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^2g)	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 (m^3/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 (25.49m^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 Barrel type	Single suction, vertical type 6-stage diffuser pump
*Capacity x head x number	lbs/h (t/h)	2,100,000 (952.56)	4,440 g/m (1,008.3 m^3/h)
	psi (kg/m^2)	355 (24.96) 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

		Unit No. 1	Unit No. 2
4) Transformers			
a. Main transformer			
*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) 11.5 (LV-PV) 10.5 (HV-LV) 370 MVA Base	24.83 (HV-PV) 13.40 (LV-PV) 10.25 (HV-LV) 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) 8.52 (HV-LV2) 16.10 (LV1-LV2) 12.5 MVA Base	9.89 (HV-LV1) 10.03 (HV-LV2) 11.11 (LV1-LV2) 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 l/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 PRESENT CONDITION OF POWER PLANTS

5.2.1 Gardner Thermal Plant

BOILER

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
Superheater	-	All secondary superheater tubes are replaced (60 panels) during overhaul. (June 26, 1982)
Reheater	-	200 loops on pendant reheater were replaced during overhaul. 7 tubes that leaked on horizontal reheater during hydrostatic test were patch-welded due to unavailability of spares (June 26, 1982). This is weak point of the boiler.
Water Wall	Partial retubing was done in 1979 overhaul. On portions that were not retubed, 11 tubes (rupture/ bulging) were found on water wall during annual overhaul (Jan. 13, 1982 - March 5, 1982) Water wall tubes are weak points of boiler. After annual over-haul 3 tubes had been replaced/ repaired during June 11 to June 20, 1982.	Misaligned tubes and those with pit-ting corrosion were not completely replaced during 1982 overhaul due to insufficient quantity of spare tubes/ panels.

BOILER

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
Buffle Wall	All boiler baffle wall were replaced during annual overhaul (Jan. 13 - March 5, 1982).	No problem
Casing	There are plenty of gas leaks	Gas leaks were repaired during annual overhaul (June 26, 1982)
Burner	-	Checking/inspection was done during annual overhaul (June 26, 1982 - September, 1982)
Economizer	-	Non-return valve on the feed water line between economizer and final HP feedwater heater is not installed.

BOILER AUXILIARY EQUIPMENT

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
Forced Draft Fans	There seems lacking of capacity.	
	A-FDF Babbit bearing was scraped off and also bearing housing was damaged (May 20, 1981).	B-FDF There was excessive vibration (June 10, 1982). Stuck-up blade was replaced on Mar. 11, 1982.
	B-FDF There are excessive vibration due to unbalanced fan rotor and misalignment (June 26, 1981 and July 10, 1982).	
Gas Recirculating Fan	No problem is reported.	-
Air Heater	Partial elements were replaced (Nov. 11, 1981)	A side 22 hot-end baskets were replaced (April 17, 1981).
Steam Coil Air Heater	Temperature control is not in service.	Checking/repairing was carried out during annual overhaul.
Fuel Oil Pump	Constant differential FOP is not in service.	-
Ash Handling System	Conveyor line is clogged.	Same as G-1

BOILER AUXILIARY EQUIPMENT

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
Auxiliary Steam System		
	There is poor heat insulation. Control valve is out of order.	Under repairing of heat insulation
Pipings and Valves		
	Poor insulation is found. There is no indication of direction of flow on pipings and no name plate on valves.	Under repairing of heat insulation
Air and Flue Gas Duct		
	There are plenty of gas leaks. Poor insulation is found.	Under repair
Fuel Oil Storage Tank		
	-	-
Chemical Injection System		
	-	-

TURBINE

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
Turbine Proper		
	1) No blade failure 2) There was steam leak on cross over pipe RH side (Nov. 26, 1981). 3) Bellows of turbine crossover pipe RH side was replaced with spare parts on Dec. 5, 1981.	6 blades of last stage were cut by 140 mm on March 30, 1982.
Major Valves		
	-	Reported problem is now under inspection/repair.
Governor		
	-	Under inspection/checking.
Lubrication Oil System		
	Oil leaks are found.	Same as G-1

TURBINE AUXILIARY EQUIPMENT

GARDNER UNIT No. 1	GARDNER UNIT No. 2
Main Condenser	
Number of tubes plugged is as follows: 549pcs (549/14,748 = 3.72%) (as of June 15, 1979). All tubes were replaced with cupro nickel tubes during last overhaul (Oct. 24, 1979 - Jan. 12, 1980). Previous tube material was admiralty.	Number of tubes plugged is as Follows: 266pcs(266/24,400 = 1.09%) (as of Aug. 4, 1982).
LP Heater	
1-LPH Number of tubes plugged was 2 pcs as of March 23, 1980 (2/509 = 0.39%). Since the above date, no more tube leak was reported.	1-LPH No plugged tube
2-LPH Number of tubes plugged was 2 pcs as of Jan. 22, 1982 (2/363=0.55%)	2-LPH Number of tubes plugged is 3 pcs. as of August 17, 1980 (3/539 = 0.55%)
3-LPH Number of tubes plugged was 16 pcs. as of Jan. 22, 1982 (^{16}/229 = 6.98%).	3-LPH Number of tubes plugged was 59 pcs. as of July 21, 1982. (59/540 = 10.9%).

TURBINE AUXILIARY EQUIPMENT

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
HP Heater		
	5-HPH	5A-HPH
	Number of tubes plugged was 59 pcs. as of Nov. 6, 1981 (59/440 = 13.4%).	Number of tubes plugged was 1 pc. as of July 10, 1982 (1/633 = 0.16%).
		5B-HPH
		Number of tubes plugged was 1 pc. as of Aug. 1982 (1/633 = 0.15%).
	6-HPH	6A-HPH
	No plugged tube	Number of tubes plugged was 40 pcs. as of Mar. 31, 1982 (40/633 = 6.3%).
		6B-HPH
		Number of tubes plugged was 94 pcs. as of Aug. 4, 1982 (94/633 = 14.8%)
Deaerator		
	-	-
Condensate Pump		
	There is no pressure gage between pump and suction strainer of B condensate pump.	Pressure gages of suction strainer inlet and outlet were installed during last overhaul.
Circulating Water Pump		
	B circulating water pump was put out of service due to excessive leaks on its discharge line expansion joint on Jul. 7, 1981.	B circulating water pump was overhauled due to excessive vibration reaching to 3 to 4 mils at top bearing on Mar. 12, 1982.

TURBINE AUXILIARY EQUIPMENT

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
Chlorination and Ball Cleaning Devide	Chlorination equipment has not bee in service. Ball cleaning device is not installed.	Same as G-1
Bearing Cooling Water System	There are plenty of leaks at attached valves. Number of plugged tubes are 29 for A side and 261 for B side: (29/1618 = 1.79%) (261/1618 =16.13%)	Same as G-1 Number of plugged tubes are 110 pcs. for A side and 92 pcs. for B side: (110/1840 = 5.97%) (92/1840 = 5.0%)
Raw Water Pump	-	-
Deepwell Water Intake Equipment and Water Tank	-	-
Others	Poor drainage are found in such place as condenser pit and condensate pump pit, etc.	Same as G-1

ELECTRICAL EQUIPMENT

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
Generator	During last overhauling, March 9, 1982 - May 11, 1982, it was found that generator seal ring at the collector end was defective and there was H_2 leak on the hydrogen housing at the collector end. Hydrogen leakage has not been stopped at present, consuming about 6 hydrogen cylinders per day.	Excessive hydrogen leakage was experienced on the unit on October 25, 1978, and now the unit consumer about 1 hydrogen cylinder per day.
Exciter	-	Failure of main exciter occurred two times in the past, and main exciter is replaced with new one during 1982 overhauling.

ELECTRICAL EQUIPMENT

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
Switchgear and Motor Control Center		
1)	All the metal-clad switchgear, power center and motor control center except boiler control center are installed on the basement floor lower than power plant compound.	Same as G-1
2)	Lake water comes out considerably from the foundation of station service control center. This may cause insulation breakdown due to excessive moisture.	Same as G-1
3)	All the magnetic contactors and auxiliary relays in the units are open type, and the relays are very dusty because of bad circumstance.	Same as G-1
4)	No cable work and wiring identification mark.	Same as G-1
5)	There are many defective operation indicating lamps	Same as G-1
DC Supply System		
	Batteries except several new batteries are now reaching the end of life.	Common facilities to G-1

ELECTRICAL EQUIPMENT

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
Emergency Diesel Generator	Cabling to the auxiliaries has not been provided, and no provision of automatic start. Routine start-up test are not carried out. (Time counter indicates operating time of 3.6 hours since initial test running.)	Common facilities to all units
Transformer	There exists no problem.	Under replacement of insulation oil for main transformer during overhauling by MERALCO.
Substation	Five 115 kV outgoing transmission lines and two emergency transformer feeders and four generator circuit breakers are maintained by MERALCO.	Common facilities to all units

ELECTRICAL EQUIPMENT

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
Others		
1)	Auxiliary electric outlets for maintenance and repair works are provided not many enough, especially in the boiler yard.	1) Auxiliary electric outlets for maintenance and repair works are provided not many enough especially in the boiler yard, and so auxiliary power for G-2 overhauling is supplied from another unit under normal operation.
2)	Not enough lighting is installed in boiler yard.	2) Same as G-1
3)	All indicators on combustible gas alarm panels including gas sampling pumps are defective and not used at present.	3) Same as G-1
4)	Instruments and controls laboratory is very dirty and not cleaned-up.	4) Common facilities to G-1
Protective Relays		
1)	Setting of earth-fault preventive relay for generator and overcurrent relay for 4.16 kV high voltage motor should be re-considered.	1) Same as G-1
2)	Frequency relay is not placed into service	

CONTROL AND INSTRUMENT

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
Fuel Oil Flow Control	Automatic operation	Manual operation due to defective fuel oil flow transmitter. Under planning control signal replacement to oval-type fuel oil meter.
Feed Water Flow Control	Automatic operation	Manual operation due to slow response of feed water flow regulator (BFP-T). Leakages from feed water control valves are considerably large (BFP-M)
Steam Temperature Control	Manual operation due to defective temperature sensors.	Manual operation before overhauling, but under calibration during overhauling.
Air Flow Control	Manual operation due to AH clogging.	Manual operation due to air flow transmitter signal hunting.
Start-up By-pass System	none	Manual operation due to defective signal transmitter and slow response of the actuators (CV-101, CV-103, and CV-107) and motor-driven valves (MV-3, MV-4 and MV-5) are manually operated due to inadequate design. Flash tank pressure and level controls are operated automatically.

CONTROL AND INSTRUMENT

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
Interlock System	LP/HP heater drain level switches used for BTI system are all defective.	LP/HP heater drain level switches used for BTI systems are all defective. Wiring for under frequency interlock is not completed. "Economizer inlet feed water pressure low" interlock is not in service because of reduced pressure operation.
Instruments and Recorders	The following instruments are not placed into service: * Economizer outlet O_2% recorder * pH recorder * Attemperator outlet steam temperature is hunting.	Under calibration. The following instruments are not placed into service. * Economizer outlet O_2 recorder * pH recorder * Conductivity meter
Local Control	Almost all controllers are not placed into service,and operated manually with the aid of control valve by-pass valve. Especially the following important control loops are defective. 1) HP/LP feed water heater drain level controllers	Same as G-1

CONTROL AND INSTRUMENT

	GARDNER UNIT No. 1	GARDNER UNIT No. 2
2)	Auxiliary steam pressure controllers	
3)	SAH temperature controllers	
4)	Deaerator spill-over and over flow controllers	
Control Air System		
	Two instrument air compressors are continuously loading, and can not exert pressure up to 90 psi (unloading setting). Back-up line from station service air system has no non-return valve and filter.	Only one air compressor is installed and continuously loading. Back-up line from G-1 control air line is provided.
Central Control Room and Cubicle Room		
	The central control room is maintained relatively in good condition since the room is partitioned with cable marchalling room. Central control room temperature: 76°F (24.4°C)	Common facilities to G-1

5.2.2 Snyder Thermal Plant

BOILER

	SNYDER UNIT No. 1	SNYDER UNIT No. 2
Superheater		
	1) No. 1 loop of #13, 20, 31, 39, 24, 27 and 35 panels of secondary superheater were failed on Apr. 9, 1981.	The following was done during overhaul (Feb. 25, 1981 - Aug. 19, 1981): 1) Replacement of tube panel #27, 31, 32, 34, 36
	2) No. 1 and 7 loops of secondary SH, welded at field were failed on Apr. 25, 1981.	2) Replacement of the first 2 loops from bottom of #9 to 44 panel of secondary SH except the new five panel listed above.
		First row tubes of 50, 65, 66 and 68 panel failed on July 12, 1982.
Reheater		
	1) One tube, #1 loop of panel #13 failed with 1-1/2 inches crack on May 22, 1981.	All panels of RH bottom tubes were replaced during overhaul (Feb. 25, 1981 - Aug. 19, 1981).
	2) One tube of panel #10 was failed on June 12, 1981.	
Water Wall		
	JICA team was informed that several tubes are misaligned and failures due to pitting corrosion has been experienced.	Seven tubes had been leaking and had been repaired temporarily during Sept. 15, 1981 - May 15, 1982.

BOILER

	SNYDER UNIT No. 1	SNYDER UNIT No. 2
Casing		
	There were found plenty of gas leaks	Same as S-1
Burner		
	-	-
Economizer		
	There is no non-return valve between economizer and final HP feedwater heater.	Same as S-1

BOILER AUXILIARY EQUIPMENT

SNYDER UNIT No. 1

Forced Draft Fan

A-FDF

1) Thrust collar was replaced on - Sept. 16, 1981.

2) Excessive heat of motor inboard bearing occurred on Sept. 20, 1981.

B-FDF

Excessive vibration occurred.

Boiler Feed Water Pump

B-MBFP

July 19, 1981 - Aug. 4, 1981:
During this period, suction strainer was clogged up six (6) times by resin breakthrough.

T-BFP

1) Excessive vibration occurred on May 28, 1981 due to blade failure. One blade, second from the last stage, was cut by 1 inch on May 31, 1981 and blades of this stage were previously cut to 5 inches. One blade of last stage was cut to 4 inches previously.

SNYDER UNIT No. 2

Dec. 24, 1981 - April 10, 1982:
During this period stationary blades from 1st stage to 17th stage and rotating blade from 1st to 10th stage were replaced. The minimum flow valve was also replaced.

BOILER AUXILIARY EQUIPMENT

	SNYDER UNIT No. 1	SNYDER UNIT No. 2
	2) Turning device motor was burned out on June 22, 1981. 3) Minimum flow line for M-BFP is provided in common with T-BFP.	
Gas Recirculation Fan	-	-
Air Heater	1) Cold end element was replaced on Aug. 13, 1981. 2) AHs have been washed often.	1) During 1981 overhauling, air heater elements were replaced and extensive repairs were performed on the rotor. 2) Same as S-1
Steam Coil Air Heater	Temperature control valve is not in service.	Same as S-1
Fuel Oil Pump	-	-

BOILER AUXILIARY EQUIPMENT

	SNYDER UNIT No. 1	SNYDER UNIT No. 2
Ash Handling System		
	Conveying line has been clogged up. Not serviceable.	Not used
Auxiliary Steam System		
	1) Poor insulation is found. 2) Control valves are not in service. 3) Local automatic controls are not functioning.	Same as S-1
Pipings and Valves		
	There are no indications of flow direction and no nameplate on valve and found poor insulation.	Same as S-1
Air and Flue Gas Duct		
	There are plenty of gas leaks and poor insulation.	Same as S-1
Chemical Injection System		
	-	-

TURBINE

SNYDER UNIT No. 1

Turbine Proper

LP turbine blades failed as follows:

Generator Side (Blade length 625 mm)

1) Last stage

No.	Remaining Length
3	335 mm
4	335
22	255
23	255
32	355
33	355
51	255
52	255

All other blades previously cut to 425 mm.

2) Second to the last stage

No.	Remaining Length
63	300 mm

All other blades cut to 315 mm (Dec. 10, 1981).

SNYDER UNIT No. 2

During 1981-82 overhaul of the unit cracks were found on LP turbine blades which were temporarily repaired as follows:

LP - 1

Generator Side

1) Last stage - all blades were cut to a remaining length of 320 mm

2) Second to the last stage

All blades are still at their original length. No cuts.

TURBINE

SNYDER UNIT No. 1

Turbine Side

1) Last stage

No.	Remaining Length
18	334 mm
47	334 mm

All other blades cut.

2) Second to the last stage

No.	Remaining Length
46	290 mm
8	290 mm
60	240 mm
61	240 mm
26	288 mm
27	243 mm

All other blades cut to 315 mm remaining length.

3) Third to the last stage

No.	Remaining Length
4	260 mm
10	260 mm
11	260 mm
12	260 mm
18	260 mm
19	260 mm

SNYDER UNIT No. 2

1) Last stage

All blades were cut to a remaining length of 320 mm.

2) Second to the last stage

All blades were cut to a remaining length of 225 mm

LP - 2

1) Last stage

All blades were cut to a remaining length to 320 mm

2) Second to the last stage

All blades were cut to a remaining length of 225 mm

H.P. Turbine

One impulse blade was broken on Nov. 28, 1981. Rotor assembly replaced with M-1 spare having old design. Damaged rotor was sent to KWU factory for repairs.

TURBINE

	SNYDER UNIT No. 1	SNYDER UNIT No. 2
	No. Remaining length	
	29 260 mm	
	46 0 mm	
	54 260 mm	
	55 260 mm	
	56 260 mm	
Major Valves	No problem	Sept. 21, 1981 HPCV #2 spindle chattering. Sept. 25, 1981 HPCV #2 worn out. HPCV #1 and 4 crack on welding portion. Problem on the chattering and breakage of HP control valve spindles was experienced in 1981. Problem was solved after replacing spindle and valve seat with modified design as per recommendation of KWU.
Governor	Electro-hydraulic governor is not in service.	Same as S-1
Lubrication Oil System	Slight oil leaks were found on system.	Same as S-1

TURBINE AUXILIARY EQUIPMENT

	SNYDER UNIT No. 1	SNYDER UNIT No. 2
Main Condenser		
	Number of plugged tubes was 255 pcs. as of July 25, 1982 (255/24,400 = 1.05%).	Number of plugged tubes was 58 pcs. as of June 2, 1981 (58/34,800 = 0.17%).
LP Heater		
	1-LPH	1-LPH
	Number of plugged tubes was 1 pc. as of July 10, 1980 (1/508 = 0.19%)	Number of plugged tubes was 2 pcs. as of May 14, 1982 (2/835 = 0.024%).
	2-LPH	2-LPH
	Number of plugged tubes was 38 pcs. as of Mar. 7, 1982 (38/539 = 7.05%).	Number of plugged tubes was 135 pcs. as of July 24, 1981 (135/755 = 17.8%).
	3-LPH	3-LPH
	Number of plugged tubes was 233 pcs. as of Mar. 6, 1982. Heater assembly will be replaced with new one during coming annual overhaul of 1982 (under planning) (233/539 = 43.2%).	Number of plugged tubes was 12 pcs. as of May 14, 1982 (12/906 = 1.32%).
HP Heater		
	5A-HPH	5A-HPH
	Number of plugged tubes was 35 pcs. as of Mar. 19, 1982 (35/633 = 5.53%).	Number of plugged tubes was 295 pcs. as of Aug. 27, 1981 (295/749 = 39.3%).

TURBINE AUXILIARY EQUIPMENT

SNYDER UNIT No. 1	SNYDER UNIT No. 2
5B-HPH Number of plugged tubes was 46 pcs. as of 1982 (46/633 = 7.2%).	Heater assembly was replaced during March, 1982 of annual overhaul.
	5B-HPH Number of plugged tubes was 123 pcs. as of Aug. 20, 1981 (123/749 = 16.3%). Heater assembly was replaced during March 1982 of annual overhaul.
6A-HPH Number of plugged tubes was 12 pcs. as of July 25, 1982 (12/633 = 1.89%).	6A-HPH Number of plugged tubes was 229 pcs. as of Aug. 28, 1981 (229/707 = 32.3%). Heater assembly was replaced with new one during Mar. 1982 of annual overhaul.
6B-HPH Number of plugged tubes was 33 pcs. as of July 25, 1982 (33/633 = 5.21%).	6B-HPH Number of plugged tubes was 324 pcs. as of Dec. 13, 1981 (324/707 = 45.8%). 6B-HPH was put out of service due to excessive tube leak.
Deaerator	
-	-

TURBINE AUXILIARY EQUIPMENT

	SNYDER UNIT No. 1	SNYDER UNIT No. 2
Condensate Pump		
	There are no pressure gage between pump and suction strainer.	Same as S-2
Circulating Water Pump		
	B circulating water pump was tripped due to low lube oil pressure	B-CWP All stud bolts at inner base that holds the column casing sheared off which caused the column casing to fall down to suction well.
Chlorination and Ball Cleaning Device		
	Chlorination equipment has not been in service and trite. Ball cleaning device is not installed.	Same as S-1
Bearing Cooling Water System		
	There are plenty of leaks at attached valves.	Same as S-1
	Number of plugged tubes is 2 pcs. for A side and 124 pcs. for B side: (2/1840 = 0.1%) (124/1840 = 6.73%)	Number of plugged tubes is 117 pcs. for A side and 118 pcs. for B side: (117/1857 = 6.3%) (118/1857 = 6.35%)
Raw Water Pump		
	-	-
Deep Well Water Intake and Storage Tank		
	-	-

TURBINE AUXILIARY EQUIPMENT

	SNYDER UNIT No. 1	SNYDER UNIT No. 2
Others		
	Poor drainage are found in such place as condenser pit and condensate pit.	Same as S-1

ELECTRICAL EQUIPMENT

	SNYDER UNIT No. 1	SNYDER UNIT No. 2
Generator	The unit was shut down due to checking of generator - LP coupling, and found misaligned and generator H_2 seal ring damages on December 11, 1981.	The unit was shut down due to DC-hi-pot test of generator stator on November 5, 1977. H_2 press is raised up to 60 psig from 45 psig design. It is reported by KWU that hot spots were found on the core end during last annual overhaul.
Exciter	-	-
Switchgear and Motor Control Center		
	1) Same as G-1	1) Same as G-1
	2) Boiler control center is installed very closely to the boiler hot air duct, and is heated up.	
	3) Same as G-1	3) Same as G-1
	4) Same as G-1	4) Same as G-1
	5) Same as G-1	5) Same as G-1
DC Supply System	Batteries are maintained relatively in good conditions, but several battery units are now coming the end of life.	Common facilities to S-1 unit
Emergency Diesel Generator	Common facilities to all units	
Transformers	-	-

ELECTRICAL EQUIPMENT

	SNYDER UNIT No. 1	SNYDER UNIT No. 2
Substation		
	Common facilities to all units	Common facilities to all units
Others		
1)	Electric outlet Same as G-1	1) Same as G-1
2)	Lighting Same as G-1	2) Same as G-1
3)	Gas alarm pannel Same as G-1	3) Same as G-1
4)	Instruments and controls laboratory Common facilities to G-1 and G-2	4) Common facilities to G-1 and G-2
Protective relays		
1)	Setting of earth-fault preventive relay Same as G-1	1) Same as G-1
2)	Frequency relay Same as G-1	2) Same as G-1

CONTROL AND INSTRUMENT

	SNYDER UNIT No. 1	SNYDER UNIT No. 2
Fuel Oil Flow Control	Same as G-2	Same as G-2
Feed Water Flow Control	Same as G-2	Manual operation due to slow response of feedwater flow regulator
Steam Temperature Control	Manual operation due to considerable spray water leakage from control valves	Same as S-1
Air Flow Control	Same as G-2	Same as G-2
Start-up By-pass System	Manual operation due to defective signal transmitter and slow response of the actuators (CV-103 and CV-101) and motor-driven valves (MV-3, MV-4 and MV-5) are manually operated due to inadequate design. Flash tank pressure and level controls are operated automatically.	Manual operation due to signal transmitter and motor-driven valves (MV-4 and MV-5) are manually operated due to inadequate design. Flash tank pressure and level controls are operated automatically.

CONTROL AND INSTRUMENT

	SNYDER UNIT No. 1	SNYDER UNIT No. 2
Interlock System		
	LP/HP heater drain level switches used for BTI system are all defective.	LP/HP heater drain level switches used for BTI system are all defective.
	"Economizer inlet feed water pressure low" interlock is not in service because of reduced pressure operation.	
	Furnace purge interlock is manually reset due to defective air flow switch.	
Instruments and Recorders		
	The following instruments are not placed into service * Boiler metal temperature recorder (under supervising by temporary recorder) * pH recorder * Economizer outlet O_2% recorder * Conductivity meter	The following instruments are not placed into service * Economizer outlet O_2% recorder * Boiler metal temperature recorder * Conductivity meter
	Opening indicators of turbine extraction steam non-return valves are not correct because of defective slide wires.	Opening indicators of turbine extraction steam non-return valves are not correct because of defective slide wires.
Local Control		
	Same as G-1	Same as G-1

CONTROL AND INSTRUMENT

	SNYDER UNIT No. 1	SNYDER UNIT No. 2
Control Air System		
	Only one air compressor is installed and cannot exert pressure up to 90 psi (unloading setting). Back-up line from station service air system has no non-return valve and filter.	Only one air compressor is installed and cannot exert pressure up to 90 psi (unloading setting). Control valves for back-up line from station service line were already removed.
Central Control Room and Cubicle Room		
	The central control room and cubicle room are in very bad conditions since the openings for cable marshalling are widely opened and air conditioners are frequently defective. Central control room temperature: 95°F (35°C) Cubicle room temperature: 99°F (37.2°C)	Common facilities to S-1

5.2.3 Malaya Thermal Plant

BOILER

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Superheater	Secondary superheater tubes are already deteriorated. Complete replacement will be carried out during the coming overhaul of the units.	-
Reheater	Pendant reheater bottom loops are already deteriorated due to presence of deposits inside the tubes. Complete replacement of the bottom loops portion will be carried out during the coming overhaul of the unit.	-
Waterwall	Operating pressure was reduced from 2700 psig to 2100 psig due to weak condition of waterwall tubes. There is a decrease in thickness by 1.2 mm due to bulging of some tubes which was overheated. BHK has recommended to replace about 20% of the total waterwall area.	On April 6, 1982, M-2 unit had to shut down due to baffle wall tube leakage. After this trouble M-2 unit is being carried out on reduced pressure operation until weak tubes will be replaced (Drum press. 160 kg).

BOILER

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Casing	Flue gas leakages are found as follows: 1) At the corner of boiler casing (primary superheater and economizer area) 2) Boiler bottom connection part of GRF gas duct.	-
Burner	There are plenty of flue gas leakage in burner enclosure and plenty of oil spillage around burner area.	1) Around AH gas duct There are plenty of oil spillage around burner area. Automatic burner control equipment supplied by Forney is not in service due to numerous defects.
Starting By-pass System	This system is operated by manual and there seems no seat leak but outside of valve and attached equipments are corroded by flue gas.	-
Others	There are many corroded parts by flue gas as a whole. Many gland leaks, pinhole leaks are found.	Plant is maintained clean because of smaller leakage than that of M-1. There are some difficulties on patrol check due to insufficient illumination in the upper boiler room.

BOILER AUXILIARY EQUIPMENT

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Forced Draft Fan	Temperature of bearings is comparatively higher as a whole. Especially, actual temperature of 1-B inboard side bearing is apparently higher than the indicated temperature, 72.5°C at 220 MW on the recorder. Calibration of temperature recorder should be performed and the fans should be overhauled during annual shutdown.	There are some vibrations observed on the A and B fans' inboard bearing. Fans should be overhauled during annual shutdown.
Gas Recirculation Fan	Patrol inspection cannot be done due to no steps and floor which must be furnished immediately.	There is vibration being observed on the motor side bearing of fan. There are plenty of dust of insulation which must be cleaned immediately.
Air Heater	1B-AH hot end about 25% of the whole part are removed due to burnt condition.	Output of plant is limited due to air heater clogging. In this year, recently, there is rapid increase of AH differential pressure. The elements should be replaced with new ones at the first opportunity.

BOILER AUXILIARY EQUIPMENT

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Steam Coil Air Heater	The pressure control valve from auxiliary steam and the pressure control valve of SCAH are manaully operated because of defective controllers.	A side temperature cannot be raised due to isolated coils which are leaking. Drain control is manually operated because of defective controllers.
Fuel Oil Pump	MFOP and fuel oil heater area is dirty. Some indicators are out of order.	Same as M-1. Constant differential fuel oil pump cannot be operated because of motor overload, vibration of pump and overheating of motor bearing.
Ash Handling System	This system cannot be used due to all equipments corroded.	Same as M-1
Auxiliary Steam	There are plenty of steam leakage.	-
Compressor	Service air compressor 1A is loading at 82 psig continuously. Control air compressor 1B is loading at 86 psig continuously and the control air back-up valve is isolated.	Control air compressors 2A, 2B are loading at 6 kg/cm^2 continuously and back-up valve for control air is isolated.

BOILER AUXILIARY EQUIPMENT

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Valve Pipings	There are plenty of corroded parts, gland leaks. Feed water economizer inlet non-return valve is not provided.	Feed water economizer inlet non-return valve is provided.
Flue Gas Duct and Air Duct	There are plenty of gas leak, and drop out of thermal insulation and cover sheets.	Comparatively good
Fuel Oil Tank	All controllers of fuel oil tank farm are out of service due to oil contamination of control air line. Tank yard is covered with tall grasses so that patrol check cannot be done.	Common to M-1
Chemical Injection	Hydrazine is continuously injected during operation. According to water quality, NH_4OH is injected.	Hydrazine is continuously injected during operation. According to water quality, disodium phosphate-trisodium phosphate are injected.

TURBINE

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Turbine		
	Around front stand and area are dirty.	-
	There is steam leak at gland.	
	LP turbine blades are damaged and are cut.	
Turbine Valves		
	Thermal insulation around valve is insufficient.	Pilot valve of MSV right side was broken and now it is welded temporarily.
Governing System		
	EHC device is dirty with dust.	-
Oil System		
	-	-

TURBINE AUXILIARY EQUIPMENT

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Condenser		
	A side: 3% (517 pcs.) plugged	A side: 31.52% (3177 pcs.) plugged;
	B side: 3.05% (531 pcs.) plugged	B side: 12.19% (1229 pcs.) plugged.
		The tendency is toward increase tube leak rapidly.
		Replacement of tube should be done as soon as possible.
Low Pressure Heater		
	LP No. 3 heater: 14.9% plugged	LP No. 2 heater 8 pcs. plugged
	LP No. 2 heater: 2.66% plugged	
High Pressure Heater		
	HP No. 5A heater: 100% plugged	-
	This heater is isolated from feed water line.	
	No. 5B heater: 22.07% plugged	
	No. 6A heater: 3.3% plugged	
	No. 6B heater: 18.3% plugged	
Deaerator		
	Tank drain valve seat leak	-
Condensate Pump		
	-	-
Circulating Water Pump		
		2A CWP has much vibration on shaft.

TURBINE AUXILIARY EQUIPMENT

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Travelling Screen, Chlorine Injection, Ball Cleaning Device	Chlorine injection is suspended from Mar. 27, 1979 due to no chlorine is available.	No chlorine injection Plenty of balls including spare balls were lost. Further the equipment was damaged when the upper and lower screen motors were submerged in sump water.
Bearing Cooling Water System	Cooling water pressure, temperature control is not working. 100% capacity heat exchangers are used in parallel and inlet and outlet water temperature gages are defective.	Stand pipe level control valve and flow integrator are isolated. 696 tubes of 2A heat exchanger, 67 tubes of 2B and 55 tubes of 2C are plugged.
Raw Water Pump	Impeller and shaft were found broken during recent inspection.	-
Valve, Pipings	There are plenty of thermal insulation flaking or falling due to poor maintenance.	-

TURBINE AUXILIARY EQUIPMENT

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Well Water Supply		
	There is lack of water supply by three deep well pumps which are running with outlet valve crack open due to low well water level.	Common to M-1
Others		
	Pit under the condenser is not completely drained.	Same as M-1 Screen drive device for ball cleaning equipment and condenser tube leak detecting device are submerged.

BOILER FEED PUMP

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Motor Driven BFP	-	-
Turbine Driven BFP	-	Abnormal noise and temperature rise were found and defective bearings were replaced with new one on Sept. 4, 1982 (T-BFP Booster Pump Motor).

ELECTRICAL EQUIPMENT

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Generator		
	H_2 pressure is raised up to 60 psig from 45 psig design. H_2 cooler control valve is already full open though output is only 220 MW and H_2 gas temperature is 46°C exceeding design temperature of 40°C. Coil temperature rise at 220 MW is 11°C which has some allowance. It is reported by KWU that hot spots were found on the core end during last annual overhaul.	-
Exciter		
	-	-
Hydrogen Supply System and Cooling Water System		
	Hydrogen supply: 2 bottles/day Gas dryer is not in service.	Same as M-1
Switchgear and Motor Control Center		
	Some spare units of motor control center are not complete condition.	Same as M-1
DC Supply System		
	Batteries are now reaching end of life.	New batteries are now under installation

ELECTRICAL EQUIPMENT

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Emergency Diesel Generator		
	No provision of automatic start	Common to M-1
Transformer		
	Frequent breakdown of 230 kV lightning arrester was reported and all lightning arresters on the main transformer were replaced with Ohio-brass lightning arrester rated to 192 kV.	Same as M-1
	There are some oil leaks found	Same as M-1
	There is misalignment between main transformer and isolated phase bus.	
Substation		
	Main transformer's circuit breakers and disconnecting switch of 230 kV were coated with silicon compound.	Same as M-1
	115 kV circuit breakers of transformers are maintained by MERALCO.	
Protection Relay		
	There is record of back-up relay tripping.	Back-up ground relay tripping was experienced on Aug. 14, 1982.
	Coordination of relay setting should be re-studied.	Same as M-1

ELECTRICAL EQUIPMENT

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Others		
	There are plenty rain leak inside the building, and these affect electrical equipments.	Same as M-1

CONTROL AND INSTRUMENT

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Fuel Oil Flow Control	On manual operation due to feed water control system hunting.	On automatic operation
Feed Water Control	There is hunting in T-BFP governing system.	On automatic operation
Steam Temperature Control	On manual operation due to feed water control system hunting. Temperature sensor is defective.	On manual operation due to defective temperature sensor.
Starting By-pass System	On manual operation due to slow response in control system	-
Interlock System	The following interlocks are defeated: * Economizer inlet pressure low trip * HP heater level high trip * LP heater level high trip * Under frequency relay trip	The following interlocks are defeated: * All flame failure trip * Burner light delay * Under frequency relay trip
Local Control	Almost all controllers are not in service.	Feedwater heater drain control system is in good condition. Controller of auxiliary steam system is not in service.

CONTROL AND INSTRUMENT

	MALAYA UNIT No. 1	MALAYA UNIT No. 2
Control Air System		
	One out of two sets of compressor is continuously loading.	Two sets of compressor are continuously loading.
	Air dryer is maintained in good condition.	Same as M-1
	Back-up line from station air system is isolated.	Same as M-1
Instrument Recorder		
	pH recorder, conductivity recorder, T-BFP bearing temperature recorder, etc. are not in service.	O_2 recorder, boiler feed pump bearing temperature recorder, pH recorder, etc. are not in service.
	Almost all local indicators are defective.	
	O_2 recorder is put in service during JICA survey but not reliable because no calibration with standard gas.	
Central Control Room and Cubicle Room		
	Temperature of cubicle room is 25°C and control room is around 33°C.	Common to M-1

5.3 PROBLEMS IN POWER PLANTS AND COUNTERMEASURES

5.3.1 Plant Facilities and Equipment

1) Gardner/Snyder Thermal Plant

a. Boiler Proper

(a) Water Wall, Reheater and Superheater

G - 1

i. Waterwall Tube

January 13, 1982 to March 5, 1982, the Unit was shut down for annual overhauling after which it was synchronized to the grid. Unfortunately, it was shut down again on March 9 to May 11, 1982 for repair of generator seals. It was resynchronized on May 12, 1982 but was then immediately shutdown due to an evident tube failure. Investigation conducted after cooling down showed the following results. North side rear waterwall tubes No. 59 ws ruptured while No. 54 and No. 60 tube were found with five (5) and three (3) buldge portion each respectively. All these tubes were cut and replaced after which the boiler circuit was subject to hydrostatic test but pinhole leaks were noted on the same tube as mentioned above. Replacement was immediately initiated and a second hydrostatic test was conducted. The boiler circuit successfully passed the hydro-test pressure of 2600 psig. The unit was put back on the line on June 15, 1982. Considering, however the weak condition of the

boiler tubes the drum pressure was reduced to 1600 psig as against a rated throttle pressure of 1800 psig. This operating condition further reduced the unit output capability to 120 MW.

After only twenty-four (24) hours operation, however, the unit had to be shutdown on June 16, 1982 on account of noted excessive feedwater make-up, a clear indication of another tube leak. Evidently waterwall tube No. 49 which previously patched was ruptured. The point of failure was on the same elevation as the previous tube failures. After repair, it was decided that a further reduction of drum pressure from 1600 psig to 1400 psig had to be resorted to in order to sustain possible continuous operation and consequently limited unit maximum capability to 100 MW.

(i) Final analysis indicated that the nature of failure/rupture was possibly caused by apparent overheating due to abnormal tube internal deposits.

Bulged and Cracked Tube Internal Deposit Analysis Result

Composition	Buldged Tube percent in wt.	Cracked Tubes percent in wt.
Acid Insoluble	4.72	2.605
Silica SiO_2 (total)	1.524	1.970
Chloride, Cl	0.091	0.033
Copper, Cu	14.83	16.365

The extent or degree of waterwall tube internal deposit measured from the defective tube sample indicated the figures, 71.12 mg/cm^2 and 12.67 mg/cm^2 at fire side and cold side respectively. Fire side internal tube deposit limitation is 30 mg/cm^2. This figures indicated that the degree of deposit had increased to approximately 42.04% over the maximum allowable limit.

(ii) G-1 was placed on commercial oeration on August 1, 1968 and had over 90,000 operating hours to date. According to the past record unit shutdown caused by boiler trouble from commercial operation up to June 30, 1982 was thirteen (13) times consisting of three (3) times from 1968 to 1978 and ten times from 1978 to 1982. This shows that there is an increasing trend of unit outage frequency caused by boiler trouble which could be attributed to the following:

Possible Causes of Boiler Tube Leak

* Water and steam purity problem
* Combustion and feedwater control regulation problems and/or difficulty
* Improper operation or problems in SH and RH spray system
* High and low temperature corrosion
* Inappropriate implementation of sliding pressure operation

In view of the above, it can be concluded that waterwall tube problem is the major factor which caused unit capability limitation.

G - 2

i. Waterwall Tube

Inspection result of waterwall tube at the unit overhauling on June 16, 1982.

(i) Tube thickness check - TSR within allowable limit

*) Gas Side = Elephant skin appearance

*) Tube Internal = plenty of pitting corrosion ranging from about 0.1 mm - 0.3 mm in depth, TSR is about 4.0 mm which is still acceptable.

ii. Pendant Reheater

During the overhauling a total of 241 tube loops were replaced except tube loop bends. Old tubes had elephant skin appearance and thick scale deposits were noted on boiler tube insides.

iii. Horizontal Reheater

Horizontal reheater tubes were also inspected during the annual overhauling conducted from June to September, 1982. Hydrostatic test was conducted and eleven (11) leaking tubes were repaired. Inspection on tube insides showed a considerable degree of pitting corrosion. Since S-1 boiler is similar to G-2, it is suggested that similar inspection should be done in the forthcoming overhauling of the unit.

iv. Secondary Superheater

A total of sixty (60) tube panels were all replaced. Reduced pressure operation was resorted to last February 14, 1981 from the working pressure of 2700 psig to 2400 psig. This value was again reduced down to 2300 psig on January 1, 1982.

S - 1

i. Superheater and Reheater

The unit was put on line on July 1, 1971. After the annual overhauling conducted during July 16 to November, 1978, however, frequent superheater and reheater tube failures had been noted and recorded. These failures were 7 times on superheater tubes and twice on the reheater circuit. Past record shows that in April, 1981 the tube panels on loop No. 1, such as #13, 20, 26, 27, 31, 35 & 39, of the superheater have been subjected to the failures.

The following items had been carefully studied and were included in the 1982 rehabilitation program of thermal power plants of NAPOCOR.

(i) Secondary Superheater coils of 60 sets made of SUS material are scheduled to be used for replacement.

(ii) Reheater lower bend and deteriorated parts are also scheduled to be replaced.

Reduced pressure operation at 2,300 psig was adopted on November 1980 at first because of the aforementioned water leaking tubes. This boiler pressure is being maintained up to the present.

S - 2

i. Superheater Section

During the overhauling conducted from last February 25 to August 1981, the following jobs were performed.

(i) Tube Panel No. 27, 31, 32, 34 and 36 were replaced with new tubes.

(ii) Bottom loop of Panel No. 9 to panel No. 44 were also replaced with new one except bottom loops of the panels mentioned above.

Annual overhauling records showed that first straight tubes of the first four loops were subjected to microstructure examination and random sampling on some tubes of the entire circuit. Radiographic Test (X-ray) was also conducted. It is recommended that the bend tubes below allowable thickness (TSR) should be replaced during next overhauling.

In another report dated March 22, 1982, it was stated that there is a scale deposit built-up ranging from 2 - 10 mm of tube internal lower bends.

ii. Reheater Tubes

All panels of the reheater circuit bottom or outer loops were replaced during the overhauling conducted last February 25 to August 19, 1981.

iii. Waterwall Tubes

Within a span of approximately six (6) months from September 15, 1981 to March 15, 1982, a total of six tube failures occurred. Waterwall tube near the burner throats and sidewalls were still within allowable wall thickness. Ultrasonic testing was carried out however, it showed some signs of gradual pitting corrosion to take place.

(b) Boiler Casing

Common to G-1, S-1 and S-2:

Actual feild observation showed that excessive boiler casing and ductwork gas leak is common to all of the above units. This condition adversely affects the effectivity of daily inspection by the operation personnel and execution of preventive maintenance in the surrounding areas.

High sulfur content in the fuel oil coupled with unstable combustion accelerate the accumulation or attachment of corrosive materials on boiler parts and consequently leaks due to corrosion. It is therefore, important the thorough routine inspection be conducted. All noted or reported leaks should be adequately repaired during overhauling or at the eraliest opportunity.

(c) Economizer

G-2, S-1 and S-2

No non-return valve on the feedwater line between economizer and final high pressure feedwater heater. This set-up allows high temperature liquid from the boiler circuit to backflow to the high pressure heaters especially during banking and/or sudden unit tripping, a situation which will adversely affect the high pressure heaters due to sudden thermal stress.

b. Boiler Auxiliary Equipment

(a) Air Heater and Steam Coil Air Heater

G-1

i. Defective air heater and steam coil air heater element were replaced November 10, 1972. Steam coil air heater element was replaced again on December 30, 1981.

ii. Steam coil air heater temperature control valve inoperative. These of S-1 and S-2 are same as G-1 except G-2 which was not observed as it is under overhauling at the moment.

G-2

i. Air heater fire occurred on September 3, 1981. This was possibly caused by excessive soot and unburned hydro-carbon accumulation on the heating element. In view of this, it is suggested that air heater sootblower should always be checked to ensure its effective operation as designed.

ii. Inadequate air heater washing is also a contributory factor that lead to air heater fires and fouling of elements, therefore, the frequency of air heater sootblowing should be considered depending on the pressure drop across the air heater.

S-1

i. Since July 23, 1971 up to June 1982, the unit was repeatedly shutdown to facilitate air heater washing. A recorded total of twenty-three (23) unit outage was attributed to this particular activity alone. It is hereby suggested that the objective recommendation provided for under G-2 above be adopted on the air heater of this unit.

S-2

i. From July 21, 1972 up to June 1982 a recorded total of thirty-two (32) unit outages was also traced to have been caused by clogging of air heater element hence the necessity of air heater washing.

(b) Fuel Oil Pump (including CDFOP)

G-1

i. The constant differential fuel oil pump (CDFOP) had been out of service. It should be noted however that the main burners are designed as return flow atomizing type and not as straight mechanical burners. To continuously operate the boiler without CDFOP is not advisable.

ii. Fuel oil heater drain line to condenser is not suitably designed. The present set-up is likely to contaminate the heater drains if there is a fuel oil leak in the fuel oil heater.

(c) Ash Handling

Conveying of ash handling equipment of each unit in Gardner/Snyder Thermal Plant are all clogged-up hence they are rendered unoperational. As soon as possible thorough inspections and subsequent repairs of all defective components should be initiated to restore the equipment to operating condition.

In case of replacement of ash handling equipment, caution should be given on the following items.

i. Characteristic and quantity of ash to be handled

ii. Conditions of air used for transportation

iii. Associated equipment

(i) Ash storage equipment

(ii) Ash incineration plant

(iii) Drainage equipment

(iv) Ammonia injection

iv. Environmental criteria

v. Installation of E.P.

In case of installation of EP, please refer to the "Installation Planning of Electrostatic Precipitator" submitted to QA group separately and thoroughly negotiate with manufacturer.

(d) Auxiliary Steam System

Almost all local control valves (CVs) in each unit are found not operational. For more details, please refer to report under section of local control system. It is also suggested that a study be made to further improve the auxiliary steam supply set-up to ensure reliability.

(e) Piping System Including Valves

i. Insulation jobs on various systems are ongoing. Identification marks and flow direction on plant pipings should however be carried out by plant management.

ii. Travel indicator positions of all constant and spring hangers should be recorded at boiler cold and hot condition.

(f) Safety Valve

Steam Drum, Superheater, Reheater, Safety Valve Setting Record

Unit : psig

Valve No.	Desired Popping	Actual Popping	Drawdown	Blowdown	
				Desired	Actual
G - 1					
Steam Drum BM - 1	2243	2210	2120	139	90
Steam Drum BM - 2	2212	2200	2100	133	100
BM - 3	2180	2155	1995	130	140
S.H. Outlet SH - 1	2070	-	-	110	-
SH - 2	2040	1840	1840	100	-
RH Inlet RH - 1	520	-	-	42	-
RH - 2	530	-	-	43	-
RH - 3	538	-	-	43	-
RH - 4	545	-	-	44	-
RH Outlet RH - 5	497	-	-	40	-

* Recorded: March 4, 1982

Valve No.	Desired Popping	Actual Popping	Drawdown	Unit: psig Blowdown	
				Desired	Actual
S - 2					
Flash Tank BV - 501	770	780	702		78
Flash Tank BV - 502	780	765	699		76
Flash Tank BV - 503	790	755	688		75
RH Inlet RH - 1	722	730	660		70
RH Inlet RH - 2	767	765	715		50
RH Inlet RH - 3	780	770	660		110
RH Inlet RH - 4	785	775	720		55
RH Inlet RH - 5	790	800	763		37
Sec. S.H. SH - 1	3500				
Primary SH SH - 2	3520				
Primary SH SH - 3	3535				
Primary SH SH - 4	3550				

Recorded: August 1981

(g) Sootblowers

During boiler operation, it is necessary that all tube sootblowers and AH sootblowers should be operated at required intervals to avoid fouling. This will also help in maintaining boiler efficiency.

It was noted however, that the number of operating sootblowers against the total number of installed sootblower is very low. This is attributed to the following reasons.

- Some sootblower lance tubes were removed and were not immediately replaced.
- Excessive steam leakage on valves and/or lance tube packings.

It is therefore, suggested that all defective sootblowers should be immediately and properly repaired so that they can be effectively used while the units are operating.

The percentage of operating sootblowers in all units of Gardner/Snyder Thermal Plant except G-2 which is under overhauling are as follows:

No. of Operating Tube Sootblower (Air Heater)

Number of Installed Sootblower

G-1	S-1	S-2
15 (2)	2 (2)	3 (2)
24 (2)	24 (2)	20 (2)

c. Turbine

(a) HP, IP, LP Turbine

i. G-1

No damage on turbine blades.

ii. G-2

Dec. 28, 1981

Shaft vibration was observed to be increasing to 6 mils on the 1st casing, front (Point #7, on vibration recorder).

March 30, 1982

After 6 pcs. of condenser tubes were found leaking (upper portion A side), turbine inspection was conducted. Found two (2) broken blades (140 mm & 110 mm long) at the last stage turbine side.

LP turbine (turbine end). On the last stage, the six (6) broken blades were cut to a reamining length of 485 mm.

iii. S-1

(i) On Oct. 26, 1981, excessive vibration occurred on the LP casing causing unit shutdown.

Magnaflux testing was conducted on the turbine blades, the result of which revealed several minutes cracks. These blades were cut-off however, the diametrically opposite blades were not cut.

(ii) Several expansion bellows were found damaged. These were replaced with new spares.

Location of the bellows:

One (1) - extraction of LP to LPH#2

One (1) - extraction of LP to LPH#1

One (1) - left cross-under pipe cracked at the welded portion.

(iii) The No. 4 bearing was found with a heavily scored babbit. This was replaced.

(iv) During test-run of the turbine at rated speed and 110 MW, bearing #5 was vibrating excessively. Horizontal-5.2 mils, axial-5.5 mils.

(v) Vibration was caused by the unbalance in the turbine blades since the diametrically opposite sides of the trimmed-off blades were not cut.

(vi) There is the summary of the blade failure as a result of the magnaflux.

TURBINE END	Broken-off	Cracked	Dented	With Erosion
Last Row	0	1	12	4
2nd to the last row	1	9	32	0
3rd to-the last row	1	0	17	0
Sub-total	2	10	61	4
Generator End				
Last Row	0	3	13	0
2nd to the last row	0	1	2	0
Sub-total	0	4	15	0
TOTAL	2	14	76	4

MEASUREMENTS OF CUT - OFF BLADES

Turbine Side

BLADES	Remaining length in mm.	Remarks
1. Last row		
blade no. 18	334	with crack 346 mm from root
blade no. 47	334	Opposite blade of No. 18
All other blades were previously cut to 425 mm		
2. 2nd to the last row		
blade no. 46		Broke-off
blade no. 8		Opposite blade of.no. 46
blade no. 60	240	Old cut
blade no. 61	240	Old cut
blade no. 26	288	Old cut
blade no. 27	243	Old cut
All other blades were cut to 315 mm remaining length		
3. 3rd to the last stage		
blade no. 4	260	broken
blade no. 10	260	dented
blade no. 11	260	-do-
blade no. 12	260	-do-
blade no. 18	260	-do-
blade no. 19	260	-do-
blade no. 29	260	-do-
blade no. 46	0	Old
blade no. 54	260	dented
blade no. 55	260	-do-
blade no. 56	260	-do-

Generator Side

Blades	Remaining length in mm	Remarks
1. Last Stage		
Blade no. 3	335	With crack 337 mm from root
blade no. 4	335	With crack 352 mm from root
blade no. 22	255	Old cut-opposite of no. 51
blade no. 23	255	Old cut-opposite of no. 52
blade no. 32	355	Opposite of no. 3
blade no. 33	355	Opposite of no. 4
blade no. 51	255	Old cut
blade no. 52	255	Old cut
All others blades previously cut to 425 mm		
2. Second to the last stage		
blade no. 63	300	With crack 311 mm from root
All other blades cut to 315 mm.		
3. 3rd to the last stage		
No blades cut.		

iv. S-2

During overhauling, circular inspection of the last two stages revealed some blades with crack initiation. Magna-flux test on the LP blades was conducted and 69 blades were found with crack all located at hardened leading edge. At the LP - 1 turbine, blade stages with cracks (last two stages at the turbine end and last stage at the generator end) were trimmed to 320 mm for the last stage and 225 mm for the second to the last stage - exactly to maintain balance. Likewise, at the LP - 2 turbine, the last two stages were trimmed correspondingly to the same length.

August 19, 1981

After overhauling the unit was placed back "on-the-line".

December 28, 1981

Between September 10, 1981 and December 25, 1981, the main turbine experienced several cases of excessive vibrations. Chattering of the HP control valve spindle was likewise experienced. During this period, maintenance repair works were made to correct the problem.

However, turbine vibration still persisted even after the balancing of the turbine. The following items were considered which could have caused the vibrations:

(i) Unbalanced turbine

(ii) Damage on bearings

(iii) Damage on other turbine parts

It was finally decided to put again the unit on overhauling as the excessive vibration may badly affect the other turbine parts.

Herewith are the trouble reports of the unit between August 19, 1981 and December 12, 1981.

August 23, 1981

Shutdown caused by de-bugging operation. Replaced HPCV No. 1 valve spindle. Replace worn-out valve spindle of HPCV No. 2.

September 10, 1981

Hunting of HPCV No. 1, No. 2, & No. 4.

September 13, 1981

Unit shutdown due to sudden load dropping from 140 MW to 0. Trouble on the turbine hydraulic governor.

September 19, 1981

Unit placed back "on-the-line"

September 21, 1981

HPCV No. 2 valve spindle strongly chattering.

September 25, 1981

Unit shutdown due to the increase in chloride concentration. During this outage, inspection and repair of HPCV No. 1 and No. 4 was made.

October 8, 1981

Unit placed back "on-the-line". But HPCV No. 2 valve spindle was still chattering strongly and was taken off-service.

October 10, 1981

Unit "off-the-line" due to excessive vibration of the main turbine bearing No. 1. The following major jobs were undertaken.

i. Realignment of CRH header line to the non-return valve which was found misaligned.

ii. Replacement of one beam support rigid hanger in the CRH line.

iii. Checking and adjustment of all constant hangers.

November 1, 1981

Unit place back "on-the-line".

Major observations:

i. HPCV No. 2 chattering was still evident. This was taken off-service.

ii. Turbine vibration on bearing No. 1 still exceeding the allowable limitations.

November 20, 1981

Unit shutdown. Major repairs:

i. The CRH pipe hanger which was adjusted before was returned to the original position.

ii. HPCV No. 1 valve spindle was found broken at the threaded portion.

November 28, 1981

The turbo-generator set was rolled at 3600 rpm but a strong and unusual sound was heard. Turbo-set was manually tripped.

December 12, 1981

The unit was placed back "on-the-line". Turbine vibrations were still above limits.

d. Turbine Auxiliary

(a) Main Condenser

i. G-1

Total No. of tubes : 14,748

No. of tubes plugged as of June 15, 1979: 549

% plugged : 3.72

In the period of overhauling from Oct. 24, 1979 to Jan. 12, 1980, all tubes were replaced with those of cupro-nickel with the original of admiralty.

ii. G-2

Total No. of tubes : 24,400

No. of tubes plugged as of Aug. 4, 1982: 266

% plugged : 1.09

iii. S-1

Total No. of tubes : 24,400

No. of tubes plugegd as of July 25, 1982: 255

% plugged : 1.05

iv. S-2

Total No. of tubes : 34,800

No. of tubes plugged as of June 2, 1982: 58

% plugged : 0.7

(b) LPH

i. G-1

(i) 1-LPH

Total No. of tubes : 509

No. of tubes plugged as of Mar. 23, 1980: 2

% plugged : 0.39

(ii) 2-LPH

Total No. of tubes : 363

No. of tubes plugged as of Jan. 22, 1982: 2

% plugged : 0.55

(iii) 3-LPH

Total No. of tubes : 229

No. of tubes plugged as of Jan. 22, 1982: 16

% plugged : 6.98

ii. G-2

(i) 1-LPH

Good, without any tube leak

(ii) 2-LPH

Total No. of tubes : 539

No. of tubes plugged as of July 24, 1982: 3

% plugged : 0.55

(iii) 3-LPH

Total No. of tubes : 540

No. of tubes plugged as of July 21, 1982: 59

% plugged : 10.9

iii. S-1

(i) 1-LPH

Total No. of tubes : 508

No. of tubes plugged as of July 10, 1980: 1

% plugged : 0.19

(ii) 2-LPH

Total No. of tubes : 539

No. of tubes plugged as of Mar. 7, 1982: 38

% plugged : 7.05

(iii) 3-LPH

Total No. of tubes : 539

No. of tubes plugged as of Mar. 6, 1982: 233

% plugged : 43.2

Whole heater will be replaced during the coming unit overhauling (plan) : '82

iv. S-2

(i) 1-LPH

Total No. of tubes : 835

No. of tubes plugged as of May 14, 1982: 2

% plugged : 0.23

(ii) 2-LPH

Total No. of tubes : 755

No. of tubes plugged as of July 24, 1981: 135

% plugged : 17.8

(iii) 3-LPH

Total No. of tubes : 906

No. of tubes plugged as of May 14, 1982: 12

% plugged : 1.32

(c) HPH

i. G-1

(i) 5-HPH

Total No. of tubes : 440

No. of tubes plugged as of Nov. 6, 1981: 57

% plugged : 12.9

(ii) 6-HPH

No plugging

ii. G-2

(i) 5A-HPH

Total No. of tubes : 633

No. of tubes plugged as of July 10, 1982: 1

% plugged : 0.16

(ii) 5B-HPH

Total No. of tubes : 633

No. of tubes plugged as of May 3, 1982 : 1

% plugged : 0.16

(iii) 6A-HPH

Total No. of tubes : 633

No. of tubes plugged as of Mar. 31, 1982: 40

% plugged : 6.3

(iv) 6B-HPH

Total No. of tubes : 633

No. of tubes plugged as of Aug. 4, 1982: 94

% plugged : 14.3

iii. S-1

(i) 5A-HPH

Total No. of tubes : 633

No. of tubes plugged as of Mar. 19, 1982: 35

% plugged : 5.53

(ii) 5B-HPH

Total No. of tubes : 633

No. of tubes plugged as of 1982 : 46

% plugged : 7.2

Tube bundle replaced during overhauling of March to April, 1977 -- % plugged : 16.74

(iii) 6A-HPH

Total No. of tubes : 633

No. of tubes plugged as of July 25, 1982: 12

% plugged : 5.21

iv. S-2

(i) 5A-HPH

Total No. of tubes : 749

No. of tubes plugged as of Aug. 27, 1982: 295

% plugged : 39.3

Heater was replaced during overhauling of June 26 to August 1979.

(ii) 5B-HPH

Total No. of tubes : 749

No. of tubes plugged as of Aug. 20, 1981: 123

% plugged : 16.42

Heater was replaced during unit overhauling in March 1982.

(iii) 6A-HPH

Total No. of tubes : 707

No. of tubes plugged as of Aug. 28, 1981: 229

% plugged : 32.3

Heater was replaced during the unit overhauling of March 1982.

(iv) 6B-HPH

Total No. of tubes : 707

No. of tubes plugged as of Aug. 28, 1981: 324

% plugged : 45.8

6B-HPH was put off to service as a result of excessive tube leak.

(d) Condensate Pump

G-1-B : Pressure gauge at suction strainer outlet is not provided for condensate pump.

S-1-A & B: Same as above

For the purpose of the inspecting of the clogging-up of suction strainer outlet it is recommendable to fit each one (1) pressure gauge at the inlet and outlet side of it.

(e) Circulating Water Pump

There exist must leaking by pitting at CWP discharge condenser outlet, and patch welding repairs are applied. But, early replacement of the defective part with smaller thickness should be carried out by measuring the pipe thickness. Inspection on the reverse washing valves should be done at the same time.

Circulating Water Pump of G-2-B has been replaced during the overhaul of this time and reverse washing valves have been inspected already.

(f) Auxiliary Cooling Water System Heat Exchanger

i. G-1-A

Total No. of tubes	:	1618
No. of tubes plugged	:	2
% plugged	:	1.79

ii. G-1-B

Total No. of tubes	:	1618
No. of tubes plugged	:	261
% plugged	:	16.3

iii. G-2-A

Total No. of tubes	:	1840
No. of tubes plugged	:	110
% plugged	:	5.79

iv. G-2-B

Total No. of tubes	:	1840
No. of tubes plugged	:	92
% plugged	:	5

v. S-1-A

Total No. of tubes	:	1840
No. of tubes plugged	:	2
% plugged	:	0.10

vi. S-1-B

Total No. of tubes	:	1840
No. of tubes plugged	:	124
% plugged	:	6.73