

**CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY -
MARINE ENGINEER OFFICER**

EXAMINATIONS ADMINISTERED BY THE
SCOTTISH QUALIFICATIONS AUTHORITY
ON BEHALF OF
MARITIME AND COASTGUARD AGENCY

SECOND ENGINEER (UNLIMITED)

042-29 - ENGINEERING KNOWLEDGE - STEAM

WEDNESDAY, 17 December 2014

0915-1215 hrs

Examination paper inserts:

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Notes for the guidance of candidates:

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Materials to be supplied by examination centres:

Candidate's examination workbook

ENGINEERING KNOWLEDGE - STEAM

Attempt SIX questions only

Marks for each part question are shown in brackets

1. With reference to safety valves:
 - (a) state why easing gear is fitted; (2)
 - (b) explain the conditions under which easing gear may be used; (4)
 - (c) state any precautions that may have to be taken using easing gear; (3)
 - (d) state why an open drain from the valve is considered necessary; (2)
 - (e) state how the valve is protected against unauthorised adjustment; (2)
 - (f) explain what governs the relationship between the waste steam pipe size and the valve diameter. (3)

2. Explain how EACH of the following contributes to the emission of black smoke when burning fuel oil in a main propulsion boiler:
 - (a) fuel pressure well below recommended value; (3)
 - (b) carbon build up on atomiser nozzles; (3)
 - (c) excessive leakage from the air casing; (2)
 - (d) incorrect fuel viscosity; (5)
 - (e) incorrect or worn atomiser nozzles. (3)

3.
 - (a) Describe, with the aid of sketches, how a main boiler may be secured to the ship's structure and yet allowed freedom for thermal expansion in all directions. (6)
 - (b) Explain how the static and dynamic forces due to boiler deadweight and ship movement are transferred to the ship structure. (6)
 - (c) State the routine attention that should be given to the boiler support arrangements. (4)

4.
 - (a) State THREE possible sources of oil contamination of the main feed system. (3)
 - (b) Describe EACH of the following with reference to oil contamination in a main boiler:
 - (i) shutting down and preparation for cleaning; (5)
 - (ii) the internal cleaning procedure; (4)
 - (iii) the preparation to put the boiler back on line. (4)

5. With reference to steam traps:
- (a) explain why steam traps are used in steam systems; (3)
 - (b) state THREE different types of steam trap; (3)
 - (c) describe, with the aid of a sketch, the operation of TWO of the traps stated in part (b). (10)
6. Describe the procedure for warming through a main turbine set from cold, assuming the boilers are up to pressure and the main stop valves are closed. (16)
7. (a) Sketch a high pressure turbine nozzle fitted to a diaphragm. (6)
- (b) With reference to fouling of main turbine nozzles and blading:
- (i) explain how this occurs; (3)
 - (ii) explain the effect on turbine performance; (5)
 - (iii) state the operational practices taken to prevent fouling. (2)
8. With reference to main high pressure turbines, explain EACH of the following:
- (a) why nozzle boxes may be fitted to the lower half of casings only; (2)
 - (b) why blades may be located in individual axial slots in the wheel periphery; (5)
 - (c) why in some instances damping wires are fitted; (3)
 - (d) why partial admission is used for the first set of nozzles but is not considered necessary for the remaining nozzles; (3)
 - (e) why sliding feet, to allow for axial casing expansion, are no longer used in some cases. (3)
9. With reference to bottom end bearings of auxiliary diesel engines:
- (a) describe, with the aid of sketches, how hydrodynamic lubrication is achieved; (6)
 - (b) explain the effects of running with incorrect clearances; (2)
 - (c) explain how clearances are measured; (2)
 - (d) outline the precautions that should be taken before returning the unit to service after bearing renewal. (6)

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SECOND ENGINEER (UNLIMITED)

042-29 - ENGINEERING KNOWLEDGE - STEAM

WEDNESDAY, 15 October 2014

0915-1215 hrs

Examination paper inserts:

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Notes for the guidance of candidates:

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Materials to be supplied by examination centres:

Candidate's examination workbook

ENGINEERING KNOWLEDGE - STEAM

Attempt SIX questions only

Marks for each part question are shown in brackets

1. With reference to the steam drum of a main boiler:
 - (a) sketch a cross section of a longitudinal joint, explaining the method of construction; (6)
 - (b) sketch a longitudinal weld on the test plate, indicating the position of the samples; (4)
 - (c) state the tests carried out on the samples; (4)
 - (d) state TWO non-destructive tests that may carried out on the completed joint. (2)

2. With reference to steam-steam generators fitted to supply auxiliary steam:
 - (a) explain the advantages of this arrangement; (6)
 - (b) state, with reasons, the factors relating to the size of the safety valves; (4)
 - (c) describe how the output steam pressure and water level are controlled. (6)

3. With reference to a main boiler oil fuel system:
 - (a) describe the dangers of using distillate fuels in a system designed for heavy fuel; (4)
 - (b) state FOUR reasons for ALL the oil fuel burners failing or tripping during full away operations; (4)
 - (c) outline the procedures to be followed if the burners in ONE boiler of TWO operating boilers cut out unexpectedly during operation. (8)

4. With reference to boiler water test results, state in EACH of the following cases, the reasons for the change and the action to be taken:
 - (a) pH value in the boiler reducing; (4)
 - (b) total dissolved solids and chemical reserves reducing; (4)
 - (c) hydrazine reserve reducing, oxygen in feed water high and rising; (4)
 - (d) phosphate reseve reducing, chlorides and total dissolved solids increasing. (4)

5. (a) Describe, with the aid of a sketch, how a turbine rotor and casing are located accurately yet free to expand. (10)
- (b) Explain how the location of the rotor is remotely monitored, stating how this equipment is tested. (6)
6. (a) Sketch a line diagram of the complete gland steam system for a set of cross compound turbines, labelling the principal components and indicating the direction of flow in all lines. (11)
- (b) Explain how leakage of steam is minimised automatically under varying load. (5)
7. (a) Describe, with the aid of a sketch, an overspeed trip arrangement suitable for a turbine driven feed pump. (10)
- (b) State the maximum allowable overspeed. (1)
- (c) Explain why it is important that this limit is not exceeded. (5)
8. With reference to piston rings in auxiliary diesel engines:
- (a) explain the clearances and dimensions that should be checked; (4)
- (b) state the possible consequences of operating with incorrect clearances; (6)
- (c) describe, with the aid of a sketch, the function of an oil control ring, stating where it is fitted. (6)
9. With reference to the lubrication of turbine and gearing, describe the routine operational steps taken to prevent EACH of the following:
- (a) oxidation; (3)
- (b) micro-seizure of the gear teeth; (3)
- (c) frothing; (5)
- (d) microbiological degradation. (5)

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SECOND ENGINEER (UNLIMITED)

042-29 - ENGINEERING KNOWLEDGE - STEAM

WEDNESDAY, 23 July 2014

0915-1215 hrs

Examination paper inserts:

Datasheet Q5

Notes for the guidance of candidates:

Materials to be supplied by examination centres:

Candidate's examination workbook

ENGINEERING KNOWLEDGE - STEAM

Attempt SIX questions only

Marks for each part question are shown in brackets

1. (a) Explain THREE possible causes for a loss of main condenser vacuum in EACH of the following circumstances:
 - (i) over a short period of time; (6)
 - (ii) over a long period of time. (6)
- (b) State the effects of a choked first stage air ejector nozzle. (4)

2. (a) Describe the air and fuel processes that lead to efficient combustion. (6)
- (b) State the possible sources of water in fuel. (3)
- (c) Describe the possible effects on boiler operation of water in fuel. (7)

3. (a) Explain why the steam temperature at the superheater outlet should be maintained within permitted limits. (8)
- (b) Describe with the aid of a sketch, ONE method of controlling superheater temperature. (8)

4. Explain the reasons for the use of EACH of the following chemicals for boiler and feed water conditioning:
 - (a) sodium hydroxide; (4)
 - (b) sodium phosphate; (4)
 - (c) hydrazine solutions; (4)
 - (d) volatile amines. (4)

5. With reference to the illustration provided on the datasheet:
 - (a) for the part indicated by the arrow marked (a), name it correctly, explaining its function; (4)
 - (b) for the part indicated by the arrow marked (b), name it correctly, explaining its function; (3)
 - (c) for the part indicated by the arrow marked (c), name it correctly, explaining its function; (3)
 - (d) for the part indicated by the arrow marked (d), name it correctly, explaining its function; (3)
 - (e) for the part indicated by the arrow marked (e), name it correctly, explaining its function. (3)

6. Write a procedure for warming through a main propulsion turbine set from cold to "Ready For Use". Assume boilers are already at working condition. (16)
7. With reference to main high pressure turbines, explain EACH of the following:
- (a) why nozzle boxes may be fitted to the lower half of casings only; (2)
 - (b) why blades may be located in individual axial slots in the wheel periphery; (5)
 - (c) why in some instances damping wires are fitted; (3)
 - (d) why partial admission is used for the first set of nozzles but is not considered necessary for the remaining nozzles; (3)
 - (e) why sliding feet, to allow for axial casing expansion, are no longer used in some cases. (3)
8. With reference to the lubrication of turbine and gearing, describe the routine operational steps taken to prevent EACH of the following:
- (a) oxidation; (3)
 - (b) micro-seizure of the gear teeth; (3)
 - (c) frothing; (5)
 - (d) microbiological degradation. (5)
9. With reference to bottom end bearings of auxiliary diesel engines:
- (a) describe, with the aid of sketches, how hydrodynamic lubrication is achieved; (6)
 - (b) explain the effects of running with incorrect clearances; (2)
 - (c) explain how clearances are measured; (2)
 - (d) outline the precautions that should be taken before returning the unit to service after bearing renewal. (6)

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SECOND ENGINEER (UNLIMITED)

042-29 - ENGINEERING KNOWLEDGE - STEAM

WEDNESDAY, 09 April 2014

0915-1215 hrs

Examination paper inserts:

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Notes for the guidance of candidates:

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Materials to be supplied by examination centres:

Candidate's examination workbook

ENGINEERING KNOWLEDGE - STEAM

Attempt SIX questions only

Marks for each part question are shown in brackets

1. With reference to the steam drum of a main boiler:
 - (a) sketch a cross section of a longitudinal joint, explaining the method of construction; (6)
 - (b) sketch a longitudinal weld on the test plate, indicating the position of the samples; (4)
 - (c) state the test carried out on the samples; (4)
 - (d) state the non-destructive test carried out on the completed joint. (2)

2. Explain how EACH of the following contribute to the emission of black smoke when burning fuel oil:
 - (a) fuel pressure well below recommended value; (3)
 - (b) carbon build up on atomiser nozzles; (3)
 - (c) excessive leakage from the air casing; (2)
 - (d) incorrect fuel viscosity. (5)
 - (e) incorrect or worn atomiser nozzles. (3)

3. List EIGHT mountings fitted on a main boiler steam drum, stating the purpose of EACH. (16)

4. With reference to the condition of the water in a high pressure boiler, explain why there is a recommended maximum limit for EACH of the following, and the consequences of exceeding the recommended maximum:
 - (a) total dissolved solids; (2)
 - (b) chlorides; (3)
 - (c) alkalinity; (3)
 - (d) hardness; (2)
 - (e) phosphate reserve; (3)
 - (f) hydrazine reserve. (3)

5. (a) Explain why the axis of a turbine rotor will not always remain in alignment with that of its primary pinion during operation. (8)
- (b) Describe, with the aid of a sketch, how misalignment between turbine rotor and pinion is accommodated. (8)
6. (a) Describe, with the aid of a sketch, how a turbine rotor and casing are located accurately yet free to expand. (10)
- (b) Explain how the location of the rotor is remotely monitored, stating how this equipment is tested. (6)
7. With reference to steam traps:
- (a) explain why steam traps are used in steam systems; (3)
- (b) state THREE different types of steam trap; (3)
- (c) describe, with the aid of a sketch, the operation of TWO of the traps stated in part (b). (10)
8. With reference to a turbine driven feed pump fitted with a pressure controlled governor:
- (a) describe the procedure for starting the pump, giving the reasons at each step; (6)
- (b) explain why the bypass or recirculating valve should be:
- (i) open at low loads; (2)
- (ii) shut at high loads; (2)
- (c) explain how the overspeed trip is tested. (6)
9. With reference to piston rings in auxiliary diesel engines:
- (a) explain the clearances and dimensions that should be checked; (4)
- (b) state the possible consequences of operating with incorrect clearances; (6)
- (c) describe, with the aid of a sketch, the function of an oil control ring, stating where it is fitted. (6)

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SECOND ENGINEER (UNLIMITED)

042-29 - ENGINEERING KNOWLEDGE - STEAM

WEDNESDAY, 11 December 2013

0915-1215 hrs

Examination paper inserts:

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Notes for the guidance of candidates:

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Materials to be supplied by examination centres:

Candidate's examination workbook

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ENGINEERING KNOWLEDGE - STEAM

Attempt SIX questions only

Marks for each part question are shown in brackets

1. With reference to boilers of *monowall* construction, describe, with the aid of sketches, EACH of the following:
 - (a) how the tubes are connected to a header or drum; (7)
 - (b) how a wall panel is braced to prevent bulging, yet allowing freedom to expand. (9)

2.
 - (a) Describe, with the aid of a sketch, a spray type attemperator. (7)
 - (b) State where attemperation of the steam leaving the main boiler occurs, explaining why it occurs there. (4)
 - (c) State the advantages of an attemperator fitted in the steam drum. (5)

3. With reference to safety valves:
 - (a) state why easing gear is fitted; (2)
 - (b) explain the conditions under which easing gear may be used; (4)
 - (c) state any precautions that may have to be taken using easing gear; (3)
 - (d) state why an open drain from the valve is considered necessary; (2)
 - (e) state how the valve is protected against unauthorised adjustment; (2)
 - (f) explain what governs the relationship between the waste steam pipe size and the valve diameter. (3)

4. Explain how EACH of the following feed-water contaminants enter a boiler, stating the effects EACH has on the boiler and how they are detected:
 - (a) chlorides; (6)
 - (b) oxygen; (5)
 - (c) carbon dioxide. (5)

5. (a) Sketch a high pressure turbine nozzle fitted to a diaphragm. (6)
- (b) With reference to fouling of main turbine nozzles and blading:
- (i) explain how this occurs; (3)
- (ii) explain the effect on turbine performance; (5)
- (iii) state the operational practices taken to prevent fouling. (2)
6. With reference to steam-steam generators fitted to supply auxiliary steam:
- (a) explain the advantages of this arrangement; (6)
- (b) state, with reasons, the factors relating to the size of the safety valves; (4)
- (c) describe how the output steam pressure is controlled. (6)
7. (a) Describe, with the aid of a sketch, a lubricating oil system for a steam turbine plant. (8)
- (b) State the provisions incorporated in the system for dealing with the failure of a lubricating oil pump. (4)
- (c) State FOUR lubricating oil tests that may be carried out on board ship. (4)
8. With reference to an air ejector fitted to a main condenser:
- (a) describe, with the aid of a sketch, its operation; (8)
- (b) explain how condensate drainage is achieved; (4)
- (c) state why ejector efficiency deteriorates after prolonged service. (4)
9. (a) Describe the inspection of the cylinder head of an auxiliary diesel engine, stating the possible defects that may be found. (8)
- (b) Explain the consequences of continuing to use the head with the defects stated in part (a). (8)

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SECOND ENGINEER (UNLIMITED)

042-29 - ENGINEERING KNOWLEDGE - STEAM

WEDNESDAY, 16 October 2013

0915-1215 hrs

Examination paper inserts:

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Notes for the guidance of candidates:

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Materials to be supplied by examination centres:

Candidate's examination workbook

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ENGINEERING KNOWLEDGE - STEAM

Attempt SIX questions only

Marks for each part question are shown in brackets

1. Explain the reasons for the use of EACH of the following associated with main condensers:
 - (a) rolled tube to tubeplate joints; (4)
 - (b) protective inserts; (4)
 - (c) ferrous sulphate injection; (4)
 - (d) mechanical vacuum pumps as air extractors. (4)

2. With reference to steam sootblowers:
 - (a) explain the factors that determine the frequency of sootblowing; (6)
 - (b) state the precautions that should be taken before, during and after sootblowing; (6)
 - (c) explain why steam pipes in the sootblowing system should be examined regularly. (4)

3. Explain the reasons for the use of EACH of the following chemicals for boiler and feed water conditioning:
 - (a) sodium hydroxide; (4)
 - (b) sodium phosphate; (4)
 - (c) hydrazine solutions; (4)
 - (d) volatile amines. (4)

4. With reference to safety valves:
 - (a) state the ideal lift of a valve, and explain, with reasons, why it is considered ideal; (3)
 - (b) explain why the lift of an ordinary safety valve is much less than ideal; (4)
 - (c) describe TWO features used in safety valves to improve the valve lift; (4)
 - (d) state the meaning of the term *blow down*; (2)
 - (e) state why easing gear is fitted, stating the conditions under which it may be used. (3)

5. With reference to the flexible coupling fitted between the main turbine and gearing:
- (a) state why this coupling is necessary; (3)
 - (b) describe, with the aid of a sketch, a typical gear type coupling, showing how it is lubricated; (7)
 - (c) state THREE defects which may occur in a coupling, stating a reason for EACH defect. (6)
6. With reference to main turbine interstage diaphragms, explain, with the aid of a sketch, EACH of the following:
- (a) how they are sealed in the casing; (6)
 - (b) how distortion of the casing is accommodated; (5)
 - (c) how leakage at the rotor shaft is minimised. (5)
7. Describe, with the aid of sketches, the procedure for opening up and lifting the rotor of a low pressure marine propulsion turbine. (16)
8. With reference to the use of L.N.G. cargo as a boiler fuel:
- (a) state, with reasons, the means of getting rid of excess boil off gases during loading or discharge. (4)
 - (b) describe the safety precautions relating to the gas pipeline supplying the boiler and burning the gas in the boiler; (12)
9. With reference to an auxiliary diesel engine having excessive lubricating oil consumption:
- (a) explain SIX possible causes for this condition; (6)
 - (b) describe how the causes of the excess oil consumption would be identified; (6)
 - (c) explain the dangers arising from the causes explained in part (a). (4)

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SECOND ENGINEER (UNLIMITED)

042-29 - ENGINEERING KNOWLEDGE - STEAM

WEDNESDAY, 17 July 2013

0915-1215 hrs

Examination paper inserts:

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Notes for the guidance of candidates:

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Materials to be supplied by examination centres:

Candidate's examination workbook

ENGINEERING KNOWLEDGE - STEAM

Attempt SIX questions only

Marks for each part question are shown in brackets

1. Explain how EACH of the following boiler defects may occur and the operational steps that should be taken to avoid their occurrence:
 - (a) generator tube failure; (6)
 - (b) circumferential cracking of superheater support tubes; (5)
 - (c) sagging furnace roof tubes. (5)

2. As Second Engineer Officer, list the instructions for the removal, overhaul and refitting of a double plate glass water gauge to a high pressure boiler. (16)

3. With reference to combustion control, explain EACH of the following:
 - (a) state the purpose of the three flame monitors, that may be fitted to each register; (6)
 - (b) explain the sequence of operation of the flame monitors in part (a); (6)
 - (c) explain the dangers of operating with the flame monitors bypassed. (4)

4. Explain why EACH of the following chemicals are used for the treatment of boiler water:
 - (a) hydrazine; (4)
 - (b) sodium di-phosphate; (4)
 - (c) sodium hydroxide; (4)
 - (d) volatile amines. (4)

5. Explain, with the aid of diagram(s), how differential expansion of a high pressure turbine casing, bearings and rotor is accommodated. (16)

6. (a) Describe, with the aid of a sketch, a turbine bearing showing how oil is prevented from leaking into the turbine. (12)
(b) Explain how turbine bearings are monitored. (4)

7. (a) Draw a line diagram of a closed feed system incorporating a dry bottomed condenser, bled steam feed heating and a deaerator heated by exhaust steam. (10)
- (b) Explain how variations in load are accommodated and emergency feed to boilers. (6)
8. With reference to parallel slide valves in high pressure steam lines:
- (a) explain why these valves are used; (4)
- (b) describe the construction of this type of valve; (7)
- (c) explain the procedure for opening these valves. (5)
9. With reference to an auxiliary diesel engine having excessive lubricating oil consumption:
- (a) explain possible causes for this condition, stating the indications of EACH cause identified; (9)
- (b) explain the dangers arising from the causes explained in part (a). (7)

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SECOND ENGINEER (UNLIMITED)

042-29 - ENGINEERING KNOWLEDGE - STEAM

WEDNESDAY, 27 March 2013

0915-1215 hrs

Examination paper inserts:

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Notes for the guidance of candidates:

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Materials to be supplied by examination centres:

Candidate's examination workbook

ENGINEERING KNOWLEDGE - STEAM

Attempt SIX questions only

Marks for each part question are shown in brackets

Section A

1. (a) Explain THREE possible causes for a loss of main condenser vacuum in EACH of the following circumstances:
 - (i) over a short period of time; (6)
 - (ii) over a long period of time. (6)
- (b) State the effects of a choked first stage air ejector nozzle. (4)

2. State the reasons for fitting EACH of the following items to a high pressure boiler:
 - (a) large diameter downcomers; (2)
 - (b) screen tubes; (4)
 - (c) generating tubes; (4)
 - (d) water headers; (4)
 - (e) drum desuperheaters. (2)

3. With reference to the burning of fuel oil in a main boiler:
 - (a) describe the mechanism of the combustion process; (6)
 - (b) state the possible sources of water in the fuel; (3)
 - (c) describe the possible detrimental effect on boiler operation of water in the fuel. (7)

4. With reference to the condition of the water in a high pressure boiler, explain why there is a recommended maximum limit for EACH of the following, and the consequences of exceeding the recommended maximum:
 - (a) total dissolved solids; (2)
 - (b) chlorides; (3)
 - (c) alkalinity; (3)
 - (d) hardness; (2)
 - (e) phosphate reserve; (3)
 - (f) hydrazine reserve. (3)

5. (a) Describe, with the aid of a sketch, an overspeed trip arrangement suitable for a turbine driven feed pump. (10)
- (b) State the maximum allowable overspeed. (1)
- (c) Explain why it is important that this limit is not exceeded. (5)
6. (a) Describe, with the aid of a sketch, an astern guardian valve suitable for a main turbine. (9)
- (b) State why the valve described in part (a) is considered necessary. (2)
- (c) Explain the effects of steam from the main line leaking into the astern turbine whilst running ahead at full power. (5)
7. (a) Sketch a line diagram of the complete gland steam system for a set of cross compound turbines, labelling the principal components and indicating the direction of flow in all lines. (11)
- (b) Explain how leakage of steam is minimised automatically under varying load. (5)
8. (a) State the advantages of using epicyclic gearing. (4)
- (b) Sketch the layout of an epicyclic gear reduction incorporating a star, planet and parallel gear. (6)
- (c) Indicate by means of separate sketches the difference between star and planet reductions. (6)
9. List, in a logical sequence, the checks to be carried out if an auxiliary diesel engine fails to start. (16)

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MARITIME AND COASTGUARD AGENCY

STCW 95 SECOND ENGINEER REG. III/2 (UNLIMITED)

042-29 – ENGINEERING KNOWLEDGE - STEAM

WEDNESDAY, 30 MARCH 2011

0915- 1215 hrs

Examination paper inserts:

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Notes for the guidance of candidates:

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Materials to be supplied by examination centres:

Candidate's examination workbook

ENGINEERING KNOWLEDGE – STEAM

Attempt SIX questions only

All questions carry equal marks

Marks for each part question are shown in brackets

1. With reference to super heated steam temperature control:
 - (a) describe, with the aid of a sketch, a spray type attemperator; (8)
 - (b) state where in the steam flow path attemperation is carried out, explaining why this position is chosen; (4)
 - (c) state the advantages of an attemperator fitted in the steam drum. (4)

2. With reference to modern high pressure boilers:
 - (a) explain why stub tubes are used in the welded construction of generating and superheater banks and why welded connections are preferred to those that are expanded; (8)
 - (b) describe, with the aid of sketches, how isolation may be achieved so that the boiler may continue in service, in the event of failure of a tube in a *membrane wall*. (8)

3. With reference to high pressure water tube boilers:
 - (a) describe with the aid of a sketch, a suitable gauge glass; (10)
 - (b) identify the material used to protect the glass and why it is used in this type of water level indicator; (2)
 - (c) state the purpose of the safety device that may be fitted to the water side, explaining why this device is not fitted to the steam side. (4)

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4. (a) With reference to boiler water test results, explain in EACH of the following cases, the reasons for the change in values, stating the action to be taken in EACH case:
- (i) reducing total dissolved solids and chemical reserves; (3)
 - (ii) reducing phosphate reserve with increasing chlorinity and total dissolved solids; (3)
 - (iii) increasing oxygen levels only; (3)
 - (iv) slight increase in alkalinity. (3)
- (b) State the limits at which EACH of the following chemical reserves should be maintained in a high pressure marine boiler operating at pressures in excess of 60 bar:
- (i) alkalinity to phenolphthalein; (1)
 - (ii) chlorides; (1)
 - (iii) hydrazine reserve; (1)
 - (iv) phosphate reserve. (1)
5. With reference to a rotary regenerative air gas heater:
- (a) describe how it operates; (4)
 - (b) state TWO advantages and TWO disadvantages compared to other types of heater; (4)
 - (c) (i) explain why it is essential to keep air heaters clean; (4)
 - (ii) explain how cleanliness is maintained. (4)
6. (a) Describe the procedure for warming through the main propulsion steam turbine plant from cold. (10)
- (b) State SIX safety devices associated with the main turbine plant that should be tested on a regular basis. (6)
7. (a) State the advantages of using epicyclic gearing. (2)
- (b) Sketch the layout of an epicyclic gear reduction incorporating a *star*, *planet* and *parallel* gear, indicating the reductions achieved at each stage. (8)
- (c) Sketch EACH of the following:
- (i) *star* arrangements; (3)
 - (ii) *planet* arrangements. (3)

8. (a) (i) Describe, with the aid of a sketch, a lubricating oil system for a steam turbine plant. (10)
- (ii) State the provisions incorporated in the system for dealing with the total loss of electrical supplies. (3)
- (b) State THREE lubricating oil tests that may be carried out on board ship and why they are important. (3)
9. With reference to the emergency diesel generator, state with reasons:
- (a) the various checks and examinations that may have to be conducted if the engine fails to start; (9)
- (b) list the regular maintenance routines required to ensure the engine of this machine will start. (7)