DRY DOCKING
AND
HULL PAINTING
OF A SHIP

BY
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**DRYDOCKING AND LAY UP REPAIRS**

*By S.N. Batra*

**TYPES OF DRYDOCKS**

- Floating Dock
- Slipway
- Synchrolift
- Graving Dock
- Beaching

**IN-WATER SURVEYS**

**REASONS FOR DRYDOCKING SHIPS**

- Mandatory inspection of U/W portion, propeller & rudder—Not exceeding 2.5 years
- Hull cleaning & painting
- Owners inspection interval—Less than 2.5 yrs
- Assess extend / nature of damage—Essential damage repairs
- Sell vessel
- Guarantee drydocking

**QUOTATIONS / TENDERS**

- Obtain defect lists from ship for repairs / surveys to be carried out during dry docking / lay up
- Ships particulars i.e. length, breadth, tonnage, draft, trim etc
- Based on above ask for quotations for necessary repairs and dry docking from various suitable ship yards

**MAIN OBJECTIVE OF JOB SPECIFICATION**

The SPEC. should give all info necessary to carry out the job according of the intentions of the shipowner & the ship requirements from authorities / class, in such a way that the yard is able to give most accurate price and is able to plan the work

**TYPICAL JOB DESCRIPTION**

- Detailed descrp. - work to be done, dimensions, wt., materials, drawings / sketches, location, access — staging, dependence on other work, availability of spares, specialists or special tools reqd, short description of fault, testing

**EVALUATION OF BIDS / TENDERS**

- Time reqd for completion
- Quality of bid—whether realistic
- How many repr. specs quoted
- Price
- Reservations / conditions by yard and its impact
- Conditions of payment
- Cost
DISTANCE TO YARD
PREVIOUS KNOWLEDGE ABOUT YARD
CAPACITY TO COPE WITH EXTRA WORK
RELIANCE ON TIME LIMITS GIVEN
CLIMATE
LANGUAGE PROBLEMS
POLITICAL SITUATION / CUSTOMS REGULATIONS
SPARES AVAILABILITY / TRANSPORT

REPAIR SPECS—ENGINE
REPAIRS / SURVEY OF M/E, A/E, PUMPS ETC. AS REQ'D / DUE
PIPELINES IN MACHINERY SPACES
BOILERS
CARGO PUMPS
MTCE / REPR. OF ELECT MOTORS
MTCE / REPR. OF DECK MACHINERY
SPECIALISED SERVICING OF EQUIP

REPAIR SPECS—HULL
STEEL RENEWAL / REPAIRS ON SHIPSIDE HOLD, TANKS PLATES, DOUBLE BOTTOMS ETC.
CLEANING / PAINTING SHIPS HULL
PIPELINES ON DECK, TANKS ETC.
ANCHOR, ANCHOR CABLES, MOORING EQUIPMENT
O/HAUL, TESTING CARGO GEAR
SERVICING NAV. / ELECTRONIC EQUIP
INSPECTION, SURVEY, TESTING DB TANKS

RECORDS
LAST DD / PAINTING REPORT
SURVEY REPORT
DEFICIENCIES—CONDITION OF CLASS, IF ANY

SPARES
CHECK AVAILABILITY / CONDITION OF SPARE TAILSHAFT
SPARE PROPELLER
SHAFT SEALS
COUPLING BOLTS
SPARES REQ'D FOR MACHINERY DUE FOR SURVEY / REPAIRS E.G. BLR TUBES, T/C BRGS /
LO PUMPS, T/C ROTOR, PUMP & PIPPERS ETC.

SHORE CONNECTIONS / FACILITIES
CHECK LOCATION / CAPACITY FOR:
ELECTRIC POWER
FRESH WATER
STEAM
WATER FOR FIREMANS
GARBAGE DISPOSAL
OTHER FACILITIES—TOILET, PHONE, CABIN HEATING, ALTERNATE ACCOM. (IF REQ'D)
PREPARATIONS FOR DRYDOCKING LAYUP

MAX. ALLOWABLE TRIM
BALLAST / FUEL DISTRIBUTION—BEFORE, AFTER AND ON FLOATING
FIRE SAFETY
CLEANLINESS -HOLDS, TANKS, ENG. ROOM AND E.R. BILGES
TANKERS—ALL TANKS, LINES, PUMP ROOM, FILTERS—CLEAN & GASFREE
SLOP TANKS—TO EMI'TY

DRAWINGS
DOCKING PLAN
SHELL EXPN. PLAN
G.A. PLAN
MIDSHIP PLAN
DECKS AND DOUBLE BOTTOMS
RUDDER
PROPELLER AND SHAFTING
SHIPSIDE VALVES LOCATION PLAN

SPECIAL TOOLS
PROP SHAFT WEAR DOWN GAUGE
RUDDER DROP GAUGE
DISMANTLING DEVICES
HYDR-DEVICES FOR PROP NUT
PROP NUT SPANNER

DRYDOCK ENTRY
SHIPS TANK CONDITIONS - INFORM YARD DOCKMASTER WHO MUST CONFIRM
ACCEPTANCE
MONITOR DD PUMPING OUT AND CHECK WHEN TAKEN TO BLOCKS
CHECK WATER LEVEL IN DD. SHUT OFF AUX ENGINES PRIOR LOSING SUCTION
READY RECEIVE SHORE POWER / WATER SUPPLY. RECORD METER READING

DOCKING SURVEY
ON COMPL. OF H.P. JET WASHING
FOLLOWING INSPECTIONS:—
SHIPS HULL
ANCHORS AND CABLES
SEASUCTION GRIDS AND CHESTS
RUDDER—RUDDER DROP, PINTLE, JUMPING CLEARANCES, RUDDER SWUNG
PROP.—BLADES SHAFT CLEARANCES, SEAL LEAKAGES
ECHO SOUNDER / SAL LOG

SAFETY IN DRYDOCK
RESPONSIBILITY OF MASTER AND
CHIEF ENGR.
DAILY SAFETY MEETING—SHIP MGMT TEAM, SUPDT, YARD MGR. TO DISCUSS / PLAN DAY
TO DAY WORK, INCL. HOT / HAZARDOUS WORK & PRECAUTIONS
AWARENESS OF HOTWORK LOCATIONS, PROPER SUPERVISION AND SUITABLE
PRECAUTIONARY / PREVENTIVE MEASURES TAKE
FIRE PATROL ROUND THE CLOCK
ESTABLISH EFFECTIVE MODES OF COMMUNICATION EMERGENCY SIGNALS
EMERGENCY RESPONSE PROCEDURES
DRAWN UP IN CASE OF FIRE, OIL/GAS LEAKAGE, INJURY, NATURAL CALAMITIES
CHECK DISPLAY PHONE NOS OF FIRE STATION, HOSPITALS, FIRST AID POLICE, AND CO.AGENTS & SUPDTS.
ENSURE WATER PRESS IN FIRE MAINS, AVAILABILITY OF FIRE EXTINGUISHING MEDIUM INSTRS./PRECAUTION RE OPERN. OF PUMPS, VVS WHICH CAN CAUSE ACCIDENTAL RELEASE OF OIL/GAS
ENSURE SAFE/ ADEQUATE VENTILATION, LIGHTING AND STAGINGS SHIP TO BE EARTHEd (GROUNDED)
PRECAUTIONS FOR HOTWORK--HOTWORK PERMIT
FENCING AND CAUTION SIGNS AT ALL OPENINGS SPACES--MANENTRY PERMIT
PRECAUTIONS --MONITOR ATMOS. FOR MANENTRY
VERIFY/ MAINTAIN SHIPYARD SAFETY PRECAUTION
DAILY CLEANLINESS --REMOVAL OF GARBAGE, SLUDGE AND DEBRIS. FINAL CLEANUP BALLAST ROUTINE / DEBALLASTING TO PLAN WITH PRIOR APPROVAL OF YARD. INFORM ALL CONCERNED TRIALS/ TESTS AFTER APPROVAL OF YARD UNDER RESPONSIBLE SUPERVISION

SCOPE OF DRYDOCKING WORK
BOTTOM INSPECTION.--ACTION AS RECOMMENDED BY SURVEYOR
HULL PREPARATION & PAINTING AS PER OWNERS PAINTING SPECS
ANCHOR CABLES RANGING AND CALIBRATION
CLEANING AND PAINTING CHAIN LOCKER
ECHOSOUNDER TRANSUDCERS--CLEAN AND CHECK W.T. TERMINAL BOX IN DBT.
SAL LOG PILOT TUBE OR DOPPLER SPEED LOG TRANSUDCERS
SACRIFICIAL ZINC ANODES
SEA CHESTS CLEANING AND PAINTING
SEA SUCTION / DISCHARGE VALVES OVERHAUL AND SURVEY
SANITARY STORM VALVES OVERHAUL
RUDDER PINTLE AND JUMPING CLEARANCES
PROPPELLER DROP & OIL SEAL
PROP POLISHING AND BLADE REPAIRS IF REQD
PROP SHAFT SURVEY IF DUE

SHAFT SEALS
CHECK FOR LEAKAGE UNDER FULL PRESS.
IF LEAKING, RENEW LIP RINGS
CHECK GARTER SPRINGS
CHECK S.S. SLEEVE: FOR GROOVING MACHINE/ POLISH OR RENEW
IF TSS NOT DUE, SHIFT SLEEVE BY INSERTING JOINT AT FLANGE AT PROP. BOSS

CHECKS ON TAIL SHAFT DURING SURVEY
KEY AND KEYWAY--MUST BE A GOOD FIT
FIT OF PROP ON TAPERED PORTION--ABSENCE OF FRETTING MARKS INDICATES GOOD FIT IF ABOVE IS SUSPECT. CAN BE IMPROVED BY CHECKING BEDDING THE PUSHPUP ETC.
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FIT OF PROP ON TAPERED PORTION--ABSENCE OF FRETTING MARKS INDICATES GOOD FIT IF ABOVE IS SUSPECT, CAN BE IMPROVED BY CHECKING BEDDING THE PUSHPUP ETC.
PROPELLERS—FITTING ON SHAFT

TRADITIONAL
MATING TAPERED BORE OF PROP BOSS TO CONICAL END OF PROP SHAFT IS FORCED IN BY NUT
SURFACE CONTACT REQD = 70-80%
KEY FITTED TO TAKE ON ADDL TORQUE
CONTROLLED FITS
AS POWER REQD TO BE TRANSMITTED INCREASED EXTEND OF INTERFERENCE REQD
DIFFICULT TO ACHIEVE, IN EXTREME CASES LEADING TO FAILURE OF KEY/KEYWAY AND SHAFT
IN THE HYDR. PILGRIM NUT AXIAL LOADS CAN BE CALCULATED / MONITORED TO ENSURE ACCURACY OF INTERFERENCE ACHIEVED
KEYLESS PROPPELLERS
GEOMETRY OF KEYWAY RESULTS IN DISCONTINUITIES, LEADING TO STRESS CONCENTRATIONS OR CRACKS
WITH IMPROVED / HYDR. METHODS OF FITTING AND ACHIEVING NECESSARY (INCREASED) INTERFERENCE – KEYS DISPENCED
THE PROP BOSS IS "EXPANDED" BY OIL PRESSURE IN THE GROOVES AT THE SAME TIME PUSHING UP THE PROP. THE PUSHUP CAREFULLY MONITORED.

UNDOCKING
STABILITY OF VESSEL– DISCUSS CHANGES WITH MASTER FOR APPROVAL
INFORM MASTER COMPL. OF ALL U/W WORK WHO WILL THEN CONVEY TO YARD
LEAVE ALL SHIPSIDE: VALVES OPEN
STOP FLOODING, JUST BEFORE SHIP OFF THE BLOCKS AND CHECK FOR LEAKAGES
INCASE OF LEAKAGES, MAY HAVE TO PUMP OUT DD TO RECTIFY SAME
IF ALL OK, INFORM MASTER – RECOMMENCE FLOODING
START POWER PLANT,CW PUMPS ETC.

Later
1st (last day) – L x B x 1
other days – L x B x 1.5
HULL PAINTING IN DRY DOCK

EFFECTS OF HULL ROUGHNESS
- Reduction/drop in ship speed
- Increased engine power required to maintain same speed
- Skin resistance in water increases resulting in increased fuel consumption

CAUSES OF HULL ROUGHNESS
- Initial surface condition of steel plates
- Rusting causing surface rust due to wrong application technique
- Fouling - marine "growth" and barnacles

CORROSION DURING OPERATION
- Certain amount of corrosion takes place if
  - Quality of paint poor
  - Due abrasion, contact damage, paint scrapes off exposing bare metal
  - Resulting in corrosion

FOULING
- Fouling - growth of marine plants, animals on structures in the sea
- Sea is teeming with marine life with all types of fish, animals and organisms, some can only be seen with aid of microscope
- Larvae of some organisms e.g. mussels, sponges, sea anemones, barnacles and weeds get attached to any hard surface when in reproduction phase
- These larvae cause fouling as they settle and metamorphose into stationary attached organisms
- Similarly when plant spores arrive, a sea weed appears, small at first but grows steadily if left alone
- Once settled, the adhesion is permanent and subsequent killing of the adult will not influence its adhesion to the substrate
- Occurrence of fouling varies with time of the year, geographical locality, presence of currents and water depth

MAINTAINING SMOOTH HULL
- Corrosion protection with paints good quality paints
- Cathodic protection
- Long lasting anti-fouling treatment
- Proper surface preparation
- Correct application of paints

PAINTS
- Paint consists of:
  - Solids
  - Pigments
  - Binder
  - Extenders/fillers
  - Solvents
TYPES OF PAINT

CONVENTIONAL PAINTS
- Bituminous paints -- based on asphalt, bitumen or coal-tar pitch and solvent, physically drying
- Alkyd resin paints -- based on drying oil e.g. linseed oil, castor oil, fish oil

ADVANCED PAINTS
- Chlorinated rubber -- physically drying
- Vinyl tar -- physically drying
- Epoxy / Epoxy tar -- chemical curing
- Polyurethane -- chemical curing
- Zinc silicate

PAINT CONTRACT
- Paint is the 2nd most expensive consumable item on the ship
- Normally a long term contract with reputed int'l. paint manufacturer signed for the fleet
- Paint manufacturer recommends a painting scheme for painting diff. parts of the ship
- Supplies painting manual / data sheet to each contracted ship

PAINTING SCHEME / DATA SHEET
- Trade name and type of paint
- Method of application
- Drying and overcoating time
- Dry & wet film thickness of each coat of paint
- No. of coats of each type of paint to be applied
- Solid content (vol%) of the paint

SURFACE PREPARATION
- It is an integral part of painting system
- Proper surface preparation essential for long life and effectiveness of paint coating system
- Two main objectives
  - To remove loose material viz. scale, dirt, oxide film, grease so that paint adheres properly to surface
  - To increase surface area of substrate by increasing roughness and anchor pattern of the surface

BLAST CLEANING
- Nowadays corrosion on the ships hull is removed by grit or shot blasting with help of CoM. R. Air at 7 kg/cm. Grit is "shot" on ships plate thru special nozzle from a dist. of 20-40 cm
- The grit impact removes all loose rust or paint and slightly roughens the surface

DEGREE / STD OF BLAST CLEANING
- Most commonly used standards are defined by the Swedish Standards Institution viz. Sa1, Sa2, Sa 2.5, Sa 3
- These grades are described / defined along with sample photographs
- Best way to judge degree of shot blasting/cleaning is comparison with comparators / photos published by SSI
- Most painting schemes recommend Sa 2.5
MANUAL SCRAPING/ WIRE BRUSHING
- Areas where shot blasting cannot be carried out disc sander/elect. wire brushes used
- Hand chipping not used these days as it dents/damages surfaces, increasing hull roughness

APPLICATION OF PAINTS
- Painting the ship in dry dock done by spray and not by brush or roller
- There are two types of spray painting
  - Air spray—paint mixed with medium press. air (~10kg/sq.cm) sprayed thru suitable nozzle
  - Nowadays solid injection (airless spray) system used, injects paint at high press. (100-450kg/sq.cm) without mixing any thinner or air
- Compressed air used only to operate H.P. paint injection pump

PRIOR COMMENCEMENT OF PAINTING
- All surface contaminants viz. salt, dust, rust, scale, grease must be removed
- Corroded areas cleaned by grit blasting
- Surface washed down with F.W. blown by comp. air and be absolutely clean

PAINT FILM THICKNESS
- The painting scheme/data sheet gives the recommended paint film thickness for each coat
- This thickness of the layer or coat of paint applied can be measured when
  - When paint dry—dry film thickness (DFT)
  - Paint still wet—wet film thickness (WFT)

MEASUREMENT OF DFT AND WFT
- DFT by elect. gadget based on ultra sound principle indicates layer in microns, accurate only on very smooth surfaces—impractical for use on ships hull
- WFT—Toothed measuring gauge of diff. depths pressed on freshly applied paint indicates paint layer in microns (as demonstrated)

DFT / WFT RELATIONSHIP
- Paint data sheet shows the solid content of the paint of say 40%, therefore the solvents = 60%
- When the paint dries up, solvents = 0
- And dry layer = 40% (solid content)
- Conclusion—DFT = WFT x % solid content
DRYING / CURING TIME
• DRYING TIME OF PAINT SPECIFIED IN PAINT DATA SHEET
• CURING TIME - THE MIN. INTERVAL AFTER WHICH NEXT COAT APPLIED ALSO SPECIFIED
• PAINT MAY BE "TOUCH DRY" BUT MUST BE FULLY CURED AND DRIED BEFORE NEXT
  COAT APPLIED
• IF NOT FULLY CURED AND OVER PAINTED LOWER LAYER STILL SOFT WILL
  "SHIFT" LEADING TO UNEVEN SURFACE

LAYERS / COATS OF PAINT
• PAINTING SCHEME SPECIFIES NO. OF COATS OF EACH TYPE OF PAINT TO BE APPLIED ON
  BARE STEEL AFTER BLAST CLEANING AS SHOWN IN NEXT SLIDE
• SUPERVISORY STAFF MUST CHECK WFT OF EACH COAT OF PAINT APPLIED, ENSURE
  ADEQUATE CURING INTERVAL (DEPENDING ON AMBIENT TEMP. WEATHER CONDITIONS)
  BEFORE THE NEXT COAT IS APPLIED

PERILS OF POOR SURFACE PREPARATION
• NO PAINT SYSTEM WILL PERFORM UNLESS SURFACE PROPERLY PREPARED
• CONTAMINENTS SUCH AS DUST, GREASE, SALT ETC. REDUCE CONTACT, LEADING TO
  POOR ADHESION
• IMPROPER CONTACT BETWEEN NEW PAINT AND STEEL ALLOW POCKETS OF AIR TO
  REMAIN, FORMING CORROSION CELLS BENEATH NEW PAINT FILM

WEATHER CONDITIONS / MOISTURE
• PAINT & MOISTURE NEVER COMBINE
• PAINTING TO BE CARRIED OUT IN DRY WEATHER
• CHECK AMBIENT TEMP / HUMIDITY.
• IF HUMIDITY > 85% - STOP WORK
• CHECK DEW PT.
• TEMP OF STEEL BEING PAINTED TO BE AT LEAST 3 DEG.C, ABOVE DEW PT

WHAT SHOULD BE CONTROLLED / LOGGED
• TYPE OF WORK
• AIR TEMP MAX. / MIN.
• STEEL TEMPERATURE
• % RELATIVE HUMIDITY
• THE DEW-POINT
• VENTILATION
• AREA OF GRIT-BLASTED OR PAINTED SURFACE
• CONSUMPTION OF GRIT OR PAINT
• TYPE OF PAINT AND PROD NO.
• DRYING TIME MAX. / MIN.
• CONTROL OF DRY-FILM THICKNESS
• ANY IRREGULARITIES
• GENL WEATHER CONDITION