# 5. 発電所のリハビリテーション

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## 5．1　発電所設備の仕様

### 5．1．1　ガードナー発電設備

1) Boiler Equipment

a. Boiler Proper

| | | Unit No. 1 | | Unit No. 2 | |
|---|---|---|---|---|---|
| ｡ Type | | Drum | | Once-Through Benson Type | |
| **Steam pressure** | | | | | |
| *Design pressure | psig(kg/cm$^2$g) | 2,180 | (153.27) | 3,425 | (240.8) |
| *Final Superheater outlet | psig(kg/cm$^2$g) | 1,800 | (126.56) | 2,770 | (194.76) |
| *Reheater outlet | psig(kg/cm$^2$g) | 530 | (37.26) | 544.3 | ( 38.27) |
| **Steam temperature** | | | | | |
| *Rating temperature | °F (°C) | 1,005 | (540.5) | 1,005 | (540.5) |
| *Economizer inlet | °F (°C) | 451 | (232.8) | 481 | (249.4) |
| *Reheater inlet | °F (°C) | 645 | (340.55) | | |
| *Reheater Outlet | °F (°C) | 1,005 | (540.5) | 1,005 | (540.5) |
| *Superheater outlet | °F (°C) | 1,005 | (540.5) | 1,005 | (540.5) |
| **Evaporation** | | | | | |
| *Boiler MCR | lb/h (t/h) | 1,065,000 | (483.07) | 1,675,485 | (760.0) |
| *Unit 4/4 load | lb/h (t/h) | 978,194 | (443.70) | 1,494,270 | (677.8) |
| **Superheater** | | | | | |
| *Primary Superheater | | | | | |
| Type | | Convection | | Horizontal Continuous Tube Type | |
| Heating surface | ft$^2$ (m$^2$) | 31,500 | (2,920.4) | | |

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| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Top and Roof superheater | | | |
| Type | | - | Tangent type |
| Heating surface | $ft^2$ ($m^2$) | - | |
| *Secondary superheater | | | |
| Type | | Radiant type | Pendant type |
| Heating surface | $ft^2$ ($m^2$) | 6,400 (594.6) | |
| *Superheater materials | | - | STPT - 49<br>STBA-12,22,23,24 |
| Reheater | | | |
| *Type | | Horizontal continuous tube type | Horizontal and pendant continuous tube |
| *Surface area | $ft^2$ ($m^2$) | 13,300 (1,235.6) | 44,800 (4,162.0) |
| *Material | | | STBA-12,22,24<br>STB-35 |
| Economizer | | | |
| *Material (tube) | | | JIS STBA-42<br>(ASTM A210A-1) |
| *Surface area | $ft^2$ ($m^2$) | 26,200 (2,434.06) | 30,200 (2,805.7) |
| *In/outlet temperature | °F (°C) | 451/540 (232.8/282.2) | 481/545 (249.4/285.0) |

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| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| Furnace | | | |
| *Volume | $ft^3$ ($m^3$) | - | 79,750 (2,258.2) |
| *Construction of water wall | | Water walls are 2-1/2 and 2-31/32 OD carbon steel tubes. The lower heater offront rear and side wall are fed from two 22" OD downcomers | Horizontal menader |
| *Manufacturer/erector | | Babcock - Hitachi | Babcock - Hitachi |
| b. Air Preheater | | | |
| Regenerative air heater | | | |
| *Type | | Ljungstrom Horizontal type | Horizontal regenerative type |
| *Heating area | $ft^2$ ($m^2$) | 78,850 (7,325.4)/Heater | 98,070 (9,111)/Heater |
| *In/outlet air temperature | °F (°C) | 135/565 (57.2/296.1) | 160/555 (71.1/290.5) |
| *Manufacturer/erector | | Gadelius | Gadelius |
| Steam coil air heater | | | |
| *Type | | HDI-2V5-17-96 | 21-450M4V-5TI-FE3 |
| (Heating area | $ft^2$ ($m^2$) | - | 18,510 (1,719.6) |

Gardner

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| c. Sootblower | | |
| *Type/units number | RSB53 rack type retractable lance 24 units | RSB-53A retractable rack 22 units |
| *Manufacturer/erector | Babcock - Hitachi | Babcock - Hitachi |
| d. Boiler Automatic Control | | |
| Combustion control | | |
| *Type | Pneumatic | Pneumatic |
| *Manufacturer/erector | Bailey | Bailey |
| Temperature control | | |
| *Type | Pneumatic | Electropneumatic |
| *Manufacturer/erector | Bailey | Siemens |
| Feedwater control | | |
| *Type | Pneumatic | Pneumatic |
| *Manufacturer/erector | Bailey | Bailey/Siemens |
| e. Fuel Supply & Firing System | | |
| Heavy oil storage tank | | |
| *Type | Common use for G1, G2, S1, and S2 | |
| *Capacity $m^3$ x number | Floating roof type | |
| *Manufacturer/erector | Tank No. 1 --- 8,751.6 | |
| | Tank No. 2 --- 8,751.6 | |
| | Tank No. 3 --- 23,550.0 | |
| | Tank No. 4 --- 23,550.0 | |
| Light Oil Storage Tank | | |
| *Type | Cylindorical : L-12'-00" W-12'-00" | |
| *Capacity x number gal ($m^3$) | 11,720 (44.36) x 1 set | |

Gardner

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Manufacturer/erector | | | |
| Heavy oil service tank | | None | None |
| *Type | | | |
| *Capacity, number of tank | | | |
| *Manufacturer/erector | | | |
| Heavy oil burner | | | |
| *Type | | Return flow mechanical atomizing | Wide range return flow mechanical atomizing |
| *Capacity, number of burner | g/h (l/h) | 722.0 (2,732) x 16 sets | 1,280 (4,845) x 18 sets |
| *Manufacturer/erector | | Babcock & Wilcox | Babcock & Wilcox |
| Light oil burner | | | |
| *Type | | - | - |
| *Capacity | | - | - |
| Number of burner | | 16 sets | 18 sets |
| Main fuel oil pump | | | |
| *Type | | No. A6DH - 400 Rotary, Screw | IMO-Screw-type Spindle pump |
| *Discharge pressure | psig($kg/cm^2g$) | 765 (53.8) x | 720 (50.6) |
| Capacity | gal/min($m^3/h$) | 264 (59.95) | 380 (74.9) |
| & number of pump | | 2 sets | |
| *Manufacturer/erector | | IMO - DeLaval | Siemens |

Gardner

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Driver - Type | | G.E. explosion proof motor coupled by a falk type coupling | |
| - Capacity | | 200 HP (149.2 kW), 1200 rpm | 250 kW, 1800 rpm 440 V, 60 herz |
| **Constant differential fuel oil pump** | | | |
| *Type | | Centrifugal, vertical 2 stages | |
| *Capacity & number of pump | gal/min($m^3$/h) | 215 (48.82) x 1 set | |
| *Discharge pressure | psig(kg/$m^2$g) | 915 (64.33) | |
| *Suction pressure | psig(kg/$m^2$g) | 740 (52.03) | |
| **Light fuel oil pump** | | | |
| *Type | | No. A6DB-137 SCREW | |
| *In/outlet pressure, capacity & number of pump | psig(kg/$m^2$g) gal/min($m^3$/h) | 17 in Hg/259(0.59/18.2) 27.8 (6.31) x 2 sets | |
| *Manufacturer/erector | | IMO - DE LAVAL | |
| *Driver - Type | | G.E. explosion proof motor | Induction motor |
| - Capacity | HP (kW) | 7.5 (5.6) | 7.5 (5.6) |
| *Manufacturer/erector | | General Electric | |

Gardner

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| Main fuel oil heater | | | |
| *Type | | OWS 14-96-2F thermofilm | MESCO 2EV13-162F |
| *Capacity & number of heater | gal/min($m^3$/h) | 100 (22.7) x 3 sets | 135 (30.7) x 3 sets |
| *Manufacturer/erector | | Old Dominion Iron and Steel Corporation | The Engineer Co. |

f. Boiler Draughting Equipments

| | | | |
|---|---|---|---|
| Forced draught fan | | | |
| *Type | | No. 560 Series 120 C-D11 with inlet vanes and connection of combustion control | Axial flow, 2 stage horizontal, with oil hydraulic motor blade adjustment |
| *Capacity & number | $ft^3$/min ($m^3$/min) | 178,410 (5,052.6) x 2 sets | 232 lb/sec(105.2 kg/sec) x 2 sets |
| *Pressure | in wg (mmwg) | 37 (940) | 45 (1143) |
| *Revolution speed | rpm | 1,180 | 1,750 |
| *Manufacturer/erector | | American Standard | Dinzler |
| *Driver - Type | | - | Squirrel cage, horizontal |
| - Capacity x number | HP (kW) | 1,250 (932.5) x 2 sets | 2,250 (1680) x 2 sets |
| - Manufacturer/ erector | | General Electric | Siemens |

Gardner

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| Gas recirculation fan | | | |
| *Type | | - | 6600 DT - CH |
| *Capacity x number | $ft^3/min$ ($m^3/min$) | - | 250,800 (7,101.6) x 1 set |
| *Pressure | mmAq | - | - |
| *Revolution speed | rpm | 885 | 900 |
| *Manufacture/erector | | | |
| *Driver - Type | | EFUP 3 Ø | Motor Drive |
| - Capacity kW x number | | Induction motor 400 x 1 set | 475 x 1 set |
| - Manufacturer/ erector | | Hitachi, Ltd. | |
| Stack | | | |
| *Construction | | Constructed of welded steel plate, insulated with 2' thick magnesia and gunitelined with 2" thick mixture of sand and "Lunirite" cement. | |
| *Top outside diameter | | 25'-6" (4.725m) | |
| *Height | | 301'-63/4" (91.906m) | |
| *Number | | One stack for Unit 1 and Unit 2 | |
| *Manufacturer/erector | | Pacific Engineering | |

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| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| g. Boiler Feed Water Pump | | | |
| Turbine driven feed water pump | | | |
| *Type & number of stage | | None | HDGr 7S, 7 stage centrifugal |
| *Capacity & number of pump | lbs/h(T/h) | | 1,863,000 (845) x 1 set |
| *Total head & revolution | psi (m)<br>rpm | None | 3,545 (2,492.5)<br>4600 |
| *Manufacturer/erector | | | KS & B |
| Turbine for BFP | | | |
| *Type | | None | Axial reaction, single cylinder condensing type |
| *Capacity & number of turbine | kW | | 14,200 x 1 set |
| *Manufacturer/erector | | | Siemens |
| T-BFP booster pump | | | |
| *Type | | None | YNK N 400/300, doubt suction, single stage |
| *Capacity & number of pump | lbs/h (t/h) | | 1,863,000 (845.0) x 1 set |
| *Total head & revolution | psi (m)<br>rpm | None | 96 (67.5)<br>1,500 |
| *Driver (pump input) | kW | | 200 |
| *Manufacturer/erector | | | KSB |

Gardner

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| Motor driven feed water pump | | | |
| *Type & number of stage | | 8" HH-BFI, horizontal barrel type 9 stages | HDGr 55S/7 stage centrifugal, motor drive |
| *Capacity & number of pump | g/m($m^3$/h) | 1,328 (301.6) x 2 sets | 1,631 (370.5) x 2 sets |
| *Total head & revolution | psi (m)/rpm<br>rpm | 3,025 (2,134)<br>3570 | 3,585 (2,520)<br>4870 |
| *Manufacturer/erector | | Pacific Pumps | KSB |
| *Driver - Type | | | Totally enclosed fan cooled |
| - Capacity & number of motor | kW | 3,100 x 2 sets | 4,400 x 2 sets |
| - Manufacturer/ erector | | | Siemens |
| h. Feed Water Heaters Equipment | | | |
| No. 1 LP feed water heater | | | |
| *Type | | Horizontal U-tube L.P. size 34-35B | Vavl 115.4/470, horizontal U-tube, 4 pass |
| *Heating surface area & number of heater | $ft^2$ ($m^2$) | 5.056 (469.7) 1 set | 4,740 (440.3) 1 set |
| *Material of heating tube | | Admiralty | St. 35.8 Seamless Steel |

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| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Heating steam in/ drain outlet temperature | °F (°C) | 242/114 (116.7/45.6) | 177/172 (80.6/77.8) |
| *Feed water flow | lbs/h (kg/h) | 894,300 (405,654) | 1,117,700 (506,988) |
| *Manufacturer/erector | | Yuba Heat Transfer Corp. | Atlas - Mak Maschinenbau - GmbH |

No. 2 LP feed water heater

| | | | |
|---|---|---|---|
| *Type | | Horizontal U-tube L.P. size 32-319 | Vval 1.2.4/490, horizontal U-tube, 4-pass |
| *Heating surface area | $ft^2$ ($m^2$) | 3,240 (301.0) | 4,850 (450.6) |
| *Number of heater | | 1 set | 1 set |
| *Material of heating tube | | Admiralty | S+ 35.8 Seamless steel |
| *Heating steam in/ drain outlet temperature | °F (°C) | 458/200 (236.7/93.3) | 275/172 (135.0/80.6) |
| *Feedwater in/outlet temperature | °F (°C) | 190/257 (87.94/125.0) | 167/208 (75.0/97.8) |
| *Feed water flow | lb/h (kg/h) | 896,510 (406,657) | 1,117,672 (506,976) |
| *Manufacturer/erector | | Yuba Heat Transfer Corp. | Atlas - Mak Maschnenbau - GmbH |

Gardner

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| No. 3 LP Feed Water Heater | | | |
| *Type | | Horizontal U-tube, L.P. size 30-298 | Vwal 12.4/580, horizontal U-tube 4-pass |
| *Heating surface area & number of heater | $ft^2$ ($m^2$) | 2,280 (211.8) 1 set | 5,814 (540.1) 1 set |
| *Material of heating tube | | Admiralty | St. 35.8 Seamless Steel |
| *Heating steam in/ drain outlet temperature | °F (°C) | 574/267 (301.1/130.5) | 502/218 (261.1/103.3) |
| *Feed water in/outlet temperature | °F (°C) | 257/294 (125.0/145.5) | 208/289 (97.8/142.7) |
| *Feed water flow | lbs/h (kg/h) | 896,510 (406,657) | 1,117,672 (506,976) |
| *Manufacturer/erector | | Yuba Heat Transfer Corp. | Atlas - Mak Maschinenbau - GmbH |
| Deaerator | | | |
| *Type | | Direct contact, spray tray mounted, on horizontal storage tank | Spray type, mounted on horizontal storage tank |
| *Deaerator Capacity | lbs/h (kg/h) | | |
| *Condensate to deaerator | lbs/h (kg/h) | | |

| Gardner | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Outlet feed water flow | lbs/h (kg/h) | 1,161,490 (526,852) | 1,494,270 (677,800) |
| *Storage tank capacity | $ft^3$ ($m^3$) | 5,620 (159.1) | 5,124 (145.1) |
| *Deaerator pressure | psig($kg/cm^2g$) | 120 (8.44) | 142.3 (10.0) |
| *Manufacturer/erector | | Worthington Corp. | Atlas - Mak Maschinenbau - GmbH |
| *Heating steam inlet temperature | °F (°C) | - | 663 (350.5) |
| *Dissolved oxygen guarantee value | cc/1 | 0.005 | 0.005 |
| No. 5 HP feed water heater | | | |
| *Type | | U-type multilok, Horizontal, HP size 34-274 | VU Way 95.2/400 horizontal U-tube 2-pass |
| *Heating surface area & number of heater | $ft^2$ ($m^2$) | 3,350 (311.2) 1 set | 3,660 (340.0) 2 sets |
| *Material of heating tube | | 70-3-Cu-Ni (PHelps Dodge Cuffenloy 30) | St 35.8 Seamless Steel |
| *Heating steam in/ drain outlet temperature | °F (°C) | 830/356.8 (443.3/180.4) | 820/369 (437.8/187.2) |
| *Feed water in/outlet temperature | °F (°C) | 346.8/383.5 (174.9/195.3) | 359.4/408.7 (181.9/209.3) |

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| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Feed water flow | lbs/h (kg/h) | 1,055,930 (478,962.37) | 1,358,425 (616,181.6) |
| *Manufacturer/erector | | Yuba Heat Transfer Corp. | Atlas - Mak Maschinenbau - GmbH |

No. 6 HP Feed water heater

| | | | |
|---|---|---|---|
| *Type | | U-tube multi lok, horizontal, HP size 39-332 | VU Way 95:2/420 horizontal U-tube 2-pass |
| *Heating surface area & number of heater | °F (°C) | 5,752 (534.4) 1 set | 3,770 (350.2) 2 sets |
| *Material of heating tube | | 70-30 Cu-Ni (Phelps Dodge Cuffenloy 30) | St 45.8 III Seamless Steel |
| *Heating steam in/ drain outlet temperature | °F (°C) | 650/393.4 (343.3/200.8) | 629/418.8 (331.7/214.9) |
| *Feed water in/outlet temperature | °F (°C) | 383.5/457.9 (195.3/236.6) | 408.7/481.5 (209.3/249.7) |
| *Feed water flow | lbs/h (kg/h) | 1,055,930 (478,961.4) | 1,358.425 (616,181.6) |
| *Manufacturer/erector | | Yuba Heat Transfer Corporation | Atlas - Mak Maschinenbau - GmbH |

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| 2) Turbine and Auxiliary | | | |
| a. Turbine | | | |
| *Type | | Tanden-compound reheat, condensing unit | Tanden-compound single reheat |
| *Rating output | kW | 150,000 | 200,000 |
| *Throttle steam pressure at MSV inlet | psig(kg/cm$^2$g) | 1,804 (126.8) | 2,706 (190.2) |
| *Throttle steam temperature (main steam/hot reheat) | °F (°C) | 1,000/1,000 (537.8/537.8) | 1,000/1,000 (537.8/537.8) |
| *Exhaust vacuum | inHg (mmHg) | 3.5 (88.9) | 3.5 (88.9) |
| *Number of bled steam stages | | 6 | 6 |
| *Manufacturer/erector | | General Electric Company | Siemens |
| b. Condenser | | | |
| *Type | | 107E - RBT - 30 two-pass vertically divided condenser with reflushing deaerating hotwell | Surface rectangular single shell |
| *Circulating water | gal/m (m$^3$/h) | - | - |
| *Tube cleanliness factor | % | - | - |
| *Condensate flow | lbs/h (t/h) | 820,000 (371.94) | 971,100 (440.48) |

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| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| *Cooling water design temperature °F (°C) | 85 (29.4) | 85 (29.4) |
| *Cooling water outlet °F (°C) design temperature | - | - |
| *Design point tube inside flow velocity ft (m/s) | 7.0 (2.134) | 6.7 (2.042) |
| *Tube material of condensing zone | Arserical Admiralty | Admiralty |
| *Tube dimensions of condensing zone | 1" OD 18 BWG | 1" OD #18 |
| *Effective tube length | - | - |
| *Tube material of air cooling zone | - | - |
| *Cooling surface $ft^2$ ($m^2$) | 115,060 (10,689) | 130,300 (12,150) |
| *Material of tube plate | Steel | Steel with tarset coating |
| *Material of water box | Steel | Steel with tarset coating |
| *Cathodic protection system type | - | |
| *Manufacturer/erector | Ingersoll - Rand Company | Siemens |

Gardner

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| c. Circulating Water Pump | | |
| *Type | Vertical, single stage mixed flow size 40A PMA, non-pullout | Vertical shaft, mixed flow single stage with variable pitch propeller blades |
| *Capacity x head x number | 55,555 g/m x 30' (12,616 $m^3$/h x 9.14 m) x 2 sets | 102,900 g/m x 25' (23,368 $m^3$/h x 7.62 m x 2 sets |
| *Manufacturer/erector | Ingersoll - Rand Company | Siemens |
| *Driver - Type | | |
| - Capacity kW x rpm | 373 x 500 | 650 x 1,785 |
| d. Air Ejector Equipment | | |
| *Type | JS 200, twin element, two stage, steam hot with combined surface inter-after condenser | Roman 1/25, twin elements, two stage steam jet |
| *Capacity x number | - x 2 sets | 45 lbs/h (20.4 kg/h) x 2 sets |
| *Suction pressure inHg (mmHg) | 1.0 (25.4) | 2.5 (63.5) |

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| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Working steam consumption (in case of steam jet ejector) | lbs/h (kg/h) | 827 (375.1) | 960 (435.5) |
| *Driver capacity kW x rpm (in case of mechanical ejector) | | - | - |
| *Manufacturer/erector | | Ingersoll - Rand Company | Siemens |
| e. Condensate Pump | | | |
| *Type | | Vertical, 6 stages size 20 APKC - 6 | WKT 250 vertical 5 stage, 14"x12" ring sectional design with barrels |
| *Capacity gpm x head ft x number | | 1850 gpm x 605 ft x 2 sets ($420\ m^3/h$) x (184.4 m) | 2880 gpm x 820 ft x 2 sets ($654\ m^3/h$) x (250 m) |
| *Manufacturer/erector | | Ingersoll - Rand Company | Siemens |
| *Driver - Type | | | |
| - Capacity | kW x rpm | 298.4 x 1,180 (400 HP) | 610 x 1,180 |

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| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| 3) Generator and Auxiliary | | | |
| a. Generator | | | |
| *Type | | Totally enclosed hydrogen cooled GE Type ATB | Totally enclosed hydrogen cooled FTHD.540/62-2/60 |
| *Rating capacity | kVA | 188,000 (30 psig) | 245,000 |
| *Power factor | | 0.9 | 0.9 |
| *Voltage | V | 18,000 | 14,400 |
| *Frequency | Hz | 60 | 60 |
| *Revolution | rpm | 3,600 | 3,600 |
| *Cooling type - Stator | | Hydrogen cooled | Hydrogen cooled |
| - Rotor | | | |
| *Hydrogen pressure | psig($kg/cm^2g$) | 30 (2.113) | 45 (3.164) |
| *Connection | | Star | Double Star |
| *Exciting system | | Static Type | Brushless Type |
| *Short circuit ration | | 0.604 | 0.596 |
| *Neutral grounding system | | Transformer 75 kVA 14,400/240 V, resistance, 0.63 ohm, 300A | Transformer 50kVA 10,000/220 V, resistance, 0.804 ohm, 220A |
| *Manufacturer/erector | | General Electric | Siemens |
| b. Exciter | | | |
| *Type | | Static Type | 3 phase, 6 pole revolving armature type with silicon rectifier |

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| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Capacity | kW | Rectifier 846A DC 2 sets | 1,870 (main exciter) |
| | | C.T. 6,030A 3 phase | 940 (rectifier) |
| *Voltage | V | 1ry P.T. 116 kVA 18,000/120 V | 570(main exciter) |
| | | 2ry P.T. 340 kVA 18,000/256 V | 410 (rectifier) |
| *Revolution speed (if rotating type) | rpm | - | 3,600 |
| *Number | | 1 set | 1 set |
| *Manufacturer/erector | | General Electric | Siemens |
| *Kind of driver (if rotating type) | | - | Directly coupled to generator |

Gardner

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| 4) Transformers | | | |
| a. Main Transformer | | | |
| *Type | | G.E. "Atmoseal" Oil-immersed(OA/FA) outdoor type | KFUM 1985N/130E Oil-immersed (FOD) outdoor type |
| *Capacity | kVA | 130,000 a 55°C Rise, OA<br>173,000 a 55°C Rise, FA<br>193,760 a 65°CV Rise, FA | 232,000 |
| *Primary voltage | V | 17,500 | 14,400 |
| *Secondary voltage | V | 115,000 | 115,000 |
| *Phase | | 3 | 3 |
| *Impedance voltage | % | 7.13 | 10.7 |
| *Connection | | Delta - WYE | Delta - WYE |
| *Neutral (HV side) | | Solidly-grounded | Solidly-grounded |
| *Cooling system | | Air cooled | Forced oil cooled<br>Forced air cooled |
| *Number | | 1 set | 1 set |
| *Manufacturer/erector | | General Electric | Siemens |
| b. Station Service Transformer | | | |
| *Type | | Oil immersed, sealed air, (OA) | KOUM, 1425 n/20 (OA) |
| *Capacity | kVA | 10,000 | 17,000 |
| *Primary voltage | V | 18,000 | 14,400 |
| *Secondary voltage | V | 4,160 | 4,160 |

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| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Phase | | 3 | 3 |
| *Impedance voltage | % | 5.5 | 9.9 |
| *Connection | | Delta - WYE | Delta - WYE |
| *Neutral (L.V. side) | | Solidly grounded | Solidly grounded |
| *Cooling system | | Oil air self cooled | oil air self cooled |
| *Number | | 1 set | 1 set |
| *Manufacturer/erector | | General Electric | Siemens |

c. Emergency Station Service Transformer

| | | Common Use |
|---|---|---|
| *Type | | Oil immersed (OA) Out door, type |
| *Capacity | kVA | 12,000 |
| *Primary Voltage | V | 115,000 |
| *Secondary voltage | V | 4,160 |
| *Phase | | 3 |
| *Impedance voltage | % | 6.0 |
| *Connection | | Delta-Zigzag |
| *Neutral (L.V. side) | | Solidly grounded |
| *Cooling system | | Oil, air, self cooled |
| *Number | | 1 set |
| *Manufacturer/erector | | G.E. |

Gardner

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| 5) Water Treatment System | | |
| a. Raw Water | Common Use | |
| *Kind | Deepwell water | |
| *Total hardness ($CaCO_3$) ppm | 95 | |
| *pH | 6.9 | |
| *Silica ($SiO_2$) ppm | 70 | |
| *Turbidity degree | - | |
| b. Raw Water Tank | | |
| *Type | | |
| *Capacity $m^3$ x number | | |
| *Manufacturer/erector | | |
| c. Sedimentation System | | |
| *Type | | |
| *Applied chemical | | |
| *Manufacturer/erector | | |
| d. Filtering System | | |
| *Type | | |
| *Applied chemical | | |
| *Capacity t/day x number | | |
| *Manufacturer/erector | | |
| e. Filtering System | | |
| *Type | | |
| *Capacity t/day x number | | |
| *Type of reverse washing | | |
| *Filter material | | |
| *Manufacturer/erector | | |

Gardner

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| f. Water Dimineralizing Equipment | | |
| *Type | Graver | |
| *Capacity GPM($m^3$/H) x number of train | 50 (11.4) x 3 | |
| | Mixed Bed 76 (17.3) x 2 | |
| *Capacity per 1 cycle service gal($m^3$) | Cation 90500 (286) | |
| | Anion 71000 (269) | |
| | Mixed Bed 1,000,000 (3785) | |
| *Type of resin x resin filling capacity $ft^3$ | Cation RE-3 108 (3058) | |
| | Anion AE-61 96 (2718) | |
| | Mixed Bed Cation RE-6 17 (481) | |
| | Anion AE-61 11 (311) | |
| g. Condensate Demineralizer | | |
| *Pre-filter Type | None | None |
| *Condensate Demineralizer Capacity x number GPM($m^3$/H) | None | 1400 (318) x 3 |
| *Regeneration Equipment | | 2 sets in GSTP |

5．1．2　スナイダー発電設備

1) Boiler

a. Boiler Proper

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| Type | | Meander Waterwall radiant type | Meander Waterwall radiant type |
| Steam Pressure at 100% load | | | |
| *Design pressure | psig(kg/cm$^2$g) | 3,425 (240.8) | 3,425 (240.8) |
| *Final superheater outlet | psig(kg/cm$^2$g) | 2,770 (194.76) | 2,770 (194.76) |
| *Reheater outlet | psig(kg/cm$^2$g) | 544.3 (38.27) | 544.3 (38.27) |
| Steam temperature at 100 % load | | | |
| *Rating temperature | °F (°C) | 1,005 (540.5) | 1,005 (540.5) |
| Economizer inlet | °F (°C) | 481 (249.4) | 481 (249.4) |
| Reheater inlet | °F (°C) | - | 627 (330.5) |
| Reheater outlet | °F (°C) | 1,005 (540.5) | 1,005 (540.5) |
| Superheater outlet | °F (°C) | 1,005 (540.5) | 1,005 (540.5) |
| Evaporation | | | |
| *Boiler MCR | lbs/h (t/h) | 1,675,485 (760) | 2,274,227 (1,031.6) |
| *Unit 4/4 load | lbs/h (t/h) | 1,494,270 (677.8) | 2,028,507 (920.1) |
| Superheater | | | |
| *Primary superheater | | | |
| Type | | horizontal continuous tube | horizontal continuous tube type |
| Heating surface | ft$^2$ (m$^2$) | (S.H. Total) 57,360 (5328.9) | 52,560 (4,883) |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Top and Roof SH | | | |
| Type | | Tangent type | Tangent type |
| Heating surface | $ft^2$ ($m^2$) | | 9,860 (916) |
| *Secondary Superheater | | | |
| Type | | | Pendant continuous tube type |
| Heating surface | $ft^2$ ($m^2$) | | 26,570 (2,468.4) |
| Superheater materials | | STPT-49<br>STBA-12, 22, 23, 24 | - |
| Reheater | | | |
| *Type | | Horizontal & pendant continuous tube | Horizontal & pendant continuous tube |
| *Heating surface | $ft^2$ ($m^2$) | 44,810 (4163.0) | 41,900 (3,985.5) |
| *Materials | | STBA-12,22,24<br>STB-34<br>SUS-27 HTB | STBA-12,23,24,<br>STB-35 |
| Economizer | | | |
| *Material | | STB 42<br>(ASTM A210 A-1) | STB 42 |
| *heating surface | $ft^2$ ($m^2$) | 30,200 (2,805.7) | 54,600 (5,072.5) |
| *In/outlet temperatue | °F (°C) | 481/545<br>(249.4/285.0) | 481/564<br>(249.4/295.5) |
| Furnace | | | |
| *Volume | $ft^3$ ($m^3$) | 79,750 (2,258.2) | 120,000 (3,398) |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Construction of water wall | | Horizontal meander | Meander construction |
| *Manufacturer/erector | | Babcock - Hitachi | Babcock - Hitachi |
| b. Air Preheater | | | |
| Regenerative air heater. | | | |
| *Type | | Horizontal regenerative type | Ljungstrom horizontal regenerative type |
| *Heating area | $ft^2$ ($m^2$) | 98,070 (9,111)/ heater | (149,210 (13,862) |
| *In/outlet air temperature | °F (°C) | 160/555 (71.1/290.5) | 137/559 (58.3/292.8) |
| *Manufacturer/erector | | Ljungstrom Gadelius | Ljungstrom Gadelius |
| Steam air heater | | | |
| *Type | | 21-450M4V-ETI-FE 31 | 21-530H5V-ETI-FE 41 |
| *Heating area | $ft^2$ ($m^2$) | 18,510 (1,719.6) | 27,835 (2,586) |
| *In/outlet air temperature | °F (°C) | 136/160 (57.8/71.1) | 100/134 (37.8/56.7) |
| *Manufacturer/erector | | GEA Luftkunkler-gestllschaft Bothum | GEA Luftkunkler-gesellschaft Bothum |

Snyder

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| c. Sootblower | | |
| *Type/units number | RSB-53A Retract-able rack 22 units | RSB-53A retract-able rack type 18 sets swing type 2 sets |
| *Manufacturer/erector | Babcock - Hitachi | Babcock - Hitachi |
| d. Boiler Automatic Control | | |
| Combustion control | | |
| *Type | Electronic | Electronic |
| *Manufacturer/erector | Siemens | Siemens |
| Temperature control | | |
| *Type | Electropneumatic | Electropneumatic |
| *Manufacturer/erector | Bailey & Siemens | Bailey & Siemens |
| Feed water control | | |
| *Type | Electronic | Electronic |
| *Manufacturer/erector | Siemens | Siemens |
| e. Fuel Supply & Firing System | | |
| Heavy oil storage tank | | |
| *Type | Floating roof type | |
| *Capacity $m^3$ x number | Tank No. 1 | 8752 $m^3$ |
| | Tank No. 2 | 8752 $m^3$ |
| | Tank No. 3 | 23550 $m^3$ |
| | Tank No. 4 | 23550 $m^3$ |
| *Manufacturer/erector | | |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| Light oil tank | | | |
| *Type | | Common use for G1, G2, S1 and S2 | |
| *Capacity x number | gal ($m^3$) | 11,720 (44.36 ) x 1 set | |
| *Manufacturer/erector | | | |
| Heavy oil service tank | | None | none |
| *Type | | | |
| *Capacity, Number of tank | | | |
| *Manufacturer/erector | | | |
| Heavy oil burner | | | |
| *Type | | Wide range mechanical atomizing | Mechanical atomizing type |
| *Capacity, Number of burner | g/h (l/h) | 1,280 (4,845) x 18 | 972 (3,679) x 24 |
| *Manufacturer/erector | | Babcock & Wilcox | Babcock & Wilcox |
| Light oil burner | | | |
| *Type | | B & W standard pressure and atomizing | B & W standard pressure and atomizing with replaceable sprayer plate |
| *Capacity, number of burner | lb/h (kg/h) | 440 (199.6)/18 pcs | /24 pcs |
| *Manufacturer/erector | | Babcock & Wilcox | Babcock & Wilcox |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| Main fuel oil pump | | | |
| *Type | | IMO-Saren type spindle pump | IMO-Screw type ALG-110-4B spindle pump |
| *Discharge pressure, capacity & number of pump | psig(kg/cm$^2$g) | 720 (50.6) | 900 (63.3) |
| | g/m (m$^3$/h) | 330 (74.9) 2 sets | 380 (86.3) x 2 sets |
| *Manufacturer/erector | | Siemens | Steinmeller |
| *Driver - Type | | - | 1MJ5428 - 4F |
| - Capacity | kW | 250 | 250 |
| Constant differential fuel oil pump | | | |
| *Type | | | 81, HSZ-5321 |
| *Capacity | g/m (m$^3$/h) | | 430 (97.7) |
| *Suction pressure | psig(kg/cm$^2$g) | | 730 (51.3) |
| *Discharge pressure | psig(kg/cm$^2$g) | | 900 (63.3) |
| Light fuel oil pump | | | |
| *Type | | De Laval - IMO | 4800-Gear pump |
| *Discharge pressure | psig(kg/cm$^2$g) | | 250 (17.6) |
| Capacity & number of pump | g/m (m$^3$/h) | 2 sets | 86 (19.5) x 1 set |
| *Manufacturer/erector | | | The Engineering Co. |
| *Driver - Type | | AC motor | AC motor |
| - Capacity | HP (kW) | 7.5 (5.6) | 25 (18.65) |
| *Manufacturer/erector | | General Electric | Westing House |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| Main fuel oil heater | | | |
| *Type | | MESCO 2 EV 13 - 1625 | MESCO 2 EU15-168-F Triplex fuel oil heater |
| *Capacity & number of heater | g/m ($m^3$/h) | 135 (30.7) x 3 sets | 190 (43.2) x 3 sets |
| *Manufacturer/erector | | The Engineering Co. | The Engineering Co. |

f. Boiler Draughting Equipment

| | | | |
|---|---|---|---|
| Forced Draught Fan | | | |
| *Type | | Axial Flow, 2 stage horizontal, with oil hydraulic rotor blade adjustment | Model FAF 22.4/ 12.5-2 axial flow 2 stage horizontal, with oil hydraulic rotor blade |
| *Capacity & number | $ft^3$/min ($m^3$/min) | 232 lb/sec (105.2 kg/sec) | 380,000 (10,760) x 2 sets |
| *Pressure | inwg (mmwg) | 45 (1,143) | 43 (1,092.2) |
| *Revolution speed | rpm | 1,750 | 1,150 |
| (Manufacturer/erector | | Dingler | Dingler |
| *Driver - Type | | AC motor squirrel cage, horizontal | AC motor 1, RN3, 352-LHE-90Z |
| - Capacity HP(KW) x number | | 2 sets | 2,250 (1,680) x 3,300 (2, 2 sets |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| - Manufacturer/ erector | | Siemens | Siemens |
| Gas Recirculation Fan | | | |
| *Type | | 6600 POT - CH | Double suction turbo fan NV - 1CO #16 -1/2 |
| *Capacity & number | $ft^3(m^3/min)$ | 250,800 (7,101.6) x 1 set | 416,400 (11,790.8) x 1 set |
| *Pressure | inwg (mmwq) | - | 12.2 (309.9) |
| *Revolution speed | rpm | 900 | 870 |
| *Manufacturer/erector | | - | - |
| *Driver - Type | | AC motor | AC motor ETA-KK weather protected NEMA type II |
| - Capacity KW x number | | 475 x 1 set | 930 x 1 set |
| - Manufacturer/ erector | | - | - |
| Stack - handles flue gas from S1 and S2 | | | |
| *Construction | | Welded steel plate and gunitelined with 2.5" thick mixture of sand | |
| *Top inside diameter | m | 17'6" (5.34m) | |
| *Height | m | 284' (86.6m) | |
| *Number | | One stack for S1 and S2 | |
| *Manufacturer/erector | | Pacific Engineering | |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| g. Boiler Feed Water Pump | | | |
| Turbine driven feed water pump | | | |
| *Type & number of stage | | HDGR 75, 7 stage centrifugal | HDR8S, 6 stage centrifugal |
| *Capacity & number of pump | lbs/h (t/h) | 1,863,000 (845) x 1 set | 2,600,000 (1,179.4) x 1 set |
| *Total head & revolution | psi (m)/rpm | 3,545 (2492.5)/ 4600 | 3,804 (2,674.6)/ 5000 |
| *Manufacturer/erector | | KSB | KSB |
| Turbine for BFP | | | |
| *Type | | Axial reaction single cylinder condensing type | Axial reaction single cylinder, condensing type |
| *Capacity & number of turbine | kW | 14,200 x 1 set | 12,214 x 1 set |
| *Manufacturer/erector | | Siemens | Siemens |
| T-BFP booster pump | | | |
| *Type | | YNK N 400/300, double suction, single stage | YNKN 400/300, double suction single stage |
| *Capacity & number | lbs/h (t/h) | 1,863,000 (845.0) x 1 set | 2,600,000 (1,179.4) x 1 set |
| *Total head & revolution | psi m/rpm | 96 (67.5)/1,500 | 96 (67.5)/1,630 |
| *Driver (pump input) | kW | 200 | 420 |
| *Manufacturer/erector | | KSB | KSB |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| Motor driven feed water pump | | | |
| *Type & number of stage | | HDGr 555/7 stage centrifugal, motor driven | HDG 55n, 11 stage centrifugal, motor driven |
| *Capacity & number of pump | lbs/h (t/h) | 706,470 (320.4) x 2 sets | 760,000 (344.7) x 1 set |
| *Total head & revolution | psi (m) rpm | 3,585 (2,520)/4870 | 2,950 (2,074.1)/ 3,570 |
| *Manufacturer/erector | | KSB | KSB |
| *Driver - Type | | Totally enclosed fan cooled | ITC 2929-3 EPOI-Z |
| - Capacity kW & number of motor | | 4,400 x 1 set | 3,120 x 1 set |
| - Manufacturer/ erector | | Siemens | Siemens |

h. Feed Water Heaters Equipment

| | | | |
|---|---|---|---|
| No. 1 LP feed water heater | | | |
| *Type | | Vwakl 115.4/470 horizontal U-tube 4 pass | Vwakl 115.2/750, horizontal U-tube 2 pass low pressure, 4 separate drain cooler |
| *Heating surface & number of heater | $ft^2$ ($m^2$) | 4,740 (440.3) 1 set | 7,410 (688.4) 1 set |
| *Material of heating tube | | St 35.8 seamless steel | St 35.8 |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Heating steam in/ drain outlet temperature | °F (°C) | 177/172 (80.6/77.8) | 182.5/176.5 (83.6/80.3) |
| *Feed water in/outlet temperature | °F (°C) | 112/167 (44.4/75.0) | 113.4/170.1 (45.2/76.7) |
| *Feed water flow | lbs/h (kg/h) | 1,117,690 (506,975) | 1,863,526 (845.295) |
| *Manufacturer/erector | | Atlas - Mak Maschinenbau GmbH | Atlas - Mak Maschinenbau - GmbH |

No. 2 LP feed water heater

| | | | |
|---|---|---|---|
| *Type | | Vwakl 12.4/490 horizontal U-tube 4 pass | Vwakl 115.2/750, horizontal U-tube design, 2 pass low press. with internal drain cooler |
| *Heating surface & number of heater | $ft^2$ ($m^2$) | 4,850 (450.6) 1 set | 7,410 (688.4) 1 set |
| *Material of heating tube | | St 35.8 | St 35.8 |
| *Heating steam in/ drain outlet temperature | °F (°C) | 275/172 (135/80.6) | 266.6/182.5 (130.3/83.6) |
| *Feed water in/outlet temperature | °F (°C) | 167/208 (75.0/97.8) | 170.1/214 (76.7/101.1) |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Feed water flow | lbs/h (kg/h) | 1,117,672 (506,976) | 1,863,526 (845,295) |
| *Manufacturer/erector | | Atlas-Mak Maschinenbau - GmbH | Atlas-Mak Maschinenbau - GmbH |
| **No. 3 LP feed water heater** | | | |
| *Type | | Vwak1-12.4/580 horizontal U-tube 4 pass | Vwak1 125.2/900 horizontal U-tube 2 pass low press. and with internal drain cooler |
| *Heating surface & number of heater | $ft^2$ ($m^2$) | 5,814 (540.1) 1 set | 8,880 (825.0) 1 set |
| *Material of heating tube | | St 35.8 seamless steel | St 35.8 |
| *Heating steam in/ drain outlet temperature | °F (°C) | 502/218 (261.1/103.3) | 499/226.6 (259.4/108.1) |
| *Feed water in/outlet temperature | °F (°C) | 208/289 (97.8/142.7) | 214/299.3 (101.1/148.5) |
| *Feedwater flow | lbs/h (kg/h) | 1,117,672 (506,976) | 1,863,526 (845,295) |
| *Manufacturer/erector | | Atlas-Mak Maschinenbau GmbH | Atlas-Mak Maschinenbau GmbH |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| Deaerator | | | |
| *Type | | Spray type mounted on horizontal storage tank | spray deaerator mounted on horizontal storage tank |
| *Deaerating capacity | lbs/h (kg/h) | - | 2,425,600 (1,100,252) |
| *Condensate to deaerator | lbs/h (kg/h) | - | 1,674,262 (759,445) |
| *Outlet feed water flow | lbs/h (kg/h) | 1,494,270 (677,800) | 2,028,507 (920,130.8) |
| *Heating steam inlet temperature | °F (°C) | 663 (350.5) | 642 (338.9) |
| *Storage tank capacity | Cu.ft.($m^3$) | 5,124 (145.1) | 6,762.8 (191.5) |
| *Design pressure | psig($kg/cm^2g$) | 142.3 (10.0) | 171 (12.0) |
| *Dissolved oxygen guarantee value | cc/1 | 0.005 | 0.005 |
| *Manufacturer/erector | | Atlas-Mak Maschinenbau GmbH | Atlas-Mak Maschinenbau GmbH |
| No. 5 HP feed water heater | | | |
| *Type | | VU way 95.2/400 horizontal U-tube 2 pass | VU way 110.2/530 horizontal U-tube 2 pass high pressure with internal drain cooler |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Heating surface & number of heater | $ft^2$ ($m^2$) | 3,660 (340.0) x 2 sets | 4,990 (463.6) x 2 sets |
| *Material of heating tube | | St 35.8 seamless steel | 15 MO3 |
| *Heating steam in/ drain outlet temperature | °F (°C) | 820/369 (437.8/187.2) | 432.9/375 (222.7/190.5) |
| *Feed water in/outlet temperature | °F (°C) | 359.4/408.7 (181.9/209.3) | (362.7/420 (183.7/215.5) |
| *Feed water flow (both heaters) | lbs/h (kg/h) | 1,358,448 (616,181.6) | 2,274,199 (1,031,559.3) |
| *Manufacturer/erector | | Atlas-Mak Maschinenbau GmbH | Atlas-Mak Maschinenbau GmbH |
| **No. 6 HP feed water heater** | | | |
| *Type | | VU way 95.2/420 horizontal U-tube 2 pass | VU way 110.2/560 horizontal U-tube 2 pass, high press. with internal drain cooler |
| *Heating surface & number of heater | $ft^2$ ($m^2$) | 3,770 (350.2) x 2 sets | 5,280 (490.5) x 2 sets |
| *Material of heating tube | | St 45.8 III seamless steel | 13 CrMo44 |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Heating steam in/ drain outlet temperature | °F (°C) | 629/418.8 (331.7/214.9) | 647/432.9 (341.7/222.7) |
| *Feed water in/outlet temperature | °F (°C) | 408.7/481.5 (209.3/249.7) | 420.3/492.3 (215.7/255.7) |
| *Feed water flow (both heaters) | lbs/h (kg/h) | 1,358,448 (616,181.6) | 2,274,199 (1,031,559.3) |
| *Manufacturer/erector | | Atlas-Mak Maschinenbau GmbH | Atlas-Mak Maschinenbau GmbH |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| 2) Turbine and Auxiliary | | | |
| a. Turbine | | | |
| *Type | | Tanden compound single reheat | Tanden compound reheat retraction condensing type |
| *Rating output | kW | 200,000 | 300,000 |
| *Throttle steam pressure at MSV inlet | psig(kg/cm$^2$g) | 2,706 (190.2) | 2,700 (189.8) |
| *Throttle steam temperature (main steam/hot reheat) | °F (°C) | 1,000/1,000 (537.8/537.8) | 1,000/1,000 (537.8/537.8) |
| *Exhaust vacuum | inHg (mmHg) | 3.5 (88.9) | 3.5 (88.9) |
| *Number of bled steam stages | | 6 | 6 |
| *Manufacturer/erector | | Siemens | siemens |
| b. Condenser | | | |
| *Type | | Surface, rectangular single shell | Surface rectangular single shell |
| *Circulating water | gal/min (m$^3$/h) | | 222,200 (50,462) |
| *Tube cleanliness factor | % | - | 85 |
| *Condensate flow | lbs/h (t/h) | 971,100 (440.48) | 1,335,893 (605.95) |
| *Cooling water design temperature | °F (°C) | 85 (29.4) | 85 (29.4) |

Snyder

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| *Cooling water outlet °F (°C) design temperature | | |
| *Design point tube ft/s (m/s) inside flow velocity | 6.8 (2.072) | 6.4 (1.95) |
| *Tube material of condensing zone | Admiralty metal | SOMS, 76 (AL-Bross) |
| *Tube dimensions of condensing zone | 1' OD #18 | 1"OD 25' |
| *Effective tube length | | 25', 11-3/64" (7,900.6 m/m) |
| *Tube material of air cooling zone | | 90 - 10 Cu - Ni |
| *Cooling surface $ft^2$ ($m^2$) | 130,300 (12,105) | 236,000 (21,925) |
| *Material of tube plate | Steel with tarset coating | Steel with epoxy coating |
| *Material of water box | Steel with tarset coating | Steel with tarset coating |
| *Chathodic protection system type | - | - |
| *Manufacturer/erector | Siemens | Kraftwerke Union, West Germany |

Snyder

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| c. Circulating water pump | | |
| *Type | Vertical shaft, mixed flow, single case with variable pitch propeller blades | PEZ-1600, vertical shaft mixed flow single phase with variable pitch propeller blade |
| *Capacity x head x number | 102,900 g/m x 25' (23,368 $m^3$/h x 7.62 m) x 2 sets | 128,480 g/m x 30.1 ft (29,178 $m^3$/h x 9.17 m) x 2 sets |
| *Manufacturer/erector | Siemens | Pump KSB Drive-draftwerke Union (Siemens) |
| *Driver - Type | Siemens | |
| - Capacity kW x rpm | 650 x 1,785 | 1,100 x 1,190 |
| d. Air ejector equipment | | |
| *Type | Roman I/2E, twin element, two stage, steam jet | Roman I/2E, twin element, two stage steam jet with combined surface inter and after condenser |
| *Capacity (dry air) x number | 45 lbs/h(20.4 kg/h) x 2 sets | 33 lbs/h(15 kg/h) x 2 sets |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Suction pressure | inHg (mmHg) | 2.5 (63.5) | 2 (50.8) |
| *Working steam consumption | lbs/h (kg/h) | 960 (435.4) | 868 (393.7) |
| *Inter Condenser surface | $ft^2$ ($m^2$) | - | 77.5 (7.2) |
| *After condenser surface | $ft^2$ ($m^2$) | | 50.6 (4.7) |
| *Manufacturer/erector | | Siemens | Siemens |
| e. Condensate pump | | | |
| *Type | | WKT-250 vertical 5 stage 14" x 12" ring sectional design with barrels | WKT-300 vertical 4 stage, 16" x 14" ring sectional design with barrels equipped with radial impellers |
| *Capacity x head x number | | 2880 gpm x 820 ft x 2 sets (654.0 $m^3/h$) x (250 m) | 2,100,000 lb/h x 355 psi x 2 sets (952.56 t/h x (24.96 $kg/m^2$) |
| *Manufacturer/erector | | Siemens | Pump - KSB Drive - Kraftwerte Union |
| *Driver - Type | | | |
| - Capacity kW x rpm | | 610 x 1,180 | 900 x 1,180 |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| 3) Generator and Auxiliary | | | |
| a. Generator | | | |
| *Type | | Totally enclosed Hydrogen cooled | Totally enclosed hydrogen cooled FTHDD 540/66-2/60 |
| *Rating capacity | kVA | 245,000 | 370,000 (45 psig Hz) |
| *Power factor | | 0.9 | 0.9 |
| *Voltage | V | 14,400 | 21,000 |
| *Frequency | Hz | 60 | 60 |
| *Revolution | rpm | 3,600 | 3,600 |
| *Cooling type - Stator | | Hydrogen cooled | Direct cooling |
| - Rotor | | Hydrogen cooled | Direct cooling |
| *Hydrogen pressure | psig($kg/cm^2g$) | 45 (3.164) | 45 (3.164) 60 (4.219) |
| *Connection | | Double Star | Double Star |
| *Exciting system | | Brushless type | Brushless type |
| *Short circuit ration | | 0.596 | 0.62 |
| *Neutral grounding system | | Transformer 50 kVA 10,000/220 V Resistance 0.804ohm 220 A | Transformer 175 kBS 21,000/240 V, 0.198 ohm 730 A SLIV-CC |
| *Manufacturer/erector | | Siemens | Siemens |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| b. Exciter | | | |
| *Type | | 3 phase, 6 pole revolving arm type with silicon rectifier | 3 phase, 6 pole revolving armature type F 340 - 32 - 6 |
| *Capacity | kW | | |
| Main Exciter | | 1,870 | 1,880 |
| Rectifier | | 940 | 1,665 |
| *Voltage | V | | |
| Main exciter | | 570 | 415 |
| Rectifier | | 410 | 520 |
| *Revolution speed (if rotating type | rpm | 3,600 | 3,600 |
| *Number | | 1 set | 1 set |
| *Manufacturer/erector | | Siemens | Siemens |
| *Kind of driver (if rotating type) | | Directly coupled with generator shaft | Directly coupled with generator shaft |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| 4) Transformers | | | |
| a. Main Transformer | | | |
| *Type | | Oil immersed (FOA) outdoor type | AFOC - 3NY5CP, oil immersed, (FOA) outdoor type |
| *Capacity | kVA | 232,000 | 370,000 |
| *Primary voltage | V | 14,400 | 21,000 |
| *Secondary voltage | V | 115,000 | 115,000 |
| *Phase | | 3 phase | 3 phase |
| *Impedance voltage | % | 11.0 | 14.97 |
| *Connection | | Delta - WYE | Delta - WYE |
| *Neutral (HV side) | | Solidly grounded | Solidly grounded |
| *Cooling system | | Forced oil cooled forced air cooled (FOA) | Forced oil, forced air cooled (FOA) |
| *Number | | 1 set | 1 set |
| *Manufacturer/erector | | Siemens | Hitachi Ltd. |
| b. Station Service Transformer | | | |
| *Type | | Oil immersed (OA) outdoor type | Oil immersed (OA/FA) outdoor type having 2 LV windings |
| *Capacity | kVA | 17,000 | HV-18,750/25,000 LV-9,375/12,500 |
| *Primary voltage | V | 14,400 | 21,000 |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Secondary voltage | V | 4,160 | 4,160/4,160 |
| *Phase | | 3 phase | 3 phase |
| *Impedence voltage | % | 9.7 | $HV-LV_1$ 8.59<br>$HV-LV_2$ 8.67<br>$LV_1-LV_2$ 16.04<br>12.5 MVA, Base |
| *Connection | | Delta - WYE | Delta - WYE |
| *Neutral (LV side) | | Solidly grounded | 249 ohm, 10 A, grounding resistor |
| *Cooling system | | Oil, air self cooled | Oil, air, self cooled |
| *Number | | 1 set | 1 set |
| *Manufacturer/erector | | Siemens | Hitachi |

c. Emergency station service transformer

| | | Common Use |
|---|---|---|
| *Type | | Oil immersed (OA) outdoor type |
| *Capacity | kVA | 30,000 - 15,000/15,000 |
| *Primary voltage | V | 34,500 |
| *Secondary voltage | V | 4.160/4.160 |
| *Phase | | 3 phase |
| *Impedance voltage | % | $HV-LV_1$ 7.63<br>$HV-LV_2$ 7.19<br>$HV-LV_2$ 16.63<br>15 MVA base |

Snyder

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| *Connection | Delta - WYE | |
| *Cooling system | Self cooled | |
| *Number | 1 set | |
| *Manufacturer/erector | Mitsubishi | |

Snyder

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| 5) Water Treatment System | | | |
| a. Raw water | | | |
| *Kind | | Deepwell water | |
| *Total hardness ($CaCO_3$) | ppm | 95 | |
| *pH | | 6.9 | |
| Silica ($SiO_3$) | ppm | 70 | |
| *Turbidity | degree | - | |
| b. Raw water tank | | | |
| *Type | | Cylindrical | |
| *Capacity x number | gal ($m^3$) | 300,000 (1,135.5) x 1 | |
| (Manufacturer/erector | | | |
| c. Sedimentation system | | | |
| *Type | | | |
| *Applied chemical | | | |
| *Capacity t/day x number | | | |
| *Manufacturer/erector | | | |
| d. Filtering system | | | |
| *Type | | Reverse Osmosis | |
| *Capacity t/day x number | | 5167/cycle (cation) | |
| *Type of reverse washing | | | |
| *Filter material | | | |
| *Manufacturer/erector | | | |

Snyder

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| e. Water Demineralizing Equipment | | |
| *Type | Permutit | |
| *Capacity GPM ($m^3$/h) | 100 (22.7) x 2 | |
| x number of train | Mixed Bed 100 (22.7) x 2 | |
| *Capacity per 1 cycle | Cation 136400 (516) | |
| service gal ($m^3$) | Anion 125,600 (475) | |
| | Mixed Bed 514000 (1946) | |
| *Type of resin x resin | Cation IR-120 172 | |
| filling capacity $ft^3$ (1) | Anion IRA-402 102 (2888) | |
| | Mixed Bed Cation IR-120 28 (793) | |
| | Anion IRA-402 24 (679) | |
| f. Condensate Demineralizer | | |
| *Pre-filter type | None | None |
| *Condensate demineralizer | 1400 (318) x 3 | 1400 (318) x 4 |
| capacity x number GPM ($m^3$/H) | | |
| *Regeneration Equipment | 2 sets in GSTP | |

5．1．3　マラヤ発電設備

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| 1) Boiler Equipment | | | |
| a. Boiler Proper | | | |
| *Type | | Meander Waterwall radiant type | Single drum, EI pass, radiant type |
| Steam Pressure at 100 % load | | | |
| *Design pressure | psig(kg/cm$^2$) | 3,425 (240.8) | 2,910 (204.6) |
| *Final superheater outlet | psig(kg/cm$^2$) | 2,770 (194.76) | 2,471 (173.8) |
| *Reheater outlet | psig(kg/cm$^2$) | 544.3 (38.27) | 465 (32.7) |
| Steam temperature at 100% load | | | |
| *Rating temperature | °F (°C) | 1,005 (540.5) | 1,005 (541) |
| *Economizer inlet | °F (°C) | 481 (249.4) | 518.4 (270.2) |
| *Reheater inlet | °F (°C) | 627 (330.5) | 606 (318.9) |
| *Reheater outlet | °F (°C) | 1,005 (540.5) | 1,005 (541) |
| *Final superheater outlet | °F (°C) | 1,005 (540.5) | 1,005 (541) |
| Evaporation | | | |
| *Boiler MCR | lbs/h (t/h) | 2,278,780 (1,033.636) | 2,657,500 (1,305.423) |
| *Unit 4/4 load | t/h | - | - |
| Heating surface area | | | |
| *Contact heat transfer area | ft$^2$ (m$^2$) | 186,600 (17,335) | 321,850 (29,900) |
| *Radiant heat transfer area | ft$^2$ (m$^2$) | 11,330 (1,052.5) | 17,300 (1,610) |

Malaya

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| Superheater | | |
| *Primary superheater | | |
| Type | Horizontal continuous tube type | Horizontal continuous multi-loop tube, drainable type |
| Heating surface $ft^2$ ($m^2$) | 52,560 (4,883.0) | 107,700 (10,010) |
| *Top and Roof Superheater | | |
| Type | Tangent type | - |
| Heating surface $ft^2$ ($m^2$) | 9,860 (916.0) | - |
| *Secondary Superheater | | |
| Type | Pendant continuous tube type | Horizontal continuous multi-loop type, drainable type |
| Heating surface $ft^2$ ($m^2$) | 26,570 (2,468.4) | 25,530 (2,370) |
| *Materials | Austenitic Alloy Steel tubes | STBA 12, 22, 24 SUS 321 HTB |
| Reheater | | |
| *Type | Horizontal & pendant continuous tube | Continuous multi-drop drainable type |
| *Heating surface $ft^2$ ($m^2h$) | 42,900 (3,985.5) | 36,330 (3,380) |
| *Materials | STBA 35, 123, 23, 24 SUS 27 HTB | STB 35 |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| Economizer | | | |
| *Material | | STB 42 | STB 42 |
| *Heating surface | $ft^2$ ($m^2$) | 54,600 (5,072.5) | 44,550 (4,140) |
| Furnace | | | |
| *Volume | $ft^3$ ($m^3$) | 116,400 (3,295.9) | 148,700 (4,210.6) |
| *Construction of water wall | | Horizontal meander | Ribbed membrane wall |
| *Manufacturer/erector | | Babcock - Hitachi | Babcock - HItachi |
| b. Air Preheater | | | |
| Regenerative air heater | | | |
| *Type | | Horizontal | Vertical |
| *Heating area | $ft^2$ ($m^2$) | 149,210 (13,862) | 172,000 (15,990) |
| *In/outlet air temperature | °F (°C) | 137/559 (58.3/292.8) | 137/560 (58/293) |
| *Manufacturer/erector | | Ljungstrom/ Gadelius | Ljungstrom/ Gadelius |
| Steam air heater | | | |
| *Type | | Finned | Helically fined double U-tube |
| *Heating area | $ft^2$ ($m^2$) | 27,835 (2,586) | 24,335 (2260.7) |
| *In/outlet air temperature | °F (°C) | 100/134 (37.8/56.7) | 80/201 (26.7/93.9) |
| *Manufacturer/erector | | GEA Luftkunklekgesellschaft | |
| c. Sootblower | | | |
| *Type/units number | | KK Type RSB 53A/18 | Single nozzle swing type/20 |

Malaya

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| *Manufacturer/erector | Babcock - Hitachi | Babcock - Hitachi |

d. Boiler Automatic Control

Combustion control

| | | |
|---|---|---|
| *Type | Electronic | Pneumatic |
| *Manufacturer/erector | Siemens | Bailey |

Temperature control

| | | |
|---|---|---|
| *Type | Pneumatic | Pneumatic/ electronic |
| *Manufacturer/erector | Hitachi | Bailey |

Feedwater control

| | | |
|---|---|---|
| *Type | Electronic | Pneumatic/ electronic |
| *Manufacturer/erector | Siemens | Bailey |

e. Fuel Supply & Firing System

Heavy oil storage tank

| | |
|---|---|
| *Type | Pontoon type Floating roof |
| *Capacity, bbl, ($m^3$) x number | 193,400 (30,750) x 3 sets |
| *Manufacturer/erector | ECCO - ASIA |

Light oil tank

| | |
|---|---|
| *Type | Fixed cone roof |
| *Capacity $m^3$ x number | |
| *Manufacturer/erector | ECCO - ASIA |

Heavy oil service tank

| | | |
|---|---|---|
| *Type | None | None |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Capacity, number of tank | $m^3$ | | |
| *Manufacturer/erector | | | |
| **Heavy oil burner** | | | |
| *Type | | Baw Return flow atomizer | Baw return flow atomizer |
| *Capacity, number of burner | lb/h (kg/h) | 7,300 (3,310) 24 | 8,500 (3,855) (24 nozzles) |
| *Manufacturer/erector | | Babcock, Hitachi | Babcock, Hitachi |
| **Light oil burner** | | | |
| *Type | | Band w/air ope- equipped with electrode for sparked ignition | Band w/oil fired electrically ignited lighter |
| *Capacity, number of burner | g/h (1/h) | 1,585 (6,000) x 24 | 400 lbs/h (181.4 kg/h) x 12 sets |
| *Manufacturer/erector | | Babcock, Hitachi | Babcock, Hitachi |
| **Main fuel oil pump** | | | |
| *Type | | Screw 1 | Screw-rotary |
| *Discharge pressure | psig($kg/cm^2g$) | 765 (53.87) | 821 (57.7) |
| Capacity & number of pump | g/m ($m^3/g$) | 395 (89.7) x 2 sets | 436 (99.03) x 2 |
| *Manufacturer/erector | | De Laval IMO | Sier - Bath |
| *Driver - Type | | TEFC - XP | Explosion - Proof |
| - Capacity HP (kW) | | 300 (223.8) | 350 (261.1) |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| Light fuel oil pump | | | |
| *Type | | Gear | Same as M1 |
| *In/outlet pressure | psig(kg/cm$^2$g) | 0/230 (0/16.2) | |
| Capacity & number of pump | g/m ($m^3$/h) | 50 (11.4) x 2 sets | |
| *Manufacturer/erector | | Northern Ord | |
| *Driver - Type | | AC motor (TEFC _ XP) | |
| - Capacity HP (kW) | | 15 (11.19) | |
| *Manufacturer/erector | | Westinghouse | |
| Constant Differential fuel oil pump | | | |
| *Type | | Horizontal SVC type | Horizontal type, centrifugal pump |
| *Capacity | g/m ($m^3$/h) | 400 (90.8) | 480 (109.02) |
| *Suction pressure | psig(kg/cm$^2$g) | 755 (53.1) | 725 (50.97) |
| *Discharge pressure | psig(kg/cm$^2$g) | 925 (65.0) | 901 (53.35) |
| Heavy oil heater | | | |
| *Type | | Horizontal | Horizontal |
| *Capacity & number of heater | g/m ($m^3$/h) | 195 (44.3) x 3 sets | 205 (46.5) x 3 sets |
| *Manufacturer/erector | | MESCO | WELDON |

f. Boiler Draughting Equipment

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| Forced Draught Fan | | | |
| *Type | | Axial flow, 2 state horizontal | Horizontal centrifugal type F-29B, 80-75, $A_3$ DWDI BX-VIV |
| *Capacity & number | $ft^3/m$ ($m^3/m$) | 380,000 (10,760) x 2 sets | 394,000 (11,160) x 2 sets |
| *Pressure | inwg (mmwg) | 43 (1,092.2) | 53.5 (1,105) |
| *Revolution speed | rpm | 1,150 | 1,183 |
| *Manufacturer/erector | | KWU | Honden Parson/ Babcock-Hitachi |
| *Driver - Type | | AC motor Siemens RN5 634-6HE90-X | AC motor |
| - Capacity kW x number | | 2,460 x 2 sets | 2,600 x 2 sets |
| - Manufacturer/ erector | | Siemens | Babcock - Hitachi |
| Gas recirculation | | | |
| *Type | | Double suction turbo-fan NV1CD, 16-1/2 | Double suction with backward-curved air foil type blades |
| *Capacity x number | $ft^3/m$ ($m^3/m$) | 416,400 (11,790.8) x 1 set | 464,600 (13,160) x 1 set |
| *Pressure | inwg (mmwg) | 12.2 (309.9) | 11.8 (300) |
| *Revolution speed | rpm | 870 | 1,180 |

Malaya

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| *Manufacturer/erector | Nakashima | Howder Parson/ BC Hitachi K.K. |
| *Driver - Type | AC Motor EFA-KK NEMA type II | AC motor |
| - Capacity kW x number | 930 x 1 set | 930 x 1 set |
| - Manufacturer/ erector | | Babcock - Hitachi |

Stack

| | | |
|---|---|---|
| *Construction | Tower supported structure anchored on a girder | Consists of 2 sections constructed one on top of the other |
| *Top inside diameter ft (m) | 15 (4.57) | 17'-3/12" (5.25) |
| *Height ft (m) (Base of stuck elevation ft (m)) | 220 (67.06) | 220 (67.06) |
| *Number | one | one |
| *Manufacturer/erector | Pacific Engineering/ PECCO | ECCO ASIA |

g. Boiler Feed Water Pump

Turbine driven feed water pump

| | | |
|---|---|---|
| *Type & number of stage | HDR8S, centrifugal 6 stage | Impulse type single flow condensing turbine 5 stage |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Capacity & number of pump | lbs/m ($m^3$/hr) | 2,600,000 (1,179.4) x 1 set | 6,850 g/m (1,555.64$m^3$/h) x 1 set |
| *Total head & revolution | psig(m) | 3,804 (1,674.6) | 3,260 *2,292.1) |
| | rpm | 5,000 | 5,060 |
| *Manufacturer/erector | | Siemens | Hitachi |
| Turbine for BFP | | | |
| *Type | | Axial, reaction, single cylinder, condensing type | |
| *Capacity & number of turbine | kW | 12,214 x 1 set | |
| *Manufacturer/erector | | Siemens | |
| T-BFP booster pump | | | |
| *Type | | YNKN 400/300 double suction single stage | Horizontal type |
| *Capacity & number of pump | lbs/m (t/h) | 2,600,000 (1,179.4) x 1 set | 6,850 g/m (1,555.64)$m^3$/h x 1 set |
| *Total head & revolution | psig(m) | 96 (67.5) | 125.2 (88) |
| | rpm | 1630 | 1,765 |
| *Driver | kW | 420 | 505 |
| *Manufacturer/erector | | KSB | Hitachi |
| Motor driven feed water pump | | | |
| *Type & number of stage | | HDG h/11 - 11 | Horizontal |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Capacity & Number of pump | lbs/h (t/h) | 760,000 (344.7) x 1 set | 3,425 g/m ($777.8\ m^3/h$) x 2 sets |
| *Total head & revolution | psi (m) rpm | 2,950 (2,074.1) 3,570 | 3,220 (2,264) 5,300 |
| *Manufacturer/erector | | Kelin, Achanzlin & Becker | Hitachi Ltd |
| *Driver - Type | | Motor driven | Motor driven |
| - Capacity & number of motor | kW | 3,120 x 1 set | 3,050 x 2 sets |
| - Manufacturer/ erector | | Siemens | Hitachi, Ltd. |

M-BFP booster pump

| | | | |
|---|---|---|---|
| *Type | | None | Horizontal type |
| *Capacity & Number of pump | g/m($m^3/h$) | | 3,425 (777.8) x 2 sets |
| *Total head & revolution | psig (m)/rpm | | 100 (70.3)/1800 |
| *Manufacturer/erector | | | Hitachi, Ltd. |
| *Drive - Type | | | FWP, Direct |

h. Feed Water Heaters Equipment

No. 1 LP Feed water heater

| | | | |
|---|---|---|---|
| *Type | | Horizontal U-tube | Horizontal U-tube |
| *Heating surface are & number of heater | $ft^2(m^2)$ | 7,410 (688.4) x 1 set | 5,597 (519.98) x 2 sets |
| *Material of heating tube | | St 35.8 | SUS 304 TB |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Heating steam in/ drain outlet temperature | °F (°C) | 182.5/176.5 (83.6/80.3) | 193.9/177.4 (89.94/80.8) |
| *Condensate in/ outlet temperature | °F (°C) | 113.4/170.1 (45.2/76.7) | 117.9/172.4 (47.72/78.0) |
| *Condensate flow | lbs/h (kg/h) | 1,863,520 (845,295) | 1,859,101 (845,045.9) |
| *Manufacturer/erector | | Atlas-Mak Maschinenbau GmbH | Hitachi, Ltd. |
| No. 2 LP feed water heater | | | |
| *Type | | Vwakl 115.2/750 Horizontal U-tube 2 pass low pressure | Horizontal U-tube 2 pass |
| *Heating surface area & number of heater | $ft^2$ ($m^2$) | 6,954 (646.0) x 1 set | 8,810 (818.5) x 1 set |
| *Material of heating tube | | St 35.8 | 0.5 M. Cs STBA 12 |
| *Heating steam in/ drain outlet temperature | °F (°C) | 266.6/182.5 (130.3/83.6) | 382.5/182.4 (194.7/83.5) |
| *Condensate in/outlet temperature | °F (°C) | 170.1/214 (76.7/101.1) | 172.4/238.1 (78/114.5) |
| *Condensate flow | lbs/m (kg/h) | 1,863,520 (845,295) | 1,859,101 (845,045.9) |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Manufacturer/erector | | Atlas-Mas Mas chinenbau GmbH | Hitachi, Ltd. |
| **No. 3 LP feed water heater** | | | |
| *Type | | Vwakl 125.2/900 Horizontal U-tube 2 pass low pressure | Horizontal U-tube |
| *Heating surface are & number of heater | $ft^2$ ($m^2$) | 8,880 (825.0) x 1 set | 5,904 (548.5) x 1 set |
| *Material of heating tube | | S. 35.8 | 0.5 M. CS STBA 12 |
| *Heating steam in/ drain outlet temperature | °F (°C) | 499/226.6 (259.44/108.1) | 485/248.1 (251.7/120.1) |
| *Condensate in/outlet temperature | °F (°C) | 214/299.3 (101.1/148.5) | 238.1/270.8 (114.5/132.7) |
| *Condensate flow | lbs/m (kg/h) | 1,863,526 (845,295) | 1,859,101 (845,045.9) |
| *Manufacturer.erector | | Atlas-Mak Maschi-nenbau GmbH | Hitachi, Ltd. |
| **Deaerator** | | | |
| *Type | | Spray, deaerator mounted on hori-zontal storage tank | Spray deaerator |
| *Outlet feed water flow | lbs/h (t/h) | 2,279,000 (1,033.7) | 2,421,957 (1,100.9) |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Dissolved oxygen guarantee value | cc/l | 0.005 | 0.005 |
| *Storage tank capacity | gal ($m^3$) | 50,635 (191.6) | 38,300 gal (145) |
| *Deaerator pressure | psig($kg/cm^2g$) | 150 (10.5) | 160 (11.3) |
| *Manufacturer/erector | | Atlas-Mak Maschinenbau GmbH | Hitachi, Ltd. |
| *Heating steam inlet temperature | °F (°C) | 640 (337.8) | |

No. 5 HP feed water heater

| | | | |
|---|---|---|---|
| *Type | | VU way 110.2/530 Horizontal U-tube 2 pass, high pressure | Horizontal U-tube |
| *Heating surface area & number of heater | ft ($m^2$) | 4,990 (463.6) x 2 sets | 11,733 (1,090.0) x 1 set |
| *Material of heating tube | | 15 $MO_3$ | SA - 556 GR. C2 |
| *Heating steam in/ drain outlet temperature | °F (°C) | 432.9/375 (222.7/190.5) | 839.4/352.2 (448.6/177.9) |
| *Feed water in/outlet temperature | °F (°C) | 362.7/420 (183.7/215.5) | 342/393.5 (172.2/200.8) |
| *Feed water flow | lbs/h (t/h) | 2,274,199 (1,031.6) | 2,421,957 (1,100.9) |
| *Manufacturer/erector | | Atlas-Mak Maschinenban GmbH | Hitachi, Ltd. |

Malaya

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| No. 6 HP feed water heater | | |
| *Type | VU way 110.23/560 Horizontal U-tube 2 pass high pressure | Horizontal U-tube |
| *Heating surface area $ft^2$ ($m^2$) & number of heater | 5,280 (490.5) x 2 sets | 16,288 (1,513.2) x 1 set |
| *Material of heating tube | 13CrMo 44 | SA-556 GR. C2 |
| *Heating steam in/ drain outlet temperature °F (°C) | 647/432.9 (341.7/222.7) | 604.7/403.5 (318.2/206.4) |
| *Feed water in/outlet temperature °F (°C) | 420.3/492.3 (215.7/255.7) | 393.5/464.3 (200,8/240.2) |
| *Feed water flow lbs/h (T/h) | 2,274,199 (1,031.6) | 2,421,957 (1,100.9) |
| *Manufacturer/erector | Atlas-Mak Maschinenban GmbH | Hitachi, Ltd. |
| No. 7 HP feed water heater | | |
| *Type | None | Horizontal U-type |
| *Heating surface area $ft^2$ ($m^2$ & number of heater | | 15,535 (1,443.25) x 1 set |
| *Material of heating tube | | SA-556 GR C2 |
| *Heating steam in/ drain outlet temperature °F (°C) | | 719.6/474.3 (382.0/245.7) |

Malaya

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| *Feed water in/outlet °F (°C) temperature | | 464.3/518.4 (240.2/270.2) |
| *Feed warer flow lbs/h (T/h) | | 2,421,957 (1,100.9) |
| *Manufacturer/erector | | Hitachi, Ltd. |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| 2) Turbine and Auxiliary | | | |
| a. Turbine | | | |
| *Type | | Tandem-compound, single reheat extraction, condensing | TC4F-26 reheat, tandem compound, four flow, extraction |
| *Rating output | kW | 330,000 | 350,000 |
| *Throttle steam pressure at MSV inlet | psig(kg/cm$^2$g) | 2,700 (189.8) | 2,400 (168.7) |
| *Throttle steam temperature main steam/hot reheat | °F (°C) | 1,000/1,000 (537.7/537.7) | 1,000/1,000 (537.7/537.7) |
| *Exhaust vacuum | inHg (mmHg) | 2 (50.8) | 2.4 (60.9) |
| *Number of bled steam stages | | 6 | 7 |
| *Manufacturer/erector | | Siemens | Hitachi, Ltd. |
| b. Condenser | | | |
| *Type | | Surface, rectangular single shell | Single pass, divided water box surface type |
| *Circulating water | g/m (m3/h) | 222,200 (50,462) | 318,775 (72,400) |
| *Tube cleanliness factor | % | 85 | 85 |
| *Condensate flow | g/m (m$^3$/h) | 1,335,893 (605.96) | 1,859,101 lb/h (845.045 T/h) |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Cooling water design temperature | °F (°C) | 85 (29.4) | 87 (30.6) |
| *Cooling water outlet design temperature | °F (°C) | | 96.6 (35.9) |
| *Design point tube inside flow velocity | ft/s (m/s) | 6.4 (1.95) | 7.5 (2.286) |
| *Tube material of condensing zone | | CuZnZo Al (Al-bras) | SUS 316 |
| *Tube dimensions of condensing zone | in (mm) | 1" OD - #18 SWG | 1" OD. BWG #22 (25.4) |
| *Effective tube length | ft (mm) | 25'-11 3/64"(7,900) | 40 (12,192) |
| *Tube material of air cooling zone | | 90-10 Cu-Ni | |
| *Inner tube surface | $ft^2(m^2)$ | 236,000 (21,925) | 209,900 (19,500) |
| *Outer tube surface | $ft^2(m^2)$ | | |
| *Material of tube plate | | Steel with tarset coating | Naval Brass |
| *Material of water box | | Steel with tarset coating | Tar epoxy |
| *Chemical dosing in cooling waer | | N O N E | N O N E |
| *Ball cleaning equipment | | N O N E | Not on service |
| *Chathodic protection system type | | Impressed current | Impressed current |
| *Manufacturer/erector | | KWU - West Germany | Hitachi, Ltd. |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| c. Circulating water pump | | | |
| *Type | | Vertical shaft mixed flow type | Vertical |
| *Capacity x head x number | g/m ($m^3$/h) | 128,480 x 30.1 ft (29,178 x 9.17 m) x 2 sets | 163,400 x 33.0 ft (37,112 x 10.06m) x 2 sets |
| *Manufacturer/erector | | KSB | Hitachi, Ltd. |
| *Driver - Type | | AC Motor | Motor driven |
| - Capacity | kW x rpm | 1,100 x 1,190 | 1,350 x 276 |
| d. Air ejector equipment | | | |
| *Type | | Roman 1/2 E Twin element, 2 stage steam jet with inter & after condenser | Single element, two stage steam jet and ejector with combined surface type inter & after condensers on a single shell 2 sets |
| *Capacity (dry air) x number | lbs/h (kg/h) | 33 (15.0) x 2 sets | 15 cfm (25.49$m^3$/h) |
| *Suction pressure | inHg (mmHg) | 2.0 (50.8) | 1.0 (25.4) |
| *Working steam consumption (in case of steam jet ejector) | lbs/h (t/h) | 868 (0.394) | 1,430 (0.649) |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Inter condenser surface | $ft^2$ ($m^2$) | 77.5 (7.2) | 409 (37.947) |
| *Outer condenser | $ft^2$ ($m^2$) | 50.6 (4.7) | |
| *Manufacturer/erector | | Siemens AG | Hitachi, Ltd. |
| e. Condensate Pump | | | |
| *Type | | WKTN 300<br>Barrel type | Single suction,<br>vertical type<br>6-stage diffuser<br>pump |
| *Capacity x head x number | lbs/h (t/h) | 2,100,000<br>(952.56) | 4,440 g/m<br>(1,008.3 $m^3$/h) |
| | psi ($kg/m^2$) | 355 (24.96)<br>x 2 sets | |
| *Manufacturer/erector | | | Hitachi, Ltd. |
| *Driver - Type | | Motor driven | Motor driven |
| - Capacity | kW x rpm | 900 x 1,180 | 870 x 900 |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| 3) Generator and Auxiliary | | | |
| a. Generator | | | |
| *Type | | Totally enclosed Hydrogen cooled FTHDD 540/66-2/60 | Totally enclosed hydrogen cooled Hitachi type-form TFLQQ-KD |
| *Rating capacity | kVA | 370,000 (45 psig $H_2$) | 438,000 (45 psig $H_2$) |
| *Power factor | | 0.9 | 0.9 |
| *Voltage | V | 21,000 | 21,000 |
| *Frequency | Hz | 60 | 60 |
| *Revolution | rpm | 3,600 | 3,600 |
| *Cooling type - Stator | | Direct hydrogen cooled | Water cooled |
| - Rotor | | Direct hydrogen cooled | Direct hydrogen cooled |
| *Hydrogen pressure | psig($kg/cm^2g$) | 45 (3.169) 60 (4.219) | 45 (3.169) |
| *Connection | | Double star | Double star |
| *Exciting system | | Brushes type | Sttic(with brush) |
| *Short circuit ratio | | 0.58 guaranteed | 0.619 |
| *Neutral grounding | | Non-flammable oil immensed transformer 175 kV, 21,000/240 V Resistor 0.19 ohm 730 A | Mineral oil filled transformer 21,000/210 V Resistor 0.15 ohm 808 A |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Manufacturer/erector | | Siemens | Hitachi, Ltd. |
| b. Exciter | | | |
| *Type | | 6-pole 3-phase revolving armature | Static excitation system with thyristor converter and power transformer |
| *Capacity | kVA | 1,880(Main exciter) | 2,600 (Transformer) |
| | kW | 1,665 (Rectifier) | 1,550 (Thyristor) |
| *Voltage | V | 415 (Main exciter) | 450 (Transformer) |
| | | 520 (Rectifier) | 390 (Thyristor) |
| *Revolution speed (if rotating type) | rpm | 3,600 | - |
| *Number | | one | one |
| *Manufacturer/erector | | Siemens | Hitachi, Ltd. |
| *Kind of driver (if rotating type) | | Two-rectifier wheels | - |

Malaya

4) Transformers

a. Main transformer

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| *Type | | AFOC-3AMN/Y5CP, oil immensed, (FOA) auto transformer outdoor type | AFOC-3AMN/Y5CP oil-immensed (FOA) auto transformer outdoor type |
| *Capacity | kVA | 370,000 | 442,000 |
| *Primary voltage (PV) | kV | 21 | 21 |
| *Secondary voltage (HV/LV) | kV | 230/117.3 | 230/117.3 |
| *Phase | | 3 phase | 3 phase |
| *Impedance voltage | % | 23.0 (HV-PV)<br>11.5 (LV-PV)<br>10.5 (HV-LV)<br>370 MVA Base | 24.83 (HV-PV)<br>13.40 (LV-PV)<br>10.25 (HV-LV)<br>442 MVA Base |
| *Connection | | Delta - WYE/WYE auto transformer | Delta - WYE/WYE auto transformer |
| *Neutral (HV side) | | Solidly grounded | Solidly grounded |
| *Cooling system | | Forced oil, forced air cooled (FOA) | Forced oi, forced air cooled (FOA) |
| *Number | | 1 set | 1 set |
| *Manufacturer/erector | | Hitachi, Ltd. | Hitachi, Ltd. |

Malaya

| | | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|---|
| b. Station service transformer | | | | |
| *Type | | | SAOCR-3MC, oil immersed (OA/FA) outdoor type having two LV windings | SAOCR-3MC, oil immersed (OA/FA) outdoor type having 2 LV windings |
| Capacity | kVA | HV; | 18,750/25,000 (OA/FA) | 26,200/35,000 (OA/FA) |
| | | LV; | 9,350/12,500 (OA/FA) | 13,200/17,500 (OA/FA) |
| *Primary voltage | V | | 21,000 | 21,000 |
| *Secondary voltage | V | | 4,160/4,160 | 4,160/4,160 |
| *Phase | | | 3 phase | 3 phase |
| *Impedance voltage | % | | 8.58 (HV-LV1)<br>8.52 (HV-LV2)<br>16.10 (LV1-LV2)<br>12.5 MVA Base | 9.89 (HV-LV1)<br>10.03 (HV-LV2)<br>11.11 (LV1-LV2)<br>17.5 MVA Base |
| *Connection | | | Delta - WYE/WYE | Delta WYE/WYE |
| *Neutral (LV side) | | | Grounding resistance, 96 ohm 25 A | Grounding resistance 96 ohm 25A |
| *Cooling system | | | Self cooled/forced air cooled (OA/FA) | Self cooled/forced air cooled(OA/FA) |
| *Number | | | 1 set | 1 set |
| *Manufacturer/erector | | | Hitachi, Ltd. | Hitachi, Ltd. |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| c. Emergency station service transformer | | | |
| *Type | | Oil immersed, (OA/FA) outdoor type with 4 windings | |
| *Capacity (55°C rise) kVA | HV | 20,000/26,667(OA/FA) | |
| | LV | 10,000/13,333(OA/FA) x 2 | |
| | TV | 7,000/9,333 (OA/FA) | |
| *Primary voltage (HV) V | | 115,000 | |
| *Secondary voltage V (LV) | | 4,160/4,160 | |
| *Tertiary voltage | | 4,800 (Stabilize winding) | |
| *Phase | | 3 phase | |
| *Impedance voltage % (10 MVA, Base) | | 5.8 (HV-TV) | 7.5 (TV-LV1) |
| | | 7.75 (HV-LV1) | 7.5 (TV-LV2) |
| | | 7.65 (HV-LV2) | 15.5 (LV1-LV2) |
| *Connection | | WYE-WYE x 2 - Delta | |
| *Neutral (LV side) | | Grounding resistor (commonly) 96 ohm, 25 A | |
| *Cooling system | | Self cooled/forced air cooled (OA/FA) | |
| *Number | | 1 set | |
| *Manufacturer/erector | | McGraw Edison Systems Division | |

Malaya

| | | Unit No. 1 | Unit No. 2 |
|---|---|---|---|
| 5) Water Treatment System | | | |
| a. Raw water | | | |
| *Kind | | Deepwell | |
| *Total hardness ($CACo_3$) | ppm | 44 | |
| *pH | | 8.3 | |
| *Silica ($SiO_2$) | ppm | 86 | |
| *Turbidity | degree | clear | |
| b. Raw water tank | | | |
| *Type | | Cylindrical tank (FWP) | |
| *Capacity x number | gal ($m^3$) | 5,500 (20.83) | |
| *Manufacturer/erector | | ECCO ASIA | |
| c. Sedimentation system | | | |
| *Type | | None | |
| *Applied chemical | | | |
| *Capacity t/day x number | | | |
| *Erector | | | |
| d. Filtering system | | | |
| *Type | | AVGF | |
| *Capacity t/day x number | | | |
| *Type of reverse washing | | Automatic back-washing | Automatic back-washing |
| *Filter material | | Anthracite sand | |
| *Manufacturer/erector | | Permutit Co. | |

Malaya

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| e. Water demineralizing equipment | | |
| *Type | Permutit | |
| *Capacity GPM($m^3$/H) | 100(22.7) x 2 | |
| x number of train | Mixed Bed 100 (22.7) x 2 | |
| *Capacity per 1 cycle | Cation 136,400 (516) | |
| service gal ($m^3$) | Anion 125,600 (475) | |
| | Mixed Bed 514,000 (1946) | |
| *Regenerating hour per 1 cycle | Cation 2 Hr 55 min. | |
| | Anion 2 Hr 45 min. | |
| *Type of resin x resin | Cation IR-120 172 (4870) | |
| filling capacity $ft^3$(1) | Anion IRA-402 102 (2888) | |
| | Mixed Bed CationIR-120 28 (793) | |
| | Anion IRA-402 24 (679) | |
| f. Condensate Demineralizer | | |
| *Pre-filter type | None | None |
| *Condensate demineralizer | 1400 (318) x 4 | None |
| capacity x number GPM($m^3$/H) | | |
| *Regeneration Equipment | 1 set | |
| g. Chemical dosing system | | |
| Feedwater | | |
| *Kind of chemical | $N_2H_4$ & $NH_4OH$ | |
| *Pump capacity x number | 0.0028/0.29 1/min | |
| *Tank capacity | 1159.25/1159.25 liter | |
| *Manufacturer/erector | ECCO Asia | |

Malaya

| | Unit No. 1 | Unit No. 2 |
|---|---|---|
| Auxiliary cooling water | | |
| *Kind of chemical | $N_2H_4$ (demi water is being used) | |
| *Pump capacity x number | 58390.88 1/min x 2 sets | |
| *Tank capacity | 783.94 liter | |
| *Manufacturer/erector | Siemens | |
| Chlorination for circulating water | | |
| *Kind of circulating water | Lake water | |
| *Type | Program control & vacuum type | |
| *Chlorination capacity kg/h x number | 151.5 kg/hr chlorine gas | |
| *Manufacturer/erector | Columbiana Boiler Company | |

5．2　発電所の現状

5．2．1　ガ　ドナー発電ユニット

ボイラ本体

| | ガードナー１号 | ガードナー２号 |
|---|---|---|
| 過熱器 | ―――――― | 過熱器管全数（６０パネル）を1982年６月２６日からの定期修理中に取替（１９８２年６月２６日） |
| 再熱器 | ―――――― | 吊下げ型再熱器管の２００ループを今回の定期修理中に取替えた。なお、定期修理中の水圧試験で発見された７本の横置型再熱器はスペアパーツが得られないためパッチ当溶接で修理した。これはボイラのウイークポイントである。 |
| 炉壁管 | １９７９年の定期修理時に炉壁管を部分的に取替えている。<br>破孔、或いは膨出した１１本の炉壁管は１９８２年１月１３日から同年３月５日の間に行われた定期修理期間に発見されたもので、炉壁管はこのボイラのウイークポイントである。<br>定期修理完了後、３本の管は1982年６月１１日から２０日の間に取替又は修理をしている。 | 管列の乱れや管内面にピッチングコロージョンの発生している管は、1982年の定期修理期間中にはスペアーチューブやパネルの数量不足のため十分な管取替が出来ていない。 |
| バッフルウォール | ボイラバッフルウォールチューブの全数は１９８２年1月１３日から同年３月５日までの定期修理期間中に取替えている。 | 特別な問題はない。 |

| | ガードナー　1号 | ガードナー　2号 |
|---|---|---|
| ボイラ．ケーシング | ボイラケーシングからのガス漏洩が非常に多い。 | ボイラケーシングからのガス漏洩は、定期修理期間に修繕が行われている。（1982年6月26日～　） |
| バーナ | ―――― | 定期修理期間中に点検、検査を実施している。（1982年6月26日～　） |
| 節炭器 | ―――― | ボイラ給水系統で節炭器とNo.6高圧給水加熱器の間に逆止弁が設置されていない。 |

ボイラー補機

| | ガードナー 1号 | ガードナー 2号 |
|---|---|---|
| 押込通風機 | A－押込通風機<br>バビットメタルの剝離とベアリングハウジングに損傷があった。<br>（1981年5月20日）<br>B－押込通風機<br>ファンローターのアンバランスとアライメント不良による激しい震動を却している。<br>押込通風機の容量不足の懸念がある。（1982年6月、7月） | B－押込通風機<br>1982年1月10日、激しい震動を起したので障害となる翼を同年3月11日取替。 |
| ガス再循環ファン | 特別な問題はない。 | ―――― |
| 空気予熱器 | 部分的にエレメントの取替。<br>（1981年11月11／9） | A側のホットエンドバスケットの取替<br>（1981年4月17日） |
| 蒸気式空気予熱器 | 温度制御装置は作動していない。 | 今回の定期修理中に点検と不良品の取替を実施。 |
| 燃料油ポンプ | 定差圧燃料油ポンプは稼働していない。 | |
| 灰処理装置 | 灰搬出ラインがつまっていて稼働していない。 | 左記に同じ |
| 補助蒸気 | 補助蒸気配管の保温脱落個所が非常に多い。<br>また、蒸気量制御弁は作動していない。 | 補助蒸気配管の保温、脱落個所は修理中である。 |

| | ガードナー　1号 | ガードナー　2号 |
|---|---|---|
| 配管及び弁類 | 配管及び弁類の保温状況は悪い。また、配管識別はなされておらず、弁名称の標示もない。 | 配管及び弁類の保温修理中。 |
| 煙　風　道 | 煙道からのガス漏洩が非常に多い。保温の状況は悪い。 | 現在修理中。 |
| 燃料貯油槽 | ――― | ――― |
| 薬品注入装置 | ――― | ――― |

タービン本体

| | ガードナー 1号 | ガードナー 2号 |
|---|---|---|
| タービン翼 | 1) タービン翼の欠損はない。<br>2) 1981年11月26日に再熱蒸気側のクロスオーバーパイプからの蒸気漏洩事故がある。<br>3) 1981年12月5日、再熱蒸気側のクロスオーバーパイプの伸縮接手をスペアパーツと取替。 | 1982年3月30日、タービン側低圧最終段6枚の翼を翼端から140mm切断している。 |
| 弁類 | ―――― | 問題のあった弁は現在定期修理中で検査及び修理中である。 |
| 調速機 | ―――― | 現在、点検、検査中である。 |
| 潤滑油系統 | 潤滑油配管からの漏油が見られる。 | 左記に同じ。 |

| | ガードナー 1号 | ガードナー 2号 |
|---|---|---|
| 主復水器 | プラグチューブは1979年6月15日で、549本、チューブ総数14,748本でプラグ率は3.72%である。<br>1979年10月24日から1980年1月12日までの定期修理期間中にチューブ全数を材質キュープロニッケルの新管と取替え。取替え前のチューブ材質はアドミラルティであった。 | プラグチューブは1982年8月24日で266本、チューブ総数24,400本で、プラグ率は1.09%である。 |
| 低圧給水加熱器 | No.1 低圧給水加熱器<br>1980年3月23日付でプラグチューブ数2本、チューブ総数509本でプラグ率は0.39%である。<br>なお、上記日付から今日までチューブリークはない。<br><br>No.3 低圧給水加熱器<br>1982年1月22日付でプラグチューブ数16本、チューブ総数229本、プラグ率6.98%。 | No.1 低圧給水加熱器<br>プラグチューブはない。<br><br>No.2 低圧給水加熱器<br>1980年8月17日付でプラグチューブは3本、チューブ総数539本でプラグ率は0.55%である。<br><br>No.3 低圧給水加熱器<br>1982年7月21日付でプラグチューブ59本、チューブ総数504本、プラグ率10.9%。 |

| | ガードナー　1号 | ガードナー　2号 |
|---|---|---|
| 高圧給水加熱器 | No.5　高圧給水加熱器<br>1981年11月6日付でプラグチューブ数59本、チューブ総数440本、プラグ率13.4%。<br><br>No.6　高圧給水加熱器<br>プラグチューブなし。 | No.5A　高圧給水加熱器<br>1982年7月10日付でプラグチューブ数1本、チューブ総数633本、プラグ率0.16%。<br><br>No.5B　高圧給水加熱器<br>1982年8月付でプラグチューブ数1本、チューブ総数633本、プラグ率0.15%。<br><br>No.6A　高圧給水加熱器<br>1982年3月31日付でプラグチューブ数46本、チューブ総数633本、プラグ率6.33%。<br><br>No.6B　高圧給水加熱器<br>1982年8月4日付でプラグチューブ数94本、チューブ総数633本、ペラグ率14.8%。 |
| 脱気器 | ―――― | ―――― |
| 復水ポンプ | B－復水ポンプサクションストレーナ後の圧力計は設備されていない。 | サクションストレーナ前後の圧力計は今回の定期修理中に取付けられた。 |
| 復水器循環水ポンプ | 1981年7月7日、B－循環水ポンプ吐出管の伸縮接手からの漏水が激しく同ポンプを停止するという事故があった。 | 1982年3月12日、B－循環水ポンプの上部軸受の振動が3～4ミルに達し、同ポンプを分解点検しなければならない事故が発生している。 |

| | ガードナー　1号 | ガードナー　2号 |
|---|---|---|
| 塩素処理装置及びボールクリーニング装置 | 塩素処理装置は全然使用されておらず、腐腐化設備となっている。なおボールクリーニング装置の設備はない。 | 左に同じ |
| 機器軸受冷却水装置 | 付属弁の漏洩が多い。熱交換器のプラグチューブ数は、<br>A－熱交換器：２９本、チューブ総数１６１８本、プラグ率1.７９％<br>B－熱交換器：２６１本、チューブ総数１６１８本、プラグ率１６.１３％となっている。 | 左に同じ<br>熱交換器のプラグチューブ数は、<br>A－熱交換器：１１０本、チューブ総数１８４０本、プラグ率5.９７％<br>B－熱交換器：９２本、チューブ総数１８４０本、プラグ率5％となっている。 |
| 原水ポンプ | ――― | ――― |
| 深井戸ポンプ取水口機器 | ――― | ――― |
| その他 | コンデンサーピット、復水ポンプピットなどその他１階オペレーテングフロアーの排水が非常に悪い。 | 左に同じ |

電気関係

| | ガードナー 1号 | ガードナー 2号 |
|---|---|---|
| 発電機 | 1982年3月9日～同年5月11日の定期修理中に発電機集電環端部のシール・リングに故障が発見され、水素ガスの漏洩が見つけられた。水素ガス漏洩は現在も止っていず、1日に6本の水素ボンベを消費している。 | 1978年10月25日、多量の水素ガス漏洩を経験している。<br>現在、1日に約1本の水素ボンベ消費している。 |
| 励磁機 | ―――――― | 過去2回主励磁機事故を起しており、1982年の定期修理で新品と取替られている。 |
| スイッチギア及びモーター・コントロール・センタ | 1) ボイラ・コントロール・センターを除いてメタル・クラッド・スイッチギア及びモーター・コントロール・センターは発電所構内レベルより低い1階面に設置されている。 | 1) 左に同じ |
| | 2) 雑用コントロール・センターの基礎より湖水が湧水しており、高湿度により絶縁破壊もありうる。 | 2) ―――――― |
| | 3) スイッチギア及びコントロールセンター内の電磁接触器及び補助リレーは開放形であり、環境が悪いため上記リレーは非常にほこりがしている。 | 3) 左に同じ |
| | 4) ケーブル・マーク及び配線番号等がない。 | 同 左 |
| | 5) 多くの運転表示灯が故障中である。 | 同 左 |

| | ガードナー 1号 | ガードナー 2号 |
|---|---|---|
| 直流電源 | いくつかの新しい蓄電池を除いて寿命が来ている。 | ガードナー1号との共用設備 |
| 非常用ディーゼル発電機 | 補機への動力ケーブルが布設されておらず、自動起動の回路もない。（建設時試運転よりの運転時間積算は3.6時間となっている。） | ガードナー／スナイダー発電所の共用設備 |
| 変圧器 | 特に問題はない。 | 定期修理期間中、主変圧器の絶縁油の入れ替えがMELARCOによって実施されていた。 |
| 変電所 | 115kV送電線5回線、非常用電源供給母線2回線及び4台の発電機し断器がMELARCOによって保守されている。 | ガードナー／スナイダー発電所の共用設備 |
| 保護継電器 | 1) 発電機接地保護継電器及び4.16 kV 電動機用過電流保護継電器の設定値は見直しが必要。<br>2) 周波数継電器は使用されていない。 | 1) 同 左<br>2) 同 左 |
| その他 | 1) 保修及び修理作業用電源箱が充分設置されていない。特にボイラヤードが少ない。<br>2) ボイラヤードの照明が充分でない。 | 1) 同 左<br>ガードナー2号の定期修理作業用電源は通常運転中の他ユニットから供給されている。<br>2) 同 左 |

| | ガードナー　1号 | ガードナー　2号 |
|---|---|---|
| | 3) ガス吸引ポンプを含めた可燃性ガス警報盤上の表示灯はすべて故障している。<br>4) 計器室は非常に汚れており、清掃がされていない。 | 3) 同　左<br>4) ガードナー／スナイダー発電所の共用施設。 |

制御・計測装置

| | ガードナー 1号 | ガードナー 2号 |
|---|---|---|
| 燃料油制御 | 自動運転中 | 流量発信器故障のため手動運転。オーバル・タイプ燃料油流量計による制御信号の変更を計画中。 |
| 給水流量制御 | 自動運転中 | 給水流量調節器の信号遅れのため手動運転中。<br>（タービン駆動ボイラ給水ポンプ）<br>給水流量調節弁の漏洩が大きい。<br>（電動機駆動ボイラ給水ポンプ） |
| 蒸気温度制御 | 蒸気温度検出器故障のため手動運転中。 | 定期修理以前も手動運転中。現在調整中。 |
| 空気流量制御 | 空気予熱器閉塞のため手動運転中。 | 空気流量信号ハンチングのため手動運転中。 |
| 起動バイパス制御 | 設備なし | 信号発信器故障及び制御器の応答遅れ（CV－101，CV－103及びCV－107）のため手動運転中。<br>電動弁（MV－3，MV－4及びMV-5）は設計不備のため手動運転中。<br>フラッシュ・タンク圧力、水位制御は自動運転中。 |
| インターロック | ボイラ・トリップ・インターロックに使われている高低圧給水加熱器ドレンレベル・スイッチは全て壊れている。 | 同　左<br>周波数低継電器用の配線がされていない。ボイラの減圧運転のため“節炭器入口給水圧力低”インターロックが使用されていない。 |

| | ガードナー　1号 | ガードナー　2号 |
|---|---|---|
| 計器及び記録計 | 下記の計器が使用されていない。<br>＊ 節炭器出口$O_2$記録計<br>＊ pH 記録計<br>＊ 減温器出口温度計パンチング | 定期修理のため調整中である。下記の計器は使用されていない。<br>＊ 節炭器出口$O_2$記録計<br>＊ pH 記録計<br>＊ 導電率計 |
| ローカル制御 | ほとんど全ての制御装置が使用されておらず（故障のため）、制御弁のバイパス弁を使って手動運転中である。特に下記に述べる重要な制御装置が故障している。<br>1）高低圧給水加熱器ドレンレベル制御<br>2）補助蒸気圧力制御<br>3）蒸気式空気予熱器温度制御<br>4）脱気器スピルオーバー、オーバーフロー制御 | 同　左 |
| 計装用空気系統 | 2台の空気圧縮機は連続ローディングしており、アンローディング圧力設定（90 psi）迄圧力が上がらない。雑用空気ラインよりのバックアップ系統に逆止弁及びフィルターがない。 | 1台のみの空気圧縮機が設置され、連続ローディングである。ガードナー1号側よりのバックアップがある。 |
| 中央制御室及びリレー室 | ケーブル処理室があるため、中央制御室は比較的良好な状態である。中央制御室内温度は76°F（24.4℃）である。 | ガードナー1号との共用設備。 |