ESSENTIAL ROLE OF DRY DOCK IN SHIP MAINTENANCE

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AGENDA

- Introduction to Dry Docking
- Dry Docking Process & Phases
- Engineering Work in Dry Dock
- Risk, Compliance & Management
- Case Studies
- Future & Conclusion

Introduction to Dry Dock

What is Dry Docking?

Dry docking is the process of placing a vessel into a dry facility for inspection, maintenance and repairs that cannot be done while afloat. It allows access to the hull, propeller, rudder, sea chest, and other underwater components.

Introduction to Dry Dock

Why is Dry Docking Important?

Dry docking ensures ship safety, operational reliability, and compliance with regulatory standards.

It prevents marine growth, corrosion, and structural degradation, all of which could lead to inefficiencies or failures.

Protecting Lives:

- To minimize the risk of injury or death to crew members and passengers.

Protecting Property:

- To prevent damage to the ship and its cargo.

Protecting the Environment:

- To minimize the risk of pollution and environmental damage.

Maintaining Operational Efficiency:

- To increased efficiency and productivity.

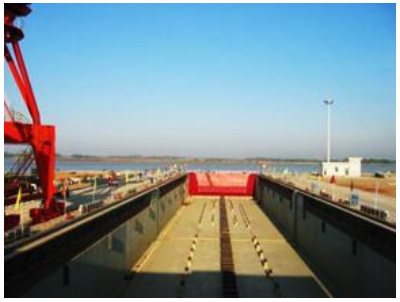
Compliance with Regulations:

Legal requirement for all ships, contribute to the overall safety of the maritime industry.

Introduction to Dry Dock

Types of Dry Docks

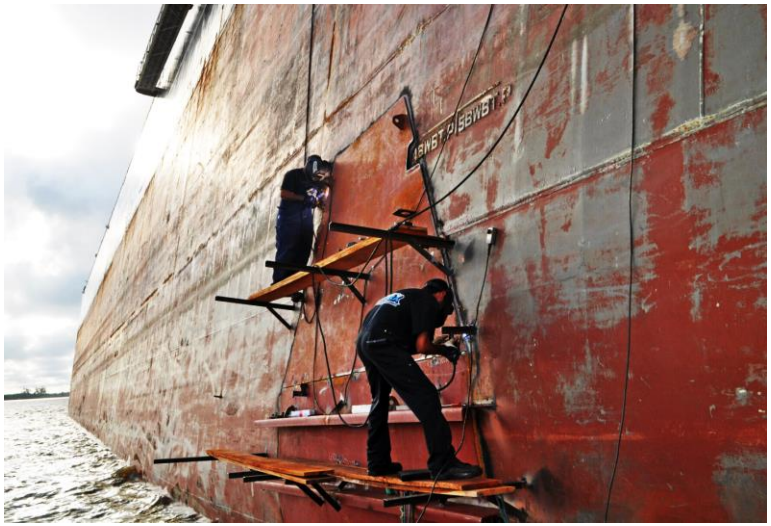
- Graving Dock: Permanent concrete basin below sea level.
- Floating Dock: Movable structure that submerges to allow ship entry.
- Syncrolift: Platform lifts ships out of water vertically.
- Slipway: Rail-based hauling system for small to medium ships.



Introduction to Dry Dock

Dry Docking vs Wet Docking

Wet docking involves afloat repairs, while dry docking permits access to submerged areas.



Introduction to Dry Dock

Global Standards and Guidelines

IMO regulations and class society (IACS) requirements define periodic dry docking intervals and inspections (e.g., ABS, DNV, BV, LR).

Name	Abbreviation	Formed	Head office
American Bureau of Shipping	ABS	1862	Houston
Bureau Veritas	BV	1828	Paris
Croatian Register of Shipping	CRS	1949	Split
China Classification Society	CCS	1956	Beijing
DNV	DNV	1864	Oslo (Norway)
Indian Register of Shipping	IRClass	1975	Mumbai
Lloyd's Register	LR	1760	London
Korean Register of Shipping	KR	1960	Busan
Nippon Kaiji Kyokai	ClassNK	1899	Tokyo
Polish Register of Shipping	PRS	1936	Gdańsk (Poland)
Registro Italiano Navale	RINA	1861	Genoa
Türk Loydu	TL	1962	Istanbul (Turkey)

Introduction to Dry Dock

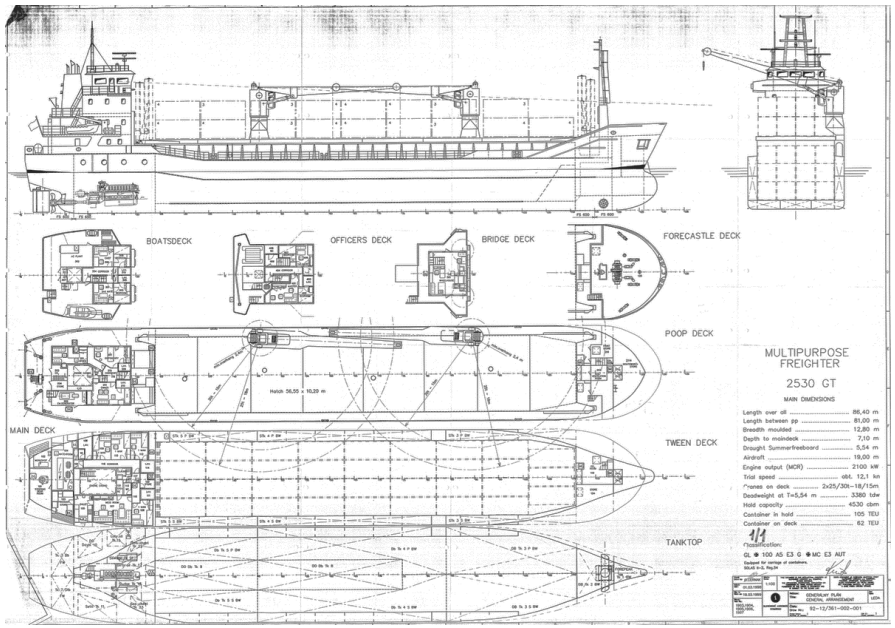
Dry Docking Frequency

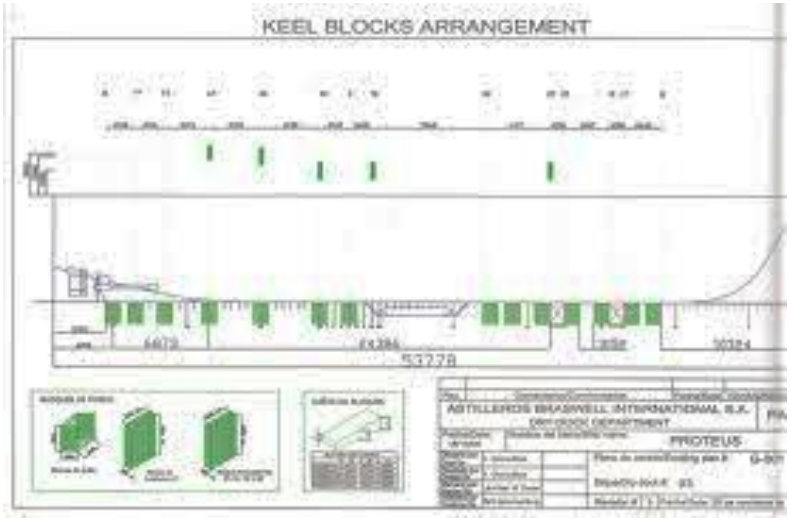
- Annually afloat survey
- Every 2.5 to 5 years

Dry Dock Process & Phases

Planning and Preparation Phase

Dry dock slot booking, block plan preparation, material arrangement, and crew coordination are essential.





Dry Dock Process & Phases

Pre-Docking Inspection

- A pre-docking inspection is a comprehensive assessment of a vessel's condition before it undergoes dry docking for maintenance or repairs.

- Identify potential issues,
- Plan necessary work, and
- Acquire required spare parts in advance,
- Saving time and money.

Dry Dock Process & Phases

Docking Operation

- Entering dock
- Ballasting/de-ballasting
- Positioning on keel blocks
- Draining the dock

Dry Dock Process & Phases

Maintenance Scope Overview

Tasks cover mechanical work, hull treatment, electrical repairs, and class-required inspections.

- Hull Maintenance,
- Engine and Machinery Maintenance,
- Electrical and Electronic Systems,
- Deck and Outfitting,
- Pipe and Valve Systems,
- Safety Equipment,
- Structural Repairs,
- Underwater Services,
- Tank Cleaning and Maintenance,
- Specialized Systems

Dry Dock Process & Phases

Undocking Process

Reverse of docking: sea water flooding, clearance checks, and tug-assisted departure.

- Inspection and Testing
- Securing the Vessel
- Dock Flooding
- Tugboat Positioning
- Initial Movement
- Guiding Lines
- Tugboat Assistance
- Gate Clearance
- Final Departure
- Final Inspections
- Departure

Dry Dock Process & Phases

Post-Docking

Sea trial performance, engine monitoring, and inspection results determine the success of dry docking.

- The ship may be fitted with a Doppler speed log or a Sal log in the case of older ships. These equipments are to be serviced and calibrated.
- The dry dock provides the best situation for verification since any transducers fitted underwater can be thoroughly checked and renewed if they are faulty.

(6) SACRIFICIAL ZINC ANODES OR IMPRESSED CURRENT SYSTEM

- All zinc sacrificial anodes are to be renewed. Most of them would be completely wasted, if any un-wasted anodes are found they are not of good quality and hence must be renewed.
- The number of zinc anodes should not be reduced as they are calculated as a total quantity of zinc to be distributed all over the hull surface especially on the bilge keels, the stern portion and on the rudder.
- The total mass of zinc used is proportional to wetted surface area of the ship and the mass of the propeller.
- If the ship is fitted with an impressed current system then it must be serviced and calibrated.

(7) SEA CHESTS CLEANING AND PAINTING.

- All ships are fitted with at least 2-3 sea chests in the machinery space area. They are high sea suction , the low sea suction and the emergency fire pump sea suction.
- Their suction grids are to be dismantled and cleaned.
- The internal surface of the chests have to be scraped clean of all growth.

Dry Dock Process & Phases

Dry Docking Timeline

Typical durations: 15 to 30 days, depending on vessel type and scope.

Dry Dock Process & Phases

Dockyard Facilities

Includes cranes, mechanical shops, paint booths, hydraulic testing benches, and power systems.

DRY DOCKING OPERATION

- Key step of Dry Dock Operation
  - Water Filling
  - Dock Gate Opening
  - Vessel Entering
  - Positioning & Align on center line
  - Docking Gate Closing
  - Water Pump Out
  - Vessel Seated on Docking Block
  - Chamber Cleaning

INSPECTION AND DOCKING REPAIR PRACTICES

- **Dock Master and Docker Team**
  - Manages and oversees all dry dock activities, ensuring safety and efficiency.
  - Coordinates with various teams and departments to align work schedules and priorities.
  - Supervises the docking and undocking processes.
  - Safely guide the vessel into the dry dock, positioning it accurately using blocks and supports.
  - Monitor the docking process to prevent any accidents or misalignments.
  - Secure the vessel in place to ensure stability during maintenance and repairs.

INSPECTION AND DOCKING REPAIR PRACTICES

- Vessel Safety Coordination Committee Meeting (VSCC)
  - Yard Representative and Team
  - Owner Representative, and Ship Crew
  - Safety Officer
  - Contractors
    - Steel, Pipe & Valve,
    - Underwater Shaft & Rudder, Propeller
    - Painting & Blasting, Machinery, Electrical, Cleaning, etc
  - Surveyor, Makers and Third parties, etc
  - Defect Lists or Repair Job Scope

INSPECTION AND DOCKING REPAIR PRACTICES

- Defect Lists or Job Scope
  - Marine Surveyor (IACS) - Class Requirements
    - Intermediate Survey
    - Special Survey
  - Ship maintenance teams (MS, Master and CE)
    - Defect Lists
      - Engine Depts
      - Deck Depts

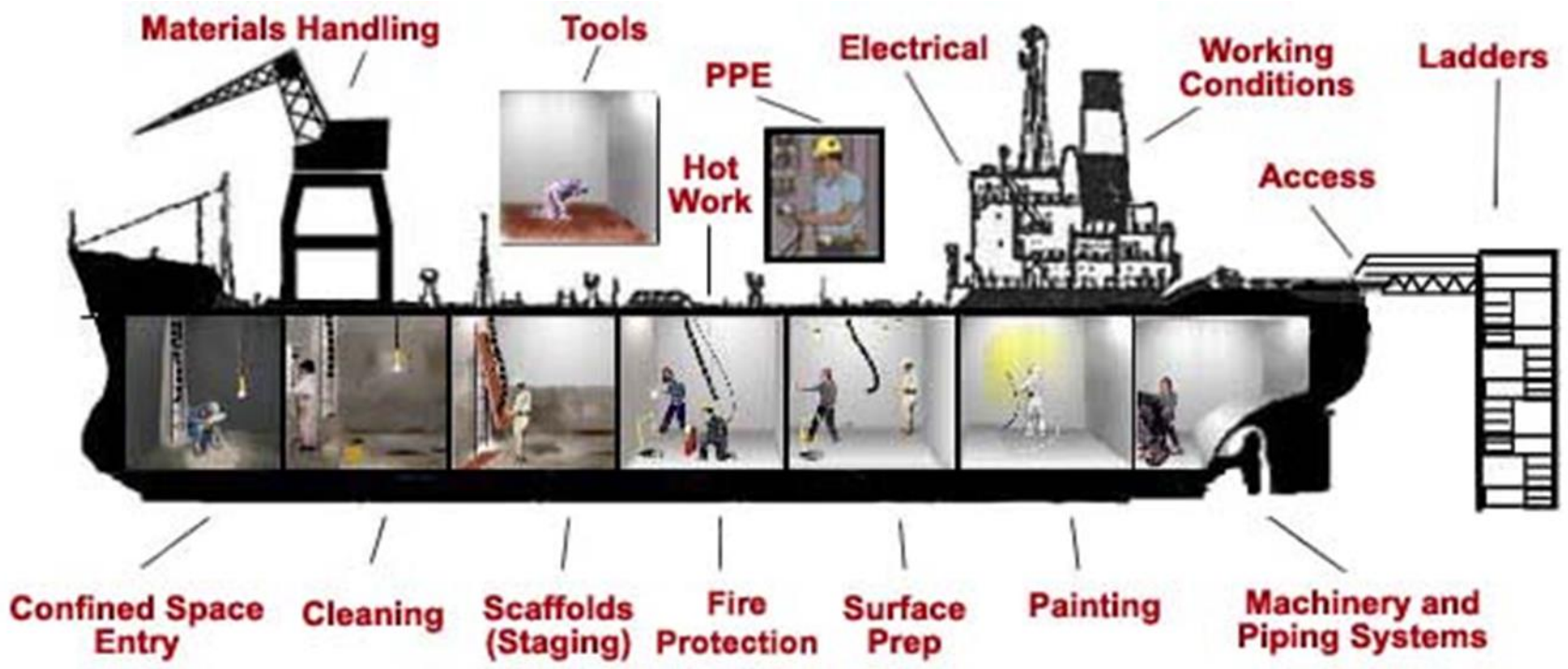
INSPECTION AND DOCKING REPAIR PRACTICES

- Defect Lists or Job Scope
  - Deck Depts
    - Painting & blasting
    - Anchor & chain
    - Hull & outfitting , etc. (TM reports)
  - Engine Depts
    - Pipe & Valves, Pump & Motors
    - Electrical
    - Under work (Propeller, Shaft, Rudder), etc.

INSPECTION AND DOCKING REPAIR PRACTICES

- Initial Dry Docking Inspection
  - Docking block and additional support
  - Echo Sounder and Transducer
- Hull Inspection
  - Corrosion, Cathodic Protection, and Damage Condition
- Underwater
  - Propeller, rudder, sea chest grating and rope guard

DRY DOCK GENERAL WORKING CONDITION



INSPECTION AND DOCKING REPAIR PRACTICES

- Hull and Outfitting
  - Steel Work according to TM Reports
  - IACS Class (NK,
  - Side Shall Plate
  - Deck Plate
  - Bulkhead Plate
  - Internal Structure

SURVEY REQUIREMENTS

ANNEX 1

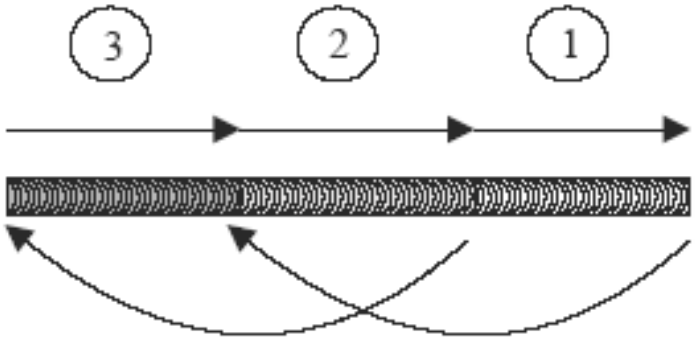
REQUIREMENTS FOR CLOSE-UP SURVEY AT RENEWAL SURVEYS

Age ≤ 5 years Renewal Survey No. 1	5 < Age ≤ 10 years Renewal Survey No. 2	10 < Age ≤ 15 years Renewal Survey No. 3	Age > 15 years Renewal Survey No. 4 and subsequent
(A) 25% of shell frames in the forward cargo hold at representative positions (A) Selected frames in remaining cargo holds (B) One transverse web with associated plating and longitudinals in two representative water ballast tanks of each type (i.e. topside, or hopper side tank) (C) Two selected cargo hold transverse bulkheads, including internal structure of upper and lower stools, where fitted (D) All cargo hold hatch covers and coamings (plating and stiffeners)	(A) All shell frames in the forward cargo hold and 25% of shell frames in each of the remaining cargo holds including upper and lower end attachments and adjacent shell plating (A) For bulk carriers of 100,000 dwt and above, all shell frames in the forward cargo hold and 50% of shell frames in each of the remaining cargo holds, including upper and lower end attachments and adjacent shell plating. (B) One transverse web with associated plating and longitudinals in each water ballast tank (B) Forward and aft transverse bulkhead in one ballast tank, including stiffening system (C) All cargo hold transverse bulkheads, including internal structure of upper and lower stools, where fitted (D) All cargo hold hatch covers and coamings (plating and stiffeners) (E) All deck plating and under deck structure inside line of hatch openings between all cargo hold hatches	(A) All shell frames in the forward and one other selected cargo hold and 50% of frames in each of the remaining cargo holds, including upper and lower end attachments and adjacent shell plating (B) All transverse bulkheads in ballast tanks, including stiffening system (B) All transverse webs with associated plating and longitudinals in each water ballast tank Areas (C), (D), and (E) as for renewal survey No.2	(A) All shell frames in all cargo holds including upper and lower end attachments and adjacent shell plating. Areas (B)–(E) as for column 3

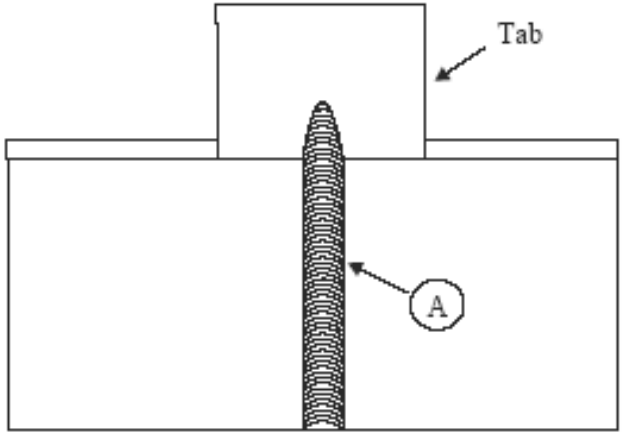
STEEL GRADES ACCORDING TO CLASSIFICATION SOCIETIES' RULES

Steel grades according to Classification Societies' rules (ref. 5)							Comparable steel grades			
Grade	Yield stress R_{eH} min. N/mm^2	Tensile strength R_m N/mm^2	Elongation A_5 min. %	Average impact energy Temp. ^oC	J, min. L	J, min. T	ISO 630-80 4950/2/3/ 1981	EN EN 10025-93 EN 10113-93	ASTM A 131	JIS G 3106
A				+20	-	-	Fe 360B	S235JRG2	A	SM41B
B	235	400-502	22	0	27	20	Fe 360C	S235J0	B	SM41B
D				-20	27	20	Fe 360D	S235J2G3	D	(SM41C)
E				-40	27	20	-	S275NL/ML	E	-
A 27				0			Fe 430C	S275J0G3	-	-
D 27	265	400-530	22	-20	27	20	Fe 430D	S275N/M	-	-
E 27				-40			-	S275NL/ML	-	-
A 32				0			-	-	AH32	SM50B
D 32	315	440-590	22	-20	31	22	-	-	DH32	(SM50C)
E 32				-40			-	-	EH32	-
A 36				0			Fe 510C	S355N/M	AH36	SM53B
D 36	355	490-620	21	-20	34	24	Fe 510D	S355N/M	DH36	(SM53C)
E 36				-40			E355E	S355NL/ML	EH36	-
A 40				0			E390CC	S420N/M	AH40	(SM58)
D 40	390	510-650	20	-20	41	27	E390DD	S420N/M	DH40	-
E 40				-40			E390E	S420NL/ML	EH40	-

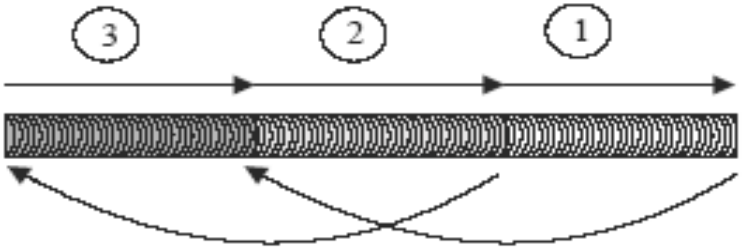
WELDING REPAIR FOR CRACKS

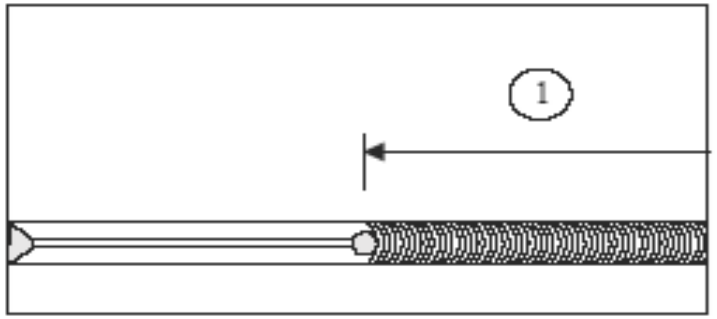


Step back technique



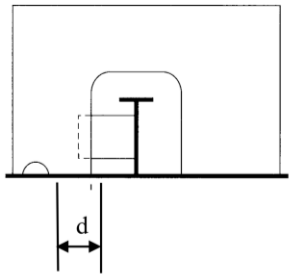
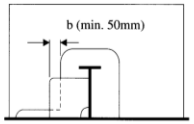
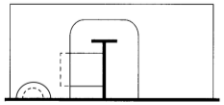
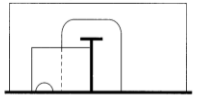
End crack termination

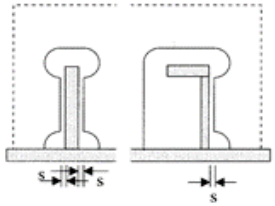
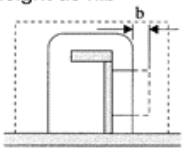




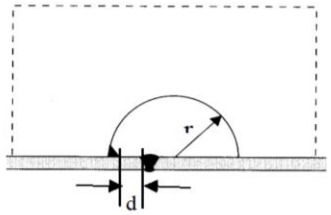
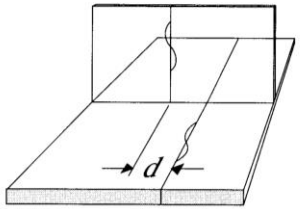
Welding sequence for cracks with length less than 300mm

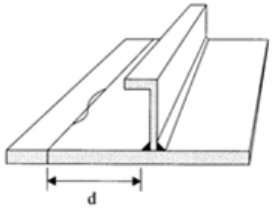
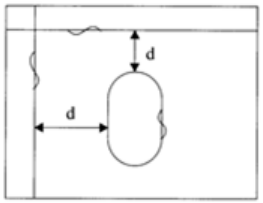
MISALIGNMENT REMEDIAL

Detail	Remedial standard	Remarks
Position of scallop  	When d < 75 mm web plate to be cut between scallop and slot, and collar plate to be fitted  Or fit small collar over scallop  Or fit collar plate over scallop 	

Detail	Remedial standard	Remarks
Gap around stiffener cut-out  	When 3 mm < s ≤ 5 mm weld leg length to be increased by the same amount as increase in gap in excess of 2 mm When 5 mm < s ≤ 10 mm nib to be chamfered and built up by welding When s > 10 mm cut off nib and fit collar plate of same height as nib  20 mm ≤ b ≤ 50 mm	

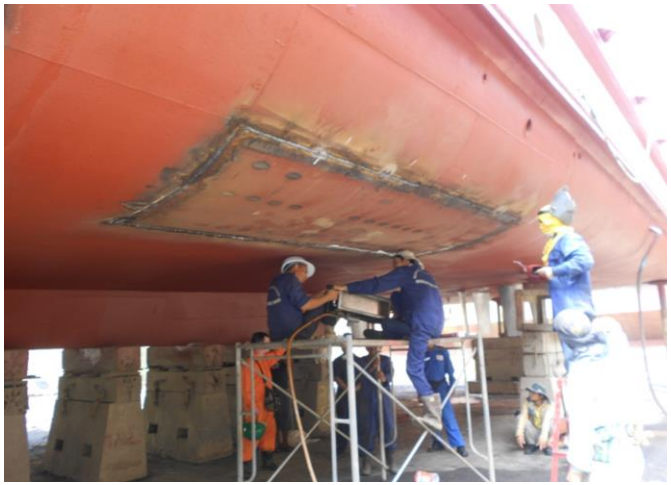
DISTANCE BETWEEN WELDS

Detail	Standard	Limit	Remarks
Scallops over weld seams 		for strength member d ≥ 5mm for other d ≥ 0mm	The “d” is to be measured from the toe of the fillet weld to the toe of the butt weld.
Distance between two butt welds 		d ≥ 0 mm	

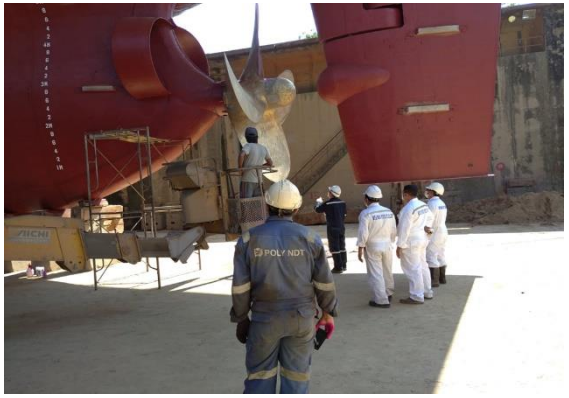
Detail	Standard	Limit	Remarks
Distance between butt weld and fillet weld 		for strength member d ≥ 10 mm for other d ≥ 0 mm	The “d” is to be measured from the toe of the fillet weld to the toe of the butt weld.
Distance between butt welds 	for cut-outs d ≥ 30 mm		
	for margin plates d ≥ 300 mm	150 mm	

INSPECTION AND DOCKING REPAIR PRACTICES

- Bottom Plate Renewal
  - Class Welder
  - NDT (Vacuum Box)
  - Welding Procedure Specification (WPS)
  - Safety Measure



INSPECTION AND DOCKING REPAIR PRACTICES



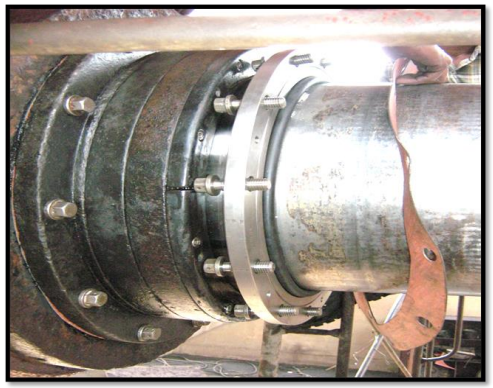
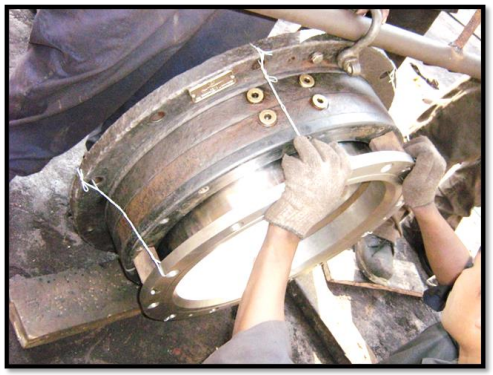
Inspection of UT , LPT, Visual Check by Third Party Inspection and NK Class Surveyor

INSPECTION AND DOCKING REPAIR PRACTICES

Bottom plate,
deck plate and hatch coaming visual check by Class Surveyor

INSPECTION AND DOCKING REPAIR PRACTICES

- Tail Shaft
  - Check the stern tube for oil leakage
  - Cut off the rope guard and note any fouling by fishing nets or cables/ropes
  - Measure the wear down

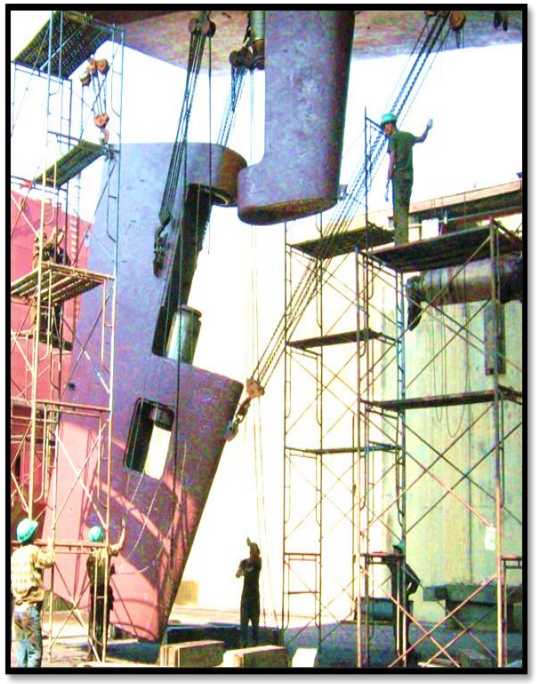




INSPECTION AND DOCKING REPAIR PRACTICES

- Propeller
  - Inspect blade surfaces for erosion, pitting, impact damage, and bending.
  - Polishing rudder blades

INSPECTION AND DOCKING REPAIR PRACTICES

- Rudder
  - Measure the clearances of all bearings
  - Check jumping clearance
  - Welding seam and blade thickness
  - Pressure test
  - Check the true position of the rudder
  - Function test after inspection



INSPECTION AND DOCKING REPAIR PRACTICES

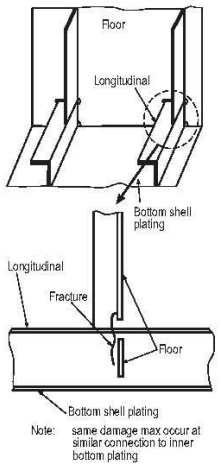
Spare propeller replacement as recommended by the NK Class Surveyor

INSPECTION AND REPAIR PRACTICES

No. 84 (cont)

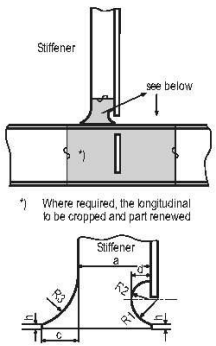
CONTAINER SHIPS	Guidelines for Surveys, Assessment and Repair of Hull Structure	
Part 1	Cargo hold region	Example No.
Area 4	Double bottom tank structure	3
Detail of damage	Fractures in longitudinal at floor or bulkhead	

Sketch of damage



Note: same damage may occur at similar connection to inner bottom plating

Sketch of repair



*) Where required, the longitudinal to be cropped and part renewed

Various cutout shapes have been developed. The following ist one example.
1. Toe height as small as possible (h = 10 - 15 mm)
2. Depth "d" of key hole notch as small a possible, max. 30 mm
3. For a slope at toe max. 1 : 3
4. R1 = 1.5 d
   R2 = d and
   R3 = 1.5 c

Notes on possible cause of damage

1. Damage can be caused by stress concentrations leading to accelerated fatigue in this region.

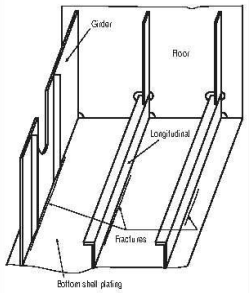
Notes on repairs

1. If fractures extends to over one third of the depth of the longitudinal, then crop and part renew. Otherwise the fracture can be veed-out and welded.

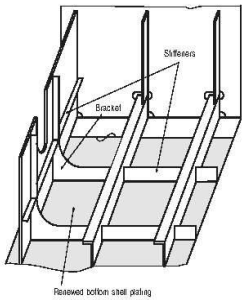
No. 84 (cont)

CONTAINER SHIPS	Guidelines for Surveys, Assessment and Repair of Hull Structure	
Part 1	Cargo hold region	Example No.
Area 4	Double bottom tank structure	7
Detail of damage	Fractures in bottom plating alongside girder and/or bottom longitudinal	

Sketch of damage



Sketch of repair



Notes on possible cause of damage

1. Vibration.

Notes on repairs

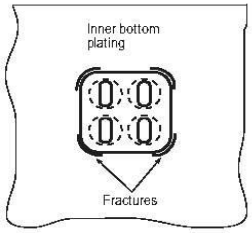
1. Fractured bottom shell plating should be cropped and renewed.
2. Natural frequency of the panel should be changed, e.g. reinforcement by additional stiffener/bracket.

INSPECTION AND REPAIR PRACTICES

No. 84 (cont)

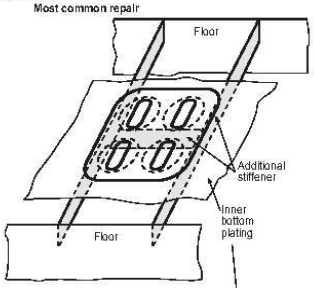
CONTAINER SHIPS	Guidelines for Surveys, Assessment and Repair of Hull Structure	
Part 1	Cargo hold region	Example No. 1
Area 4	Double bottom tank structure	
Detail of damage	Fractures in inner bottom plating around container bottom pocket	

Sketch of damage

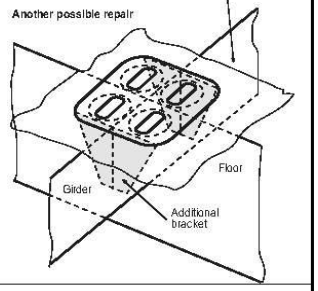


Sketch of repair

Most common repair



Another possible repair



Notes on possible cause of damage

1. Pocket is not supported correctly by floor, longitudinal and/or stiffener.

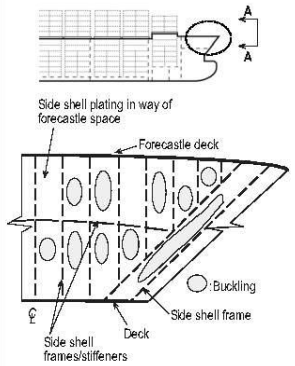
Notes on repairs

1. Fractured plating should be cropped and part renewed.
2. Adequate reinforcement should be considered.

No. 84 (cont)

CONTAINER SHIPS	Guidelines for Surveys, Assessment and Repair of Hull Structure	
Part 2	Fore and aft end regions	Example No. 4
Area 1	Fore end structure	
Detail of damage	Deformation of side shell plating in way of forecastle space	

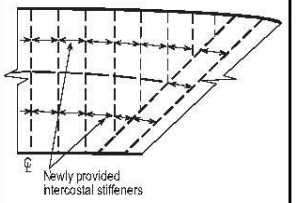
Sketch of damage



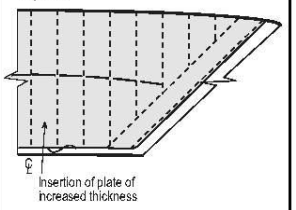
View A - A

Sketch of repair

Repair A



Repair B



Notes on possible cause of damage

1. Heavy weather.
2. Insufficient strength.

Notes on repairs

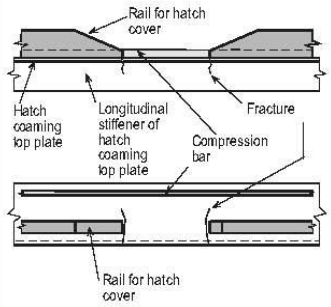
1. Deformed part should be cropped and part renewed.
2. **Repair A**
Additional stiffeners between existing stiffeners should be considered.
Repair B
Insertion of plate of increased thickness without additional stiffeners.

INSPECTION AND REPAIR PRACTICES

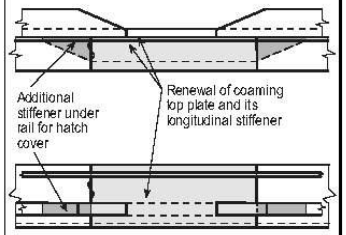
No. 84 (cont)

CONTAINER SHIPS	Guidelines for Surveys, Assessment and Repair of Hull Structure	
Part 1	Cargo hold region	Example No.
Area 1	Upper deck structure including passageways	8-a
Detail of damage	Fractures in hatch coaming top plate at the termination of rail for hatch cover	

Sketch of damage



Sketch of repair



Notes on possible cause of damage

1. Stress concentration at the termination of the rail for hatch cover due to poor design.

Notes on repairs

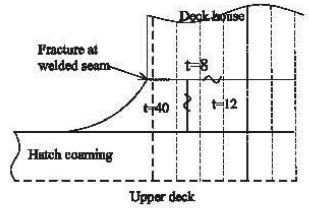
1. Fractured plate is to be cropped and part renewed.

2. Thicker insert plate and/or reinforcement by additional stiffener under the top plate should be considered. Also refer to **Example 9-b**.

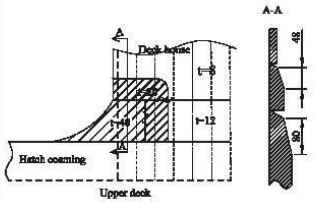
No. 84 (cont)

CONTAINER SHIPS	Guidelines for Surveys, Assessment and Repair of Hull Structure	
Part 1	Cargo hold region	Example No.
Area 1	Upper deck structure including passageways	17
Detail of damage	Fractures in the cconnections between hatch coaming and bulkhead of deck house	

Sketch of damage



Sketch of repair



Notes on possible cause of damage

1. Stress concentration at the welding seam between plates with great differences of thickness.

Notes on repairs

1. Inserting plates with medium thickness between the plates with great differences of thickness.

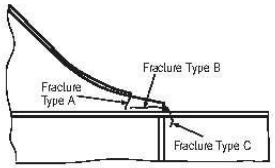
2 The plate to be tapered from thick plate to thin one

INSPECTION AND REPAIR PRACTICES

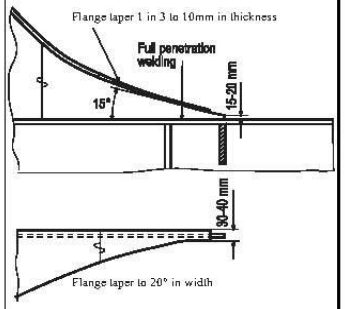
No. 84 (cont)

CONTAINER SHIPS	Guidelines for Surveys, Assessment and Repair of Hull Structure	
Part 1	Cargo hold region	Example No.
Area 1	Upper deck structure including passageways	5
Detail of damage	Fractures in continuous longitudinal hatch coaming extension bracket	

Sketch of damage



Sketch of repair



Notes on possible cause of damage

1. Flange force at the end of the flange too high due to insufficient tapering (**Fracture Type A**, propagating in the web).
2. Shear force in the web plate too high due to insufficient reduction of the web height at the end (**Fracture Type B**, propagating in the web at the undercut or HAZ of the fillet weld).
3. Insufficient support of the extension bracket below the deck (**Fracture Type C**, starting from undercut or HAZ of the fillet weld and propagating in the deck plating).

Notes on repairs

1. Extend the extension bracket as long as possible to arrange a gradual transition.
2. Reduce the web height at the end of the bracket; in case of high stress areas grind smooth the transition to the deck plating welding.
3. Reduce the cross sectional area of the flange at the end as far as possible. Such as flange taper 1 in 3 to 10mm in thickness and taper 20°in width.

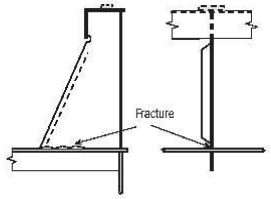
4 Provide longitudinal structure in way of the web of the extension bracket to the next transverse structure or provide a new transverse structure.

5. The web plate to be cropped and renewed with new plate which increase in thickness of 30-50%, if it does not become excessive

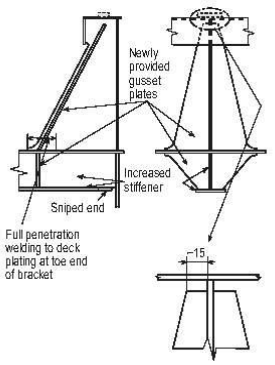
No. 84 (cont)

CONTAINER SHIPS	Guidelines for Surveys, Assessment and Repair of Hull Structure	
Part 1	Cargo hold region	Example No.
Area 1	Upper deck structure including passageways	12-a
Detail of damage	Fractures in web of transverse hatch coaming stay	

Sketch of damage



Sketch of repair



Notes on possible cause of damage

1. Insufficient consideration of the horizontal friction forces in way of the resting pads for hatch cover.

Notes on repairs

1. Modification of the design of the hatch coaming stay.
2. Full penetration welding between gusset plates and deck plating.
3. Strengthening and continuation of the structure below the deck.
4. Use pads with smaller coefficient of friction.

Engineering Work in Dry Dock

Hull Cleaning and Painting

Removal of marine fouling and corrosion products, followed by primer and antifouling application.

To prevent biofouling and reduce drag, improving fuel economy.

Engineering Work in Dry Dock

Cathodic Protection

- Sacrificial anodes (zinc/aluminum)

A more reactive metal, like zinc or aluminum, is attached to the ship's hull.

- Impressed Current Cathodic Protection (ICCP)

An external power source (like a transformer-rectifier) provides a controlled electrical current to the ship's hull.

- Extends Ship Lifespan
- Reduces Maintenance Costs
- Dynamic Adjustment (Current out put - speed)

Engineering Work in Dry Dock

Propeller Maintenance

Propeller polishing, checking for cracks, and dynamic balancing are essential.

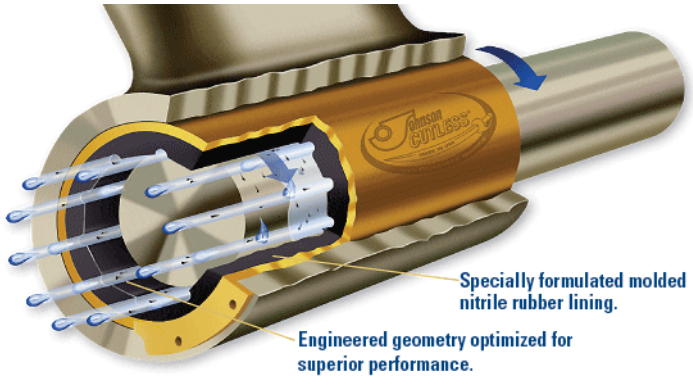
Engineering Work in Dry Dock

Shaft and Stern Tube Work

Includes shaft alignment, bearing inspections, and seal checks.

Stern Tube Bearings:

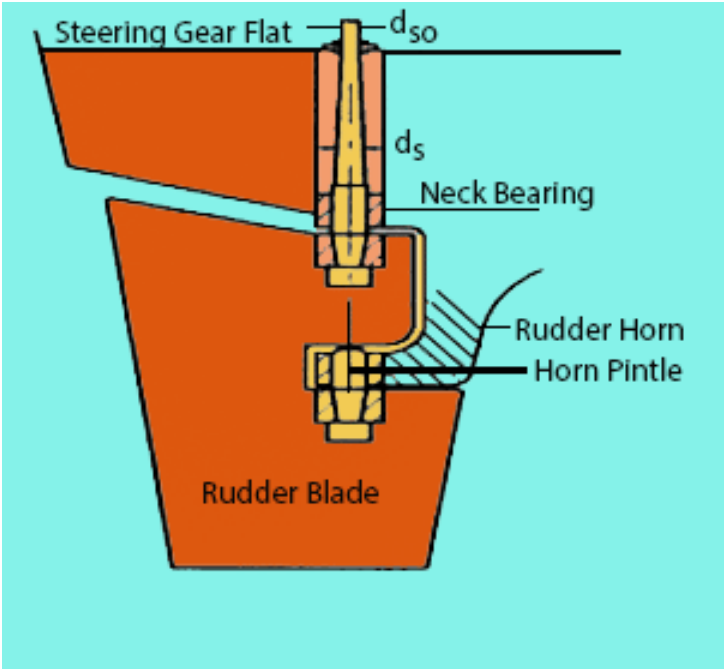
Special attention is needed for stern tube bearings, as they are critical for supporting the propeller shaft. Water-lubricated and oil-lubricated systems have different alignment requirements



Engineering Work in Dry Dock

Steering Gear and Rudder Maintenance

Includes ram alignment, seal replacement, and greasing.



Engineering Work in Dry Dock

Valve and Sea Chest Servicing

Strainers cleaning, valve disassembly, gasket replacement, and hydro-testing.

Risk, Compliance & Management

Safety Measures in Dry Dock

- Hot work permits
- PPE enforcement
- Confined space entry protocols
- Fire watch

Risk Assessment

Evaluation of hazards including slips, toxic fumes, and falling objects.

Risk, Compliance & Management

Environmental Compliance

Wastewater, used paint, and oil must be properly disposed according to MARPOL.

Risk, Compliance & Management

Cost Breakdown

- Dock charges
- Labor
- Materials
- Surveys and class fees

Risk, Compliance & Management

Consequences of No Dry Docking

- Increased fuel usage
- Higher insurance premiums
- Class certificate withdrawal

Insurance and Class Compliance

Underwriters require up-to-date dry docking records for hull and machinery cover.

Risk, Compliance & Management

Project Management Tools

Use of Gantt charts, work breakdown structures (WBS), and reporting systems.

Dry Dock Delay Case Examples

- Spare part delays
- Weather issues
- Discovery of unexpected damage

Risk, Compliance & Management

Case Study

Container Ship Hull cleaning resulted in 12% fuel efficiency improvement.

Tanker Coating Renewal Re-blasting and epoxy coating added 5 years to tank life.

Rudder Stock Crack discovered during MPI, repaired and certified.

Before vs After dry dock: repairs reduce operational expenditure.

Future & Conclusion

Sustainable Practices

Eco-friendly coatings, zero-waste systems, and energy-efficient lighting.


THANK YOU
FOR YOUR ATTENTION