1. MANAGEMENT OF WORK SITE AND SAFETY OF WORKS

1.1 Toolbox Meeting

Tool box meetings can be a challenge. To help make it easier, the following meetings guides have been developed to provide a simple, clear format for conducting tool box talk these guides include information on specific safety topics that should help encourage safe work practices.

Tool box meeting shall be carried out in accordance with the procedures of safety management system for the purpose of managing risk, safely completing planned jobs, addressing all safety, health and crew management matters and finally securing work site.

The senior officers shall have a tool box meeting to discuss & plan the assigned jobs prior commencement of day work. The following should be considered and discussed as a minimum:

a. Risk associated with planned work activity, its existing and additional control measures and available time schedule
b. Ascertain need for formal risk assessment procedures or JHA procedures
c. Personal Protective Equipment
d. Use of work equipment and associated operation and safety procedures
e. Permits to work
f. Lock Out / Tag Out
g. Applicable rules and regulations
h. Communication and inter-relation of work activities or non-availability of required equipment
i. Availability of resources including equipment
j. Work and rest hours

Each responsible person for maintenance shall draw up a maintenance work plan for his own department, and make efforts to ensure the safe and smooth performance of maintenance work by keeping close contact among departments in relation to important work or work that concerns two or more departments.

2. Job Hazard Assessment

A job safety analysis (JSA) is a procedure which helps integrate accepted safety and health principles and practices into a particular task or job operation. In a JSA, each basic step of the job is to identify potential hazards and to recommend the safest way to do the job. Other terms used to describe this procedure are job hazard analysis (JHA) and job hazard breakdown.

Four Basic Steps

Four basic stages in conducting a JSA are:

- selecting the job to be analyzed
- breaking the job down into a sequence of steps
- identifying potential hazards
- determining preventive measures to overcome these hazards

Factors to be considered in setting a priority for analysis of jobs include:

- Accident frequency and severity: jobs where accidents occur frequently or where they occur infrequently but result in disabling injuries.
- Potential for severe injuries or illnesses: the consequences of an accident, hazardous condition, or exposure to harmful substance are potentially severe.
- Newly established jobs: due to lack of experience in these jobs, hazards may not be evident or anticipated.
- Modified jobs: new hazards may be associated with changes in job procedures.
- Infrequently performed jobs: workers may be at greater risk when undertaking non-routine jobs and a JSA provides a means of reviewing hazards.

Identify Potential Hazards

Once the basic steps have been recorded, potential hazards must be identified at each step. Based on observations of the job, knowledge of accident and injury causes, and personal experience, list the things that could go wrong at each step.

To help identify potential hazards, the job analyst may use questions such as these (this is not a complete list):

- Can any body part get caught in or between objects?
- Do tools, machines, or equipment present any hazards?
- Can the worker make harmful contact with moving objects?

- Can the worker slip, trip, or fall?
- Can the worker suffer strain from lifting, pushing, or pulling?
- Is the worker exposed to extreme heat or cold?
- Is excessive noise or vibration a problem?
- Is there a danger from falling objects?
- Is lighting a problem?
- Can weather conditions affect safety?
- Is harmful radiation a possibility?
- Can contact be made with hot, toxic, or caustic substances?
- Are there dusts, fumes, mists, or vapors in the air?

1. Eliminate the hazard

This is the most effective measure. These techniques should be used to eliminate the hazards:

- Choose a different process
- Modify an existing process
- Substitute with less hazardous substance
- Improve environment (ventilation)
- Modify or change equipment or tools

2. Contain the hazard

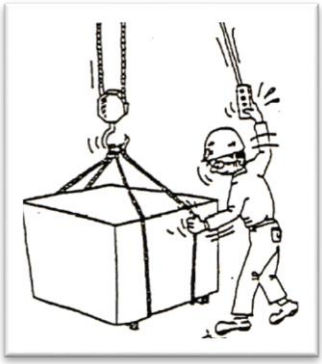
If the hazard cannot be eliminated, contact might be prevented by using enclosures, machine guards, worker booths or similar devices.

3. Revise work procedures

Consideration might be given to modifying steps which are hazardous, changing the sequence of steps, or adding additional steps (such as locking out energy sources).

4. Reduce the exposure

These measures are the least effective and should only be used if no other solutions are possible. One way of minimizing exposure is to reduce the number of times the hazard is encountered. An example would be modifying machinery so that less maintenance is necessary. The use of appropriate personal protective equipment may be required. To reduce the severity of an accident, emergency facilities, such as eyewash stations, may need to be provided.



Examples of Unsafe Condition:

KYT (KikenYochi Training)

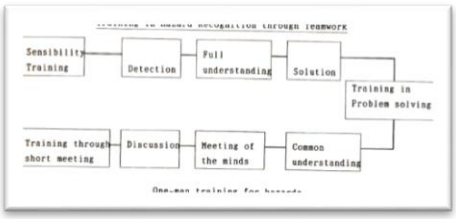
The Hazard Recognition Training (KYT) Concept

A. What is the hazard recognition training?

Hazard Recognition Training implemented under the Zero-Accident Campaign is safety anticipation training, through teamwork in the field, by everyone, quickly and correctly. It is also acceptable to carry out this teamwork training at the same time as one-man training.

The following three types of training are involved.
1. Sensibility Training
2. Training through Short Meetings
3. Training in Problem Solving

The following diagram illustrates the relationship among these three types.



B.Take Occupational Health and Safety in advance

1. To anticipate unsafe conditions, it is necessary to heighten the team's and the individual's sensibility to hazards.

Safety anticipation means preventing the development of accidents related to labor calamities in advance. In order to do this, it is extremely important to discover conditions which may cause accidents which are concealed in the workplace or within the work itself, and have a full understanding of these conditions before the work commences. The starting point of any safety activity is to realize that a hazard is a hazard.

If the ability to sense the underlying factors of a hazardous condition is labeled "sensibility" then it is necessary to heighten sensibility to hazards, and stress that the safety of everyone must be maintained by everyone, not only for the individual, but as a complete team. Hazard sensibility is heightened by repeated training in fact, accurate hazard recognition.
(Hazard Recognition Training is training for heightening sensibility in uncovering causes of hazardous conditions in workplace and working conditions, from individual level to the team level.)

2. For safety anticipation, it is necessary that all workers hold active discussions at a workplace, especially in the form of short meetings. The management function does not just consist of unilaterally issuing instructions and orders. It is also necessary to have meetings in which hazardous conditions in the workplace and conditions of work are discussed with all team members, agreement reached and action decided upon. It is especially necessary to hold effective, very short, tool box meetings (TBM) in the field.

3. In safety anticipation, it is necessary to upgrade the problem solving performance of the team which is to eliminate the uncovered hazards. The Zero-accident Campaign is a movement for independently eliminating workplace problems and hazards. This does not simply mean sensing and recognizing the hazard. If a hazard exists, such as a footboard being shaky, the team immediately rectifies the condition, independently, before commencing work. In short, recognition the hazardous and solving the problem must be tied together. In the Zero-accident Campaign, in order to solve the problem, discussion, meeting of the minds, and common understanding, based on the following four rounds are recommended.

C. Plan for Introducing and Establishing KYT

1. Introductory Field Training
The field step in introducing KYT is to go through the four rounds several times, taking up 20 to 30 minutes during the course of a safety meeting, to explain the concepts of Hazard Recognition Training.

2. The Second Stage in Making the Introduction in the Field Carry out repeated training in the form of continuing short KYT meetings, when holding a safety meeting or a daily tool box meeting. In order to keep the discussion time within 10 minutes it is necessary to select an appropriate sheet for the training, or limit the discussion to a specific part of the sheet.

3. Third Introductory Stage
The real thing is carried out in the field when a tool box meeting is held in the field concerning that day's work, especially problematic fundamental operations, or ascertain step, in the form of Hazard Recognition Training taking less than five minutes, especially short term hazard recognition, such as KYT and Triangular KYT.

4. Long Term Training Plan
To spread hazard recognition activities throughout the workplace,
(I) When TBM's are held daily -- A total of about 3 months
(2) When TBM's are held on alternate days -- A total of about 6 months
Accordingly, a plan for introducing and firmly establishing hazard recognition training should be carried out steadily and unhurriedly.

D. Ten Rules for the Leader Implementing KYT

1. Draw up a Training Plan
When the leader carries out Hazard Recognition Training with his own team, he should draw up an approximate plan, with the intention of carrying it out dairy, unhurriedly, in fixed form for about a six month period.

2. Cut Down on the Lecture Time
Making use of the motto "Practice KY quickly and accurately by a1l" the training should be implemented on a continuous basis as soon as possible.

3. The First Requirement is to uncover the Causes of the Hazards. There are some persons who look at an illustration sheet and immediately want to propose a countermeasure.

4. Reducing the Range
The conditions in the illustrations can, at times, cover too wide a range, for short meeting it is a good idea to limit the part that will be discussed. A sheet which contains about five hazardous items acceptable. When implementing the real thing in the field, it is also necessary to limit the range to fundamental steps and actions.

5. Decisive Elimination of Important Hazards
When thinking of hazards which the team can independently resolve, rather than "What type of hazard exist?" the important question is “What hazardous points can be restrained?". It is necessary that mutual agreement be created that important hazards marked with a double circle are the ones to deal with, or that the items for priority implementation should by all means be handled.

6. Do Not Overlook Dangerous Points
The items which you wish to have detected, without fail, from the sheets, should always be clarified ahead of time. It is best if the leader, during the discussion, does not bring these items to the fore. But can make the members understand them by having the brought up in a natural manner.

7. Do Not Limit the Scope to Unsafe Actions Only

The items which you wish to have detected, without fail, from the sheets, should always be clarified ahead of time. It is best if the leader, during the discussion, does not bring these items to the fore. But can make the members understand them by having the brought up in a natural manner.

8. Use Four Rounds as Required

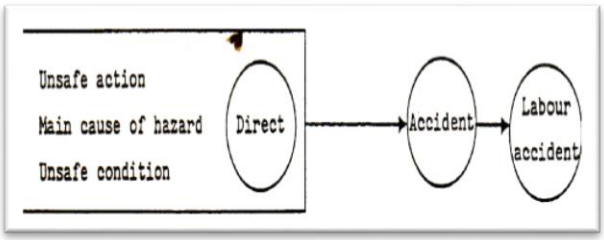
Use Four Rounds As required all situations do not require the full four rounds. It is usually recommended that the second round be completed. It is also acceptable to proceed as far as the 3.5 round.

9. Narrow Down and Finger Pointing and Call

The items marked with a double circle in Round Two, and the team's course of action in the Round Four must always be recited in chorus with appointing finger. AII members of the team should individually get into the habit of confirming by finger pointing and call double-circled items and asterisked items, not only during training, but when working in the field.

10. Proceed with Clarity and Base

Hazard Recognition Training has the most appeal when conducted in a good, relaxing atmosphere. There are cases when unrealistic and fanciful items come up, causing laughter, but amidst the discussion unnatural items are subject to natural selection. The leader should not get excited about the individual items, but should make every effort to establish an open atmosphere.



3. Near Miss

DEVIL = Dangerous Events and Irregular Looks
= Unsafe Acts and Unsafe Condition

The Importance of Near Miss Reporting

Reporting near misses is important to prevent accident by identifying situations that can lead to accidents and implementing corrective actions.
Objectives of near miss reporting

If one vessel will report a near miss, multiply that one vessel to the number of vessel in the fleet, then accidents will be prevented for the number in the fleet, for example, 1 near miss report times, send copy to the other 100 ships in the fleet, then 100 near misses of same nature was prevented. This is because the other vessels will be aware and will implement preventive actions.

Comparison of ship type to the number of near misses and accidents:

The relationship of near miss reporting against number of accident for FY 2011 and 2012 is shown in the figure below. For LNG vessels, there are many near miss reports but very small incidents of accident. On the contrary, bulkers have the least number of near miss reports but most number of accidents. It shows that when crews are active in finding near misses, they became more safety conscious and aware of accident prevention.

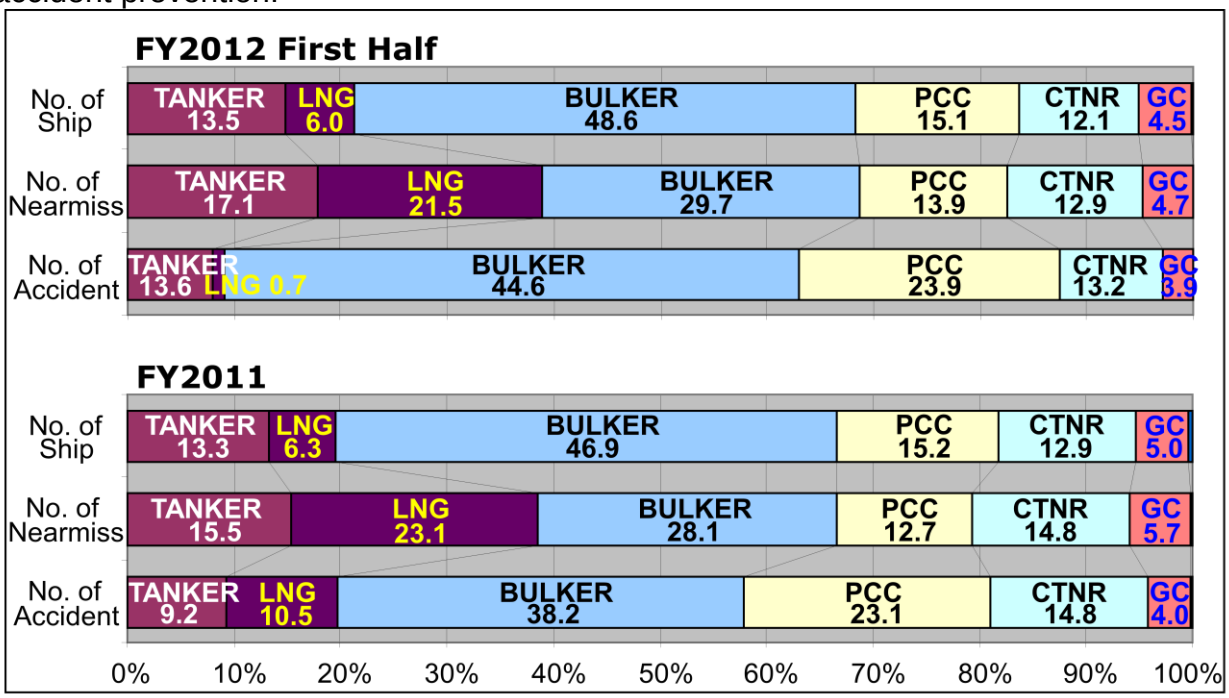


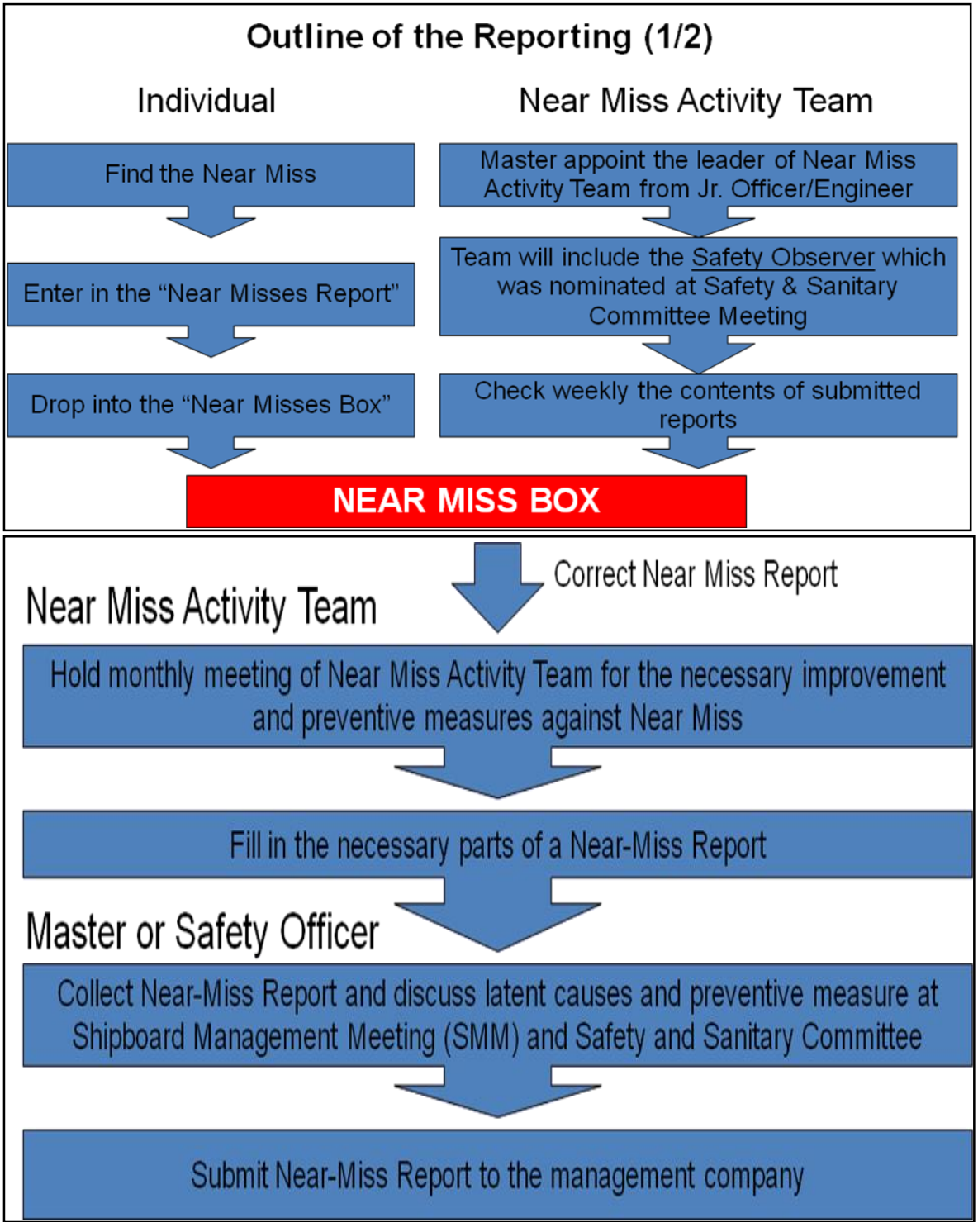
Figure: Comparison of ship type to the number of near misses and accidents

Examples of near miss that can be encountered on board while working:

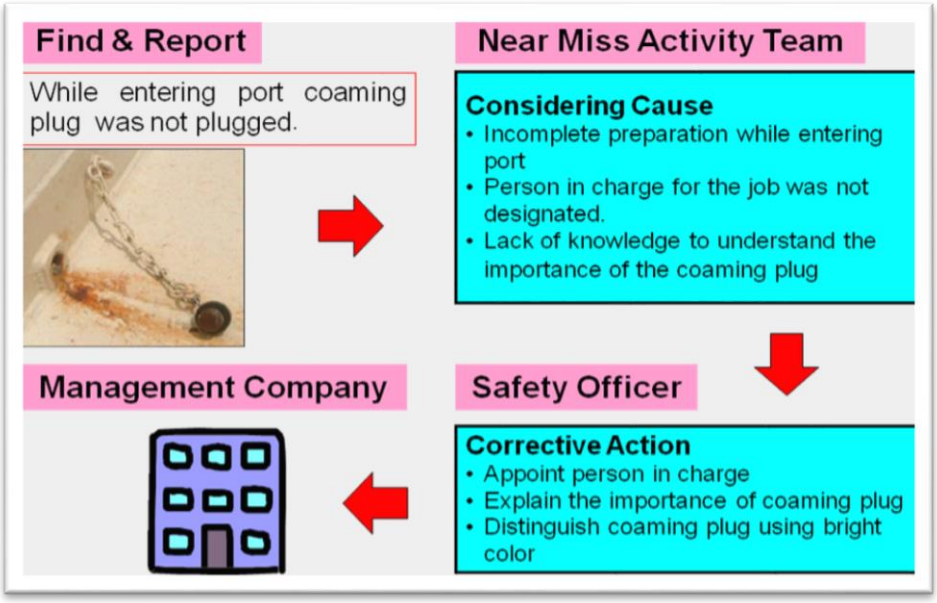
1. One crew working with lathe machine and NOT wearing safety goggles.
2. One crew working with welding machine and NOT wearing the proper welding gloves.
3. One crew working in the engine room and NOT wearing a safety helmet.
4. The floor in the engine room lower flooring is slippery due to oil stain, therefore it may cause slipping hazard to those who will do a maintenance job in that area.
5. Some crew forgot to secure a couple of tools and left it on top of a boiler drum, making it a falling hazard to those who will work below that area.

After finding a near miss, a report should be written in a near miss report form, and to be submitted to the near miss activity team leader, to chief mate, or it can also be dropped in a near miss report box.

The following is a flow chart showing the procedure of reporting a near miss:



The flow chart below shows a sample flow for reporting:



4. Matters needed to be reported to Chief Engineer by Duty Engineer

- When the engine damage or malfunctions occur, which to his opinion are such as to endanger the safe operation of the ship.
- When malfunctions occur, which in his opinion may cause damage or breakdown of propulsion machinery, auxiliary machinery or monitoring and governing systems?
- In emergencies or in situations when he is in doubt as to what decision or measure to take.
- In other circumstances as required in the C/E's standing and night orders.
- The chief engineer must be called at standby when entering and leaving harbor, during passage through narrow channels, congested area, navigation under foggy condition or at sea whenever maneuvering is required.
- The Chief engineer is to be informed immediately in case of any abnormal parameters from any machinery and if main engine rpm is to be reduced or increased.

5. Personal Safety in the Engine Room

Protective clothing is the first barrier against hazards in the engine room. Overalls with long sleeves will protect the skin against dirt and abrasion. A good fit prevents clothing getting caught in moving machinery. Rings and jewelry can also be caught in moving machines, so remove them before duty. Safety footwear is designed to be slip resistant and to protect your feet from heat, knocks and cuts.

Good housekeeping is an important part of working safely and is everyone's responsibility. If floor plates have been temporarily removed, the openings should be protected. Warning notices should be posted where they can be seen at all times until it is safe to remove them. Missing floor plates are dangerous. Replace them as soon as possible. If lifting handles are not available, use a sensible lever, not your fingers.

Avoid tiredness by having sufficient sleep and rest periods. Drinking plenty of liquids will counter the effects of dehydration.

Safe working practices, attention to training, and good housekeeping will form the basis of personal safety in the engine room. At the end of the day, it is your own skill and judgment that will take you safely home.

5.1 Main Personal Protective Equipments (PPE) Used Onboard Ship

Safety of self and co-workers is the prime priority kept in mind by a professional seafarer while working onboard ship. All shipping companies ensure that their crew follows personal safety procedures and rules for all the operation carried onboard ships.

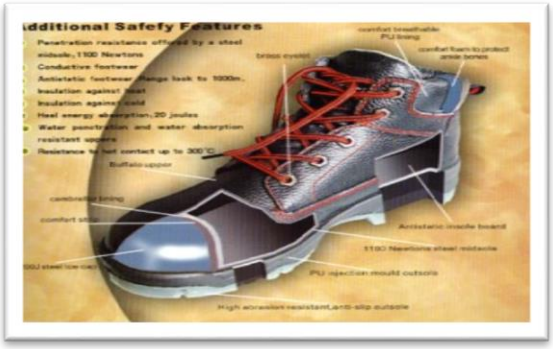
To achieve utmost safety on board ship, the basic step is to make sure that everybody wears their personal protective equipment's made for different types of jobs carried out on ship.

Following are the basic personal protective equipment's (ppe) that are always present onboard a ship to ensure safety of the working crew:

1) Protective Clothing: Protective clothing is a coverall which protects the body of the crew member from hazardous substance like hot oil, water, welding spark etc. It is popularly known as "dangri "or "boiler suit".

2) Helmet: The most important part of the human body is the head. It needs utmost protection which is provided by a hard plastic helmet on the ship. A chin strap is also provided with the helmet which keeps the helmet on place when there is a trip or fall.

3) Safety Shoes: Maximum of the internal space of the ship is utilized by cargo and machinery, which is made of hard metal and which make it clumsy for crew to walk around. Safety shoes ensure that nothing happens to the crew member's feet while working or walking onboard.



4) Safety Hand gloves: Different types of hand gloves are provided onboard ship. All these are used in operations wherein it becomes imperative to protect ones hands. Some of the gloves provided are heat resistant gloves to work on hot surface, cotton gloves for normal operation, welding gloves, chemical gloves etc.

5) Goggles: Eyes are the most sensitive part of the human body and in daily operations on ship chances are very high for having an eye injury. Protective glass or goggles are used for eye protection, whereas welding goggles are used for welding operation which protects the eyes from high intensity spark.

6) Ear Muff/plug: Engine room of the ship produces 110-120 db of sound which is very high for human ears. Even few minutes of exposure can lead to head ache, irritation and sometimes partial or full hearing loss. An ear muff or ear plug is used on board ship which dampens the noise to a bearable decibel value.

7) Safety harness: Routine ship operation includes maintenance and painting of high and elevated surfaces which require crew members to reach areas that are not easily accessible. To avoid a fall from such heightened area, safety harness is used. Safety harness is donned by the operator at one end and tied at a strong point on the other end.

8) Face mask: Working on insulation surface, painting or carbon cleaning involves minor hazardous particles which are harmful for human body if inhaled directly. To avoid this, face mask are provided which acts as shield from hazardous particle.

9) Chemical suit: Use of chemicals onboard ship is very frequent and some chemicals are very dangerous when they come in direct contact with human skin. A chemical suit is worn to avoid such situations.

10) Welding shield: Welding is a very common operation onboard ship for structural repairs. A welder is provided with welding shield or mask which protects the eyes from coming in direct contact with ultraviolet rays of the spark of the weld.

6. Proper Use of Tools and Measuring Instruments that are commonly used in Engine Room

The use of safety hand tools should be a key component of most industrial safety programs. An understanding of the hand tool's intended use and environment, combined with proper tool selection, maintenance and storage, will greatly reduce the risk of explosion and fire.

- Keep non-sparking tools clean and free from ferrous or other contaminants, which may impair the non-sparking properties.
- Do not use non-sparking hand tools in direct contact with acetylene, due to the possible formation of explosive acetylenes, especially in the presence of moisture.
- During normal use, all hammers and chisels will progressively develop some damage to the striking faces of hammers or the cutting edge and striking end of chisels.

- Do not store hammers and other hand tools fitted with wooden handles in places where the handles may dry out and shrink. This will increase the risk of the handle breaking or the head becoming loose.
- Avoid overstrikes, causing damage to the shaft. Supply replacement handles are often available from the manufacturer, and should be fitted by a competent operator, using an approved method of fitting and paying particular attention to the fitting of the wedges.
- Fiberglass handles can offer advantages over wooden handles in terms of breaking stress and tolerance for adverse environmental conditions. Fiberglass shafts fail progressively, rather than catastrophically, reducing the risk of sudden failure, injury or damage.
- When selecting a wrench, the jaw opening should have a close and tight fit on the head of the nut or bolt to which it is being applied. This is especially true with non-sparking tools, as they typically do not have the hardness of steel tools.
- Tools are designed for specific use. As with any tool, additional torque should not be applied through the use of "cheater bars." In addition to the probability that the tool will be damaged, this is a dangerous practice for the safety of the operator. Wrenches should not be used as levers; nor screwdrivers as chisels, and so on.
- The accepted standards of safety and maintenance for common steel hand tools must also be adopted with non-sparking hand tools, in addition to any specific recommendations resulting from the alloys used.
- When sharpening non-spark safety tools, follow normal safety procedures, such as the provision of eye and face protection, adequate extraction and dust collecting facilities.

Kinds of Tools

Adjustable Wrench

Adjustable wrench is an adjustable tool for gripping hexagonal nuts, with adjusting screw in the head of the implement. But it is not applicable for fastening, it is lack of fitting measurement that a dedicated tool would have they also have a tendency to" round off "the corner of the fasteners itself due to a poor fitting.

Single open ended spanners/ Double open end spanners

It is a tool used to provide grip and mechanical advantage in applying torque to turn objects usually rotary fasteners, such as nuts and bolts or keep them from turning.


Straight Pipe Wrench

The pipe wrench is an adjustable wrench used for turning soft iron pipes and fittings with a rounded surface.

Solid Steel Bar Wrench

It is an old type of adjustable wrench with a straight handle and smooth jaws whose gripping faces are perpendicular to the handle.

Spud Wrench

A steel erecting tool which consists of a normal wrench at one end and a spike at the other, used for lining up bolt holes (typically when mating two pipe flanges).

Single End Angle Wrench

This is a one-piece wrench with an enclosed opening that grips the faces of the bolt or nut and commonly use in angle position.

Hook Spanner Wrench

A wrench with one or several pins or hooks, designed to drive spanner head screws, threaded collars and retainer rings, shafts, and so on.

Socket Wrench

It contains a one-way mechanism which allows the socket to be turned without removing it from the nut or bolt simply by cycling the handle backward and forward.

Hexagon Wrench (Allen Key)

A wrench used to turn screw or bolt heads designed with a hexagonal socket (recess) to receive the wrench. The wrenches come in two common forms: L-shaped and T-handles.

T- Wrench

A T-shaped wrench with a handle having a socket (either fixed or removable) which fits over a nut or bolt head.

Flat Nose Pliers

It is designed for making sharp bends and right angles in wire. Flat nose pliers can also grip flat objects and work well for straightening bent wire.

Combination Pliers

They have gripping jaws cutting edge and insulating handling grips that reduce (but did not eliminate) the risk of electric shock when contact with live wire.

Side- cutting Pliers

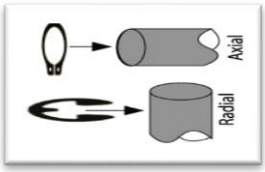
Side-cutting pliers, are used for gripping, wire splicing, wire cutting, insulation stripping, and for crushing insulation.

Water Pump Pliers

It is designed primarily for gripping objects by using leverage. These pliers aredesigned for numerous purposes and sometimes require different jaw configurations to grip, turn, pull, or crimp a variety of things.

Snap Ring Pliers

A tool used to forced open any retaining ring in shaft or in bores, it snap back into place to make a snug fit.





Hand Snip

A toolwhich uses a compound leverage handle system to increase the mechanical advantage for cutting metal sheets, gaskets and it is similar to common scissors.

Tongs

It is a grasping device consisting of two arms that are joined, often at one end, as by a pivot or a scissor like hinge.

Hammer/ Lead Hammer

It serves to hit the object of soft or hard materials without damaging the component.

Ball Peen Hammer

Is also known as a machinist's hammer, is a type of peen hammer used in metalworking. It is distinguished from a point-peen hammer or chisel-peen hammer by having a hemispherical head. Though the process of peening has become rarer in metal fabrication, the ball-peen hammer remains useful for many tasks, such as striking punches and chisels.

Cold Chisel

It is a tool made of tempered steel used for cutting 'cold' metals, meaning that they are not used in conjunction with heating torches, forges, etc. Cold chisels are used to remove waste metal.

Hand Taps

It is a cutting tools used to create screw threads, which is called threading. A tap is used to cut the female portion of the mating pair.

Dies

A die is used to cut the male portion of the mating pair.

Gasket Cutter

It is a precision, hand-operated machine that cuts inside diameter and outside diameter, with speed and ease from all types of non-metallic sheet packing.

Machinist Files

Files come in far too many patterns and cuts to treat in detail here, but are generally either Machinists or Engineers Files for shaping, Saw or Sharpening Files for sharpening, Aluminum Files for that soft material, Rasps with coarse teeth for wood, Needle Files for small work or large Blacksmith Files.

Gear and Wheel Puller

Pullers are designed to be used in motor repair shops, shipyards, railroads, paper mills, steel plants and other process industries, for pulling frozen gears, bearings and couplings from shafts.

Pipe Cutter

A pipe cutter is a type of tool used on board to cut pipe. Besides producing a clean cut, the tool is often a faster, cleaner, and more convenient way of cutting pipe than using a hacksaw.

Bench Vice

It is a mechanical screw apparatus used for holding or clamping a work piece to allow work to be performed on it with tools such as saws, planes, drills, mills, screwdrivers, sandpaper, etc. Vises usually have one fixed jaw and another, parallel, jaw which is moved towards or away from the fixed jaw by the screw.

C-Type Screw Clamp

This type of device hold a wood or metal work piece, and are often used in, but are not limited to, carpentry and welding. These clamps are called "C" clamps because of their C shaped frame.

Screw Drivers

A screwdriver is a tool for driving screws or bolts with special slots, and sometimes for rotating other machine elements with the mating drive system.

-  The slot screw driver has a single slot in the fastener head and is driven by a flat-bladed screwdriver.
-  A cross-recess screw driver has two slots, oriented perpendicular to each other, in the fastener head; a slotted screwdriver is still used to drive just one of the slots. This type is usually found in cheaply made roofing bolts and the like, where a thread of 5 mm (0.20 in) or above has a large flattened pan head.
-  Phillips screw driver was purposely designed to cam out when the screw stalled, to prevent the fastener damaging the work or the head, instead damaging the driver. This was caused by the relative difficulty in building torque limiting into the early drivers.
-  The Frearson screw driver, also known as the Reed and Prince Screw driver, is similar to a Phillips but the Frearson has a more pointed 75° V shape. One advantage over the Phillips drive is that one driver or bit fits all screw sizes.
-  The Mortorq drive is a format used in automotive and aerospace applications. It is designed to be a lightweight, low-profile and high-strength drive, with full contact over the entire recess wing reducing risk of stripping.
-  The Pozidriv, sometimes misspelled Pozidrive, screw driver is an improved version of the Phillips screw drive. It is a set of radial indentations set 45 degrees from the cross recess.
-  A Robertson, also known as a square, or Scrulox screw driver has a square-shaped socket in the screw head and a square protrusion on the tool. Both the tool and the socket have a taper.

-  The Bristol screw driver is a spline with four or six splines. The grooves in the wrench are cut by a square-cornered broach, giving a slight undercut to the outer corners of the driver. The main advantage to this drive system is that almost all of the turning force is applied at right angles to the fastener spline face, which reduces the possibility of stripping the fastener.

Hammering screwdriver

It is a tungsten alloy blades are pierced througha hard wooden handle the end is reinforced with a large nut that permits hammering.

Chain Hoist

Is a device used for lifting or lowering a load by means of a drum or lift-wheel aroundwhich rope or chain wraps. It may be manuallyoperated, electrically or pneumatically driven and may use chain,

Surface Plate

Surface plate is a solid, flat plate used as the main horizontal reference plane for precision inspection, marking out (layout), and tooling setup. The surface plate is often used as the baseline for all measurements to the work piece; therefore one primary surface is finished extremely flat with accuracy up to .00001"/.00025 mm for a grade AA or AAA plate.

Scriber

A scriber is a hand tool used in metalworking to mark lines on work pieces, prior to machining.


Trammel

This is used for scribing larger arcs and circles because of its sliding and adjustable heads.

Hammer test

is done for the purpose of checking the integrity and tightness of the bolts and nuts. Hammer testing is done by striking the bolts or nuts at the counter clockwise direction or the loosening direction of the bolt or nut.
By hearing the sound and feeling the movement of the bolt or nut, you can distinguish if it is in good.

Feeler Gauge

Feeler gauge is a tool used to measure gap widths. Feeler gauges are mostly used in engineering to measure the clearance between two parts

They consist of a number of small lengths of steel of different thicknesses with measurements marked on each piece. They are flexible enough that, even if they are all on the same hinge, several can be stacked together to gauge intermediate values.


Dial Indicator

The dial indicator is a precision measuring tool that measures relative distances. Use to measure the difference in distance to two or more locations. The dial indicator is great for checking alignment and run out.


A plunger moves in and out from the body of the indicator and rotates the measuring needle on a dial face. Dial indicators usually have either a 1" or 2" range and are calibrated in increments of .001". A smaller dial reads each revolution of the larger dial in increments of 0.100".

The outer bezel rotates and turns the numeric scale with it so that you can set the indicator to zero at any plunger position. Most D/Is have two little movable markers on the outside of the dial face that can be used as reference points.

A dial indicator (DI) set up to center a bolt in a 4-jaw chuck. If the bolt is off-center, the DI plunger will move in and out as the chuck rotates. When the bolt is properly centered there will be little or no movement of the plunger and the needle of the DI will move only .001 or less.

Tools That Are Commonly Used in the Engine Room

The tools lessons will be found quite elementary in places, since they are prepared so as to be suitable for the beginning student, as just explained. They should be studied carefully, however, as this will enable all trainees to practice the art of study (which they may not have been doing recently) and will help them to master the more difficult engineering principles that follow in later lessons.

Good tools are essential if an engineer is to do his best work quickly, properly and accurately. Without the proper tools and the knowledge of how to use them, time is wasted, efficiency is reduced, and the person doing the work may injure himself.

Torque wrench - is a tool used to precisely apply a specific torque to a fastener such as a nut or bolt.


Proper use and maintenance of Torque Wrench

A torque wrench is a precision instrument designed to apply a specific amount of force to a fastener. Whether tightening head bolts on an engine, inspecting fastener tolerances on high-performance equipment, it is extremely important that proper care is used.

Guidelines are typically provided noting acceptable torque ranges, the order in which specific fasteners are tightened and the number of times a fastener must be tightened and loosened to ensure uniform torque application. Failure to properly torque fasteners can lead to equipment damage, personal injury or worse.

It is important to follow acceptable maintenance and use practices, such as:

1. Safety glasses or goggles should be worn at all times when using any hand too.
2. Always follow the manufacturer's directions regarding torque direction, proper force, torque pattern/sequence, use or non-use of lubrication on fasteners and torque "tighten/release" cycles.
3. Do not exceed the recommended working range of the torque wrench. Reliable measurements are based on a percentage of the working range. In general, most mechanical wrenches have a useable range from 20% to 100% of full scale. Most electronic wrenches have a useable range from 10% to 100% of full scale.
4. Do not use accessories or handle extensions unless specifically allowed by the torque wrench manufacturer.
5. Take time to inspect the tool and check for worn or cracked sockets. Properly lubricate and replace worn parts.
6. Avoid dropping or sliding a torque wrench. Dropping a torque wrench on a hard surface can cause the instrument to lose reliable calibration. If you suspect that a wrench has been dropped, have the tool inspected by the manufacturer or reputable calibration service.
7. Always store a torque wrench in a protective case and/or location when not in use.
8. Avoid exposure to temperature extremes, high humidity, fluid immersion and corrosive environments.
9. If using a click-type torque wrench, always store it at the lowest level on the scale.
10. Avoid marking, etching or placing labels on torque wrenches.
11. Use a torque wrench to apply a specific torque value during the final assembly process. Do not use a torque wrench as the primary means of tightening or loosening fasteners.
12. As most torque wrenches are length specific, always grasp the torque wrench in the center of the handle. If two hands need to be used, place one hand on top of the other.
13. Apply torque in a slow, methodical manner and avoid sudden, "jerking" movements.
14. When the wrench signals (by clicking, beeping or lights) that a specific torque has been reached, stop pulling immediately.

15. After 5,000 cycles or up to one year of use, whichever comes first, have your torque wrench inspected and recalibrated by the manufacturer or reputable calibration service. With proper care, a high-quality torque wrench should provide accurate measurements for many years.

Conversion of units of Measurement

Basic Equivalence of Units of Force:

1 N = 1 kgf•m/s^2
1 kgf = 9.81 N
1N = 0.102 kgf

Force = mass x acceleration
Gravitational acceleration (g) = 9.81 m/s^2
Therefore, N = kgf x g; N = kgf x 9.81 m/s^2
And, kgf = N ÷ g; kgf = N ÷ 9.81 m/s^2

For Torque Wrench:

1 N•m (Newton metre) = 0.102 kgf•m (kilogram-force meter)

Pressure Conversion:

1 Pa (pascal) = 1 N/m² (newton per square meter)

1 Bar	100 000 Pa (pascal)
	0.1 MPa (megapascal)
	1.019 kgf/cm² (kilogram-force per square centimeter)
	14.503 psi (pound per square inch)
	0.986 atm (atmosphere)

Example of how to convert units by manual calculation:
1. Prove that 100,000 Pa = 1.019 kgf/cm^2
Solution:
Note equivalents
100,000 Pa = 100,000 N/m^2; 1 kgf = 9.81 N; 1 m = 100 cm

Solve by elimination of units:

$$= \frac{100{,}000\ \text{N}}{1\ \text{m}^2} \times \frac{1\ \text{kgf}}{9.81\ \text{N}} \times \frac{(1\ \text{m})^2}{(100\ \text{cm})^2} = \frac{100{,}000\ \text{N} \times 1\ \text{kgf} \times 1\ \text{m}^2}{1\ \text{m}^2 \times 9.81\ \text{N} \times 10000\ \text{cm}^2}$$

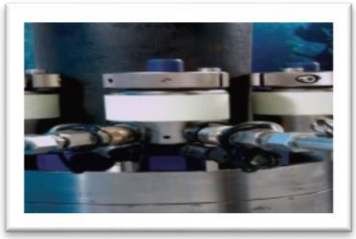
$$= \frac{100{,}000\ \text{kgf}}{98100\ \text{cm}^2} = 1.019\ \text{kgf/cm}^2$$

Hydraulic Tightening

Hydraulic torque is a method used to tighten bolts rapidly and accurately with the necessary tension required. One of the advantages is that it is easy to operate; another is that hydraulic torque wrenches create no spark during operation and therefore it is an approved technique for oil and gas, underground mining and other industry applications.

Leak Testing for Hydraulic

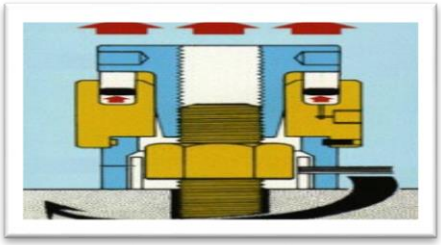
Leak testing or bubble testing is commonly performed after bolt tightening or flushing to ensure that there are no leaks in the system, and that the system is ready for operational use. Gas detectors and detergent are commonly used in performing the leak testing procedure. The testing will ensure that there are no leaks in the system that may cause an environmental issue, as well as ensuring that no contaminants enter the system whilst in operation.



Hydra tight has been at the forefront of the development of bolt tensioning systems for 30 years, and we've been responsible for the extensive uptake of this technology across the world in the oil and gas and power generation markets.

Bolt tensioners are suited to both topside and subsea applications. We have designed innovative features to increase the efficiency and speed of use across both these sectors.

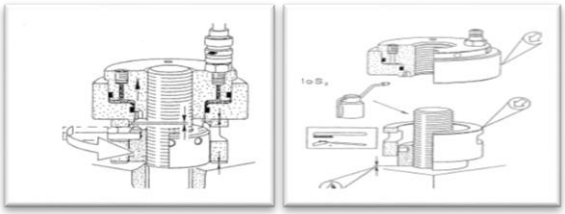
The technology surrounding hydraulic bolt tensioners can either be very simple or extremely complex. Our wealth of experience is perfectly suited to cope with the wide variation of requirements we receive. We design and manufacture tensioning products in-house at three Hydra tight locations, and our tension product group is focused on the continued development of the range as well as new product development.



Direct: Tension is applied directly to stretch the bolt, so we don't need to fight against friction or losses.

Accurate: The applied load is controlled very accurately, because it is directly proportional to the pressure applied to the tensioner.

Calculated: The load transfer factor is calculable, helping to give the correct residual load.



Fast: Operation of tooling and improved accuracy reduces time required to retighten the load.

Versatile: Tensioning allows for loading multiple fasteners in a joint at the same time.

Reliable: Uniform bolt loading ensures a high level of accuracy by applying a consistent force.

Stress-free: Purely axial, tensile loading ensures no torsional stresses are introduced.

Use and Maintenance of Hydraulic Oil Jack: D/G

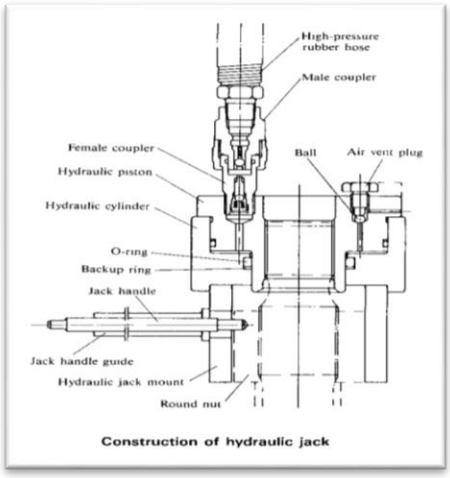
The hydraulic jack is used to tighten and loosen the following parts:

- cylinder head tightening nuts;
- connecting rod big-end tightening nuts;
- main bearing tightening nuts;
- sole plate; and
- Engine frame fixing nuts.

Maintenance Aux. Eng. Hydraulic Jack

1. O-ring and backup ring should be replaced with new ones over 4 ~ 5 years.

2. To overhaul jack, knock out liner by hitting bottom of hydraulic piston with wooden hammer. Take care not to damage exterior of piston and interior of liner.
3. When reassembling, take care not to damage O-ring and backup ring.



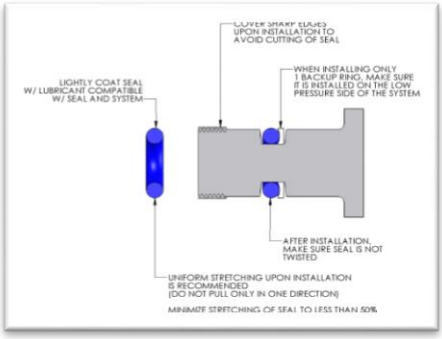
Construction of hydraulic jack

O-ring Installation Guide:

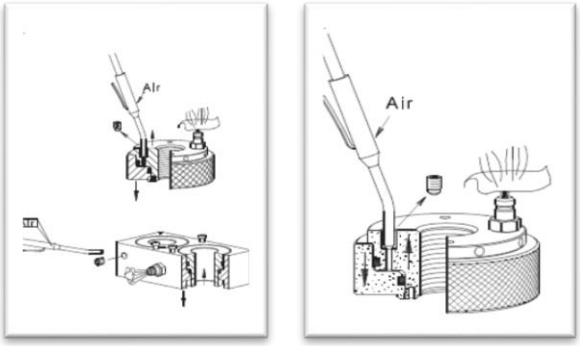
The diagram below shows good tips on how to properly install an O-ring. The O-ring installation procedures are the following:

1. Lightly coat the O-ring seal with lubricant that is compatible with your system.
2. If necessary, cover any sharp edges upon installation to avoid cutting or damaging of the O-ring seal.

1. If you are installing a backup ring, a good tip is to make sure it is installed on the low pressure side of the system, that way the high pressure side of the system pushes the O-ring against the backup ring.
2. Upon installation of the O-ring, make sure there is uniform stretching of the O-ring and do not just pull only on one side of the O-ring.
3. Minimize the installation stretch of the O-ring to less than 50%.
4. After installation of the O-ring, make sure that the seal is not twisted in your O-ring groove or gland.



Hydraulic Tools Maintenance (Replacement of Sealing Rings)



1. The hydraulic jacks require no maintenance except replacement of defective sealing rings, each of which consist of an O-ring and a back –up ring fitted in ring grooves in the piston and cylinder.

   The piston and cylinder are easily separated by taking out the bleed screw and pressing the parts apart with the help of compressed air

   Note: Always use protective gloves and eye protection when working with compressed air.
   Make sure there are no marks or scratches on the sliding surfaces of the parts. The presences of metal particles will damage the sealing rings.

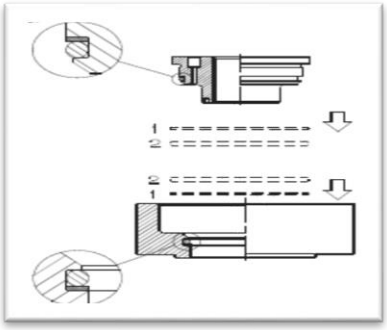
   Keep the sliding surfaces and threads coated with acid free grease or molybdenum disulphide grease.

2. The pistons and cylinders of the double jacks are separated in the same way as described for the single jack.

3. When changing the sealing rings, first mount the back-up ring and the o-ring.

   Note: Back up ring 1 must be away from the pressure chamber and the o-ring 2 close to the pressure chamber.

4. After fitting the sealing rings, coat the piston and cylinder with molybdenum disulphide grease and press the piston and cylinder together. See that the rings do not get stuck between the piston and cylinder.



Use of Hydraulic Jack for M/E Exhaust Valve

- Clean the tool attachment thread, the nut other parts.
- Grease the tool attachment
- Place the spacer ring around the nut.
- Ready the Tommy bar used to loosen the nut
- Screw the Hyd. Jack on the stud firmly against the spacer ring then one turn back.
- Connect the hydraulic jack, the distributor block and the high pressure pump by means of high pressure hoses.
- Confirm that sufficient oil was Fill up the pump system.
- Check the Pressure Gauge is Calibrated
- Re-tight by using Hydraulic Pump at prescribed value.
- If the nut does not come loose, the pressure may be increased a little.
- Unscrew the nut with the Tommy bar; making sure that the nut is not screwed up against the jack.
- Relieve the system of pressure, disconnect the high-pressure pump, and remove the hydraulic tools.

NOTE:
Make sure not to exceed the “max lift” stamped on the jack

Bolt tightening Sequence Procedure

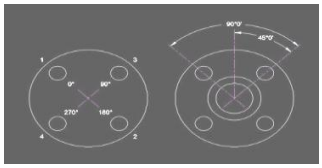



Start the tightening procedure by lubricating the nuts and bolts. Then hand tightened till they are snug against the flanges. If an air wrench is used make sure the pressure is set to the minimum. When tightening, always use the correct sequential bolt order for the flange.

4 and 8 Bolt Flanges

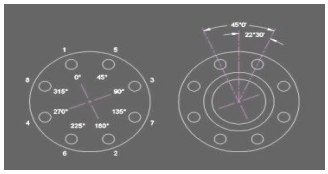
- First round - 30% of final torque (flange sequential order)
- Second round- 60% of final torque (flange sequential order)
- Third round - 100% of final torque (flange sequential order)
- One final time - clockwise or counter clockwise sequentially around the flange.

4 Bolt Tightening Sequence



- Sequential Order: 1-2, 3-4
- Rotation Order: 1, 3, 2, 4

8 Bolt Tightening Sequence

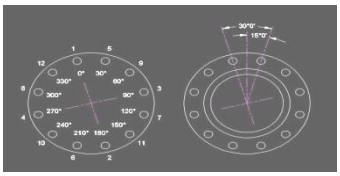


- Sequential Order: 1-2, 3-4, 5-6, 7-8
- Rotation Order: 1, 5, 3, 7, 2, 6, 4, 8

12 Bolt Flanges and More

- First round - 20% of final torque (flange sequential order)
- Second round - 40% of final torque (flange sequential order)
- Third round - 80% of final torque (flange sequential order)
- Fourth round - 100% of final torque (sequential order)
- One final time - clockwise or counter clockwise sequentially around the flange.

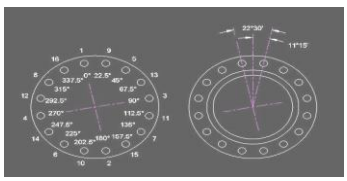
12 Bolt Tightening Sequence



- Sequential Order: 1-2, 3-4, 5-6, 7-8, 9-10, 11-12
- Rotation Order: 1, 5, 9, 3, 7, 11, 2, 6, 10, 4, 8, 12

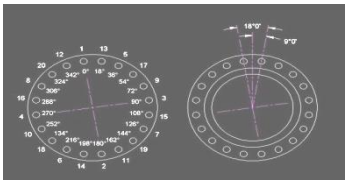
16 Bolt Tightening Sequence

- Sequential Order: 1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16
- Rotation Order: 1, 9, 5, 13, 3, 11, 7, 15, 2, 10, 6, 14, 4, 12, 8, 16



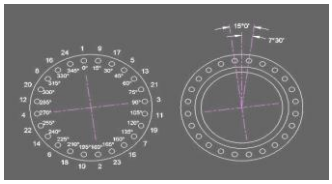
20 Bolt Tightening Sequence

- Sequential Order: 1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16, 17-18, 19-20
- Rotation Order: 1, 9, 5, 13, 3, 11, 7, 15, 2, 10, 6, 14, 4, 12, 8, 16



24 Bolt Tightening Sequence

- Sequential Order: 1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16, 17-18, 19-20, 21-22, 23-24
- Rotation Order: 1, 9, 17, 5, 13, 21, 3, 11, 19, 7, 15, 23, 2, 10, 18, 6, 14, 22, 20, 8, 16, 24



Torque Factor

Pipe Size (NPS)	150# (ft-lbs)	300# (ft-lbs)	400# (ft-lbs)	600# (ft-lbs)	900# (ft-lbs)	1500# (ft-lbs)	2500# (ft-lbs)
1/2	45	45	45	45	150	150	
3/4	45	90	90	90	150	150	
1	45	90	90	90	240	240	
1 1/4							
1 1/2	45	150	150	150	368	368	
2	90	90	90	90	240	240	
2 1/2	90	150	150	150	368	368	
3	90	150	150	150	240	533	

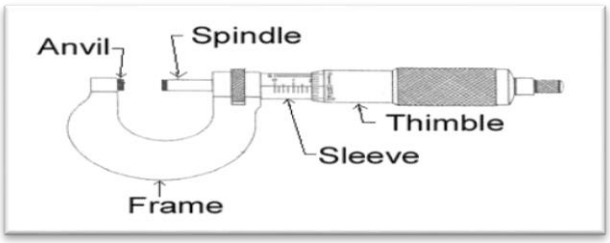
3 1/2							
4	90	150	240	240	533	750	
5	150	150	240	368	750	1200	
6	150	150	240	368	533	1020	
8	150	240	368	533	1020	1650	
10	240	368	533	750	1020	3000	
12	240	533	750	750	1020	3300	
14	368	533	750	1020	1020	4770	-
16	368	750	1020	1020	1650	6600	-
18	533	750	1020	1650	3000	8800	-
20	533	750	1200	1650	3300	11580	-
22							-
24	750	1200	2250	3000	6600		-

Proper Use of Measuring Instrument

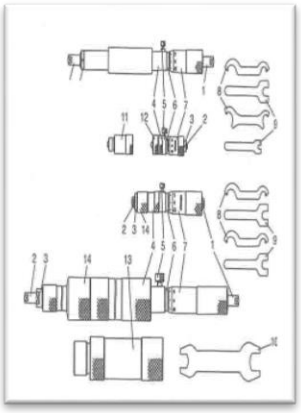
Micrometer

A micrometer allows a measurement of the size of a body. It is one of the most accurate mechanical devices in common use.

Outside Micrometer
Parts of Outside Micrometer

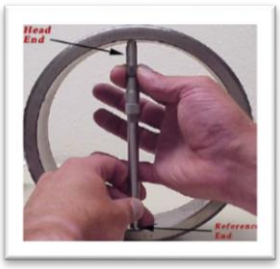


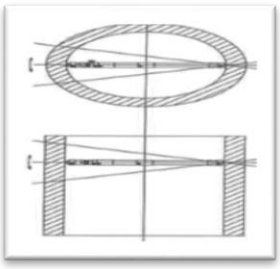
Inside Micrometer



Parts of Inside Micrometer

1. **Anvil** **7. Thimble**
2. **Adjusting Anvil** **8-10 Wrench**
3. **Adjusting nut** **11. Extension Rod**
4. **Main Body** **12. Cap**
5. **Clamp** **13. Extension Pipe**
6. **Sleeve** **14. Adjusting Rod**

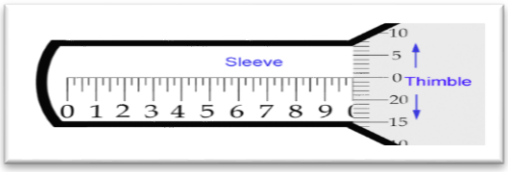




Setting the Reference Point

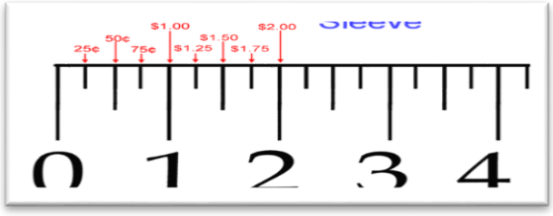
1. Clean the contact faces of the gauge and the measuring point.
2. Insert the gauge a little shorter to a work piece , set the reference point.
3. Move the thimble to the Measuring contact by moving back and forth until obtain the maximum point.
4. Lock then read the indicated value

To learn to read the mike you need to understand the Thimble and the Sleeve. Here we are going to learn to read the micrometer by figuring out the markings on the Thimble and the Sleeve.

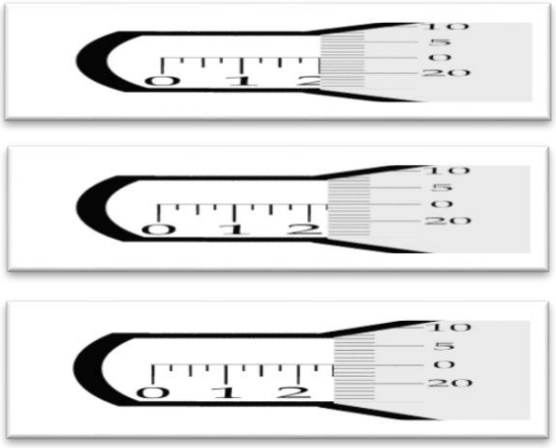


The sleeve does not move it looks like a ruler with ten numbers; the space between each is divided into quarters, as the thimble rotates around this sleeve it covers up or reveals the number marked on the sleeve.

It is easy to read micrometer if you think the marker of the sleeve as a dollar and quarters.



Now it gets a little easier to read the mike. For example, what are the readings on the micrometers shown below?



Vernier Caliper

The Vernier Caliper is a precision instrument that can be used to measure internal and external distances extremely accurately.

How to read vernier caliper?

Read the centimeter mark on the fixed scale to the left of the 0-mark on the vernier scale. (10mm on the fixed caliper)

Find the millimeter mark on the fixed scale that is just to the left of the 0-mark on the vernier scale. (6mm on the fixed caliper)

Look along the ten marks on the vernier scale and the millimeter marks on the adjacent

Fix scale, until you find the two that most nearly line up. (0.25mm on the vernier scale)

To get the correct reading, simply add this found digit to your previous reading. (10mm + 6mm + 0.25mm= 16.25 mm)

7. Proper Use of Tools

It will greatly reduce the risk of explosion or fire:

- Understand the Hand Tool's Intended Use.
- Proper Selection of Tools.
- Maintenance and Storage.

8. Proper Care of Basic Tools

The information in the lessons is extremely important to all who desire to be completely familiar with and well trained in the knowledge, care, and uses of hand tools. This also contain much of interest to engineering personnel who have picked up their knowledge of tools more or less by chance as their work required various tools to be used. Even engineers with long experience may gain valuable information that they had known about previously.

Good tools are essential if personnel are to do his best work quickly, properly and accurately. Without the proper tools and the knowledge of how to use them, time is wasted, efficiency is reduced, and the person doing the work may injure himself. Good

tools are carefully made, and must be handled properly if they are to work and last as intended. They cannot take rough usage. This is especially important aboard ship where it may be impossible to procure a replacement when needed.

In such a good practice onboard, with the ship engineer and crew taking care of his tools, as valuable time and possibly lives may depend on the accomplishment of piece of work quickly and accurately. He will keep cutting tools sharp, grind them, if necessary, when through using them, and store them so that their edges will not be damaged or dulled by contact with each other or with other hard objects. He will handle delicate measuring instrument with care, and will not keep them where they might be damage by heavy tools.

Some tools can be used for several purposes, but the wrong tool may ruin not only it, but the work as well. If s screwdriver is used as a prying tool (informal used),it may bend or break. If a chisel is used instead of a wrench, an important part of the machinery may be scarred or broken. The way in which tools are handled, and the care given to them, indicates the quality of workmanship and the kind of engineering to be expected in your department.

Tools handler Philosophy;

1. Used tools for their intended purpose acutely.
2. Clean the tools immediately after using them.
3. Keep tools in their proper places.
4. Always cover sharp pointed tools with cork.
5. Be sure are in good working condition before using them.
6. Handle and use tools property

9. Proper storage and correct location of tools needed during emergency Situation

As part of the Company safety campaign and Best practices onboard ship applied particularly in engine room, tools arrangement and location was made available for its intended use at every part or deck nearby where the machinery is located, e.g. tool board was made nearby the sea chest suction wherein all its necessary tools to be used during dismantling and cleaning are essentially available.

When work is being done, the necessary tools should be kept within easy reach, but not where they can fall and be damaged, or where they may fall and injure someone, as might occur from an upper level in the engine room. It is advisable to spread canvas along a grating, if tools are to be place on it, or if work is being carried on where tools might drop and fall through it. Opening in the engine or other equipment being worked on should be covered or plugged to prevent tools, nuts, bolts,

etc., from accidentally falling through the openings. Such objects within the cylinder or crankcase of an engine, and not observed and removed before starting up, can cause considerable damage.

Tools should never be place on the finished parts of a machine, on the ways of a lathe, for example. Sharp tools should not be carried in the pockets of clothing or left protruding from work benches, as they may tear or puncture objects with which they come in contact, including the workman.

In general, every tool should be given its own place on a tool rack or tool board, or in tool box. Some tools should be kept close by the machine for which they are used. Other tools must be stored in the tool room. Tools should be cleaned after being used, should be oiled, in some cases, to prevent rust, and should then be returned to their respective places.

10. General Guidelines for safe practices in work site

1. Demonstrate knowledge of evacuation procedures
2. Identify and report dangerous situations
3. Use safety clothing and equipment (PPE's)
4. Demonstrate knowledge of fire prevention and control procedures
5. Maintain correct posture to avoid injury
6. Demonstrate knowledge of hazardous substances and associated procedures
7. Use ladders safely
8. Employ the safety tag system
9. Recognise responsibilities for providing, maintaining and using associated equipment for safety

Lapping and Grinding Compounds are abrasive pastes for the cutting, smoothing and finishing of metal surfaces, and for the precision mating of metal parts.

Types of Grinding Compounds

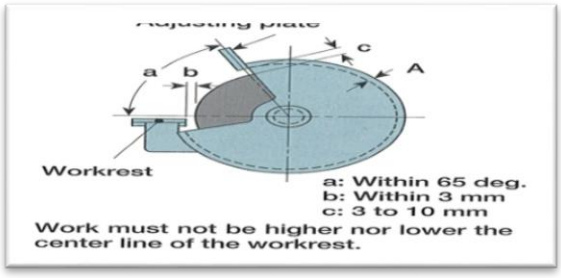
Grade and Grit Selector Guide

GRIT	Descriptions	Average Particle Sizes of Abrasive Grains	
		1/1000 inches	Microns (0.001 mm)
1200	**EXTREMELY FINE** Polishing, High Precision Lapping	0.12	3
1000		0.20	5

800		0.38	9
600	**VERY FINE** For fine Polishing and Lapping	0.56	14
500		0.68	17
400		0.90	23
320	**FINE** For Finishing, Valve Lapping, Bearings, Dies and Gauges	1.28	33
280		1.75	44
240	**MEDIUM FINE** For Cylinder Lapping	2.48	63
220		2.6	66
180	**MEDIUM** General Purpose for controlled Metal Removal	3.4	86
150		4.8	122
120	**COARSE** For the Initial "Cut" Fast Removal of Metal	5.6	142
100		6.8	173
80		15	267
54	**VERY COARSE** For Fastest Metal Removal	18	463

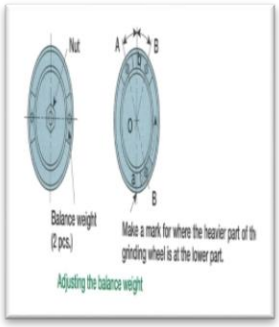
Handling of Bench Grinder

- Adjust clearance between the grinding wheel and the work rest for approximately 3 mm or less.
- Adjust the height of the work rest to the centre of the grinding wheel.
- When the surface of the grinding wheel is uneven, flatten the surface with a dresser.
- Precaution when using a grinder: wear safety goggles, the side face of the grinding wheel shall not be use, check the condition of the grinding wheel for any crack.
- Check the tightening nut of the grinding wheel it is a left handed screw a safety precaution must be taken.



How to adjust if the grinder is in balance and vibrates during operation

- Adjustment when a balance weight is provided.
- Softy turn the grinding wheel by hand and the wheel will stop with a heavier part downwards, move the wheel to the opposite side namely to the top .repeat this procedures until the wheel stops randomly.
- Adjustment when a balance weight is not provided.
- Slightly tighten the nut, adjust the clearance between the shaft and the grinding wheel while rotating the wheel by hand. If it is not effective replace the grinding wheel with a new one.



11. General Works in Engine Room

Crack and Flaw Detection on Main Bearings

Cracks tend to form, spread and get worse as the heat, thermal stress, heavy loads, repeated bending and flexing, metal fatigue, pounding and vibration take their toll on the part. So if metal is pulling away from metal, it means an area is experiencing more stress than it can handle. That's why cracks form in the first place.

If critical parts are not inspected for cracks, there's no way to know if they will stand up to normal use and abuse. In the case of cylinder heads and blocks, you won't know if the castings can hold pressure until the engine has been assembled - which means you may have wasted a lot of time and effort if a casting turns out to be full of holes.
And it's not only cracks that you should be on the lookout for: other flaws such as porosity leaks in castings need to be identified so a decision can be made as to whether repair or replacement is the best option. With hard-to-find and high value cores and parts, the decision may hinge on the extent of the damage. If the part can be repaired economically and with a high degree of success, then it's probably worth fixing. But if it can't, you'll have to factor in the cost to replace it.

Even new parts aren't excluded: Cylinder heads, engine blocks, crankshafts, camshafts and connecting rods are just some of the components a savvy engine builder will check using nondestructive testing methods. There are a variety of techniques that can be used by themselves or in combination with other methods to find cracks in castings and other components.

Cracking Up

Cracks are quite common in late model cylinder heads and are often found between valve seats, in exhaust ports, between the spark plug hole and valve seats, around valve guides, between combustion chambers, and even on top of the head.

The blame is often placed on thinner castings and higher engine loads, but in many instances the underlying cause is engine overheating due to a cooling system failure (coolant leak, inoperative cooling fan, stuck thermostat, etc.), or a detonation problem (carbon buildup, inoperative EGR valve, too much ignition advance, etc.) or some other user (or builder) error such as incorrect installation (wrong torque on head bolts, dirty bolt threads, etc.).

One of the causes of cracking in cast iron heads is stress created when the valve seats are induction hardened. The concentrated heating process that hardens the valve seats also creates residual stresses in the head that may cause it to crack later - even if the engine has never overheated. The cracks typically form where stresses are highest, which is often between the valve seats.

Cracks typically form when a cylinder head undergoes too much thermal stress. Loss of coolant - severe overheating as well as sudden changes in operating temperature from hot to cold - can all create the conditions that can cause cracks to form.

Simply put, when metal is heated it expands. Aluminum expands at nearly twice the rate of cast iron, which creates a mismatch in expansion rates on bimetal engines with aluminum heads and cast iron blocks. While the heads are designed to handle a certain amount of normal expansion, elevated operating temperatures can push a head beyond those design limits, causing the metal to deform. This, in turn, may cause cracks to form as the metal cools and contracts.

Crack and Flaw Detection Techniques

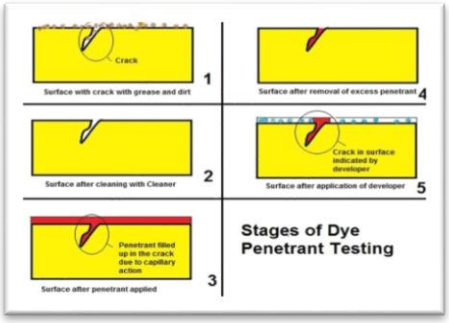
1. Dye Penetrant Inspection Procedures

Dye penetrant testing or liquid penetrant testing is one of the most common and cost effective techniques used in nondestructive testing.

Dye penetrant testing is used to detect the presence of surface cracks in components. The ideology to detect these cracks is by means of a dye usually highly colorful and less viscous that enables it to penetrate into cracks in the surfaces. This happens mainly due to the capillary action. The dye tends to remain inside the crack, which is made to surface out by the use of appropriate chemicals thus indicating the size and structure of the crack.

Here’s how we practically carry out the dye penetrant testing. The dye penetrant kit basically constitutes of three chemicals in pressurized cans namely:

- Cleaner
-Penetrant
-Developer

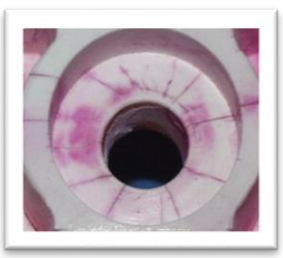


Testing Procedure:

Pre-cleaning:
This is the most important and vital stage of the dye penetrant testing. The surface to be tested is to be free from grease, oil, paints, etc. Dust particles covering the area can be removed by using pressurized air. The materials that have the capability to stick to the surface like grease, oil, gum, diesel, etc. can be removed easily by means of the cleaner. The cleaner disintegrates the sticky particles on the surface and carries away the same while flowing away. Any residual cleaner left on the surface tends to get evaporated all by itself. The area cleaned using the cleaner is to be left to dry for about 5 to 6 minutes.

Penetrant Application: The dye penetrant is now applied to the area where the cracks are to be determined. A dwelling period of about 10 to 15 minutes would be very much ideal for the penetrant to get itself settled inside the cracks present on the surface of the component.
Penetrant Removal: The excess *penetrant* that is present on the surface is removed using lint free clothing soaked with the cleaner. Care needs to be taken to ensure that the cleaner does not flow on the surface. The excess penetrant needs to be wiped out of the surface very carefully. This basically requires a good amount of expertise.
Developing: The *developer* is used to develop the penetrant present inside the cracks. Good amount of care needs to be taken by the user ensuring that no excess amount of developer is added to the surface. This may cause penetrant present inside the crack to be absorbed more quickly and distributed in the excess developer chemical. This can lead to an indication that no crack is present in the area.
Inspection: The developer used properly tends to indicate the areas where cracks are present. Cracks present are indicates a bright spots usually the color of the penetrant. The developer normally tends to provide a white background for the same enabling the inspector to identify the crack immediately.

Application Areas of Dye penetrant



Testing:
The dye penetrant testing is applicable in all areas where the surface finish tends to be quite good.

- for checking of cracks in roll formed sections
- surface crack detection in railway rails
- crack detection in gear teeth
- Detection of cracks in welding's particularly in boiler welding for detection of surface cracks.
- Detection of surface cracks caused by high speed grinding

Advantages:

- Very low cost method for determination of surface cracks.
- portable kit enables easy carrying of the kit
- instant results can be obtained by the user and no highly trained personal required to interpret results

Disadvantages

- Only surface cracks can be detected. Any cracks below the surface or sub surface cracks cannot be detected
- Method works well only for surfaces that are machined or polished. Irregular or very rough surfaces tend to provide false results.

Proper checking of screw thread condition

1. Clean the thread with a wire brush.

2. Repair with file and die if it was found with slight damage.

Proper way of using thread lubricant
Types of Lubricant: Molycote Thread Lubricant
Solid lubricants - Mineral oil - Thickener - Powdered metal

How to Use:

- If possible, clean the thread and the bolt with a wire brush.
- Spread an adequate amount of the paste on the thread, right up to its root in order to obtain a good seal.
- In order not to alter the properties the paste, it must not be mixed with grease or oils.
- It is advisable to use the aerosol application to enable this product to be applied more quickly and cleanly to larger areas.

Importance of Lock washer

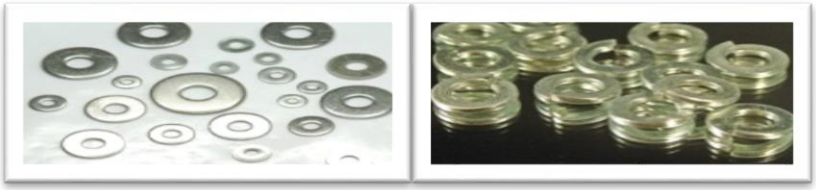
Washers

Nuts and bolts are common household fasteners that have a multitude of uses. While they may be effect by themselves, oftentimes the addition of a washer to one or both sides can increase their strength, appearance and efficiency. Different types of washers provide different advantages. Before reaching for a flat washer or a lock washer, it is important to know what you wish to accomplish.

Types of Washers

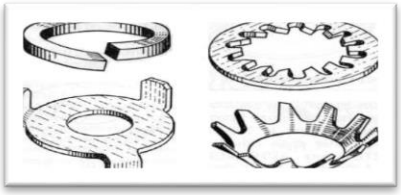
Flat Washers

Flat washers are used to increase the surface area in order to more evenly distribute the force applied with tightening the fastener.



Lock Washers

Lock washers are used as a means of creating tension during tightening in order to help keep the nut from working loose later.



- Both flat and lock washers come in a wide variety of interior diameters, exterior diameters and thicknesses. Flat washers may be constructed from a variety of materials including brass, silicon bronze, stainless steel, zinc plated steel, chrome, rubber and many others. Lock washers may also be made from a number of different materials including stainless steel, zinc plated steel, silicon bronze, galvanized steel and many others.

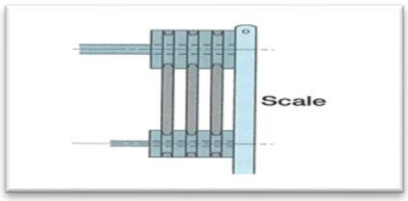
Application and Uses of Washers

Flat washers may be used on the bolt side, the nut side or both sides of the fastener. Flat washers help to distribute the force of tightening the nut by increasing the surface area. They may also be useful as spacers when a bolt may be a bit too long for the job. Lock washers are typically used on the nut side of the fastener. The most common type of lock washer is the split coil washer. This type of washer creates tension as the coil is forced down by the tightening of the nut. This tension helps to keep the nut in place. Lock washers

are frequently used in applications that involve vibration which may tend to work the nut loose.

Adjusting V- belt (with JOB CARD)

As shown in the figure, move the motor to adjust the tension of the V-belt while adjusting the parallelism applying a ruler (if not applicable, a string or a fine steel wire) to the pulley.



Proper tension of V-belt

- When you can pick and twist the v-belt with your fingers by approximately 90 degrees.
- When you can push the down the v-belt with your finger by approximately with its thickness.

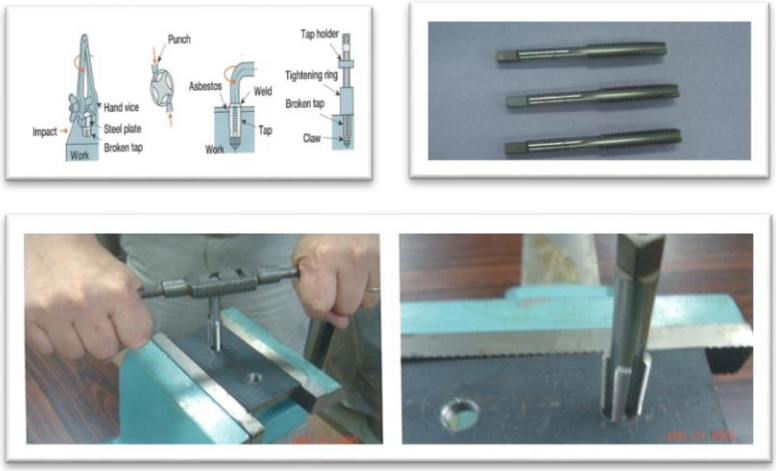
Handling Precautions

- Increase the tension of the belt if slipping noise is emitted at the start or during operation.
- Length of V-belt changes with operating time, proper interval of adjusting the tension of the V belt.
- When multiple V-belt are used, they shall be the same in length
- For renewal replace all the belts at the same time.
- The shape and the condition of pulley groove have a great influence on the life and transmission efficiency of the belt.
- If the pulley groove has been deformed or worn out replace with a new available spare, and send the old one to shore for recondition or repair.
- V-belt is structured so that the underneath surface does not move towards the groove bottom
- If ever it touches to the groove bottom, due to elongation or wear it is necessary to replace the V belt with new one.
- Oil sticking in the V belt is dangerous, check for any oil sticking in the belt.

Note: Angle of V-belt is 40 deg. Irrespective of the type (A, B, and C) while angle of the pulley differs (34, 36, or 38 deg.) according to the belt size and type.

How to remove a broken tap

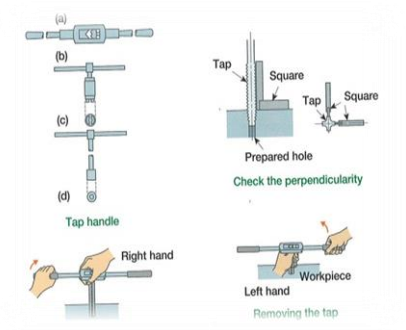
- Pinch the tip of the hand tap with a vice; slowly turn the vice while applying an impact on the work piece.
- Weld a steel piece on the tap to remove it
- If available, use a tap holder to remove the tap.



Proper use of tap and die

Making a prepared hole for a female screw

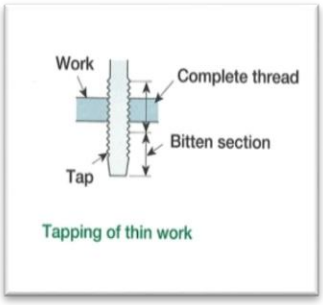
- To tap a female screw of nominal size M10, make a prepared hole with 8mm drill, although size of the prepared hole is 8.21mm according to the table.
- Relation between the nominal size of metric coarse screw thread and the inner diameter of female screw.
- It is desirable to make a prepared hole for a female screw at right angle to the base metal. Be careful of the perpendicular position, especially when a portable electric drill is used.
- For starting in making a hole in the work piece, start first with small size diameter drill then followed by the specified diameter drill.
- In the case of a blind hole, use a drill after making the required depth on it.

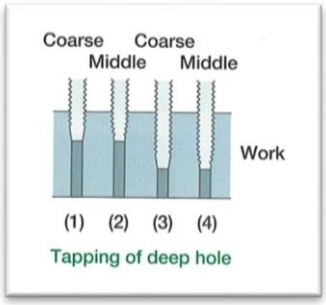


Normal size	Inner diameter of female screw	Normal size	Inner diameter of female screw
2	1.52	14	11.62
3	2.28	16	13.62
4	3.10	20	17.02
5	3.92	24	20.43
6	4.80	27	23.43
8	6.51	30	25.83
10	8.21	36	31.23
12	9.91	42	36.64

Tapping: 3 piece set hand tap

- Set a no.1 tap at the prepared hole perpendicular and slowly turn it clockwise until it bites the prepared hole, caring the tap does not tilt.
- When the tap nibbles the prepared hole, rotate the taps 2 turns and check for tilting.
- If tilting was observed removed and correct to perpendicular position.





Turn the Handle

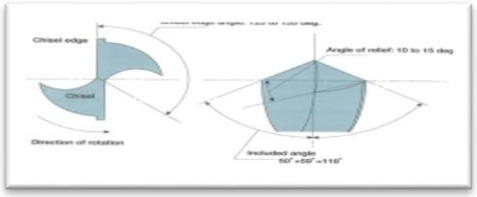
- When the tap is corrected and direction is determined, turn the handle horizontally and evenly by both hands.
- Return the handle by ¼ turn each time it is rotated by ¾ turn.
- Add oil at proper intervals, in the case of a blind hole; take the tap out of the hole to removed chips occasionally.

Note: If tapping is too hard that the tap is twisted when you apply a force on the handle, the prepared hole may be too small or the tap must be tilted against the hole. Remove the hand tap out of the hole and widen the hole with a round machinist file.

Grinding of Drill bit, and its Angle

1.1 Grinding of cutting edge

- As shown in the figure, hold the drill with your left hand placing on the tip side and right on the shank side.



With your left hand on the pedestal to keep a cutting edge horizontally, allow the edge to touch the periphery of the grinding wheel so that the included angle becomes 118 deg.

- Grind the end face of the drill while turning it by your right hand slowly as if you scoop up the grinding wheel and the end face shape the cutting edge in angle.

Note: The sharpness of your cutting edge have a great effect on the performance of your tool bit, therefore when grinding focus your interest to the tip of your tool bit cutting edge.

Procedure of Tag-in/ Tag-out

The lock-out, tag-out procedure applies to any jobs involving stopping, isolation of device, equipment, machinery for the purpose of testing, routine maintenance, servicing. The purpose of this procedure is to ensure that the device, equipment, machinery is stopped, de-energized, isolated from all potentially hazardous energy sources and locked out before employees perform any testing, servicing, maintenance.

The use of these tags is not a substitute for other safety measures while working in hazardous machinery, but it could minimize the accident that is happening on board ship due to human error. It is important that there must be a lockout /tag out station on board that is accessible to all crew.

Lock Out Device

A device that uses a positive means (such as a key or lock) to seize an energy or isolate a device on a safe position.


Tag Out Device

It is a warning device, or a tag, that attached and fastened to an energy isolating device to prevent erroneous operation of certain machinery, Tags should be simple, durable and include legends such as "DO NOT START", "DO NOT OPEN", "DO NOT CLOSE", "DO NOT OPERATE", “ISOLATED” ,”MEN AT WORK”.

Procedures:

The following standard lock out procedures shall be used for all corrective and preventive maintenance requirements:

a. When a requirement for lock-out/ tag-out has been identified, the Chief Officer or First Engineer (authorized officers) shall obtain permission from the Master and/ or Chief Engineer as per the job scope. Master and Chief Engineer shall be informed prior performing the lock-out.

b. Locks or Tags are to be attached such that they are apparent to anyone who may attempt to operate the component. DO NOT attach tags to breaker covers or valve caps which may be subsequently removed.
c. Notify all affected crew members regarding planned lock-out/ tag-out. The information shall also be repeated on PA system.
d. The authorizing officer shall identify the type and magnitude of the energy that the machine or equipment utilizes, shall understand the hazards of the energy, and shall know the methods to control the energy.
e. De-activate the energy isolating device(s) so that the machine or equipment is isolated from the energy source(s).
f. Lock-out the energy isolating device(s) with assigned individual lock(s)
g. Stored or residual energy (such as that in capacitors, springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water

pressure, etc.) must be dissipated or restrained by methods such as grounding, repositioning, blocking, bleeding down, etc.

h. Warning: Work shall not be permitted to start until Locks/Tags required for the protection of personnel or equipment has been attached in accordance with this procedure.

Restoration on Normal Procedures:

Before power is restored to the equipment, an authorizing officer shall inspect the work area to confirm:

a. It is safe to remove tags.
b. Equipment components are operationally intact and the work has been completed.
c. Personnel are physically clear of the work.

After all are confirmed as OK, each lockout/ tag-out device shall be removed by the authorizing officer.

12. Maintenance of Auxiliary Machinery

Diesel Generator Overhauling

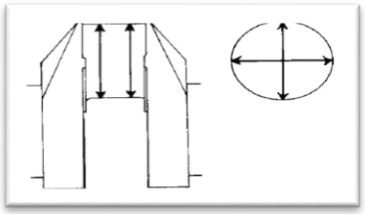
Check points prior D/G overhauling

1. Secure starting air
2. Secure cooling F.W. inlet and outlet
3. Shut D.O. line
4. Shut L.O. inlet from purifier
5. Transfer L.O. to Diesel engine settling tank
6. Turn remote to local control
7. Turn operation level to “STOP”
8. Remove turning bar
9. Drain of cooling Fresh Water
10. STOP-LOCK-TAG L.O. prim. Pump
11. Tag D/G Panel at MSB

- **Crankshaft**

Items to Check and Measure

1. Scratches or dents on bearing surface, condition of fit-up, uneven or abnormal wear.
2. Fillet portion and lubricating oil hole in bearing (color penetrant testing method)
3. Soiling or clogging of lubricating oil hole
4. Loose balance weight fixing bolt
5. Crankshaft deflection
6. Contours of pin and journal



7. Surface hardness: if hardness degrades below the specified value, consult with the manufacturer.

Precautions for Disassembly and Reassembly

2) With sheeting, protect bearing part from damage during disassembly or reassembly.
3) Wash lubricating oil hole carefully and air blow dry.
4) Clean bearing surface thoroughly to keep it free from dirt.

- **Measurement of Crankshaft Deflection (Refer to JOB CARD)**

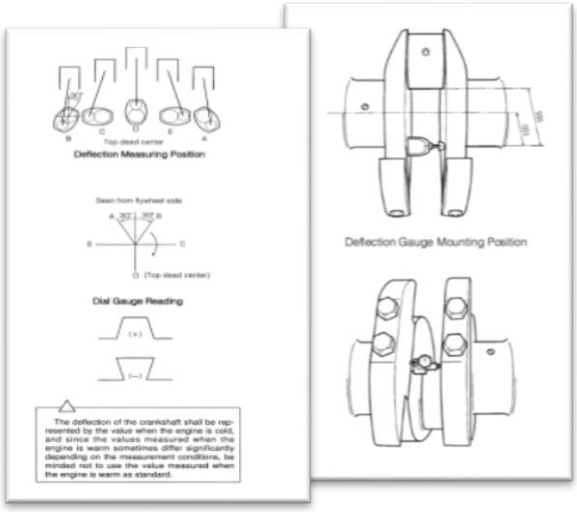
Excessive deflection may sometimes cause crankshaft breakage. Therefore, crankshaft deflection should be measured at installation and every six months after entering normal operation. Measure when crankshaft is cold.

Calculating Deflection

Calculate the deflection values as based on the measured values and in accordance with the following formula, and record he calculated values.

- Vertical (V) deflection: $dV = D - \frac{A+B}{2}$
- Horizontal (H) deflection: dH = C - E
- Positive/negative deflection: Open downward (+), closing downward (-)

A, B, C, D, and E represent the measured values respectively at each corresponding position shown in the figure on the right.



(5) Correction Limit for Deflection

a) The correction limit shall apply to whichever is larger of dV and dH as shown in the following table.

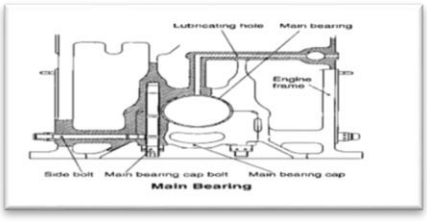
(Unit : mm)

	Adjusted value	Allowable limit	Direction
In case of direct connection : (One-side bearing generator)	0.03 or less	0.08	
	$\frac{1}{10,000}$ x stroke	$\frac{2.8}{10,000}$ x stroke	
In case of direct connection : (Both-side bearing generator)	0.03 or less	0.08	
	$\frac{1}{10,000}$ x stroke	$\frac{2.8}{10,000}$ x stroke	
In case of direct connection with flexible coupling:	0.09 or less	0.12	
	$\frac{3}{10,000}$ x stroke	$\frac{4}{10,000}$ x stroke	

- **Cylinder Head Maintenance and Inspection (Refer to JOB CARD)**
- **Piston Maintenance and Inspection (Refer to JOB CARD)**
- **Bearing**

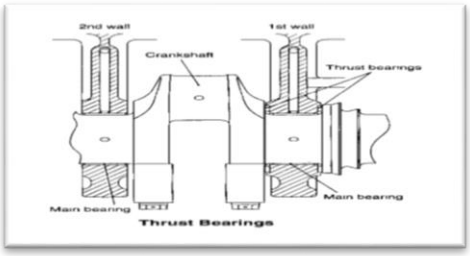
Main bearing and thrust bearing
General of Structure

The main bearing is of a suspension type. The main bearing cap is hydraulically tightened firmly by the main bearing cap bolts and the side bolts. The main bearing is



made of aluminum alloy having high wear resistance. The bearing upper and lower parts are positioned based on the claw. The main bearing is lubricated with oil supplied to the upper part thorough a drilled a hole in the engine frame.

The thrust bearing are also are made of aluminum alloy. They are mounted at the top and bottom on both sides of the first wall at the rear of the engine. Lubricating oil is supplied to them through the main bearing.

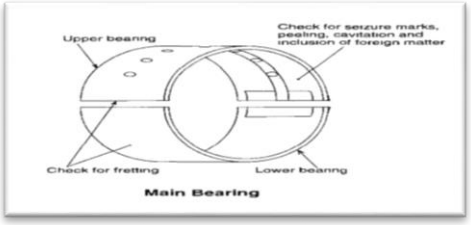


Thrust Bearings

Main Bearing

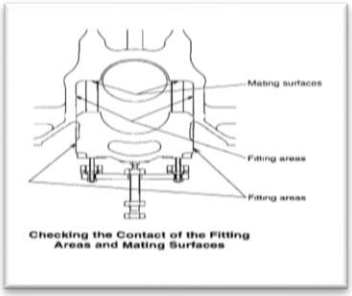
Normally, disassemble and inspect the main bearing without completely removing the main bearing without completely removes the main bearing cap. Lower the main bearing cap, and only the main bearing can be dismantled.

A. Check the bearing surface of the tightening nuts and on the cap. If the surfaces are rough repair them



Main Bearing

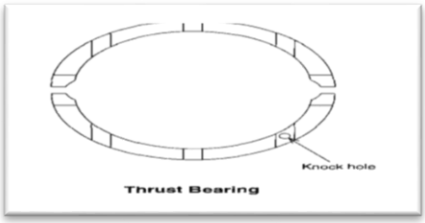
B. If the disassembled main bearing cap tightening nuts is loosened, tighten the nuts of other main bearings.
C. Check that the main bearing cap mating surfaces and the contact surface of the fitting areas are free from defects, such as fretting.
D. Check for flaws, hit marks and wear on the crankshaft surface



Checking the Contact of the Fitting Areas and Mating Surfaces

Maintenance of Thrust Bearing

A. Check the thrust bearing for seizure marks and inclusion of foreign matters. If minor defects are found, repair them with an oil whetstone.
B. Measure the thrust bearing thickness by using an outside micrometer, and record the measurement.
C. When the thrust bearing was worn heavily and the clearance between he thrust bearing and crank shaft (side clearance) (d) exceeds the limit for replacement, replace the thrust bearing with a new one. Replace the thrust bearing upper and lower parts simultaneously.

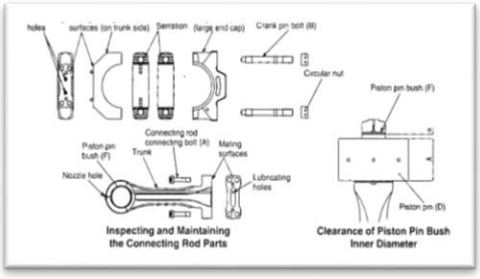


Nominal size (mm)	Standard Clearance (mm)	Limit for replacement (mm)
D = 83	d = 0.13-0.30	0.6

Inspection and Maintenance of Connecting Rod

A. Check the following parts, record their conditions and if defective parts found repair or replace them.
1. Check the contact of the piston pin bush (F) at the small end. Check for looseness and deviation of the bush and the fitting area.
2. Check for flaws and fretting on the mating surfaces of the trunk and the large end part.
3. Check for hit marks and peeling on the threaded portions and bearing surfaces of the connecting rod connecting bolts (A) and the crankpin bolts (B).
4. Check for wear and fretting on the serrated surfaces.
5. Check for hit marks and peeling on the contact surfaces of the large end cap with the circular nuts.
6. Check for hit marks and peeling on the threaded portions and bearing surfaces of the circular nuts (K).

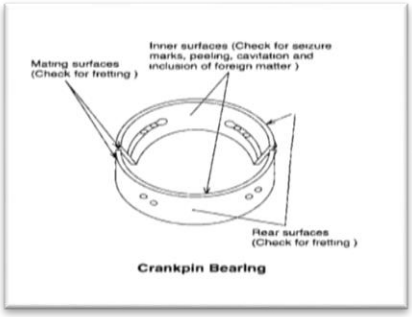
B. After cleaning the serrated surfaces, perform color check to check for flaws.
C. Blow air into lubricating holes through the trunk and the nozzle hole at the front to clean them.
D. Measure the inner diameter of the piston pin bush. Calculate the clearance based on the inner diameter and the measure outer diameter of the piston pin. If the clearance exceeds the limit for replacement, replace the bush with a new one.



Nominal size (mm)	Standard clearance (mm)	Limit for replacement (mm)
A= ø76	a= 0.04-0.12	0.25

Inspection and Maintenance of Crankpin Bearing

A. Check that the rear surfaces and mating surfaces of the crankpin bearing are free from fretting. Check that the inner surfaces are free from seizure marks, peeling, cavitations and inclusion of foreign matter. When defects are minor, repair the surfaces with an oil whetstone.
Note: The bearing is a thin- walled finish part, which is provided with appropriate interference (crush) and tension so that it can get into close contact with the housing surface. Therefore, do not repair the rear surfaces and mating surfaces with a file or scraper.

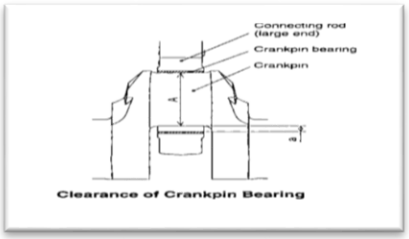


B. Clean the bearing, measure the bearing thickness with a spherical micrometer and record the thickness. Calculate the clearance based on the measured large end housing inner diameter bearing thickness and crankpin diameter. If the clearance exceeds the limit for replacement replace the bearing with a new one.

Nominal size (mm)	Standard clearance (mm)	Limit for replacement (mm)
A = ø 145	a = 0.08-0.17	0.3

Note:

5. Replace the upper and lower parts of the bearing at the same time.
6. While the bearing is used for a long time, the tension decrease, and the inner surface harden thereby causing cracking and peeling. Replace the bearing with a new one every 20,000 hours (4 to 5 years) even if the wear is less than the allowable limit.



Clearance of Crankpin Bearing

- **Fuel Injection Pump (Refer to JOB CARD)**
- **Fuel Valve Needle Condition (Refer to JOB CARD)**
- **Turbocharger Cleaning and Inspection (Refer to JOB CARD)**
- **Cleaning and Inspection of Filters and Strainers (Refer to JOB CARD)**

13. Filter & Strainer on Ship

Filter is a fine mesh screen which is used to remove impurities from oil, water and air on ship. Filters are mounted in pairs as a duplex system so that one can be used and other is kept on standby at a time. Filter can be used both in low pressure (suction) and discharge (high pressure) side of the system and is used to remove the smallest part of dirt which is carried away in the system. The cleaning frequency of filters depends upon the type of the filter and is decided by the manufacturer. The schedule is normally included in the planned maintenance system on board.

Strainer is a type of filter used mostly on low pressure or suction side and is used to remove large contamination particles from the system. This is because the mesh screen openings in the strainer are bigger in size and are similar to those of coarse filter. If the suction condition is critical, then the strainer can be fitted on the

discharge side. This purely depends upon the make and recommendation of the manufacturer. Normally strainers are cleaned whenever they are opened or when the pressure drop on the filter side is high.

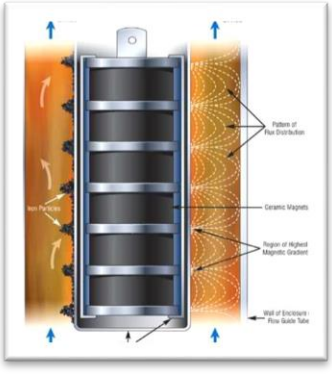
Type of Filters Used on Ship

Types of filters depending upon the Media

1) Hydraulic Filter: Hydraulic filters are very useful for removing solid contamination from lube and fuel oil systems of marine machinery. Without filters in the lube or fuel oil system, the machinery internal parts, bearings, piston, rings, liners etc. can get damaged, which will result in inefficient working of the machinery. Different applications of hydraulic filters are:

a) Fine Mesh Screen Filter: It is the most commonly used filter in lube and fuel oil systems on board. It can be used both on suction and discharge side of the system. It is normally used in cylinder lube oil line, main engine and auxiliary engine fuel oil line & diesel oil line, boiler fuel oil line and in different lube oil systems on board etc.

b) Magnetic filter: This normally consists of filter elements which are magnetic in nature and which help in catching fine metal or ferrous particles that run in the system. These elements are surrounded by a basket screen which also acts as a filter and simplifies the cleaning of the filter. Magnetic filters are used in lube oil system.

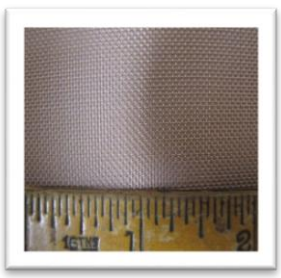


c) Auto Back Wash Filter: In auto back wash filters, when the pressure difference increases, an indication of filter getting clogged, the auto system cuts-off the filter and opens the bypass. The auto wash takes place with the help of an electric motor connected to a shaft which cleans the filter. During this operation, the drain of the filter gets open.

d) Centrifugal filter: As the name suggests, these filters work on the principal of centrifugal force removing high density fluids and impurity from the oil. It is normally used for lube oil systems. Most of the Auxiliary engines have attached centrifugal filters.

How to measure size of Mesh?

The chart below roughly converts between U.S. Mesh, microns, and fractions of an inch. There is no simple formula to convert between microns and wire mesh because it would have to account for changing wire diameter. To measure wire mesh properly, the mesh count should be taken in both directions. On coarse meshes, this can be accomplished by counting the number of openings per linear inch measuring from wire center to wire center. After taking the first count, a second count should be taken at a 90 degree angle to the original measurement. The mesh count of the cloth shown is 10x10.



Conversion Information U.S. Mesh to Micron Particle Size

COMPARATIVE PARTICLE SIZE

U. S. MESH	INCHES	MICRONS	U.S. MESH	INCHES	MICRONS
3	.265	6730	40	.0165	420
3-1/2	.223	5660	45	.0138	354
4	.187	4760	50	.0117	297
5	.157	4000	60	.0098	250
6	.132	3360	70	.0083	210
7	.111	2830	80	.0070	177
8	.0937	2380	100	.0059	149
10	.0787	2000	120	.0049	125
12	.0661	1680	140	.0041	105
14	.0555	1410	170	.0035	88
16	.0469	1190	200	.0029	74
18	.0394	1000	230	.0024	63
20	.0331	841	270	.0021	53
25	.0280	707	325	.0017	44
30	.0232	595	400	.0015	37
35	.0197	500			

14. Auxiliary Boiler

The common auxiliary boilers used onboard are the composite Boiler-economizer. Two main classification are used the water tube where water heated inside the tube and fire/smoke tube where the water is heated outside the tube.

Safety Devices

Ship's Name: _____

AUX. BOILER ALARM TESTING RECORD

PLACE:
TEST DATE: TESTING INTERVAL-6M

	DESCRIPTION	ALARM	TRIP RESULT		TEST METHOD
1	SOURCE FAILURE			GOOD	BREAKER OFF
2	FLAME FAILURE			GOOD	OFF FLAME EYE
3	F.D. FAN STOP			GOOD	CUT NBR
4	F.O TEMP. TOO LOW	LOW T	80 deg.C	GOOD	THERMOCOUPLE OFF

5	DRUM LEVEL TOO LOW	LOW L	N.W.L. - 180mm	GOOD	BLOWDOWN
6	BURNER MOTOR STOP			GOOD	BREAKER OFF
7	FLAME EYE ABNORMAL			GOOD	OFF FLAME EYE
8	SUPPLY AIR PRESS.LOW PRIMARY	LOW P	4.9 Kpa	GOOD	AIR HOSE DISCONNECT
9	SUPPLY AIR PRESS.LOW SECONDARY	LOW P	0.98 Kpa	GOOD	AIR HOSE DISCONNECT
10	DRUM WATER HIGH LEVEL	HIGH L	N.W.L. + 200mm	GOOD	FILL-UP MANUALLY
11	DRUM WATER LOW LEVEL	LOW L	N.W.L. - 150mm	GOOD	BLOWDOWN
12	F.O HEATER OUT HIGH TEMP.	HIGH T	145 deg.C	GOOD	THERMOCOUPLE HEAT-UP
13	F.O HEATER OUT LOW TEMP.	LOW T	90 deg.C	GOOD	THERMOCOUPLE OFF
14	DRUM STEAM PRESSURE LOW	LOW P	0.45 MPa	GOOD	MANUAL DUMPING STEAM
15	F.O. TEMP. LOW (PUMPCONTROL)	LOW T	110 deg.C	GOOD	THERMOCOUPLE OFF

CHIEF ENGINEER 3RD ENGINEER

Boiler Rotary Cup Burner Maintenance (JOB CARD)

MAINTENANCE

1. Check the main shaft lubrication.
2. Clean the rotary cup burner.
3. Inspect each screws connection and fixation.
4. Check the rotating body for vibration and abnormal noise.
5. Grease up rotating parts and sliding parts.

a. The frequency of each maintenance item shown above is a standard: change appropriately by understanding the actual method adopted in the ship concerned.

b. Pay special attention to the items relating to soot fire.

c. Completely understand the descriptions not only in this list but also in the instruction manual.

Cleaning

If a sufficient amount of circulating water is continuously supplied and the water quality is controlled in a proper condition, no problem will occur. Scales adhering to the inner surface can only be removed by a professional's chemical cleaning.

Types of Boiler Burner

a. Pressure Jet Type Fuel Oil Burner

A pressure jet oil burner forms a simple robust unit, widely used in marine boilers. The basic assembly consists of a steel tube, or barrel, to which are attached swirl and orifice plates; these are made of a high grade or low alloy steel, and are held in place by a cap nut. The complete unit is clamped into a burner carrier attached to the boiler casing. This both holds the burner in its correct position relative to the furnace, and also permits the supply of fuel through an oil tight connection.

The oil is supplied to the burner under pressure and, as it passes through, the burner performs two basic operations. First it imparts rotational energy to the oil as it passes through angled holes in the swirl plate. The rotating stream of oil thus formed is then forced under pressure through a small hole in the orifice plate which causes the jet to break up into fine droplets. This latter process is termed as atomization, although each individual droplet of oil is formed of vast numbers of atom. As the final result of these operations a hallow rotating cone, formed of fine particles of oil, leaves the burner tip.

In all pressure jet burners, however, a minimum supply pressure in the order of 700 kN/m^2 is necessary to ensure efficient atomization is maintained. At the same time various practical considerations limit the maximum pressure to about 7000 kN/m^2. The control over the throughput of oil is obtained in two ways; by varying the oil supply pressure and/or by changing the diameter of the hole in the orifice plate. Whilethis system is convenient for manual operation, it is not suitable for automatic control due to the need to change orifice sizes when the oil supply pressure reaches its upper or lower limits.

Safety Precautions:

- The burners must be kept clean and care should be taken during this operation not to damage or scratch the finely machined surfaces of the swirl and orifice plates. The latter should be renewed as the orifice wears beyond a certain amount. This should be checked at regular intervals by means of a gauge.
- After cleaning make sure all the various parts are correctly assembled.
- Any oil leaks must be rectified as soon as possible as they can lead to fires in the air register or double casing of the boiler.
- Burners not in use should be removed, otherwise the heat from the furnace will cause any oil remaining in the burner barrel to carbonized.

b. Steam Blast Jet Type Fuel Oil Burner

This type of burner atomizes the oil by spraying it into the path of high velocity jet of steam or air. Although either medium can be used, steam is usually both more readily available and economical at sea. Compressed air is therefore seldom used, except when lighting up from cold.

In this the steam flows along the central passage, and is then expanded through a convergent divergent nozzle, where its pressure energy is converted to kinetic energy resulting in a high velocity jet of steam. Oil sprayed into this jet is entrained by it, being torn to shreds and atomized in the process.

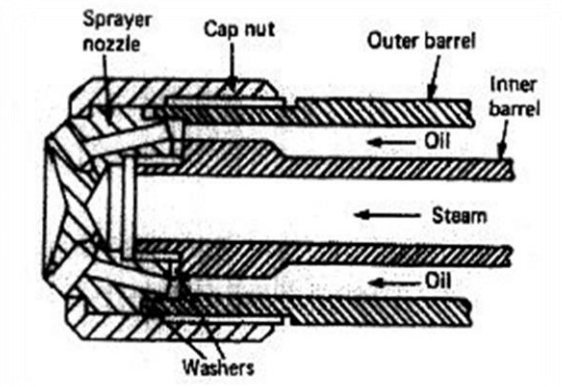
The oil supply pressure ranges from about 140-2000 kN/m^2, with corresponding steam pressures of 140-1500 kN/m^2.

Safety Precautions:

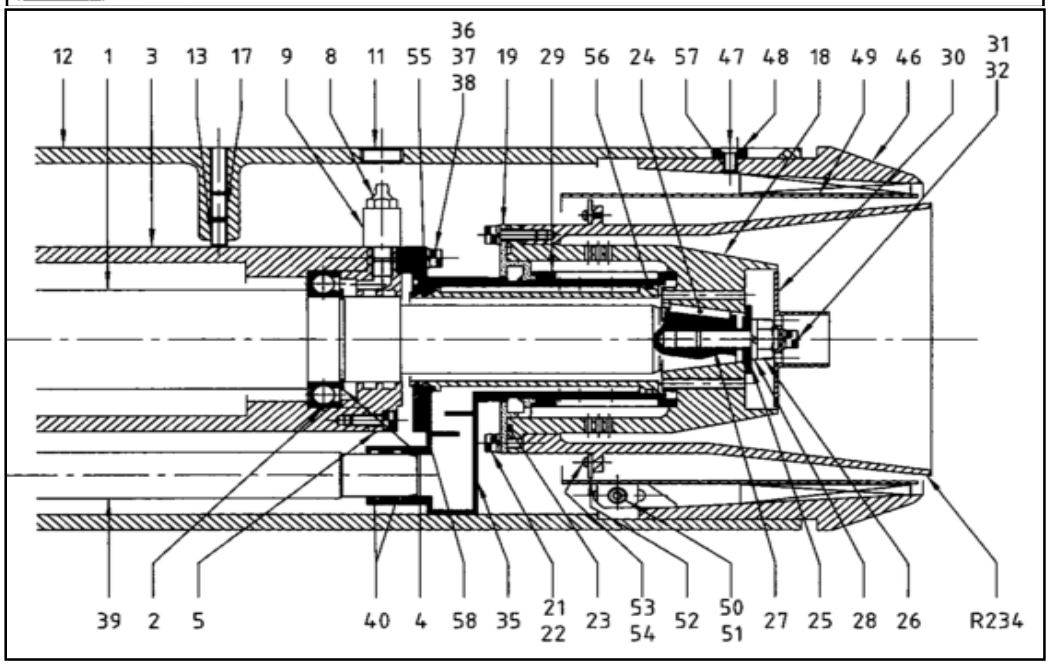
- Care must be taken to use only dry steam, any water present having a chilling effect which could cause flame instability. The steam may be obtained directly from the boiler, the pressure being dropped to the required value by passing it through reducing valves. Alternatively it may be obtained from an auxiliary source such as a steam to steam generator.
- Excessive use of steam can be caused by incorrect setting of the burner or by leakage across the joint faces in the atomizing head of the burner, and in some versions gaskets are fitted to prevent this.
- Steam is left on all the time the burner is in operation, even when the oil is turned off, in order to cool the burner and prevent any remnants of oil in the burner passages from carbonizing.
- Safety shut off valves are fitted to the burner carrier; these are opened by projections on the burner so that oil and steam are automatically shut off when the burner is removed.

Maintenance of Burner

Rotary Cup Type Fuel Oil Burner



MARK	NAME OF PARTS	Q'TY	REMARKS	MARK	NAME OF PARTS	Q'TY	REMARKS
30	DIFLECTOR	1		R234	ROTARY CUP MANTLE	1	
29	HUB SLEEVE	1					
28	WASHER	1		58	RETAINING RING	1	
27	HELI-COIL MID-GRIP INSERT	1		57	HELI-COIL MID-GRIP INSERT	4	
26	LOCK BOLT	1	M12 P=1	56	O-RINFG	1	
25	MAIN SHAFT END DISC	1		55	O-RINFG	1	
24	ROTARY CUP SHAFT KEY	1		54	LOCK WASHER	3	
23	O-RINFG	1		53	SLOTTED HEAD SCREW	3	M4 x 6
22	LOCK WASHER	8		52	RESTRICTION RING	1	
21	ALLEN CAP SCREW	8	M6 x 25	51	LOCK WASHER	4	
19	ROTARY CUP HUB COVER	1		50	ALLEN CAP SCREW	4	M5 x 10
18	ROTARY CUP HUB	1		49	NOZZLE SLEEVE	1	
17	ALLEN SET SCREW	3	M10 x 25	48	LOCKING PRISM	4	
13	CENTERING SCREW	3	M10 x 25	47	COUNTER-SUNK ALLEN HEAD SCREW	4	M6 x 15
12	PRIMARY AIR TUBE	1		46	PRIMARY AIR NOZZLE	1	
11	LUBRICATION PLUG	1		40	O-RINFG	2	
9	GREASE NIPPLE EXTENSION	1		39	FUEL OIL TUBE	1	
8	GREASE NIPPLE	1		38	COUNTER-SUNK SCREW	2	M6 x 20
5	FRONT BEARING COVER	1		37	LOCK WASHER	4	
4	RETAINING RING	1	6010Z	36	ALLEN CAP SCREW	4	M6 x 40
3	MAIN SHAFT BEARING HOUSING	1		35	FUEL OIL DISTRIBUTOR	1	
2	MAIN SHAFT BALL BEARING	1		32	LOCK WASHER	1	M5
1	MAIN SHAFT	1		31	ALLEN CAP SCREW	1	M5 x 15



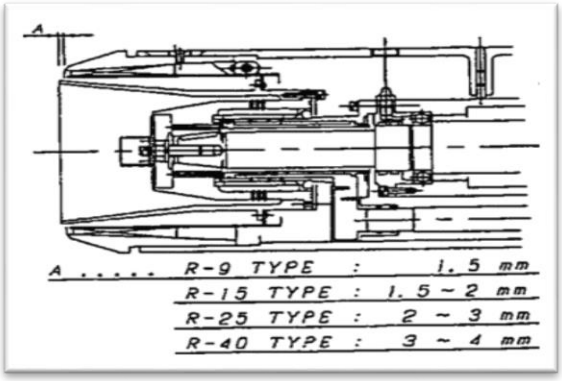
The rotary cup burner is attached to the burner front door and can be opened without removing air/oil piping and electric wiring. With the burner opened, all burner parts can be seen for inspection and maintenance. The secondary air register is made of steel plate and does not require insulation materials. The register can be removed for maintenance from opening at burner front.

Table: Maintenance and Interval

No.	ITEM	JOB ITEM	INTERVAL	REMARKS
1.	F.O. Pressure	Visual check	All times	Set-press. for ship: 0.6 MPa
2.	Rotary-cup in-side	Cleaning & check	Weekly	Cleaning of inside and confirmation of mounting posit
3.	Rotary-cup hub & distributor	Disassembling & cleaning	Monthly	Depending on the dirt condition, the interval to be changed
4.	Ignition burner	Cleaning & check	Week/twice or more	Confirmation of electrode mounting position, visual check of electrode glace
5.	Flame-eye glass	Cleaning & check	Weekly	Confirmation of electric resistance (600~20kΩ)
6.	Strainer screen	Cleaning	Weekly	Depending on the dirt condition, the interval to be changed
7.	Burner belt	Visual check	Weekly	Adjustment of tension and check of consumption
8.	Air/oil linkage	Visual check	Monthly	Check of each bolt and screw
9.	Bearing	Audible check	Monthly	Check of abnormal sound of bearing for burner main shaft & each motor
10.	Heater element	Cleaning & check	Yearly	Cleaning of heating surface; Electric type: check of terminal wiring connection
11.	Electric parts	Visual check	Monthly	Check of terminal wiring connection

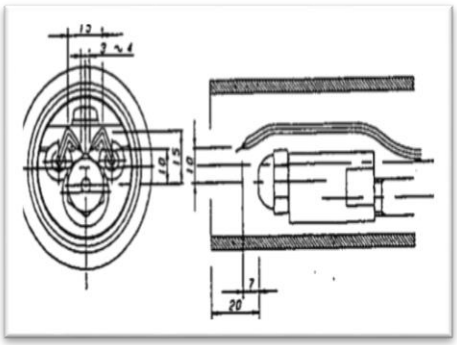
Clearance for rotary cup type fuel oil burner:

A = clearance from the tip/end of the rotary cup mantle (R234) to the tip/end of the primary air nozzle (46)



Take note of the clearance end required for the burner and this should be maintained or follow up on assembly.

Clearance for ignition burner:



Others

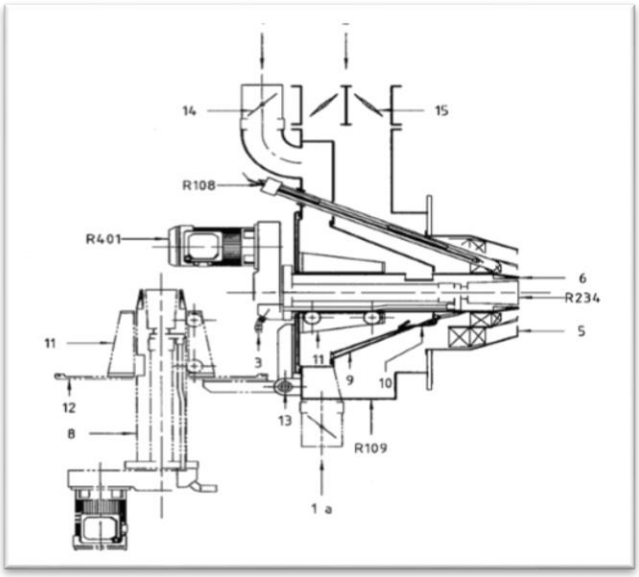
1. Re-adjust tension of the burner belt after initial operation for 50-100 hours. Set the belt tension so that the belt sinks about 15mm when it is pushed with a force of about 20N.

Pour grease of 4-5 g to the main shaft5 bearing every 1,000 hours. Use grease for wide temperature range.

The rotary cup can be cleaned without removing it from the main shaft. However, after long-term operation, it is necessary to clean the rotary cup after removing the primary air nozzle, cut, distributor.

ROTARY CUP BURNER GENERAL ARRANGEMENT

1	PRIMARY AIR ENTRY	12	BURNER FRONT DOOR
1 a	DITTO ALTERNATIVE LOCATION	13	HINGES
2	SECONDARY AIR ENTRY	14	PRIMARY AIR DAMPER
3	FUEL OIL ENTRY	15	SECONDARY AIR DAMPER
6	PRIMARY AIR NOZZLE	R108	IGNITION BURNER UNIT
8	PRIMARY AIR TUBE	R109	BURNER WIND-BOX
9	PRIMARY AIR HOUSING	R237	ROTARY-CUP
10	AUTOMATIC SHUTTERS	R401	BURNER MOTOR
11	SPOOKED BRACKET WITH ROLLERS	R510	SECONDARY AIR REGISTER



15. Pump Maintenance

Gear Pump Maintenance and Inspection (Refer to JOB CARD)

Centrifugal Pump Maintenance and Inspection (Refer to JOB CARD)

Pulling out of coupling, bearing and impeller

1.1 Before Disassembly

Check (by referring to drawing or instruction manual) the parts of the scheduled machinery, purpose of overhaul and prepare necessary spare parts and special tools.

1.2 During disassembly

Use proper tools to prevent parts from damages, appropriate container for storage to avoid missing parts.
Use the correct size of bolts and nuts, and loosen with a box wrench or close wrench.
Avoid using adjustable wrench or pipe wrench if it is not appropriate to avoid rounding off the fastener, proper disassembly procedure should be taken.
When a damage parts is found inform the matter to the personnel in charge of the equipment.

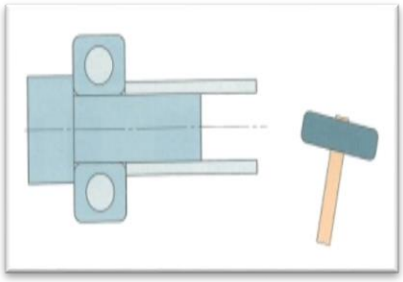
1.3 Disassembly and Reassembly

Marking with paint should be considered when disassembling mating parts so that the combination and contact condition still intact after assembly.

Part having a mounting direction shall be marked with a match mark avoids miss mounting.
Careful not to damage nor scratch the shaft with oil seal, if ever the mounting part is fitted too tightly avoid tapping to remove it. Place disassembled part in order, sorting it in group.

Proper Procedure for Installation and Removal of Ball Bearing

A middle or small size bearing shall be applied by press-fitting at room temperature.

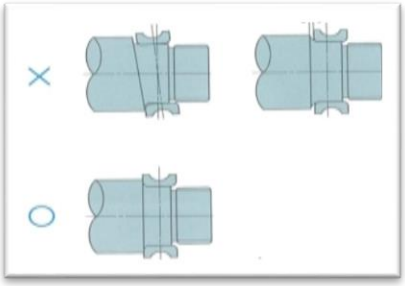


(1)When any intrusion in both inner and outer ring housing, and a small size bearing mounted gradual tapping is necessary in removing the bearing.

(2) In a case of a bearing with an adapter, sleeve and lock, loosen first the mounting nut before removing the bearing.

Check the following before removing the bearing

Before removing the bearing, be sure that the corner and right angle section ofthe bearing housing comes in close contact with the end face of the bearing.If the contact is in the proper position, check the section circled in the figure.

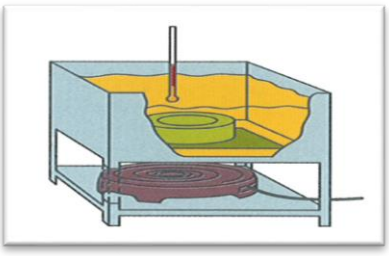


Shrink Fitting

*(1)*Bearing is fit in the shaft after expanded in a heating oil bath.

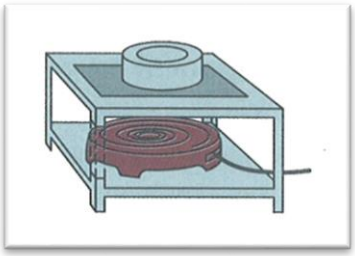
Heating temperature: 100 to 120 deg. Celsius (must not exceed 120 degrees Celsius because the hardness of bearing increases when heated.)

2) Make the end face of the inner ring of bearing come in close contact with the shaft until both bearing are sufficiently cooled. (Applicable only to open type bearing)



Reminder:
Sealed type bearing must not be dipped in hot oil bath.

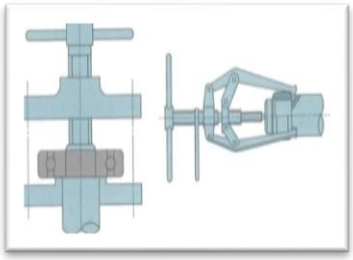
In the case of fitting seal bearing with large interference, put the bearing on a steel plate and heat up at the bottom.



Note: Extra care with the temperature to avoid damage the shield.

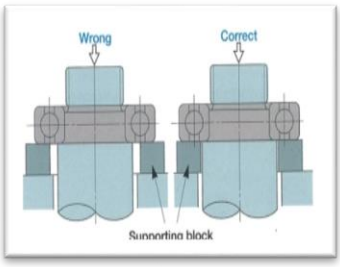
Extraction of Bearing

Turning the handle unscrew the bolt exerting a pulling force on the bearing.

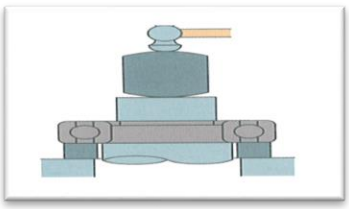


Removal by a Hand press

Set the bearing shaft to the block to support the inner ring and the centre of the line bearing becomes perpendicular.

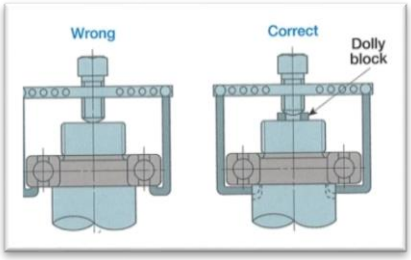


To remove by using a hammer, be sure to use a dolly block to avoid damaging the shaft.

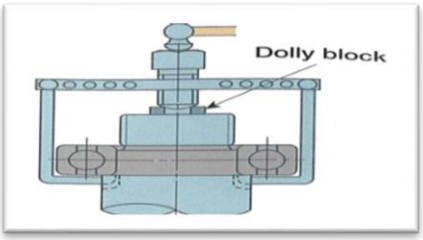


Removal Using a Puller

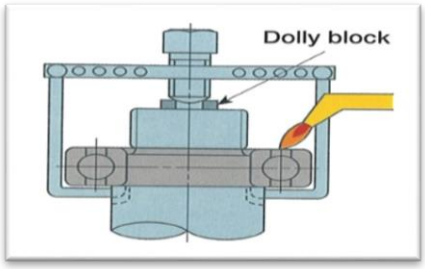
To remove a bearing from a shaft set the puller with the claw on the inner ring.



When find it difficult to remove the bearing shock by tapping the head of the bearing puller.



If no changes with the above method, heat the bearing with a gas torch with pulling force applied on the bearing, avoid heating the shaft.



If no changes of the above method:

- Cut the outer ring and metal support fitting with gas cutting torch and leave the inner ring, heat the inner ring with gas torch carefully not to heat the shaft to take out.
- If the bearing still difficult to remove cut the inner ring with gas torch.

Note: This method is for emergency use only not recommended for normal overhauling because they may bend, flaw or degrade the material of the shaft.

- For gas cutting torch use as small flame as possible as well as minimize the opening of high pressure oxygen valve.
- After removing the bearing cool down the shaft with the ambient temperature.

Feel-over technique and Guide for Fitting, mounting the bearing:

1. Check the condition of the shaft to be mounted with new bearing. This should be clean, free of rust and no splashes of paint. A quick rub with sandpaper will clean this up.
2. It is important to identify which bearing is the front and which is the rear prior to insertion.
3. Your new bearing must be heated for expansion before fitting to the shaft, follow below procedure of bearing type.

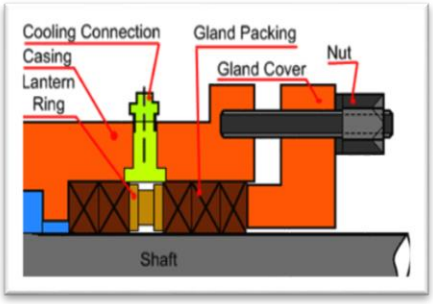
- **Open type bearing**

a. Fill up a can with oil enough to immerse the new bearing.
b. Heat up the can using the steel plate oven. Heating temperature must be about 100 to 120 deg. Celsius.

- **Closed type bearing**
  a. Put the bearing on the base of the steel plate and heat up to about 100-120 deg. Celsius.

4. Grease up the shaft and insert the hot bearing, making sure it is firmly pushed in close contact with the shaft.
5. Let it cool the new bearing down to a temperature that is possible to hand touch by **feeling over** then mount the shaft with bearing to the housing
6. Apply slight grease to the housing before mounting the shaft with the new bearing.

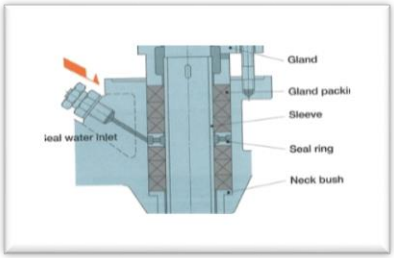
Tightening and replacement of pump gland packing (Refer to JOB CARD)



Tightening of Gland Packing

A seal ring is inserted in the middle of a gland packing to introduce seal water and to prevent seizing of shaft due to frictional heat generated between the packing and the rotating shaft. A minimal amount of water leaking from the gland is normal condition. Additional tightening of the gland to get rid of water leaking could result in a burn out packing and excessive seizure of the rotating shaft.

Change in the leakage from the gland



The cause of pump pressure fluctuating (1) pump load (2) boiler steam pressure in the case of boiler related pump (3) hull motion (4) others. The higher the pump discharge pressure the greater the leakage from the gland.

Additional tightening of the gland

Additional re- tighten of the gland, the above matter shall be bear in mind; minimal amount of water leaking to prevent burn out of packing and seizure of shaft even at a lower pump discharge.

When additional tightening is required, tighten each of the cap nuts gradual and equal. And check the condition of the leak and the shaft, if heat is generated and other abnormality observed avoid tightening at a single twist.

If the leaking exists replace the packing with new spare.

Uses	Manufacturer					
	Beldam	**Ameroid**	**Chesterton**	**J.Walker**	**Tombow**	**Pillar**
All Purpose	160		210	270S	1000	5000
Steam	165 174	Amerite	281	400	1303 1301	5000
Water	184		119	237	1651	
Oil Water	166 175		140 145	348 420	1630 1030	
Oil	163		270	372	1100	5000
Chemical	161		235	367	1500	5000

Pillar Gland Packing Table

Kind	Manufacture	Application	Pillar
PILLAR FOIL® Low-torque packing series		**Manual valve, electric valve**	
		For low-temperature/low-pressure	**No.6114**
		For medium-temperature/medium-pressure	**No.6315CL**
		For medium-temperature/high-pressure	**No.6710CL** **No.6616CL** **No.6610CL**
		For high-temperature/medium-pressure	**No.6315CH** **No.6710CH** **No.6616CH** **No.6610CH**
		Control valve temperature/low-pressure: For medium-temperature/medium-	**No.4519** **No.6720** **No. 6610CL**
LIVE SEAL UNIT PILLAR		- Single gland type - Double gland type - Floating gland type	**No.6300**
PILLAR WHITE PACKING SERIES		used widely for a rotary machine	**No.4536WL**
PILLAR CARBONIZED FIBER PACKING		applicable to a wide range of applications such as rotary machine, reciprocating machine, etc.	**No.6501L**

1. Universal Packing – all purpose packing

Construction:
Plaited from a special white asbestos yarn to which Isadded a unique surface treatment ofPTFE (Polytetrafluoroethylen resin) and lubricant.

Applications:
Rotary reciprocating and static.
Universal pump packing
Service:
Max. Temp. Pumps 300 ºC
Valves 350 ºC
Pressure: 100bar

2. Steam Packing

Constructions:
This packing is built of alternate layers of antifriction metal and asbestos cloth placed diagonally and boned with heat resisting rubber compound. It is coated on the outside with graphite.

Applications:
Reciprocating rods. Piston and valve rods. Bilge, cargo, feed and other pumps.

Service:
Max. Temp. 200ºC
Pressure 70bar

3. Steam & Water Packing

Constructions:
A valve packing with an inconel wire reinforced asbestos cover is braided around a plastic core of pure asbestos and graphite.

Applications:
Static. Universal, resilient valve packing for saturated and super-heated steam.

Service:
Max. Temp. 700ºC
Pressure 250 bar

4. Water Packing

Constructions:
This is plaited from high grade flax blended with other natural fibers carefully selected to provide a high wet strength when in contact with seawater thereby ensuring a long packing life. Each strand is through impregnated with a special water resistant mica lubricant before plaiting.

Applications:
Stern Gland and General purpose water packing.

Service:
Max. Temp. 120ºC
Pressure 70 bar

For Pumps and Valves (asbestos – free)

5. Acid, Alkali Solvent, Oil & Water Packing

Constructions:
This is a unique interlocking braided ASBESTOS FREE packing which is braided with aramid fiber. It impregnates PTFE (Ploytetrafluoroethylen resin) heat resistant lubricant. Unique braiding method, interlocking in 36 strands, is adopted on style No. 4526L. In long term operation, such unique interlocking braided packing style No. 4526L brings superior sealing and stability.

Applications:
Seawater Pump, Bilge Pump, Fuel Oil Pump, Boiler Water Circulating Pump, Valves.

Service:
Max. Temp. 260ºC
Pressure 16 bar

16. Air Compressor

NYKSM Recommendation during overhauling of compressor valves
Ref: HSEQ/PMS/001/15; 30 July 2015

Gist:
Main Air Compressor Piston and Liner failures have been frequently onboard our managed vessel. A study was carried out and found that these failures were mainly due to failure and breakage of compressor valves and these broken parts in turn damaging the piston and liner while running.

Action required:
- **Carry out overhauling and inspection of compressor valves as per intervals stated in the PMS.**
- **Ensure overhauling intervals stated in PMS do not exceed the intervals as recommended by the maker.**

Recommendation during overhauling of compressor valves
- **Disassemble and clean all parts with soft cloth or brush.**
- **Renew springs / Spring plates and Valve during every overhaul (even if these parts are not worn out).**
- **DO NOT LAP THE VALVE PLATES.**
- **Valve seat (body) can be lapped and replacement of valve seat (body) must be in accordance with the maker's wear down limit.**

After assembling, test the valves by doing the following
- **Push the valve plate from the valve seat side using a screw driver and check action of spring. Put the screw driver in several place and check the action of spring.**
- **Test the valve for any leakage by filling water.**
- **Ensure adequate tightening of valve retainer by torque spanner, as many failures have happened due to improper tightening or due to over tightening.**

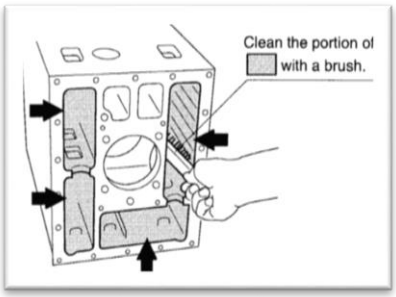
1st and 2nd Stage Suction and Delivery Maintenance and Inspection
(Refer to JOB CARD)

Connecting Rod Bolt Tightening (Refer to JOB CARD)
@250hrs:
1)Clean air filter
2)Check un-loader operation
3)If belt is provided for driving cooling water pump, check its tightness

@500hrs:
1)Change lubricating oil and clean sump.
2)Clean lube oil filter
3) Check and renew suction and discharge valves with overhauled one.

@1000hrs:
1)Crankcase inspection, main and big end bearing inspection
2)Relief valve overhauling

@4000hrs:
1)Piston and big bearing overhauling, piston ring renewal.
2)Intercooler cleaning
3)Motor overhauling



Other Parts for Maintenance
1. Inside of Cylinder
Check if cylinder inside is worn or proper quantity of oil is applied.
2. Water Jacket
a. Check if water dirt is stuck on the water jacket surface (both 1st and 2nd stages.)
b. When water dirt is stuck, clean the portion shown below with the brush.
c.
3. Cooler
When air is compressed, temperature is considerably increase and affect the efficiency of the machine. Cooler is provided to maintain constant temperature of the air while it is being charged. To ensure cooler efficiency, Carry out periodical inspection and cleaning as recommended by the maker.

Remove the cooler covers of both 1st and 2nd stages.
a. Check if water dirt is stuck on the water jacket surfaces.
b. When water dirt is stuck, clean the portion shown in the figure with brush.

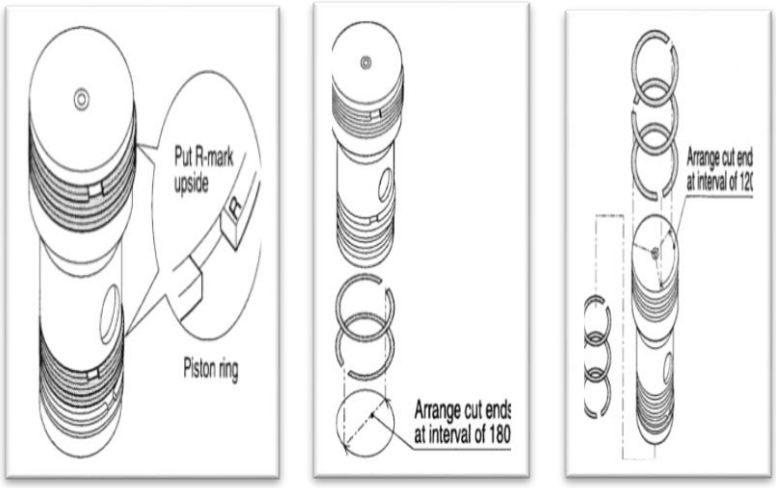
4. Piston

a. Remove the cylinder head.
b. Remove the rod cap from the connecting rod.
c. Screw in the piston removing tool at the top of piston, then extract the piston carefully so that the crank pin and the inside of the cylinder may not be scratched. At this time, connecting rod comes up together with piston assembly.

Caution:
* Carefully treat the piston since it is easily scratched.
* Use a ring mounting tool when reassembling the ring.
* The piston should not be clamped by vise or hit by hammer.
* Piston ring has sharpened edge. Be careful not to injure your finger.

1. Outside the Piston
a. Check that oil is properly applied.
b. When quantity of oil applied is insufficient, first readjust the lubricator then replace it when it was found to be damaged or fault.

2. Piston Rings
a. Three piston rings are set on the 1st stage and three piston rings are set on the 2nd stage.
b. Check direction of the ring (face and back) and extent of wear.
c. If the direction of the ring is wrong, mount it correctly.
d. Replace the worn piston ring.
e. When setting piston rings into piston ring grooves, put the R-mark side of each ring upside and arrange the cut ends at interval of 120° so that all the cut ends will not be aligned.
f. As each ring is narrow shaped and easily deforms, handle it with care.



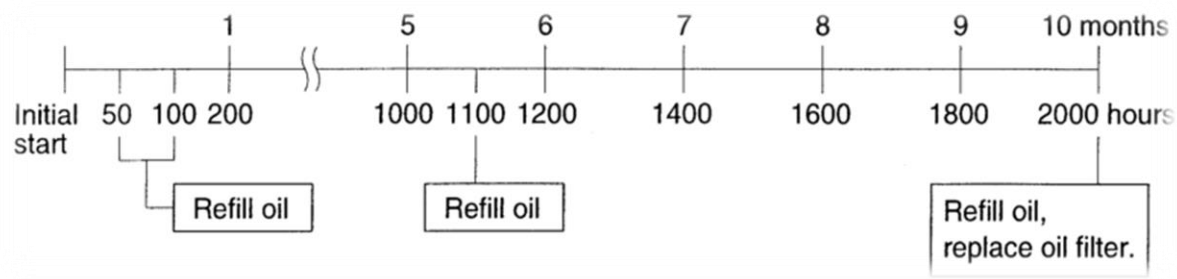
5. Oil Scraper

a. Two oil scraper rings are set on the piston skirt.
b. Check direction of the ring (face and back) and extent of wear.
c. If the direction of the ring is wrong, mount it correctly.

d. Replace the worn scraper ring.
e. When setting scraper rings into piston ring grooves, put the R-mark side of each ring upside and arrange the cut ends at interval of 180° so that the cut ends will not be aligned.
f. As each ring is narrow shaped and easily deforms, handle it with care.

Oil System

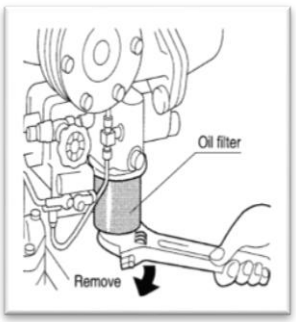
Replace the oil according to the time table.

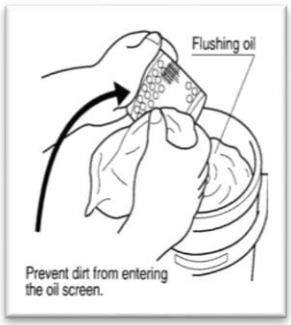


1. Oil Screen
Oil screen blocks coarse dirt.

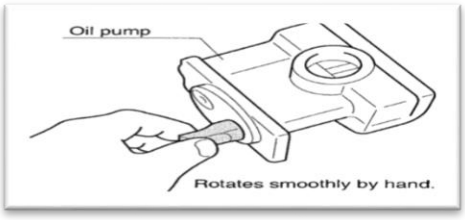
a. Clean the oil screen when replacing the oil.
b. Cover so that no dirt enters the oil screen, remove the stain with soft cloth, and wash with clean flushing oil.
c. Replace the oil screen if it is broken.

2. Oil Filter
a. Oil filter filters minute dirt.
b. Oil filter is cartridge type.
c. Replace oil filter with a new one at every two times of replacement.



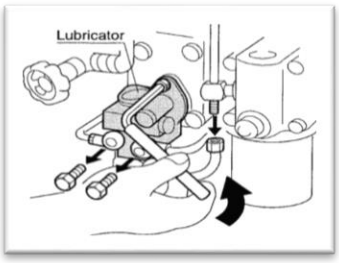


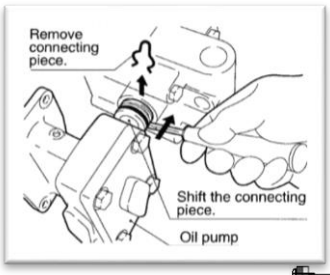
3. Oil Pump
a. Inspect oil pump every 8000 hours of operation.
b. After removing the bolts, replace the connecting piece suppressor as shown in the figure below. Shift the connecting piece toward the oil release valve body side using a minus screwdriver, then remove the oil pump.



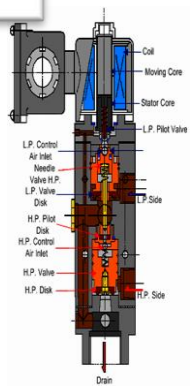
4. Make sure that the pump can be rotated freely by hand. If it cannot be rotated by hand or resistance is large, disassemble and clean. Replace if necessary.

5. Lubricator (works for the lubrication of 1st stage cylinder)
a. Replace the lubricator at every 8000 hours of operation.
b. Replace the lubricator as illustrated in figure below.
c. As quantity of oil supply has been adjusted to appropriate quantity before shipment, basically do not change it. But when reconditioning becomes necessary ask for its details to compressor manufacturer.





Magnetic Un-loader Valve



A device used to load/unload the air compressor during starting and stopping to reduce the operating torque, controlled by a solenoid valve and by a timer relay in the control panel. The magnetic un-loader valve is in open position during starting and will close automatically within 10 seconds maximum setting (depending on the setting of timer relay) from the point of starting and load operation begins. When stopping the magnetic un-loader valve will open until to the point of starting to release the remaining air pressure in the compressor system.

When the solenoid coil is energized, the L.P. Pilot valve and H.P. needle valve is forced by the spring to open the pilot line to the atmosphere. The air from the air compressor casing 1st (L.P.) and 2nd (H.P.) stage is released to the atmosphere by forcing to open the L.P. valve and H.P. valve. When the solenoid coil is de-energized, the control air from L.P and H.P. Control Air will force to close L.P. and H.P. Valve thus, compressor is in load operation.

17. Heat Exchangers

A heat exchanger is a piece of equipment built for efficient heat transfer from one medium to another. The media may be separated by a solid wall, so that they never mix, or they may be in direct contact. They are widely used in space heating, refrigeration, air conditioning, power plants, chemical plants, petrochemical plants, petroleum refineries, natural gas processing, and sewage treatment.

There are two primary classifications of heat exchangers according to their flow arrangement. In parallel-flow heat exchangers, the two fluids enter the exchanger at the same end, and travel in parallel to one another to the other side. In counter-flow heat exchangers the fluids enter the exchanger from opposite ends. The counter current design is the most efficient, in that it can transfer the most heat from the heat (transfer) medium due to the fact that the average temperature difference along any unit length is greater. See countercurrent exchange. In a cross-flow heat exchanger, the fluids travel roughly perpendicular to one another through the exchanger.

For efficiency, heat exchangers are designed to maximize the surface area of the wall between the two fluids, while minimizing resistance to fluid flow through the exchanger. The exchanger's performance can also be affected by the addition of fins or corrugations in one or both directions, which increase surface area and may channel fluid flow or induce turbulence.

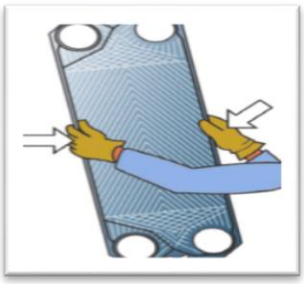
PLATE TYPE HEAT EXCHANGER

It is composed of multiple, thin, slightly separated plates that have very large surface areas and fluid flow passages for heat transfer. This stacked-plate arrangement can be more effective, in a given space, than the shell and tube heat exchanger. Advances in gasket and brazing technology have made the plate-type heat exchanger increasingly practical. In HVAC applications, large heat exchangers of this type are called plate-and-frame; when used in open loops, these heat exchangers are normally of the gasket type to allow periodic disassembly, cleaning, and inspection. There are many types of permanently bonded plate heat exchangers, such as dip-brazed and vacuum-brazed plate varieties, and they are often specified for closed-loop applications such as refrigeration. Plate heat exchangers also differ in the types of plates that are used, and in the configurations of those plates. Some plates may be stamped with "chevron" or other patterns, where others may have machined fins and/or grooves.

Maintenance

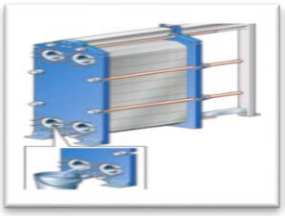
Warning!

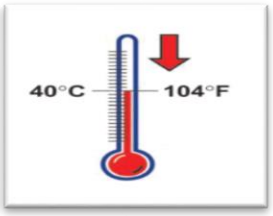
To avoid hand injuries owing to sharp edges, protective gloves should always be worn when handling plates and protective sheets.

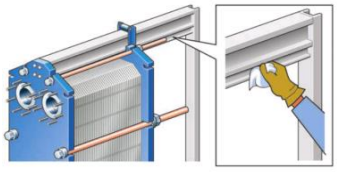


Warning!If the heat exchanger is hot, wait until it has cooled down to about 40°C (104°F).

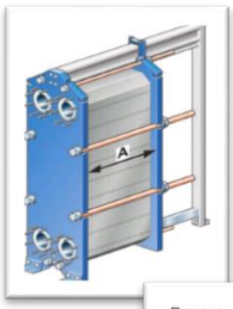
1. Drain the plate heat exchanger.

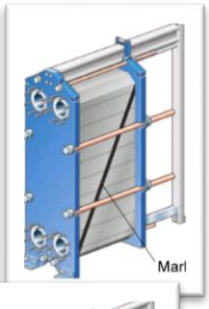




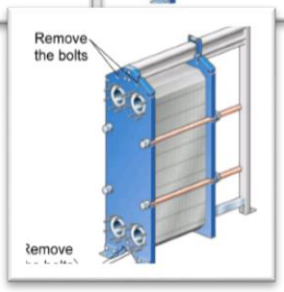


2. Inspect the sliding surfaces of the carrying bar and wipe clean.
3. Mark the plate assembly on the outside by a diagonal line.





4. Measure and note down the dimension A.

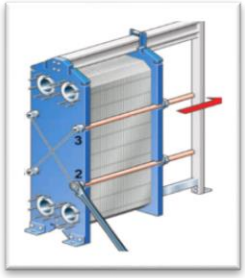


5. Loosen the bolts which are not fitted with bearing boxes and remove them.

6. The pairs of bolts that are fitted with bearing boxes are opened alternately and diagonally in two steps, see below.

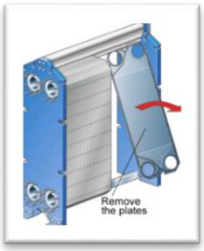
Step	Bolt No.	To Dimension
1	1-2-3-4	1,05 A
2	1-2 or 3-4	Opening

Be careful so that the frame plate and pressure plate are always in parallel. Skewing of the pressure plate during opening must not exceed 10mm (2 turns per bolt) across the width and 25mm (5 turns per bolt) vertically.



Step 1: Loosen the four bolts alternately and diagonally until the plate package measures 1,05A.

Step 2: Loosen the two diagonal pairs of bolts are loosened alternately, as shown in the figure below.



7. Open the plate pack by letting the pressure plate glide on the carrying bar.
If the plates are to be numbered, do this before removing the plates. Plates need not to be removed if cleaning is done using only water, i.e. without cleaning agent.

MANUAL CLEANING OF OPENED UNITS
Caution:
Never use hydrochloric acid with stainless steel plates. Water of more than 330 ppm Cl may not be used for the preparation of cleaning solutions. It is very important that carrying bars and support columns in aluminum are protected against chemicals.

Note
Be careful not to damage the gasket during manual cleaning.
Deposits removable with water and brush.
Plates need not to be removed from the plate heat exchanger during cleaning.

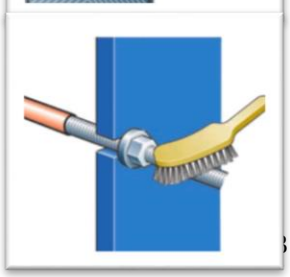
1. Remove deposits using a soft brush and running water.

2. Rinse with water using a high pressure hose.

Deposits not removable with water should be brushed.
Plates must be removed from the plate heat exchanger during cleaning.

1. Brush with cleaning agent.

2. Rinse with water.

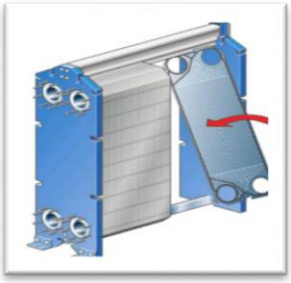


CLOSING

1. Check that all the sealing surfaces are clean.

2. Brush the threads of the bolts clean, using a steel wire brush. Lubricate the threads with a thin layer of grease, e.g. Gleitmo 800 or equivalent.

3. Attach gaskets to the plates or check that all the gaskets are properly attached.

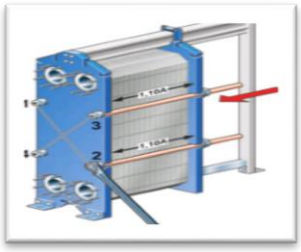


NOTE
If the gasket is wrongly positioned, it will show by the fact that it rises out of the gasket groove or that it is positioned outside the groove.

4. Insert the plates with the herring bone pattern positioned in alternate directions and with the gaskets turned towards the frame plate.

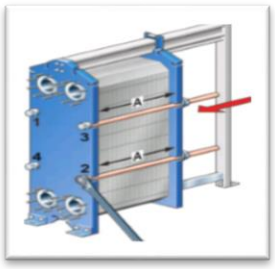
5. Press the plate assembly together. Tightening is done in two steps, see figures below. Be careful so that the frame plate and the pressure plate are always in parallel.

Step	Bolt No.	To Dimension
1	1-2 or 3-4	1, 10A
2	1-2-3-4	
A		



Step 1: Tighten the two diagonal pairs of bolts alternately until the plate package measures 1,10A.

Step 2: After that bolts are tightened alternately and diagonally, as shown in the figure below. Check the dimension A during tightening at the positions of the bolts that are being used.



Maximum Tightening Torque

NOTE

When a pneumatic tightening device is used, see table below for maximum torque. Measure dimension A during tightening.

Bolt Size	Bolt with Bearing Box		Bolt with Washers	
	Nm	Kpm	Nm	Kpm
M24	------	-----	450	45
M30	------	-----	900	90
M39	1300	130	2000	200
M48	2100	210	3300	330

For manual tightening, the tightening torque has to be estimated.

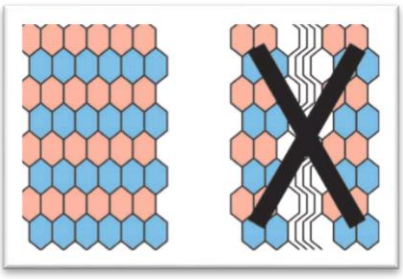
If dimension A cannot be reached
-Check the number of plates and the dimension A.
-Check that all the nuts and bearing boxes are running freely. If not, clean and lubricate, or replace.

The dimension A can be exceeded in exceptional cases. The following plate package lengths could then be accepted:

Plate package length/plate	Plate package length (dimension A)
> 4 mm	A + 1%
3-4 mm	A + 1.5%
< 3 mm	A + 2%

6. Place the other bolts in position.
-Inspect the washers.
-When fully tightened, the bolts should all be equally tensioned.
-The difference between the plate package lengths (the Dimension A) measured at adjacent bolts should not exceed:
-2 mm when A < 1000 mm
-4 mm when A > 1000 mm
-The plate package length at all bolts must no differ more than 1%.
-If the unit does not seal fully, it can be tightened to give dimension A -1%. The maximum tightening torque must not, however, be exceeded.

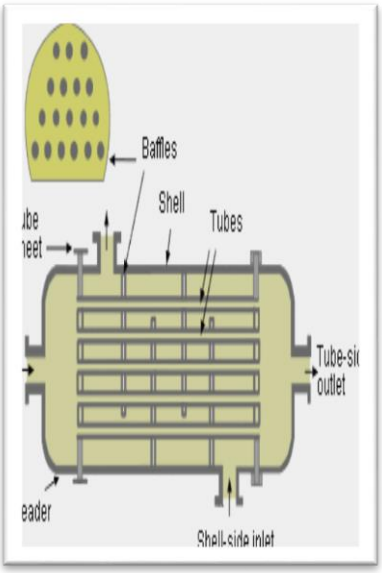
7. If the plates are correctly assembled, the edges form a "honeycomb" pattern, see picture below.
If the plate pack has been marked on the outside (see step 3 in section "Opening") check that the plates have been assembled in correct order.



Shell and Tube Type Heat Exchanger

The shell and tube heat exchanger is the most widely used heat exchanger in industry today. One fluid passes through the tubes while the other flows through the shell. This prevents the fluids from mixing with each other. Most of the heat transfer occurs through the walls of the tubes. A large number of tubes are used to provide a greater surface area so the heat transfer is faster.

One fluid is flowing through the inside (tube-side) of the pipes and the other fluid is flowing over the outside (shell-side) of the pipes. It is important in the case of flowing liquids that the inside of the pipes is full of fluid and has no air gaps. Air has a low thermal conductivity and will reduce the rate of heat transfer. This will reduce the efficiency of the heat exchanger and can lead to hot spots which may damage the tubes if they are not cooled properly. For the same reason, the space outside the tubes should have no air gaps as well. Since air/gas pockets will rise, they can be removed by vents located at the top of the heat exchanger.



Minor Maintenance

When the heat exchanger is isolated, minor maintenance such as clearing blockages, cleaning, lubrication, and oil level checks can be carried out in accordance with the Standard Operating Procedures and the Permit To Work system.

Maintenance of heat exchangers

Cleaning

For a heat exchanger to work efficiently, the heat transfer surfaces must be clean, and the flow passages must be clear of obstruction. Fouling is indicated by a gradual increase in the temperature difference between the two fluids over a period of time. This is usually accompanied by a noticeable rise in pressure loss at a given flow rate.

Fouling and scaling cannot be completely avoided. A cleaning program should be put in place to help insure the continued optimal, or near optimal, performance of heat exchangers. Exchanger cleaning methods are classified as either mechanical or chemical. Mechanical cleaning takes time and people, therefore it's preferable to use chemical cleaning.

Mechanical cleaning requires opening the exchanger. This involves the removal of the end covers and the tube bundle (plates in the case of a plate exchanger), then cleaning and then reassembly.

Damage of the exchanger components, particularly the tube bundle, is always a risk and great care must be taken.

If the deposit is on the inside of the tubes then an abrasive brush, either hand or power operated, can be used. Another technique involves the use of an abrasive bullet forced through the tube by compressed air. These bullets have the advantage of being able to negotiate tube bends, unlike other mechanical means.

Shell-side deposits require you to place the tube bundle in a specially designed cleaning cradle. This enable high pressure water or grit blasting to be carried out.

Chemical cleaning
With chemical cleaning it is important to identify the deposit in order to select the correct method for its removal.

Some of the common chemicals used to clean exchangers are:

- Mineral acids

  Hydrochloric acid (If sulphuric acid was used to remove calcium carbonate scale, calcium sulphate would form this is another insoluble substance). Otherwise, this would result in the formation of calcium sulphate, another equally insoluble substance.

- Organic acids

  Citric and formic acids are widely used - especially in steam generators where chlorine ions would cause problems with austenitic steels. Citric acid is used, in the form of ammonium acid citrate, to prevent the formation of insoluble ferrous acid citrates.

- Alkaline agents

  these agents have a detergent action and are capable of neutralizing acids. Some examples are: soda ash, caustic soda, sodium silicates and tri-sodium phosphates.

- Organic solvents

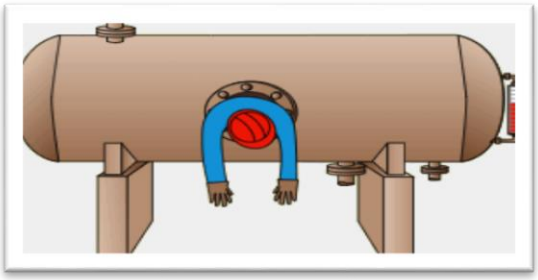
These are used where fouling is due to waxes and tars. They include kerosene, diesel fuels and trichloroethane. Organic solvents do not dissolve mineral deposits.

*** Before opening manholes, hatches or pipe lines into the heat exchanger, ensure that:

- the heat exchanger is drained and depressured to prevent spills
- steam or water are isolated, depressurized and drained to prevent burns
- the heat exchanger is purged of explosive vapors or toxic vapors to prevent poisoning, fire or explosions.

Vessel entry
If vessel entry is required, confined space entry permits must be used and, prior to entry, the vessel may require:

- draining, depressurization and purging of the heat exchanger vessel before man ways or inspection hatches are opened
- gas testing to be carried out inside the heat exchanger
- ventilation equipment to continuously purge the vessel with clear air
- cleaning the vessel to remove any build up of hazardous deposits inside the heat exchanger
- Personal Protective Equipment and respirator protection for people entering the vessel
- a standby safety watch person.



An Oxygen Deficient Atmosphere (ODA) can rapidly cause death

Pressure test of heat exchanger to check for leaks

When you suspect leakage, immediately inform the first engineer. The procedures for pressure test are as follows:

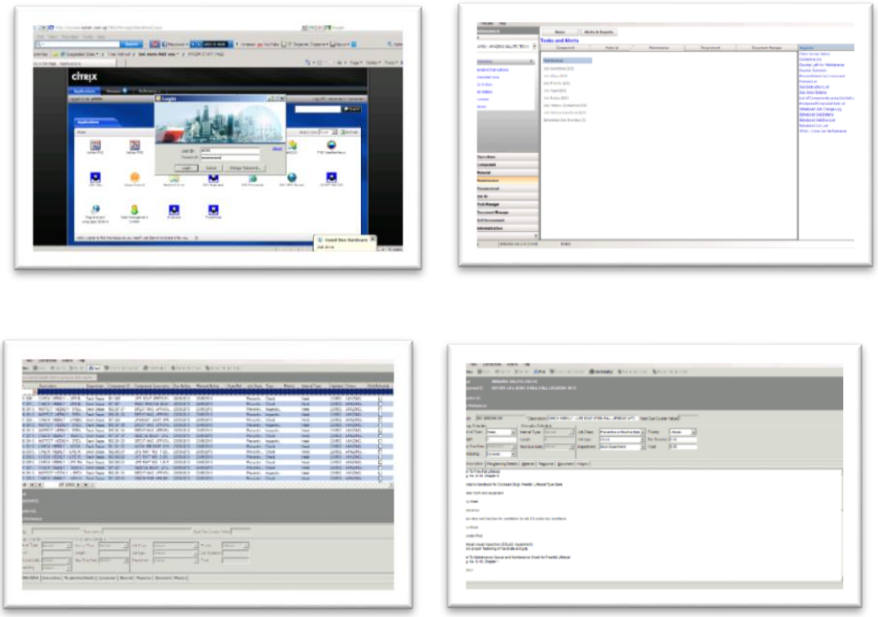
- Close inlet and outlet of cooling water of heat exchanger.
- Drain the liquid content.
- Install fabricated flange with pressure gauge to the chemical cleaning pipe.
- Supply pressurized air from fabricated flanged to reach about 0.5 mpa then close the supply valve.
- Check for any pressure drop.

18. Planning of Engine Maintenance and Condition

The PMS - Planned Maintenance System is a paper/software-based system which allows ship owners or operators to carry out maintenance in intervals according to manufacturers and class/Classification society requirements. The maintenance, primarily supervised by the on board personnel, is then credited towards inspections required by periodic surveys. The planning and scheduling of the maintenance, as well as its documentation, must be made according to a system that is approved by classification societies like Germanischer Lloyd, Lloyd's Register, Bureau Veritas or Det Norske Veritas, etc. All these classification societies are members of IACS (International Association Of Classification Societies Ltd). Having a planned maintenance system on ships is now mandatory as per ISM (International Safety Management Code).

Computerized Planned Maintenance Systems for use in shipping industry

2) BASSNET PMS Vessel Main Screen



The development of computerized PMS was boosted by computer development, especially the development of Windows· A variety of PMS programs for shipboard use appeared, and gradually they become more and more sophisticated and complex. Producers recognized shipping needs and most of the programs today have several (semi)independent modules and the customer (shipping company) can choose what package they want to use. Programs today do not contain only maintenance; they offer almost all what is needed on board the ship.

Most common modules in modern PMS system include:

- Maintenance (main and essential part of program'
- Stock ordering and purchase

- Stock control (inventory)
- Safety management
- Quality management
- Crewing and staff
- Self assessment

Modules can vary between different programs, but they are all based and built around main module, Maintenance.

Maintenance

This module should meet requirements listed in ISM (International Safety Management Code), chapter 5, section 10. The database should be constructed according to the manufacturer's recommendations, and good seamanship practice. The database should include all shipboard vital equipment, and all equipment should have a clearly defined maintenance plan. Performed tasks should be kept in the system as well as notes from crew members performing the task. Access to various aspects in the system must be selective and programs must have ability to individually recognize users (login ID and password). Best example of this practice is Class requirement that only Chief Engineer have access to jobs linked with Surveys.

Class societies allow special status to ships with well implemented PMS. Survey of various machinery components is performed usually with regular Class surveyor inspection, and it is based on schedule given in Continuous Machinery Survey. Surveyor comes to ship several times per year and inspects various machinery components, determining their condition. Inspection is scheduled every five years and the system is intended to assure good functionality of ship's machinery and therefore safety of the ship. As PMS is increasing overall safety and reliability of the ship, Class societies allow another form of Survey to be performed on the ships with well established PMS. Most of CSM inspections (all except steering gear and pressure vessels) is carried out by Chief Engineer, based on regular PMS jobs, and Class surveyor is coming on board the ship only once a year to inspect items Chief Engineer is not entitled to and to check what items were inspected since last Class inspection.

Today, there is a minimum requirement that one Planned Maintenance system must contain:

- The description and documentation of the Planned Maintenance system are to be in the English language.
- Reports in Planned Maintenance system should be in English, except when not suitable for the crew. In that case a brief English summary is required.
- Planned Maintenance program must include equipment manufacturer requirements.
- Inventory content, i.e. items/systems has to be included in the maintenance program.
- Maintenance time intervals, i.e. time intervals at which the maintenance jobs are to take place.
- Maintenance instructions, i.e. maintenance procedures to be followed.

- Maintenance documentation and history, i.e. documents specifying maintenance jobs carried out and their results.
- Reference documentation, i.e. performance results and measurements taken at certain intervals for trend investigations from delivery stage.
- Document flow chart, i.e. chart showing flow and filling of maintenance documents as planning cards, job cards etc.
- Signing instructions, i.e. who signs documents for verification of maintenance work carried out.

For computerized Planned Maintenance systems there are several additional requirements:

- Each person working on system must have unique login ID and password.
- Computerized system must have adequate backup, either backup copy on board or a regular exchange of data between ship and office.

Documentation on maintenance of the category "Classification Surveys" carried out on items/systems covered by the rules is to be signed by the Chief engineer. With computerized systems, access to update the related maintenance documentation and the maintenance program should only be granted to the Chief engineer.

For ships trading in specific areas, e.g. ferries, planned maintenance systems using other languages than English may be accepted. This arrangement is automatically cancelled in case of change of trade.

19. UNDERSTANDING OF PIPING DIAGRAM

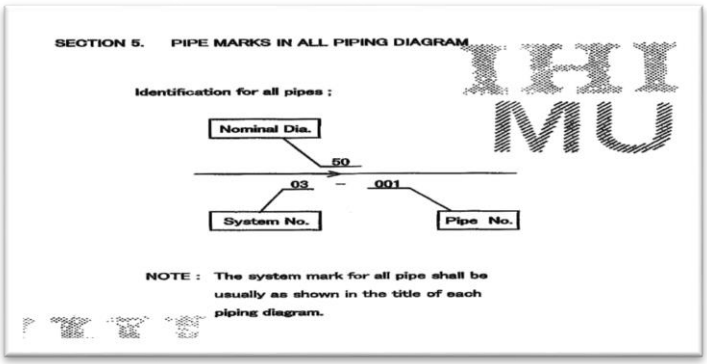
Piping arrangement on board

A ship's machinery space contains hundreds of meters of piping and fittings. The various systems are arranged to carry many different liquids at various temperatures and pressures. Valves, strainers, branch pipes, etc., are examples of fittings which are found in a pipe system.

Machinery space pipe work is made up of assorted straight lengths and bends joined by flanges with an appropriate gasket or joint between or very small-bore piping may use compression couplings. The piping material will be chosen to suit the liquid carried and the system conditions.

Where piping is to be galvanized, the completed pipe with all joints fully welded is to be hot dipped galvanized. The pipes are supported and held in by hangers or pipe clips in such a way as to minimize vibration. Steam pipes or pipes in systems with considerable temperature variation may be supported on spring hangers which permit a degree of movement. An alternative to spring hangers is the use of expansion loops of

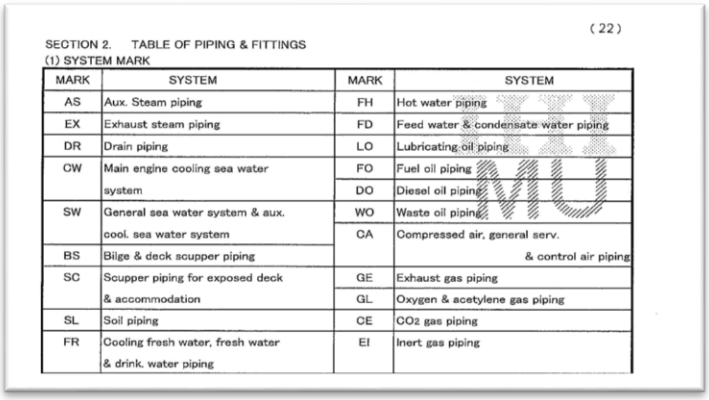
piping or an expansion joint. It is important that the crew member must be familiar and have knowledge on how to use the piping diagram.



SECTION 5. PIPE MARKS IN ALL PIPING DIAGRAM

Identification for all pipes :

NOTE : The system mark for all pipe shall be usually as shown in the title of each piping diagram.



SECTION 2. TABLE OF PIPING & FITTINGS

(1) SYSTEM MARK

MARK	SYSTEM	MARK	SYSTEM
AS	Aux. Steam piping	FH	Hot water piping
EX	Exhaust steam piping	FD	Feed water & condensate water piping
DR	Drain piping	LO	Lubricating oil piping
CW	Main engine cooling sea water system	FO	Fuel oil piping
		DO	Diesel oil piping
SW	General sea water system & aux. cool. sea water system	WO	Waste oil piping
		CA	Compressed air, general serv. & control air piping
BS	Bilge & deck scupper piping		
SC	Scupper piping for exposed deck & accommodation	GE	Exhaust gas piping
		GL	Oxygen & acetylene gas piping
SL	Soil piping	CE	CO_2 gas piping
FR	Cooling fresh water, fresh water & drink. water piping	EI	Inert gas piping

12.4 DIMENSIONS AND MATERIALS OF PIPES

12.4.1 Steel Pipes

Dimensions

Nominal Diameter mm	Outside Diameter mm	Wall Thickness mm						
		A	Sch.40	BC	Sch.80		Sch.120	Sch.160
			B,BB,SB		C,CC	SC	SD	SE
6	10.5			1.0		2.4		
10	17.3			1.0		3.2		
15	21.7	2.8	2.8		3.7	3.7		4.7
20	27.2	2.8	2.9		3.9	3.9		5.5
25	34.0	3.2	3.4		4.5	4.5		6.4
32	42.7	3.5	3.6		4.9	4.9		6.4
40	48.6	3.5	3.7		5.1	5.1		7.1
50	60.5	3.8	3.9		5.5	5.5		8.7
65	76.3	4.2	5.2		7.0	7.0		9.5
80	89.1	4.2	5.5		7.6	7.6		11.1
100	114.3	4.5	6.0		8.6	8.6	11.1	
125	139.8	4.5	6.6		9.5	9.5	12.7	
150	165.2	5.0	7.1		11.0	11.0	14.3	
200	216.3	5.8	8.2		12.7	12.7	18.2	
250	267.4	6.6	9.3			15.1	21.4	
300	318.5	6.9	10.3			17.4	25.4	

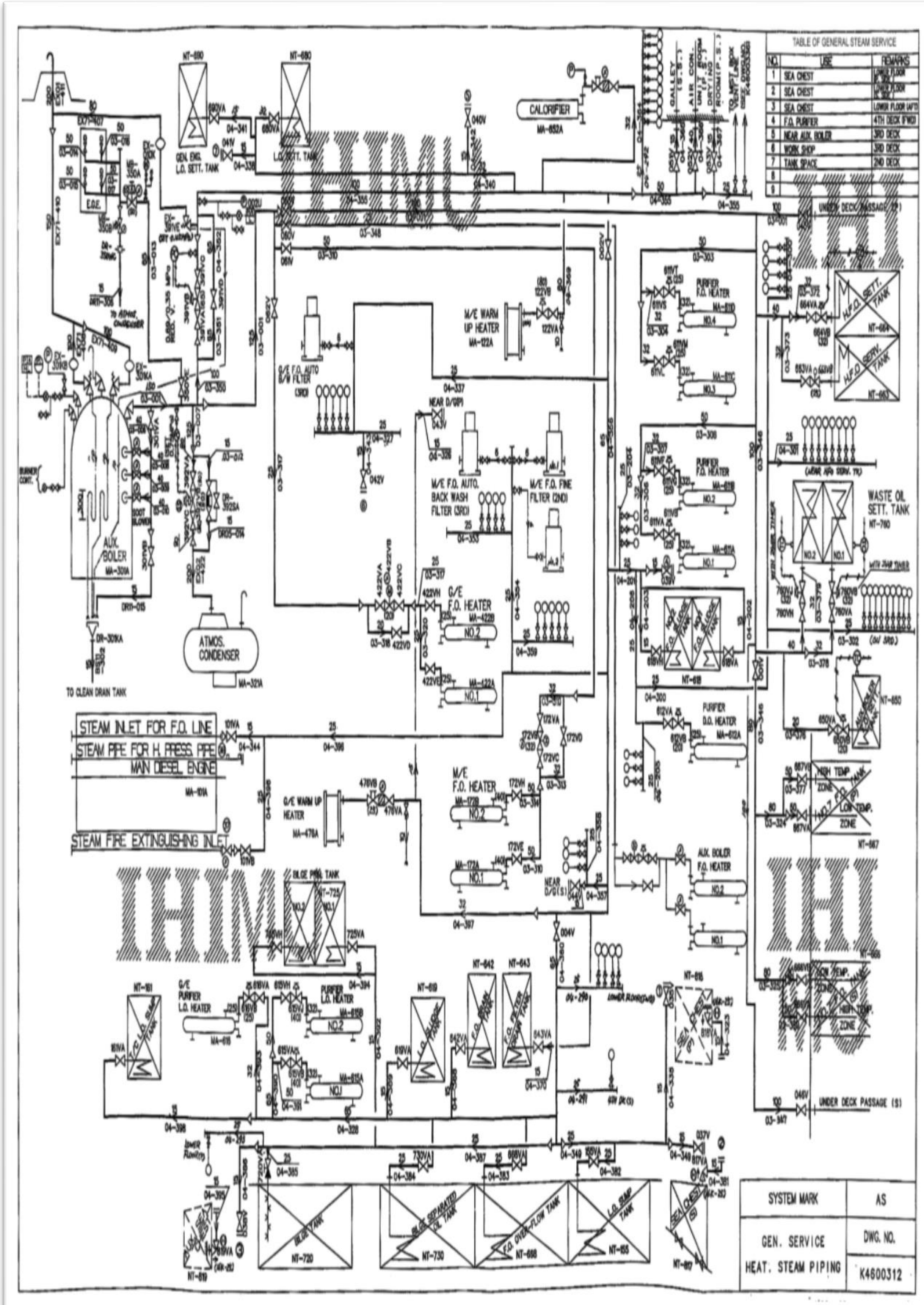
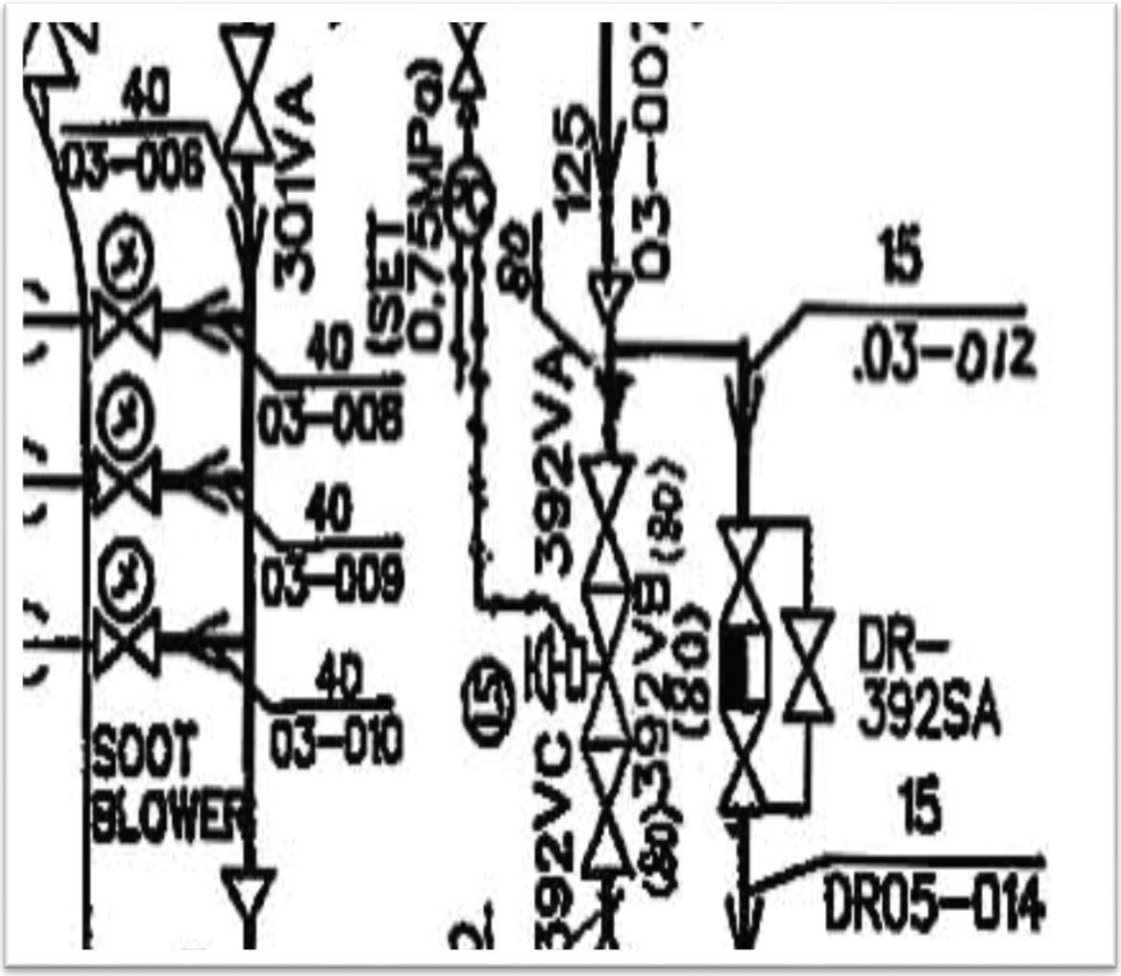


TABLE OF GENERAL STEAM SERVICE
NO.
USE
REMARKS
SEA CHEST
F.O. PURIFIER
WORK SHOP
TANK SPACE
3RD DECK
2ND DECK
CALORIFIER
L.O. SETT. TANK
M/E WARM UP HEATER
PURIFIER F.O. HEATER
G/E F.O. AUTO B/W FILTER
M/E F.O. AUTO. BACK WASH FILTER (3RD)
M/E F.O. FINE FILTER (2ND)
AUX. BOILER
ATMOS. CONDENSER
G/E F.O. HEATER
WASTE OIL SETT. TANK
TO CLEAN DRAIN TANK
STEAM INLET FOR F.O. LINE
STEAM PIPE FOR H. PRESS. PIPE
MAIN DIESEL ENGINE
STEAM FIRE EXTINGUISHING INLET
G/E WARM UP HEATER
M/E F.O. HEATER
PURIFIER D.O. HEATER
AUX. BOILER F.O. HEATER
HIGH TEMP. ZONE
LOW TEMP. ZONE
G/E PURIFIER L.O. HEATER
PURIFIER L.O. HEATER
UNDER DECK PASSAGE (S)
BILGE TANK
BILGE SEPARATED OIL TANK
F.O. OVERFLOW TANK
L.O. SUMP TANK
SEA CHEST
SYSTEM MARK
AS
GEN. SERVICE
HEAT. STEAM PIPING
DWG. NO.
K4600312

System mark & number System	Max. Work press. & temp. MPa×℃	Hyd. test press. MPa	Nominal dia. range Mm	Pipe Material	Pipe Thick	Pipe treatment	Standard pipe joint Press. & Type	Standard pipe joint Material	Valve Press. & Type	Valve Material Body	Valve Material Trim	Gasket	Bolt & Nut	Insulation	Pipe branch connection	Remarks
AS 03 DR 03 0.69 MPa STEAM AND DRAIN (TO DRAIN TRAP)	0.69 (Safety valve set press. 0.79) × 169.6℃ [NK-II]	W:1.19 *9	350 & over	AS 03 Electric resistance welded steel	AS 03 Sch40 (B)	X3 for 100 & over	JIS 10K Flange (*2)	Rolled steel SS 400	JIS 10K Flange	Cast steel SC 480	13% Cr. Stainless steel	Non asbestos spiral wound gasket with outer ring	Carbon steel Bolt stud: S45C Nut: S35C	Moulded glass wool Symbol D2	Welded pipe branch	AS03-B(3) DR03-C(3)
			50-300	STPG 370-E	DR 03					Cast iron FC 200						
			15-40	DR 03 Seamless steel STPG 370-S	Sch 40 (BB)				JIS 16K Flange	Bronze BC 6	Bronze or Brass					
AS 04 DR 04 0.35 MPa STEAM AND DRAIN (TO DRAIN TRAP)	0.35 (Safety valve set press. 0.45) × 147.2℃	W:0.68 *9 (except EX line)	550 & over	Welded steel STPY400	7.9mm (EB)		JIS 10K Flange (*2)	Rolled steel SS 400	JIS 10K Flange	Cast iron FC 200	13% Cr. Stainless steel	Non asbestos spiral wound gasket with outer ring	Carbon steel Bolt stud: S45C Nut: S35C	Moulded glass wool Symbol F for AS04 DR04 D2 for EX02	Welded pipe branch	C, (3)
			50-500	AS 04 EX 02 Electric resistance welded steel	AS 04 EX 02 (A)											
			15-40	SGP-E (*11)					JIS 16K Flange	Bronze BC 6	Bronze or Brass					
EX 02 STEAM EXHAUST				DR 04 Seamless Steel STPG 370-S	DR 04 Sch40 (BB)		JIS 5K Flange (*2)		JIS 5K Flange			Heat-oil resisting Non asbestos	Rolled steel SS 400			
DR 05 EX 01 ALL DRAIN AFTER STEAM TRAP, ESCAPE LINE FROM STEAM SAFETY V. & RELIEF V.	Below 0.2		550 & over	Welded steel STPY400	7.9mm (EB)		JIS 5K Flange (*2)	Rolled steel SS 400	JIS 5K Flange	Cast iron FC 200	13% Cr. Stainless steel	Heat-oil resisting Non asbestos	Rolled steel SS 400	Glass cloth Symbol M	Welded pipe branch	Where easily touched by the hand is to be insulated with glass cloth C, (3)
			50-500	EX 01 Electric resistance welded steel	EX 01 (A)											
			15-40	SGP-E (*11)						Bronze BC 6	Bronze or Brass					
				DR 05 Seamless Steel STPG 370-S	DR 05 Sch40 (BB)											

Item	Symbols	Name		Remarks
Standard valves		Valve	(globe & angle) ①	Flange Bat Welded Screw Union
		Screw down check valve	(globe & angle) ①	
		Swing check valve	(globe & angle) ①	
		Swing check valve with handle	(globe & angle) ⑤	
		Lift check valve	(globe & angle) ①	
		Foot valve	②	
		Cock	①	
		3-way cock	(T & L type)	①
		Gate valve		①
		Hose valve	(globe & angle)	②
		Non return hose valve	(globe & angle)	②
		Butterfly valve		⑤
		Storm valve	(vertical : ○, horizontal : ◎)	⑤
		Storm valve with handle	(vertical : ○, horizontal : ◎)	⑤
		Storm valve 135°		⑤
		Valve manifold		②
		Diaphram valve		④



SYSTEM MARK	AS
GEN. SERVICE	DWG. NO.
HEAT. STEAM PIPING	K4600312

12.4 DIMENSIONS AND MATERIALS OF PIPES

12.4.1 Steel Pipes

Dimensions

Nominal Diameter mm	Outside Diameter mm	Wall Thickness mm					
		A	Sch.40	BC	Sch.80	Sch.120	Sch.160
			B,BB,SB		C,CC	SC	SD	SE
6	10.5			1.0		2.4		
10	17.3			1.0		3.2		
15	21.7	2.8	2.8		3.7	3.7		4.7
20	27.2	2.8	2.9		3.9	3.9		5.5
25	34.0	3.2	3.4		4.5	4.5		6.4
32	42.7	3.5	3.6		4.9	4.9		6.4
40	48.6	3.5	3.7		5.1	5.1		7.1
50	60.5	3.8	3.9		5.5	5.5		8.7
65	76.3	4.2	5.2		7.0	7.0		9.5
80	89.1	4.2	5.5		7.6	7.6		11.1
100	114.3	4.5	6.0		8.6	8.6	11.1	
125	139.8	4.5	6.6		9.5	9.5	12.7	
150	165.2	5.0	7.1		11.0	11.0	14.3	
200	216.3	5.8	8.2		12.7	12.7	18.2	
250	267.4	6.6	9.3			15.1	21.4	
300	318.5	6.9	10.3			17.4	25.4	

Notes:

1

Combined Material & Thickness Symbol		JIS Material Designation
A	.....	SGP-E or SGP-B
B,C	.....	STPG370E
BB, CC	.....	STPG370S
SB, SC, SD, SE	.....	STPT370S
EB, EC, ED	.....	STPY400

2 Unless otherwise mentioned above:

1) Wherever B is specified, EC shall be used for nominal diameter of 300 mm and above.

2) Wherever C is specified, ED shall be used for nominal diameter of 250 mm and above.

3) Wherever A is specified, EB shall be used for nominal diameter of 550 mm and above.

4) Wherever SGP-E is specified, SGP-B shall be used for nominal diameter of 100 mm and below.

3 JIS Material Designations mentioned above are:

1) SGP-E, STPG370E and STPY400 are electric welded seam pipes.

2) SGP-B are butt welding pipes.

3) STPG370S and STPT370S are seamless pipes.

(2)PIPE TREATMANT MARK

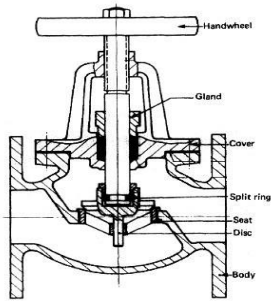
MARK	PIPE TREATMENT	MARK	PIPE TREATMENT	
A	Insulation (401≦t<515℃)	G	Galvanization	
B	Do. (t≧301℃)	G3	Parkerizing	
C	Do. (t≧205℃)	L	Synthetic rubber lining	
D1	Do. (t≧185℃)	L2	Polyethylene lining	
D2	Do. (t≧155℃)	L3	Tar epoxy coating	
F	Do. (t≧101℃)	P	Acid pickling and VPI filled	
I,L	Do. (t≧ 60℃)	S	Acid pickling and oil cost	
J	Tracer & adjacent pipe	T	Anti corrosive painting	
K	Insulation for M/E exh. pipe	W	Water pressure test (Shop without class)	
	Insulation for D/G exh. pipe	W3	Water pressure test (On board)	
M	Open drain & other pipes	X	Non destructive test	ALL
R	Insulation for I.G pipe	X3	(Radiograph test)	Sample
R1	Insulation for up-tank	Y	Stress relieving	
Z	Non treatment & other treatment	WO	water pressure test (Shop with class)	

Different type valves for ships use

Valves are provided in a piping system to regulate or stop the liquid flow. Various types exist in a machinery space with their associated particular function or advantages.

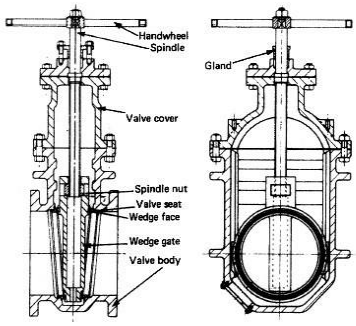
Globe valve

A globe valve has a somewhat spherical body enclosing the valve seat and valve disc. Flanges are provided at either side for connecting to adjacent pipe work, and internal passages guide the liquid flow through the valve seat. Liquid flow is always arranged to come from below the valve seat so that the upper chamber is not pressurized when the valve is closed. A screw lift valve arrangement is shown where the spindle is joined to the valve disc. A gland with appropriate packing surrounds the spindle where it leaves the valve bonnet. The upper part of the spindle is threaded and passes through a similarly threaded bridge piece.



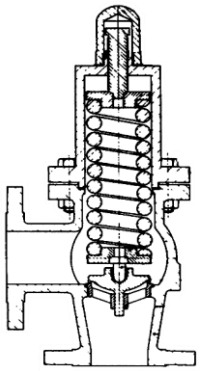
Gate valve

A gate valve should be fully open or closed; it is not suitable for flow control. When open it provides a clear full-bore internal passage for the liquid since the valve or gate is raised clear. The spindle is threaded over its lower portion and when turned causes the gate to raise or lower. The gate may be parallel or wedge-shaped in section fitting against a matching seat. Larger valves have replaceable seat rings and gate facings.



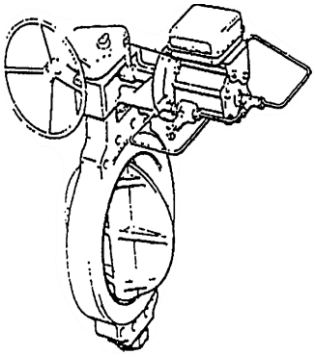
Relief valves

Excess pressure is avoided in pipe systems by the use of relief valves. The valve disc is held closed by a spring arrangement on the stem. The spring compression can be adjusted to enable the valve to open at the appropriate pressure.



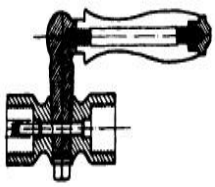
Butterfly Valves

The Butterfly Valves are the most common type of valve being used for automatic operation. Full open and full shut operation requires minimal movement .Most commonly used type on tanker vessels because of its ease in operation. However, a big part of the disk restricts flow even when full open.



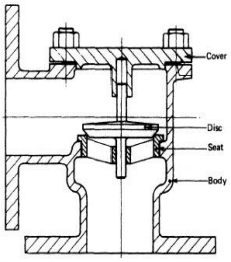
Cock

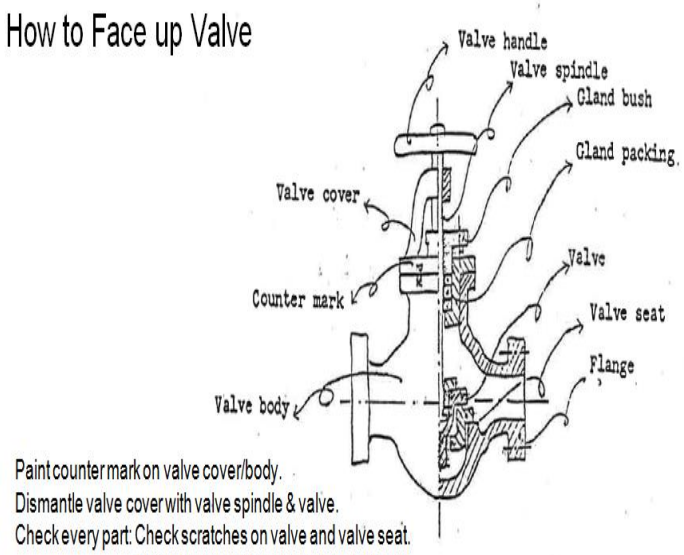
A cock is used in small-bore pipe work and is joined to adjacent pipe work by a compression coupling. A cock can restrict or close an internal passage by moving central plug, usually by an external lever. An example of a straight-through cock below:



Non-return valves

Non-return or check valves are arranged in various pipelines to prevent reverse flow. Where the valve disc is not attached to the spindle it is known as screw-down non-return (SDNR). The valve disc in such a valve must have some form of guide or wings to ensure it can reseat correctly when screwed closed. Non-return valves are sometimes arranged without spindles, in which case they are liquid operated and cannot be manually closed. A free lifting valve may be used or a hinged flap.





1. Paint counter mark on valve cover/body.
2. Dismantle valve cover with valve spindle & valve.
3. Check every part: Check scratches on valve and valve seat.
   Check clearance between valve-leg/seat.
   Check corrosion or abrasion on spindle.
4. Use "Seat Cutter" for Big scratch.
1. Use "Emery cloth" for tiny scratch.
2. Use "Lathe" to skim valve.
3. Finally face up valve/valve seat with Carborundum.
   Keep clean of valve-leg while facing up.