



# Massachusetts Maritime Academy

EN-1112 Engineering Systems and Safety  
Lab Manual  
Fall 2017



# Lab 1: TS Kennedy Engineering Spaces Tour and Safety Equipment

## Outside Areas:

### Main Deck

- Fire Plans (P & S Side)
- Emergency Diesel Generator
- Refrigeration Boxes
- Watertight Door Controls

### Steering Gear Room

- Sound Powered Phone
- Eyewash Station
- Egress/Access
- Fire Station
- Life Jacket Storage Box

## Engine Room:

### Boat Deck

- Life Jacket Storage Box
- Egress/Access Main Deck
- Fire Station

### Upper Tween Deck

- Life Jacket Storage Box
- Potable Water Tanks
- Eye Wash Station
- Egress/Access

### Operating Level

- Evacuation Alarm
- Fire Station
- General Alarm Bell
- Sound Powered Phone
- CO<sub>2</sub> Alarm
- Semi-Portable CO<sub>2</sub> Hose Reel
- Portable Fire Extinguisher
- Remote Start for Fire Pump
- Eye Wash Station
- Fuel Oil Discharge Strainer
- EEBD

### Upper Tween Deck

- CO<sub>2</sub> Room
- Remote Fuel Oil Shutdown
- Forced Draft Fan Shutdowns
- CO<sub>2</sub> Release Stations
- Wärtsillä remote LO/FO shutdowns

### Aft MSD

- Eyewash Station

### Two Hold Lower Tween Deck

- Pressurized Sprinkler Tank

### Lower Level

- Fire Pump
- Fire Station
- Fuel Oil and Lube Oil Strainers
- Eye Wash Station
- Watertight Doors
- FO Pump Start and Stop Buttons
- Portable Fire Extinguisher
- Shaft Alley
- Escape Trunk
- Fire Pump
- Potable Water Tanks
- EEBD

### AMR

- Sound Powered Phone
- Eye Wash Station
- Fuel Oil Strainers for Wärtsillä
- Forward Escape
- Aft Escape Trunk
- Portable Fire Extinguisher
- Fire Pump and Fire Station
- Life Jacket Storage Box
- CO<sub>2</sub> Release Stations
- Fuel Handling Room

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## Lab 2: Main Steam Cycle / Boiler Accessories

### Main Steam Cycle

**Purpose:** The purpose of this lab is to locate and explain the components of the main steam cycle. A detailed explanation of these components is included in the textbook.

**Steam Drum:** The drum is located near the top of the boiler. There should be a normal water level (half full) indicated by the gage glass on the steam drum. (600 PSIA, 486 F)

**Dry Pipe:** Located inside the steam drum near the top of the drum. Used to remove moisture from the steam.

**Superheater:** Steam collected in the dry pipe is directed to the superheater section of the boiler, where its temperature is raised above the saturation temperature. The superheater located in the hottest portions of the combustion gas path. (600 PSIA, 850 F)

**Main Steam Stop Valve:** Located on the outlet of the superheater. Used to connect or isolate the boiler from the rest of the steam cycle.

**Bulkhead Stop Valve:** Located in the main steam line, downstream of the main steam stop valve, and provides backup protection for it.

**Steam Strainer:** Located in the steam line upstream of the main engine to prevent objects other than steam from entering the turbines. If solid objects impact the turbine blades this would quickly destroy the turbine.

**Throttles:** The throttle valves are the primary valves used to control the amount of steam to the turbines. There is an ahead and astern throttle. The ahead throttle controls the amount of steam to the High Pressure Turbine. The astern throttle controls the amount of steam to the Low Pressure Turbine. The astern guardian valve protects against astern steam leakage.

**HP Turbine & LP Turbine:** Used to make the ship go ahead or astern. Takes the steam and uses it to extract power. The HP turbine makes the ship go ahead. The last stages in the LP turbine makes the ship go astern. There is a cross-over between the HP and LP turbines for ahead use.

**Main Condenser:** Is a shell and tube heat exchanger which provides a low pressure area for the turbine to discharge into. The steam is then condensed and the condensate is collected in the *hot well*. The main condenser is operates in a 28.5 in HG vacuum or greater.

**Condensate Pump:** The condensate pump is a centrifugal pump that takes suction on the hot well and raises the condensate pressure enough to force the condensate up to the DC Heater.

**Air Ejector Condensers:** Used as a heat exchanger to raise the temperature of the condensate. Also used to create and maintain a vacuum on the main condenser.

**Gland Exhaust Condenser:** Uses steam that leaks out of the turbine glands and heats the condensate up as it continues through the steam cycle.

**First Stage Heater:** This unit contains two internal sections: the drain cooler and the first stage heater. LP bleed steam is used as a steam supply for the first stage heater which in return heats the condensate as it continues to the DC heater.

**DC Heater:** The direct contact heater, heats, stores, and deaerates. It uses 31-35 psi steam to heat the condensate, the tank stores the condensate, and it removes dissolved oxygen from the condensate. Once the condensate leaves the DC heater it changes into feedwater.

**Main Feed Pump:** Used to raise the pressure of the feedwater above the pressure inside the steam drum so that the feedwater can be forced back into the steam drum to being the cycle again.

**Feed Valves:** Check, Regulator, and Stop Valves. Used to regulate the amount of feedwater allowed into the boiler at one time. Also prevents the feedwater from flowing out of the boiler.

**Economizer:** Used exhaust gases to heat the feedwater one last time before entering the boiler. This improves the efficiency of the boiler and reduces the exhaust gas temp.

**Steam Drum:** The steam cycle has now been completed.

## Boiler Accessories

**Fire Eye:** This device is located on the boiler near the burners. It can tell if there is a fire in the boiler. If the fire goes out, the fire eye sends a signal to the solenoid valve to secure the fuel oil to the burner.

**Peep Hole:** This is located near the fire eye. It is a window on the boiler which allows you to look into the furnace to see the condition of the flame.

**Air Register:** The air register is located inside the boiler. It is opened under normal operations providing air to enter into the furnace.

**Diffuser Plate:** The diffuser plate prevents the full blast of incoming air from blowing the oil spray and flame away from the atomizer, but at the same time passes enough primary air through the slots to permit ignition of the oil spray.

**Burner:** Breaks up the fuel into a fine mist and sprays it into the furnace.

**Sprayer Plate:** Forces fuel into the furnace as small droplets. The fuel forms a cone that extends into the furnace.

**Eye High:** There are two sets of eye highs on the operating level. There are two located above the main console on the gauge board. There are also two located between the boilers. The eye highs are used to tell the water level in the boiler from the operating level without having to go up to Upper Tween Deck to look at the gauge glasses.

**DC Heater Water Level:** This gauge is the same as the eye highs. It is located above the logbook desk. It is used to tell the level in the DC Heater without having to go all the way up to it.

**Periscopes:** The periscopes are used to see how much the boiler is smoking. There are sets of mirrors with a light shining through the stack. The stack gasses pass between the mirror and the light. If there is clear smoke present, then you will be able to see the light. If there is black smoke, too much fuel and not enough air, or white smoke, too much air and not enough fuel.

**Tachometer:** This tells how many revolutions per minute the shaft is moving.

**Engine Order Telegraph:** This is how the Bridge communicates to the engine room in regards to the speed needed. The Bridge rings down a speed and the engineer on watch answers the Bridge by lining up the two needles in the instrument. The engineer then opens or closes the throttles to obtain the desired RPM.

**Boiler Pressure Gauge:** This tells the pressure in the steam drum, superheater, and desuperheater. There are two needles: one indicating the actual pressure, the other indicating the max allowable working pressure.

**Superheater Tubes:** Located at the hottest part of the gas passage.

**Mud Drum:** Used to help with the circulation of water throughout the boiler. The mud drum is also a point at which sludge and sediment are collected.

**Superheater Safety Valves:** Located on the outlet piping to the superheater. The valve lifts automatically if the pressure in the superheater becomes high. This valve will open first and then the steam drum safety valves will open to ensure flow through the superheater at all times. If the safety valves lift, you should secure the fires. The safety valves are piped to the atmosphere.

**Air Cock:** This fitting is located on the top of the steam drum. It is used when starting the boiler till the boiler is up to 20-30 PSI. It is also used when securing the boiler to prevent a vacuum. The air cock is also used to remove non-condensable gases.

**Steam Drum Safety Valves:** These valves are located on the top of the steam drum. They open automatically when the pressure gets too high in the steam drum. These valves are used to prevent the boiler from exploding.





## Lab 3: Fuel Oil and Lube Oil Service System

### Fuel Oil System Lower Level Engine Room

**Port and Starboard Fuel Oil Settlers:** The settlers are tanks that are used to store and heat the oil. If there is water present in the fuel, it will settle to the bottom of the tank. Both settlers are equipped with steam heating coils so the oil temperature can be kept between 110-120°F.

**High and Low Suction Valves:** The high and low suction valves on the settlers are used to take suction from the tank to the fuel oil pump. These valves are air operated. The low suction valve is used during normal operation. The high suction on the settler is used if there is water in the settler.

**High and Low Suction Valves before the Strainer:** Whichever valve is open at the tank, high or low; the corresponding valve must be open to the pump. They are rising stem valves, which makes it easy to see if the high or low suction is being used.

**Suction Strainer:** The suction strainer is a duplex strainer. It is located on the suction side of the pump. This type of strainer allows for changing and cleaning of the strainer without interruption in the fuel flow. The handle on the top indicates which strainer is in use (the handle is covering the in use strainer). When there is a pressure differential greater than 10 PSI, the strainer should be changed over and cleaned.

**FO Service Pump Steam Driven:** The steam driven pump is powered by a steam turbine. The steam comes from the 600 PSI desuperheated system. The turbine is connected directly to the pump. The pump is a screw type rotary pump. The steam driven pump is used as a stand-by FO pump.

**FO Service Pump Motor Driven:** This pump is also a screw type rotary pump. It is driven by an electric motor. The motor driven pump is a two-speed pump that has a remote control for starting, stopping, and speed selection, located on the control console.

Both fuel oil pumps have a discharge pressure capacity of 350 PSI and are equipped with a relief valve set at a pressure of 360 PSI which will relieve the pressure if it becomes too great on the suction side of the pump.

**Fuel Oil Meter:** The meter is used to keep track of how much fuel is burned per watch. It records in gallons. The meter is by-passed when the fuel is being pre-heated.

**Fuel Oil Heaters:** There are three fuel oil heaters. The heaters are used to heat the fuel so it can be burned in the furnace. The fuel oil heaters use 50 PSI steam to heat the fuel. It is a single pass shell and tube heat exchanger. The outlet fuel oil temperature from the heaters should be around 220°F. Only one or two heaters are in use at any given time. One will always remain as a stand-by.

### Fuel Oil System Operating Level in the Engine Room

**Fine Fuel Oil Strainer:** The duplex discharge strainer is located on the discharge side of the pump after the fuel oil heaters. The fuel in this strainer is under a higher pressure and temperature than the suction strainer. If you take the wrong cover off this strainer while it is in use, hot oil will spray everywhere and it is highly likely to start a fire. The strainer is operated and cleaned similar to the suction strainer.

**Combustion Control Valves:** This controls the amount of fuel being sent to the boiler. A signal from the master sender is used to automatically position this valve. The middle hand wheel can also control it.

**Solenoid Valves in between the Boiler:** These valves are used to turn off the fuel to the boiler in case of a low water alarm, force draft fan shut down, or when the fire eye does not sense a flame.

**Re-circulating Valve:** This valve is used to re-circulate fuel before you light off. It is also used to re-circulate the fuel if there is water in the fuel oil. This valve sends fuel back to the port settling tank and the suction side of the pump.

**Root Valve:** This valve is the first valve in the line to the boiler at the boiler front. You open this valve first, then trace the line to the burner and open the valves to the burner.

**Solenoid Valve:** The second set of solenoid valves is located at the boiler front. These valves are activated when the burner control is turned to light off.

**Burner Valve:** This valve is located on the boiler. This valve is opened to let fuel into the burner. It is a ball valve for easy opening and closing if the flame should go out.

## Lab 4: Lube Oil Service System

**Sump:** A storage tank for all the lube oil in the system, located under the reduction gear casing.

**Steam Driven Pump:** The steam driven pump is a 400 gpm, vertical, rotary screw pump. It is run off of 600 psi desuperheated steam and is usually kept in the stand-by mode.

**Motor Driven Pump:** The motor driven pump is a 400 gpm, vertical, rotary screw pump. Used as the main lube oil pump.

**Orifice:** Used to drop the pressure in the lube oil system from 70 psi to 12 psi.

**Thermostatic Mixing Valve:** This valve automatically controls the lube oil temperature, by regulating the flow either to the coolers or by passing them. The temperature of the lube oil must be maintained between 110-120°F.

**Lube Oil Coolers:** Used to cool down the lube oil if needed. Seawater passes through the tubes and is used as a cooling means. There are two lube oil coolers, each a shell and tube type.

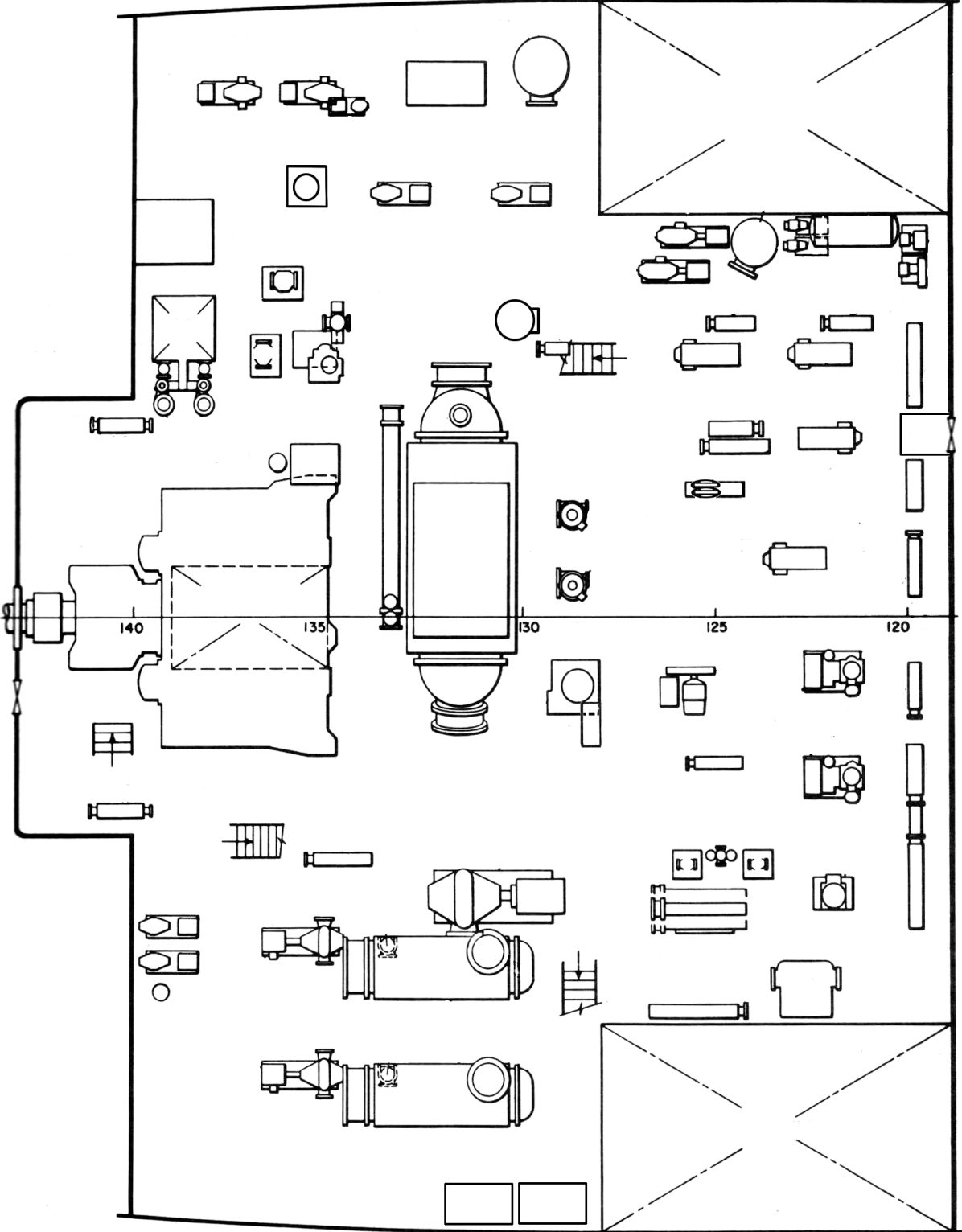
**Discharge Strainer:** This is a duplex strainer used to remove any sediment and metal before the lube oil goes to the reduction gears. There are magnets in the duplex strainer to remove any metal that might be present in the lube oil.

**Unloading Valve:** Used to maintain the correct pressure in the lube oil system. If the pressure becomes too high, the valve will open discharging some of the lube oil to the sump to lower the pressure.

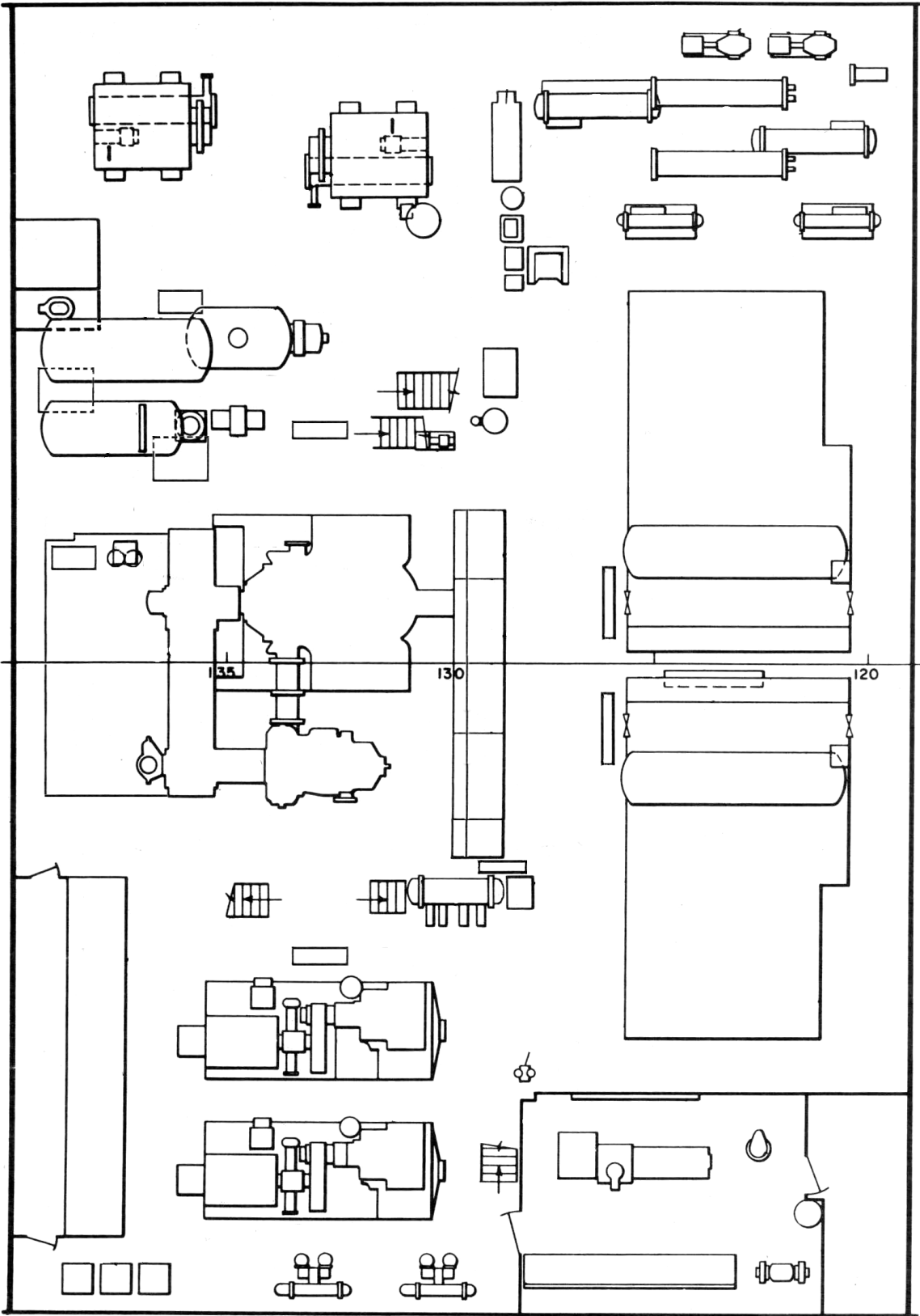
**Gravity Tank:** The gravity tank holds 1250 gallons of lube oil in case of an emergency. The lube oil is continuously replenished. The engineer can insure there is lube oil in the gravity tank by seeing the overflow of lube oil through the bull's eye.

**Reduction Gears:** The lube oil is distributed over and around the reduction gear and bearings to keep the metal cool. There should never be a rise of the lube oil temperature greater than 40°F across the bearings.

# Lab 4: Engine Room Machinery Layout



LOWER LEVEL



UPPER LEVEL