Royal Australian Navy Apprentice Training Establishment

SHIP HUSBANDRY

CONTENTS

CHAPTER 1

HULL MAINTENANCE

0101. INTRODUCTION

1. In the days of sail "Ship Husbandry" was the term used to denote all aspects of ship maintenance - hull, rigging, and weapons. As science and invention have made machinery, weapons and other equipments more and more intricate, the term "Maintenance" has tended to become associated with the technical work of the specialist departments only. Many aspects of the equally important work of hull maintenance have become accepted as non-technical and too often attention is paid to appearance, rather than material preservation.

2. With the realisation, during the 1939-45 War, of the enormous importance of Damage Control, came the appreciation of the need to treat hull maintenance on an equal footing with the maintenance of technical equipments. From that time the term "Ship Husbandry" has gradually been restored to the Naval vocabulary, to denote the various aspects of ship maintenance which are not specifically within the provinces of the Technical Departments.

3. Although a great part of such work is, strictly the responsibility of the Seaman Department, it must be stressed that the responsibility is shared by all departments and by every member of the ships company. Also the application of science to the problems of hull maintenance is beginning to introduce methods and procedures which preclude consideration of ship husbandry as an entirely non-technical activity; therefore instruction, training, practice, and experience now assume a greater importance than before.

0102. GENERAL

1. The hull of a ship provides a buoyant, and stable platform of suitable strength to carry the guns, aircraft, machinery, and other equipment with which it is desired to fit her. The problem of hull maintenance is largely one of preserving this buoyancy, stability and strength, and is the concern of every man in the ship, officers as well as sailors. Firstly, because the size of the task demands the co-operation of all hands, as much by avoiding bad practices, as by direct participation in maintenance and repairs, and secondly, because everyone on board has a personal interest in making sure that the ship can withstand the stress of weather and action damage.

2. Although hull maintenance is a big task, it can be made much easier, if it is organised methodically, if the knowledge of the experts on board is used for advice, and for training of the less skilled men, and if full and careful use is made of the mechanical aids provided. None of these are difficult if tackled with common sense and team spirit; but it must be realised that hull maintenance is not merely a means of occupying unskilled labour. It is a vital, semi-skilled task calling for careful planning, sound training, and close supervision. Because much of the work is laborious and repetitive, it is also a fruitful field for sound leadership.

0103. THE RULES OF SHIP HUSBANDRY

Sound hull maintenance will only be achieved if the basic rules of ship husbandry are observed. These are -

(a) Immaculate cleanliness.

(b) Prevention of malpractice and slovenly habits.

(c) Correct use of equipments, fittings, and aids to maintenance.

(d) Correct stowage of equipments, fittings, and aids to maintenance.

(e) Provision of adequate and prompt maintenance effort - both for the prevention and repair of damage.

(f) Use of safety precautions.

0104. CLEANLINESS

1. Apart from its effect on the health, comfort and well-being of the ships company, cleanliness plays a direct part in sound hull maintenance; not only does dirt make the visual inspection of structure more difficult, but, because it harbours moisture, it fosters deterioration of every kind.

2. The basic rule for cleanliness is that, if the awkward corners are kept clean the rest will almost look after itself: for example, in a passageway of a ship, if the tops of the carrier plates, fan trunks, and the spaces behind and under bulkhead fittings and hatch coamings are kept clean, it is a simple job to clean the bulkheads and decks, and to polish the brightwork; if, on the other hand, the difficult corners are dirty, no amount of brightwork and new paint will prevent the passage appearing dingy, while, at the first vibration or shock of gunfire, the dirt will rain down and the whole space will be filthy again.

Other points about cleaning techniques are -

(a) Always use the authorised cleaning materials and nothing else.

(b) Use clean materials, and when washing down, change the water frequently.

(c) Never use more water than is absolutely necessary: drying up afterwards makes extra work, and any moisture remaining will quickly set up corrosive cells.

0105. PREVENTION OF MALPRACTICE

1. It is regrettably true that a large proportion of the work of hull maintenance is caused by carelessness and bad practices of one kind or another: it is, therefore a positive part of ship husbandry to see that such practices are stopped.

2. A few examples are -

(a) Sweeping rubbish down scuppers.

(b) Throwing rubbish down WCs; urinals, sinks and wash-basins.

(c) Spilling water, oil, etc from buckets when carrying them to the gash chutes.

(d) Throwing cigarette packets, cigarette ends, and matchsticks on the deck instead of using the receptacles provided.

(e) Stubbing out cigarette ends on wooden decks and linoleum.

(f) Burning mess tables with cigarettes and irons.

(g) Leaving milk bottles and cartons around the ship instead of disposing of them properly.

(h) Dropping heavy articles down ladders thus breaking the treads and handrails.

(j) Dropping hatch covers, thus damaging coatings and rubber joints.

(k) Painting over grease nipples, tally plates, and rubber gaskets.

(l) Standing on, or slinging hammocks from pipes, valves and other fittings which are not designed to take such a load.

0106. CORRECT USE

The equipment in ships has been designed and developed for specific tasks; if it is used for any other purpose it will inevitably be damaged. For instance, if branch pipes are used as hammers their flanges will be distorted and they will be useless when they are most needed to fight a fire; similarly, if mechanical aids are used incorrectly or for the wrong purpose nothing useful will be achieved, the ships structure and fittings will be damaged, or the machine itself will break down - in any event time and labour will have been wasted, extra work and expense will be incurred in repairing the damage, and laborious manual work will again be needed while the machine is unserviceable.

0107. CORRECT STOWAGE

It is easy to appreciate that gear left sculling around will deteriorate rapidly, collect dirt, and, sooner or later, will be lost or damaged. It is less obvious that equipment which is stowed in its correct place, may also be deteriorating quickly, because it has been incorrectly stowed, for example -

(a) Boats inadequately chocked will become distorted and develope leaks.

(b) Canvas stowed away while it is still damp will rot and may start fires by spontaneous combustion.

(c) Berthing wires on their reels may appear quite ship-shape under neat canvas covers; but if the wires have not been properly dried and preserved they will rust unseen and may be extremely dangerous when subsequently used.

(d) To ensure safe handling and stowage of paint remover, the basis of which is an extremely volatile material, all such paint removers are to be stored in authorised screw topped containers only On no account should press-on lids be used.

0108. RESPONSIBILITIES OF OFFICERS AND SENIOR SAILORS

1. The responsibilities of various Officers for the maintenance of the hull and its fittings are laid down in BR 31 Queens-Regulations and Admiralty Instructions, Chapters 27, 29, 32, 54, 55, 56, BR 3000 Marine Engineering Manual, Chapters 06, 08, 12, 24, 25, 26, 28, ABR 5016 Regulations and Instructions for the RAN Chapters 29 (Section II) 41, 42, 43 and 54, ANOs and other publications, but nothing in these regulations absolves the Departmental and Divisional Officers of their responsibility for ensuring that their departments and parts of ship are maintained to the highest possible standard, and that defects do not arise through carelessness or abuse. The same considerations apply to senior sailors of every branch of the service. Constant repression of the bad practices mentioned above is an integral part of the senior sailors duty 'to ensure that order and regularity are preserved in his vicinity among those men, of whatever branch and whether on duty or not, who hold a rank junior to him'- *see* BR 31 Articles 1853 and 1854.

2. Officers and senior sailors also have a responsibility for ensuring that reasonable economy is exercised in the use of materials for maintenance. One means of exercising this economy is the system of valuation allowances of consumable naval stores. Where these allowances are consistently or heavily exceeded, it is usually due to lack of planning or inadequate supervision. Not only does this lead to a waste of money, but it generally implies that time and labour have been wasted, and poor results achieved.

0109. OTHER ASPECTS OF HULL MAINTENANCE

1. Although the problem of hull maintenance is mainly one of combatting corrosion, there are a host of items to be attended to in addition to the main hull structure.

2 The most important of these are the watertight closures: the doors, hatches, scuttles, escape scuttles, square ports, valves etc which close off the holes provided for access and for the passage of pipes, cables, ventilation trunking etc. It is on the efficiency of these closures, and their ability to prevent interflooding that the safety of the ship depends when holed

3 Finally there are many items which play their part in the safety and efficiency of the ship, her smartness and comfort. Such items as anchors and cables, replenishment at sea fittings, running and standing rigging, awnings and other canvas gear, wooden decking, tiles and linoleum, domestic equipments and systems, mess and cabin furniture etc. Their upkeep depends on regular examination and maintenance, correct stowage and proper use, proper cleaning methods, and the avoidance of bad practices at all times.

0110. PRECAUTIONS

1. As with all activities on board ship, there are many precautions designed to try to avoid accidents and damage to the ship and her personnel, which are relevant to hull maintenance It is in his own interest that every man should make himself familiar with them and discipline himself to obey them implicity, however trivial the occasion may seem.

2. Some reminders are noted below -

(a) Ventilate confined spaces before entering.

(b) Test air for oxygen content with a Davies Safety Lamp.

(c) Test air with an explosimeter before entering a space which has contained fuel or other volatile liquid.

(d) Obtain a gas free certificate for fuel tanks.

(e) Observe smoking rules when fuelling, ammunitioning and entering confined spaces.

(f) Beware of toxic fumes when spray painting.

(g) Remove inflammable material before welding.

(h) Take care when operating heavy or armoured hatches.

(j) When working aloft attach tools with lanyards and draw "safe to transmit" keys.

(k) Use lifelines when working over the side.

(l) Use protective gloves when using paint remover.

(m) Use protective clothing and eyeshields when working with de-rusting fluid, welding equipment, spray painting equipment, descaling and wire-brushing machines.

3. Details of these and other safety precautions are published regularly in ANO's and are also contained in BR 3000, BR 31, ABR 5016, ABR 19, DNC Welding Handbook, ABR 4.

CHAPTER 2

EXAMINATION AND TESTS OF HULL AND STRUCTURE

0201. INTRODUCTION

Unlike weapons and machinery whose condition can largely be assessed during operation from the evidence of performance and gauge readings, the state of the hull must be investigated almost entirely by simple tests. Regular inspection of all parts of the hull structure and prompt rectification of defects are essential -

(a) To ensure that it is free of major material defects - e.g. cracks, loose rivets, excessive corrosion - which would jeopardise strength, water-tightness and safety.

(b) To ensure that the prescribed measures for the prevention of deterioration and corrosion have been correctly applied and still retain their usefulness.

0202. GENERAL

1. Visual examination of the hull structure by the specialist departments is a formidable task which is best achieved as a continuous process - taking a section at a time whenever operational conditions permit, making a thorough examination and recording fully in the relevant forms and books the results discovered. To make this task easier the RAN System of Planned Maintenance which is described in Chapter 3 was developed.

2. Because, by its nature, the visual inspection is a lengthy process which can be progressed only at infrequent intervals, it is most necessary that everyone, especially those responsible for particular compartments, should assist the specialist's task by taking every opportunity to inspect, maintain, and improve the material state of the hull.

3. Rounds by Commanding Officers and Heads of Departments provide opportunity to focus attention upon this aspect of departmental and ship efficiency.

0203. EXAMINATION

1. The equipment required for examination is not elaborate, and usually consists of a small chipping hammer, a scraper, a probe, and a powerful torch.

2. Because much of the work must be done in cramped almost inaccessible places and often in wet and dirty conditions, the use of an assistant to write down the particulars of an examination will greatly assist its speed and usefulness. His presence is also a wise safety precaution, especially in confined and ill ventilated spaces.

3. Before examination of a compartment, give ample warning to the responsible department so that preparations may be made to move items and stores which impede access and to make arrangements to safeguard valuable and attractive stores, delicate instruments etc.

4. Full examination of some areas necessitates the prior removal of fixtures, heavy fittings or equipments which may be beyond the capacity of the ships staff, or entail unacceptable dislocation of the ships operational routine. Opportunity to survey these, with dockyard or base staff assistance should be taken during refits, long self maintenance and mid cycle docking periods. (The procedure to be adopted to obtain dockyard assistance in these matters is similar to that requesting dockyard assistance in any other matter, and is fully described in relevant ANO's).

5. Examples of such places, which must not be neglected because of the inherent difficulty are -

(a) Behind mess-deck furniture especially at the ship's side and in the way of scuttles.

(b) Behind the linings of bathrooms.

(c) In way of bulkhead boundaries, and along stringers in compartments.

(d) Beneath the deck coverings of galleys, bathrooms and heads.

(e) Under insulation, especially in cold and cool rooms.

6. Even though a complete survey of such places cannot always be made by ship's staff, sample examinations should be made at regular intervals to obtain evidence of the general condition, in order to decide priorities when opportunity and assistance become available and to enable early information to be given to the refitting authority on the probable extent of dismantling, repair and renewal that will be necessary when the ship comes in hand for refit.

7. What to Look For -

(a) Leaks and major material defects such as cracks, bulges, and distortions; areas of active corrosion.

(b) Rust spots, particularly on deckheads and crowns of compartments; these, usually are a sign of excessive condensation, but at worst indicate that the plates above are perforated.

(c) Scattered groups of rust scabs; these are serious because they cover pits of active corrosion. If they are not treated immediately further deterioration is rapid.

(d) Edges of deck coverings that lift easily: if corrosion is not already present it will soon set in.

(e) Cracking, bulging or discolouration of paint, deck covering, or insulation: these almost invariably denote the presence of rust.

(f) Surface stains on paintwork etc: these are usually caused by rusty water trickling or dripping down and provide useful clues to the discovery of leaks.

(g) Holes in decks and bulkheads where pipes, bolts, or cables have been removed and the holes have not been blanked.

(h) Items of equipment - suction pipes, valves, rod-gearing, ventilation flaps and valves which are liable to become inoperable due to -

(i) Misapplication of paint.

(ii) Lack of lubrication.

(iii) Chocking or jamming by stores, cloths, waste or dirt.

8. Places Requiring Particular Attention

All places that are difficult of access for cleaning, drying and painting require particular attention e.g. -

(a) Structures obscured by furniture, lockers, fittings, pipes, cable carriers etc.

(b) Areas near deck-tubes, cable guards, and bulkhead glands.

(c) Bottom sections of machinery space bulkheads and machinery seatings.

(d) Behind and below stowages for gear and stores.

(e) Plating behind protection bars or plates in cable lockers.

(f) Non watertight spaces behind and below WC pedestals, and urinals.

9. All places where water - be it from sea or weather, condensation, spillage or leaks - can accumulate or is almost continually trickling are prone to corrosion e.g. -

(a) Near scuppers, spurnwaters, and washdeck valves.

(b) Tank tops, and longitudinals in machinery spaces.

(c) Junctions of near horizontal stiffeners with near vertical plates, particularly where drainage or limbering is inadequate or has become choked with dirt and paint.

(d) Bays of side frames and deck plates below side scuttles.

(e) Plating and framing around the rudder post.

(f) Junctions of mushroom ventilators with decks.

(g) Sumps and save-alls.

(h) Bilges, particularly those which contain pipe systems made of non-ferrous metal.

(j) Ventilation trunking which is subject to the ingress of spray or rain.

10. All places where the paint-work (or other protective surface) is liable to abrasion or damage require frequent inspection e.g. -

(a) Ships side in way of fendering areas.

(b) The water-line at the ends of the ship.

(c) Ship's side in way of the anchors.

(d) The deck in way of cable-working.

11. Parts of the structure which are less frequently examined include -

(a) Light plating of superstructure and bridge particularly near coamings.

(b) Uptake spaces and fan chambers.

(c) Beneath deck coverings.

(d) Behind special linings and insulation.

12. To improve safety efficiency or habitability, those carrying out a hull examination should also -

(a) Ensure that limber holes, scuppers, drains and suctions are clear, and that they are adequate for their task. (Alterations or modifications to these should be made by a dockyard or repair base, and the normal routine for A & A is to be followed).

(b) See that bilges, sumps, and save-alls are kept clean and dry.

(c) See that paint work is not allowed to become too thick, (to minimise the fire hazard).

(d) Investigate the cause of any mould, fungoid growth or excessive condensation discovered. A common cause of this is poor ventilation or air circulation which may be due to -

(i) Original poor design or arrangement.

(ii) Incorrect operation.

(iii) Unauthorised alterations of fittings and equipment which interrupt or deflect the air-flow.

(iv) Defective lagging of structure, pipes or ventilation trunks.

(e) Ensure that paint surfaces, which have been broken or damaged in the course of the examination, are made good immediately.

13. At periodical dockings, careful examination should be made of the following parts of the hull and underwater fittings.

(a) Outer-bottom plating, particularly strakes along the water-line.

(b) Areas adjacent to sonar outfits.

(c) Areas near non-ferrous fittings such as propellers, inlet and discharge pipes.

(d) Underside of keel, especially near the after cut up.

(e) Shaft brackets, rope guards, and eddy-plates.

(f) Protective covering of propeller shafting.

(g) Cathodic protection anodes and dielectric shields.

(h) Rivets or welding in way of tanks containing liquids (e.g. FFO) where seepage can give indication of leaks.

(j) Composition fairing of lap joints.

(k) Areas adjacent to bilge keels: ensure limber holes in bilge keels are clear.

(l) The physical condition of the underwater and boot topping paint.

Note - Intermediate inspections of particular or suspect items can be made by taking advantage of routine diving practices.

0204. AIRTESTING OF WATER-TIGHT AND GAS-TIGHT COMPARTMENTS

1. To prevent the spread of flooding in the event of underwater damage, maintenance of the watertight integrity of the hull is essential. For instance, a hole only 2 in. square 20 ft. below the water-line will allow the entry of flood water at a rate greater than a pump with a capacity of 70 tons per hour can remove it. An equivalent area can easily be made up of the sum of a number of small holes, e.g. bolt holes, cable glands where equipment has been removed, leaking door and hatch joints, defective closures, defective ventilation etc.

2. Absolute gas-tightness requires even stricter attention to the discovery and repair of small leaks.

3. The regular visual examination should discover many of the leaks but, in order to make quite sure that none have been missed, all watertight and gas-tight compartments must be regularly air-tested making use of the indicator test plugs and a special adaptor.

4. Detailed information about these tests and the compartments to be tested are contained in Hull Technical Maintenance Schedules, BR 3000, and relevant ANO's.

5. Briefly the method of airtesting is -

(a) Pressure Test

(i) Raise the pressure in the compartment to the specified level above atmospheric (Normally 2 lbs per sq. in. or 54 in. water gauge).

(ii) Leave for a period of time and by means of a gauge or manometer note whether the pressure drops, and if so by how much. This will indicate whether any significant leaks exist.

(iii) Keeping the pressure up to the specified limit, search all the boundaries in adjacent compartments to find leaks. A solution of soapy water painted on the boundaries will greatly assist this search. If a leak exists the soapy water will bubble.

(iv) After repair of the leaks so found, apply a check test and if the pressure does not now fall more than a certain amount in a given time, the compartment is considered to be acceptably free of leaks. The figure for this fall of pressure depends upon the size of the compartment and upon relative temperatures, but a general standard is that 6 inch water gauge of pressure should not fall more than $\frac{1}{2}$ inch in ten minutes.

(v) If the check test is not satisfactory, the search and test must be repeated.

(vi) This method, using a positive pressure within a compartment, unfortunately necessitates access to all the surrounding compartments and boundaries, and renders the search long and tedious and often incurs difficulty of organisation.

(b) Vacuum Tests

(i) An alternative to the Pressure Test is to use a negative pressure within the compartment while men inside carry out a search for leaks. A sufficient partial vacuum can be applied very simply by means of a vacuum cleaner and the sequence of operations is the same as for the Pressure Test. Although not as efficient as the pressure method, which uses a higher pressure differential, this test has certain advantages -

(A) It is much quicker because it obviates opening a large number of adjacent compartments some of which may be "confined spaces" and require prior ventilation and testing.

(B) It permits the air-testing programme to be progressed under conditions which might prohibit the pressure method, and thus assists in maintaining a better standard of water-tightness than if no test was made.

(C) It is independant of a low pressure air supply and can be carried out on all ships.

(D) There is little possibility of applying too great a pressure and thus over-stressing and distorting light structures.

(ii) There are however certain limitations to the vacuum test - these are -

(A) Men must not be shut up in compartments to which access is by manhole only.

(B) Searchers within a compartment must not be left too long without ventilation and a positive means of communication must be employed and maintained.

6. In both methods the location of leaks is assisted by the fact that usually the escape of air is audible.

7. During air-testing great care must be taken to avoid excess pressure which may over-stress and distort light or weakened structures, and careful watch must be kept for any unusual deflection or bulging; these should be controlled, if necessary, by shoring. Such faults may be indicative of weakening by corrosion or the effect of some previous damage and their cause should always be investigated.

8. Apart from the more obvious sources of leakage previously indicated, other leaks less easy to detect may have to be tracked down viz -

(a) Leaking joints and glands of pipe systems.

(b) Valves not fully closed due to stiff operating gear or rod gearing.

(c) Defective rivets or caulking; either due to original bad workmanship or to structural strain during service.

CHAPTER 3

ORGANISATION

0301. PLANNING - THE RAN SYSTEM OF PLANNED MAINTENANCE

1. The aim of the common planned maintenance system as used in the RAN is to provide -

(a) A standard system for controlling maintenance along sound and proven lines with the minimum of supervision.

(b) A central record of work completed, results of tests, and of alterations carried out on structure and equipment.

(c) A standard method of reporting progress of maintenance in ships and establishments.

2. The planned maintenance system in no way alters the responsibilities of officers as laid down in RI, BR 31, BR 3000, and departures may accordingly be made at the direction of the officers concerned. In such cases amendment proposals on Form ~~AS 2062~~ T.M.146. will be required.

3. The system is based on a modern card index which contains a number of cards giving a permanent record of each maintainable item of equipment. The index is contained in a cabinet consisting of a number of card carrying trays, or in a visible card book which is known as the master index.

4. Each card in the master index has a related polyethylene envelope containing a variety of cards which give details of routine maintenance and provide a means for the responsible sailor to report details of maintenance and the results of tests carried out. This envelope, complete with maintenance cards and maintenance report card, is enclosed in an outer polyethylene envelope known as a "maintenance envelope", and is normally kept in a four drawer filing cabinet.

5. The master index and maintenance envelopes are operated on monthly cycles and above, and at the commencement of each programming period appropriate envelopes are selected for issue.

6. Since a large number of important routines are carried out more frequently, daily and weekly check off maintenance instructions and report forms are issued to the leader of each maintenance party.

7. The three items -

(a) Master index.

(b) Maintenance envelope.

(c) Check off maintenance instructions.

together comprise the working part of the system and are fully described later in this chapter.

8. To support the system, and to assist in compiling reports, making good lost or damaged cards, and in preparing amendment proposals, the following documents which are also described later in this chapter, are also supplied -

(a) Key plans.

(b) Books of maintenance schedules.

(c) Quarterly progress report forms.

(d) Dockyard planned maintenance progress chart.

9. All documents associated with the system are initially supplied by Navy Office. Replacement cards, envelopes and forms, with the exception of AS 3007 (Equipment Card), are obtainable from SVSO on demand. Equipment Card AS 3007 is issued from Navy Office complete with equipment details.

10. Amendment proposals, Form AS 2062, TM 146 are to be forwarded to Navy Office through the administrative authorities. These will be considered and the ship or establishment informed of the action taken.

11. Reports required are -

(a) Quarterly by signal.

(b) Quarterly progress report forms are to be completed in accordance with the instruction printed on the reverse side of the report forms cover sheet and forwarded directly to The Secretary, Department of the Navy, Navy Office, Canberra.

12. When ships become due for refit, Ships Officers are required to include in their main defect list all items of the dockyard component of planned maintenance. The relevant card number only is to be quoted under the equipment title for each item and the associated Form AS 2061Z, serial number quoted. TM 145

13. Defect recording and reporting procedure, although allied with planned maintenance, is applicable to all ships and establishments and separate instructions have been promulgated in other orders. The prefix letter before the serial number on Forms AS 2061Z for defects made good by ships staff is to be strictly adhered to TM 145 as follows -

H. Hull

E. Engineering

L. Electrical including Weapons Electrical

W. Weapons.

The letters denote the originating department and other prefixes are not to be used.

14. Reports of defective material or design are dealt with by using Form AS 2022 procedure. This procedure is standard for all ships and establishments whether operating planned maintenance or not, and separate instruction detail the procedure.

15. Starred items are included in the schedules. These are items for which the inspection, examination, and overhaul is mandatory. Naval Board approval is to be obtained before a starred item can be deferred.

0302. THE MASTER INDEX

1. The master index consists of a kalamazoo cabinet or folder containing equipment cards. Each maintainable item of equipment is represented by its own equipment card which carries full details of the equipment. Associated with each equipment card are auxiliary sheets. These sheets will, of necessity, differ with each department according to the details which that department desires to be recorded.

2. Equipment cards on issue from Navy Office have a strip on the lower visible edge which is colour coded to indicate when routines are due. The colour conforms with the colour code for maintenance cards shown below.

0303. MAINTENANCE ENVELOPES

1. Each equipment card has a related maintenance outer envelope containing a maintenance report card with the appropriate maintenance cards enclosed in a smaller inner envelope.

2. Maintenance cards are coloured to indicate the periodicity of the routine inspection and have the relevant maintenance instructions posted on them. Colour definitions in use are as follows -

Periodicity	Colour
Monthly	Blue
Quarterly	Yellow
Half-Yearly	Red
Annual	Green
Biennial and over	White

0304. CHECK OFF MAINTENANCE INSTRUCTIONS

These are maintenance routines for which no permanent record of completion is required, and are issued in sheet or book form. The method of completion will be stated on the appropriate sheets or in the books.

0305. OPERATION

The master index is scanned at the beginning of each programming period to select the maintenance envelope for the work being planned. These selected envelopes are then issued to section leaders who arrange to perform the maintenance. When the specified maintenance is completed, the report cards are filled in and the envelopes returned to the maintenance office. Any relevant information is then transcribed to the master index and the quarterly progress report and the returned cards are then replaced in the inner envelope which had been retained. The inner envelope is then replaced in the outer envelope and returned to the filing cabinet drawer.

0306. BOOKS OF SCHEDULES

These are issued to ships, establishments, administrative authorities and dockyards by Navy Office and contain the following -

(a) An index which lists all relevant equipments with schedule and card numbers.

(b) Maintenance schedules applicable to the ship or establishment. Each schedule bears an identifying number. When maintenance cards are lost, new cards available from SVSO can be prepared and the appropriate routines copied from the relevant schedule.

(c) Key plans are prepared in Navy Office for planning a satisfactory distribution of maintenance over the year. The key plan lists every maintainable item of equipment, its location, appropriate schedule and card number. All routines required to be completed are also shown.

0307. QUARTERLY REPORT FORMS

These are supplied to simplify the reporting procedure and consist of -

(a) Front cover sheet with instructions for compiling the report and a table to be completed by ship or establishment showing how the available man hours during the quarter were used.

(b) An extract of the key plan showing all routines due during the quarter with a space left for recording man hours; a maintenance summary for each section, and a space for remarks.

(i) The manhours spent on planned maintenance is exclusive of monthly and more frequent routines for Hull, Engineering and Weapons Departments, and of daily and weekly routines for Electrical Department. These are shown separately in the space provided.

(ii) The estimated man hours to complete outstanding planned maintenance is to be calculated by adding together all the estimated times for routines not completed during the quarter.

(iii) The man hours spent on defects is calculated by adding together all the times shown on the submitted defect records Forms ~~AS 2061Z~~. TM 145.

(iv) The estimated man hours to complete outstanding defects is to be calculated from all the outstanding defect records Forms ~~AS 2061Z~~. TM 145.

0308. THE DOCKYARD PLANNED MAINTENANCE CHART

This is a wall chart showing each routine of the dockyard component of planned maintenance, and separate instructions are issued for its use.

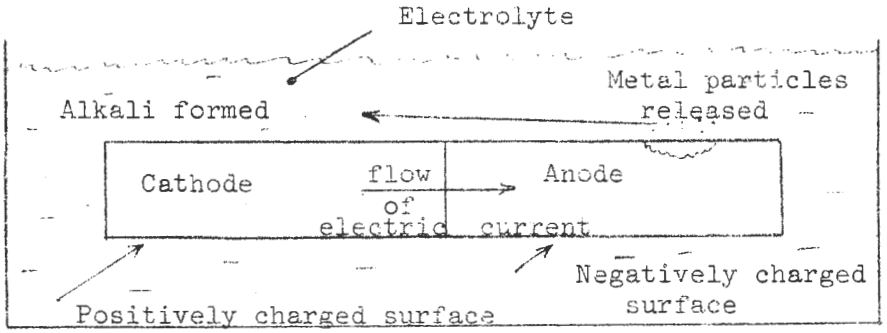
CHAPTER 4

CORROSION

⊕ 0401. INTRODUCTION

1. Corrosion is the destruction of a metal by electro-chemical processes. Most metals occur in a natural state as stable compounds such as oxides or salts. Whenever the environment is suitable they will tend to revert to their more stable natural form.

2. The electro-chemical process of corrosion involves chemical reactions and the flow of electric current from one area to another both through the metal and through a solution called the electrolyte. The area where the current leaves the metal and enters the electrolyte is called the anode, and it is in this area where solution of the metal occurs and corrosion takes place. The area where the current returns to the metal is called the cathode and in this area no corrosion occurs.



CORROSION CELL

3. The rusting of a steel surface in the atmosphere is a common example of the corrosion process. In this case the electrolyte is atmospheric moisture. Due to lack of surface homogeniety, local differences in chemical composition and stress, differences in potential exist and numerous anodic and cathodic areas are formed on the surface of the steel. These areas may be so numerous that the result is an apparent uniform rusting of steel and only a microscopic examination will reveal pitting at anode areas.

The same corrosion process occurs when two different metals are in contact in the presence of an electrolyte. A potential will be developed between the two metals and current will flow from one metal to the other and through the electrolyte. One metal will become the anode and corrode while the other becomes the cathode and is protected.

The difference in potential between metals and alloys in a particular environment can be measured and the metals listed in a galvanic series. The position of one metal or alloy in the galvanic series is a guide to its relative corrosion resistance when connected to another metal or alloy.

0402. TABLE OF GALVANIC SERIES FOR SEA WATER

1. When two metals on this table are in contact with each other in an electrolyte, such as sea water, the more anodic (most corrodable) metal in the series will corrode preferentially.

Most Corrodable (anodic or least noble)	(cont from previous column)
Magnesium	Nickel (active)
Magnesium Alloys	Inconel (active)
	Hastelloy (active)
Zinc	
Galvanised steel or Galvanised wrought iron	Brasses
	Aluminium Bronze
Aluminium (commercially pure)	Copper
	Silicon Bronze
	Copper-nickel alloys
	Monel
Cadmium	
	Silver Solder
Aluminium (4% copper)	
Mild Steel on Wrought Iron	Nickel (passive)
Cast Iron	Inconel (passive)
Chromium - Iron (active)	Chromium - Iron (passive)
Ni-Resist	Titanium
18-8 Chromium-nickel - iron	18-8 Chromium-nickel - iron
Type 304 (active)	Type 304 (passive)
18-8-3 Chromium-nickel - molybdenum-iron Type 316 (active)	18-8-3 Chromium-nickel - molybdenum-iron Type 316 (passive)
	Hastelloy C (passive)
Lead - Tin solders	Silver
Lead	
Tin	Graphite
	Gold

Platinum

Least Corrodable

(Cathodic or most noble)

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2. Oxygen also plays a part in the corrosion process. If the supply of oxygen at the cathode is increased, corrosion at the anode will be increased. Conversely, reduction in the oxygen will result in diminished corrosion at the anode. Also in an otherwise homogeneous system, oxygen rich areas will become cathodic and oxygen deficient areas anodic. The corrosion process, therefore, involves an electrolyte, a cathode and an anode. It follows that any means of corrosion prevention must be aimed at one or more of the following-

(a) removal of the electrolyte. Provided the metal can be kept dry no corrosion will occur. This can be done by drying the atmosphere to prevent condensation or absorption of moisture on the surface.

This is called 'dehumidification'. Also the metal can be covered by a surface coating which is impervious to water. These are called 'lock-out' coatings';

(b) stifling the anode reaction. This is done by the use of primers, containing pigments such as zinc chromate which inhibit the anode reaction;

(c) insulate the anode from the cathode in bimetallic systems to prevent current flow. An example of this is the use of insulating tape between the faying surfaces of aluminium and steel in ships superstructures. Where insulation is not feasible avoid as far as possible coupling together metals which are far apart on the galvanic series;

(d) make the whole system cathodic by connecting the system to an anode which will sacrificially corrode. This is possible when the system is totally immersed in an electrolyte, eg sea water, and is called 'cathodic protection'. The same conditions can be achieved by applying a current in the reverse direction to equalise the current formed by the corrosion cell. This is called 'impressed current cathodic protection';

(e) use of a metal or alloy in which the corrosion product formed at the anode is insoluble in the electrolyte and forms an adherent impervious film on the surface of the anode and stifles any further reaction. This involves the use of materials such as stainless steel or copper alloys, eg aluminium, phosphor or silicon bronzes or copper nickel alloys;

(f) provide a coating which in itself is an anode and will sacrificially corrode thus protecting the underlying metal by making it the cathode. This is, in effect, cathodic protection but is suitable for atmospheric exposure.

Typical examples of this are galvanising of steel, metal spraying with an anodic metal, zine rich primers on steel, and cadmium plating on steel; and

(g) use of non-metallic material, particularly plastics, which are replacing metals in many ship applications.

0403. PREVENTING ELECTRO-CHEMICAL CORROSION

1. To arrest corrosion in a galvanic corrosion cell it is only necessary to stop the current from flowing from the anode into the electrolyte. This can be done by one of the following techniques.

(a) Paints and Coatings. Coat the anode, the cathode, or both with an impervious layer such as a heavy duty paint. This prevents the electrolyte from coming into contact with the metal so no current flows, and no corrosion occurs.

(b) Remove the electrolyte or render it non conducting eg by replacing salt water with pure fresh water.

(c) Insulate the anode from the cathode eg use plastic between aluminium and steel. This prevents current from flowing and hence no corrosion can occur.

(d) Cathodic Protection. Apply a potential to the surface relative to another anode so that a current flows into both surfaces of the corrosion cell. If a sufficiently high potential is applied the current at the anode will be reversed, and corrosion will stop. This is called cathodic protection because the entire surface being protected becomes a cathode. The potential can be applied by connecting the surface to be protected to an anode made from a metal which is more negatively charged than the surface to be protected. The protective anode corrodes away in time; this is called sacrificial cathodic protection. Zinc, aluminium or magnesium are used as sacrificial anodes.

2. Alternatively an anode of any metal can be connected to the negative terminal of a source of DC current. If the other terminal is in electrical contact with the metals to be protected, a current will flow which will overwhelm the current which was emitting from the corroding area of the metal and corrosion will cease. This is impressed current cathodic protection. Anodes made of lead-silver and antimony, or platinised titanium suffer negligable corrosion and can be used to transmit current for many years.

0404. CATHODE RE-ACTIONS

At the cathode the current entering the surface of the metal can -

(a) Cause metallic particles to plate out onto the cathode. If the cathode is part of an aluminium structure, copper which may be dissolved in the electrolyte will plate onto the surface and form the cathode of a more powerful corrosion cell.

(b) Cause oxygen and hydrogen in the water to combine to form a strong alkali which damages some underwater paints. This is an important factor in selecting underwater paints for ships which are to be given cathodic protection. Current RAN underwater

paints do not suffer from such attacks.

0405. ATMOSPHERIC CORROSION

1. Unless moisture is present atmospheric corrosion is purely chemical and is usually self stifling. However, moisture will condense on a surface even at quite low humidities. If any salt is present on the surface it attracts moisture to form a film of electolyte which supports electro-chemical attack.

2. Dirt on the surface, or rust from previous corrosion, can cause condensation at lower humidities and can retain moisture in their structure. These factors result in corrosion continuing when a clean well painted surface would suffer no corrosion.

3. Soot containing sulphur can form sulphuric acid which is an excellent electrolyte and which can cause very rapid local corrosion.

4. Inter-crystalline corrosion can occur in aluminium alloys having a high magnesium content. The magnesium is originally dispersed throughout the aluminium but in time it precipitates in the grain boundaries which then become anodic. Corrosion of the grain boundaries causes the metal to disintegrate very rapidly.

5. If a stress is applied to a metal which is prone to inter-crystalline attack the crevices on the grain boundaries will open and this will break any protective film of corrosion products. This can cause further acceleration of corrosion.

0406. PREVENTING ATMOSPHERIC CORROSION

1. Under fairly dry conditions a normal paint system provides adequate protection providing a primer of zinc rich paint or an inhibiting zinc chromate is applied to the metal surface. Any moisture which passed through the outer coats of paint will re-act with the zinc rich primer, or the zinc chromate, to form products which seal the surface and stifle further attack.

2. Areas of high humidity need one of the following heavy duty systems -

(a) Coal tar epoxies.

(b) Sprayed aluminium for decks and bilges.

(c) Electro plated zinc for threaded components.

(d) Hot dip galvanising for small non threaded components, eg ladders, guard-rail slips etc.

3. Such metals as monel, phosphor bronze, gun-metal, aluminium bronze, and aluminium alloys which have a low magnesium content and contain no copper, require no protective coating because of their adherent oxide film.

4. Stainless steel also has a good protective oxide film in air, but most stainless steels are prone to corrosion under water.

5. Chrome plating and cadmium plating should not be used on steel in a marine environment if stainless steel is available.

0407. SOME EXAMPLES OF CORROSION UNDER IMMERSED CONDITIONS

(a) Crevice Corrosion

Oxygen cannot reach the surface of the metal in a crevice as readily as it can reach the remainder of the surface of the metal which is in contact with the electrolyte. Consequently a small anode forms in the crevice which then suffers rapid attack.

(b) Impingement Attack

Metals used in salt water systems are selected because they form adherent oxide films under immersed conditions. Fast flowing water removes some of this film, leaving small areas of bare metal which are anodic to the surrounding oxide covered metal and which then corrode rapidly to form pits.

(c) Dezincification

Brass is made of zinc, copper and tin. Under immersed conditions the zinc is anodic and is corroded away, leaving a soft structure of copper and tin.

0408. PREVENTING CORROSION UNDER IMMERSED CONDITIONS

1. Normal paints are not very effective underwater because they are slightly porous and when they become impregnated with water they cease to insulate the metal from the electrolyte. It is necessary to use a non porous paint such as an epoxy, or a bituminous paint.

2. If zinc or aluminium is included in one of these coatings, it helps to seal small breaks in the paint film because it re-acts with the bare metal to form corrosion products.

3. Cathodic protection can be used wherever a surface is permanently immersed, but it is not economic to protect bare metal. The bare metal is usually coated with a heavy duty paint which greatly reduces the current required to give protection. Cathodic protection stops corrosion occurring where there are any breaks in the paint film.

4. In cooling systems, a coating of heavy duty paint would adversely effect the transfer of heat into the cooling water. Inhibitors are often used to reduce corrosion in such systems. Anodic inhibitors such as sodium nitrate or sodium chromate, form insoluable ferric salts which stifle any corrosion at the anode but they are too expensive to use except in closed systems.

CHAPTER 4

CORROSION

0401. INTRODUCTION

1. Corrosion is the destruction of a metal by chemical or electro-chemical agencies, starting at the surface. Most metals occur in a natural state as stable compounds such as oxides, and it is only by careful refining that they can be isolated as relatively pure metals. Whenever the environment is suitable they will revert to their more stable unrefined form.

2. Corrosion can occur by one, or a combination of the following reactions -

(a) Direct Chemical Attack

This occurs when a metal is freshly cut and is in contact with oxygen or other re-active agents. Usually the metal forms a thin adherent film of corrosion products which, in the absence of moisture, will protect the metal from further attack.

(b) Electro-Chemical Attack

Electro-chemical attack occurs when a current passes from a metal which is corrodible into a conducting fluid. Conducting fluids are called electrolytes. The current passing into the electrolyte takes metallic particles with it, which usually combine with elements in the electrolyte. When the metal is immersed in the electrolyte the corrosion products often form remote from the surface and are carried away. If only a thin film of electrolyte is on the metallic surface, corrosion products will usually form as a loosely adherent film. Some metals form a protective film, but many will continue to corrode.

3. The current which causes an electro-chemical type of corrosion can be produced in several ways but the most important one are -

(a) Stray Currents

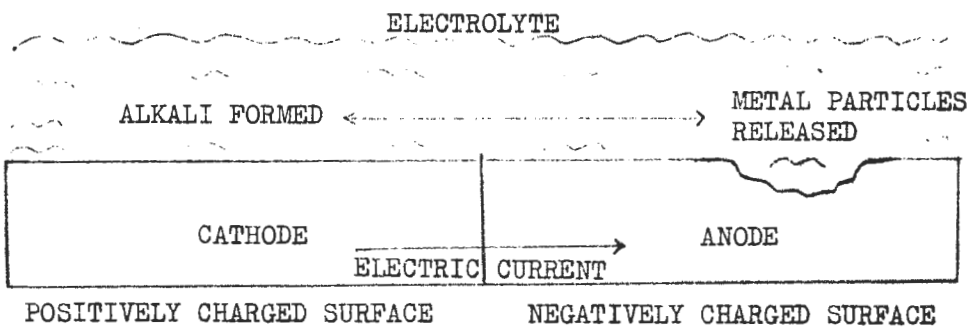
These can be any currents which use the hull of a ship and an electrolyte as a low resistance path e.g. if power for welding is supplied from a jetty to a ship and there is no low resistance earthing strap between the hull and the jetty, it is quite likely that a current will pass from the hull through the sea water (the electrolyte) to the shore connection of the welding set. It will of course cause rapid electro-chemical attack where it passes from the hull to the water. It is therefore important to bond a ship to the shore whenever any shore power is being supplied to a ship.

(b) Corrosion Cells

Whenever a metal is in contact with an electrolyte there will be two conflicting tendencies. Electrons will tend to pass into the electrolyte causing the metal to become charged with a positive electrical charge. Metallic particles will tend to pass into the electrolyte causing the metal to become charged with a negative electrical charge. The relative strength of these two tendencies varies with different metals, with the result that each type of metal [illegible]

If the two metals are in metallic contact and are also joined externally by a current path through the electrolyte, an electric current will flow. It will pass from the most positively charged metal to the more negatively charged metal via the metallic path. Simultaneously a current will flow through the electrolyte path from the negatively charged metal to the positively charged metal. This is called a corrosion cell. The negatively charged metal is called the anode and the positively charged metal is called the cathode.

CORROSION CELL



4. As has already been explained an electric current passing from a metal into an electrolyte causes corrosion, so the anode of a corrosion cell will suffer corrosion. There is no corrosion at the cathode.

0402. ELECTRODE POTENTIALS

1. The potential to which various metals will be charged when in contact with sea water are given below.

Normal Electrode Potentials at 25°C.

Metal	Normal Electrode Potential	
Gold	+ 1.42	Least corrosive
Platinum	+ 1.2	
Silver	+ 0.799	
Mercury	+ 0.798	
Copper	+ 0.34	
Bismuth	+ 0.277	
Hydrogen	+ 0.000	
Lead	- 0.126	
Tin	- 0.136	
Nickel	- 0.23	
Cobalt	- 0.27	
Cadmium	- 0.402	
Iron	- 0.44	
Chronium	- 0.71	
Zinc	- 0.763	
Manganese	- 1.05	
Aluminium	- 1.66	
Sodium	- 2.713	
Magnesium	- 2.38	
Potassium	- 2.92	
Lithium	- 3.01	Most corrosive

2. If any two of the above metals are in metallic contact and are both in contact with sea water, the metal which is lower on this table will suffer severe corrosion unless some form of corrosion prevention is being used.

3. The potentials given in the above table are the average potentials to which the surface of a metal will be charged when in contact with sea water. Some areas of the metal surface will be higher, and others lower than this potential.

4. The differences result from such things as -

(a) Variations in the structure of the metal due to welding or working.

(b) Variations in the speed of the electrolyte.

(c) Variations in the oxygen content of the electrolyte.

5. The result is that corrosion cells can be set up on the surface of a metal which is in contact with an electrolyte. Welds, heavily worked areas, and areas which cannot be reached by oxygen, will be anodes and will corrode. The rest of the surface is the cathode and does not corrode.

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4. In cooling systems, a coating of heavy duty paint would adversely effect the transfer of heat into the cooling water. Inhibitors are often used to reduce corrosion in such systems. Anodic inhibitors such as sodium nitrate or sodium chromate, form insoluble ferric salts which stifle any corrosion at the anode but they are too expensive to use except in closed systems.

CHAPTER 5

WATERTIGHT CLOSURES, VENTILATION AND DOMESTIC SERVICES

0501. INTRODUCTION

1. The term "Watertight Closures" is here taken to include all doors, hatches and scuttles in watertight decks and bulkheads and external covers for ventilation inlets and discharges.

2. Other watertight closures, such as bulkhead valves in pipe systems and ventilation trunking, storm valves on soil pipes and scuppers, and glands for electric cables, rod gearing, telegraph shafting etc., are not readily accessible and remain the responsibility of the specialist departments.

3. Maintenance of the efficiency, operability and watertightness of these closures is as vitally important to the safety of the ship as is the structure itself; chiefly to restrict the spread of flooding and to be able to restore services by isolating sections of the ship in the event of damage.

4. Although maintenance of bulkhead valves and glands is the responsibility of specialist departments, this work and the incidence of avoidable failures can be very much reduced by obeying a few simple rules -

(a) Do not paint the operating spindles, threads or any moving parts of valves.

(b) Do not paint over lubrication points and grease nipples on valves or on bearings and bevel-wheels of rod gearing and telegraph shafting.

(c) Do not paint the neck bushes, studs or nuts of bulkhead and deck glands.

(d) Do not hang heavy weights, clothing or hammocks on any part of the valves, rod gearing, etc.

0502. WATERTIGHT DOORS, HATCHES, SCUTTLES

1. There are certain basic requirements common to all -

(a) Operation

(i) Never drop or slam them, nor close them on any obstruction; such action will cause distortion of some part or damage the rubber joints.

(ii) Take care, when handling heavy articles, not to damage sills or coamings.

(iii) When closing, apply clips lightly and evenly all round the door or hatch, then tighten the diagonally opposite pairs of clips until the door or hatch is pressed firmly on to its seating. Never apply more force than is necessary; for correctly maintained fittings, manual force is quite sufficient and the use of mechanical aids should be forbidden.

(b) Maintenance

(i) Maintenance should normally entail no more than regular inspection, operation and lubrication of hinges and clips and cleaning of rubber joints and the faces upon which they bear. Solvents such as white spirit should not be used to clean rubber joints. Hard paint can be removed by rubbing the affected area with a piece of hard wood tapered to a blunt chisel point. A detergent solution should be used to clean grease and oil from joints.

(ii) As a guide for ships not yet programmed for the RAN System of Hull Planned Maintenance, the recommended frequency of maintenance routines is given below -

(A) Hull Technical Routine (Naval Shipwright)

Monthly

Inspect escape manholes in the ships side and decks to ensure that they are in order for immediate use. Ensure that wheel spanners, or other opening appliances are in their correct stowage and securely chained. Replace immediately any that are missing.

Half-Yearly

Check that leather washers on door clips form an effective seal, and that sealing rubbers to doors, deck scuttles, hatches, escape hatches and escape and side scuttles are in good condition and free of paint etc.

Annually

A.1 Take chalk impressions of all rubber joints, pack out or renew rubbers as necessary. Check all doors, deck scuttles, hatches, escape scuttles and side scuttles for distortion.

A.2 Check that indicator test plugs, where fitted in hatches and doors, have a leather washer and are screwed down.

A.3 Remove clips to manhole covers, examine joints for deterioration. Clean, lubricate and replace.

Biennially

B.1 Examine Dexine seals on oil-tight manhole covers for wear and deterioration. Renew as necessary.

B.2 Check all deadlights for distortion.

B.3 Check that keep chains and drop-nose pins to deadlights are in position.

(B) Hull "User" Routines. (Non Technical and User Departments)

Monthly

M.1 Clean and lubricate all working parts of doors, deck scuttles, hatches, escape scuttles, and side scuttles, exposed to the weather. Use XG 310 grease.

Half-Yearly

H.1 Clean and lubricate all working parts of doors, deck scuttles, hatches, escape hatches and side scuttles. Lubricate between deck working parts with PX 103 grease.

H.2 Check that all clips are free and effective in operation.

H.3 Check that deadlight open position retaining pins are chained in position and all retaining catches to hatches, doors, and scuttles are in good condition.

(C) Besides the routine inspections, all users of watertight closures should be alert to notice faults and defects, which should be reported at once to permit the necessary repairs being undertaken as soon as possible.

0503. CHALK TEST

After examination or repair of defects, a simple test for correct seating can be carried out by -

(a) Coat with chalk the bearing edge of the coaming or other feature which bears on the rubber gasket.

(b) Close and lightly clip the door, hatch or scuttle; then re-open it for examination of the chalk mark on the gasket.

(c) If all is correct, an even chalk mark should be evident all around the joint; uneven marking indicates that either the frame or the gasket require levelling. The chalk mark will also show whether the door is correctly aligned with its seat; if it is not, hinges and pins probably require attention.

0504. VENTILATION SYSTEMS

1. Good ventilation within a ship is necessary for the health, comfort and well-being of the ship's company, the preservation of stores and to a certain extent, the efficient operation of equipment; proper care and operation of the ventilation system is essential to maintain the quality and quantity of the air delivered and to ensure rapid closing down to the various NBCD states.

2. The following are the basic principles of ship ventilation -

(a) Fresh air is supplied by fan to spaces where men live and work.

(b) Foul, hot, oil-laden or damp air and noxious gases are expelled by fan from compartments where such conditions exist.

(c) Fan supply is usually associated with fan exhaust, but in some compartments, situated near the weather deck or subject to special consideration, it is sometimes sufficient to provide natural supply or exhaust.

3. Although the basic principles are simple, the requirements of habitability, watertight integrity and NBC Defence introduce complications, such as -

(a) Air heaters and coolers.

(b) Watertight valves and associated gearing.

(c) Watertight and gas-tight covers at inlets and outlets.

(d) Flap valves to permit recirculation of air when the ship is closed down in NBCD states, or to conserve air-cooling capacity.

(e) Filters for various purposes.

4. These refinements considerably increase the maintenance task for ventilation systems.

0505. MAINTENANCE OF VENTILATION SYSTEM

1. The majority of the maintenance does not require particular skill, but, to be successful, it does require good organisation and co-ordination; operations requiring the services of skilled sailors are carried out in conjunction with the Shipwright, Engineering and Electrical Departments as necessary.

2. The greatest hindrances to efficient ventilation are dirt and seizure of moving parts by paint or lack of lubrication. Dirt on the inner surfaces of trunking on heating and cooling elements and on fan blades and casings slows down the flow of air and reduces the volumes delivered - sometimes by as much as 50 per cent; seizure of moving parts seriously handicaps rapid closing down for NBCD purposes and thus jeopardises the safety of the ship.

3. It is also very important to ensure that orifices do not become masked or blanked by gear, stores, kit, etc., and that the designed flow of air within a compartment is not disturbed or deflected by adding or moving equipment without consideration of the possible effect on ventilation.

4. For ships which are fully documented for planned maintenance, details of examinations and routines for ventilation systems are set out in their hull maintenance schedules, but as a guide for ships not documented the recommended frequency of maintenance routines is given below.

(a) Hull Technical Routine (Naval Shipwright)

Annually

A.1 By removing the sides of gas flap boxes -

(i) Inspect flaps for corrosion, damage, or distortion.

(ii) Inspect rubber seats for damage or deterioration.

(iii) Chalk test seats and flaps.

A.2 Chalk test all hinged watertight covers.

A.3 Strip and examine ventilation valves in wet compartments. Clean and lubricate threads and seatings.

A.4 Blow through all general ventilation trunking with low pressure air and inspect the interior surfaces of selected

Biennially

B.1 Strip and examine all ventilation valves; clean and lubricate threads, seats and working parts. For weather deck components use XG 310 grease; between deck components use PX 103 grease.

(b) Hull "User" Routines (Non Technical and User Departments)

Daily

Clean the grease filters in galley ventilation systems by scrubbing in a hot detergent solution.

Weekly

W.1 Clear accumulation of water in trunking via drain plugs.

W.2 Grease hinges, swing bolts, and butterfly nuts of watertight covers.

W.3 Check that rubber seals of watertight covers are free of paint and grease.

W.4 Check that wedges where fitted in place of swing bolts are secured by chains.

W.5 Clean flame proof gauges in ventilation trunking to magazines (where fitted) mortar rooms and flammable storerooms.

W.6 Dry out condensate sumps of air conditioning units and check that drains are clear.

Monthly

M.1 Operate through their full range of valves and flaps in ventilation to magazines and mortar rooms.

M.2 Clean filters and grids of heating and cooling coils.

M.3 Lubricate one way gas flaps on weather decks.

M.4 Lubricate and operate through full limits all watertight ventilation valves in wet compartments.

M.5 Progress Monthly - ventilation trunking, throughout the ship to be blown through, and all grills, baffles, gauzes, etc. cleaned. All systems fans, banjo fittings, sirroco's etc. are to be checked and securely fastened. NBCD markings are to be checked and repainted as necessary.

Half-Yearly

H.1 Lubricate all flaps, baffle spindles, swing bolts, butterfly nuts, sliding shutters, indicators and rod gearing.

H.2 Operate through their full motion all valves and flaps in the complete ventilation system. (Magazines are done monthly).

0506. CLEANING VENTILATION SYSTEMS

1. Dirt and fluff, loosely adhering to the internal surfaces of trunking, can be removed by a vacuum cleaner or by blowing it out with low pressure air: the former is obviously the preferable method, because it avoids the risk of fouling surrounding compartments and their contents, but it cannot reach many of the less accessible portions without dismantling a large amount of trunking.

2. Whenever any ventilation equipment is removed or opened for examination or repair, opportunity should be taken to clean all trunking and internal fittings thus rendered accessible.

3. Before undertaking extensive painting of compartments, it is recommended that ventilation trunking associated with them should be cleaned as thoroughly as possible, making use of all inspection covers, louvres, diffusers, etc., as access for the nozzle of a vacuum cleaner.

4. Blowing through trunking with low pressure air should be carried out progressively from inlet to final discharge, and requires careful planning to avoid dispersing the dirt over a wide area -

(a) Stop the fan.

(b) Close all the louvres and diffusers, except one orifice at the end, and gag relief valves.

(c) Secure a finely-woven bag (e.g. a mail bag) over this final opening, to collect the dirt dislodged.

(d) Blow the dirt along the trunking from inlet to final discharge by inserting a low pressure air hose in the inlet, louvres, inspection covers, portable sections, etc.

5. Precautions -

(a) Men employed blowing through ventilation trunking must wear facemasks (as for spray painting), as the fine dust can be lethal.

(b) However carefully it is done, it is practically impossible to avoid blowing some of the dirt into compartments, therefore it is recommended that this operation should be planned to take place just prior to a major cleaning or painting operation.

(c) To ensure that all joints and fastenings are properly replaced and secured after removal, it is recommended that such work should be done by an artificer attached to the ventilation party.

6. Cleaning exhaust trunks carrying oil or grease-laden air is more difficult, but they are usually protected by fine-mesh grids to filter out much of the oily dirt. Large diameter trunks can be washed down with water and detergent solution, but smaller ones can, at present, only be cleaned by dismantling a large number of sections.

7. Fittings within ventilation systems quickly become choked, especially those passing oil or grease-laden air and therefore require very frequent cleaning -

(a) Wire-mesh grids at inlets to trunks, particularly in galleys and machinery spaces; those situated high up and in inaccessible places should not be forgotten and neglected.

(b) Elements and grids of heating and cooling equipment.

(c) Deflection vanes ('splitters') at sharp bends.

(d) Certain types of valves.

0507. VENTILATION VALVES

To avoid restriction of the flow of air, the valves fitted at bulkheads and decks to maintain watertight integrity, must be large and are usually of the sluice type. Their maintenance must ensure that they can be closed quickly and easily, and that, when closed, they are absolutely watertight; regular lubrication and operation of the valves and associated gearing, together with freedom from paint and dirt on working parts are the main essentials. Check that indicator plates are firmly secured and correctly indicate the state of the valve; indicator plates must not be painted over nor removed for cleaning.

0508. DEFECTS AND FAULTS

1. Recurrent defects and difficulties of maintenance of components should be reported on Form AS 2022 (Report of Defective Material and Design).

2. Inadequate ventilation of a compartment which cannot be cured by the elimination of defects, bad maintenance and mis-operation, should be reported on Form AS 1120 (Report of Environmental Conditions in HMA Ships).

0509. DOMESTIC SERVICES AND SYSTEMS

1. The services here considered, and the materials at present specified for their pipes, are -

(a) Main service and sanitary systems: an alloy of copper, nickel and iron.

(b) Hot and cold fresh water services: copper.

(c) Soil pipes, scuppers and drains: galvanised steel.

(d) Main suction line: galvanised steel.

2. Some simple maintenance rules, applicable to all, are -

(a) Isolation valves: at regular intervals, operate the valves through their full range of travel and lightly grease threads and spindles. Where valves can be operated by rod-gearing from remote positions, the whole system must be worked and lubricated.

(b) Leaks are not only unsightly and wasteful, but also cause corrosion of adjacent structure and fittings; always report leaks to the responsible department promptly and accurately.

(c) Tallies on valve-hand wheels must not be removed for cleaning; they may easily be lost or replaced on the wrong valve.

(d) Do not paint working parts of valves, lubrication points, indicator or tally plates.

(e) Do not hang heavy weights on pipes or valves.

0510. MAIN SERVICE AND SANITARY SYSTEMS

1. The main service provides salt water at high pressure for fire-fighting, magazine spraying, machinery cooling, bathroom ejectors and washdeck purposes; for sanitary purposes, the pressure is lowered by reducing valves.

2. Marine fouling - marine growth in salt water pipes can cause serious restrictions, loss of efficiency and damage to valves. Its onset and rate of increase can be checked by thoroughly flushing the system once a week using all available pumps. Pump water through open hydrants at the extreme ends of the line for 10-15 minutes; care must be taken that the limiting pressure is not exceeded and that parts weakened by corrosion or erosion do not develop leaks and cause flooding.

3. Erosion occurs when the fluid exceeds a critical speed which is different for each type of material. Bends and restrictions in pipes can cause local velocities to be excessive. During design and building as many as possible of these are eliminated, but where they are unavoidable, attempts are made to minimise maintenance and repair effort by fitting, for instance, short readily accessible lengths of pipe on the downstream side of bends, to simplify replacement.

4. Erosion of valves and seats occurs mostly when valves are only partially open and necessitates a disproportionate repair effort; whenever possible, valves should be either fully open or completely closed.

5. Bathroom ejectors are often fitted to discharge waste water from bathrooms below the water-line and are operated by water from the main service. Incorrect operation of the valves can cause flooding and erosion of valves and seats; ejectors must not be left running unnecessarily nor should valves be left 'cracked' open in the mistaken hope that the sump will be kept dry - water will flow back down the suction pipe and cause flooding. The rule must be: pump out sumps when it is necessary, then shut valves completely.

0511. HOT AND COLD FRESH WATER SYSTEMS

1. Scaling occurs in hot water pipes, particularly near heaters and calorifiers when hard water from shore is used; its formation is rapid when the temperature of the water exceeds 160°F., therefore thermostats controlling heaters should not be set higher than 160°F.

2. In some dish-washing and laundry machinery, steam and water are mixed to give temperatures above 160°F, a strainer is fitted in the discharge to remove calcium carbonate and other deposits. Filters and mixing valves require frequent cleaning to remove deposited scale.

3. Bathroom fittings - misuse of these fittings is responsible for employing a large amount of maintenance effort which can be ill spared from more important work.

[illegible] their chains.

(b) Swivel type shower-heads must not be forced and broken if they become stiff or seized.

(c) Taps, mixing-valves and pipes must not be used as strong-points for wringing out washed clothes.

(d) Shower pipes must not be bent to alter the direction of the water stream.

0512. CLEANING FRESH WATER TANKS

(a) Men to be employed in FW tanks must first be examined by a medical officer.

(b) Clean overalls and rubber-soled shoes, new brooms, cloths and buckets must be provided for use in the tanks.

(c) The usual method is -

(i) Wash down the tank with 6 to 10 in. of residual water.

(ii) Pump this dirty water overboard.

(iii) Rinse with about the same amount of clean, fresh water and pump it overboard.

(iv) Wipe down and dry the tank.

(v) On completion and just before final closing, the tank must be inspected by a medical officer.

0513. WATER COOLERS

The cooling capacity of water coolers is limited and water from them must not be misused or wasted. Frequently the drains are choked by the dregs from cups and utensils which have been washed under the cooled-water discharge; beside being wasteful, the consequent flooding corrodes deck-plates beneath.

0514. SOIL PIPES, SCUPPERS AND DRAINS

1. Defects of these systems due to 'fair wear and tear' are not common, but blockages due to misuse are all too frequent.

2. Because the remedy usually necessitates stripping and dismantling of the pipes, the introduction of filthy water and obnoxious smells into living spaces can seldom be completely avoided, and it is to everyone's advantage to make an effort to keep these systems clear -

(a) Remove scupper gratings only when absolutely necessary.

(b) Sweep dirt into dustpans, not into the scuppers.

(c) Never pour grease or fatty waste down galley drains.

(d) In the heads, use only the toilet paper provided.

(e) Never throw matches and cigarette ends into urinals, nor pour dirty water down WC pans - soap, scrubbers and cleaning cloths are a cause of blockages.

(f) Remove all rubbish lying about the deck, especially near scuppers.

(g) Regular flushing of soil and urinal pipes through the connections provided greatly reduces fouling of them and thus lessens the frequency of routine dismantling and cleaning.

3. At every refit, include an item in the Defect List for 50 per cent of soil pipes to be stripped, cleaned, regalvanised as necessary and replaced.

0515. MAIN SUCTION LINE

1. The main suction line is the ship's pumping main and runs through the greater part of the ship's length, with branches from it to compartments low down in the hull; at the ends of the ship it is usual to fit stand pipes to compartments to permit the use of portable pumps.

2. Apart from care of the valves, which is similar to that for other systems, the only maintenance required is to make sure that the suction strainers at the end of each branch are intact and free of obstruction. Caps of stand-pipes must not be removed for cleaning.

CHAPTER 6

BOATS, WOODEN CRAFT AND INFLATABLE LIFE RAFTS

0601. INTRODUCTION

The basic rules of ship husbandry, correct stowage, cleanliness and correct use, discussed in Chapter 1, apply equally to ship's boats and wooden craft.

0602. CAUSES OF DETERIORATION

1. The failure of structural members or serious leakage in boats and wooden craft is generally due to one or more of the following causes -

(a) Rot.

(b) Shrinking, warping and splitting.

(c) Structural deformation.

(d) Electro chemical action.

(e) Parasite attack.

2. Rot is caused by various fungi which feed on wood that is moistened with fresh water. It is the most serious and widespread cause of trouble in wooden craft and boats. The fungi cannot grow if the wood is too dry nor can they live on saturated timber. Rot can be prevented by regular inspection, adequate ventilation and good maintenance as outlined below -

(a) Ensure that all gear is thoroughly dry before stowing in lockers.

(b) Do not stow wet ropes and fenders in the forepeaks and stern lockers of power boats.

(c) Keep bilges free of water. This will also ensure that the floorboards and paintwork in power boats are not stained with oil, which is collected in the sump between the engine bearers, and is floated out if accumulated water in the bilges overflows into the sump.

(d) When power boats are inboard open seat lockers, take up portable floorboards, open up forepeak and stern locker to allow thorough ventilation.

(e) Clean out bilges at regular intervals and ensure that limber holes in timbers are clear.

(f) Dry out the bilges thoroughly once a month and touch up bare woodwork.

(g) On each occasion of hoisting boats examine the hull for evidence of leakage especially along the garboard seams, around fastenings and engine bearer bolts and at plank edges in clinker built boats.

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(g) On each occasion of hoisting boats examine the hull for evidence of leakage especially along the garboard seams, around fastenings and engine bearer bolts and at plank edges in clinker built boats.

(h) Keep all joints and seams in deck planking and cabin tops of power boats well stopped up to prevent leakage of rainwater into the hull.

(j) Rot is to be treated as an urdef.

0603. SHRINKING, WARPING AND SPLITTING

If wood is allowed to become excessively dry it will tend to shrink, warp and split. Any moisture, such as rain, subsequently entering the crevices so caused, will encourage the growth of rot fungi which will damage the hull and wooden fittings. Where boats are stowed on board or laid up ashore for long periods the following precautions should be observed -

(a) Boat covers should be fitted to protect the boats from the full heat of the sun, especially in tropical climates.

(b) Partially fill the boats with water, preferably salt, at regular intervals and drain out after soaking for a day or so, taking care that the bilges are well supported before the water is put in.

(c) Inspect the boat at regular intervals, keep any shakes and open joints which develop well stopped with white lead and ensure that the paint coatings are in good condition before the boat is put into service.

0604. STRUCTURAL DEFORMATION

Generally this will occur only when boats are carried in davits or are overloaded. It can be prevented by attention to the following details -

(a) When lifting a boat ensure that the slings are correctly fitted to avoid straining the boat in way of the sling plates.

(b) When crutching down a boat, make certain it is correctly pitched, so that the crutches bear evenly on the hull. Copper strips are generally tacked on the keel or hull planking of boats to indicate the position of the crutches. Except in an emergency never attempt to crutch a boat down in another boats crutches. Crutch pads are tailored to the boat and may not suit a similar craft. If a boat has to be stowed in crutches other than its own, the operation must be carefully carried out and adjustments made by inserting soft wood packing on the tops of the crutches to ensure an even bearing over the entire area.

(c) Do not use a boat in its stowage as a repository for loose gear nor allow large quantities of water to remain in the bilges for long periods, such overloading will strain and deform the hull.

(d) When placing a boat in a temporary stowage on deck ensure that the keel is well supported on chocks, especially in way of concentrated weights such as engines; that the bilges are well supported by high lows and, in a large boat, that additional support is provided by fitting shores under the rubbers.

(e) When securing a boat for sea in a crutched stowage, the securing pendants must not be set up too hard or the crutches will be forced into the bottom planking. In open boats the spreader chains between the gunwhale clamps of the securing pendants must be fitted and set up taut.

0605. ELECTRO-CHEMICAL ACTION

The effect of placing two dissimilar metals in sea water was discussed in Chapter 4. In boats we are not so much concerned with the effect on metals but with the fact that chemicals which attack the wood are formed in the sea water around the fastenings. Soft and discoloured areas form around the fastenings which become loosened and so cause leakage. This is called "nail sickness". Action which may be taken to minimise this defect is -

(a) Keep the bilges as dry as possible.

(b) Keep the paint coatings in good condition.

(c) Keep nail heads and joints well stopped up.

0606. PARASITE ATTACK

Boats and wooden craft which spend long periods afloat, especially in tropical waters, are liable to attack by marine wood boring parasites, those most frequently encountered being -

(a) Teredo worm - which tunnels into and honeycombs the wood. These attacks are usually confined to warm or tropical waters but under favourable conditions can occur in temperate waters.

(b) Gribble crab - a tiny crab found in all waters, which digs shallow tunnels in the wood to form a cave home for itself. Sheathing of craft, which must be maintained complete and undamaged, is the only certain method of prevention. Slipping the boat and drying out for a period of 14 days will kill any infection.

0607. RULES FOR MAINTENANCE

To summarise, the main rules for the successful maintenance of wooden boat hulls are -

(a) Prevent leakage, particularly the entry of rainwater into inaccessible places.

(b) Ventilate regularly and [illegible] any water which has gained entry in spite of [illegible]

(c) Avoid excessively [illegible] for long periods [illegible]

0608. MISCELLANEOUS MAINTENANCE REQUIREMENTS

1. Buoyancy Test. All pulling and sailing boats are to be tested for buoyancy every two years as required by QR and AI Chapter 55.

2. Care of Boats Equipment

(a) Boats Slings. - The pins of the shackles to boats slings and disengaging gear should be removed, cleaned and greased at regular intervals. Slings, bridles, disengaging gear and spreaders are to be landed for testing at each refit or after any repairs have been carried out on them by ships' artificers. The intervals between tests are not however to exceed those laid down in QR and AI as amended by current ANO's.

(b) Steering Gear. - The sheaves, wires, knuckles joints, tiller and link mechanisms, kitchen rudder gear and all other components, according to the type of steering arrangements fitted, are to be lubricated weekly.

(c) Sling Plate Fastenings. - Whenever a boat is sent into the dockyard for refit or for repair after damage, an item is to be included in the defect list accompanying the boat, to cover the examination of the fastenings of all sling and steadying chain eyeplates.

3. Common Defects. Information concerning defects common to and the maintenance requirements for, wooden craft and boats, is summarised in the accompanying table.

4. Composite Craft. The foregoing notes and the accompanying table are applicable to the wooden parts of craft of composite construction. The framing of such vessels is usually of aluminium alloy and the main troubles associated with this material are caused by galvanic action or attack by strong alkalies, such as caustic soda or washing soda. Likely trouble spots are in the bilges and in other places where water may accumulate to form an electrical link between the aluminium alloy and other materials. It is therefore necessary to keep all such structure clean and dry and to inspect it frequently to ensure that corrosion is not taking place. For Coastal Minesweepers (Ton Class) full instructions are contained in the Hull Maintenance Schedules.

0609. INFLATABLE LIFERAFTS

1. The maintenance of inflatable liferafts and survival packs on board HMA ships is the responsibility of the Executive Department and the work involved is carried out by sailors trained by the Safety Equipment and Survival Training School. Detailed operation and maintenance instructions for the equipment are given in BR 1977 (1) 'Operating and Maintenance Handbook for the 20 Man Inflatable Liferaft'.

2. Care is to be taken when working on and around the liferaft stowages that the valises of the liferafts and survival packs are not stained with grease, oil, or acids, nor marked with paint, and that securing lanyards are not chafed or cut.

TABLE

Common Defects and Maintenance Requirements for
Wooden Crafts and Boats

Defect	Cause	Likely Trouble Spots	Detection	Prevention	Cure
(Fungal Decay)	Continually damp conditions arising from presence of moisture and poor ventilation.	Fore and after peaks (hog, frames and at foot of bulkhead). Beam shelf and associated knees particularly if framing is continued through deck. Bilges particularly under flats where linoleum is laid. Structure behind lining, panelling, buoyancy tanks, fuel and water tanks, cable lockers. Structure under ballast which has not been cemented in. Deck planking under winch beds, deck fittings etc. Gaps in seams of deck planking.	Brashness and brittleness of wood, in association with shrinkage across the the grain. Darkening of varnished members. A knife point inserted in direction of grain can be easily withdrawn. Absence of ring when struck with a hammer.	Weekly opening of peaks, bilges and cabin panelling and buoyancy tanks to allow ventilation. Prevention of entry of rain water. Frequent cleaning and pumping of bilges.	Removal of infected timber and replacement with a seasoned timber treated with copper napthanate or Wolman salt preservative before coating.
...king, ...ping and ...tting.	Excessively hot or dry stowage in sunlight or in way of engines or exhaust. Prolonged stowage under dry conditions.	Planking, particularly in clinker built boats. Keels and stems, weather decks, deckhouses. Structure in way of leads of exhaust piping.	Normally obvious by distortion, surface cracks or leakage.	Stowage out of direct sunlight. Fortnightly immersion in salt water or washing down with salt water. Maintenance of efficient engine and exhaust insulation and ventilation.	

Defect	Cause	Likely Trouble Spots	Detection	Prevention	Cure
Parasite attack (a) Teredo	Prolonged immersion without protective sheathing, afloat in tropical waters.	Outer bottom particularly near the waterline. Floors and frames in bilges. Note - Any unpainted part of the outer bottom, e.g. gaps in planking or areas inaccessible for painting on the slip are particularly susceptible to attack.	(a) Small holes in surface opening out to $\frac{5}{8}$" holes behind. (b) Curfs in surface exposed by erosion. (c) and (d) Damp patches remaining in bottom when remainder has dried out on board.	Sheathing Note - Navy Office decides which craft are to be sheathed and the method to be adopted.	Remove craft or boat from the water and proceed with one or more of the following - Allow boat to dry out for 14 days. Scorch infested portions with a blowlamp. Inject holes with a wood preservative. Alternatively moor boat in fresh water for at least 14 days.
Structural deformation.	Inadequate support or overloading when stowed.	Fastenings and scrapes in longitudinal members.	Hogging or sagging of keel, loosening of fastenings, leaks.	Supports spaced about $\frac{1}{4}$ length from amidships and under local heavy loads (e.g. engines). Chocks in way of transverse members.	
Corrosion of metal fittings.	Normally due to electrolytic action arising from connection of dissimilar metals.	Propeller bracket fastenings, keel sling plates. Steel hull fittings.	Severe local pitting. Discolouration of bronze fastenings due to de-zincification.	Insulation of dissimilar metals from each other.	Replacement of fittings and fastenings so that both are of the same metal.
Steering gear seizure.	Corrosion of cam and rod mechanism. Failure of rubber bulkhead glands by contamination with oil and grease.	Where mechanism passes through bilges.		Regular inspection and greasing. Keep rubber glands clean of oil and grease.	Replace mild steel steering gear by naval brass and gun metal guides. Replace glands.

CHAPTER 7

OTHER FITTINGS

0701. ANCHORS AND CABLES

Instructions for the maintenance of anchors and cables are contained in QR and AI and BR 367 Anchors, Chain Cables etc. The latter gives the details of and intervals for survey, heat treatment, tests and examinations.

0702. RIGGING

1. General guidance on the maintenance of rigging is given in the Seamanship Manual. More detailed instructions regarding lifting appliances are laid down in ANO's. The main points of pure maintenance as distinct from operating instructions, are summarised below.

2. Cordage. - Small cordage is supplied in coils which should be stowed in a dry, well ventilated compartment. Larger ropes are kept on reels and should always be thoroughly dried before stowing away. When reeling up ropes the opportunity should be taken to lubricate the reels.

3. Wire Ropes. - When being stowed away after use, wire ropes should be washed with fresh water to free them from salt, dried and then lightly coated with an acid-free lubricant, boiled linseed oil being the one most generally used. When wire ropes are being stowed on reels, the opportunity should again be taken to see that the reels are well lubricated. Instructions for the periodical examination of wire ropes are contained in QR and AI. RI and Hull Maintenance Schedules.

4. Guard Rails. - Guard rails other than PVC coated should be well coated with boiled linseed oil in accordance with Hull Maintenance Schedules. At the same time the bottle screw slips should be cleaned, worked through their full limits and greased; the bolts and pins from the heels of stanchions and stanchion stays should be removed, greased and replaced and any damaged or missing fittings should be repaired or replaced.

5. Boats' Falls. - Boats' falls made of cordage must be examined at least every three months and turned end for end or renewed as soon as they show signs of wear. The testing of wire rope falls is covered by the orders for lifting appliances.

6. Associated Fittings. - All fittings associated with rigging, such as the heel fittings of derricks and lower booms, sheaves and swivel blocks, rollers and roller fairleads should be lubricated regularly, in accordance with Hull Maintenance Schedules.

0703. CANVAS GEAR

Canvas covers of weatherdeck fittings are gradually being replaced by nylon fabrics. The chief canvas items remaining in service are therefore awnings. The rules for their maintenance are as follows -

(a) On first spreading new awnings they will stretch under the stress of the spreading arrangements and the wind. This stretching must be done gently and gradually, i.e., new awnings must be slowly stretched over a period of days.

(b) Canvas gear must always be thoroughly dry before stowing away. Small awning accessories such as gable ends should be stowed in the bags provided. Sails wet from salt water should be rinsed in fresh water before drying.

(c) Canvas gear requiring to be moved should be lifted and carried. Dragging along the deck will tend to wear and stretch it out of shape.

(d) Canvas gear must be kept as clean as possible as frequent scrubbing wears it out.

0704. TERYLENE SAILS

Mark design limits for all sails.

0705. DECK COVERINGS

1. Wooden Decks. - The chief points to be borne in mind when cleaning wooden decks are that they should be well swept before scrubbing, so that the dirt is not scrubbed in, that water should be used as sparingly as possible, and that the decks should be thoroughly dried before traffic is allowed.

2. The general practice is to use plain salt water with a bucket of fresh water and a cloth to remove salt splashes from paintwork and fittings. With wooden decks, as with all other aspects of ship husbandry, careful preparations and forethought can save a great deal of unnecessary work. For example, when painting a bulkhead or fittings above a wooden deck, it should be an invariable rule to lay a strip of canvas on the deck below the bulkhead to protect it from paint splashes and to stand the paint pots upon. Such simple precautions will produce a tidy finish and save many wasted hours removing paint spots. In the same way wooden decks should always be limed to protect them from grease before ranging cable or wire hawsers. Should, however, wooden decks become very dirty or stained with oil or grease, the following measures can be used -

(a) A little sand may be scattered on the deck when scrubbing. This helps to remove ingrained dirt.

(b) The deck may be holystoned, but this should only be done occasionally as it wears the deck down, particularly where it is made of soft wood.

(c) When time is not available for holystoning, decks may be scrubbed with a solution of washing soda, soft soap and cleansing powder or with a 1 in 300 solution of caustic soda in water. Neither treatment is as effective as holystoning and any solution containing soda is destructive of paintwork and very harmful to aluminium alloys. Steps must therefore be taken to protect these surfaces and to remove any splashes at once.

(d) Oil and grease stains on wooden decks should be coated with a mixture of lime and fresh water which absorbs the oil and grease. When dry, the lime should be scrubbed off and more applied if necessary. The treatment is only effective when conditions allow the mixture to dry.

3. Steel and Aluminium Decks. Painting schemes for exterior steel and aluminium decks differ for the metal concerned and whether or not non-slip properties are specified. The relevant schemes are given in ABR 19/65 as also are the paint systems for internal metal decks, where it is laid down that they should be painted. The preparation and subsequent maintenance of painted metal decks is the same as for the other metal structure. Where internal decks are left bare, the only maintenance required is to keep the abrasive tread strips in good repair and the decks themselves clean, dry and free from corrosion. To save labour in keeping the decks corrosion free, full use should be made of the mechanical aids provided. Because of their specialised requirements aircraft carrier flight decks have their own painting schemes which are given in ABR 19/65.

4. Abrasive Tread Strips. Abrasive tread strips and adhesive are naval store articles and the strips are simply maintained by replacement. In areas of heavy traffic they are laid ¼in apart and in other places 6in apart. Where the deck is heavily pitted the initial preparation and laying of tread strips calls for dockyard assistance. On decks in good condition the procedure is as follows. The deck is first swept clean, mechanically scaled if necessary and power wire brushed. The surface should next be degreased and freed from old adhesive with a mixture of equal parts of naphtha and white spirit. The surface should then be painted as in ABR 19/65. The backing is then peeled from the tread strips and they are pressed firmly into position and the edges are sealed with a bead of adhesive.

5. Tiles. Experience has shown that vinyl tiles are superior to linoleum and they are now being fitted in new ships and where existing linoleum has to be replaced. They are supplied in a range of approved colours and are not to be treated with gum shellac for colouring or surfacing.

(a) Cleaning. The floor should be swept free of dust and grit with a soft brush. Surface dirt which will not brush off should be removed with a cloth damped with warm water to which detergent has been added in the approved ratio. Loose water should never be applied and floors that have been wiped with a damp cloth must be thoroughly dried. Obstinate marks may be removed by the careful use of a blunt scraper or the finest grade steel wool. Cleaning powders, coarse abrasives, strong caustic soaps etc., must not be used.

(b) Polishing. The best results are obtained by coating the tiles with plastic polish. Subsequent maintenance consists only of wiping with a damp cloth. If, after some months, the polish shows signs of wear, it can be patched where necessary. Instructions for applying the different proprietary brands of plastic polish are issued in ANOs and manufacturers instructions. Where plastic polish is not applied, wax or wax emulsion polish should be used. Wax polish must be buffed by hand or with a polishing machine at the time of application. Wax emulsion polish dries with a semi-lustre but can be buffed to obtain a high gloss.

6. Carpets. The maintenance of carpets calls for their correct treatment when new, cleaning by the approved methods and taking steps to equalise the wear over the whole surface.

(a) New carpets tend to 'fluf'. The 'fluf' consists of short wool fibres which do not reach the base of the carpet and are only a small proportion of the surface pile. As much 'fluf' as possible should be allowed to remain in the pile as this hastens the felting process, which increases the wearing qualities. To avoid unnecessary

loss of wool vigorous brushing of new carpets should be avoided and vacuum cleaners should be used with moderation.

(b) After the first month or two of use, carpets should be swept daily with a soft bristle brush and should be thoroughly cleaned with a vacuum cleaner once a week. Carpets should be swept in the direction in which the pile lies and the last stroke of the vacuum cleaner should be in that direction. Vacuum cleaners give their maximum efficiency with a slow movement. Where brushes are used they will of course raise dust, but the practice of damping with tea leaves or damp sawdust is forbidden as this adversely affects the colours. Small rugs must not be shaken or beaten harshly against a wall or over a line as these practices loosen the hem and damage the fabric.

(c) To reduce wear at doorways and between furniture, carpets should be turned around every six months. Re-arrangement of furniture may also redirect traffic and help to equalise wear over the whole surface.

7. Bathroom Deck Coverings. The policy for bathroom decks is to fit white unglazed ceramic tiles on the cork filled latex underlay in ships where the weight can be accepted. Where the weight cannot be accepted the decks are covered with vinyl-tiles. All types of deck covering should be cleaned with warm water and a mild soap. On no account should abrasives or strong detergents be used. Heavy scrubbing should be avoided.

0706. WOODWORK

1. Salt water is used for scrubbing bare woodwork. Sand may be added to remove ingrained dirt but should be used with caution when scrubbing the woodwork of boats as it is liable to be washed into the bilges where it is difficult to dislodge. Scrubbing with salt water and sharkskin produces the best finish on bare woodwork. Whichever method is used, to achieve best results, surplus water must be wiped off after scrubbing and the woodwork dried as quickly as possible. Soap should never be used as it leaves the wood greasy and may yellow it.

2 Polished wood should be washed with fresh water and dried or polished with furniture polish.

0707. MISCELLANEOUS

1. Stainless Steel and Enamel Washbasins. These should be cleaned with a soft cloth, using the standard detergent solution. Wire wool and abrasives must not be used.

2 Porcelain Lavatory Pans and Urinals. Soda ash is the approved cleaning agent for porcelain lavatory pans and urinals afloat. Commercial acid sodium sulphate, as used in shore establishments, is not to be used in ships because it corrodes the metal parts of the closets and oil pipes. Proprietary brands of cleaning materials are not to be used as these generally contain acid sodium sulphate. Hydrochloric acid may be used to remove obstinate stains or burn out blocked soil pipes. Thorough flushing after using hydrochloric acid is essential to prevent corrosion.

3. Curtains and Overcases. Curtains and overcases are normally sent to a reputable firm for dry cleaning at public expense once every twelve months.

Ships in the vicinity of a dockyard return the items to the Superintending Naval Stores Officer. The items are listed on Forms S 331 marked 'for cleaning and return' and showing the compartments of the ship in which the items are used and the date when they were last cleaned. When remote from dockyards the Supply Officer of a ship may arrange for dry cleaning locally, *see* ABR 4. Abroad, if dry cleaning facilities are not available, the articles are to be washed with yellow hard soap and tepid water.

4. Glass. Glass should be cleaned with soap and warm fresh water and then be polished with soft paper such as newspaper. Paint can be removed from glass by wetting it and then rubbing it with a copper coin laid flat.

5. Perspex. Perspex should be cleaned with a soft cloth and the special cleaner supplied for the purpose.

6. Leather Hide and Oilcloth. These are cleaned by washing with fresh warm water and soap. Dubbin or neatsfoot oil should be rubbed into leatherwork which is exposed to the weather.

7. Rubber. Rubber should be cleaned with soap and fresh water and then thoroughly dried. Paint splashes can be removed with pumice stone. Powdered chalk should be applied to the gaskets of watertight closures to stop the rubber getting sticky. Paint, oil or grease should not be allowed to come into contact with rubber.

0 8. Stainless Steel Lavatory Pans and Urinals. It is essential that both internal and external surfaces of pans and urinals be kept in a clean and bright condition. Particular care should be taken to prevent the build-up of stains, organic or calcareous deposits, and salt encrustations. Pans and urinals may be cleaned using a stiff bristle brush assisted if necessary by scouring powders. Powder residues should not be left in water traps and adhering to internal and external surfaces. Under no circumstances should steel pads, steel wool or similar type abrasive cleaners be used on stainless steel lavatory pans and urinals.

APPENDIX A

Published Instructions for Maintenance of Hull and Fittings

ABR 5016 Rules and Instructions for the Royal Australian Navy

Article	Subject
Anchors and Cables	
5485	Flukes of Anchors. - Lubrication
2912	Preservation
2912	Report of Parting of cable or loss of anchor
2912	Responsibilities of Captain
3322	Responsibilities of Boatswain
3515	Responsibilities of Navigating Officer
4128	Responsibilities of Shipwright Officer
5486	Survey and test of cables. See QR and AI 5532
Boats	
5483	Buoyancy tests see QR and AI 3248
3322	Falls responsibility for
4129	Shipwright Officers responsibilities
5487	Slings, bridles and disengaging gear - testing see QR and AI 5533
Canvas Gear	
3322	Maintenance and stowage
Capstans	
4128	Shipwright Officers responsibilities
Captains Responsibilities	
	Chapter 29, Section 2
Collision	
	Chapter 35, Section 4
Defects (See also Repairs)	
2901 & 2942	Captain to be informed
2722	Flag and Senior Officers responsibility
2942	Repair by ships staff
2723	Serious defects in ships. Senior Officer to order inquiry
Derrick Purchases	
3322	Responsibility of Boatswain

Article	Subject
Docking and Undocking	
2937, 5428	Accidents when ship is in dock and precautions
5429	Changes in weights
2715	Flag or Senior Officers responsibility for
5430	Flooding dock
4125 (9)	Custody of docking plan
3538	Precautions when entering or leaving dock
5430 (2)	Responsibility for valves
4132	Shipwright Officers responsibilities
Engineer Officer	
4211	Duties and responsibilities
Electrical Officer	
4311	Duties and responsibilities
Executive Officer	
3301 - 5	Duties and responsibilities
Fire	
2984 - 6	Precautions against
3712	Precautions in NAS
4134	Precautions by Shipwright Officer
3038	Precautions in aircraft and aircraft carriers
2943	Report by ship
Flag Officer Responsibilities	
2721	Refitting programmes
Hawsers	
3322	Responsibility of Boatswain
Hull and Fittings	
2723, 2943	Accident or serious defect affecting hull or fittings Report and enquiry
4125, 5407	Continual examination of hull and fittings
4131	Defects
4133	Draught of ship
2983, 4124	Maintenance of WT integrity
2942, 2982, 2983	Responsibilities of Captain
2982	Responsibilities of Engineer Officer
Chapter 41 Sect. II	
[illegible]	Responsibilities of Shipwright Officer

Article	Subject
2720 (1)	State of hull and fittings to be included in inspection report on ship
Chapter 54 Sect. II	Survey and examination - see QR and AI 5401
Flammable Materials	
2986	Instructions for shipment and use of flammable materials
Inspection	
2755	Inspection of HMA ship by Flag or Senior Officer
2935	Inspection by Dockyard Officers after large repairs
2901 - 2	Inspection by new Captain
2717 - 2720	Inspection general instructions
Life Buoys	
3423 (4)	Responsibility for
Life-rafts	Servicing
Lifts	Periodical test
Log	
2983	Watertight integrity log
Maintenance (Planned)	
5401	Planned maintenance
Masts and Spars	
4125	Shipwright Officers responsibility
NBCD	
4123	Control of flooding
Rigging and Ropes	
3322	Boatswains responsibilities
5487	Examination and tests of hawsers, slips etc
5488	Examination and tests of steel wire rope
Watertight Integrity	
2983	General instructions
2983	Watertight integrity log
2983	Responsibility of Captain
2982 (5)	Responsibility of Engineer Officer
3143 (13)	Responsibility of the OOW
2982, (5) 4124, 4126	Responsibility of Shipwright Officer

APPENDIX B

Published Instructions for Maintenance of Hull and Fittings

BR 31 Queen's Regulations and Admiralty Instructions

Article	Subject
2715	Commander-in-Chief - responsibility for observation of regulations for making good defects, docking etc.
2718	Inspecting Officer - report on material state of hull, etc.
2726	Flag or Senior Officer - responsibility for reports of defects and applications for repair and refit
2901	Captain - examination of state of ship, defects, etc., on assuming command
2912) 2913)	Preservation of anchors, cables and moorings - Captain's responsibility
2933	A and A defects - facilities for visits by Dockyard Officers
2936	Ship's and Dockyard Officers - inspection after large repairs
2941	Captain to be informed of the condition of hull, etc.
2982	Compartments to be kept dry and well ventilated - Captain's responsibility
2983	Watertight integrity - record of opening and closing of watertight compartments
2987	Stability - precautions to be observed
3241	Shipwright Officer - responsibility for hull, strength and stability
3242	Examination of structure - Shipwright Officer's duties
3243	Repair and maintenance of watertight doors and hatches
3244	Maintenance of sanitary services
3245	Fire precautions
3246	Capstans, anchors and cables - responsibility of Shipwright Officer
3247	Docking - examination of ship's bottom
3248	Maintenance of boats
3249	Record of defects

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Article	Subject
3253	Responsibility in the absence of the Shipwright Officer
3262	Rigging, hawsers, etc. - responsibility of Boatswain
3263	Anchors and cables - responsibility of the Boatswain
3265	Security of weather-deck gear
3266	Canvas gear - maintenance by Boatswain
3268	Examination and testing of gear in the Boatswain's charge
5401	Surveys and examinations
5402	Periodical surveys of hull, etc.
5404	Steel ships - examination, maintenance and preservation of structure
5405	Galvanic action - precautions
5406	Survey of escape manholes
5410	Cleaning and painting - responsibility of Dockyard and Ship's Staff
5531	Anchors - working of flukes
5532	Chain cables - periodic survey, Form S 194
5533	Hawsers and associated equipment, boats' slings; examinations and tests
5534	Steel wire ropes - examinations and tests
5602	Dockyard repairs for ships in commission - Form S 339(a)
5603	Record of defects
5604	Defects in ships refitted at another port
5605	Dockyard assistance - periods at which defect lists are to be rendered
5606	Defect lists - Form S 340/D 275 (pink) and Form S 340(b)/D 275(b)
5607	Supplementary defect list
5608	Defects to be made good by Ship's Staff
5609	Defects - naval stores for making good
5610	Repairs at foreign yards - procedure
5641	Periodical docking - standard intervals

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Article	Subject
5647	Docking at a foreign port
5648	Docking in a private yard
5671 to 5683	Alterations and additions - procedure and action
5721	Reduction to Reserve - preservation of hull structure

BR 3000 Marine Engineering Manual

Article	Subject
2801	Examination of structure by ship's officers - Form S 180 and Book S 338 complete examination of all accessible structure below the weather deck
2801	Quarterly inspection of certain compartments - compartments in which water is liable to accumulate
2803	Importance of careful examination - treatment of structure
2803 to 2808	Survey of structure (except FFO tanks) by Dockyard Officers - (a) Aircraft carriers and cruisers - 4-5 years (b) Fast mine-layers, destroyers, frigates and small vessels with outer bottom plating $\frac{1}{4}$in or less thick - at every dockyard refit (c) Submarines - at every dockyard refit (d) Other vessels - at alternate dockyard refits (e) Stationary and harbour vessels - complete survey within 4 years.
2812	Air pressure tests of watertight compartments - Ships in commission - at interval not exceeding 2-2$\frac{1}{2}$ years Ships under reconstruction or major alteration - tests are carried out by Dockyard Officers.
2810	Inspection of bulkheads and decks of WTCs - Visual inspection by Ship's Officers at commissioning.
2811	Fuel oil compartments in destroyers and frigates - Water-pressure test after repairs affecting watertightness Article 1913 gives other regulations for FFO tanks.
2831	Periodical working of sea valves - To be opened fully and shut again at intervals not exceeding three months.
2832	Salvage pumps and systems (aircraft carriers and depot ships) - Annual test by Ship's Staff Test by Dockyard Officers after large repairs.

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Article	Subject
2833	Portable electric pumps - To be tested under service conditions at intervals not exceeding six months
2834	Flooding and spraying systems, periodical tests - Valves to be worked quarterly Evidence of exceptional marine growth necessitates more frequent testing.
2836	Spraying arrangements, maintenance - All piping between spray valve and spray to be disconnected and cleaned by dockyard - Steel or ungalvanised iron pipes - every 2-2½ years Galvanised pipes - every 3-4 years Non-ferrous or alloyed pipes - 4-5 years.
2838	Hangar drenching system (aircraft carriers) - To be tested by actual use every 12 months
2454	Ventilation system - Interior of trunking to be examined quarterly
2455	Warm air supply to living spaces - Adjustment to steam valves and inspection of relief valves Daily examination of fans Periodical greasing of fan bearings.
2456	Air conditioning - Correct running of fan Inspection of trunking.
2816	Watertight doors, hatches and valves - To be examined and worked regularly, preferably once a week In large ships divided into four groups, one being examined and worked weekly, in rotation.
0675	Maintenance of wire rope - Regular lubrication To be examined at least once a month.
0676	Periodical examination and test of lifting appliances - see Appendix C.
2817	'A' bracket bushes - Wear-down by poker-gauge to be taken by diver when period between dockings exceeds six months.
0811 0812 0810 0813	Report of examination of propellers - Form D 488.

Article	Subject
1224	Prevention of external corrosion - Frequent examination of boiler uptakes, rainwater catchments and their drains.
1253	Funnel uptakes - Examination and adjustment of funnel guys once a week in harbour
2670	Electro-hydraulic steering gear, capstan and hoisting machinery - Examination of one pump unit of each service at intervals not exceeding two years.
2603	Capstans - Examination by dockyard at each refit
2505 2552 2553	Ropes - Aircraft catapults and arresting gear
2550	Aircraft lifts (aircraft carrier) - Quarterly examination by ship's staff Annual examination by dockyard.

APPENDIX C

Publications referring to Repair and Maintenance of Hull and Fittings

ABR 1	Catalogue of Books of Reference Etc.
BR 15	Notes on Leadership Morale and Discipline Etc.
ABR 4	Naval Storekeeping Manual
ABR 27	RAN Training Manual
ABR 19	RAN Painting Manual
BR 67	Seamanship Manuals, Volumes 1, 2 and 3
BR 31	QR and AI
BR 367	Instructions on Working, Handling, Survey and Repair of Anchors, Chain Cable and Associated Gear
BR 367A	Anchors and Cables and Associated Equipment
BR 298	Stability of Ships
BR 569	Practicable Construction of War Ships (Newton)
BR 862	Naval Magazine and Explosives Regulations (HM Ships)
BR 820	Provision of Safe Water for Drinking, Cooking, Washing and Similar Purposes
BR 1244	Fouling of Ship's Bottoms by Marine Growth
BR 1094	Warship Ventilation Hand Book
BR 1257	Ships Fire-Fighting Manual
BR 1277	The Laundry Manual
BR 1637	Anchors for Her Majesty's Service
BR 1786	Instructions for the Preservation of Gunnery Equipment
BR 1794	Craft Technical Memoranda
BR 1882	Habitability Manual for Her Majesty's Ships
BR 1940	Paint procedures for Aluminium Alloys
BR 1977(1)	Handbook for the Operation and Maintenance of 20-man Inflatable Liferafts; Patts. 5600 and 5603
BR 2170	NBCD Manual - Volume 1
BR 2171	NBCD Manual - Volume 2

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APPENDIX C (Continued.)

BR 2203	Ship Husbandry Manual
BR 3000	Marine Engineering Manual
BR 3001	Marine Engineering Technical Instructions
BR 3009	Naval Oils Manual
ABR 5016	Regulations and Instructions for the RAN
MBR 8003	Common Marine Fouling Organisms in Australian Waters
MBR 8022	Survival at Sea - Inflatable Liferafts
MBR 8026	Scales of Rust Grading and Surface Preparation of Steel Structures
BR 827	Seamans Pocketbook

APPENDIX D

Forms, etc., in Current Use, Concerning Hull Maintenance

AS 10	Daily List of Men Working in Double Bottoms
AS 10(A)	A Record Book of Work Performed in Double Bottoms and Confined Spaces
AS 180 Part 1 (Inside)	Particulars of Defects discovered during Examination. Superseded in Ships on Planned Maintenance
AS 180 Part 1 (Outside)	Report of Examination of Structures, Watertight Doors, Hatches etc. Superseded in Ships on Planned Maintenance
AS 180/AD 171 (Part 2)	Particulars of Tests Carried Out on Watertight Compartments. Superseded in Ships on Planned Maintenance
S 194	Half-yearly Returns of Survey of Chain Cable, Paravane Chains, etc.
AS 1182	Proposed Alteration and Addition Items
AS 1188	Poster - Colours and Markings of Piping
AS 1194	Precautions against Fire in Petrol Engine Boats
AS 1231/AD 786	A Certificate of Tests of Boat Slings
AS 2024 (12)	Engineering Master Record - Ship Information
AS 2024 (13)	Engineering Master Record - Ship History
AS 2024 (19)	Underwater Valves Record
AS 2024 (26)	A and A - Modifications Record
AS 2061Z	Planned Maintenance Defect Record
AS 2062Z) AD 1260Z)	Maintenance Schedule Amendment Proposal Form
AS 3006	Maintenance Report Cards. (PM)
AS 3007	Equipment Card. (PM)
AS 3008	Auxiliary Sheet. (PM)
S 228	Fire Report
AS 230	Closing Down File Report
AS 232	Report of Collision or Grounding
AS 238/AD 435 (Inside)	Underwater Paint Supplied and their Performances
AS 238/AD 435 (Outside)	A Report of Docking

APPENDIX D (Continued.)

S 326	Watertight Integrity Log
S 326 (A)	Watertight Integrity Statement
AS 338	A Record of Examination of Hull Structure up to Weather Decks and Fittings Affecting Watertight Sub-division Etc.
AS 338 (A)	Covering Instructions for AS 338
AS 541	A Report of Loss or Breakage of Anchors or Chain Cable
AS 555	A Poster - How to Operate Naval Inflatable Liferafts
AS 564 (A)	Poster - Precautions against Fire - General
AS 564 (B)	Poster - Precautions against Fire - Galleys
AS 564 (C)	Poster - Precautions against Fire - Machinery Spaces
AS 564 (D)	Poster - Precautions against Fire - Flammable Materials
AS 564 (E)	Poster - Precautions against Fire - Special Risks
AS 565	Poster - Instructions in the Use of Safety Lamps
AS 1120	Report of Environmental Conditions in HMA Ships
AS 1562	Poster - Regulations for Watertight Openings
S 1575	Poster - Regulations for NBCD Openings
S 1580	Poster - 1950 Markings
AS 2071Z	Report on Application and Performance of Paints
AS 425(14)	Report of Inspection of HMA Ships - Hull Structure
AS 2110Z (Inside)	Report of Survey and Repair of Support Craft
AS 2110Z (Outside)	Report of Survey and Repair of Support Craft
AS 197/AD 526	Amendments to List of Equipment, Portable Fittings, Spare Gear, Drawings and Instruction Books
AS 331	Large Return and Survey Voucher
AS 331	Med. Return and Survey Voucher
AS 331	Single Line Return and Survey Voucher
AS 331Z	Requisition for Survey of Stores by Ship's Officers
AS 473/ AD 787	Cover for List of Portable Fittings

APPENDIX D (Continued.)

AS 473C/ AD 787C	Certificate "A" (First Charge)
AS 473D/ AD 787D	Certificate "B" (Transfer)
AS 473E/ AD 787E	Certificate "C" (Closure)
AS 2022/ AD 400	Report of Defective Materials and Design
AS 1	List of Printed Forms - HMA Ships and Commissioned Establishments