



## ENGINE MAINTENANCE FOR RATING

### 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.



**1.2** The senior officers shall have a tool box meeting to discuss & plan the assigned jobs prior commencement of days 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. Emphasize 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
- k. Discuss Near-miss.



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.

### 1.3 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.

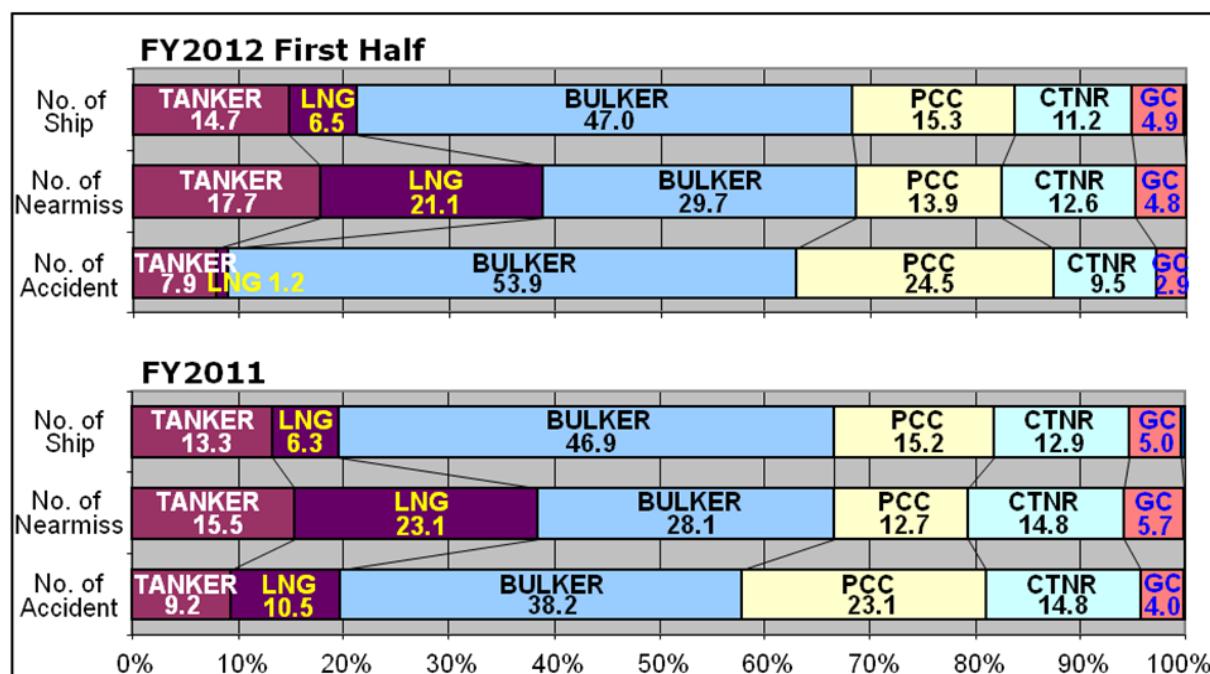


Figure: Comparison of ship type to the number of near misses and accidents



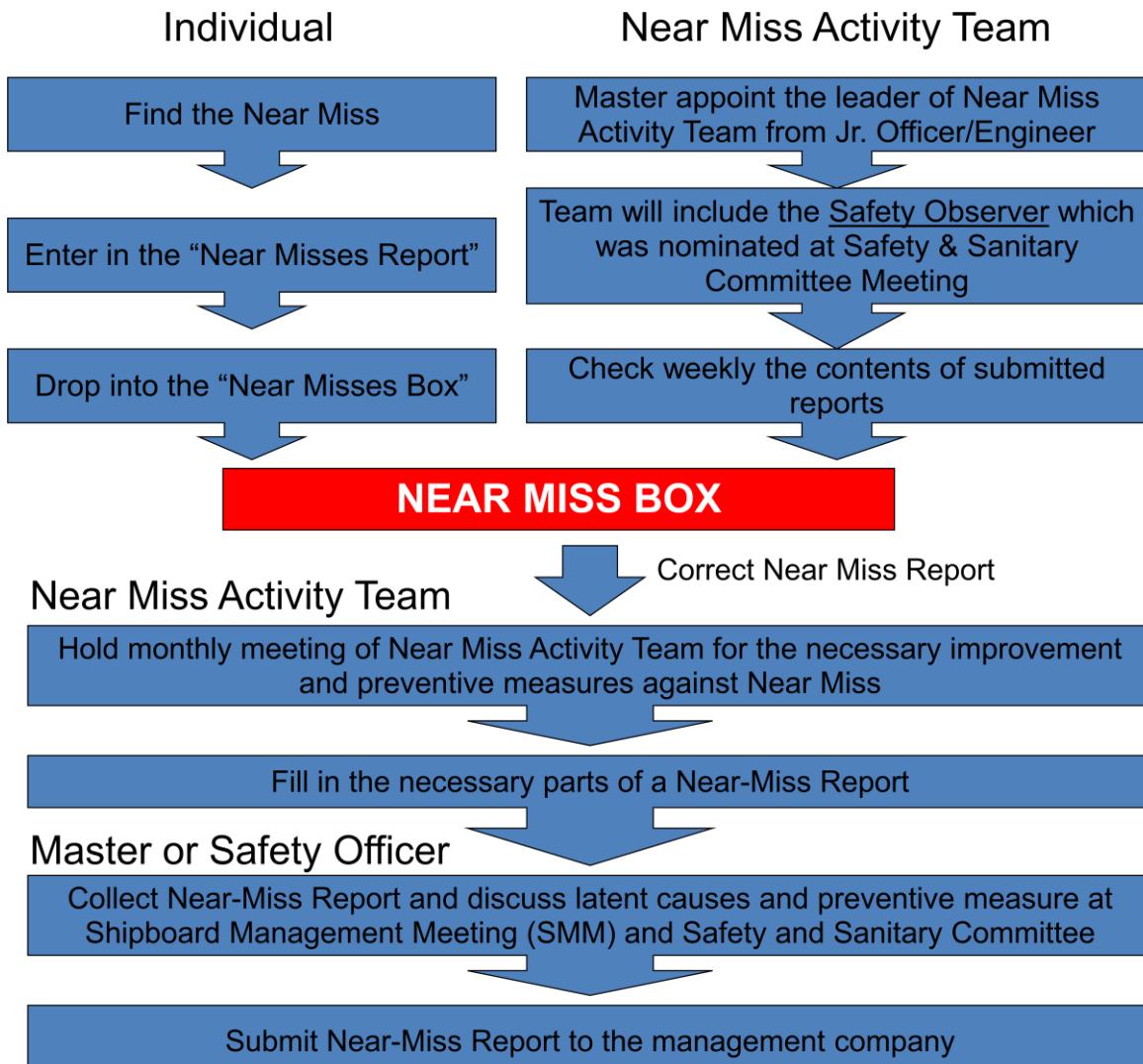
Examples of near miss that can be encountered on board while working:

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:

## Outline of the Reporting (1/2)





The flow chart below shows a sample flow for reporting:

### Find & Report

While entering port coaming plug was not plugged.



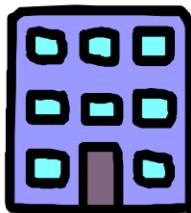
### Near Miss Activity Team

#### Considering Cause

- Incomplete preparation while entering port
- Person in charge for the job was not designated.
- Lack of knowledge to understand the importance of the coaming plug



### Management Company



### Safety Officer

#### Corrective Action

- Appoint person in charge
- Explain the importance of coaming plug
- Distinguish coaming plug using bright color

## 1.4 Proper reporting to duty Engineer

The Engine rating has an obligation not to disclose any information to the duty engineer and must avoid uses such information to the disadvantage of the engine room team. Professional Conduct provides that failure to report a situation that an engine rating believes may endanger the safety or welfare of the vessel would constitute professional misconduct.

Engine ratings are encouraged to raise their concerns internally with the duty engineer in an open and forthright manner before reporting the situation to the chief engineer. Although there may be situations to challenge the skills and knowledge of a rating, engine rating should first attempt to resolve problems themselves if the situation is only minimal.



If the engine rating assess the situation and not possible immediately report to the duty engineer without hesitation. Report the condition of all running machineries to the duty engineer every time the engine rating carried out routine inspection in engine room.

### 1.5 KYT (Kiken Yochi Training)

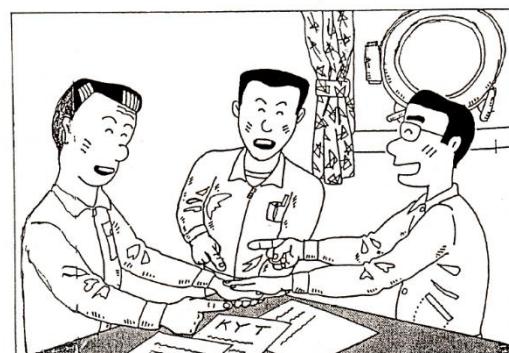
#### The Hazard Recognition Training (KYT) Concept

##### 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.

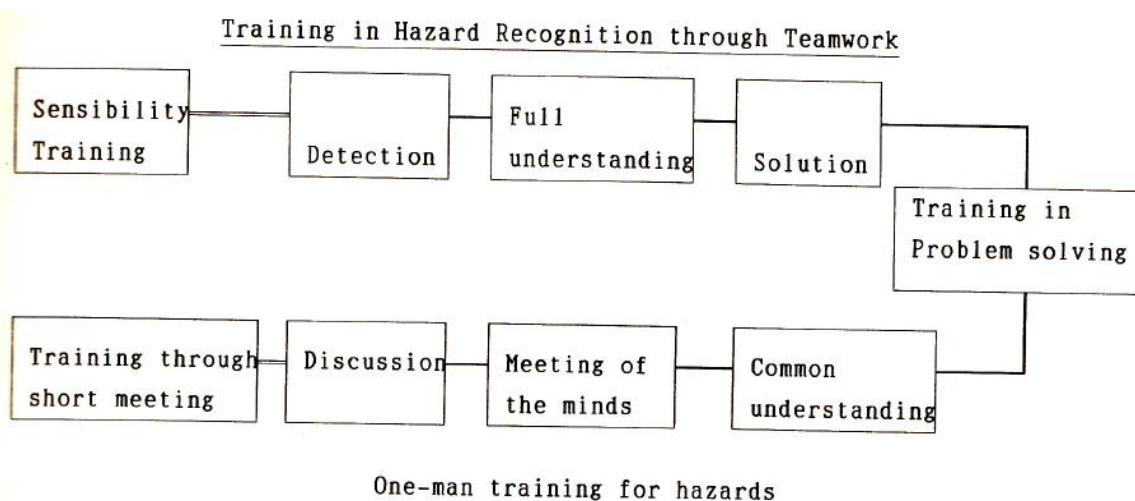
The following three types of training are involved.

1. Sensibility Training
2. Training through Short meetings
3. Training in Problem solving.



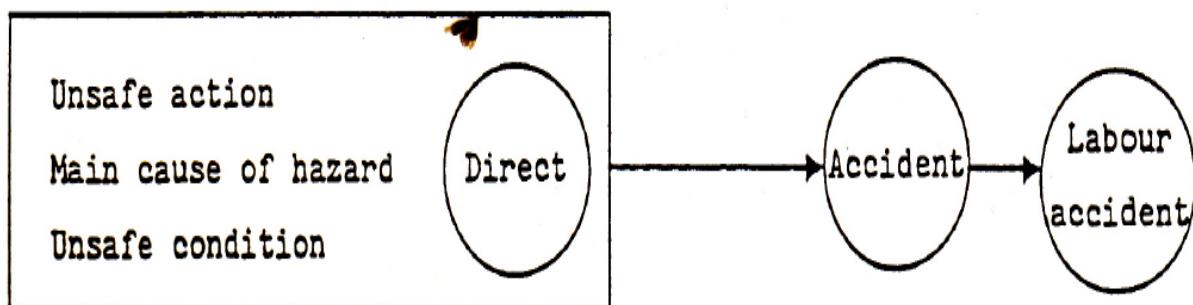


The following diagram illustrates the relationship among these three types.



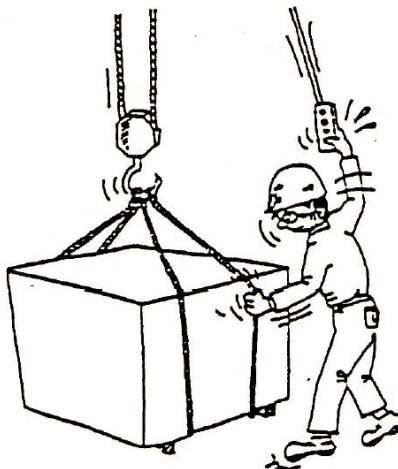
#### Ten Rules for the Leader Implementing KYT

- Draw up a Training Plan
- Cut Down on the Lecture Time
- The First Requirement is to uncover the Causes of the Hazards.
- Reducing the Range
- Decisive Elimination of Important Hazards
- Do not Overlook Dangerous Points
- Do not Limit the Scope to Unsafe Actions Only
- Use four Rounds as required.
- Narrow Down and Finger Pointing and Call
- Proceed with Clarity and Ease





### Examples of Unsafe Condition:



## 2. PROPER USE OF TOOLS AND MEASURING INSTRUMENT

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.

## Kind of Tools

**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 tool.



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 Measurement

### For Torque Wrench:

$$1 \text{ N}\cdot\text{m} (\text{Newton metre}) = 0.102 \text{ kgf}\cdot\text{m} (\text{kilogram-force meter})$$

### Pressure Conversion:

$$1 \text{ Pa (pascal)} = 1 \text{ N/m}^2 (\text{newton per square meter})$$



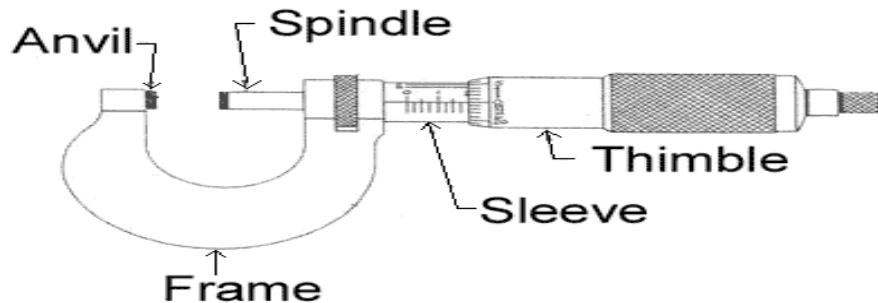
## 1 Bar

100 000 Pa (pascal)
0.1 MPa (megapascal)
1.019 kgf/cm <sup>2</sup> (kilogram-force per square centimeter)
14.503 psi (pound per square inch)
0.986 atm (atmosphere)

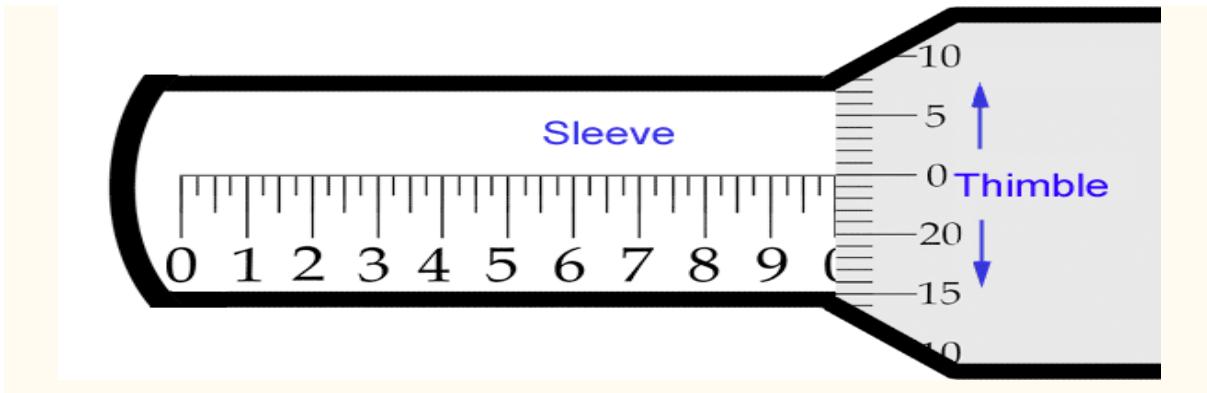
## Proper use of measuring Instrument

### Micrometer

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

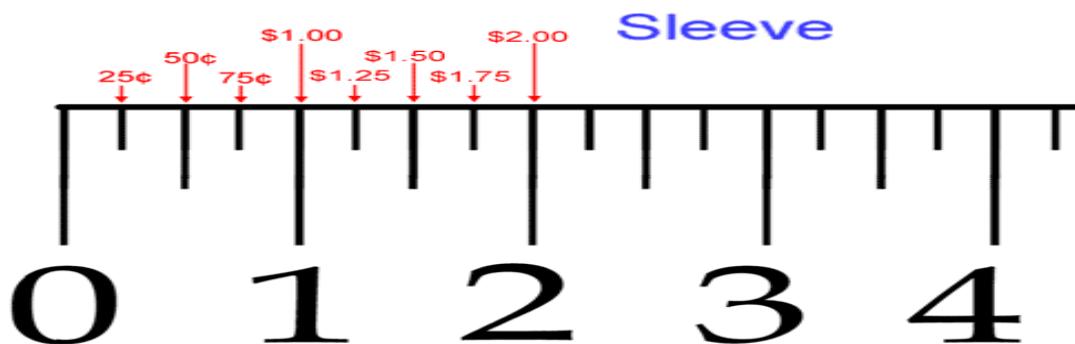


To learn to read the mike you need to understand the **Thimble** and the **Sleeve**. Here we are going to learn to read the micrometer by figuring out the markings on the Thimble and the Sleeve.

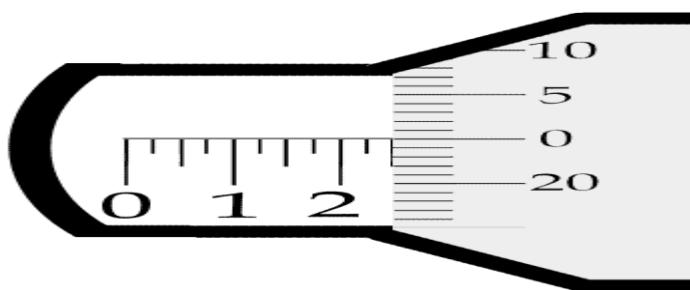
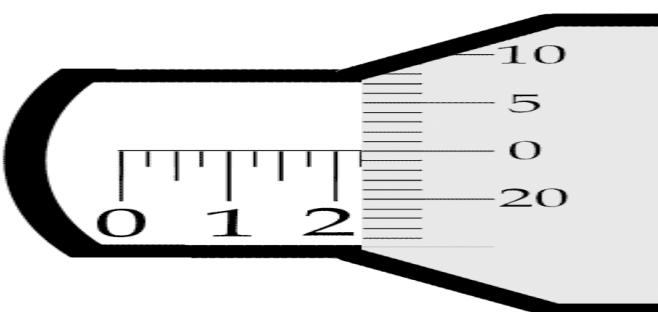
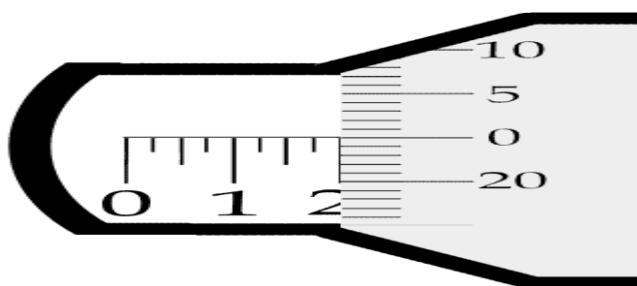


The sleeve does not move it looks like a ruler with ten numbers; the space between each is divided into quarters, as the thimble rotates around this sleeve it covers up or reveals the number marked on the sleeve.

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 vernier scale. (10mm on the fixed caliper)      0-mark on



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)      of the 0-

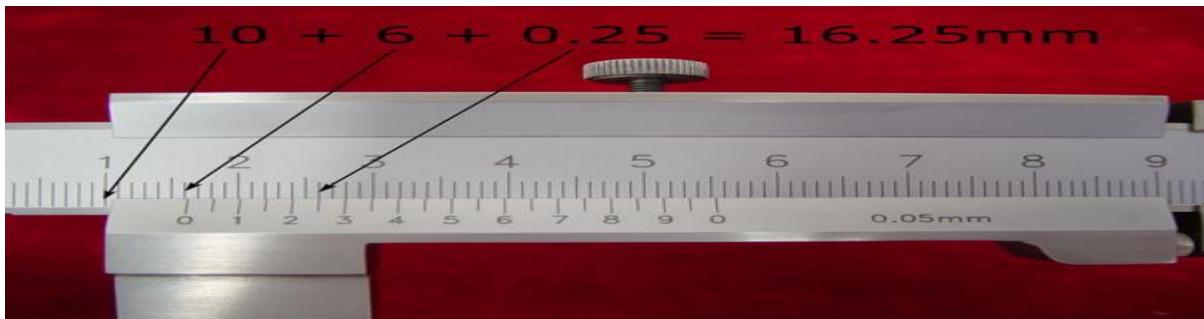


Look along the ten marks on the vernier scale and the millimeter marks on the adjacent

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

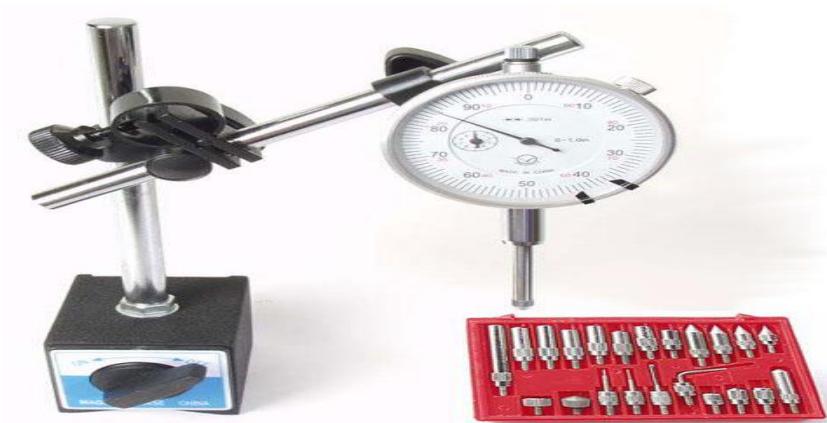


To get the correct reading, simply add this found digit to your previous reading. ( $10\text{mm} + 6\text{mm} + 0.25\text{mm} = 16.25\text{ mm}$ )



## 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.



## 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.

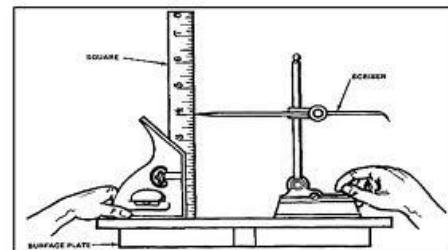
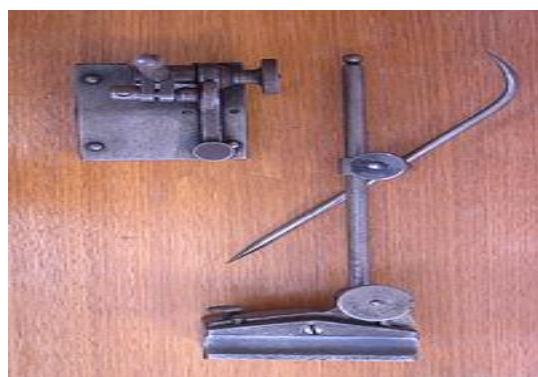


Figure 1-13: Setting surface gage scriber on surface plate 2.

## Scriber

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



## Divider

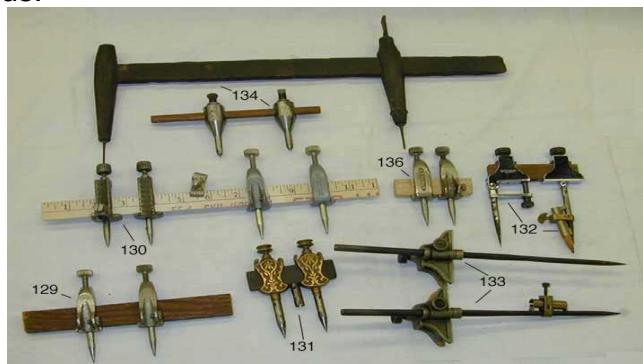


The most common spring type dividers are used for scribing larger arcs and circles of about 12 inch or less.



### Trammel

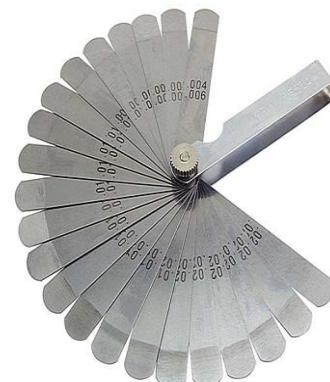
This is used for scribing larger arcs and circles because of its sliding and adjustable heads.



### 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.



## 3. TOOLS THAT ARE COMMONLY USE IN 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.

### 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



NYK Maritime College



NYK SHIPMANAGEMENT

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.



### Water Pump Pliers

It is designed primarily for gripping objects by using leverage. These pliers are designed 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



### Side- cutting Pliers

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



### Hand Snip

A tools which use 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.



### 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.



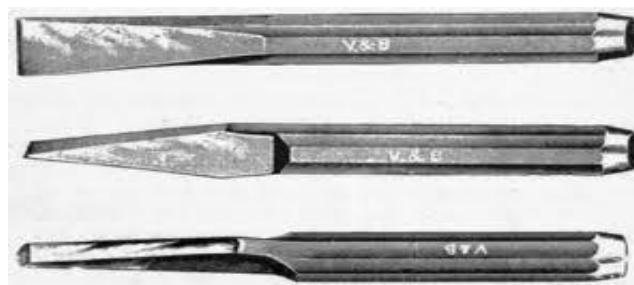
### Hammer/ Lead Hammer

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



### 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.



## 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.



## 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.



## 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.



### 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,
  - which makes inserting the tool easier, and also tends to help keep the screw on the tool tip without the user needing to hold it there.



- 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 through a hard wooden handle the end is reinforced with a large nut that permits hammering.



### 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



### Chain Hoist

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





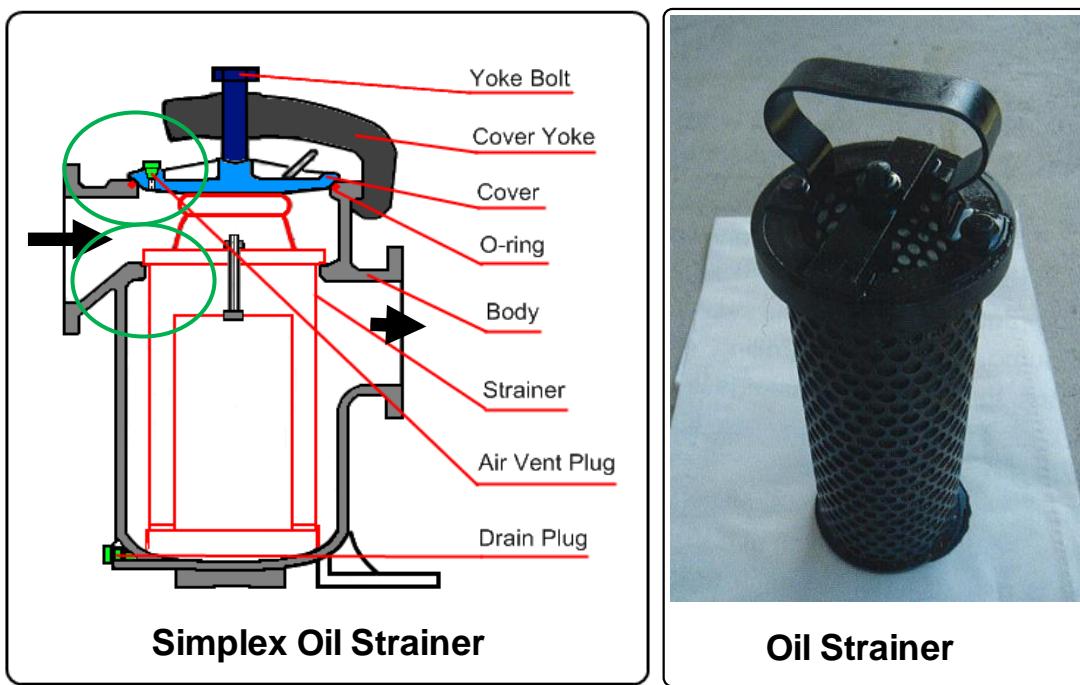
## 4. GENERAL WORKS IN ENGINE ROOM

### 4.1 Maintenance for filters and strainers ( with JOB CARD )

Cleaning of filter strainer is the common task in the engine room while on daily routine maintenance or during a watch. It is very important that one's knew the type of fluid (liquid or gas) is running in the system and its conditions before attempting to open any filter device onboard.

Filters are commonly connected to the fuel oil, lube oil, sea water, fresh water, air and bilge system.

There are various types of filters are used onboard and precautionary measures are required when operating and maintenance.



Various strainers, differing in size, shape and structure, that used in engine room such as F.O, L.O, and sea water lines are subject for periodical cleaning and after cleaning must check the following items:

#### Auto Back Wash Filter

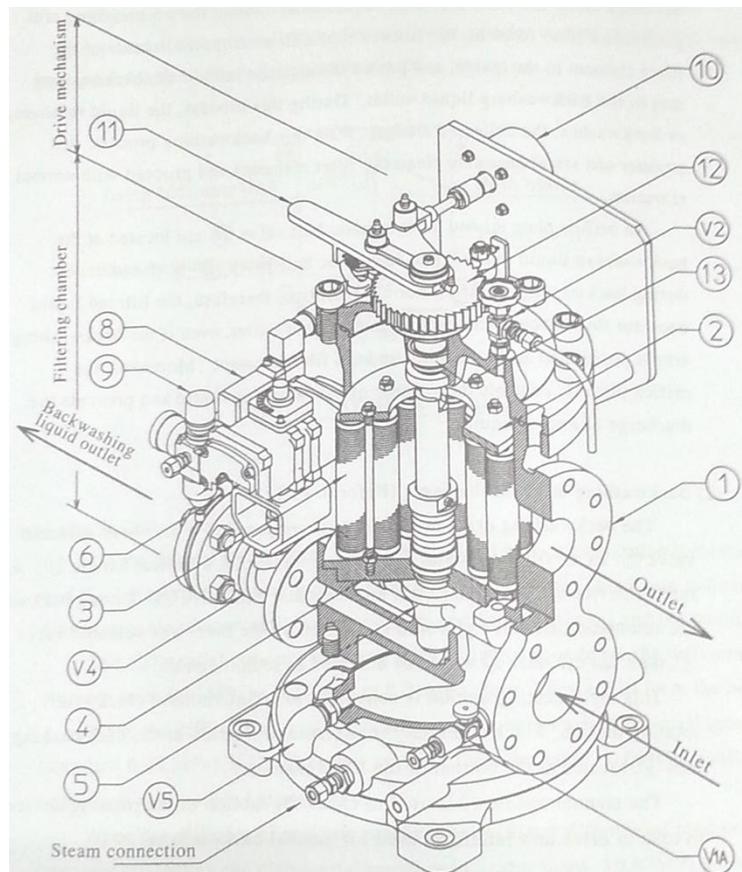
This filter has a self-cleaning function for the filter elements, using automatic backwashing without interruption of oil supply. During backwashing, sludge caught on the filter elements is discharged by the intermittent and partial reverse flow of filtered liquid. This helps maintain the normal performances of the filter elements.

The strainer adopts a combined timer and differential pressure control system, in which backwashing is performed at certain intervals according to the setting of the



timer, but backwashing may begin before these preset times whenever the differential pressure between the inlet and the outlet of the strainer reaches a specified value.

The filter elements are made of stainless steel wire mesh, are fabricated in an optimum shape for filtration and backwashing and are also sturdy and anti-corrosive. Foreign matters, like sludge, caught on the filtering element are easily removed by backwashing or air blowing during overhaul. For these reasons, replacement of the filter elements is not necessary, and their durability is almost permanent unless they are physically damaged.



## 4.2 Cleaning of Heat Exchangers

Marine heat exchangers play an important role of removing the heat produced by a running machinery to ensure smooth functioning of the equipment. It is also necessary to enhance the heat exchanging ability which would reduce after certain amount of time of operation.

The cooling medium used in the heat exchanger depends on the medium used, including other factors. Along with mediums such as fresh water, air and oil, sea water is also used abundantly in marine heat exchangers as an important cooling source. However, because of the presence of dissolved salts in sea water, corrosion and scale deposits is a common condition in heat exchangers. Maintenance of marine heat exchangers is therefore necessary at regular intervals of time to prevent reduction of heat transfer or failure of equipment.

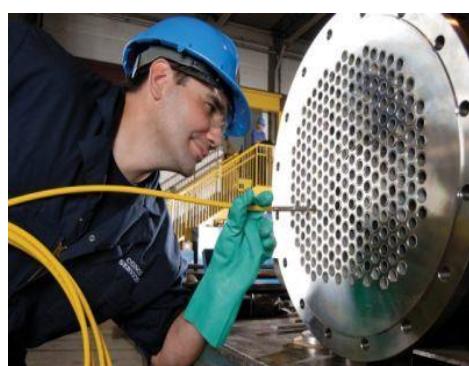


The method of maintenance used depends on the type of heat exchanger and type of deposits, but the general aim of every heat exchanger maintenance procedure remains the same cleaning of heat transfer surfaces to prevent any kind of obstruction in the flow process. The main reason for fouling of heat exchanger surface is the increase in temperature difference between the two fluids and change in pressure. But it is the sea water side of the heat exchanger which suffers the most as a result of corrosion and scale deposits.

### Methods of marine heat exchanger maintenance

Note: Prior to Maintenance, isolate the heat exchanger by shutting off the line valves for both medium and media; and drain the remaining liquid using the drain cock. The Vent must be open to ensure everything is drained from the heat exchanger.

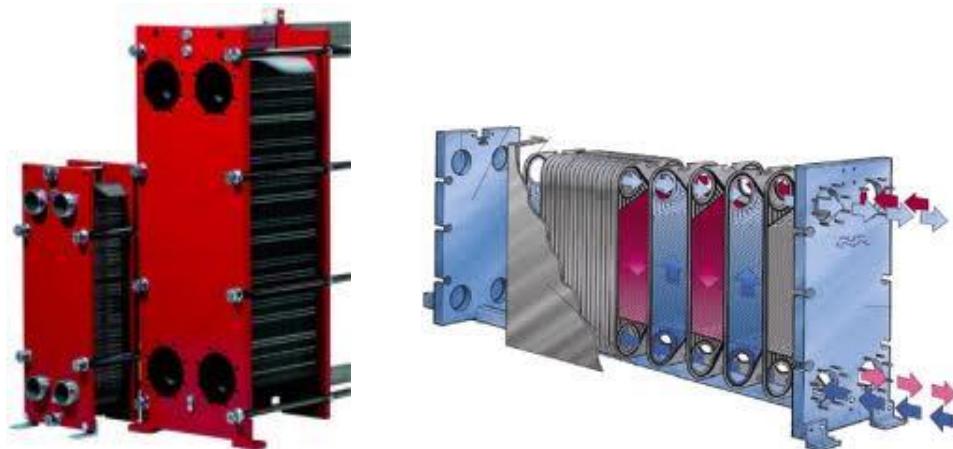
- If the deposits on the heat exchanger are not so hard, then they can be removed using a wire brush.
- If the deposits are stubborn, chemical cleaning should be used by emersion of the part using chemical solution.
- Depending on the type of the heat exchanger, there are tools provided by the manufacturers for the cleaning purpose. For e.g. there are special tools for cleaning shell and tube type heat exchangers.





- Once the cleaning is done, the heat exchanger must be flushed with fresh water to remove any remaining chemical or dirt from the surface.
- In sea water cooled heat exchanger, anodes are fitted on the cover to prevent it from galvanic corrosion. Anodes must be checked and changed if required.
- Always renew the cover gasket if it is damaged during opening of heat exchanger.
- In oil coolers and heaters, fouling can take place on the outside of the tubes as well. This can be removed by chemical flushing.

In plate type heat exchangers, the stack of plates is removed to expose the surface. The plate surface is then cleaned with brush or by the methods suggested by the manufacturer. (Sharp tools should be avoided). Cleaning should be done in such a way that it does not damage the plate seals. However, if a replacement of the seal is necessary, it must be done before putting the plates back.



While tightening the plates together, care must be taken for even tightening of all the exchanger studs and bolts or else leak will occur.

Excessive corrosion of the heat exchanger surface can also lead to perforation of the surface, resulting in mixing of one liquid with another. Minor leakage detection is not easy especially when the header tanks are automatically topped or if there is no proper manual record maintained. However, major leakages can be easily detected as a result of sudden loss of lubricating oil or jacket water. Low level alarms are also useful in detecting major leaks.

Another way to prevent mixing of two liquids because of perforation is by keeping the sea water at a pressure lower than the jacket water or any other liquid used. This reduces the risk of sea water entering into other mediums.

#### 4.3 Overhauling of pumps: 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.

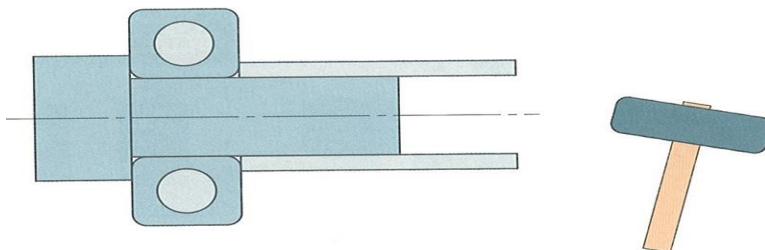
Place disassembled part in order, sorting it in group.





## Proper Procedure for Installation and Removal of Ball Bearing

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

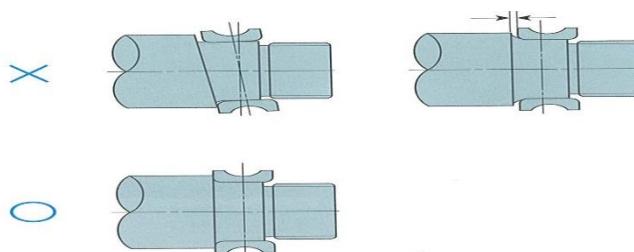


(1) When any intrusion in both inner and outer ring housing, and a small size bearing mounted gradual tapping is necessary in removing the bearing.

(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 of the 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.

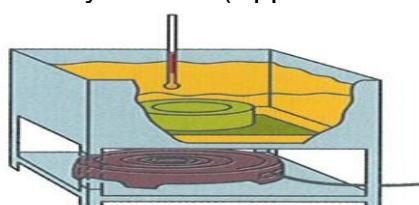


### Shrink Fitting

(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.)

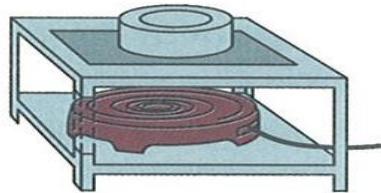
(2) Make the end face of the inner ring of bearing come in close contact with the shaft until both bearing are sufficiently cooled. (Applicable only to open type bearing)



Reminder:

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

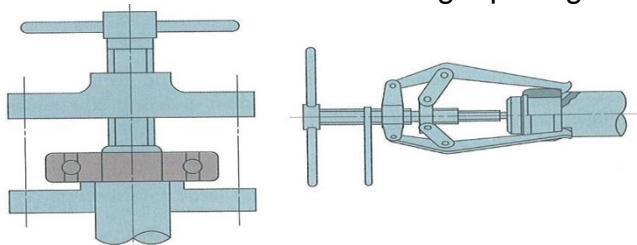
In the case of fitting seal bearing with large interference, put the bearing on a steel plate and heat up at the bottom.



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

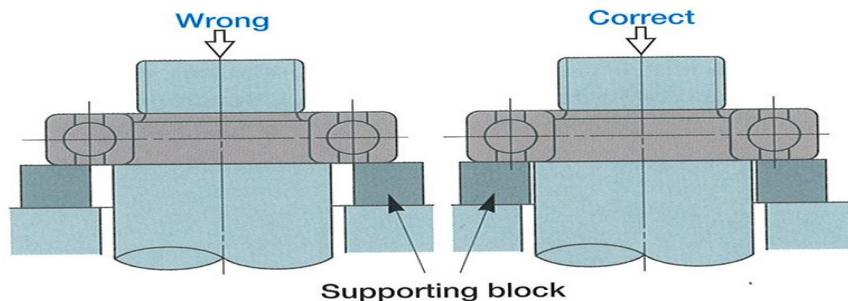
### Extraction of Bearing

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

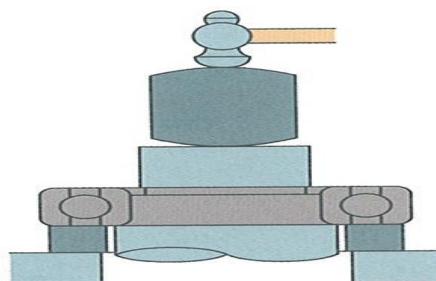


### Removal by a Hand press

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

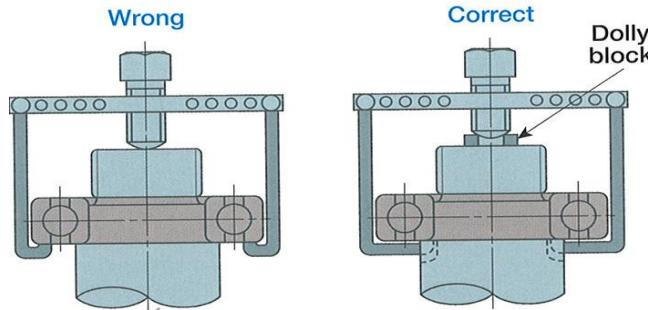


To remove by using a hammer, be sure to use a dolly block to avoid damaging the shaft.

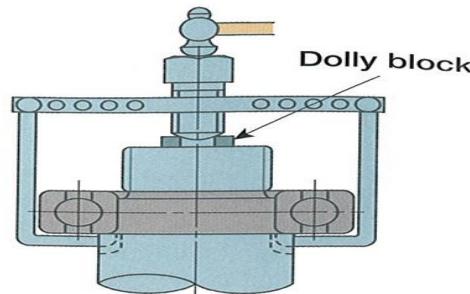


### Removal Using a Puller

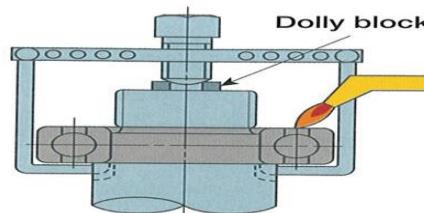
To remove a bearing from a shaft set the puller with the claw on the inner ring.



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.

## Bearings

Bearing is a device that permits constrained relative motion between two parts either in rotation or in linear movement. Bearings are broadly classified according to the motion they allow and according to their principle of operation. The commonly applied bearings for onboard machineries are the sliding bearings (called "bushes", journal bearings, sleeve bearings, rifle bearings or plain bearings) and the

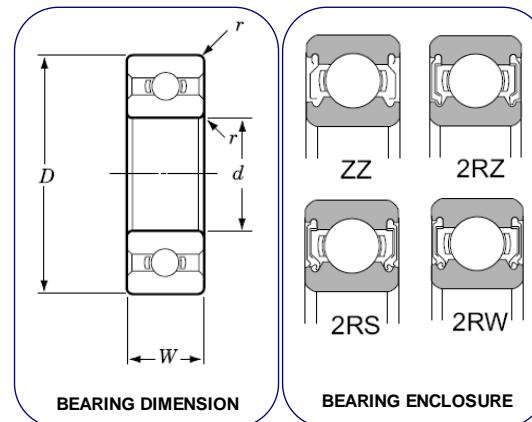


rolling elements bearings (called ball bearings and roller bearings). The sliding bearings are commonly installed in major machineries and mainly supplied by the engine manufacturers.

The ball bearings and roller bearings are usually installed to motors, purifiers and other equipments with rolling elements and they can be acquired from ordinary ship store suppliers.

Ball bearings are typically used to support axial and radial loads, can tolerate some misalignment of the inner and outer races, and mainly used to a low load capacity application.

Roller bearings are used more satisfactory under shock or impact loading than ball bearing.



#### Specifications of commonly used ball bearings in the engine room:

Series 6200ZZ Two-Side Metal Shielded Bearing			
Bearing Number	Dimension mm		
	I.D.	O.D.	Thick
6200ZZ	10	30	9
6201ZZ	12	32	10
6202ZZ	15	35	11
6203ZZ	17	40	12
6204ZZ	20	47	14
6205ZZ	25	52	15
6206ZZ	30	62	16



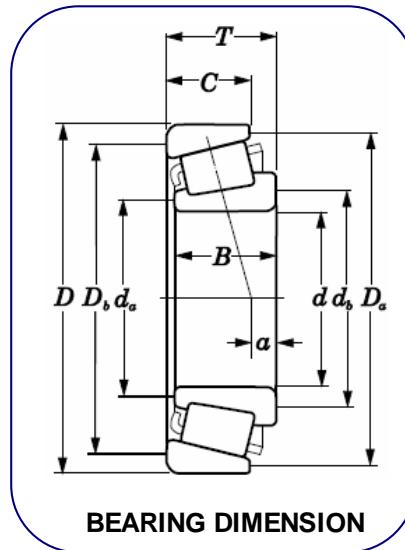
When the end of bearing number is more than 3, the inside diameter of the bearing is calculated by multiplying it to the number 5:

### For Example:

Bearing no. 6204

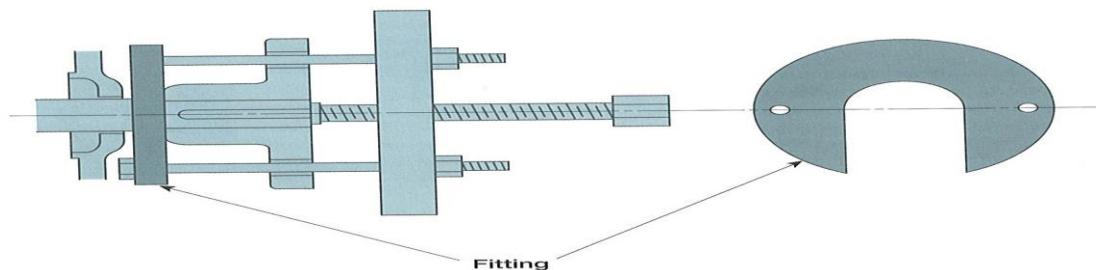
Multiplied by:  $\xrightarrow{\quad} \times 5$

To get the inside diameter = **20 mm.**



### Removing of Coupling

- Because the coupling may crack when directly applied a force by gear puller, It is recommended to prepare a fitting, shown in the figure:



- To prevent the fitting from coming in direct contact with the shaft. Wind a copper, brass or lead plate around the shaft.
- Apply pressure and lightly tapping the head of the push bolt, pull out the coupling slightly.

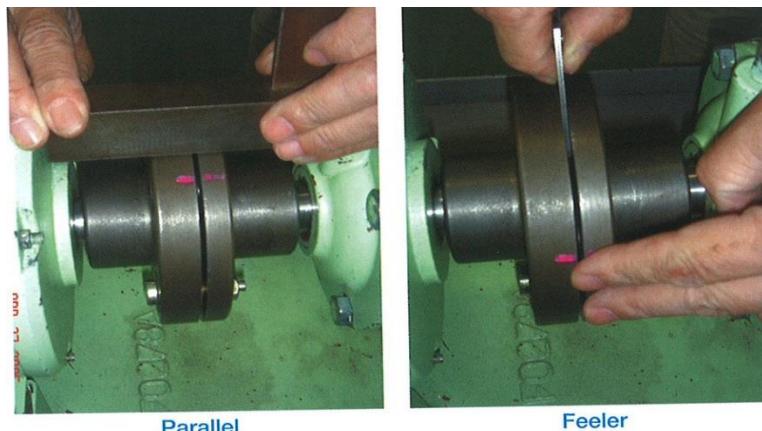
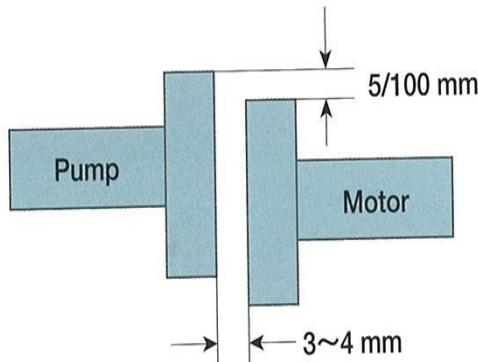


## Proper Alignment of Pump and Motor (Reference: JOB CARD)

### 1. Tolerance limit and alignment

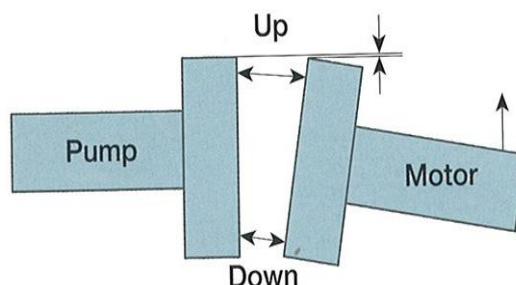
Alignment must be made within 5/100 mm (7/100 to 8/100mm) may be acceptable)

Adjust the clearance between the pump and motor coupling by 3 to 4mm. Basically adjustment shall be made at motor side ,set the coupling with two bolts and rotate vertical and sideways and the allowable difference not more than 5/100mm.



### 2. Clearance of pump and motor coupling

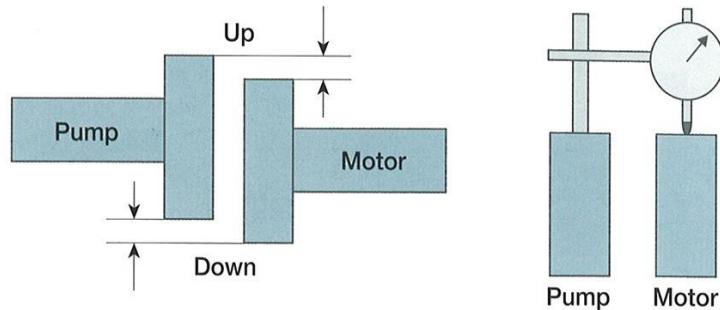
Adjust the clearance of pump and motor coupling on upper and lower side using feeler gauge for adjusting with a liner, insert the liner on the front or rear side of the mating faces. Use the liner of the same thickness on left and right sides; turn the coupling by 180 degrees to measure the clearance.



### 3. Adjustment of the height (measuring instrument: dial gauge)

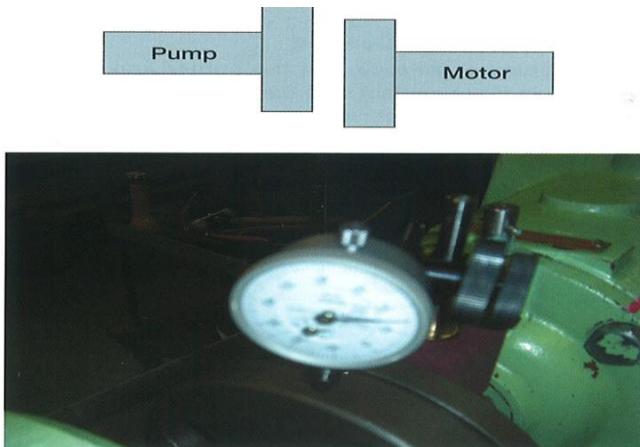


- Mount the dial gauge corresponding to the shape of coupling and other factors.
- In adjustment with liners, insert liners of the same thickness at 4 positions.



#### 4. Adjustment of a miss alignment and clearance

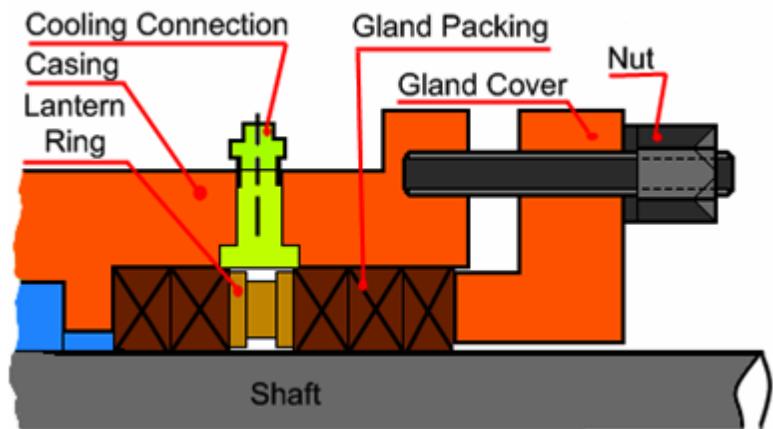
Adjustment of a miss alignment and clearance between mating faces of the motor and pump couplings, by slightly tightening the anchor bolts of the motor.



#### 5. Repeat procedure of the above (4)

6. After finishing the adjustment, tighten the anchor bolts

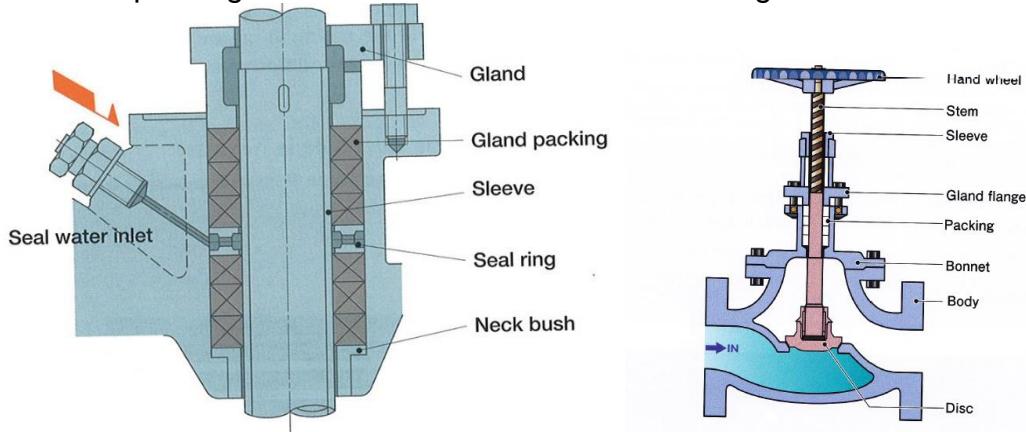
#### 4.7 Tightening and replacement of pump gland packing (with JOB CARD)



#### 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.

### Sheet Packing Comparison Table:

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		140	348	1630	



	175		145	420	1030	
<b>Oil</b>	163		270	372	1100	5000
<b>Chemical</b>	161		235	367	1500	5000

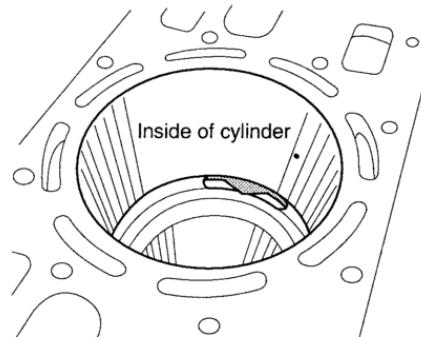
## 4.8 Compressor Maintenance

### Air compressor maintenance (Tanabe H-374)

#### 1<sup>st</sup> Stage and 2<sup>nd</sup> Stage Valve Suction and Discharge (with JOB CARD)

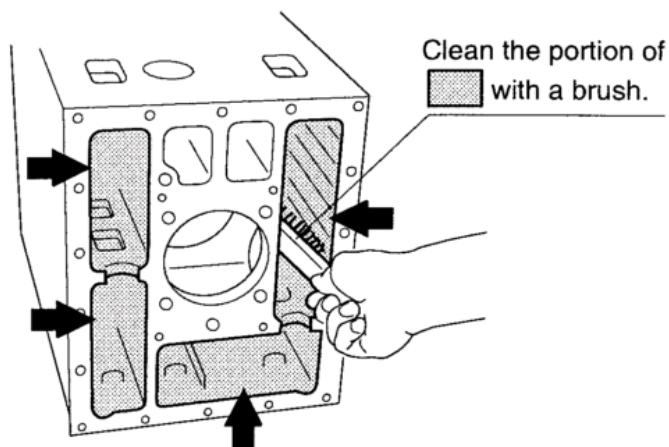
##### Inside of Cylinder

Check if cylinder inside is worn or proper quantity of oil is applied.



##### Water Jacket

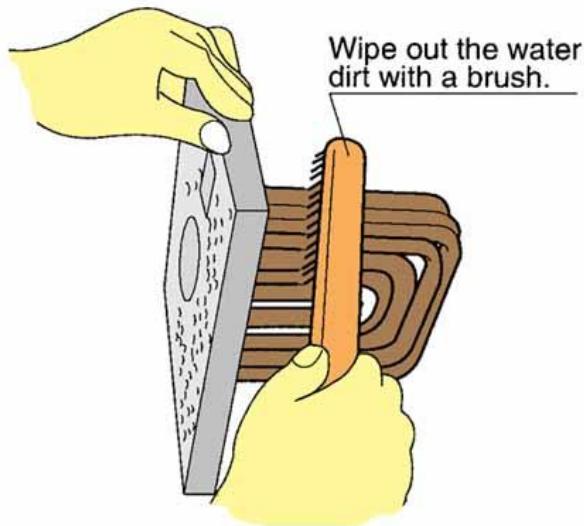
- Check if water dirt is stuck on the water jacket surface (both 1st and 2nd stages.)
- When water dirt is stuck, clean the portion shown in Figure below with brush.



##### 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.



#### 4.10 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 1<sup>st</sup> (L.P.) and 2<sup>nd</sup> (H.P.) stage is released to the atmosphere by forcing to open the

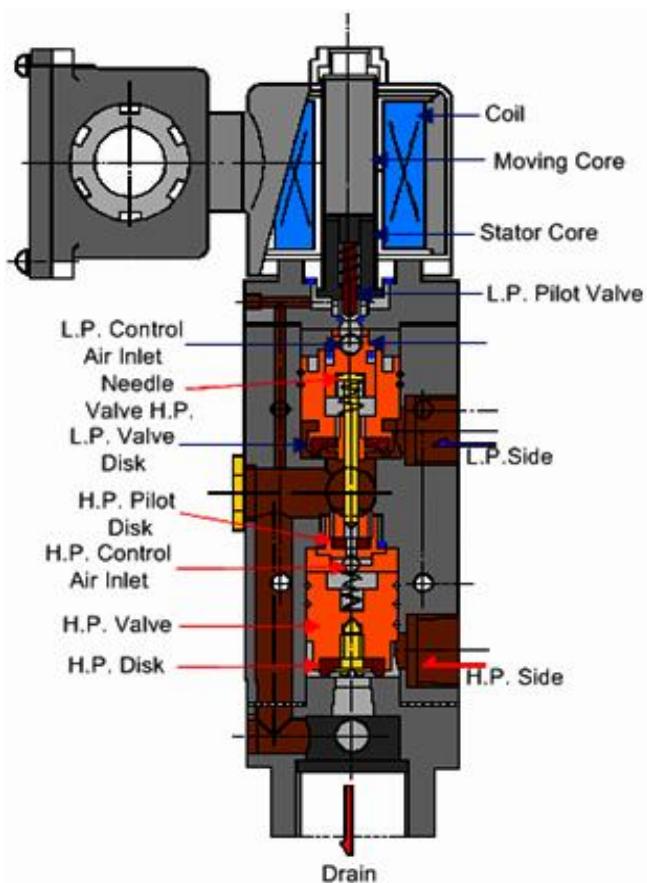


Fig.7.2.3-13 Magnetic Un-loader Valve



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.

#### 4.11 Boiler Rotary Cup Cleaning (with JOB CARD)

Daily Maintenance:

1. Check the oil strainer.
2. Check oil pressure and flow.
3. Check the furnace pressure and temperature of exhaust gas.

Weekly Maintenance:

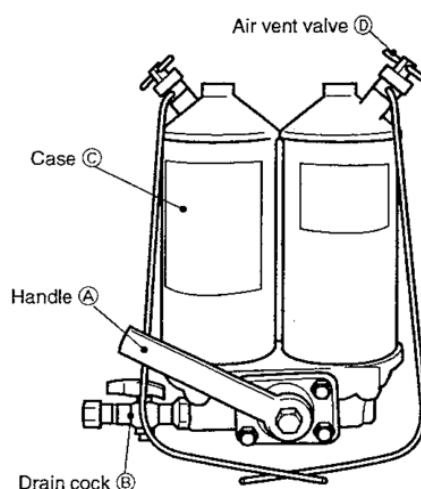
1. Check the ignition burner.
2. Check the function of flame eye.
3. Check and lubricate each linkage.

#### 4.12 Diesel Generator Fuel Oil Valve

##### Inspection and Maintenance of Fuel Oil Injection Valve (with JOB CARD)

Since the conditions of the fuel injection valve substantially affect the performance of engine operation, be minded to periodically inspect it and conduct the maintenance. However, in case those remarkable changes have been found in the maximum combustion pressure, exhaust temperature, exhaust color, and so on be minded to conduct immediate inspection and maintenance, regardless of the standard maintenance period.

#### 4.13 Cleaning Filters of D/G (with JOB CARD)



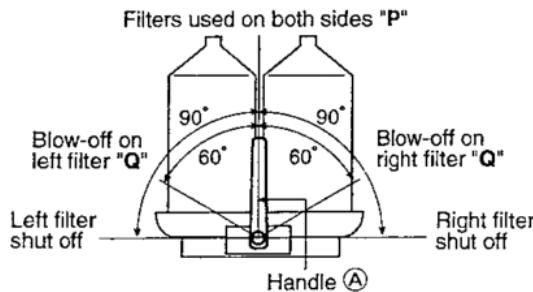
Notch-Wire Type Filter

Fuel oil filters and lubricating oil filters play a vital role in ensuring that the oil in the system is clean and free from foreign matters which helps to maintain the normal running condition of the system. Thus, periodic overhaul and cleaning should be done to ensure filtering capability is maintained.



## Types of Filters

**1. Notch-Wire Duplex Filter-** It is typically used in as both-side-parallel application. If filters have been fouled which results in a decrease in pressure in the system, conduct blow-off operation . If the pressure does not increase after conducting blow-off cleaning, overhaul the filter and then clean it.



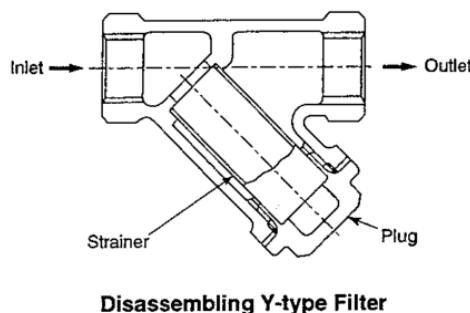
**a. Blow-off Cleaning-** In this process, the deposits can be removed by reversely flowing the fluid through the element on one side, and this type of cleaning has no cleaning effect when the element is substantially clogged, and therefore be minded to conduct the blow-off cleaning in an earlier state, while the degree of filter is still light at least once a week.

### Blow-off cleaning procedure

1. Open the drain cock (b) at the bottom part of the filter. At this time, be careful so that waste oil may not scatter or overflow out of the drain cock.
2. Turn the selector cock handle (a) which is usually set to " used on both sides" (p) position to the "blow-off" position and quickly conduct the operation to return the handle to the previous position within 0.5-1sec.
3. Repeat this operation 2-3 times.
4. Conduct the above same procedure on the other side.
5. Close the drain cock.

**Note:** Conduct the blow-off cleaning quickly. Further, do not place the lever on the middle position, but quickly move to the specified position (knock position). If too much time has been taken in blow-off cleaning and switching the lever positions, the pressure will decrease, and may activate the alarm or emergency stop/

## 2. Y-Type Filter



Disassembling Y-type Filter



1. Remove plug.
2. Remove strainer.
3. Clean the strainer with washing oil or gas oil.

#### Mounting

When mounting the Y-type filter, be minded to mount it with the plug side facing downward, so that sludge may be accumulated in the strainer.

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

#### 4.14 Types of Grinding Compounds

Grade and Grit Selector Guide

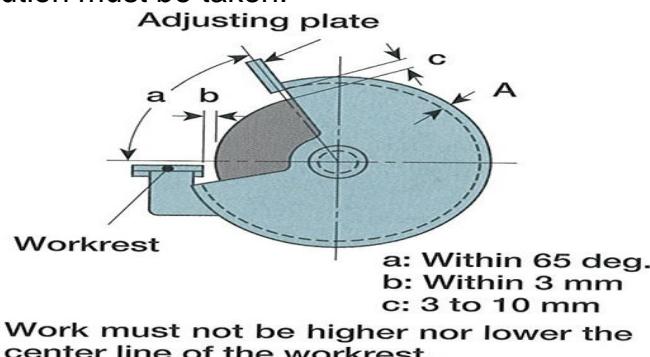
GRIT	Descriptions	Average Particle Sizes of Abrasive Grains	
		1/1000 inches	Microns (0.001 mm)
1200		0.12	3
1000	<b>EXTREMELY FINE</b> Polishing, High Precision Lapping	0.20	5
800		0.38	9
600		0.56	14
500	<b>VERY FINE</b> For fine Polishing and Lapping	0.68	17
400		0.90	23
320	<b>FINE</b> For Finishing, Valve Lapping, Bearings, Dies and Gauges	1.28	33
280		1.75	44
240	<b>MEDIUM FINE</b>	2.48	63
220	For Cylinder Lapping	2.6	66
180	<b>MEDIUM</b>	3.4	86
150	General Purpose for controlled Metal Removal	4.8	122
120	<b>COARSE</b>	5.6	142
100	For the Initial "Cut" Fast Removal of Metal	6.8	173
80		15	267
54	<b>VERY COARSE</b> For Fastest Metal Removal	18	463



\*\*\* Before Operating an Electric Grinder, be sure to wear proper protective equipment (i.e. Safety Goggles and Safety Gloves). \*\*\*

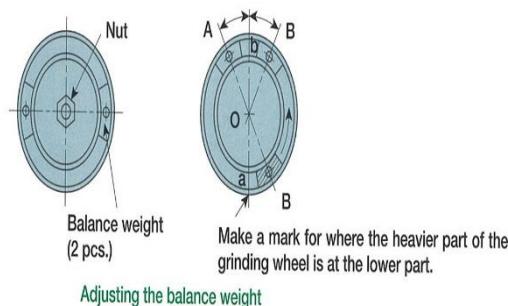
#### 4.15 Handling of Bench Grinder

- 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 used, 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.



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

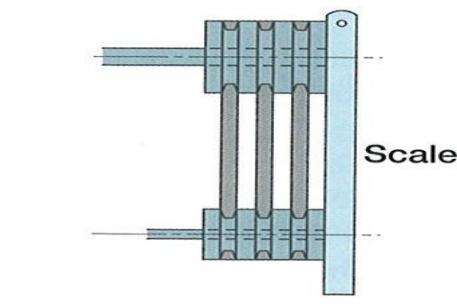
- Adjustment when a balance weight is provided.
- Softly turn the grinding wheel by hand and the wheel will stop with a heavier part downwards, move the wheel to the opposite side namely to the top .repeat this procedures until the wheel stops randomly.
- Adjustment when a balance weight is not provided.
- 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.



#### 4.18 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.



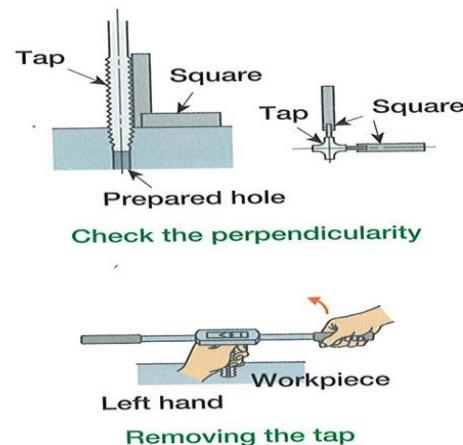
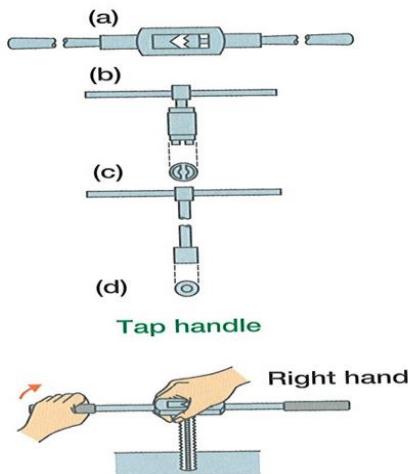
## Proper use of tap and die

### 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.

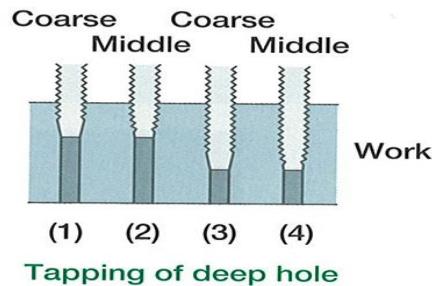
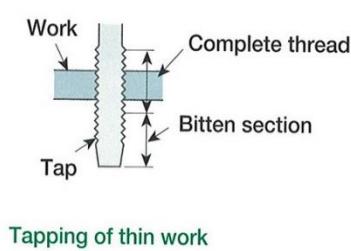
Normal size	Inner diameter of female screw	Normal size	Inner diameter of female screw
2	1.52	14	11.62
3	2.28	16	13.62
4	3.10	20	17.02
5	3.92	24	20.43
6	4.80	27	23.43
8	6.51	30	25.83
10	8.21	36	31.23
12	9.91	42	36.64

- 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.



### 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  $\frac{1}{4}$  turn each time it is rotated by  $\frac{3}{4}$  turn.
- Add oil at proper intervals, in the case of a blind hole; take the tap out of the hole to removed chips occasionally.

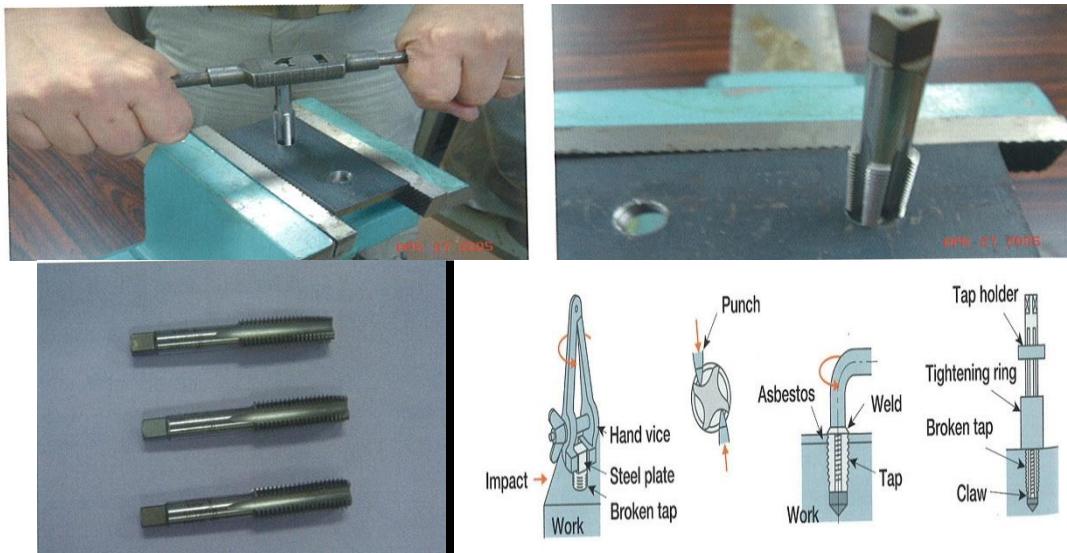
Note: If tapping is too hard that the tap is twisted when you apply a force on the handle, the prepared hole may be too small or the tap must be tilted against the hole. Remove the hand tap out of the hole and widen the hole with a round machinist file.

### 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



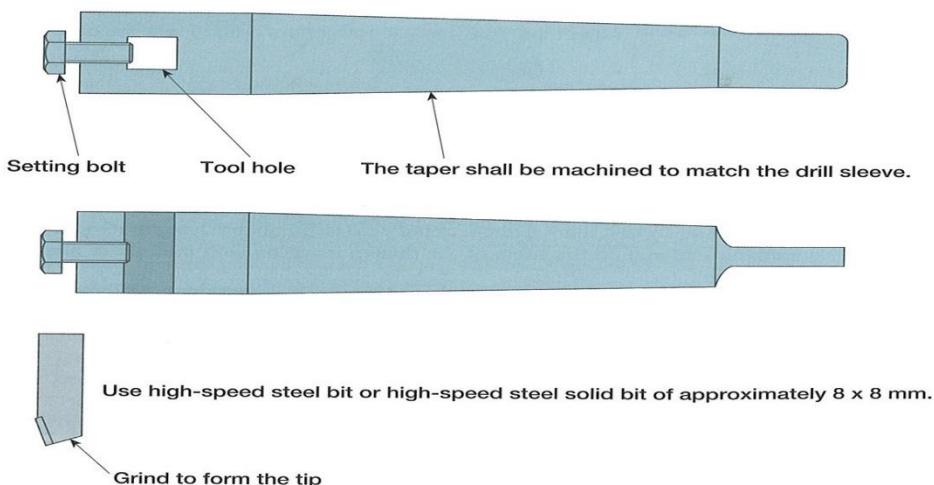
- If available, use a tap holder to remove the tap.



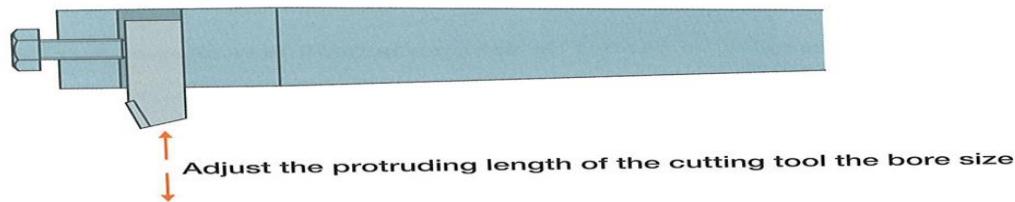
## Boring Jig

When working material cannot be set on a lathe, it is necessary to process a bigger hole than the drill in stock.

- Machine the following by the lathe.



- High speed steel bit (black square tool steel) shall be used after heat treated
- Heat treatment: Heat the tool steel to a specified smith work temperature, and then shape and grinds it to specified shape, and heats it again to the quenching temperature.
- Quenching: Heat the material until it turns dark or bright brown and then dips it into oil for quenching.
- The high speed steel solid bit must be heated treated so that it can be used for shaping.
- Set the cutting tool.



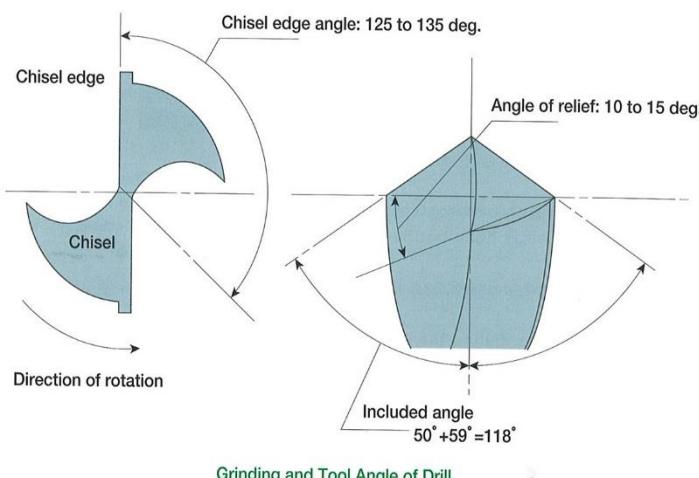
## How to drill a hole

- Apply a punch mark in the centre of the work piece to be drilled.
- From the centre mark, draw circle of the hole to be drilled by using a compass.
- Fix the material on the centre of drilling machine
- Drill a hole at the centre of the work piece with a maximum drill size.
- Removed the drill and install the boring jig (do not miss align the centre of the work piece)
- Adjust the cutting tool and fix it to boring jig, so that it can cut from 1 to 2mm depth at a time.
- Set the drillings machine to the minimum speed and cut the work material little by little.
- Repeat the above steps 6 & 7 until the specified hole is obtained.

### 4.19 Grinding of Drill bit, Chisel 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.



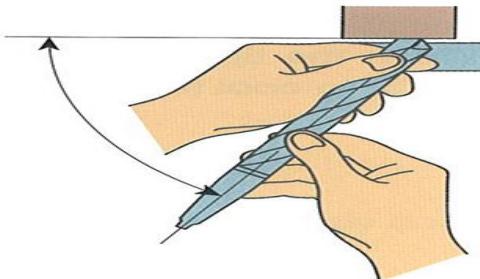
Grinding and Tool Angle of Drill

- 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.



**Grinding of Cutting edge**

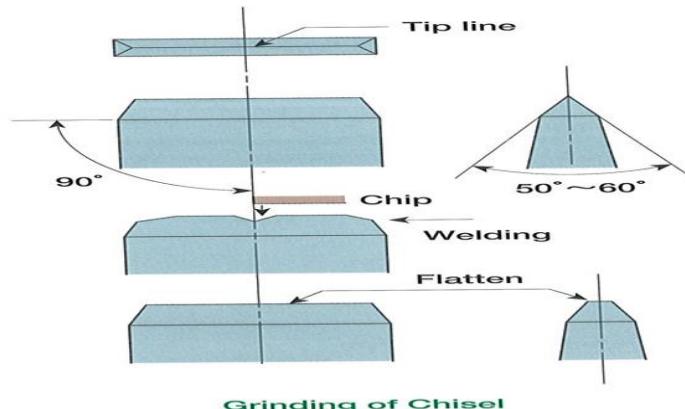
### Grinding of chisel

Tip line: flat, Include angle: 50 to 60 deg.

Tip line shall be at right angle to the centre line of the chisel.

❖ How to grind a chisel

- Grind to flatten the tip until chips and wear disappear.
- With the chisel on the base, grind it to specified included angle and tip line.



Notes: Grind the chisel while cooling it by water so that the edge would not be tempered.

- If the edge is tempered ,quench the chisel again
- Before grinding, flatten the grinding surface with a dresser.

### 4.21 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".



### 4.22 Procedures:

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

- 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.

## **5. CLASSIFICATION AND SPECIFICATION OF CARBON STEEL PIPES AND FLANGES**

Carbon steel pipe

- a. **SGP** (carbon steel pipe for ordinary piping)

Working pressure: 0 to 1MPs

Working temperature: -15 to 350°C





b. **STPG38-E** (carbon pipes for pressure piping)

Working pressure: 1.5 to 10MPs

Working temperature: -15 to 350°C

Tensile Strength: 38 kg/mm<sup>2</sup> or more

SYMBOL:

E : Electric resistance weld pipe

S-C : Cold finished seamless steel pipe

S-H : Hot finished seamless pipe

B : Welded steel pipe



c. **STPT** (Carbon steel pipe for high temperature piping)

Working pressure: 0 to 20 MPs

Working temperature: 350 to 450°C



d. **STS** (carbon steel pipes for high and low temperature piping)



Cold or hot finished seamless steel pipes

Working pressure: 10 to 29MPs

Working temperature: -15 to 350°C



## SPECIFICATION FOR CARBON STEEL PIPES FOR ORDINARY PIPING

Nominal size		Outside diameter (mm)	SGP	Thickness (mm)			
(A)	(B)			30	40	80	100
6A	1/8	10.5	2.0		1.7	2.4	
8A	1/4	13.8	2.3		2.2	3.0	
10A	3/8	17.3	2.3		2.3	3.2	
15A	1/2	21.7	2.8		2.8	3.7	
20A	3/4	27.2	2.8		2.9	3.9	
25A	1	34.0	3.2		3.4	4.5	
32A	1 1/4	42.7	3.5		3.6	4.9	
40A	1 1/2	48.6	3.5		3.7	5.1	
50A	2	60.5	3.8		3.9	5.5	
65A	2 1/2	76.3	4.2		5.2	7.0	
80A	3	89.1	4.2		5.5	7.6	
90A	3 1/2	101.6	4.2		5.7	8.1	
100A	4	114.3	4.5		6.0	8.6	
125A	5	139.8	4.5		6.6	9.5	
150A	6	165.2	5.0		7.1	11.0	
200A	8	216.3	5.8	7.0	8.2	12.7	15.1
250A	10	267.4	6.6	7.8	9.3	15.1	18.2
300A	12	318.3	6.9	8.4	10.3	17.4	21.4

### Note:

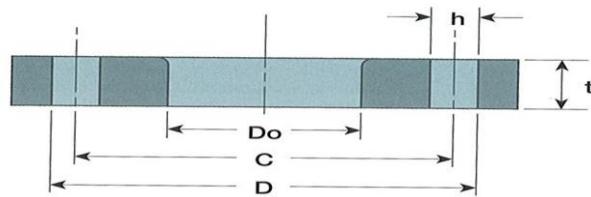
- The sizes enclosed by double lines are used frequently.
- Schedule pipes of carbon steel pipes for pressure piping (STPG) and for carbon steel pipes for high temperature (STPT) have the same wall thickness.



- The value of nominal size (A) is determined approximately the inner diameter (mm).
- Nominal size (B) is the dimension in inch which is almost equal to the inner diameter of a pipe and not equal to the outside diameter.

## Grades of Flanges

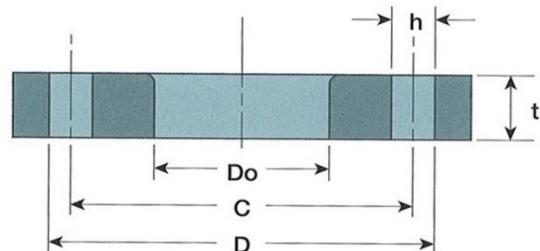
### 0.5MP's Slip on welding flange



**5 kgf/cm<sup>2</sup> Ref. JIS B 2221**

CODE	Nominal Size		Pipe O.D. (mm)	Flange Size mm							
				Bore (do)	O.D. (D)	Thick (t)	Pitch (C)	Bolt Hole			
	A	B						No.	$h \varnothing$		
73 46 01	10	3/8	17.3	17.8	75	9	55	4	12		
73 46 02	15	1/2	21.7	22.2	80	9	60	4	12		
73 46 03	20	3/4	27.2	27.7	85	10	65	4	12		
73 46 04	25	1	34	34.5	95	10	75	4	12		

## 1 MP's SLIP ON WELDING FLANGE

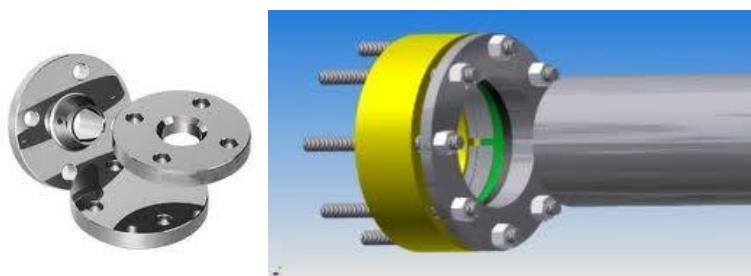


CODE	Nominal Size		Flange Size mm						
			Pipe O.D. mm	Bore do	O.D. D	Thick t	Pitch C	Bolt Hole	
	A	B	No.	h					
73 46 21	10	3/8	17.3	17.8	90	12	65	4	15
22	15	1/2	21.7	22.2	95	12	70	4	15
23	20	3/4	27.2	27.7	100	14	75	4	15
24	25	1	34	34.5	125	14	90	4	19
25	32	1-1/4	42.7	43.2	135	16	100	4	19

### Common Types and features of flanges

#### a. Flat surface flange

- When it tighten to much a possibility the periphery of mating face contact with each other and it is difficult to tighten the gasket firmly.
- When the pressure increase the gasket may come out.
- It is only applicable for low pressure steam or water line.





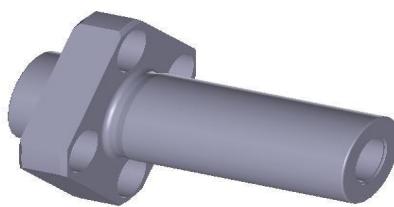
b. Protruded surface flange

- The periphery of mating surface does not contact even it is tighten firmly
- Can use small width gasket it can absorb maximum tightening pressure.



c. spigot joint

- Mainly soft gasket is used, even with high pressure the gas does not come out.



## 6. IDENTIFICATION OF PROPER USE OF GASKET, BOLTS AND NUTS

### Materials, Grades, Coatings Used for Bolts and Nuts

Fasteners and other hardware are designed and manufactured in a wide range of materials from common steel to titanium, plastic and other exotic materials. Many materials are further separated into different grades to describe specific alloy mixtures, hardening processes, temperature protection, and applications. Some materials are available with a variety of coatings or plating to enhance the corrosion resistance, or appearance of the fastener.

**Steel** Links are extremely abrasion resistant.

**Alloy Steel** is what you want for maximum security. This chain has square links, which make it difficult to cut with bolt cutters.



**Alloy 20** is a nickel-chromium-molybdenum stainless steel alloy developed for applications involving strong corrosive situations. Its strong corrosion resistance is used in the chemical, food, pharmaceutical, and plastics industries. Alloy 20 resists pitting and chloride ion corrosion and its copper content protects it from sulfuric acid.

**A286 nickel alloy** provides high strength up to temperatures of 1300° F and corrosion resistance up to a constant temperature of 1500° F. A286 is used to produce a wide variety of fasteners including nuts, bolts, screws, studs and other custom hardware.

**Brass Alloy 260** chain is nonmagnetic and non-sparking. Good for light to medium duty material handling in hazardous areas and suitable for barrier chain, decorative purposes, and suspending fixtures.,

**Aluminum chain** is light weight, nonmagnetic, non-sparking, and resists corrosion from salt water, food, and many chemicals. Besides being excellent for chemical and food processing, it's also rustproof, lightweight, and very easy to handle.

**18-8 Stainless Steel** is part of the 300 series stainless steel alloys containing approximately 18% Chromium and 8% Nickel. 18/8 stainless is most commonly used in applications that require non-magnetic fasteners and hardware.

**302 stainless steel** chain offers excellent corrosion resistance for food processing, industrial and marine environment applications. Possesses non-magnetic properties and outstanding toughness at all temperatures,

**304 Stainless Steel** has good resistance to atmospheric corrosion resistance. Typical uses for 304 stainless chains include chemical, food processing, paper, pharmaceutical and chemical industry applications.

**309 Stainless Steel** alloy is best known for its high strength and oxidation resistance in continuous service applications. This alloy withstands temperatures up to 2000 F (1093 C). It is superior to 304 stainless in both strength and corrosion resistance.

**316 Stainless Steel** has superior corrosion resistance which is ideal for chemical, food processing, coastal and offshore marine applications. 316 stainless chain offers oxidation resistance, good mechanical properties and is used in many industries, including paper, mining, pharmaceutical and petroleum industries.

**410 Stainless Steel** is the basic martensitic stainless steel that was developed to provide a category of stainless alloys that would be corrosion resistant and hardened by heat treating. Grade 410 is machinable and used in applications where high strength, moderate heat and corrosion resistance requirements are key.

**B-8 Stainless Steel** is non-magnetic and has good corrosion resistance properties. B-8 stainless has a 75,000 psi tensile strength and has the same material as AISI type 304 stainless steel

**B-8M Stainless Steel** material is similar to B8 except has added Molybdenum. Because it has better corrosion resistance than B8, hex bolts, studs and other fasteners are common to the B8M specification.



**17-4 PH Stainless Steel** is a martensitic, chromium-nickel-copper stainless steel used for applications requiring high strength and moderate levels of corrosion resistance. Stainless 17-4 PH is used in a wide range of applications that include aircraft structural parts, fasteners, pump shafts, valve parts, chemical & food processing equipment, and nuclear components.

**Hastalloy** is specially designed to suit industrial applications where superior strength and corrosion resistance is key and is especially resistant to pitting and crevice corrosion. Pollution control, chemical and refining, waste and water treatment, marine and coastal construction industries use Hastalloy fasteners to meet these requirements.

**Inconel** alloys are oxidation and corrosion resistant materials well suited for service in extreme environments typically used in high temperature environments.

**Incoloy** alloy is an outstanding material for applications where fasteners must retain high strength and resistance to oxidation at high temperatures ranging up to 1600 F. Bolts, nuts, screws, threaded rod, and washers are some of the typical uses for this material.

**Monel** is a nickel-copper alloy and has a high corrosion and acid resistance that makes it ideal for marine and coastal applications. There are two types of Monel, 400, and K-500. Monel 400 has exceptional qualities of strength, versatility, and resistance to heat and corrosion. K-500 is heat treatable, and is a higher strength version of the 400 alloy.

**Silicon Bronze** is excellent for use where fasteners are exposed to weather or along the water line. Silicon bronze fasteners are excellent for use in many marine and commercial applications. Used where a stainless steel fastener might not meet the application or a dissimilar metal is required. Available in screws, bolts, nuts, washers, threaded rod and more.

**Titanium** is a light, strong, and corrosion-resistant alloy, ideal for fasteners and hardware. Our Titanium products are used in aerospace, automotive and racing, medical, chemical and petro-chemical processing, desalination plants, and other applications.

**Gray poly-coated** finish minimizes scratching and damage to items that come in contact with the chain.

**Zinc-plated** finish provides some corrosion resistance.

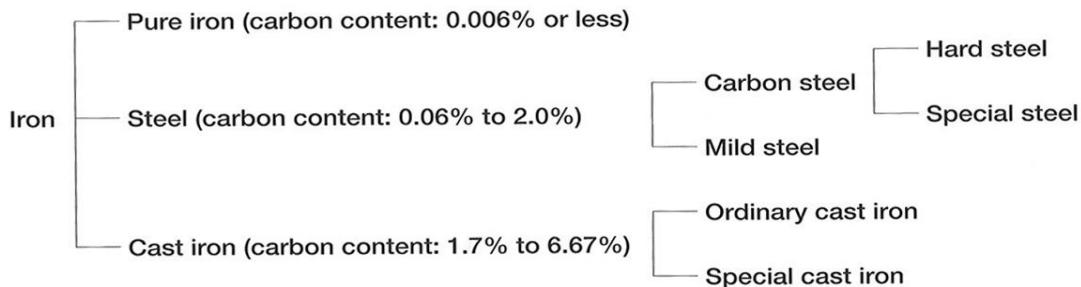
**Zinc-plated and hot-galvanized** finishes provide some corrosion resistance. Poly-coated finish offers high visibility and minimizes scratching and damage to items that come in contact with the chain.

**Zinc-plated steel** with vinyl sleeve is covered by a transparent vinyl sleeve to reduce rattling and prevent marring and scratching on finished surfaces.



## Identification of Bolts and Nuts

In general iron represents an alloy of iron and carbon; it can have various peculiar features when other metals are added such as nickel and chrome. The latter alloys are called “special steel”.



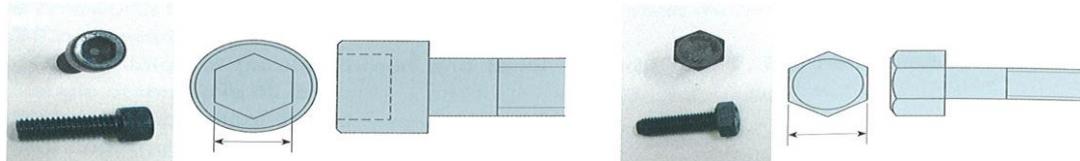
## Hexagon Bolt

Relationship between the nominal size of hexagon bolt, hexagon socket head bolt, and their width across flats.

Spanner Opening	Applicable Bolt				
	Metric Thread ISO			Old Standard	
	Hex. Bolt	Small Hex. Bolt	High Tension Bolt	Whithworth Bolt	Metric Bolt
5.5	M3				
6	M3.5				
7	M4				
8	M5				
9					
10	M6				
11	M7				
12		M8			
13	M8				
14		M10			M8
15					
17	M10	M12		W3/8	M10
19	M12	M14		W7/16	
21				W1/2	M12
22	M14	M16	M12		
23					M14
24	M16	M18			
26				W5/8	M16
27	M18	M20	M16		
29					M18
30	M20	M22			
32	M22	M24	M20	W3/4	M20



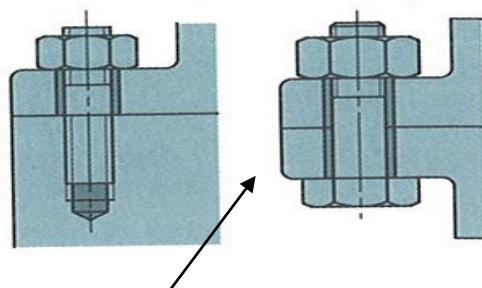
35				W7/8	
36	M24	M27	M22		
38					M24
41	M27	M30	M24	W1	M27
46	M30	M33		W1-1/8	M30
50	M33	M36		W1-1/4	M33
54				W1-3/8	M36
55	M36	M39			
58				W1-1/2	M39
60	M39				
63				W1-5/8	M42
65	M42				
67				W1-3/4	M45
70	M45				
71				W1-7/8	M48
75	M48				
77				W2	
80	M52				



## Removal of seized bolt and nut

### 1.1 How to loosen a seizing nut for through bolt and stud bolt.

- Apply a penetrating oil to the thread
- Tap the side face of the nut with a hammer to give an impact shock.
- Turn the nut with a spanner or a caulking chisel.
- Pre heat the nut with a gas torch and gradually turn it.
- Split the nut with a chisel or cut with a gas torch
- To split a large nut with a chisel it is efficient to cut half of the width at a time.



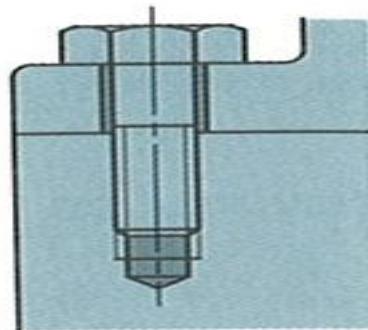
### 1.2 How to remove a tap bolt

- Apply a penetrating oil to the thread



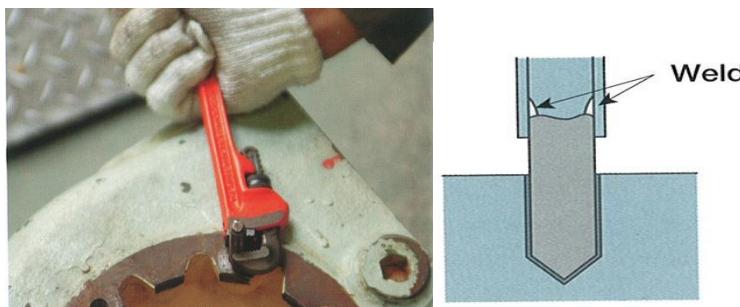
- Tap the bolt to give an impact
- Tap the bolt head and turn the bolt with a spanner or a caulking chisel
- Repeat the above item 2 and 3 while heating with a gas torch.

Note: Utmost care shall be given when the bolt is made of brittle materials such as cast iron or an aluminium alloy.

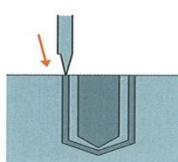


### 1.3 How to remove a broken stud or tap bolt

- When a broken part is overhang a little from the surface.
- Remove according to the above procedure of removing a tap bolt. Or weld a pipe or the like to the broken bolt and turn it with a pipe wrench.



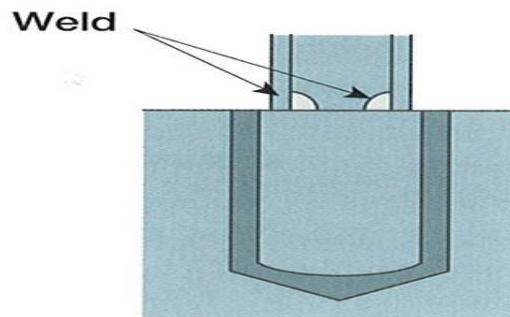
- When the above method does not work
  - Cut out the overhang part evenly, bore a hole to the bottom with a drill smaller in size than the prepared hole, and take the broken bolt with an extractor.
  - When the above is not effective drill a hole in the bolt leaving a thin peripheral wall and then remove the wall completely with a fine chisel or removed little with a sharp scriber.



- When the broken stud bolt is a fat one



- On the tap of the bolt, place a piece of pipe having the same diameter with the broken bolt, and then weld the inside of the pipe and turn it to remove the bolt.



- When thread ridges are defective
  - Re-tap threads larger than the original ones
  - Install a helical one and install a helical coil insert.

Helical coil insert: a spring shaped tool which has threads on both inside and outside, tap a thread which is one size larger than the defective one and install a helical coil insert, which enables to use a bolt of the original size. (A dedicated tool for installing a helical coil insert is on the market)



**Helical coil insert**

**Carbon Steel** – is widely used because its properties can easily be changed by carbon content or heat treatment.

Name	Carbon content (%)	Tensile strength (f/mm <sup>2</sup> )	Application
Dead soft steel	Max. 0.12	Max.38	Rivet, split pin
Mild steel	0.12-0.2	38-44	Section steel, steel pipe
Semi-mild steel	0.20-0.5	44-50	Bolt nut
Semi-hard steel	0.35-0.5	50-60	Gear shaft
Hard steel	0.5-0.8	60-70	Shaft hammer
Extra hard steel	0.8-1.0	70-100	Spring, tool



## Special Steel

It is an alloy of iron, carbon and more than one other metal such as Nickel, chrome, tungsten, molybdenum, manganese and vanadium.

Special steel includes: nickel steel, chrome steel, nickel chrome steel, Chromium molybdenum steel, and invar.

## 6.7 IDENTIFICATION AND PROPER USE OF GASKET

A **gasket** is a mechanical seal that fills the space between two objects, generally to prevent leakage between the two objects while under compression, the gasket must be able to flow into (and fill) any irregularities in the mating surfaces being sealed, while at the same time be sufficiently resilient to resist extrusion and creep under operating conditions.

### Gasket Materials

Wide varieties of materials are used in the manufacture of gaskets. This section is aimed at providing a brief overview of the common materials. For simplicity they are divided into 4 parts

- Elastomeric materials
- Fibrous materials
- Other materials
- Metallic materials

### Elastomeric materials

Commonly act as the binder when compounded with various fibers and fillers. They are made in various compositions and are available in specification grade and commercial quality.

- a. **Butyl rubber** – it is good resistance to ozone and gas permeation. Suitable for mild acids.





- b. **Chlorosulphonated polyethylene** - excellent chemical resistance against acids and alkalis. Good oil resistance.



- c. **Ethylene propylenediene(EPDM)** – Elastomer it is good resistance to ozone, steam, strong acids and alkalis, but is not suitable for solvents and aromatic hydrocarbons.



- d. **Natural rubber** - Good resistance to most inorganic salts, mild acids and alkalis. Not recommended for oils and solvents, or where exposure to ozone, oxygen or sunlight is prominent.



- e. **Silicone** - Excellent temperature properties, and unaffected by ozone and sunlight. Not suitable for many hydrocarbons and steam.



## Fibrous materials

- a. **Aramid** - Aromatic amide fiber, offering high strength and stability, with medium temperature suitability.
- b. **Asbestos** - the most common material used for sealing flanges, because of its ability to seal effectively over a broad range of service conditions.

**(Use of Asbestos is Already Banned)**

- c. **Carbon fiber** - High thermal conductivity ensures rapid heat dissipation and allows high temperature capability and it is a wide chemical resistance.
- d. **Cellulose** - Natural fiber, suitable for low temperature and medium pressure applications.

## Other materials

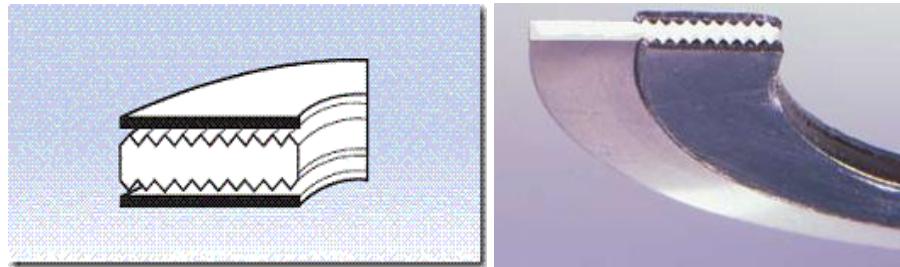
- a. **Flexible graphite** - The material has a wide chemical resistance. It is suitable for exceptionally wide temperature range from up to 400 deg. C in oxidizing environments and under certain circumstances, to 2500° deg. C in inert conditions.
- b. **Mica (vermiculite)** - The structure possesses a high degree of flexibility, elasticity and toughness. Excellent thermal stability and chemical resistance.
- c. **Cork** - It compresses readily with negligible lateral flow, recovers speedily, and is relatively inert. It lacks flexibility and mechanical strength.



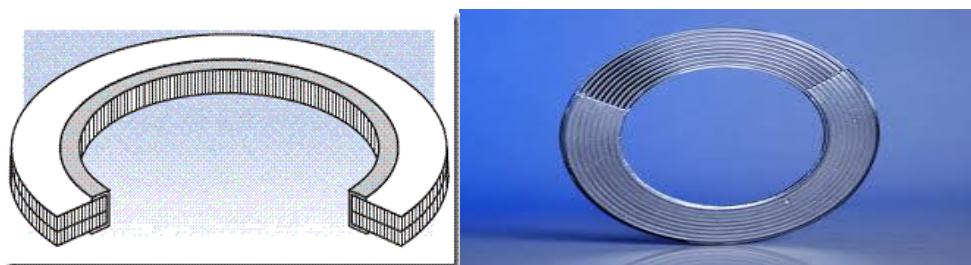
## Semi-Metallic materials

The metal generally provides the strength and resilience to the gasket. They are suitable for both low and high temperature and pressure applications.

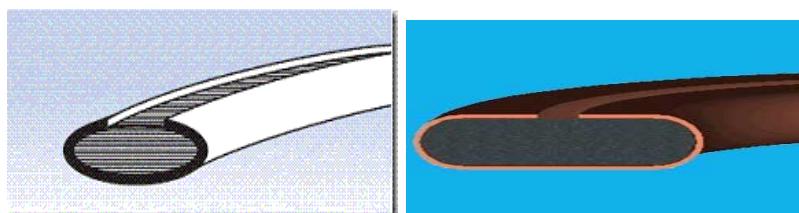
- d. **Kammprofile gaskets** - consist of a metal core with concentric serrated grooves on each side and the addition of a soft layer of sealing material bonded to each face. The serrated metallic core is very effective for sealing in applications where high temperatures, high pressures and fluctuating conditions exist.



- e. **Metal eyelet gasket** - a metal bead (usually stainless steel) is put around the inner periphery of gaskets cut from sheet material to protect the gasket's internal diameter. The gaskets can be produced using a wide variety of compressed asbestos fibre and compressed non-asbestos fiber materials.

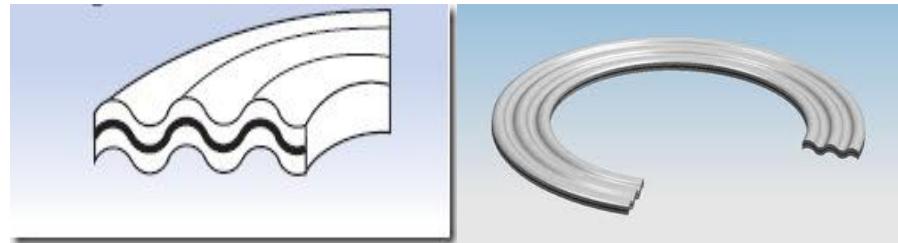


- f. **Metal jacketed** – This gaskets are specially designed and widely used for heat exchangers, autoclaves, columns, pressure vessels, valve bonnets, etc. The gaskets are manufactured from a soft, pliable filler core surrounded by a metal jacket, chemically and thermally resistant to the working conditions.

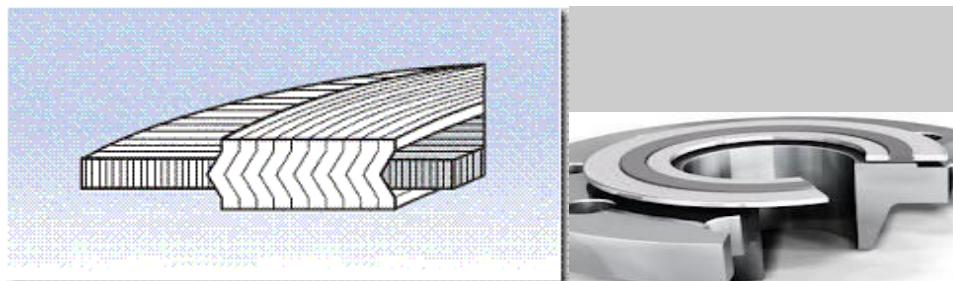




- g. **Corrugated metallic** - Corrugated metallic gaskets have a corrugated metal core (normally stainless steel), with expanded graphite facings. They are used for standard pipeline duties, and heat exchangers.



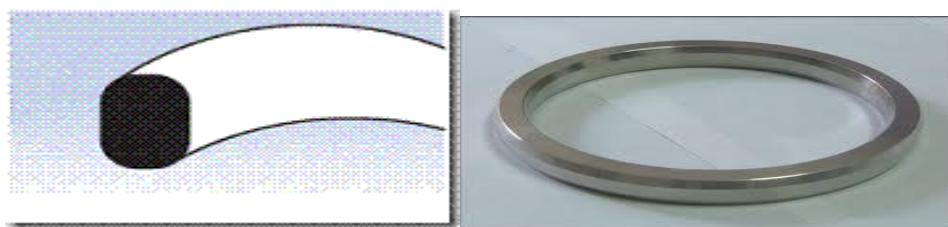
- h. **Spiral wound gaskets** - Spiral wound gaskets are manufactured from V-shaped metal strips, spirally wound with an inlay of soft filler material between each turn. They form a very effective seal when compressed between two flanges.



### Metallic gasket

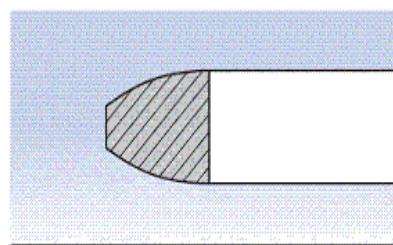
They can be fabricated from a single metal or a combination of metallic materials in a variety of shapes and sizes. They are suitable for high temperature and pressure applications.

- **Ring type gasket** -This solid metal gasket provides an excellent mechanical joint and has almost universal acceptance in the oil, petroleum and chemical processing industries where high mechanical and thermal performance is required.

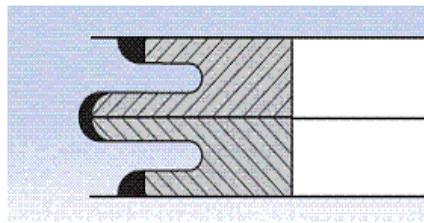




- **Lens Rings** – it is widely used in high pressure applications and are resistant to overstressing. They are manufactured in accordance with DIN 2696 PN 64 to 400 and DN 10 to 300.



**Weld ring gaskets** – this is suitable for critical applications where a leak-proof joint is essential. Sealing is achieved by welding the two gasket halves together.



### Liquid Gasket

Liquid gaskets have been developed based on entirely different concept and leak-preventing theory from solid-sheet gaskets. By coating a mechanical joint with one of these liquid gaskets before assembly, the leaks can be prevented. These materials can have very important effects in improving the performance of equipment, prolonging its functional life, and reducing the total cost. More than 20 types are available to meet the needs of working conditions such as joint temperature, vibration, pressure, contact in fluid, and clearance.





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## Sheet Packing



## 7. UNDERSTANDING OF PIPING DIAGRAM

### Piping arrangement on board

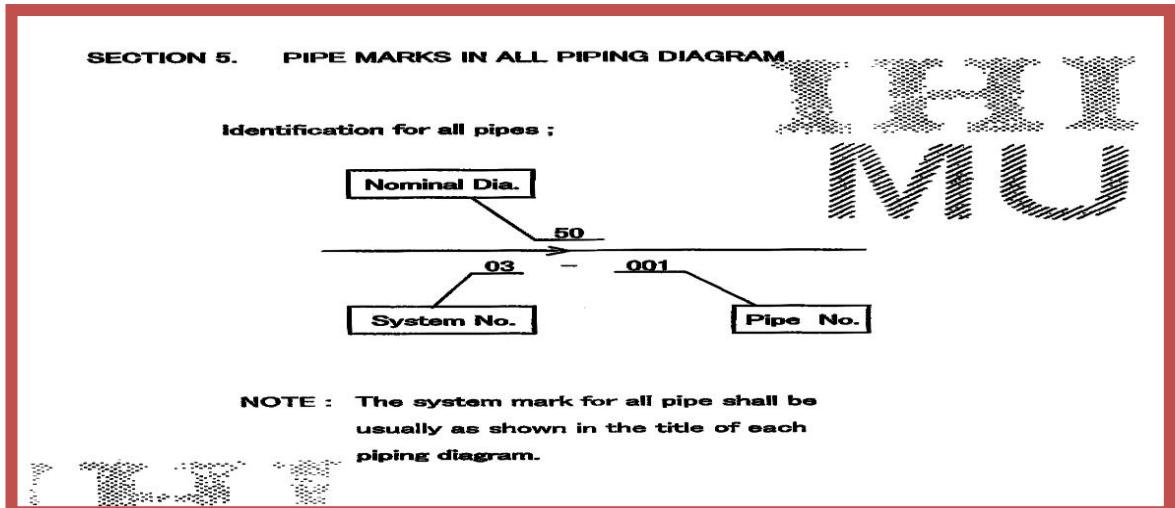
A ship's machinery space contains hundreds of meters of piping and fittings. The various systems are arranged to carry many different liquids at various temperatures and pressures. Valves, strainers, branch pipes, etc., are examples of fittings which are found in a pipe system.

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.

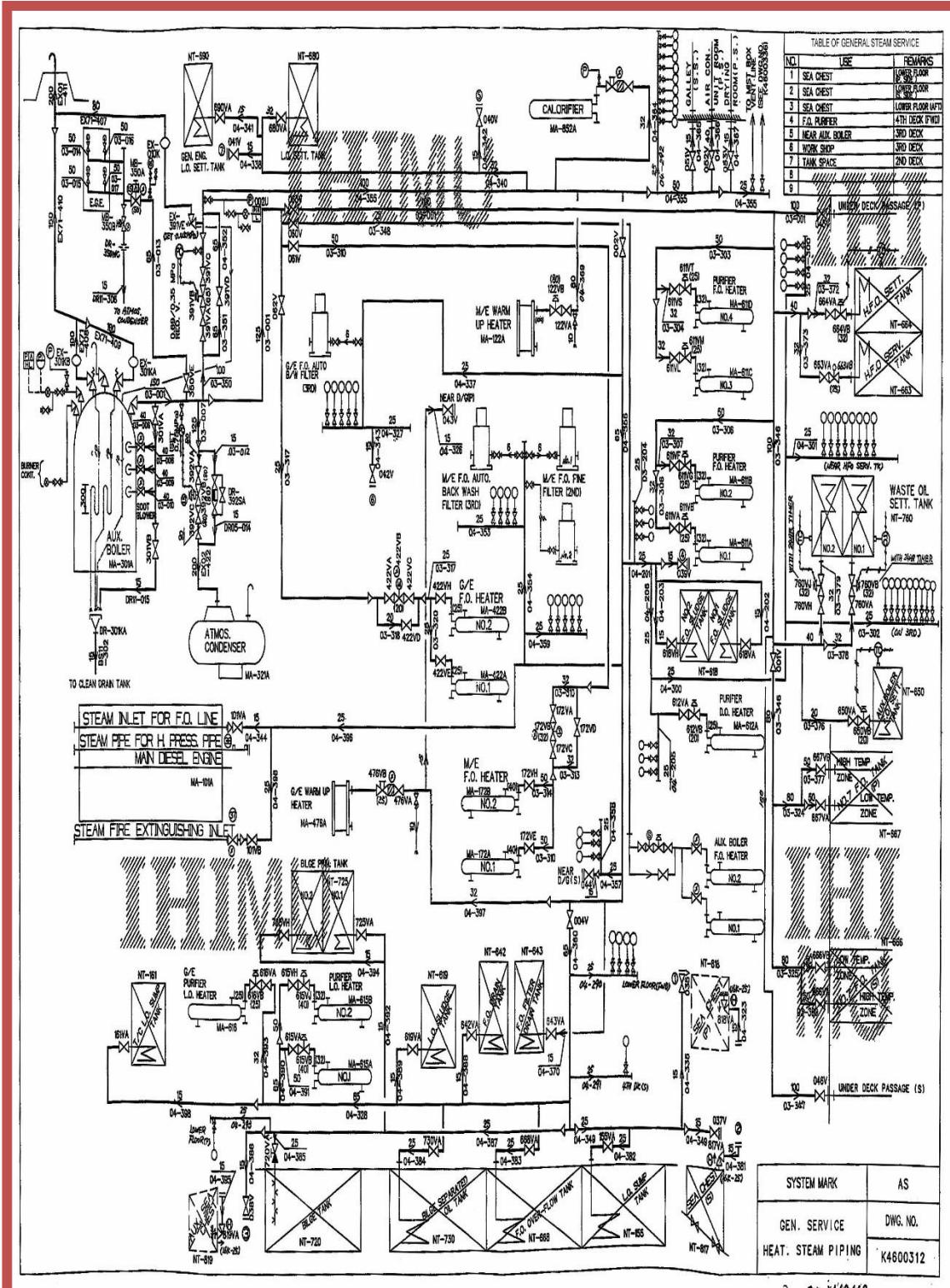




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System mark & number System	Max. Work press. & temp. MPa × °C	Hyd. test press. MPa	Nominal dia. mm	Pipe		Pipe treatment	Standard pipe joint		Valve			Gasket	Bolt & Nut	Insulation	Pipe branch connection	Remarks						
				Material	Thick		Press. & Type	Material	Material													
									Body	Trim												
AS 03 DR 03	0.69 0.69 MPa STEAM AND DRAIN (TO DRAIN TRAP)	W:1.19 (Safety valve set press. 0.79) X 169.6°C	350 & over 50-300	AS 03 Electric resistance welded steel STPG 370-E	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)						
		[NK-II]	15-40	DR 03 Seamless steel STPG 370-S	DR 03 Sch 40 (BB)				JIS 16K Flange	Bronze BC 6	Bronze or Brass											
AS 04 DR 04	0.35 0.35 MPa STEAM AND DRAIN (TO DRAIN TRAP)	W:0.68 (*9 (except EX line) X 147.2°C	550 & over 50-500	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	Welded pipe branch	C, (3)						
EX 02	STEAM EXHAUST		15-40	AS 04 EX 02 Electric resistance welded steel SGP-E (*11)	AS 04 EX 02 (A)				JIS 16K Flange	Bronze BC 6	Bronze or Brass			D2 for EX 02								
DR 05 EX 01	ALL DRAIN AFTER STEAM TRAP, ESCAPE LINE FROM STEAM SAFETY V. & RELIEF V.	Below 0.2	550 & over 50-500	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)						
			15-40	EX 01 Electric resistance welded steel SGP-E (*11)	EX 01 (A)					Bronze BC 6	Bronze or Brass											
				DR 05 Seamless Steel STPG 370-S	DR 05 Sch40 (BB)																	



( 22 )

## SECTION 2. TABLE OF PIPING &amp; FITTINGS

## (1) SYSTEM MARK

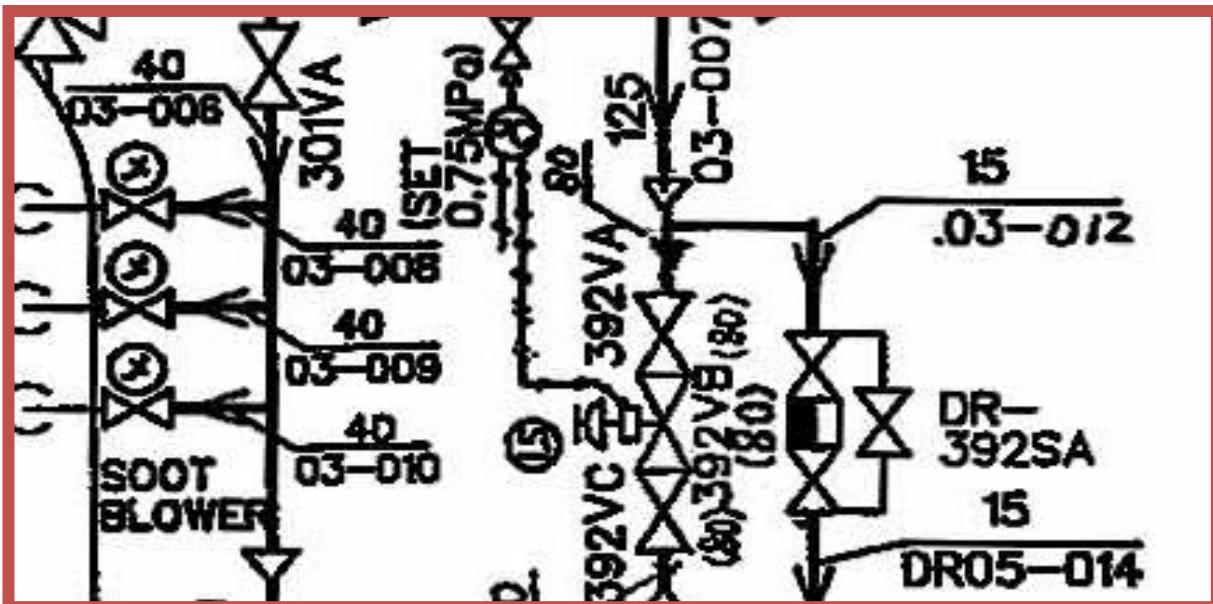
MARK	SYSTEM	MARK	SYSTEM
AS	Aux. Steam piping	FH	Hot water piping
EX	Exhaust steam piping	FD	Feed water & condensate water piping
DR	Drain piping	LO	Lubricating oil piping
CW	Main engine cooling sea water system	FO	Fuel oil piping
		DO	Diesel oil piping
SW	General sea water system & aux. cool. sea water system	WO	Waste oil piping
		CA	Compressed air, general serv. & control air piping
BS	Bilge & deck scupper piping	GE	Exhaust gas piping
		GL	Oxygen & acetylene gas piping
SL	Soil piping	CE	CO <sub>2</sub> gas piping
FR	Cooling fresh water, fresh water & drink. water piping	EI	Inert gas piping

12.4 DIMENSIONS AND MATERIALS OF PIPES12.4.1 Steel PipesDimensions

Nominal Diameter mm	Outside Diameter mm	Wall Thicknesses 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	15.1	21.4
300	318.5	6.9	10.3		17.4	17.4	25.4



Item	Symbols	Name	Remarks
		Valve (globe & angle)	(1)
		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)	(2)
		Foot valve	(2)
		Cock	(1)
		3-way cock (T & L type)	(1)
		Gate valve	(1)
Standard valves		Hose valve (globe & angle)	(2)
		Non return hose valve (globe & angle)	(2)
		Butterfly valve	(5)
		Storm valve (vertical :○, horizontal:○)	(5)
		Storm valve (vertical :○, horizontal:○) with handle	(5)
		Storm valve 135°	(5)
		Valve manifold	(2)
		Diaphragm 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		Sch.80		Sch.120
			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:**

- | <b>1</b>       | <b>Combined Material &amp; Thickness Symbol</b> | <b>JIS Material Designation</b> |
|----------------|---|---------------------------------|
| 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 TREATMENT MARK**

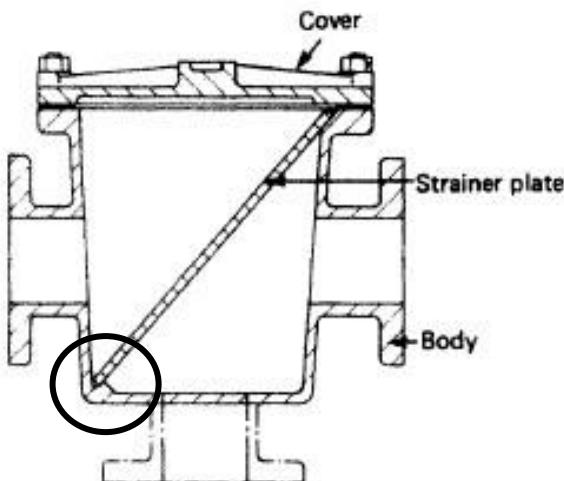
MARK	PIPE TREATMENT	MARK	PIPE TREATMENT
A	Insulation ( $401 \leq t < 515^{\circ}\text{C}$ )	G	Galvanization
B	Do. ( $t \geq 301^{\circ}\text{C}$ )	G3	Parkerizing
C	Do. ( $t \geq 205^{\circ}\text{C}$ )	L	Synthetic rubber lining
D1	Do. ( $t \geq 185^{\circ}\text{C}$ )	L2	Polyethylene lining
D2	Do. ( $t \geq 155^{\circ}\text{C}$ )	L3	Tar epoxy coating
F	Do. ( $t \geq 101^{\circ}\text{C}$ )	P	Acid pickling and VPI filled
I,L	Do. ( $t \geq 60^{\circ}\text{C}$ )	S	Acid pickling and oil coat
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
R	Insulation for I.G pipe	X3	(Radiograph test)
R1	Insulation for up-tank	Y	Stress relieving
Z	Non treatment & other treatment	WO	water pressure test (Shop with class)



Item	Symbol	Name	Remarks
General		Pipe line (cross)	(2)
		Pipe line (connecting)	(2)(1)
		Sprinkling pipe	(4)
		F.O. pipe with tracer	(4)
		Capillary tube	(2)
		Control air line	(2)
		Hydraulic line	(2)
		Electric wire	(2)
		Overboard discharge	(2)
		"U" seal	(4)
		Pipe going upwards	(5)
		Pipe going downwards	(5)

## Mud boxes

Mud boxes are fitted into the machinery space bilge suction piping. The mud box is a coarse strainer with a straight tailpipe down to the bilge. To enable the internal perforated plate to be cleaned when necessary, the lid of the mud box is easily removed without disconnecting any pipe work.



## Suction pipes

Suction pipes in tanks should be arranged with a bell mouth or foot. The bell end or foot should provide an inlet area of about one-and-a-half times the pipe area. It should also be a sufficient distance from the bottom plating and nearby structure to provide a free suction area, again about one-and-a-half times the pipe area.



## Steam traps

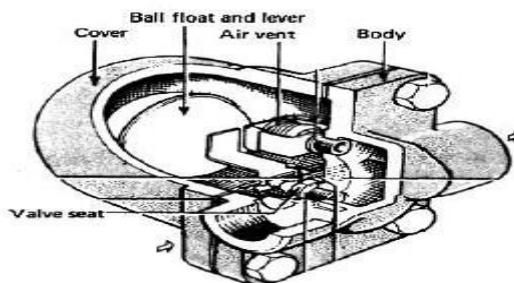


Fig: Steam trap

A steam trap does as its name implies and permits only the passage of condensed steam. It operates automatically and is situated in steam drain lines. Various designs are available utilizing mechanical floats which, when floating in condensate, will enable the condensate to discharge. Other designs employ various types of thermostat to operate the valve which discharges the condensate.

## Expansion pieces

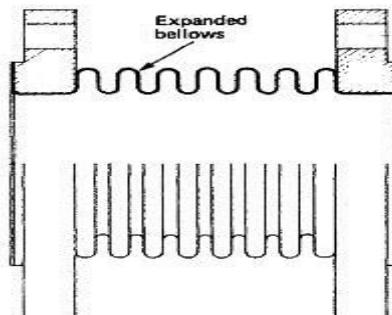


Fig: An Expansion bellows piece

An expansion piece is fitted in a pipeline which is subject to considerable temperature variations. One type consists of a bellows arrangement which will permit movement in several directions and absorb vibration. The fitting must be selected according to the variation in system temperatures and installed to permit the expansion and contraction required in the system.

## Drains

Drains are provided in pipelines and usually have small cocks to open or close them. It is essential that certain pipelines are drained regularly, particularly in steam systems. When steam is admitted to a pipeline containing a reasonable surface of water it will condense and a partial vacuum occur: the water will then be drawn along the pipe until it meets a bend or a closed valve. The impact of the moving water in the pipe work will create large forces known as 'water hammer', which can result in damage to pipe work and fittings.

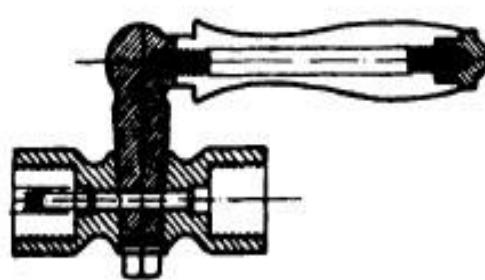
## Different type valves for ships use

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.



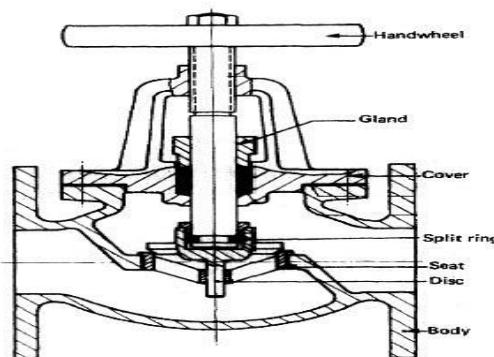
## Cock

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:



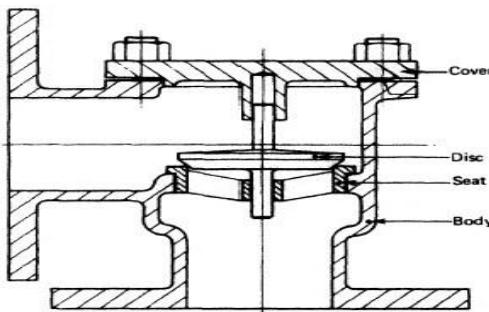
## Globe valve

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.



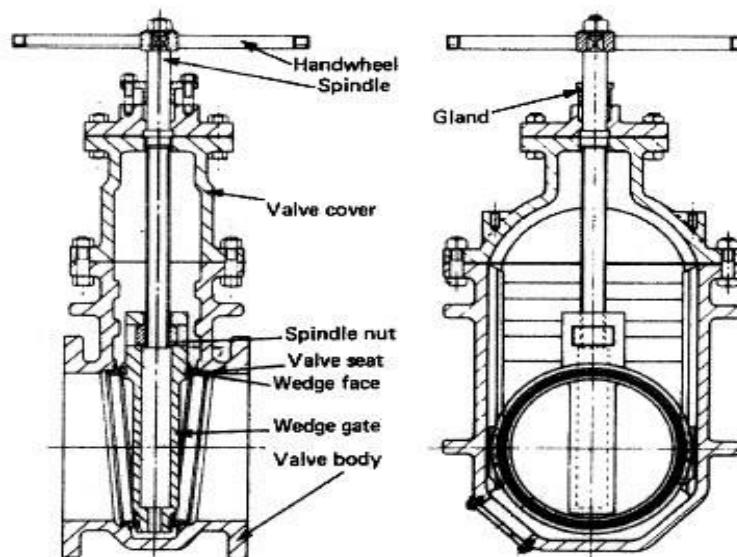
## Non-return valves

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.



### 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.



### Engine Room Bilge Water Treatment

#### Bilge Disposal Procedures (Including Piping Arrangement)

1. Precaution in handling bilge water
  - a. Bilge control is very important thing. Pay attention to leakage from fresh water/ sea water pump glands and broken piping during inspection rounds.
  - b. Never discharge any bilge water directly overboard except in emergency cases.
  - c. Bilge disposal requires caution at all times. Keep in close contact with the duty engineer and request his instructions.
  - d. It is important to be well versed in the operating procedures of the piping system and machinery system for bilge handling.
2. Requirements for automatic starting of the bilge pump
  - a. Is the starting switch for the bilge pump in the "Remote" position?

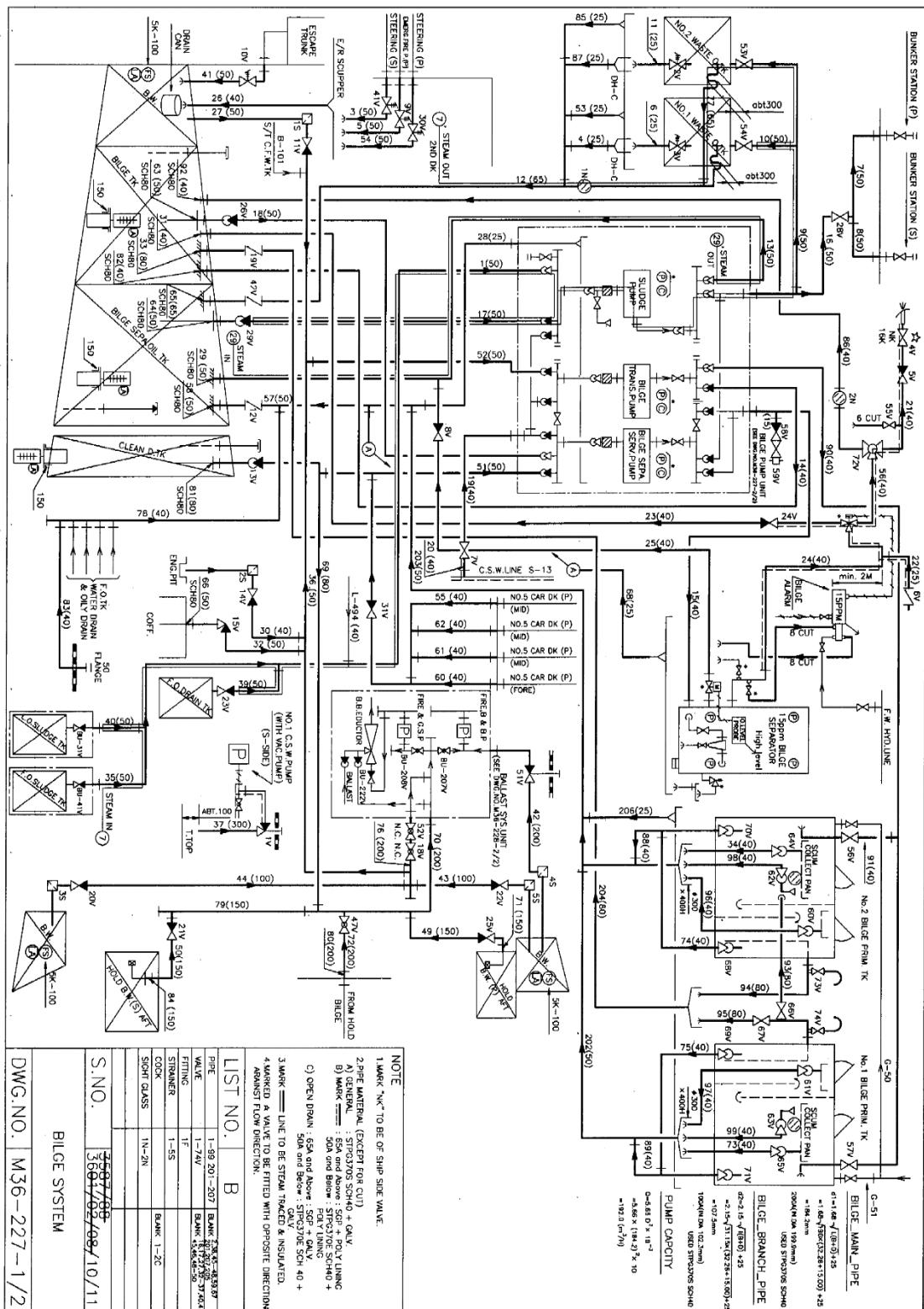


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- b. Is the primary tank not at a “High level”?
  - c. Is the bilge well limit switch not actuated?
3. Line up **AFT BILGE WELL – WASTE OIL TANK.**

Primary tanks are equipped with float switches for giving a high level alarm and stopping the bilge pump. When discharging the water portion, take care not to contaminate the bilge tank with oil.

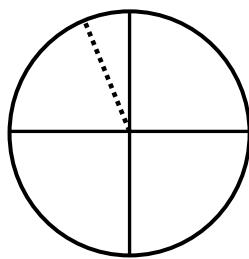
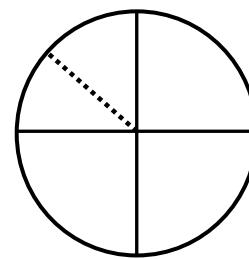


## Opening and Closing of steam valve

- Before opening the valve drain the steam line to make sure that water are no longer present in system.
- Slightly open the valve 1/16 and check for any abnormal sound such water hammer; it is usually happening depending on the steam pressure.



- After opening the valve to 1/16 turn, further open the valve to 1/8 and observed for any sound of water hammer if hammer occur reduce the opening of the valve or totally close again, additional drain to be carried out.
- Resume opening of the valve slowly to one turn, the more the pressure on both sides the more noise of steam when passing through the pipe.
- When the noise reduces, increase the opening of the steam valve until it reaches full open position.
- Other high pressure valve the same procedure to be followed.

**1/16 Valve Opening****1/8 Valve Opening**

## PROPER DRAINING OF STEAM LINE

Be sure to wear safety goggles, boiler suit and leather gloves before draining any steam line.

Position yourself away from the direction of the outlet of the steam drain valve if you suspect that the line is pressurized. Even if the line has no pressure, it is still advisable to stay on the safe side. Then crack open the steam drain valve or cock. Once condensate comes out from the line, slowly open the steam drain valve until it is fully opened. Finally, when steam comes out from the line, you can now close the steam drain valve.

## 8. PROCEDURE FOR HANDLING CHEMICALS

### Safe Handling of Chemicals

- Know the hazards involved with all chemicals you will be working with before starting the work.
- Know the types of protective equipment available and use the proper type for each job.
  - Splash goggles are required whenever a splash hazard exist. Safety glasses are only suitable in situations where physical hazards exist.
  - Closed-toe shoes, preferably leather, that cover the entire foot are required for the worker.
  - Gloves are chemical specific. Gloves suitable for one chemical may not be adequate in protecting against another. When working with a highly toxic substance, be sure you are using the proper gloves.
  - Coats and aprons are available for the crew. Heavy duty aprons are available when using concentrated acids and bases.
- Know the location of and how to use the emergency equipment on board in which you are working.



- Use caution when transporting chemicals:
  - Transport chemicals on a cart that can contain a spill.
  - Use a non-breakable, secured secondary container for transporting a hazardous chemical that exceeds 1 liter or 1 kg.
  - Do not ride the elevator when transporting compressed gas cylinders or cryogens. Place a prominent sign on the cylinder warning others not to board the elevator.
- Avoid unnecessary exposure to chemicals by any route (inhalation, absorption, ingestion or injection)
- Do not taste any chemical and always use the proper technique when smelling a chemical.
- All persons, including visitors should wear proper personal protection, wherever chemicals are stored or used.
- Avoid consuming food or beverages in areas where chemicals are being used or stored.
- Avoid hazards to the environment by following accepted waste disposal procedures.
- All chemicals must be correctly and clearly labeled.
- Avoid distracting or startling any other worker. Practical jokes or horseplay cannot be tolerated at any time.



## Chemical Storage

- Chemicals shall be segregated by hazard classification and compatibility. The following list can be used as a guide for segregating chemicals by hazard classification. A list of common incompatible chemicals.
- Storage Compatibility:
  - Inorganic acids
  - Caustics
  - In organics
  - Oxidizers
  - Water Reactive
  - Toxic - carcinogens, reproductive hazards
  - Flammable
  - Organic Peroxides
- Keep chemicals away from heaters and sunlight.
- Annual inspections of all containers for seal, label integrity, warning labels, quantity on hand, and any signs of decomposition.
- Labels on stored chemicals should be able to be read easily.
- Large quantities of chemicals should be stored in the chemical storage appropriate room.



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## Material Safety Data Sheet (MSDS)

A Material Safety Data Sheet (MSDS), Safety Data Sheet (SDS) or Product Safety Data Sheet (PSDS) is an important component of product. It is intended to provide workers and emergency personnel with procedures for handling or working with that substance in a safe manner, and includes information such as physical data (melting, point, boiling point, flash point, toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill-handling procedures. MSDS formats can vary from source to source within a country depending on national requirements.



## Arc Welding Safety

The light emitted from an electric arc is very intense and rich in short wave length radiation such as ULTRA VIOLET RAYS given off by the arc. For this reason it is essential that the eyes particularly and skins are protected from this radiation. A flash from an electric arc can cause severe irritation to eyes several hours after it has happened. Safety equipment must be used at all times.

### Personnel safety measure

#### Welding Mask

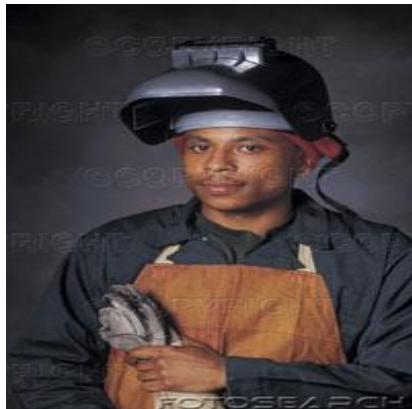
The obvious precaution is to prevent the harmful radiations from the welding arc and the molten pool from damaging the eyes. This is achieved by the used of special Filter Glass of suitable color and density which also reduce the intensity of the visible light rays.

For all arc welding operations it is essential to protect the welder's eyes and head from radiation, spatter and hot slag, and for this purpose either a helmet/headgear type or a hand shield must be worn. Helmet/headgear type is usually fitted with an adjustable band to fit the wearer's head. It is designed to pivot so as to provide two definitely located positions:

- Lower in front of the face- welding position protection and, rise in a horizontal position to enable the welder to see when not striking the arc, but the latest



version of welding mask is solar mask that it is no longer to lift up the mask to make out with the work piece.



Standard welding mask



solar welding mask

## Body Protection

The welder's body and clothing must be protected from radiation and burns caused by flying globules of molten metal. It is necessary for a welder to wear welding gloves, welding sleeves, working boots and apron to protect the whole body. Chest, arms, hands, legs and feet should be protected.

## Screens

People working in the vicinity of a welding arc, including other welders or helpers can be exposed to stray radiation from the arc that can cause considerable discomfort.

## Basic Elements of arc-welding

### Cables / The external arc -welding circuit

This is normally set up by the welder himself. There are three important connections for every welding circuit. Please refer to Fig. 6.0 and 6.1 regarding these connections.

1. The **welding lead**. This is used for carrying the welding current from the power source to the ELECTRODE HOLDER.
2. The **welding return cable**. This is the connection for carrying the 'return' current between the 'work' by a special spring or screw clamp which is properly secured to one end of the cable.
3. The **welding earth**. This is necessary on all welding circuits to maintain the work piece and any other conductors or metal structures that may come in



contact with it at EARTH POTENTIAL. A metal platform directly connected to hull structure is a mean of providing a welding earth.

## Oxy-acetylene welding

### Introduction

Use of the oxy-acetylene welding ranges from repairing or salvaging large maintenance equipment to repairing smaller items such as kitchen chairs and other household articles.

The oxy-acetylene welding equipment is used for welding, cutting, heating, bending, and soldering. With a wide assortment of different sized welding and cutting torches and a good selection of tips, the torch can supply sufficient heat for various thicknesses of metals. Many things can be repaired if the repairman is a good welder.

The oxy-acetylene flame produces a very high temperature; in fact, it is the hottest flame known, approximately 3482° C.

Misuse of the oxy-acetylene torch can cause injuries, fires, and other dangers. However, with reasonable care and knowledge, the torch is as safe as any hand tool. Carelessness in handling the equipment and cylinders and failure to exercise precaution when using the torch around flammable can make the torch a very dangerous tool. Most injuries and damage are caused by human error rather than equipment failures.

### Safety measures to be observed during gas welding

No one should try to operate the oxyacetylene until properly trained for its use or working under competent supervision. Makers' recommendations should be observed and operating principles should be closely followed.

Before commencing in any work, the need for protective equipment should be the first consideration. Goggles are essential to protect the welder's eyes from heat, glare particles of hot metal and scale. Protective clothing are usually made of wool which are not to be readily flammable.

Fire hazards may arise from sparks and slag falling on adjacent combustible materials. Safety equipments should be regularly inspected to avoid risk of explosion.

### Storage of the Gases in Cylinders

Note: Never leave a cylinder either empty or full to stand by itself without adequate support.

Oxygen cylinders must be upright position and away from heat. Always keep the cylinder valve closed when empty to avoid having foreign particles enter the cylinder. Keep oil or grease away from the cylinder, especially from the valve. Do not strike an electric arc on the cylinder because it may cause it to rupture.



The cylinder valve is made of forged brass and made to withstand high pressure. The valve is called a back seated or double seated valve. The back-seated part of the valve, seals off the thread to prevent oxygen from escaping. The cylinder valve must open all the way to seal the threads. Partially opening the valve will waste oxygen. Oxygen valve have right-handed threads.

Each valve is equipped with a safety pressure disc that will burst when the pressure gets too high (caused by excessive heat.). This will prevent a rupture of the cylinder.

Never use oil or grease on a cylinder or any part of the welding set-up at any time because a serious fire or explosion could result. Fig B shows the parts oxygen and acetylene bottle.

The cylinder is painted different colors for different gasses; however, the colors may vary with each manufacturer or distributor.

It is not advisable to use the oxygen cylinder after the pressure is down to 100 psi (690 kPa) welding or 200 psi (1380 kPa) for cutting because a serious backfire could result if the oxygen pressure were less than the acetylene.

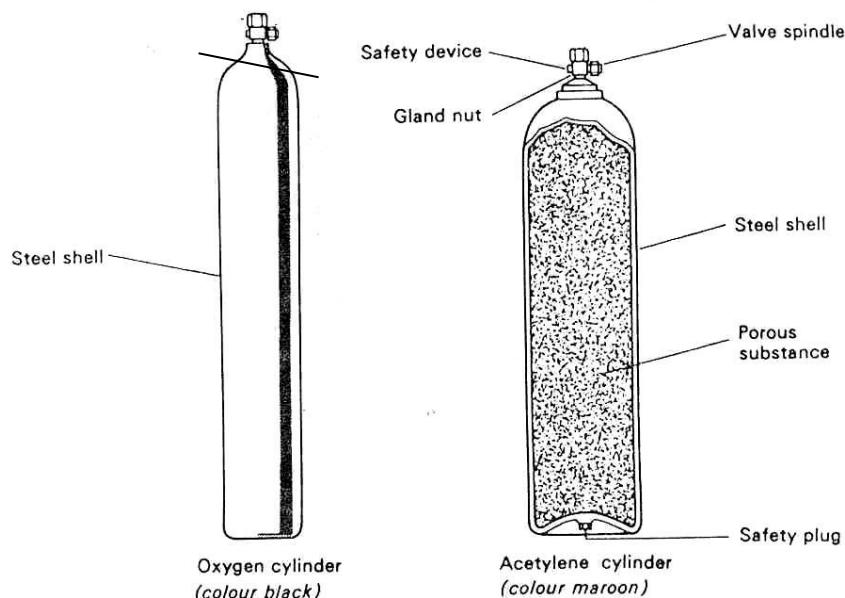


Fig. B Oxygen and acetylene bottle

## Acetylene Cylinder

Acetylene must be stored in a different type of cylinder than that used for oxygen. Acetylene cannot be stored in a hollow cylinder at a pressure over 15 psi (103 kPa) in a gaseous form because of its explosive nature. In order to store acetylene in a cylinder at a pressure up to 250 psi (1750 kPa), the cylinder are filled with a porous material such as Fuller's Earth or wood pulp, depending on the manufacturer. Next, acetone is added and is absorbed by the porous material. Acetylene is then pumped into the cylinder to a pressure of about 250 psi (1720 kPa).



The acetone readily absorbs many times its own weight of acetylene. In addition, the porous material prevents pockets of acetylene. In addition, the porous material prevents pockets of acetylene gas from accumulating. This method is the safest way to store acetylene. Some cylinders have concave bottoms and two safety plugs that will melt out at around 220 °F (104 °C) to relieve the pressure in case of excessive heat.

Note: As state, one gauge indicates the approximate amount of regulated pressure or cylinder pressure. This means that not all regulators will indicate the exact pressure; the gauges may have become worn out or damaged by handling.

One indication of the gauges not being accurate is when the acetylene regulator is set at 5 psi (34 kPa) and the torch will not light. However, by setting the regulator at 10 psi (68 kPa), the torch will light. This means that the regulator gauge is off or out of calibration. Also, when the cylinders are shut off and the gas drained from hoses, the low pressure gauge may indicate pressure.

Opening the cylinder valve too fast, especially the oxygen cylinder; is one of the main causes of damage to the gauge. Most gauges use a Bourdon tube which tends to straighten out as the pressure increases.

## Hoses and Fittings

The hoses are to carry the gasses from the regulator to the torch. The hoses must be of special construction and made of a non-porous material to withstand pressure, to take abuse and to be unaffected by either oxygen or acetylene gas. A good hose is made in four layers: a high quality gum inner liner, then two layers of strong fabric, and finally, a tough rubber outer covering. The oxygen and acetylene hoses are either fastened together by vulcanizing or by clips to avoid tangling. Most acetylene hoses are colored red with left-handed grooved ferrules or nuts. The oxygen hoses are either green or black and have right-handed ferrules or nuts. Fig. C shows the type of hoses and fitting used in oxy-acetylene welding.

Note: Do not attempt to use an acetylene hose for oxygen because a combustible mixture could result; do not switch the fittings.

Caution: Avoid dropping sharp objects or hot metal on the hoses. A rupture in the hose could cause a fire. Avoid kinking the hoses because it will hinder the flow of gas.

Be careful with the hoses and make sure that it will not be cut by sharp objects and be subjected to heavy weights which will restrict the flow of gas. Never, repair a broken line with a piece of copper tubing because the tubing could cause a chemical reaction.

Two types of valve are used for acetylene cylinders. One type use a hand wheel, the other type uses a square shank and key.

Note: When the cylinder is being used the regulators must be kept on the cylinder always to permit closing the valve in case of emergency:



The valves are of simple construction because of the lower cylinder pressure as compared to the pressure in the oxygen cylinder. The tops of the cylinder vary, some have recessed tops to protect the valve while the others have tops shaped similar to the oxygen cylinder, but the cylinder is wider.

The acetylene cylinder has left-handed threads on the cylinder outlets to avoid putting the wrong regulator on. The oxygen regulator is made to withstand a much higher pressure as compared to the acetylene regulator.

**Caution:** Never attempt to transfer acetylene from one cylinder to another cylinder or container'

**Note:** Acetylene is sold by weight, not by pressure. This is determined by weighing the cylinder after it is fined and subtracting the weight of the empty cylinder'. The difference is multiplied by 14.5 (14.5 cubic feet equal to 1 pound 410.5 liters is equal to 0.453 kilometers).

**ALWAYS** store acetylene cylinders in an upright position as acetone may enter the valves and gauges.

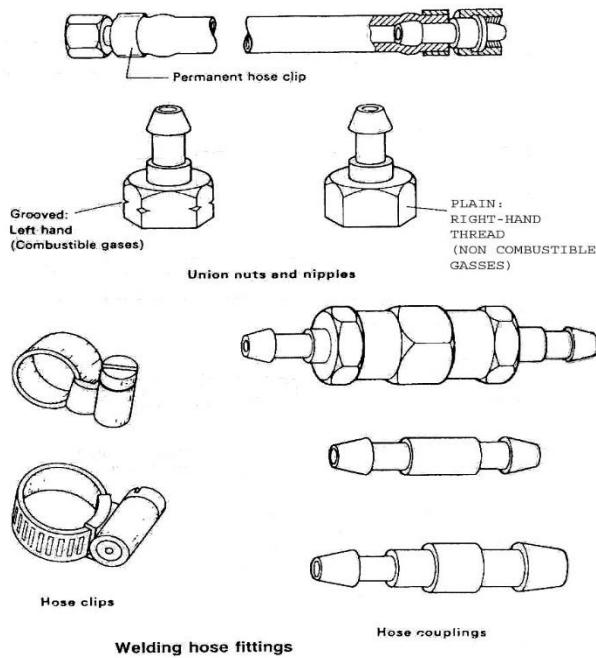


Fig. C Welding hoses and fittings

## Regulators

It was noted that the pressure of the cylinder is about 2200 psi (15,170 kPa), while the acetylene is about 250 psi (1720 kPa). This pressure is too high to be used for welding. Therefore some means must be used to reduce the pressure so that it is suitable for welding or cutting. Moreover, a constant pressure must be maintained for welding. Regulators are used for this purpose.

The regulator will maintain a constant pressure at the torch even though the pressure of the cylinder decreases as the gas is consumed. On some occasions, some regulators may have to be readjusted as the cylinders become nearly empty.



Regulations are high quality; sensitive instruments made for accurate regulation of pressure but are made rugged enough for shop handling. The regulators for both acetylene and oxygen operate on the same principle. Each regulator has two gauges, one indicates the approximate cylinder pressure and the other is for the approximate amount of regulator pressure that will be delivered to the torch as shown in Fig. D.

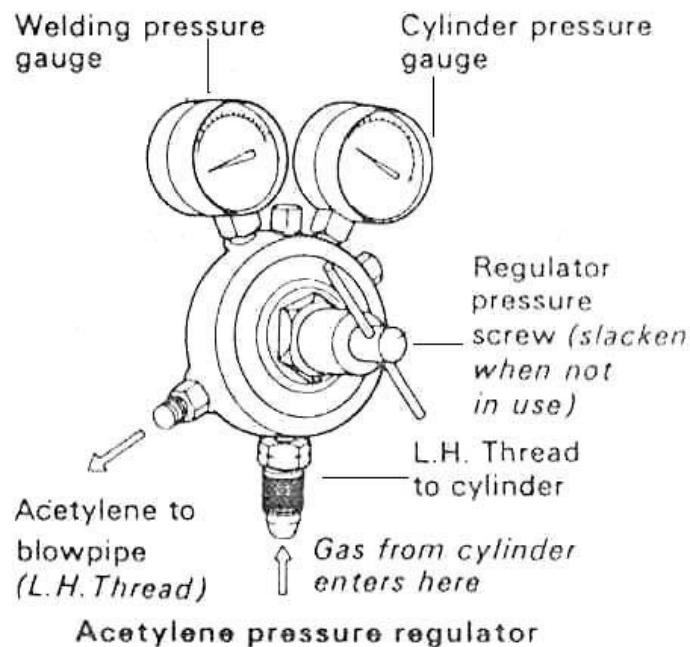


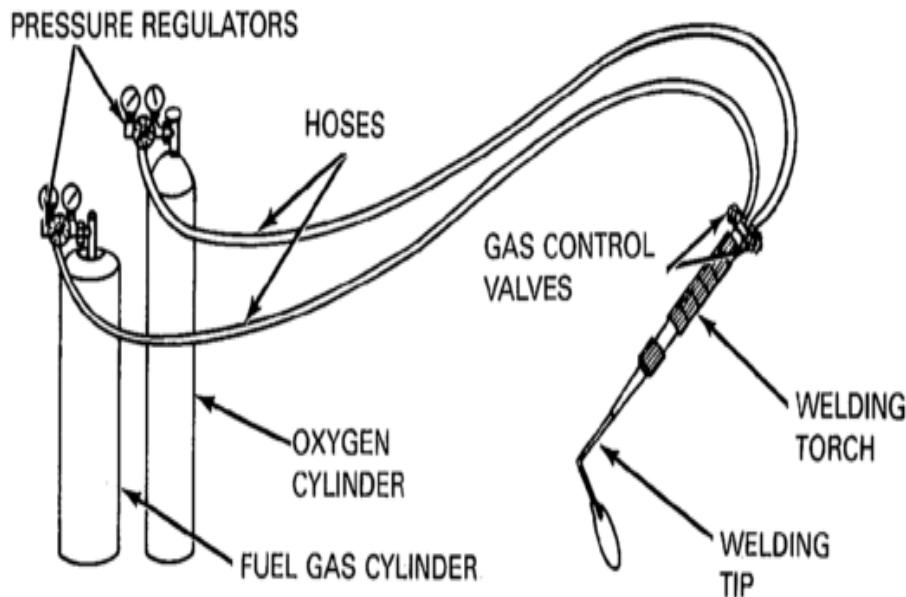
Fig. D Oxy-acetylene pressure regulator

### Spark Arrestor





## Basic Gas Welding Arrangement



*Note: some pictures are taken from internet sites.*