BITS Pilani
Pilani Campus
Department of Management

PS-1 Report
Goa Shipyard Ltd.

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ABOUT GSL

- ISO 9001:2015 for Quality Management Systems (QMS), ISO 14001:2015 for Environment Management Systems, and ISO 45001:2018 for Occupational Health & Safety Management Systems
- operates under the administrative control of the Ministry of Defence, Government of India
- strategically located on the banks of river Zuari in Vasco Da Gama, Goa, a major international tourist destination well connected by its international airport and major port en route to all important shipping lines
- excels in designing and constructing modern patrol vessels with Steel and Aluminium hull structures

HISTORY

1957: Colonial government of Portuguese India established "Estaleiros Navais de Goa" shipyard to construct barges for the flourishing mining industry in Goa
1961: Military annexation of Goa takes place, shipyard falls into Indian hands, now requisitioned to build warships for the Indian Navy and the Indian Coast Guard


DECCAN HERALD

Goa Freed: Portuguese Surrender

ERA OF BLOOD & TEARS ENDS: PLEDGE REDEEMED

Military Governor Candeth Assures Safety & Security

Our Assessment Of Situation In Goa Correct, Says Nehru

- in-house design capabilities
- caters to both defense and commercial sector
- Patrols vehicles ranging from 29m to 110m

THE MODERNISATION PROJECT

- 4 phased plan includes:
  - integrated steel fabrication facility
  - dedicated building berths with shiplift and transfer systems
  - improved material handling capabilities
  - advanced crane facilities
- GSL seeks to achieve high-quality vessel production, cost competitiveness, shorter construction timelines, faster deliveries, increased capacity, and a diversified product portfolio
- based on a "product center concept." - streamlines the ship construction process by establishing four distinct multi-functional production complexes, each equipped for a specific stage of production
- minimizing workforce movement within the shipyard, optimizing equipment and tooling efficiency,creating a highly productive work environment while reducing capital investment and operating costs

THE MODERNISATION PROJECT

- Phases 1 and 2 of the Modernization Project were commissioned on May 21st, 2011
- capable of docking 120-meter vessels weighing up to 6,000 tons
- Ship Transfer Area spanning approximately 13,600 square meters
- India's first defense shipyard equipped with a modern shiplift facility for launching and docking ships

Upon completion of the project it is expected that:

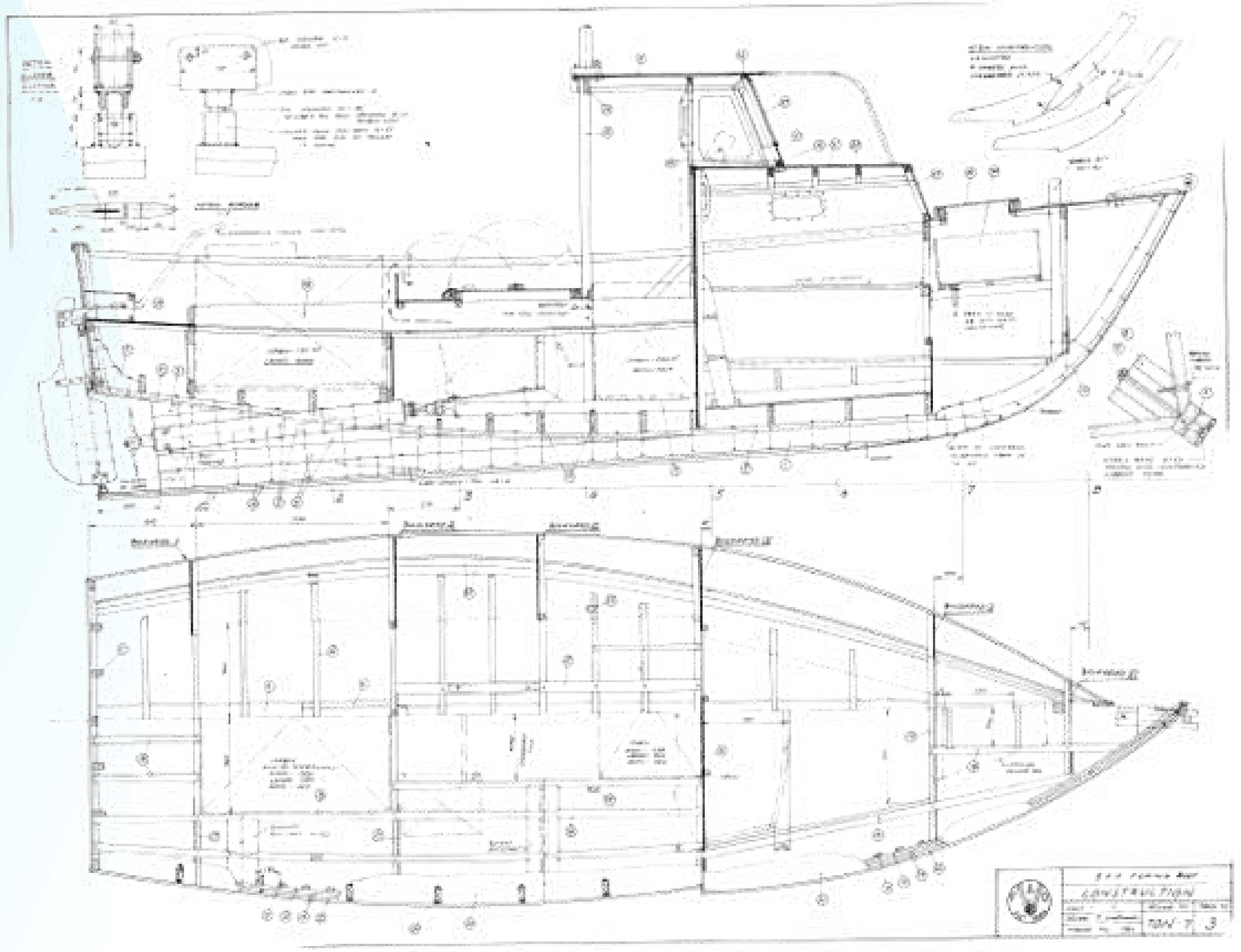
- Shipyard's capacity for fabricating steel, aluminum, and GRP hull vessels will nearly triple
- ship repair segment will experience a substantial increase

STRENGTHS

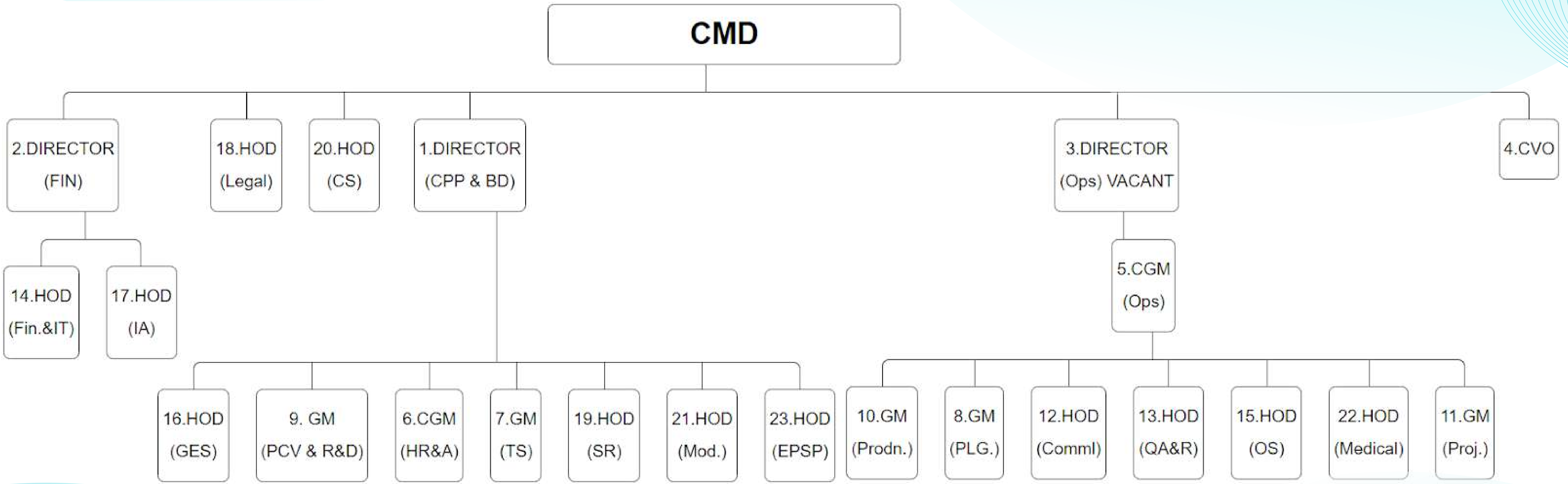
- ISO 9001:2015 certified
- world-class CAD/CAM facility utilizing the Tribon
- ERP-enabled management system integrated with design and planning applications, facilitating effective database management, project monitoring, and control
- state-of-the-art Shift Lift facility capable of accommodating vessels weighing up to 6000 tonnes
- modern steel preparation shop equipped with
    - CNC plate-cutting machines
    - automatic shot blasting equipment
    - CNC pipe bending machine
- modern electronic workshop
- skilled workforce of over 1700 personnel, including a team of more than 265 qualified engineers and naval architects

SERVICES OFFERED

- vessel design and construction
- simulated training facilities
- vessel repair and modernization
- supply of stern gear
- in-house design facility



ORGANIZATION CHART



OUTFITTING DEPARTMENT

- The outfitting engineering department deals with installation of machinery on the ship, their inspection, conducting trials and commissioning.
- Some of the various machineries that are installed are
    - Main engine
    - Gear Box
    - Shaft Generators
    - Bow Thrusters
    - Diesel generators
    - Fuel oil separator
    - Propeller
    - Fresh water generator
    - Fin stabilizer
    - Air compressor

PROPULSION SYSTEM

- Responsible for providing necessary power for movement of the vessel
- 3 important parts:
    - Engine
    - Shafting
    - Propeller
- Engine:
    - Serves as power source for propulsion system
    - traditionally diesel or gasoline IC engine
    - alternatively, can be gas turbines, steam turbines or electric motor
    - rotational energy generated, transferred to propellers via shafting

PROPULSION SYSTEM

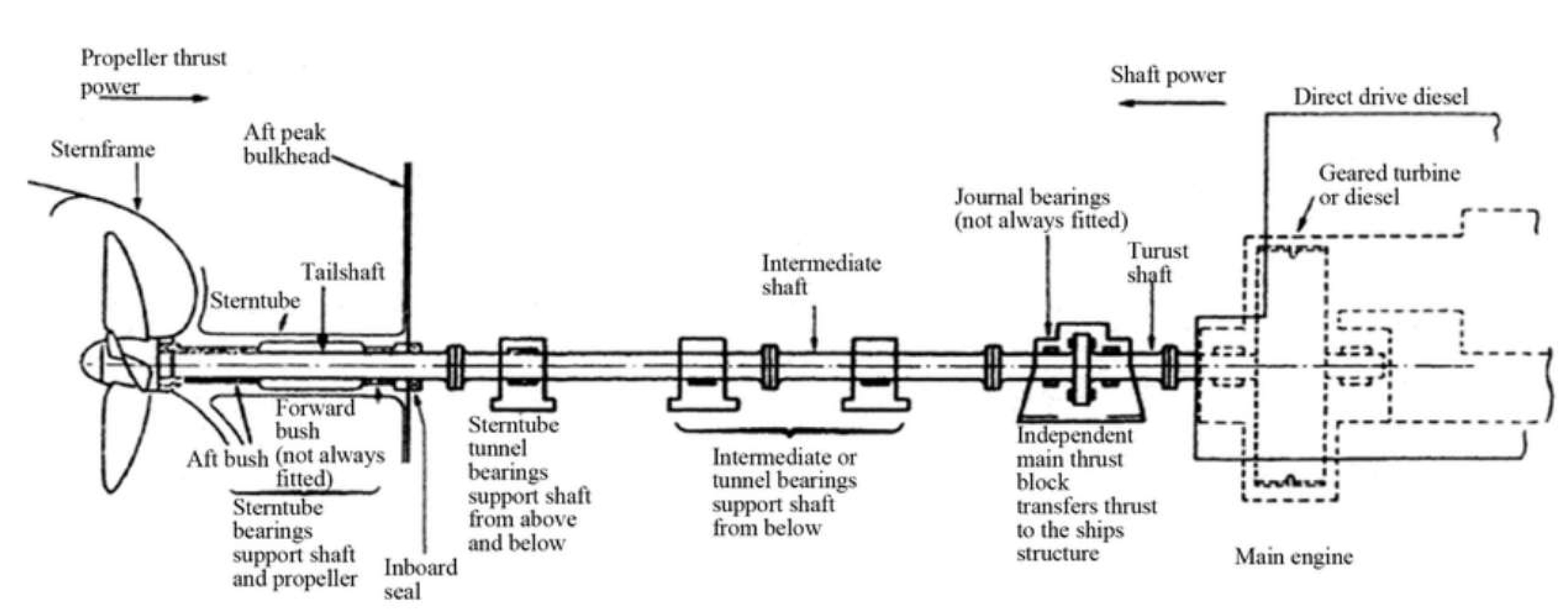
- Shafting:
  - mechanical arrangement of shafts, couples and bearings
  - transfers power from engine to propeller
  - primary shaft runs from output shaft of engine through hull towards propeller
  - sometimes assisted via intermediate shaft for support
- Propeller:
  - Converts rotational energy into thrust
  - blades attached to a hub
  - blades push water to generate thrust
  - adjustable blades to control various functions and optimize running
- Together these three systems work together so that ship can run smoothly.

ENGINES

- Engines can be mainly divided into 3 types:
  - Reciprocating Engines
    - Diesel
    - Gasoline
    - Steam
  - Turbine Engines
    - LNG
    - Kerosene/Marine Diesel
    - Steam
    - Nuclear-powered steam
  - Electric Motor
    - Purely electric (Batteries)
    - Hydrogen Fuel Cell
    - Azipods paired with DGs

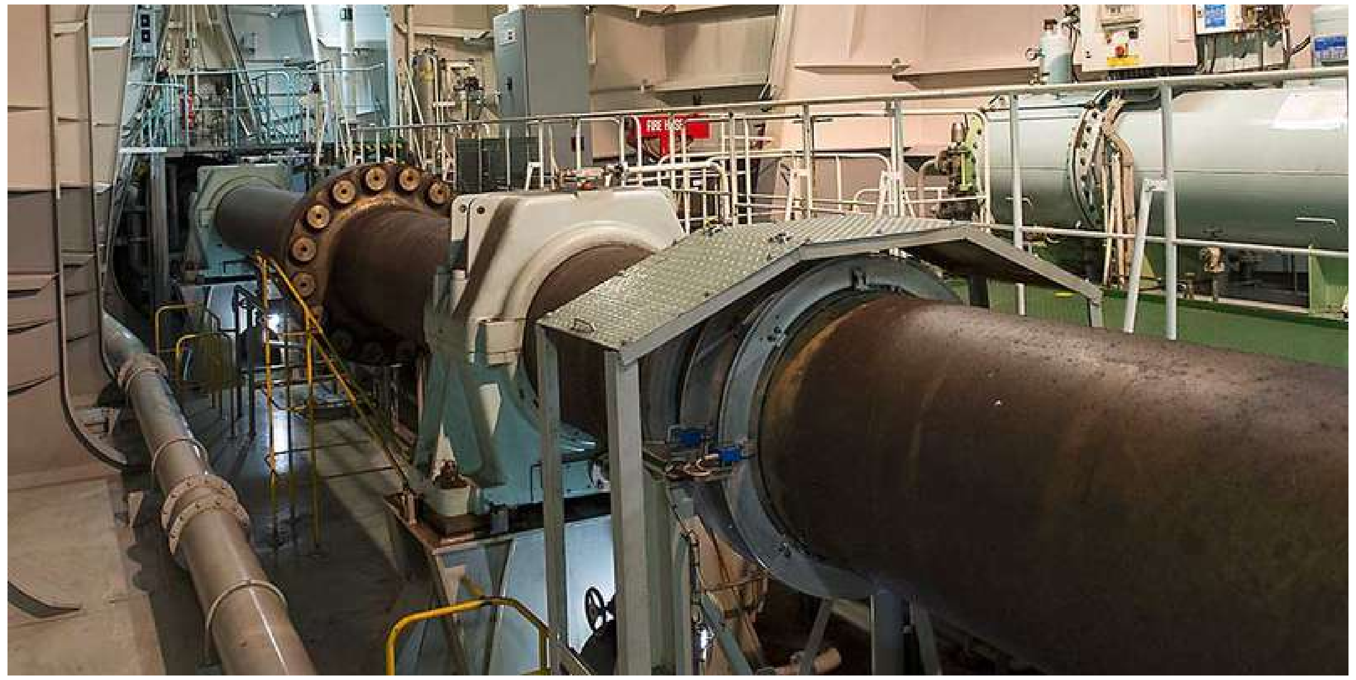
SHAFTING

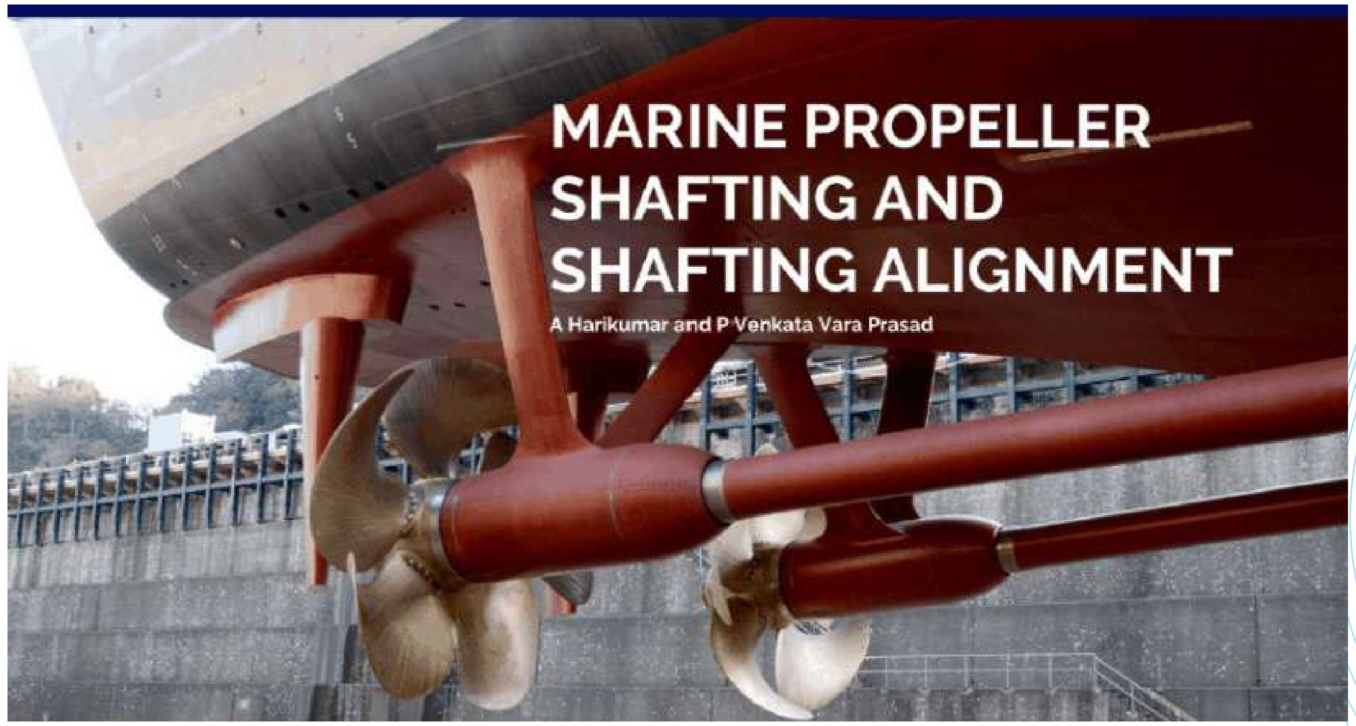
The shafting system is a vital component in ship propulsion, responsible for transmitting power from the engine to the propeller. It consists of the shafts, bearing, stern tubes, hydraulic lines for CPP, bearings and couplings.



MAIN COMPONENTS OF THE SYSTEM

- Shafts
- Bearings
- Couplings
- Sterntube
- Hydraulic system





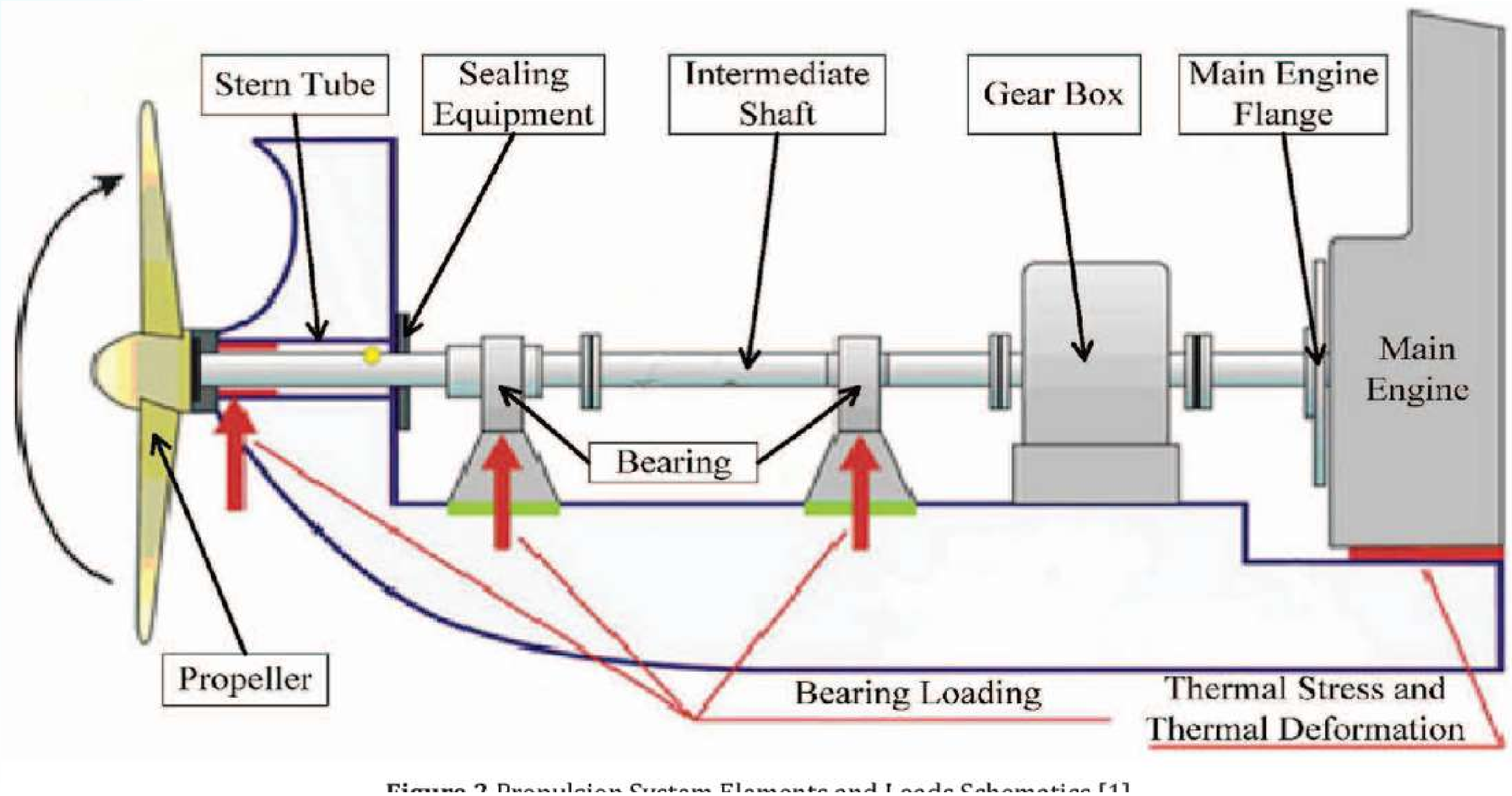
TYPES OF SHAFTS

By Location:

- Intermediate Shaft
- Stern/Tail Shaft
- Propellor Shaft

By Construction:

- Hollow Shaft
- Solid Shaft



SHAFT ALIGNMENT

Pre-Launch:

- Pre Inspection
- Initial Installation
- Bearing Alignment
- Coupling Alignment
- Fine Tuning

Post-Launch:

- Re-Alignment
- Monitoring

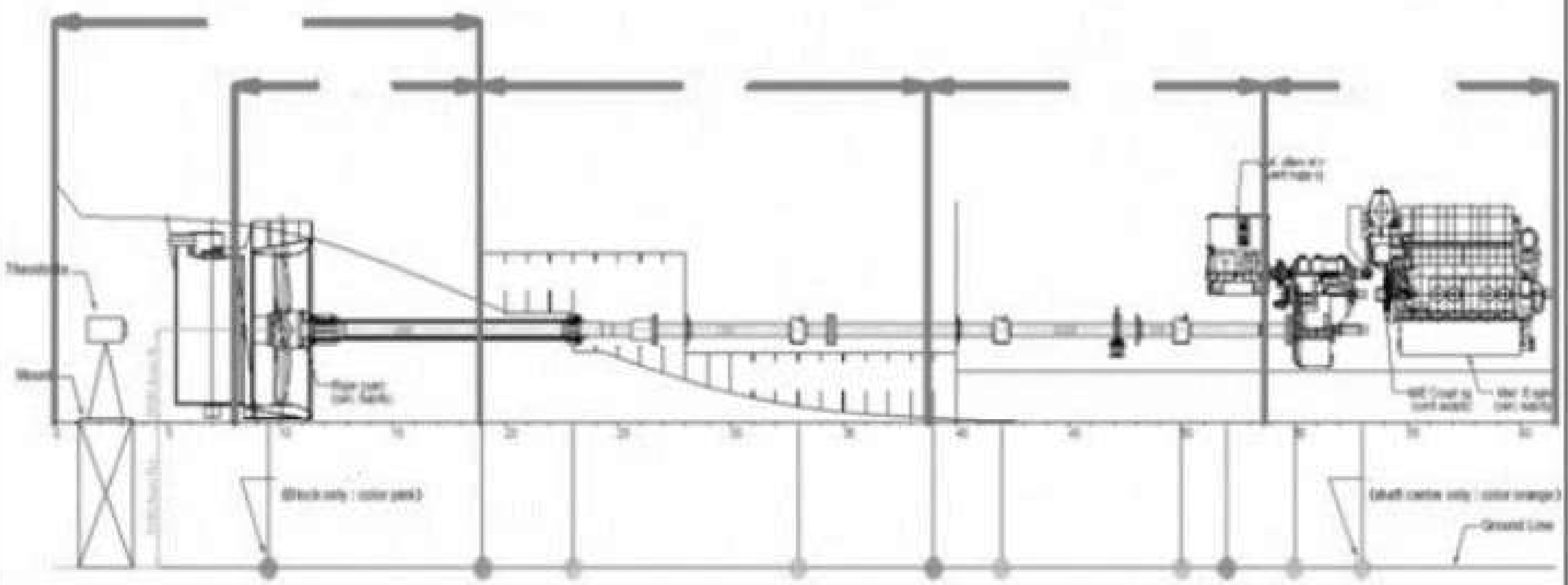


Figure – 2 (a) – Prime mover without a high speed shafting with the engines directly coupled to the gear box.

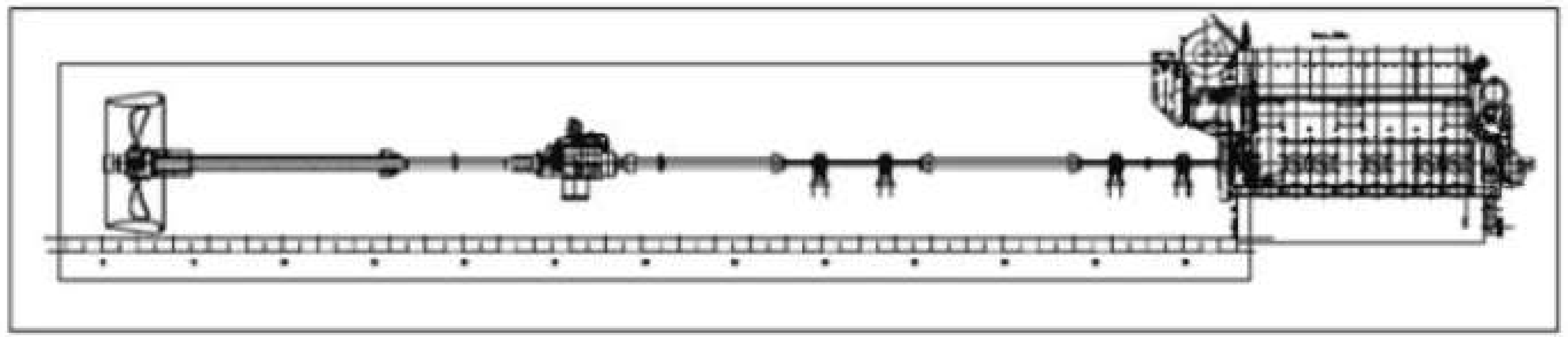
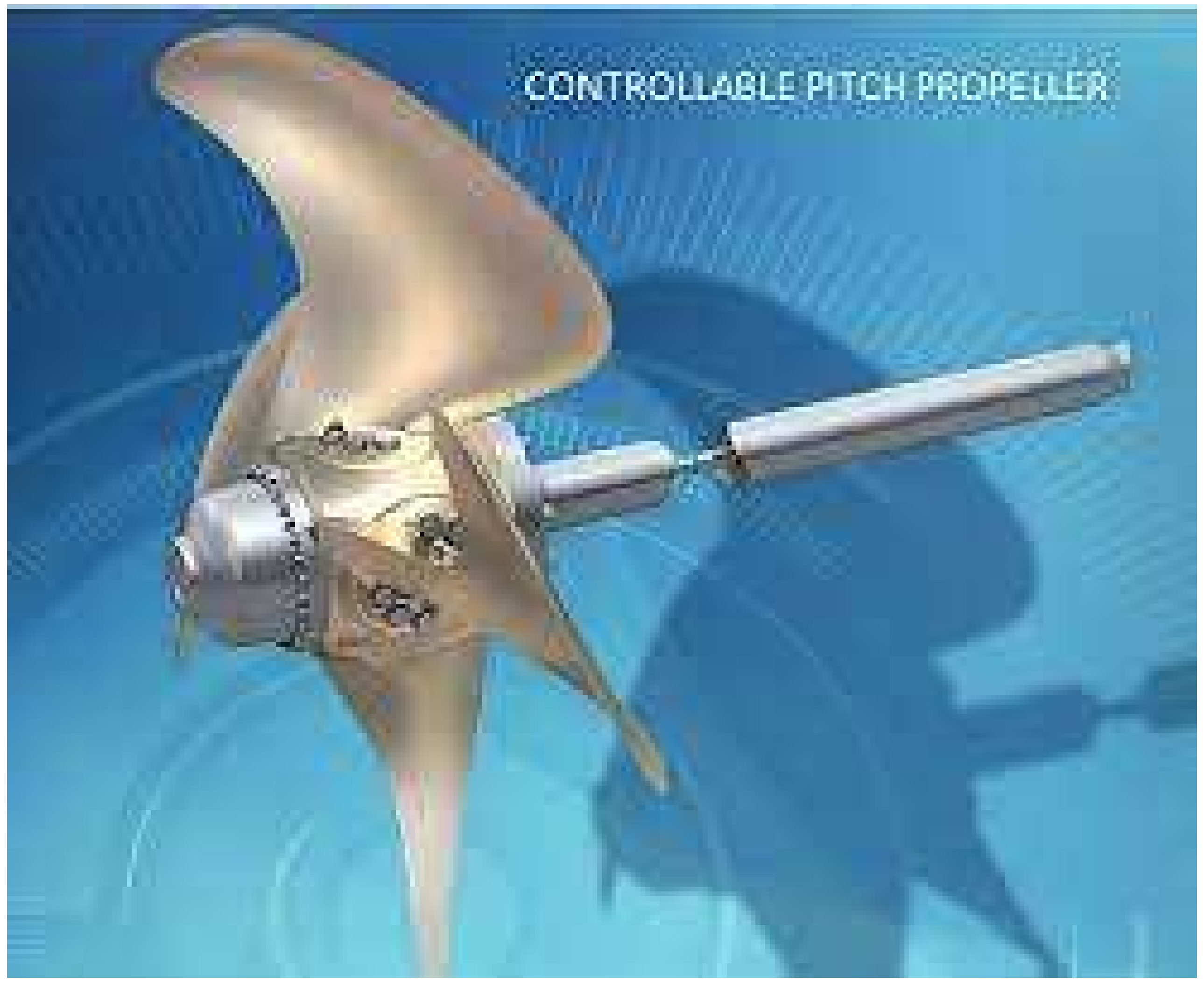


Figure – 2 (b) – Prime mover with a high speed shafting between the engine and the gear box.

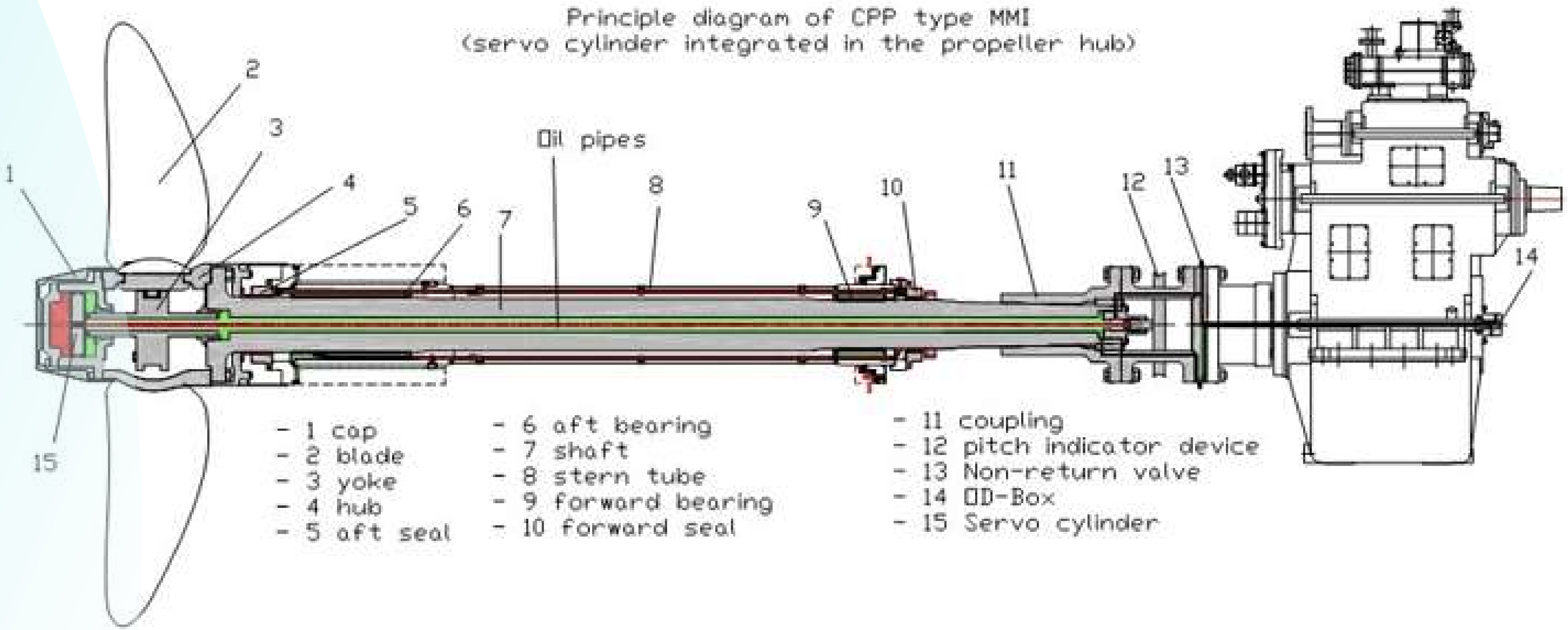
CONTROLLABLE PITCH PROPELLER

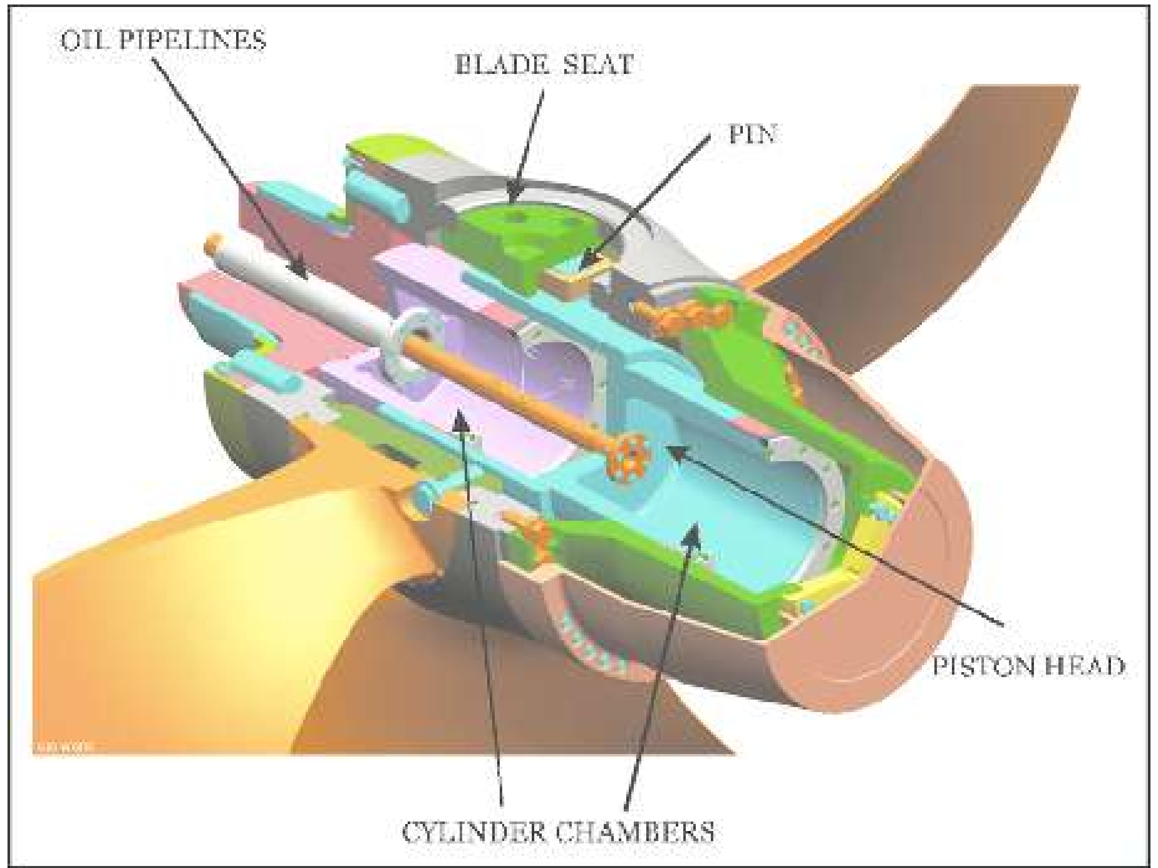
A Controllable pitch propeller enables a vessel to operate with maximum fuel efficiency, making it energy-saving, environmentally friendly and economical.
The thrust of a vessel can simply be changed by changing the angle of attack of the propeller blades rather than changing the rpm of the engine, this prevents wasting the engines energy and making the vessel more efficient.



COMPONENTS OF A CONTROLLABLE PITCH PROPELLER

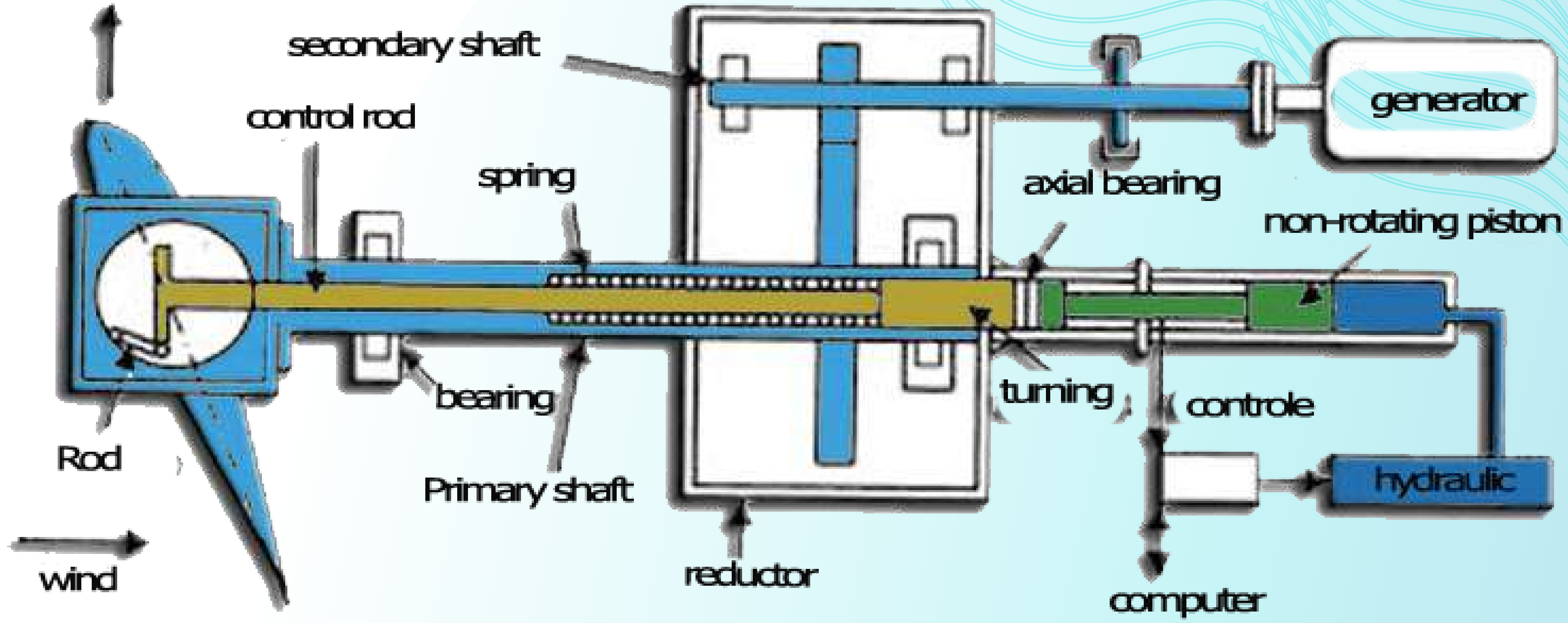
- Hub
- Power pack
- Oil distribution box
- Controllable pitch blades
- Hydraulic system

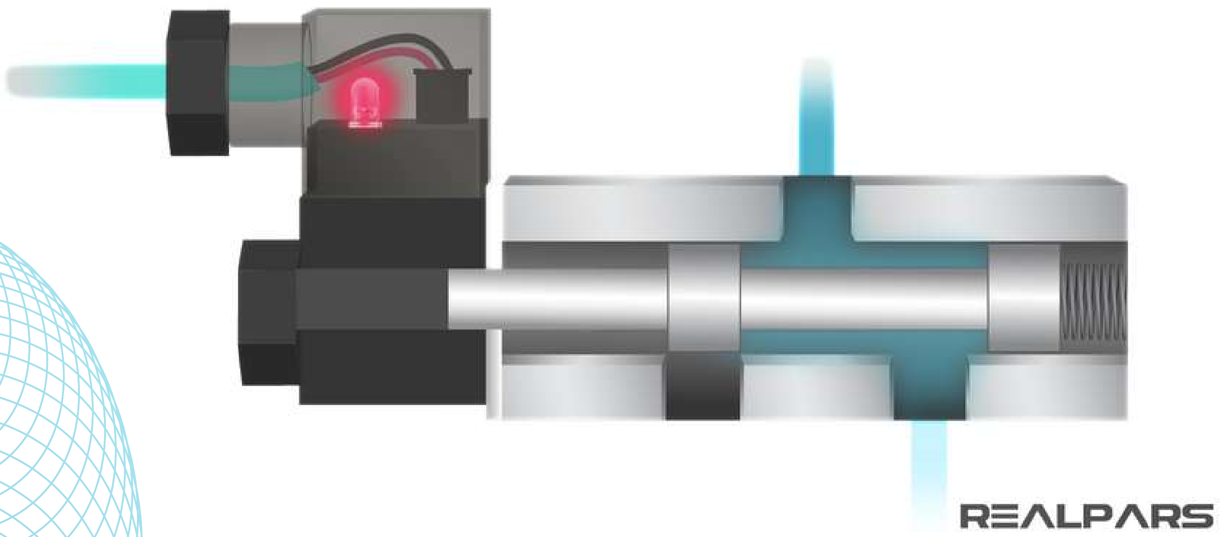




WORKING PRINCIPLE

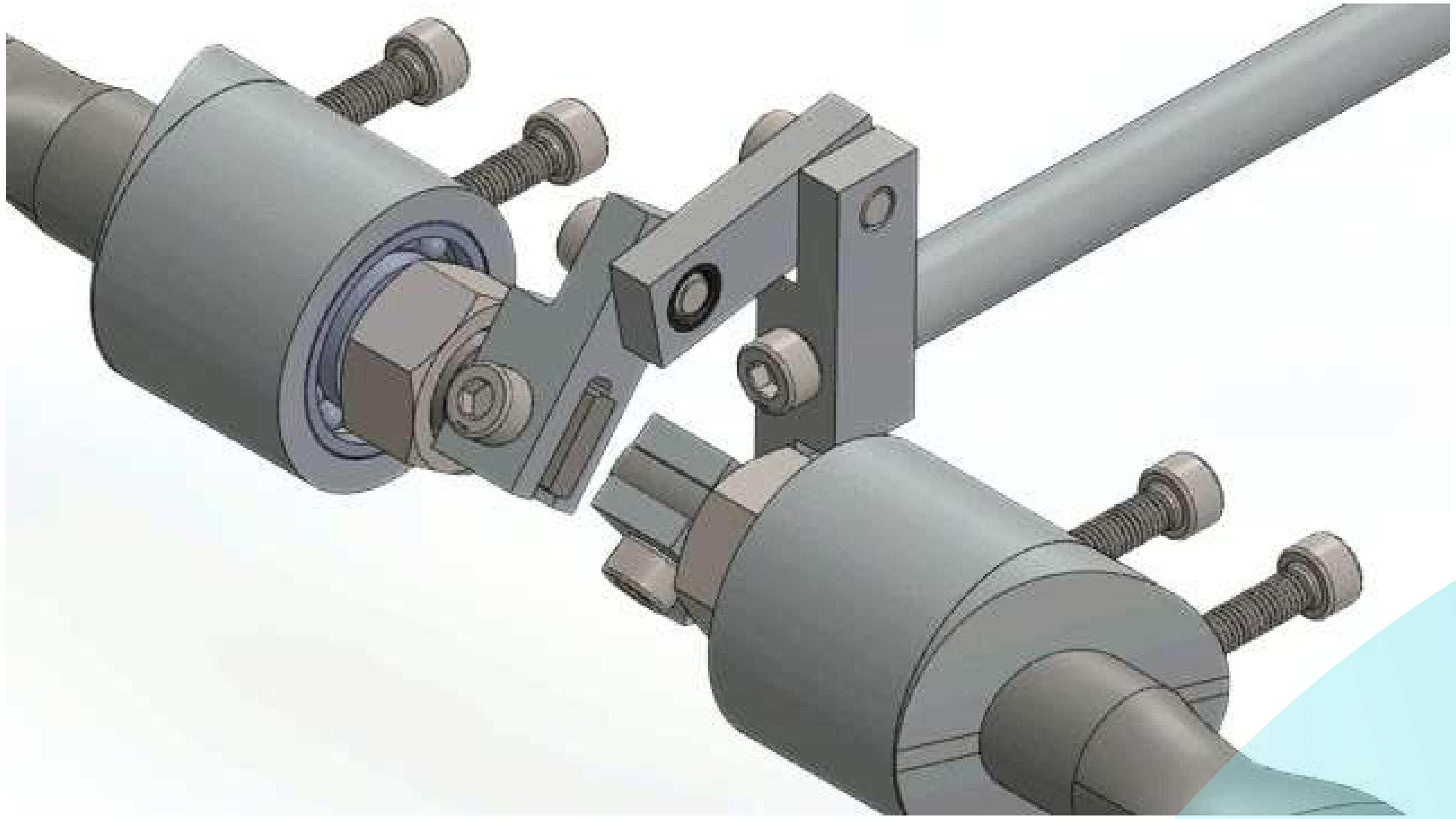
When the signal is received a spool valve is activated which is in-turn connected to a hydraulic oil pump





A servo motor pushes the hydraulic oil through the pipes inside the hollow shaft.

The hydraulic oil pushes a piston inside the hub of the propeller blades. This piston causes the blades to change pitch using the mechanism shown in the diagram



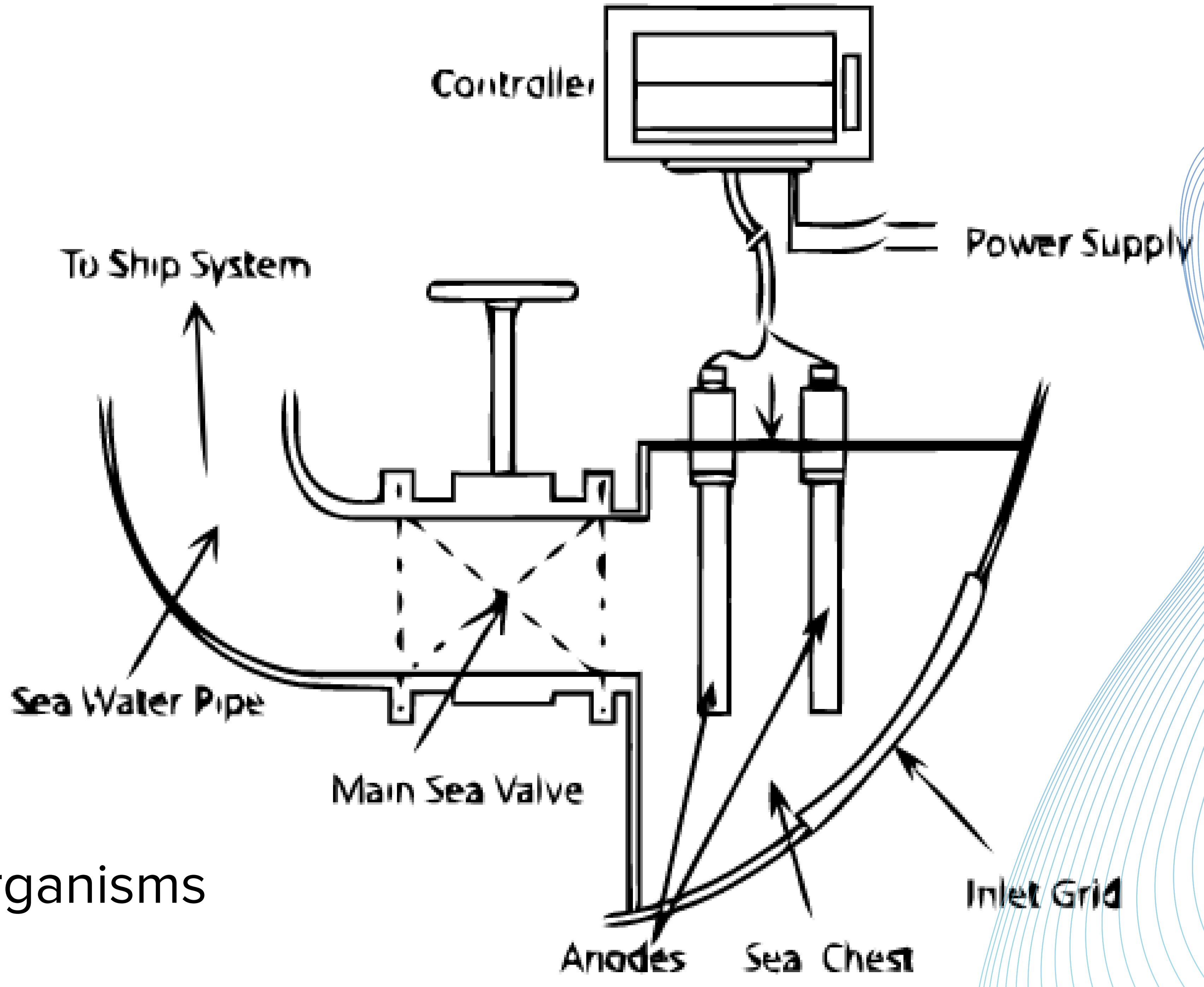
The controllable pitch propeller system also consists of a feedback system. The pump/servo keeps pushing oil until the feedback signal matches the demand signal

SEA CHEST AND SEA TUBES

Sea Chest
-a chamber located inside the hull of a ship that can be flooded for the intake of water.

Sea Pipes
-responsible for intake of water from the sea chest via pumps.
-provide for various functions inside the ship.

Both are attached with grates to remove debris and organisms before entering the ship's systems.



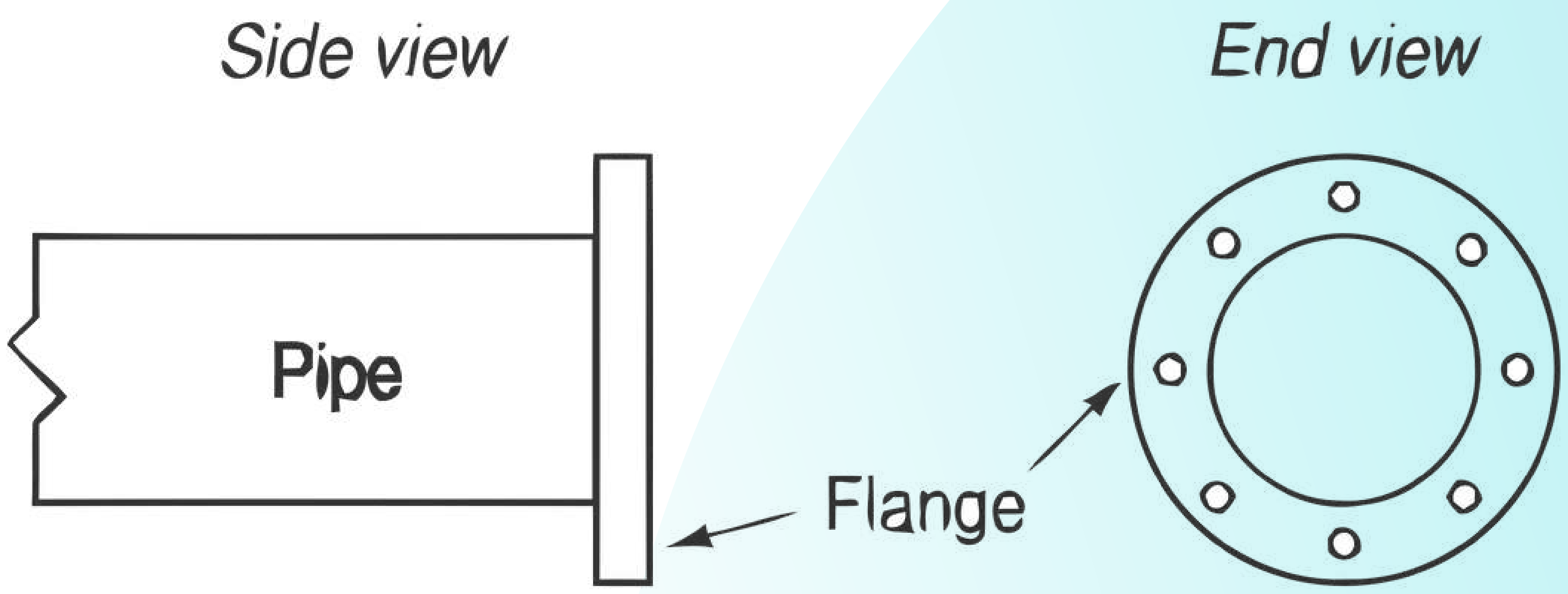
SEA CHEST ARRANGEMENT

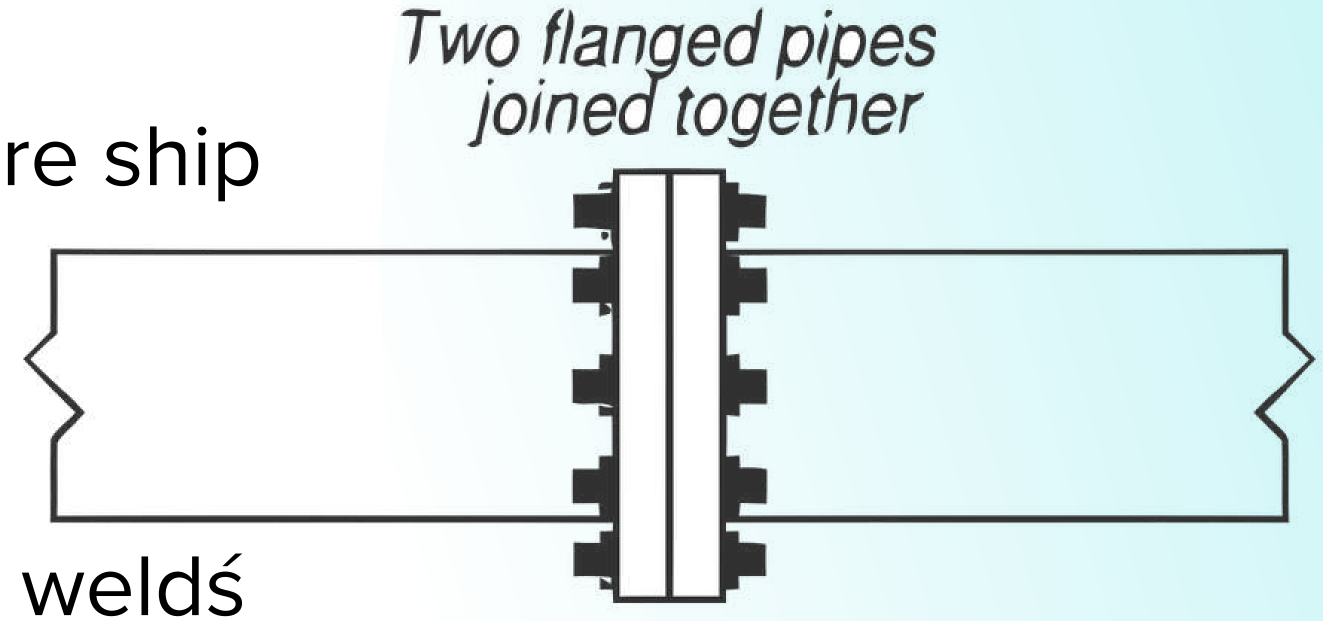
APPLICATIONS

- Engine Cooling
  - circulated through heat exchangers to cool down the engine
  - maintain optimal temp
- Machinery Cooling
  - cooling of other machinery such as pumps, generators, compressors, etc.
- Heat Recovery
  - can be used to redirect heat to required locations such as boiler feed water
- Firefighting
  - pumped quickly to sprinklers and fire hydrant pipes
- Ballast Operations
  - helps balance the ship by redistributing weight in ballast tanks

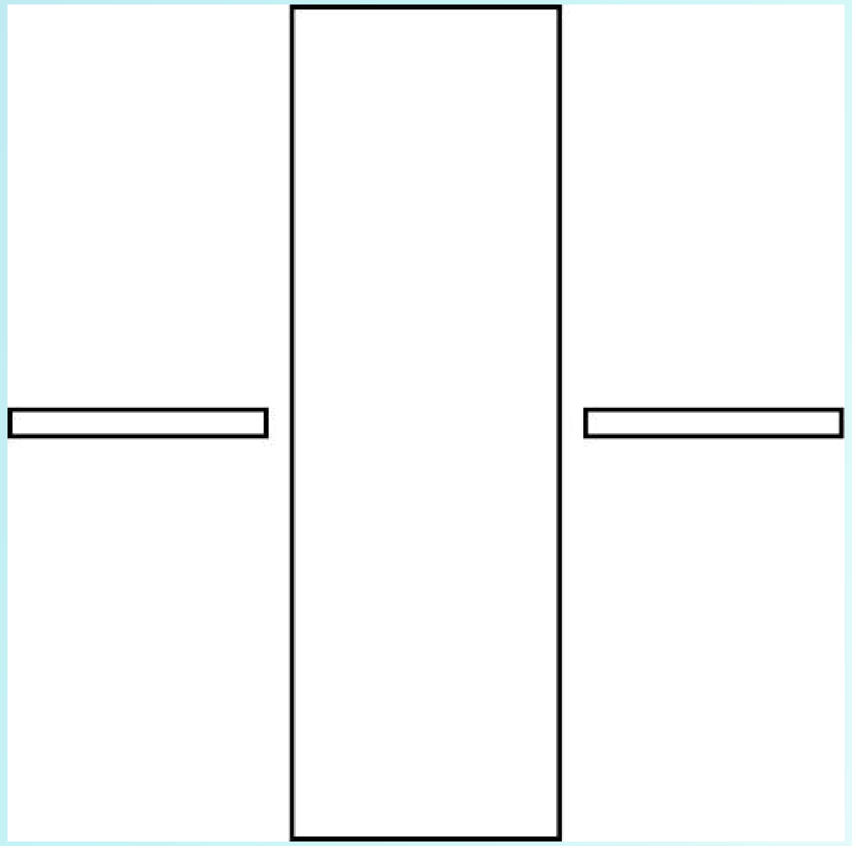
SEA TUBE INSTALLATION

- Marking
  - marks made by referencing diagrams
- Hole cutting
  - holes cut as per marks
- Pipe cutting/preparation/flanging
  - pipe cut and prepared as per needed length and angles
  - flanges added where connections to be made
- Pipe welding
  - pipes welded to each other and other parts before ship installation
- Pickling
  - Chemically treated and prepared for welding
- Fitup
  - test fitted in ship with all parts before permanent welds
- Complete welding
  - Fully welded with the main ship body making airtight seals



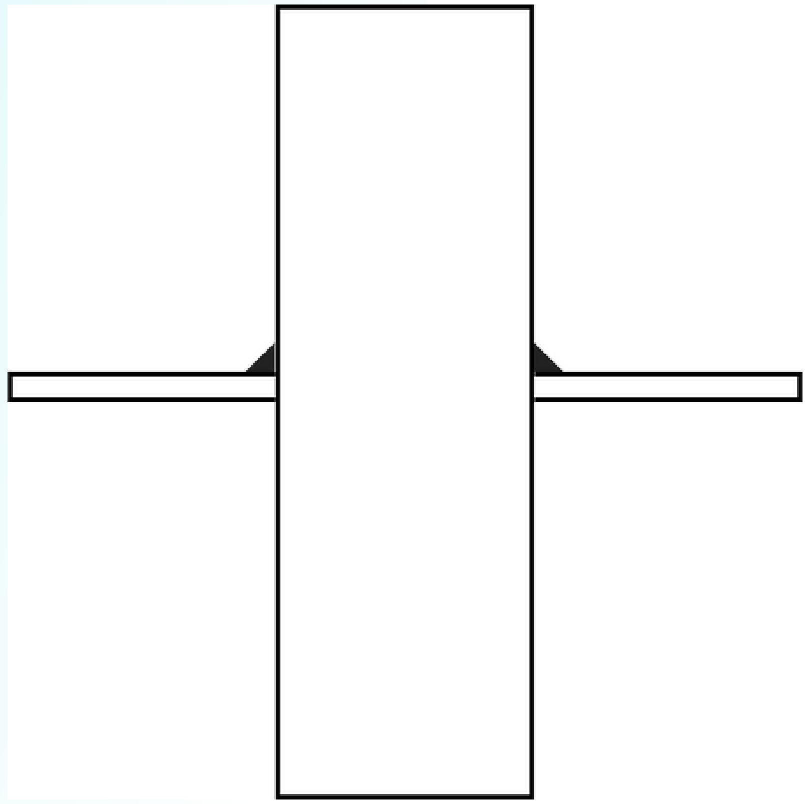


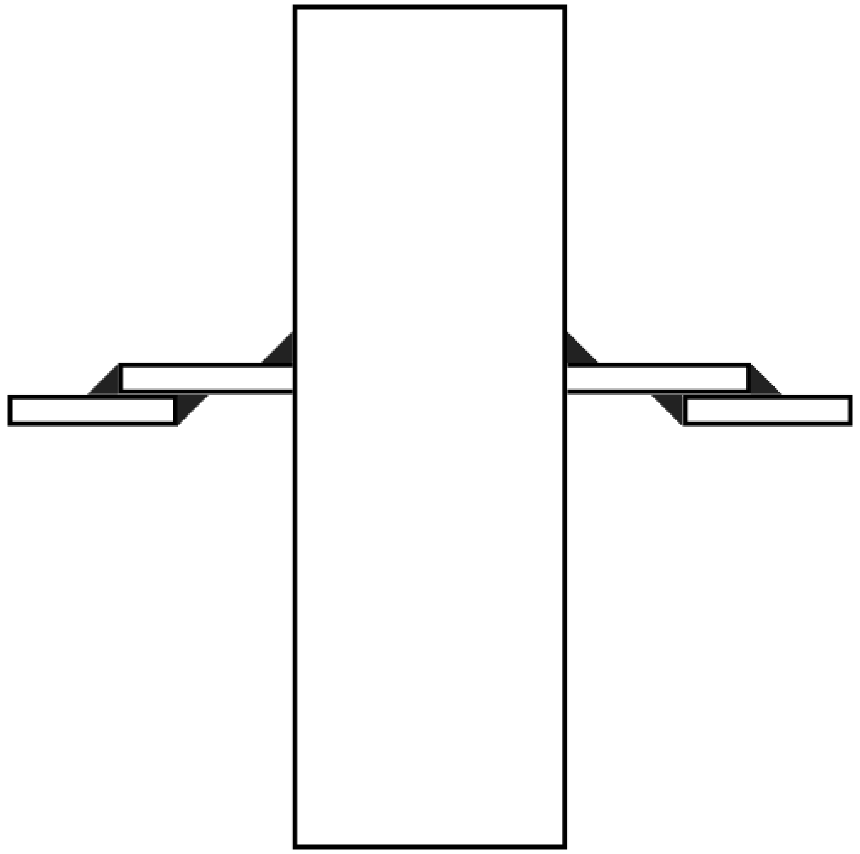
DIFFERENT TYPES OF PIPE WELDS



No Weld Pass Through

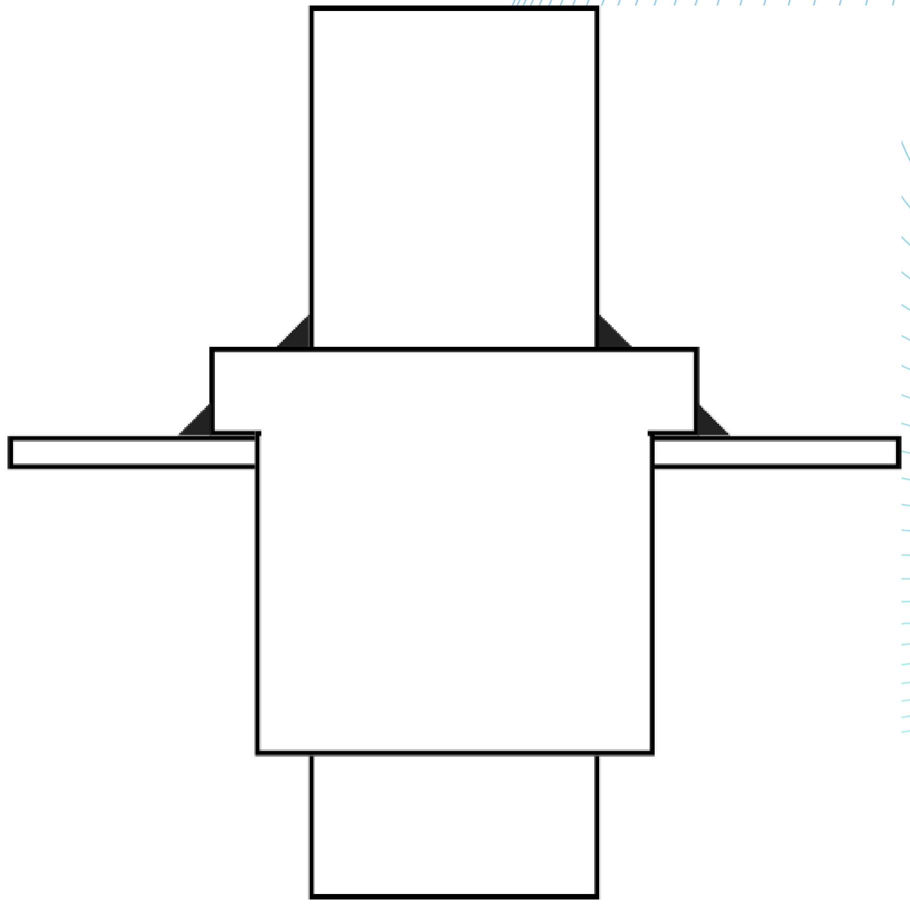
Simple Weld





Doubler Weld

Socket Weld



DIESEL GENERATOR

- reliable and powerful machines that provide a dependable source of electricity in different settings, including industries, construction sites, and remote areas.
- utilize diesel fuel to produce mechanical energy, which is then converted into electrical power
- efficient and robust
- consistent performance, even under heavy loads,
- widely used as backup power solutions
- usually have a long lifespan

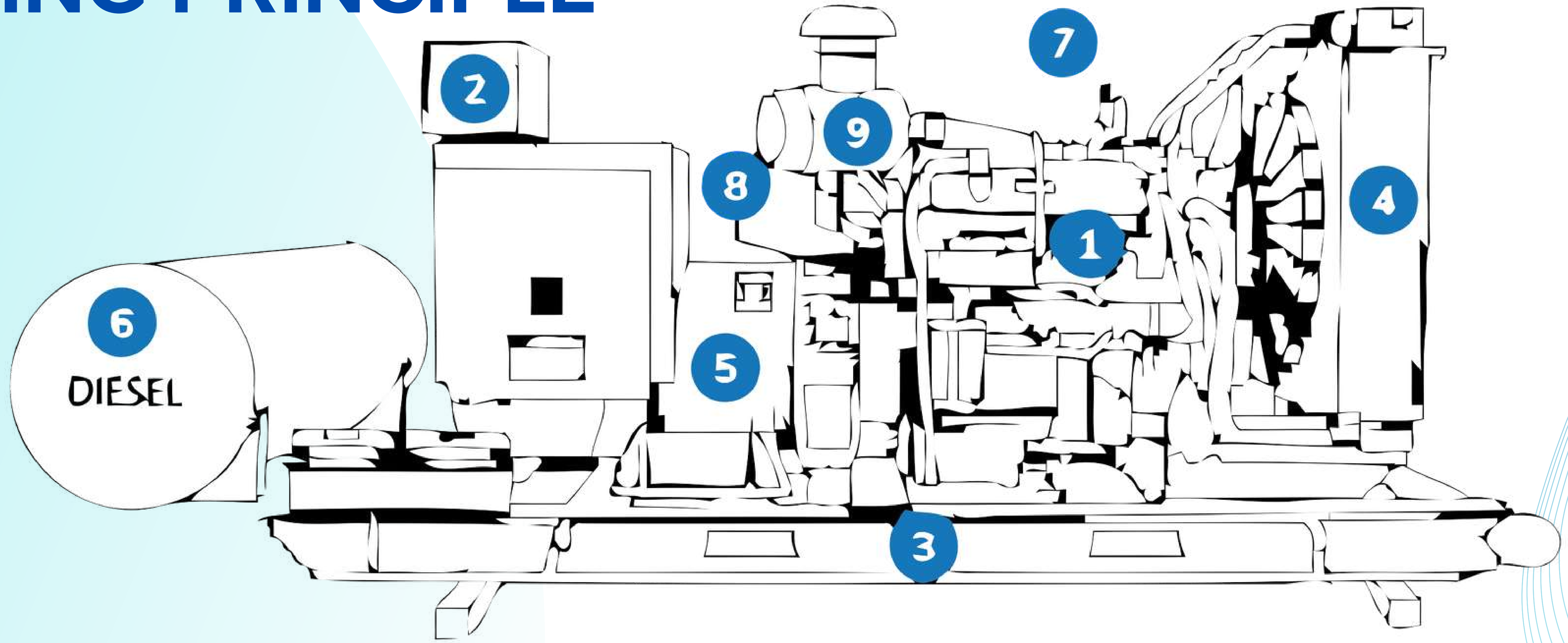
COMPONENTS

- IC Engine
  - consumes fuel to generate rotational mechanical energy
  - goes through 4 processes- Suction, Compression, Power, Exhaust
  - attached to crankshaft
- Alternator
  - attached to the other end of the crankshaft
  - has inbuilt magnets and conductive copper wiring that rotates
  - uses induction to generate electricity
- Fuel System
  - responsible for supply of fuel
  - includes pump, filter, ventilation pipe, etc needed for fuel flow
- Lubrication System
  - helps smoothly run all the various moving parts
  - avoids heating up of parts so that temp is maintained optimal

COMPONENTS

- Voltage Regulator
  - maintains stable output voltage and avoids fluctuations
- Cooling System
  - runs coolant fluid to maintain optimal operational temp
  - generally water
- Exhaust System
  - safely channels away toxic fumes released during combustion in the engine
- Starter And Battery System
  - helps initially start the diesel motor, similar to a car battery
- Control Panel
  - houses controls for all the various parameters like fuel flow, output voltage, start/stop switch, etc.
- Housing/Frame
  - covers and protects all the components of the generator in one single shell

WORKING PRINCIPLE



1. Engine
2. Control Panel
3. Base frame
4. Radiator
5. Alternator
6. Fuel system
7. Lubrication system
8. Voltage regulator
9. Exhaust system

Diesel generators go through four combustion processes: Suction, Compression, Power, and Exhaust. The cycle of processes causes the generation of rotational mechanical energy. This energy is transferred to a rotor in the alternator via a crankshaft. The alternator houses conductive copper wiring which spins inside a housing of magnets. This generates a voltage that alternates as per the rotation speed of the shaft

USAGE ON SHIPS

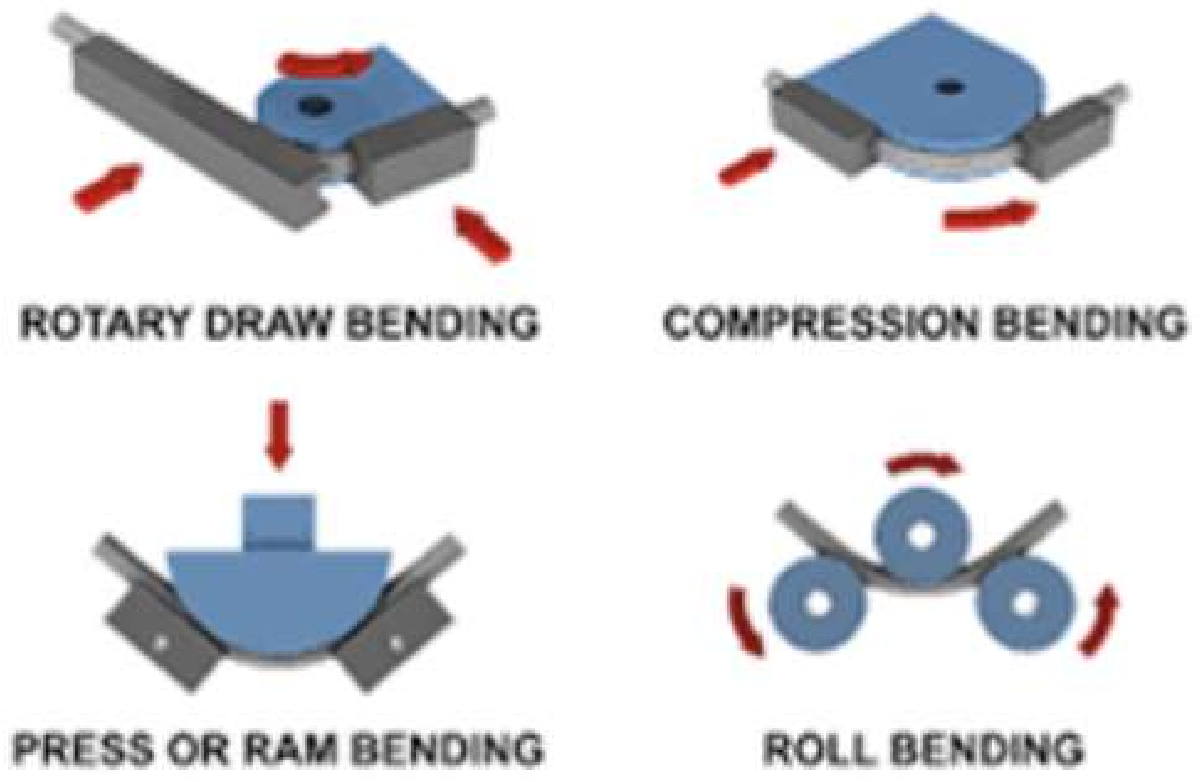
- supplying electrical power to different systems and equipment on the ship, including lighting, navigation systems, communication systems, refrigeration, ventilation, and various machinery.
- provide backup power in case of a main power failure.
- ensure critical systems like emergency lighting, communication, and essential equipment continue to operate during power outages
- in some ships, can also be used for propulsion in case of emergency
- utilized for refrigeration systems on ships to maintain the required temperature in cold storage areas, such as for perishable goods, provisions, and medical supplies.
- provide power for welding and maintenance activities onboard ships needed for repairs and maintenance work.

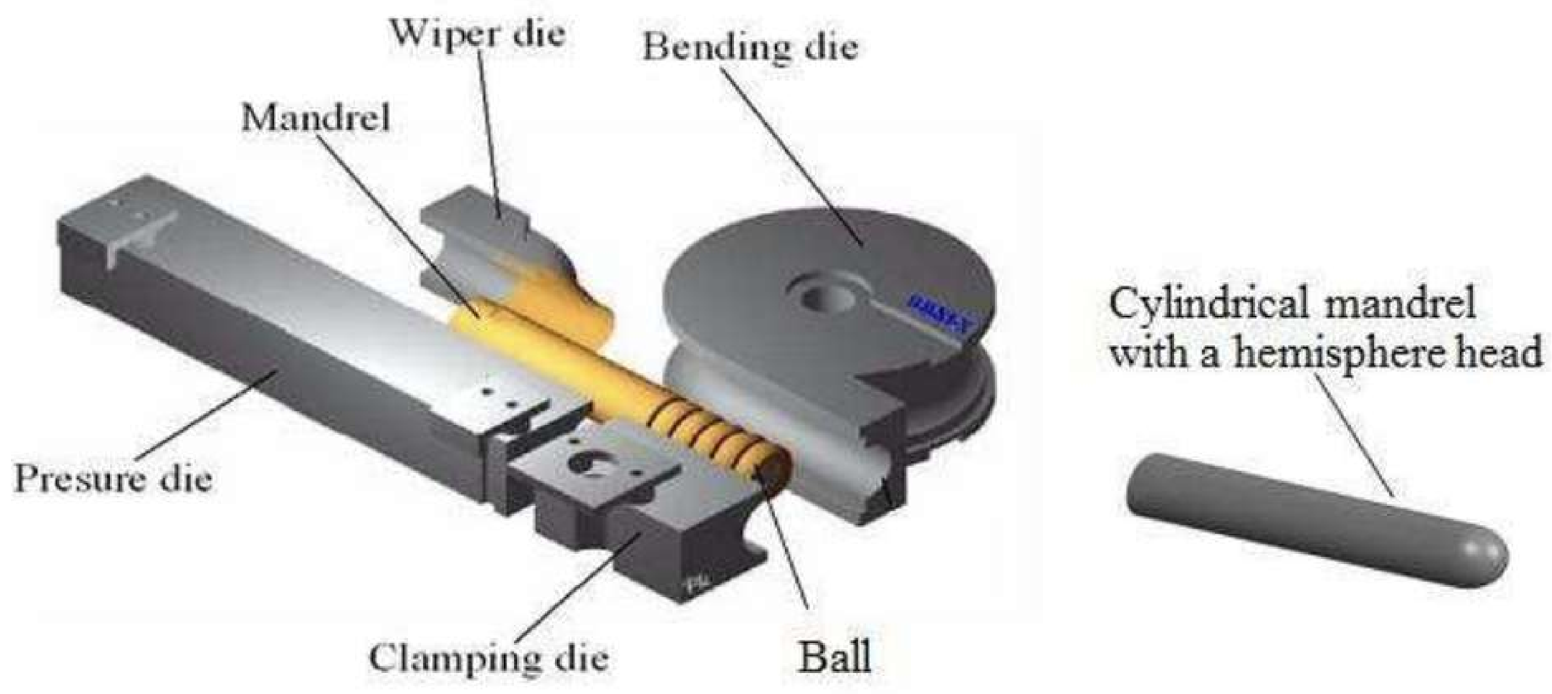
PIPE BENDING

- Various systems and machineries in ships require very complex piping involving 100s of pipes to be precisely routed in a very constrained space.
- Required for - Cooling water circulation, fresh water supply, fuel transport, lubrication system, ballast systems, hydraulic systems
- Complex routing requires a lot of joints and bends, joints usually introduce higher costs, failure points and increased manufacturing time so bending is preferred method to go to accomplish complex plumbing.

PIPE BENDING METHODS

- 4 commonly used methods
  - Rotary Draw Bending
  - Compression Bending
  - 3 point roll bending
  - Ram Bending
- Rotary draw bending with 1 axis and 3 axis semi-automatic and automatic CNC machines is mainly done here. With support for pipes up to 60mm.





CHALLENGES IN PIPE BENDING

- Thinning - The challenge of maintaining consistent material thickness during pipe bending to prevent structural weakness or failure
- Folding - The challenge of preventing undesirable creases or folds in the pipe wall during bending, which can compromise its integrity.
- Wrinkling - The challenge of avoiding the formation of wrinkles or ripples on the inner or outer surface of the bent pipe, which can affect its functionality or aesthetics.
- Roundness - The challenge of achieving and maintaining the desired circular shape of the pipe after bending, ensuring proper fit and alignment in the intended application.
- Springback - The challenge of accounting for the tendency of the pipe to return partially to its original shape after bending, requiring careful calculation and adjustment to achieve the desired final shape.

WAYS TO OVERCOME CHALLENGES

- Proper selection of bending equipment, such as mandrels, dies, and supports, to minimize material deformation.
- Choosing the right bending technique, such as rotary draw bending, mandrel bending, or heat induction bending, depending on the pipe material, size, and application.
- Applying appropriate lubrication or mandrel coatings to reduce friction and improve material flow.
- Using high-quality materials with suitable mechanical properties for bending applications.
- Conducting thorough pre-bending analysis and simulation to identify potential issues and optimize the bending process.
- It is important to note that the specific challenges and their solutions may vary depending on factors such as the pipe material (e.g., steel, aluminum, copper), wall thickness, diameter, and the complexity of the bend.

CHALLENGE OF SPRINGBACK

- Even after overcoming all the challenges of thinning, wrinkling, roundness etc. the challenge of managing springback is crucial for achieving precise and accurate pipe bends. Here are some strategies to address this challenge:
  - Over-Bending
  - Heat Treatment
  - Multiple step bending
  - Slow bending
  - Material Selection
- Easiest and commonly used method is Over-Bending, which involved bending the pipes a couple extra degrees so that it can achieve required dimension on springback

PREDICTING SPRINGBACK

- Various analytical techniques have been researched and developed to predict the springback to compensate it with overbending, but most of them don’t offer results of more than 5-7% accuracy due to the large number of factors involved in the process namely:
  - Bending Method
    - Ram Bending
    - Arc Draw Bending
    - Three Point Bending
    - Die Bending
  - Material Properties
    - Young's Modulus
    - Hardness Coefficient
  - Cracks in material
  - Wall thickness

- Hardening Method
- Temperature
- Bending Speed
- Lubrication
- Mandrel Type
  - Bead Mandrel
  - Ball Mandrel
- Die/Mandrel Material
- Coating/Paint on pipes

PREDICTING SPRINGBACK

- Involvement of all these factors make it very hard to get general analytical solutions, the only way to predict accurately is via FEM simulations.
- In Industrial applications, automatic machines take advantage of feedback mechanisms to use with a linear/quadratic regression model to get accurate predictions for a pipe type.
- Our goal was to develop a solution for the semi automatic machines to calculate the compensation angle in advance to prevent springback.
- The springback angle is almost linearly related to the bending angle and this property can be used to predict the springback angle for compensation.

PREDICTING SPRINGBACK

Method to determine the springback -

Bend the pipe by about 30-60 degrees and then measure the final angle, and then repeat the process for a couple of times. This data can be used to calculate the empirical formula to calculate the springback angle for each type of pipe.

The formula that would be obtained will be -

BA = C(RA) + SC

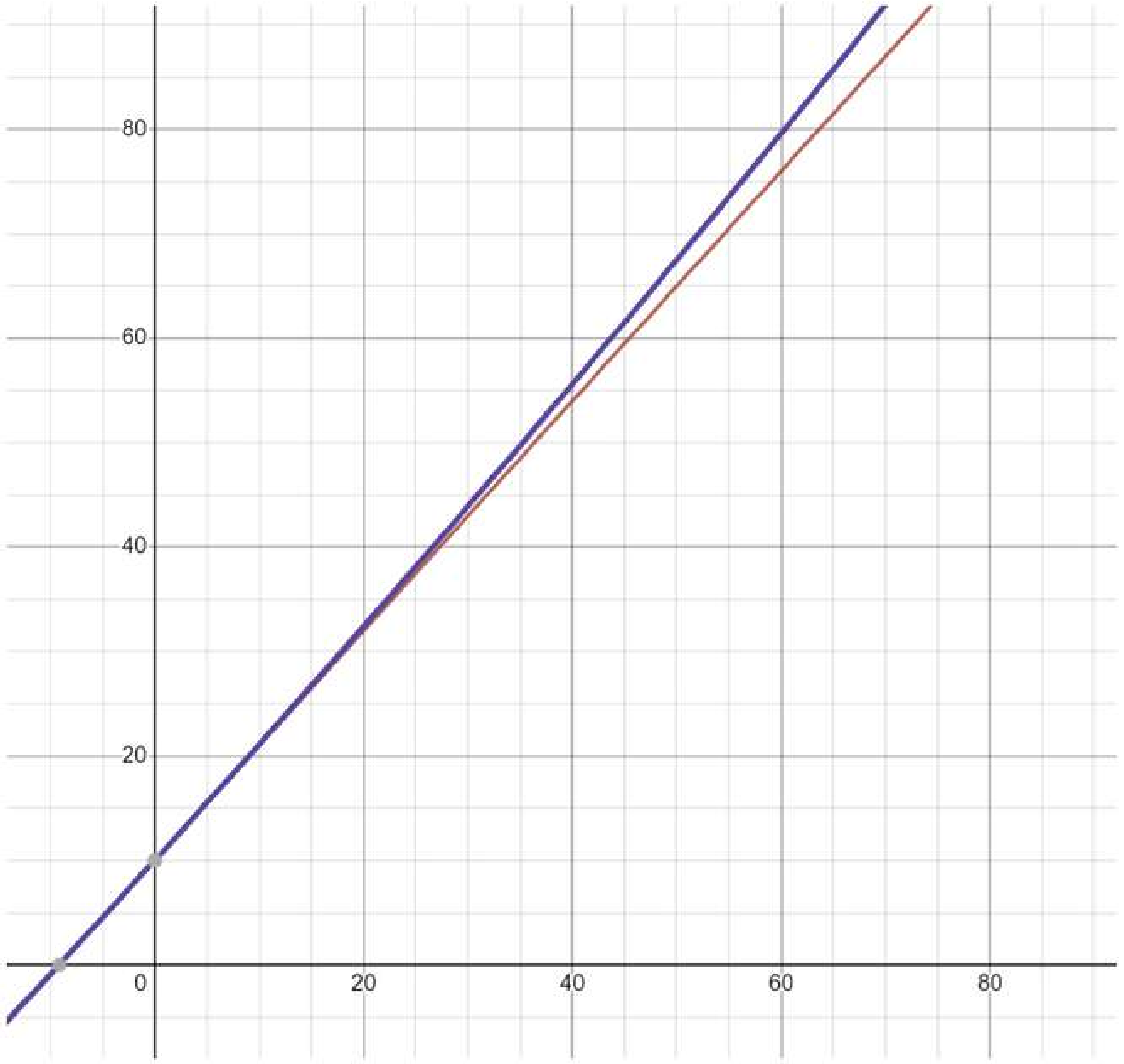
Where,

BA = Bending Angle

RA = Required Angle

SC = Springback Constant (5-15)

C = Proportionality Constant (1.025-1.075)



PREDICTING SPRINGBACK

This formula can be used to get compensation angles and can achieve results upto 2% accuracy, way higher than theoretical methods. And this just requires 2 test values to begin with.

To get even higher accuracy, quadratic correction term can be introduced which can get less than 1% error

BA = C(RA) + SC + SC*RA^2*QC

Where,

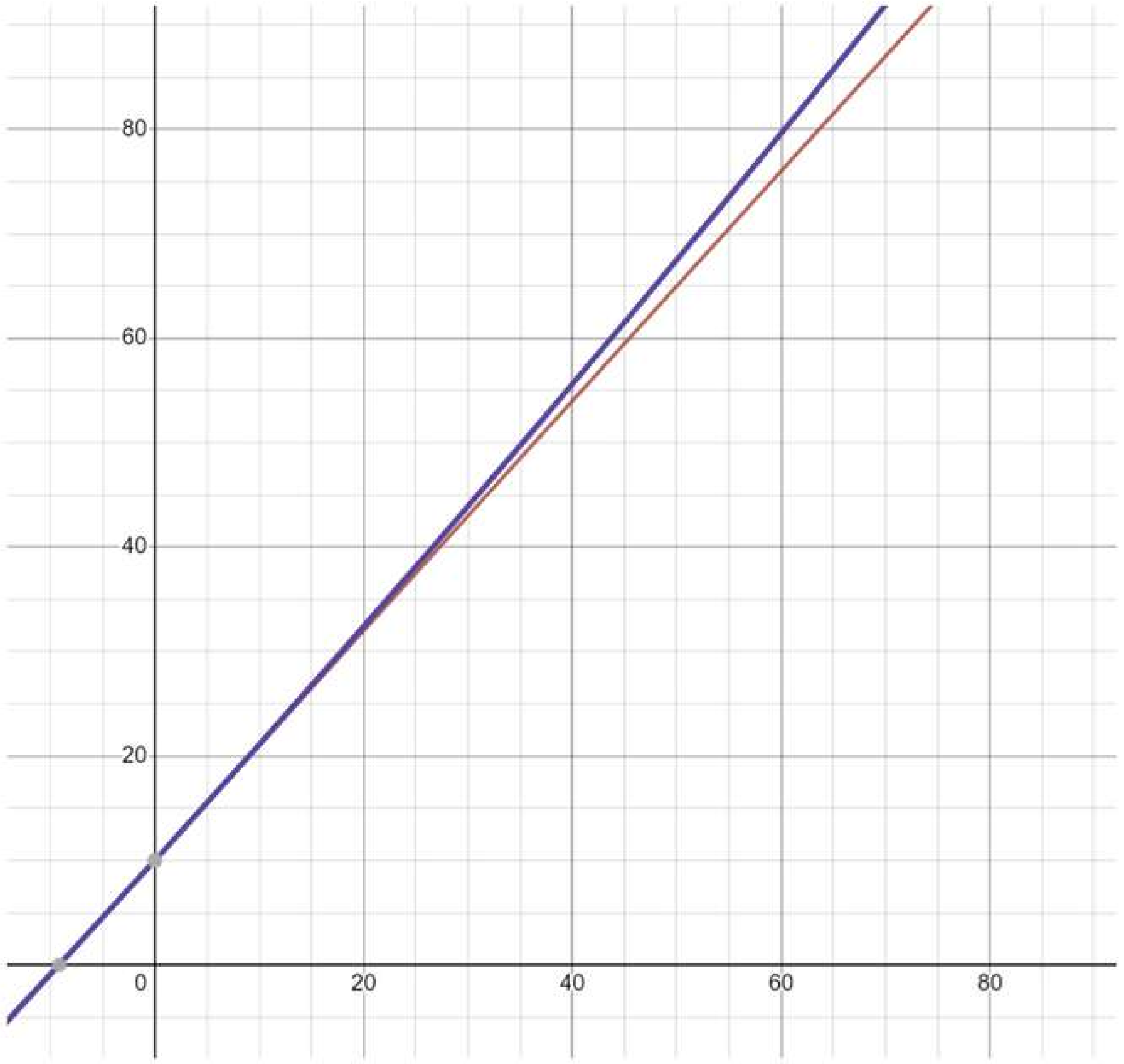
BA = Bending Angle

RA = Required Angle

SC = Springback Constant (5-15)

C = Proportionality Constant (1.025-1.075)

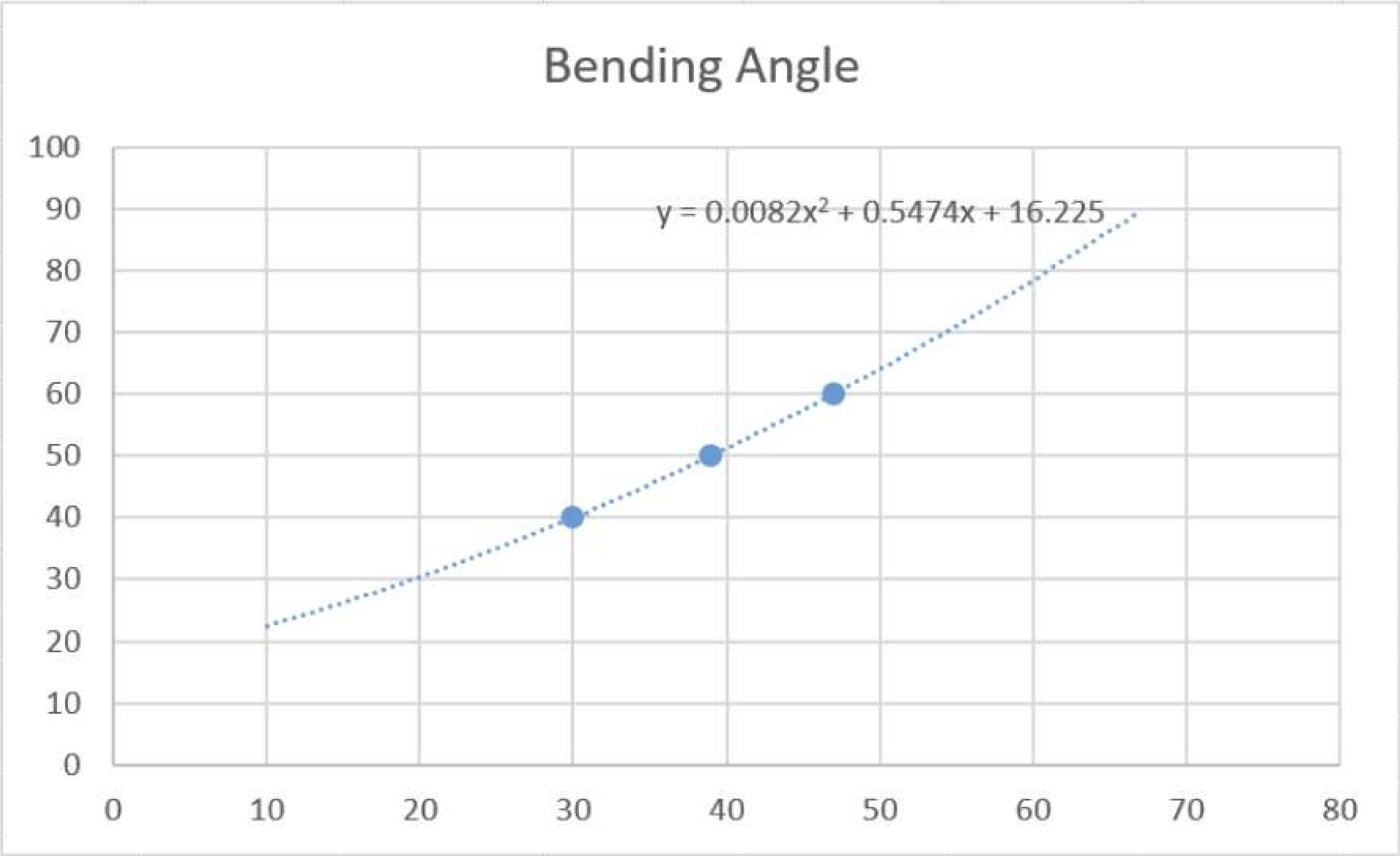
QC = Quadratic Constant (0.0001-0.001)



PREDICTING SPRINGBACK

This can be implemented in an excel spreadsheet to calculate the compensation angle for a specific type of pipe.

A	B	C
Experimental Data	Actual Angle	Bending Angle
	30	40
	39	50
	47	60
FORMULA	y = 0.5474x + 16.225 + 0.0082x2	
Calculator		
Required Angle	35	
Bending Angle	55.474	



VESSELS WE WORKED ON

TALWAR CLASS FRIGATES

• guided missile frigates built
for the Indian Navy.
• build in collaboration with
Russian Yantar shipyard.
• have a stealthy design making
them less visible to enemy radar
•They are armed with an array
of weapons, including BrahMos
supersonic cruise missiles,
surface-to-air missiles, anti-ship
missiles, torpedoes, and guns.

SPECIFICATIONS

Disp. 3,850 t (4,240 short tons) standard load [3] 4,035 t (4,448 short tons) full load [4]

Length. 124.8 m (409 ft 5 in)

Beam. 15.2 m (49 ft 10 in)

Draught. 4.2 m (13 ft 9 in)

Speed. 32 knots (59 km/h; 37 mph)

Time. 30 days

Crew. 180 (18 officers)

INS SHARDUL

- INS Shardul is an amphibious warfare ship of the Indian Navy, also known as landing craft.
- primarily used to transport troops, vehicles and equipment for launching land based attacks.
- the ship has the capability to come very close to land/beaches to deploy troops
- it can carry up to 500 troops, along with their vehicles and supplies.
- it is used extensively to carry out humanitarian missions.

SPECIFICATIONS

Displacement. 5650 tons

Length. 125 m (410 ft)

Beam. 17.5 m (57 ft)

Draught. 4 m (13 ft)

Propulsion. Kirloskar PA6 STC engines

Speed. 16 kn (30 km/h; 18 mph)

Troops. 500

Crew. 11 officers, 145 sailors

ICGS SAGAR

- ICGS Sagar is an offshore patrol vessel (OPV) of the Indian Coast Guard. It is part of the Sagar-class OPVs and serves as a versatile platform for maritime security and surveillance operations.
- ICGS Sagar is armed with medium and light machine guns for self-defense and maritime law enforcement purposes.

SPECIFICATIONS

Displacement. 1,800 t (1,800 long tons)

Length. 102 m (334 ft 8 in)

Beam. 11.5 m (37 ft 9 in)

Draught. 3.4 m (11 ft 2 in)

Propulsion. 2 x SEMT Pielstick 16 PA6V280 (4,707 kW or 6,312 hp each) diesel engines

Speed. 22 knots (41 km/h; 25 mph)

Complement. 15 officers and 113 sailors

ARMY FAST PATROL BOATS

- the fast patrol boats will be commitioned by the Indian Army in high altitude regions of Leh and Ladakh
- they have a operating speed of 35 to 40 knots and are armed with two heavy machine guns.
- these fast patrol vessels are being manufactured using futuristic manufacturing methods and are made of mould based fibre.

SPECIFICATIONS

Length : 35 m
Maximum speed : 35 to 40 knots
Armaments: 2 heavy machine guns

THANKYOU