a starting point. If the operator has historical data to show that an alternative program is providing acceptable results, that program should be continued. Further, this preventive maintenance program is a traditional time-based program. It is suggested that metrics be obtained and studied to develop a condition-based maintenance program. A properly designed and implemented condition-based maintenance program is expected to be more efficient and cost-effective.

PUMPWELL
Biennial PM

Drainage Pump: Change motor coolant. Remove impeller for inspection and measurement.

Main Dewatering Pump: Sample/change oil as necessary.

Annual PM

Structural: Inspect all structural members.

Wetwell Recorder: Clean and inspect.

Pressure Switches for Drainage Pump Control: Clean and inspect.

Pumpwell Air Compressor: Calibrate pressure gage and set/check pressure switch.

Motors for Vent Fans, Sewage Pump, Sump Pumps, and Air Compressor: Megger motor, megger line, clean/inspect motor controllers, inspect windings, and check wiring connections.

Main Dewatering Pump (MDP) Motor: Clean/inspect motor windings, slip rings, brush rigging, resistance grid, and contactor. Megger rotor, stator, and resistance grid.

MDP Discharge Valve and Sluice Gate Motors: Clean/inspect motor and controller. Inspect wiring insulation. Megger motor windings phase to ground.

Sluice Gates: Inspect gate, frame, thimble. Check fasteners for tightness. Check locking bolts/keys. Check clearances on frame.

Drainage Pump Motors: Clean/inspect motor and controller. Inspect wiring insulation. Check connections for tightness. Megger motor windings phase to ground. Change oil. Perform capacity checks. Record motor run times.

Drainage Pump Valve Actuators: Clean/inspect motor and controller. Inspect wiring insulation. Check connections for tightness.

Cathodic Protection: Inspect zinc/aluminum anodes and replace as necessary.

Semi-Annual PM

Pumpwell Vent Fans: Clean/inspect/preserve housing, motor, and fan blades. Inspect/replace/adjust fan belts. Check oil and lubricate.

Pumpwell Air Supply Filters: Inspect/replace.

Pumpwell Air Compressor: Inspect housing, tank, and motor. Drain condensate. Check belts. Check oil levels.

Pumpwell Sump and Sewage Pumps: Inspect/clean/preserve.

Exercise Discharge Valves. Lubricate.

Main Dewatering Pumps: Clean packing gland and fasteners. Inspect pump supports. Exercise vent valves.

MDP Line Shaft Bearings: Inspect/preserve. Check oil levels.

MDP Discharge Valves: Inspect/lubricate valve operators. Inspect valve packing. Clean packing gland and fasteners. Inspect/exercise valves.

Sluice Gates and Operators: Clean/inspect/grease stem threads. Inspect packing. Lubricate/preserve operator. Exercise gate.

MDP Check Valves: Check dashpot oil. Clean/preserve as necessary. Inspect dashpot packing. Lubricate trunion bearings.

Suction Chamber Anodes: Inspect/replace as necessary.

Drainage Pumps: Operate pumps. Inspect for leaks. Clean/preserve.

Drainage Pump Motors: Inspect/clean/preserve.

Drainage Pump Valves and Operators: Inspect/clean/preserve valves, packing and fasteners. Lubricate operators and steady bearings. Exercise operators/valves.

Drainage Pump Check Valves: Clean/preserve.

Quarterly PM

Secondary Transducer Battery Load Test: Test battery capacity under load.

Monthly PM

Pumpwell Sump Pumps: Inspect and operate floats.

High Water Level Alarm Tests: Test dry pit sump pump high level alarm. Test wetwell and dry dock transducer high water level alarms (both secondary and primary transducers). Test backup bubbler system high water alarm points.

CAISSON

Annual PM

Caisson Valves: Inspect/exercise all caisson valves.

Caisson Tank Level Indicators (TLIs): Inspect TLI panel and associated wiring, lights, and switches. Test high water alarm setpoints and alarm horns.

Cathodic Protection: Inspect zinc/aluminum anodes and replace as necessary.

Semi-Annual PM

Caisson Valves and Motors: Inspect motors, controllers, panel bussing, and receptacles. Megger motor windings. Megger lines back to caisson plug. Lubricate all valves and pumps. Inspect pump packing. Preserve as necessary.

Quarterly PM

Caisson Valves and Pumps: Inspect/exercise all valves and pumps. Add oil to motors and lubricate via grease lines.

DRY DOCK

Every 5 Years

Water Depth: Perform hydrographic survey in approaches. Dredge as required.

Biennial PM

Dry Dock Suction Grates: Inspect suction grates by sluice gates.

Annual PM

Tunnel Gates and Operators: Clean/inspect/grease stem threads. Inspect packing. Lubricate/preserve operator. Exercise gate. Inspect gate, frame, and thimble. Check fasteners for tightness. Check locking bolts/keys. Check clearances on frame.

Semi-Annual PM

Tunnel Gate Operator Motors: Inspect motor for signs of overheating or damaged wiring. Inspect\clean motor controller. Megger motor phase to ground. Megger line from controller to breaker.

Tunnel Gate and Operator: Check grease levels in operator. Clean/preserve operator. Exercise gate. Exercise inner seat drain valve. Inspect mooring cleat, chocks, and bollards. Inspect/exercise sump pump and drain valve.

Monthly PM

Dry Dock Tunnel Gates: Inspect/exercise sump pump and floor drain.

CAPSTANS

Annual PM

Capstans: Inspect motor and machinery foundations. Inspect structural fasteners. Inspect motor case and gearbox for cracks. Inspect for worn defective or misaligned couplings, bushings, shafts, pins, gears, and drums. Check lubricant levels. Check brake pad thickness. Operate capstans and observe proper function of motors, controls, brakes, and gears.

Semi-Annual PM

Capstans: Inspect controller. Inspect cables, wiring, and pendant controller. Megger capstan motor. Lubricate motor if necessary. Inspect capstan brakes. Lubricate upper capstan shaft.

Monthly PM

Capstans: Inspect/preserve/clean capstans and capstan pits. Check oil levels. Exercise capstans in both speeds in both directions.

APPENDIX G

SAMPLE MARINE RAILWAY MAINTENANCE TASKS

This appendix provides a minimum preventive maintenance program for marine railways. This is meant as a starting point. If the operator has historical data to show that an alternative program is providing acceptable results, that program should be continued. Further, this preventive maintenance program is a traditional time-based program. It is suggested that metrics be obtained and studied to develop a condition-based maintenance program. A properly designed and implemented condition-based maintenance program is expected to be more efficient and cost-effective.

Every 5 Years

Hauling Chain: Gauge inhaul and outhaul chain.

Water Depth: Perform hydrographic survey under cradle and approaches. Dredge as required.

Every 2 Years

Track: Check track gauge, line, and grade.

Annually

Structural: Inspect all structural members.

Power and Control Systems: Inspect mechanical and electrical components.

Cathodic Protection: Inspect zinc/aluminum anodes and replace as necessary.

Prior to Each Block Build

Cleanliness: Clean railway and associated work area.

Structure: Inspect cradle structure and fasteners.

Fixed Blocks: Inspect keel blocks and fixed side blocks.

Sliding Blocks: Inspect sliding side blocks, sliding, locking, and hauling hardware.

Prior to Each Cradle Movement

Tracks: Wash rollers and tracks.

Bearings: Grease bearings.

Downhaul System: Inspect downhaul chain/cable, check attachment point, and adjust tension.

Blocks: Check all block straps and fasteners.

Cleanliness: Clean railway and associated work area. Remove foreign material from cradle.

Brake: Inspect brake.

APPENDIX H

SAMPLE VERTICAL LIFT MAINTENANCE TASKS

This appendix provides a minimum preventive maintenance program for vertical lifts. This is meant as a starting point. If the operator has historical data to show that an alternative program is providing acceptable results, that program should be continued. Further, this preventive maintenance program is a traditional time-based program. It is suggested that metrics be obtained and studied to develop a condition-based maintenance program. A properly designed and implemented condition-based maintenance program is expected to be more efficient and cost-effective.

Every 10 Years

Wire Hoist Ropes: Replace all.

Hoist Motors: Strip, clean, and examine stator windings. Renew bearings and reassemble.

Lift Platform: Ultrasonically inspect butt welds. Visually inspect structure for corrosion loss.

Every 8 Years

Upper Sheave Bearings: Strip and examine one set.

Every 5 Years

Hoist Gear Box: Replace oil.

Water Depth: Perform hydrographic survey under cradle and approaches. Dredge as required.

Every 2 Years

Protective Coatings: Touch up hoist and cradle paint as necessary.

Hoist Motors: Inspect flexible couplings.

Annually

Structural: Inspect all structural members.

Hoist Pawls: Inspect for proper engagement

Gear Box Oil: Test and replace as necessary.

Fasteners: Check all bolts for tightness, particularly those on rope clamps and drum open gear.

Solenoid Air Gap: Check.

Brakes: Dismantle and check the friction and stationary discs. Check torque.

Hoist Motors: Test insulation resistance.

Lower Sheaves: Strip and examine one set.

Cathodic Protection: Inspect zinc/aluminum anodes and replace as necessary.

Every 6 Months

Hoist Cables: Inspect.

Upper Sheaves: Lubricate bearings.

Limit Switches: Grease actuator rod.

Pawl Shafts: Lubricate.

Brakes: Clean, inspect, check torque and solenoid air gap.

Every 3 Months

Gear Boxes: Check oil level.

Weekly

Wire Ropes: Inspect and lubricate as required.

Open Gears: Inspect and lubricate as required.

Lower Sheave Bearings: Grease.

Platform Decking: Inspect.

Transfer System: Inspect and lubricate cradle wheel bearings.

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