HMES (HULL, MECHANICAL, & ELECTRICAL SYSTEMS):

a. **Materials**. Presently PN is using ships of European, American and Chinese origin utilising different types of steels for ship's construction. These include Admiralty 'B' grade steel (BS 4360 43 A /D), 907A high tensile low alloy steel, DH 36 and grade A steel. Yield strength of these steel ranges from 235 to 390 MPa. Super structures of the vessels are made up of Marine grade Aluminium 5083. In addition to metallic materials, composite materials like GRP, FRP etc are also being used in the hull of the vessels. Rubberized inflatable hulls (Zulu Boats) are also being used by PN.

b. **Electrodes**. For welding of ferrous and non-ferrous metals, wide variety of welding consumables are used in PN including E-6013, E-7018, E-8018C-3, E-309-15 and E-309-16 etc.

c. **Water and Gas Tight Doors and Windows**. A large number of water and gas tight doors / hatches, windows and scuttles of varying sizes are used onboard PN platforms. These are tested by utilising 2 different methods i.e. vacuum testing or pressure testing at low pressure (ranging 2-5 PSI).

d. **Fixtures and Fasteners**. A variety of fixtures and fasteners (nuts, bolts, rivets etc) of various sizes and material specifications are being used onboard PN platforms. Material generally includes 316L, SS 304, MS and non ferrous alloys.

e. **Marine Ropes**. Marine ropes of different construction, types and sizes are used onboard PN vessels for berthing, lifting and hoisting purposes etc. These include steel wire rope, polyamide, polyester and poly propylene etc. Construction of these ropes ranges from 6x12 to 6x36. Sizes of the wire / strand ranges from 3mm to 28mm.

f. **Fire Retardant Cloth/Upholstery**. Due potential fire hazard onboard naval platforms, a variety of fire retardant materials are being used onboard. Fire retardant cloth is mainly used for fire fighting suits (suits, gloves, hoods etc), fire / smoke curtains and fire blankets etc.

g. **Paints and Coatings**. A large variety of paints / coatings are being used for protection of ship's structure from harsh Marine environment. These include oil / epoxy based, anti fouling, fire retardant and anti-skid paints etc. In addition, different types of coatings are also being used onboard PN vessels including Parco-plastic, abrasion/heat resistant linings and electro plating etc.

h. **Cables**. A variety of cables are being used onboard for power and data transmission. Power transmission cables onboard ships are generally marine grade halogen free type. However, various other types of the cables and

winding wires of varying diameter and amperage are also being used. Data cables include co-axial, fibre optic and RF etc.

j. **Switchboards, Distribution Switch Gear**. PN is using vast variety of switch gear in various switchboards of ships, S/Ms, and shore units. These gears comprise of VCBs, MCCBs, Control Panels, Starters and Change over switches etc; mainly ranging from 11KV to 115V AC and 6V to 50V DC.

k. **Cathodic Protection System**. PN is utilising 2 x broad types of Cathodic Protection systems. Details of the same are as follows:

(1) **Usage of Electrode (Impressed Current Cathodic Protection) System**. This is an old system in which Electrode produces a specific amount of current that ionizes the body of ship / vessel and protects it from corrosion. The amount of current produced may vary depending upon the hull of ship. Nominal values of current range from 200 mV to 900 mV. These electrodes require corrective maintenance only.

(2) **Sacrificial Anodes**. As the name indicates, this system uses anodes that dissolve with the passage of time. They react with the chemicals in water and sacrifice themselves to protect the hull of ship. This system requires docking after specific time; however, PN has modified these anodes to replace these in situ through divers.

l. **Valves**. Various type and sizes of valves are used in PN. These belong to various types of systems e.g. Fresh Water, Sea Water, Fuel, Lubricants, and Steam etc. List of various types and sizes of valves used onboard PN vessels is tabulated below:

S.No	Type of Valves	Size Range (inches)
1.	Gate Valve	2 to 12
2.	Globe Valve	2 to 12
3.	Butterfly Valve	2 to 12
4.	Cock/Plug Valve	1 to 6
5.	Ball Valve	½ to 4
6.	Diaphragm Valve	½ to 6
7.	Safety/ Relief Valve	½ to 5
8.	Check/ Non Return Valve	1 to 6
9.	Storm Valve	2 to 4
10.	Reducers	1 to 6
11.	Teleflex System Valve	-
12.	Thermostatic Regulating Valve (TRV)	-

m. **Piping**. Pipes of various sizes, specifications/dimensions and material are being utilized in PN. The diameter of these pipes varies from 0.5 inch to 36 inches. Whereas, material of these Pipes include Mild Steel, Galvanized Iron (GI), Cupronickel (CuNi 70/30 & 90/10), Brass and Al Bronze etc.

n. **Heat Exchangers**. A large number/variety of Heat Exchangers (HX) are being used onboard PN platforms. These HX mainly use sea water as heat dissipating media. Shell & Tube, Plate and Co-axial (Tube & Tube) are the main types of HX , whereas material of tube / plate include Cupronickel 70/30 & 90/10, Titanium, Al Bronze and simple copper etc. Material of the shell is generally SS, high quality MS or non ferrous based alloys suitable for harsh marine environment.

p. **Mounts**. In order to obviate chances of noise transmission to ship's hull, different types of mounts are used onboard PN vessels. These include resilient mounts, spring mounts, ring mounts, vibration dampers and raft mounts etc in various configuration / shapes e.g. K type, L type and M types etc.