National Exams May 2010

Mar-B2, Environmental Control in Ships

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is CLOSED BOOK exam. Any Casio or Sharp approved calculator is permitted.
3. Any FIVE (5) questions constitute a complete exam paper. The first five questions as they appear in the answer book will be marked.
4. Each question is of equal value. Marks for multipart questions are stated in the marking scheme.
5. Most questions require an answer in essay format. Clarity and organization of the answer are important.

Marking Scheme

1. 20 marks total: (a) 6 marks
   (b) 7 marks
   (c) 7 marks
2. 20 marks total: (a) 5 marks
   (b) 6 marks
   (c) 6 marks
   (d) 3 marks
3. 20 marks total: (a) 4 marks
   (b) 4 marks
   (c) 4 marks
   (d) 8 marks
4. 20 marks total
5. 20 marks total: (a) 7 marks
   (b) 7 marks
   (c) 6 marks
6. 20 marks total
7. 20 marks total: (a) 5 marks
   (b) 7 marks
   (c) 8 marks
8. 20 marks total: (a) 5 marks
   (b) 5 marks
   (c) 3 marks
   (d) 7 marks

1. (a) Explain the dilution method of controlling odor and gases onboard ships. Discuss the advantages and disadvantages of this method.

(b) Sketch a diagram showing the components of a typical HVAC ventilation system.

(c) A 40.0 x 25.0 x 8.0 ft passenger lounge on a ferry is designed to accommodate 100 passengers. It is estimated that CO_2 is generated at a rate of 0.011 ft^3 /minute per passenger. Air used for the ventilation of the lounge has a CO_2 concentration of 0.03%. It is desired to limit the CO_2 concentration in the lounge to 0.1%. Determine:

- The minimum volumetric air flow (in cubic feet per minute) to maintain the CO_2 concentration within the desired limit.
- The rate of the space volume change rate per hour

2. (a) Explain the following terms:
- Equivalent duct diameter for the outlet duct of a fan.
- Effective duct length for the outlet duct of a fan.

(b) The outlet duct for a fan has a rectangular cross section 2.0 feet wide and 1.0 foot high. The duct is designed to handle 12,000.00 cubic feet per minute of air flow. Calculate:

- The velocity of the air flow.
- The equivalent duct diameter.
- The effective duct length.

Table.1: Effective Duct Length

Velocity of the flow (ft/min)	L/D
4000	4
5000	5
6000	6
7000	7

L = Effective duct length
D = Equivalent duct diameter

(c) A centrifugal fan has a capacity of 12500.00 cfm at 3.5 inch water gauge static pressure. Use the performance chart given in Figure 1 to select a suitable fan speed and determine the power required to drive the fan.

(d) Determine the change in the capacity if the static pressure dropped to 3.0 in water gauge due to the addition of an elbow.

3. (a) What are the main requirements that a refrigerant must meet?

(b) Explain one of the inexpensive methods that can be used to detect refrigerant leakage on ships.

(c) Define the relative humidity. What is its recommended level for human comfort?

(d) Sketch the schematic diagram for an air conditioning system with humidity control

4. A Lab on a research vessel has dimensions of 8.0 x 8.0 x 2.5 m and is located on the main deck. The deck of the lab and one of its transverse bulkheads are exposed to the external environment. The space below the lab is heated at 7.0 ^{0} C while all the other surrounding spaces are heated to the same temperature as the lab. The exposed bulkhead has one door and 3 windows. The surface area of the door is 2.0 m^2 while the surface area for each window is 0.7 m^2. Calculate the heating load for the lab. Assume an inside design temperature of 20 ^{0} C and an outside temperature of -15 ^{0} C. Table 2 provides heat loss factors for the lab sections as well as the air infiltration.

Table 2. Heat Loss Factors

Possible Source of heat losses	Heat loss factor (w)
Deck over	0.79 (Watts/(m^2. ^{0}C))
Deck under	0.68 (Watts/(m^2. ^{0}C))
Bulkheads	1.1 (Watts/(m^2. ^{0}C))
Windows	6.5 (Watts/(m^2. ^{0}C))
Doors	1.7 (Watts/(m^2. ^{0}C))
Air infiltration	0.33 (Watts/(m^3. ^{0}C))

5. (a) Explain the "cladding" method for controlling airborne noise produced by machinery on board ships.

(b) Discuss the isolation mounts method for treating structure-borne noise on ships.

(c) Explain how to reduce the ventilation system noise.

6. A ship owner purchased a pump and motor set for $1925.00 installed. It was soon discovered that the pump had been improperly selected for the required head and discharge. As a result, the power bill for operating the pump will be $900.00 per year. A new pump, suited to the requirements, is available at $2450.00 installed, with a guarantee that operating power costs will not exceed $500.00 annually. The original pump and motor can be sold for $375.00. Assume an 8-year study period with zero salvage value for both pumps at the end of the period. The ship owner uses 12% MARR. Based on present worth calculations, should the pump be replaced? Compound Interest Factors for 12% Interest Rate are provided in the Table 3.

Table3. Discrete Compounding Factors

Number of years n	Compound Amount Factor F/P	Present Worth Factor P/F	Sinking Fund Factor A/F	Capital Recovery Factor A/P	Compound Amount Factor F/A	Present Worth Factor P/A	Gradient Conversion Factor A/G
2	1.2544	0.79719	0.4717	0.5917	2.1200	1.6901	0.4717
4	1.5735	0.63552	0.20923	0.32923	4.7793	3.0373	1.3589
6	1.9738	0.50663	0.12323	0.24323	8.1152	4.1114	2.1720
8	2.4760	0.40388	0.08130	0.20130	12.300	4.9676	2.9131

7. (a) What is the most effective method for reducing nitrogen oxides emissions from marine diesel engines? Explain the main disadvantages of this method.

(b) Discuss the advantages and disadvantages of using incineration for solid waste management on ships.

(c) Explain the necessary precautions that should be carried on ships, at the different stages of handling drinking water, to prevent contamination.

8. (a) Describe the general self auditing procedure for energy.

(b)Prepare a check list for energy audit with reference to the following areas:

- Lighting equipment
- HVAC system

(c) What should the Garbage Management Plan for cruise ships of 400 Gross Ton and above include?

(d) A centrifugal pump has a capacity of 110.0 gallons/min at a speed of 1750 rpm. The pump operates at a total head of 30.0 feet. Using the performance data diagram given in Figure 2, determine the impeller diameter, the efficiency and the power required to drive the pump.

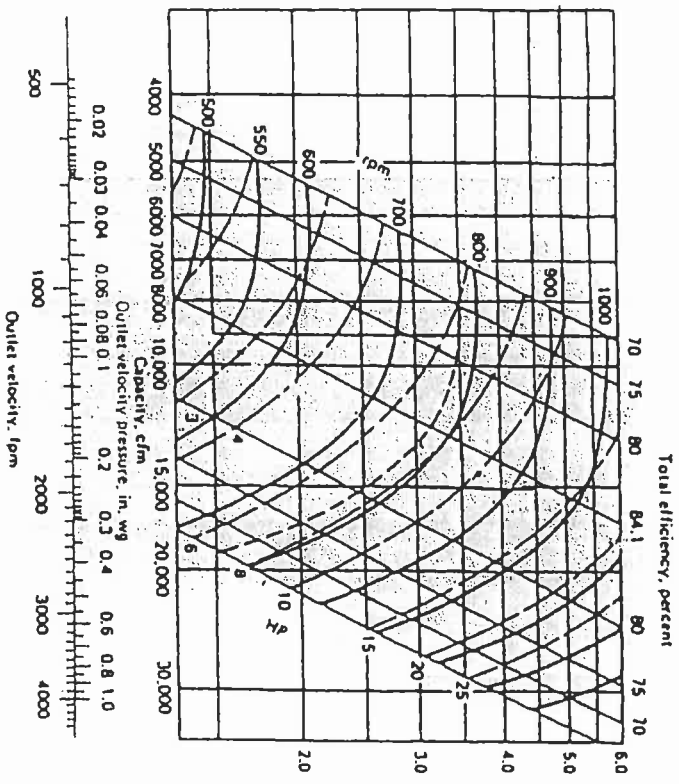

Figure 1
[Source: McQuiston (2005)]

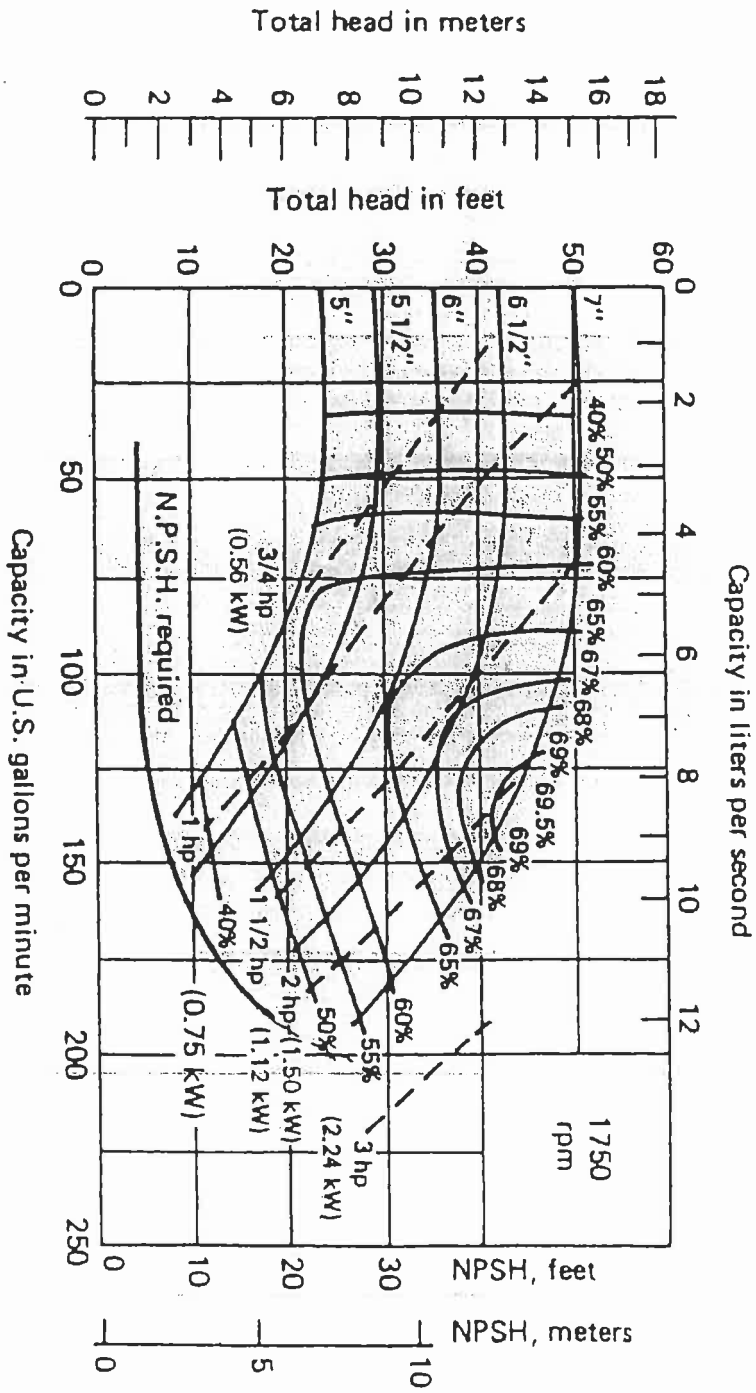

Figure 2
[Source: McQuiston (2005)]