HPH #5B

This heater has three (3) level control valves namely: BN-18B (HPH #5B to deaerator), BN-18E (HPH #5B LPH #3) and BN-18G (HPH #5B to condenser). BN-18B is isolated by trouble hence this is on manual operation. BN 18-E is on automatic control, BN-18G is isolated by trouble.

HPH #6A

This heater has two (2) level control valves, BN-17B (HPH #6A to HPH #5A) is out of service due to the isolation of HPH #5A. BN-17C (HPH #6A to condenser) is isolated by trouble, hence this is being oeprated manually.

HPH #6B

This heater has two (2) level control valves. BN-17B (HPH #6B to HPH #5B) is isolated by trouble but could be controlled manually. BN-17C (HPH #6B to condenser) is out of service, control is made manually.

iii. M-1 Feedwater heater problems which must be considered

(i) Low pressure feedwater heaters

LPH #1 and LPH #2 has no immediate problem. However LPH #3 has some problems which must be considered. LPH #3 has just been replaced with a new set last July, 1980, but still the problems on tube failure is persistent. This heater has a troublesome condensate drain system.

There are two (2) condensate drain lines entering LPH #3 from HPH #5A and HPH #5B. If these drain level control valves malfunction, LPH #3 will experience pipe hammering and/or by thermal stress by flushover and/or differential temperature between HPH #5A and HPH #5B.

JICA team believes that the cause of tube failure in LPH #3 is caused by any of the above conditions.

(ii) High-Pressure feedwater heaters

HPH #5A has more plugged tubes greater than HPH #5B although these heaters are identically similar. Moreover, the level controller of HPH #5A is in a bad condition than that of HPH #5B.

In HPH #6A and HPH #6B, the same conditions are existing.

iv. Recommendations for feedwater heater tube failure

(i) To repair/replace all drain level control systems of the feedwater heaters at once.

(ii) To maintain the drain level control on fully automatic control operation. However, if the level control will be on manual operation for a short period, an operator must closely monitor and observe the drain level at the site.

(iii) In the event of unit tripping by some accident, and hammering of the feedwater occurs', operators must immediately isolate all extraction lines to the feedwater heaters.

(iv) In the event of replacing old feedwater heaters with a new one, the following conditions on the old heaters must be checked;

* Pull-out or cut samples of the plugged tubes for analysis, of tube failure especially at these points; tube sheet, baffle plates, steam inlet portion and casing.

* Determine the cause/causes of FW heater tube failures. After determining the

cause of tube failure, initiate remedial measures and countermeasures to prevent the recurrence of the same failures.

Maintain a permanent record of the data obtained during analysis and the corresponding recommendations.

v. Countermeasure for tube leakage in feedwater heaters of M-1

Presently, there are plenty of leaky tubes in the feedwater heaters. These tubes had been plugged but still tube leakage could occur anytime. NAPOCOR already replaced two sets of feedwater heaters since the unit was commissioned. Again these same heaters have experienced tube leakage to an alarming degree such that NAPOCOR may have to replace them again in the near future.

JICA team found out that there were no analysis report on the cause of tube failures in the feedwater heaters. Normally, whenever NAPOCOR replaces a damaged feedwater heater a thorough analysis must be made to determine the root cause of tube failure. This way, the correct countermeasure will be formulated to prevent tube failure.

JICA team would like to propose a countermeasure on feedwater heater problems which JICA team had experienced. We had experienced leakage

of many tubes at the feedwater inlet part, causes of which are as follows:

(i) Eddy current of the feedwater which occurs at the feedwater inlet in the water box.

(ii) High velocity of feedwater in the tubes and solid matters in the feedwater.

(iii) Material of the tube and method of preservation to prevent corrosion during unit shutdown.

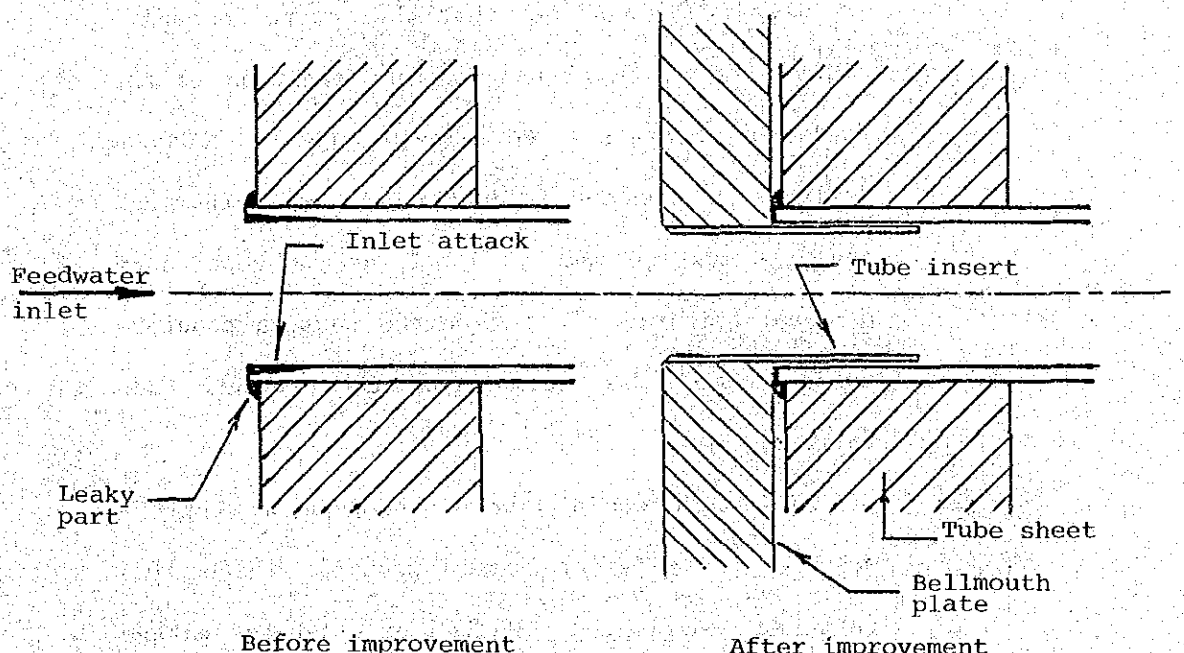
(iv) pH, temperature, and dissolved oxygen of feedwater

Countermeasure of these causes are as follows:

CASE A.

A straightening vane of the bell-mouth type and stainless steel insert in the feedwater inlet of tubes are installed sometimes.

Fig. 5M-38 COUNTERMEASURES FOR FEED WATER HEATER LEAKAGE



CASE B.

To maintain the pH value of the feedwater at 9.2.

CASE C.

To preheat the feedwater in the deaerator by auxiliary steam during unit start-up.

CASE D.

Method of preservation of heaters during unit shutdown. For a short term shutdown (few days) - fill the heater shell (steam side) with auxiliary steam. For a long term shutdown - fill the heater shell (steam side) with nitrogen.

(e) Heat Exchangers

i. Analysis of M-1 (Figure 5M-39)

(i) The total number of plugged tubes are few. For the A-side there are 10 pcs. (0.49%) plugged tubes while for the B-side, there are 16 pcs. (0.78%) plugged tubes as of May, 1982.

(ii) Since Feb. 1981, the rate of the number of plugged tubes has increased gradually. Hence inspection of the heat exchangers must be carried out occassionally.

(iii) In M-1, two (2) 100% capacity Heat Exchangers are in service. If trouble occurs in the existing set-up, the unit will be forced shut-down, as there are no more spare heat exchanger. However, if additional heat exchanger is installed, a spare heat exchanger would be available.

ii. Analysis of M-2 (Figure 5M-40)

(i) As of June 1982, M-2A has 696 pieces (19.06%) total of plugged tubes.

(ii) As of Sept. 1982 M-2B has 67 pieces (1.835%) total of plugged tubes.

(iii) On M-2C the total no. of plugged tubes are 55 pieces (1.506%).

(iv) M-2A has the most number of plugged-tubes. This is one of the causes in using this heat exchanger continuously.

These heat exchangers must be serviced on a rotation basis. When NAPOCOR conducted tube plugging on the B and C side, JICA team found out that there were plenty of rust on the tube sheets, some deep corrosion of the tube sheet, and plenty of clogged-up tubes by foreign matters.

iii. Countermeasure of maintenance work for heat exchangers

When tube-plugging job is carried-out, the following method must be followed:

(i) To clean all heat exchanger tubes with compressed air-jet.

(ii) To drain the shell side of cooling water.

(iii) To remove rust on the tube sheet by wire brush.

(iv) Inspect tube sheet for excessive corrosion.

(v) To weld and patch-up all corroded portion.

(vi) To conduct hydrostatic-test.

(vii) To plug all leaky tubes.

(viii) To repaint tube sheet.

iv. Recommendations

(i) To provide a new heat exchanger with a bigger capacity unit for M-1. In M-1, two heat exchangers are in service since 1975 when the unit was placed in commercial operation. The capacity of the heat exchanger is insufficient. When one unit is in service, vibration and rumbling sound is experienced.

(M-1)

If trouble occurs, with the existing set-up, the unit will be on forced shut-down. There is no spare heat exchanger. But if

NAPOCOR has a spare heat exchanger with a bigger capacity unit, one unit can be placed in repair work.

(ii) To replace by-pass valve of level control valve of the house service water head tank for M-1 with a new set. (M-1)

This by-pass valve has sheared-off valve stem. Operator could not use by-pass valve during emergency situations.

(iii) To repair the level controller as soon as possible and place it on automatic control function. (M-2)

(iv) To repair the flow meter and record quantity of make-up water in the operators daily log sheet. This record will help monitor the quantity of make-up water, in case the quantity rises, the possibility of tube failure in the heat exchanger could be easily detected. (M-1 & M-2)

Fig. 5M-39 CONDITION OF PLUGGED TUBES OF HOUSE SERVICE CLOSE CYCLE HEAT EXCHANGER FOR M-1

(Number of Tube 2040)

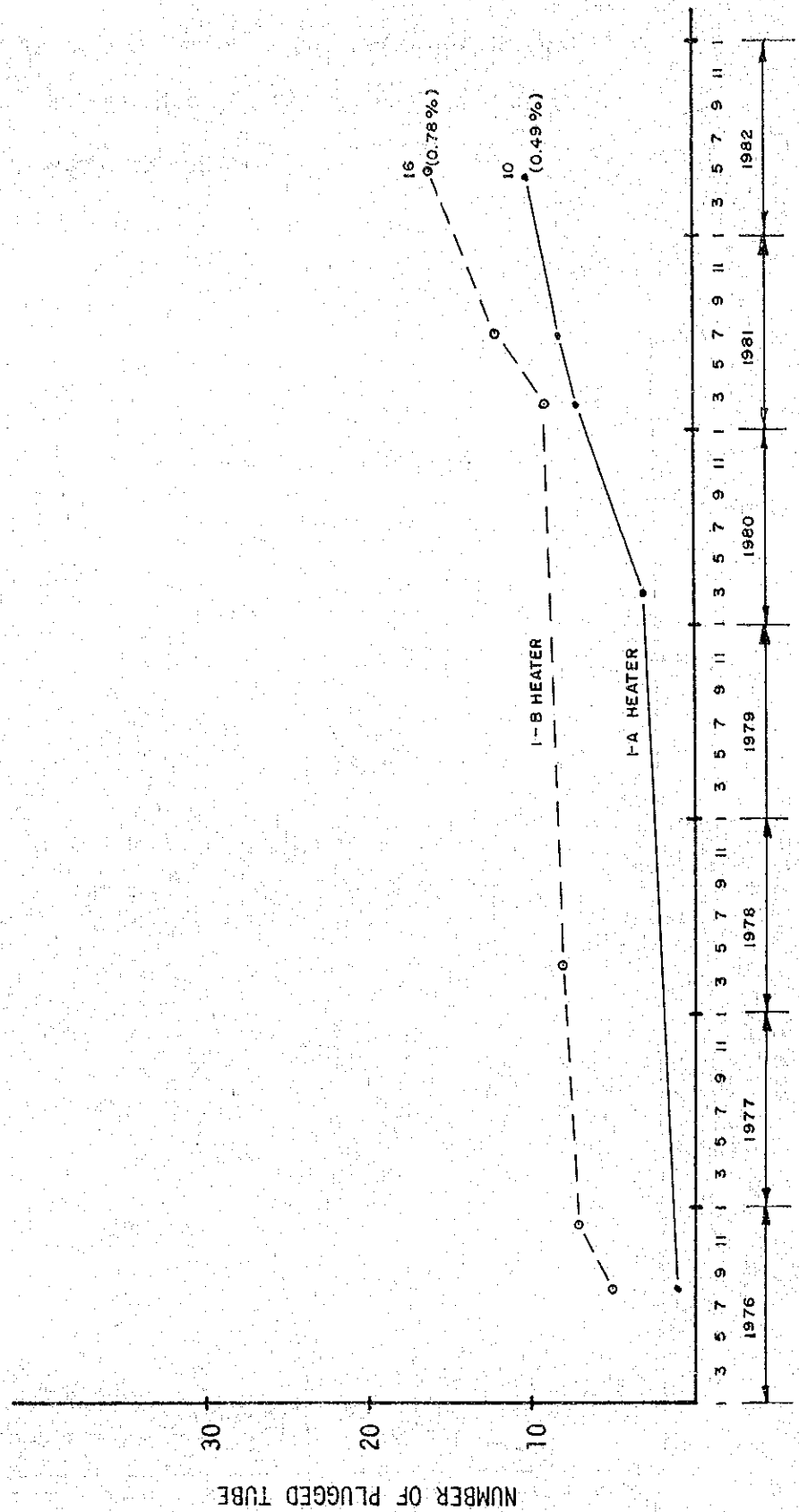
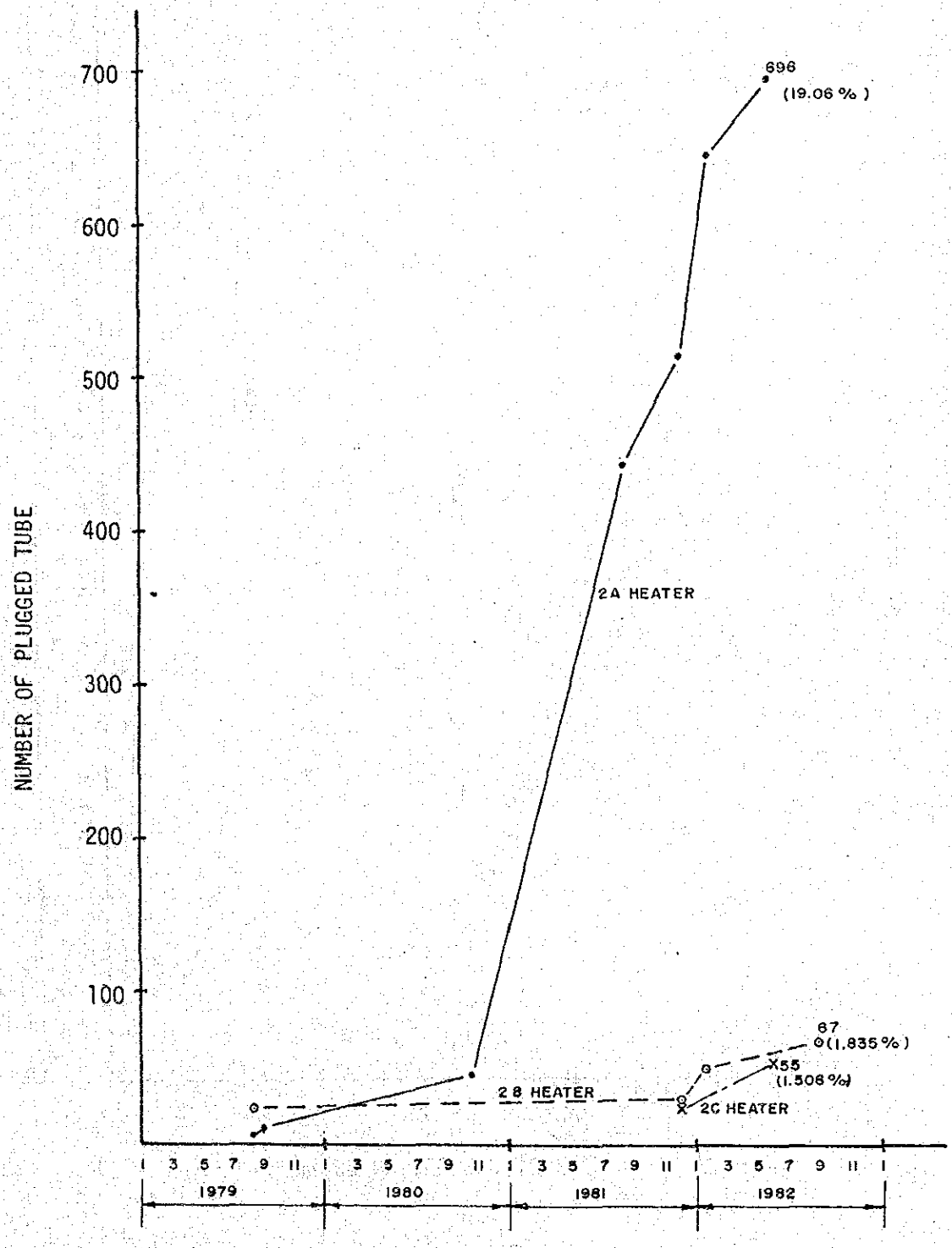


Fig. 5M-40 CONDITION OF PLUGGED TUBES OF HOUSE SERVICE CLOSED CYCLE HEAT EXCHANGER FOR M-2



e. Generator

M-1

Generator is apparently running in good condition now but hydrogen pressure is raised up to 60 psig from 45 psig designed pressure according to manufacturer recommendation and hydrogen temperature is around 46°C to the design temperature of 40°C. According to the report by manufacturer, hot spots at core end were found during last annual overhauling and installation of under excitation limiter are recommended by KWU. Detailed report is mentioned at section 5.3.1 1).

Hydrogen gas consumption is 2 bottles a day and this is seemed too high.

H2 gas drier is not in service.

Recommendations:

(a) To perform detailed inspection during annual overhaul with manufacturer's engineer.

(b) To operate in lagging power factor (rated power factor 0.9) within the range of new capability curve.

(c) To maintain the hydrogen purity as high as possible.

(d) To decrease cooling water temperature by installation of new heat exchanger and to clean hydrogen gas cooler.

(e) To perform routine test of seal oil back-up system strictly.

(f) To put H_2 gas dryer into service.

(g) These recommendations are based only on outside observation, the internal problem such as insulation of coil and hot spot on the core end should be discussed with the manufacturer, in order to find countermeasures.

Remarks:

Item (a), (c), (e) and (f) of the above recommendations are applied to M-2 unit.

f. Control and Instrumentation

(a) Automatic Boiler Control System

i. Present Condition of M-1 Unit

Automatic control system of boiler is being operated in manual position since after about two months from last annual shutdown, February 22, 1980 - July 9, 1980 due to occurence of hunting in the feedwater control system.

Fine tuning and calibration were performed by Siemens Engineers and plant control engineers during the last annual shutdown, then the automatic control system had been put into automatic operation but after two months of operation hunting occurred in governing system of the turbine driven boiler feed pump so that all controllers were put into manual position. Ever since, the automatic boiler control system has not been put into automatic operation.

(i) Feedwater Control System

Regarding the governing system of T-BFP, the following phenomena are reported by operator.

* Governing valve has slow response in manual operation
* There was hunting in automatic operation
* In order to avoid hunting, start-up device is around 70% opening and speed adjusting

device is around 30% but on normal procedure, start-up device should be 100% then the speed adjusting device should be adjusted for more opening of control valve.

(ii) Air Flow Control System

A-side flow transmitter has been defective and now waiting spare part delivery and control inlet vane has slow response in automatic operation.

(iii) Steam Temperature Control

Air leaks from controller's connections were found and fixed already and it has been tried to put into automatic operation but since feedwater control is hunting, so it is not put into automatic operation. Automatic operation also has not been experienced on gas recirculation control and reheater spray control.

(iv) Fuel Oil Flow Control

Differential type transmitter ranged to 250,000 lb/h is provided actual flow of 159,030 lb/h which seemed to be that if low load operation below 40% of MCR is required, this transmitter feedback signal is not

sufficient especially on accuracy for automatic operation.

Slow feedback signal from the actuator and no feedback signal from the actuator in automatic circuit are considered as causes of difficulty in automatic operation.

(v) Tuning of Feed Forward Signal

Static feed forward signal apparently has much difference between ideal conditions and existing conditions which are noted because there are many defective parts such as boiler being now under reduced pressure operation, turbine which has damaged on low pressure stage blade and isolated feedwater heater.

ii. Recommendation to Automatic Boiler Control of M-1

Maintenance works to be carried out during annual shutdown should be performed as indicated in Appendix 4 but, peculiar problem to be performed for M-1 unit are as follows:

(i) Feed Water Control System

To be overhauled regarding to the governing system and control valve of turbine driven boiler feed pump with Siemens Engineer(s).

(ii) Air Flow Control System

* Replacement of "A" side air flow transmitter
* Overhauling of vane drive system including hydraulic unit

(iii) Steam Temperature Control System

Overhaul of control valves.

(iv) Fuel Oil Flow Control

Overhaul of fuel control valve.

(v) After Overhauling

The characteristic curve should be taken during actual start-up operation for such items as air flow, feed water flow, fuel oil flow, steam temperature of each output of the unit so as to adjust feed forward signal in the static conditions and then the automatic control system should be put into dynamic response test.

iii. Present Condition of M-2 Unit

Automatic boiler control system is now put on the automatic position inspite of reduced pressure operation.

Previously, feedwater control system was on manual operation due to drum level transmitter is defective and there were occurence of drum level low trip sometimes. After taking the countermeasure recommended by utiility consultant

team (hereinafter refered to as UTL team) dispatched from Japan during July 12, - Aug. 26, 1982 now the feedwater control system is maintained in automatic operation.

Recommendation of UTL team is described later and it is reasonable method and similar method is performed in the recent power plant.

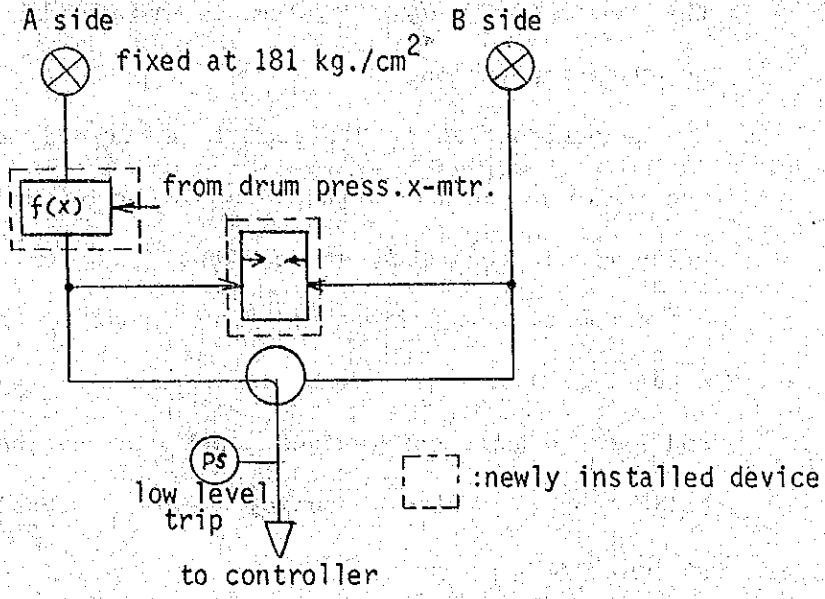
Automatic operation is carried out in good condition, but this system is a pneumatic type, and so proper maintenance such as overhaul, calibration, fine tuning are required periodically.

Automatic operation of gas recirculation control has not been experienced ever since, but these systems also should be tried into automatic operation after fine tuning.

iv. Recommendation to M-2 Automatic Boiler Control System

This system will be operated successfully in future on condition that proper maintenance such as the overhaul and adjustment/fine tuning especially on the final control element (control valve, actuat etc.) and detecting means (sensor, thermocouple etc.) are given the prioiry.

Fig. 5E-31 COUNTERMEASURE FOR DRUM LEVEL TRANSMITTER RECOMMENDED BY UTL TEAM



B side has now no response, therefore it also has to be modified same as A side.

(b) Local Control

i. Present Condition

Almost all local level control systems and some pressure controllers are not working in M-1 unit and several systems in M-2 unit.

Especially heater level controllers are very important in order to protect heater from tube leak, so they must be fixed immediately.

And also auxiliary steam control should be fixed, as defective control causes air heater clogging.

Spare parts of almost all controllers and control valves are being under procurement process however it takes long time to get spare parts, the longest time is already seven months past, and the equipment are apparently being affected during waiting and delivery period.

ii. Recommendation for Local Control

(i) Recommendations for M-1 local controllers are as follows:

* To replace all the feedwater heater level controllers with another type which is preferably used by NAPOCOR and to fix/replace associated control valve.
* To replace the deaerator and the hot well level controller with new type.

* To replace or fix the hot well level control valve which has much vibration during startup but there was no vibration in the initial commercial operation, and to fix the inlet isolating valve which may have seat leak.
* To replace or fix auxiliary steam controllers and control valve.

(ii) Recommendations for M-2 Local Control

To fix/replace all the local control systems especially auxiliary steam pressure control, steam coil AH steam control and drain system controls as soon as possible.

(iii) Recommendations Common to M-1 and M-2

* To replace or fix the other defective controllers shown on attached table.
* To provide metal tags on which name and device number are engraved, for all instrument, controllers and control valves.
* To install non return valve on the control air back-up line prior to put the back-up control valve in service.
* To improve purchasing system to get early delivery of ordered parts.

* To proceed procurement of necessary spare parts in anticipation to proper maintenance based on past experience.

M-1 PRESENT CONDITION OF LOCAL CONTROLS (Sept. 1982) No.1

Name of System	Controller	Control Valve	Remarks
No. 6A heater drain control	BN-17a level controller was already overhauled and calibrated Leaking in flange connection	6A - 5A BN-17b control valve, OK but there's a leak on isolating valve 6A)) - condenser 6B) BN-17b control valve OK	HPH No. 5A not used Manual operation
No. 6B heater drain control	BN - 17a same as above malfunctioning leaking in flange connection	6B - 5B BN-17b Control Valve OK	same as above
No. 5A heater drain control	BN - 18a controller removed	5A - Dea BN-18b No positioner available 5A - 3 BN-18f control valve OK 5A - cond. BN-18g control valve OK	HPH No. 5A not used W & K level controller P.R. No. 2059 Date Prepared: 1-13-82 Honey Well positioner P.R. No. 2072 Date Prepared: 1-22-82
No. 5B heater drain control	BN - 18a overhauled and calibrated OK	5B - Dea BN-18b No positioner available 5B - 3 BN-18e OK 5B - Cond BN-18g OK	Manual operation due to defective sight glass and control valve positioner Honey Well position P.R.MMRC No. 2072 Date Prepared: 1-22-82

M-1 No. 2

Name of System	Controller	Control Valve	Remarks
Hotwell level control (Normal)	BN - 24a Defective level controller	Cond - Dearator BN-66b Vibration in low load operation Recirculation Control Valve OK	Remote Manual Operation due to defective level controller W & K level controller P.R. No. 2059 Date Prepared: 1-13-82
Dearator level control (Spill over)	BN-66a Deffective controller	Cond - Cond str TK BN - 24b (3-9) BN - 52 (9-15) Control Valve OK	Remote Manual Operation same as above
No. 3 heater level control	BN - 19a Overhauled and Re-calibrated OK	#3 - #2 healer BN-19b control valve OK 3 - Condenser BN-19d control valve OK	Manual operation HTR #3 level keeps on raising level though the 3-2 CV is already fully open
No. 2 heater level control	BN - 20 overhauled and Re-calibrated OK	#2 - #1 heater BN - 20b control valve OK #2 - condenser BN - 20e control valve OK	On automatic operation but no fine tuning because of level gage defective.

M-1 No. 3

Name of System	Controller	Control Valve	Remarks
No. 1 heater drain control	BN-21a overhauled and re-calibrated OK	#1 - cond. / BN-21b control valve OK	Manual Operation
Deaerator level control	BN-66a No level controller available	condensate storage tank	Remote Manual operation due to defective level controller.
		condenser 2 set BN-24b(3-9) BN-52 (9-15) control valve OK	W & K level controller PR No. 2059 Date prepared: 1-13-82
	BN-23a No level controller available	spill over BN-23b	
		Not used	

M-1 No. 4

Name of System	Controller	Control Valve	Remarks
Fuel oil Tank No. 1 Bottom heater Temp. control	Temp. control OK	BN-79b OK	Manual operation copper tubing needs replacement due to oil contamination P.R.for copper tube #2714 Date prepared: 4/6/82
Fuel oil tank No. 1 Suction heater Temp. control	OK	OK	- same as above -
Fuel oil tank No. 2 Bottom heater temp. control	OK	BN=134b OK	- same as above -
Fuel oil tank No. 2 Suction heater Temp. control	OK	OK	- same as above -
Fuel oil tank No. 3 Bottom heater temp. control	OK	OK	- same as above -
Fuel oil tank No. 3 Suction heater temp. control	OK	OK	- same as above -
Pressure control for F O B P	BN-142a OK	BN-142b OK	on automatic operation

M-1 No. 5

Name of System	Controller	Control Valve	Pemarks
Fuel oil temp control	diffective ball gage balance detector	OK	Manual operation P.R.for Taylor cont'r -P.R.#MMRC:2071 Date Prepared: 1/22/82
Drip tank level control	BN-29a malfunctioning leaking in flange connection	BN-29b OK	Manual operation P.R.#MMRC - 2059 Date prepared: 1/13/82

M-1 No. 6

Name of System	Controller	Control Valve	Remarks
Auxiliary steam pressure control	BN-38 OK BN-39 OK	from CRH Seat leaking from flash tank OK	Manual Operation On auto during start-up
Deaerator heating steam press. control	BN-34c OK	CV-105 OK	On automatic during start-up
Air heater average temp. control	need fine tuning	OK	Manual operation controller to be fine tuned on long shut down
Steam air heater drip tank A level control	no controller (removed)	OK	Manual operation P.R. for controller #2059 Date Prepared: 1/13/82
Steam air heater drip tank B level control	No controller (removed)	OK	Manual operation P.R. #2059 Date Prepared:1/13/82

M-1 No. 7

Name of System	Controller	Control Valve	Remarks
steam coil air heater steam press. control valve	OK	- packing leak - valve positioner malfunctioning	Manual operation P.R. # 2072 Date Prepared: 1/23/82
Fuel oil tank and fuel oil heater steam temp. control	BN-32 OK	- isolating valve leaking thru seat - valve leaking thru packing - positioner malfunctioning	Manual operation P.R. #2072 Date Prepared: 1/23/82

M-1 No. 8

Name of System	Controller	Control Valve	Remarks
House service water temp control	no controller	A side OK B side OK	Manual operation valve positioner to be replaced by Bailey type P.R. # MMRC 2215 Date prepared:2/8/82 valve positioner to be replaced by Bailey type P.R. 2215 Date prepared: 2/8/82
House service water diff. press control	under overhauling	Butterfly valve	Manual operation - butterfly valve needs replacement
Generator H_2 cooler control valve	No controller in the Design	OK	Remote manual from the control room.

M-1

No. 9

Name of System	Controller	Control Valve	Remarks
control air emergency back-up system	deffective	OK	P.R.# 2073 Date Prepared: 1/22/82

M-2 PRESENT CONDITION OF LOCAL CONTROL Sept. 1982

No. 1

Name of System	Controller	Control Valve	Remarks
No. 7 heater level control	LC BN-6a Level Controller OK	No. 7 - No. 6 / BN-6B Control Valve OK	On... Automatic Operation
	LC BN-6a Level Controller OK	No. 7 - No. 5 / BN-6C Control Valve OK	On Automatic Operation
No. 6 heater level control	LC BN-7a Level Controller OK	No. 6 - No. 5 / BN-7b Control Valve OK	On Automatic Operation
	LC BN-7a Level Controller OK	No. 6 - Dea / BN-7c Control Valve OK	On Automatic Operation
No. 5 heater level control	LC BN-8a Level Controller OK	No.5-Dea x 2 set / BN-8b x 2 set Control Valves OK	On Automatic Operation
	LC BN-8a Level Controller OK	No. 5 - No. 3 / BN - 8e Control Valve OK	On Automatic Operation
	LC BN-8a Level Controller	No. 5 - Cond. / BN - 8g Control Valve OK	On Automatic Operation

M-2 No. 2

Name of System	Controller	Control Valve	Remarks
Deaerator level control	Transmitter OK Controller OK	CP - Dea OK CP - Cond (Recirc.) OK	On Automatic Operation
No. 3 heater level control	LC BN-9a Level Controller OK LC BN-9a Level Controller OK	No. 3 - No. 2 BN - 96 Control Valve OK No. 3 - Cond BN - 9c Control Valve OK	On Automatic Operation On Automatic Operation
No. 2 heater level control	 LC BN-10a Level Controller OK	No. 2 - No. 1 #1A #1B No. 2 - Cond BN-10d Control Valve OK	LPH No.2 - 1A & 1B On automatic and little opening of by pass valve On Automatic Operation

M-2 No. 3

Name of System	Controller	Control Valve	Remarks
No. 1A heater level Control	Hi LC BN-11a Level Controller OK	No.1A - Cond BN-11b Control Valve OK	On Automatic Operation
	Lo LC BN-11a Level Controller OK	No. 1A - Cond BN-11b Control Valve OK	On Automatic Operation
No. 1B heater level control	Hi LC BN-11a Level Controller OK	No. 1B - Cond BN-11b Control Valve OK	On Automatic Operation
	Lo LC BN-11a Level Controller OK	No. 1B - Cond BN-11b Control Valve OK	On Automatic Operation
Cold drain tank level	LC BN-61a Level Controller OK	Cold drain tank Condenser BN - 61b Control valve OK	On Automatic Operation

M-2 No. 4

Name of System	Controller	Control Valve	Remarks
Hotwell level control	OK	Cond.Stor.Tank Cond. 2 set OK	On Automatic Operation
Hotwell level control (spill over)		CP-Cond.stor.tank OK	On Automatic Operation

M-2 No. 5

Name of System	Controller	Control Valve	Remarks
House service raw water	M/A OK TC BN-70 No Sensor	R.W.P - Heat Exc.	- Controller needs fine tuning on - Manual Operation
Oil cooler temp control	M/A BK-7C Fine Tuning	Oil cooler inlet valve BK-nd OK	- H/A needs fine tuning - Manual operation
House service water head tank level control	BN-62a (no response) fine tuning	Condensate P. Head tank BN62b OK	Manual Operation Manual
BFP-Lube oil coolers temp. control	BK-8c fine tuning	Oil cooler outlet valve BK-8d OK	H/A station and electro-pneumatic controller need fine tuning (very difficult to fine tune)

M-2 No. 6

Name of System	Controller	Control Valve	Remarks
Soot blower steam press. control	PT PC OK	CU-8 OK	On autmatic Operation
Soot blower drain control valve	-	Drain valve (CB-10A) OK	On automatic operation

M-2 No. 7

Name of System	Controller	Control Valve	Remarks
Steam coil AH press. control	BN-64a	BN-64b	- controller needs fine tuning - Manual operation
Auxiliary steam press. control (header)		Primary SH - Aux. Steam header (control valve was replaced but cannot be close when there is aux. steam press)	- by pass -
Auxiliary steam press. control (to fuel oil heater)	BN-67a OK	BN 67b OK	on automatic operation
Auxiliary steam press. control (to Burner)	BN-77e Overhauling going-on	BN-77b - by pass -	- controller needs fine tunning - by pass -
Burner steam temp control	BN-77g OK	BN-77d OK BN-77c OK	On automatic operation

M-2 No. 8

Name of System	Controller	Control Valve	Remarks
Air heater inlet air temp. control	OK	SCAH inlet "A" side OK S. CAH inlet "B" side OK	Manual Operation due to steam coil individual isolating valve out of service.
Steam coil AH Drain tank	overhauling going on	To FWH No. 2 Calibration - going on To condenser calibration going-on	Manual Operation
Aux steam to tank farm	BN-66b Overhauling going on	BN66a Overhauling going on	under overhauling

M-2 No. 9

Name of System	Controller	Control Valve	Remarks
Instrument air back-up from station air	-	Station air	This valve should be on Auto, after installation of check valve
	None (direct control)	Control air	
		Isolated	

M-2 No. 10

Name of System	Controller	Control Valve	Remarks
Condensate storage tank No. 3 level control	BN-14a OK	Tank inlet valve (BN-14b) - by pass -	Manual operation due to oil contamination, copper tubing needs replacement P.R. # 2714 Date prepared 4/6/82
Condensate storage tank No. 4 level control	BN-97a eversince no controller	Tank inlet valve (BN-97b) OK	- by pass -

(c) Instrumentation

The following are found in instruments.

i. M-1 unit

(i) Oxygen recorder had been out of order but a defective summing module was replaced and it is put into operation now.

(ii) pH recorder is not working because no sensor available which is under procurement process.

(iii) Conductivity 6-point recorder is not in service, except the condensate pump discharge water, and necessary sensors are under procurement process.

(iv) Turbine driven boiler feed pump bearing temperature recorder is not in service because no sensors available.

(v) Superheater steam temperature after attemperator has no indication due to defective measuring resistance which is under procurement process.

ii. M-2 Unit

(i) Boiler feed pump bearing temperature recorder is not in service due to stepping relay in the recorder is defective and which is under procurement process.

(ii) Oxygen recorder is not in service which sensor bailey OJ type same as that of M-1 is now under procurement process.

(iii) Two sets of recorders, two sets dissolved oxygen recorders and one set hydrogen recorder are not in service due to defective printer motor which has been already ordered in December 1981 but has not arrived yet.

iii. M-1 and M-2 Unit

(i) Almost all local instrument such as pressure gage and temperature indicator are out of order.

(ii) There are no recorders of turbine speed/cam angle, condensate flow, condenser vacuum, generator output.

(iii) There are no make-up water flow integrator and well water supply integrator.

(iv) There was main fuel oil pump tripping after a few minutes from tank change over, because there seems to have suction filter clogging due to insufficient pipe line temperature.

iv. Recommendations

(i) All instruments installed in this plant are necessary in order to maintain the system in good condition therefore these instruments must be repaired hastily, even though under procurement, deterioration of equipment may be now under progress due to unsatisfactory condition of the plant.

(ii) The turbine speed/cam angle, generator output, the vacuum and condensate flow recorder should be installed on the control panel for the monitoring during start-up and normal operation.

(iii) The flow integrator for make-up water line and well water supply should be installed for management of water quantity.

(iv) To install condenser leakage detector (conductivity meter with cation pass) for both condenser of M-1 and M-2.

(v) To install temperature monitoring and alarming recorder on the line indicated below, and sensor should be put on the outside pipe every 50 m.

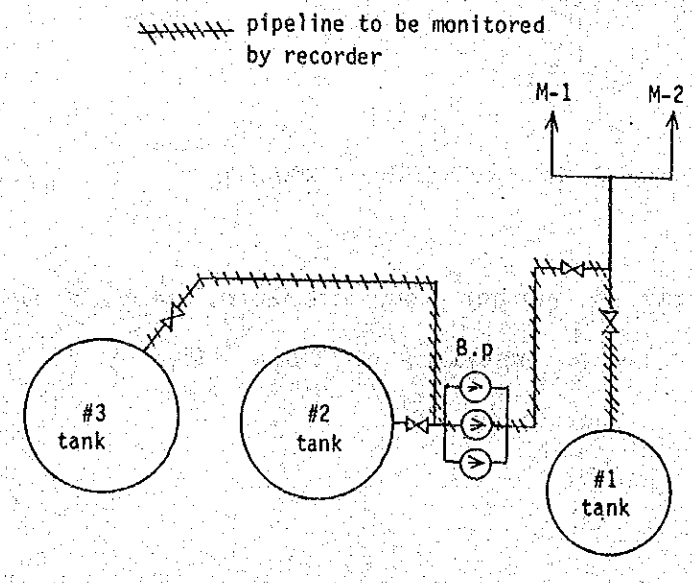


Fig. 5E-32 INSTALLATION OF TEMPERATURE RECORDER

(vi) To replace or repair the defective local gage such as temperature gage, pressure gage, level gage, sight flow, flow integrator etc.

(d) Burner control system

i. Present conditions of M-2 burner control

(i) All flame detectors have been out of order.

(ii) Countermeasures for overheating and lens misting were taken an follows but result was not satisfactory for continuous monitoring.

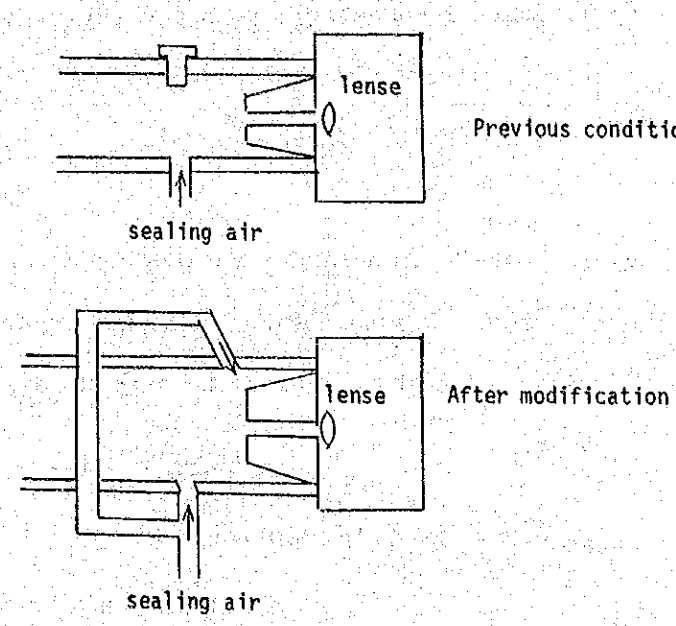


Fig. 5E-33 MODIFICATION OF COOLING

(iii) As another countermeasure, by-pass switches were installed of flame detector for burner control system.

(iv) Control module is defective sometimes due to IC damaged therefore manual operation which operate almost valve directly were installed A-b, A-2, A-3, B-1, burners.

ii. Recommendations:

(i) All burner control systems including flame detector should be inspected in detail with manufacturer's engineer(s) and necessary countermeasure should be taken completely.

(ii) Cooling air system should be reviewed including capacity of flame scanner fan because air heater clogging increases furnace pressure high and less cooling air to flame detector.

(iii) Remaining eight burner cells should be provided with manual operation switches.

(iv) For the time being, flame detector should be used for alarm only until everything is repaired/improved.

(e) Interlock System

The following interlocks are defeated:

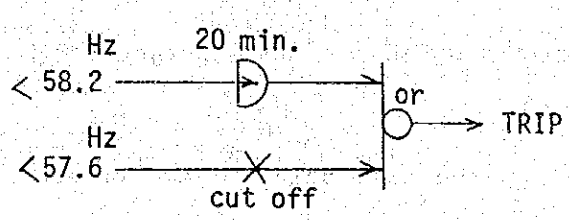
i. M-1 Unit

(i) Economizer inlet pressure low trip to be set at 2480 psig is defeated due to reduced pressure limited to 2100 psig at turbine inlet.

(ii) HP heater level high trip is defeated due to HP heater leaking.

(iii) LP heater level high trip is defeated in order to avoid faulty action caused by vibration.

(iv) Under frequency relay is defeated to extreme low frequency.



ii. M-2 Unit

(i) Drum level low trip circuit has cut-off switch to avoid faulty trip due to drum level transmitter is defective but now the level transmitter is stabilized so that the trip circuit is serviceable.

(ii) All flame failure and burner lighting delay trips are defeated because of unreliable flame detector.

(iii) Under frequency relay is defeated as same as M-1.

iii. Recommendations

M-1 Unit

(i) Economizer inlet pressure low trip should be put in service at reduced pressure setting by manufacturer recommendation because that the M-1 boiler has probability of tube failure due to thinning of tube thickness.

(ii) HP heater level high trip should be in service after replacement of heater and also LP and HP heater level switches which are recommended to use micro switch type to be more reliable, easy setting and strong against vibration.

(iii) Protection for system black-out should be initiated by load shedding system.

If there is something wrong in the load sheding system, other inadequate system should be improved first even if there are more difficulties encountered.

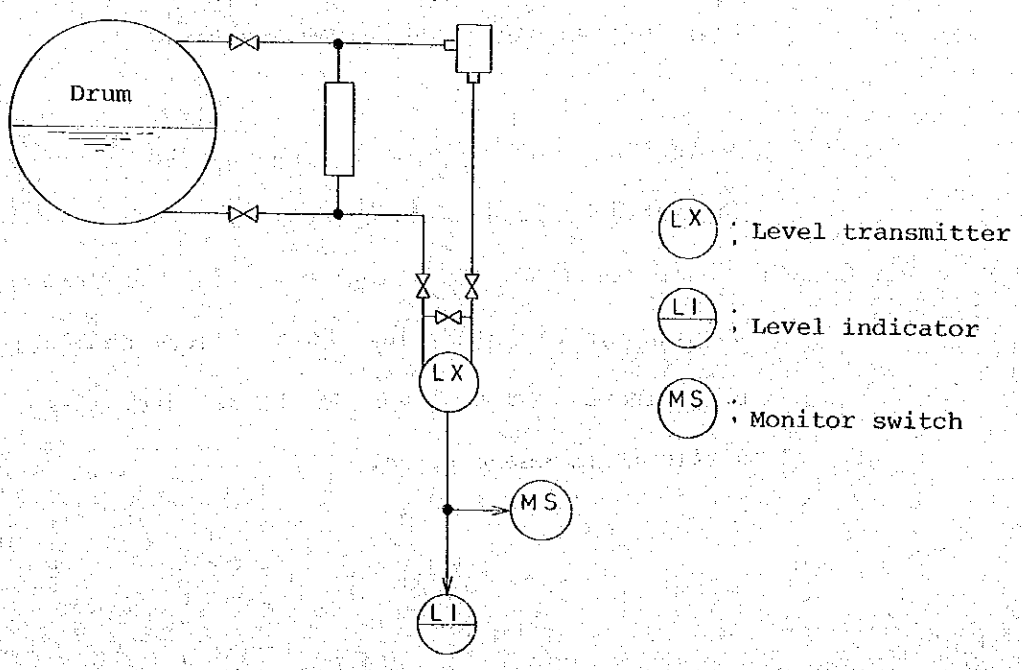
If turbine is damaged, more longer power generation will be lost instead of short time black-out.

Substantial countermeasure should be taken.

M-2 Unit

(i) Regarding drum level low trip. Ideally, the switch must be provided in the drum level detecting line, not on the transmitter signal line, but level switch is not available for high pressure steam vessel, theefore, another electrical level transmitter for trip interlock and indication should be recommended to be installed as follows:

In this case power source of transmitter and relay circuit for trip interlock should be one circuit to avoid faulty operation during power failure.



Common to M-1 and M-2

(i) All mercury type switches for level, pressure, temperature sensor should be replaced with micro switch type in order to avoid faulty operation due to vibration and to get correct setting easily.

(ii) First out indicator which indicates the first cause of unit tripping should be provided for each unit. Details are shown in the section 5.3.1 1).

(f) Improvement of Environmental Condition of Control Equipment

i. Central Control Room and Relay Room

Temperature of relay room is maintained in good condition but found some breaks of cable seal. These must be covered so as to reduce burden of airconditioner. In the control room, however, the temperature is rather higher than the relay room. There is a need of additional airconditioner in the central control room, with duct works so as to induce fresh air.

ii. Local Equipment

Local control equipment are suffered by flue gas leak from gas duct and dust. Gas leak should be repaired and plant should be cleaned up. Also ventilation system should be put in service, now almost all of them are out of order.

(g) Installation of Furnace Monitoring Television

Installation of furnace monitoring television is recommended in order to monitor the firing condition especially during the start-up or low load operation for M-1 and M-2 units.

g. Station electrical system

(a) Main transformer

i. There are oil leak from 115 KV side bushing flange of M-1 and from oil pump flange of M-2 main transformer.

ii. Silica-gel for conservator breathers for M-1, M-2 have no effect because the colour of those are already changed to pink.

iii. Lightning arrester of 230 KV circuit had been damaged two time for M-1 and once for M-2, and there are no damage on the lightning arrester located at outlet of transmission line and 115 KV side of transformers. This power plant is located close to Laguna Lake which is fresh water lake so that salt contamination is not considered. All lightning arresters of 230 KV side transformer were replaced with Ohio brass lightning arrester rated 192 KV.

iv. As main transformer of M-2 unit is used also as system tie transformer, system conditions should be considered before the shutdown of the thermal plant, specifically for maintenance of main transformer. Power plant to be shut down should have a clearance from system operation department for isolation of the main transformer for maintenance.

v. There is mis-alignment between the isolated phase bus and main transformer bus duct for M-1 unit

Recommendations:

i. Oil leaks of transformer should be repaired.

ii. Silica gel of breather should be replaced with new one.

iii. As to countermeasures for the lightning arrester please refer to the attached sheet. "230KV lightning arester for the main transformer"

iv. Tie transformer should be provided between 230 KV and the 115 KV substation in the future for a more reliable system.

v. To check connection of the isolate phase bus duct and main transformer of M-1 whether there is tensile force on flexible joint or not. If there is tensile force, alignment of the bus duct should be adjusted.

(b) Station service system

i. M-1 & M-2 4160V, 480V power supply system

(i) Some spares of motor starting unit of control center are being defective.

Inside motor control center is very dirty.

(ii) Temporary shades are provided on motor control center to cope with rain leak.

(iii) Ambient condition of 4160V/480V power center transformer is very hot.

Recommendations:

(i) Even spare unit, they should be on perfect condition because they can be used it another circuit breaker is defective.

(ii) Overhaul of 4160V and 480V switchgear should be carried out with manufacturer engineer to transfer maintenance technology to maintenance group of NAPOCOR.

(iii) Overhauling of contactor, cleaning inside panel, tightening terminal of motor control center should be performed during annual shutdown.

(iv) Building should be repaired especially roof drains, immediately.

(v) Ambient condition of power center transformer is very hot so ventilation fan should be given preventive maintenance to maintain good condition.

ii. DC Supply equipment

M-1 Unit

(i) Electrodes are bended and some flakes are found at the bottom of cells.

(ii) 2 cells were replaced with new one, recently, due to solution specific gravity below normal condition.

(iii) It is considered that the above phenomena indicate end of life of batteries coming within a few years.

M-2 Unit

(i) New batteries are now under installation.

Recommendation:

All batteries of M-1 should be replaced during next annual shutdown after M-2 battery station is commissioned.

iii. Emergency diesel generator

Common to M-1 & M-2

(i) Manual starting test is carried out every week.

(ii) There is no automatic start.

Recommendation:

Automatic start and automatic changeover of power circuit should be provided as soon as possible, because there will be many difficulties for operation when black out occurs at night.

iv. Motors

M-2

(i) Constant differential fuel oil pump cannot be operated due to overload and high bearing oil temperature.

(ii) Motors are overhauled every annual shutdown.

(iii) It was observed that Motor of T-BFP booster pump was overhauled on September 4, 1982 due to excessive noise and high temperature rise and flaking of roller bearing was found and those were replaced.

There are some problems found on repairing works for example bolts were welded to bearing inner race and coupling in order to pull them

out, but in these cases proper bearing and coupling puller should be used to avoid distorsion of shaft or coupling.

Recommendations:

(i) To fix or replace CDFOP motor of M-2 unit.

(ii) To measure and record insulation resistance of motor which has been shut down for long time, before start.

(iii) To use proper lubricant and to prepare lubricant list for all equipments.

(iv) To use proper maintenance tools.

v. Lighting of power house

There are insufficient lightings and many blown out lamps in power house especially boiler room. Additional lighting fixtures should be installed in strategic places and blown out lamps should be replaced with new one for convenience of operation and maintenance.

230 KV LIGHTNING ARRESTER FOR THE MAIN TRANSFORMER

1. Background

Consecutive breakage of the lightning arresters mounted on the main transformers of M-1 and M-2 were experienced as follows:

M-1	February 28, 1981
	May 19, 1981
M-2	December 26, 1981

The bursted lightning arresters were Hitachi made and rated 192 KV.

All the lightning arresters have been replaced with those manufactured by OHIO BRASS rated 192 KV type MPR -192.

2. Recommendation of JEC (Japanese Electric Committee)

JEC recommends that 210 KV rating arresters are to be applied for 230 KV circuit and 900 KV BIL. (Refer to the Table on the next page)

M-1 and M-2 transformers are designed to withstand 900 KV full wave impulse voltage which meets JEC recommendation.

Before adoption of 210 KV rating arresters, however, it is advisable to have discussions with the manufacturer of transformer (Hitachi) concerning the application of JEC recommendation.

TABLE 5E-4 PROTECTION CHARACTERISTICS AND INSULATION COORDINATION OF LIGHTNING ARRESTER

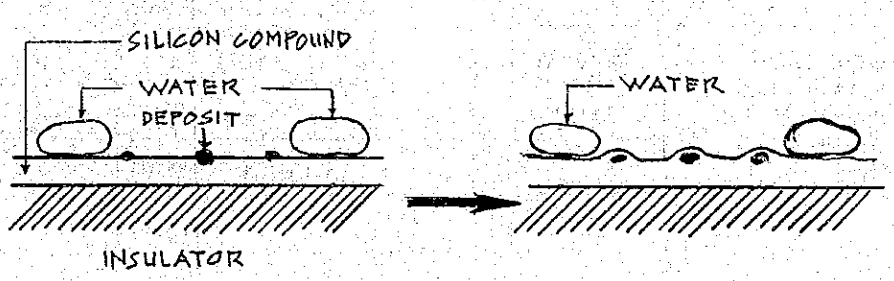
(In case of effective grounding system)

System	Normal Volatage KV	(1)	220
	Maximum operation Voltage (KV)	(2)	240
	Insulation Class	(3)	170
Insulation Level (KV)	BIL	(4)	900
	BSIL	(5)	-
	At Rated Frequency	(6)	395
Rating and Allowance of Applicable Lightning Arrester	K %	(7)	90
	Rated Voltage (KV)	(8)	210
	(8)/(2) %	(9)	87.5
	3 %	(10)	-
	B	(11)	-
	Normal Discharge Current (KV)	(12)	10
Lightning Impulse Discharge Voltage (KV)		(13)	638
Residual Voltage (KV)	10 KA	(14)	672
	5 KA	(15)	609
	2.5 KA	(16)	-
Surge Impulse Discharge Voltage (KV)		(17)	601
Protection Level and Allowance of Withstand Voltage (%)	$= \frac{(4) - (13)}{(4)}$	(18)	29
	$= \frac{(4) - (14)}{(4)}$	(19)	25
	$= \frac{(4) - (15)}{(4)}$	(20)	32
	$= \frac{(4) - (16)}{(4)}$	(21)	-

3. Other Recommendation by JICA Team

In order to prevent bursting of the lightining arresters, coating of the insulator surface with silicon compound (not silicon grease) will be effective.

Silicon compound will contribute to maintain the insulation performance of the insulator surface by the effect of amoeba action, thus deriving uniform voltage distribution of the discharging elements so that characteristic of discharge can be kept stable.



Thickness of silicon compound is recommendable to be kept between 0.5mm to 1.0mm.

To prepare for the silicon compound coating surface area of the insulator should previously be known to calculate the necessary quantity of the compound by the following formula.

$Q = t.s$ (1)

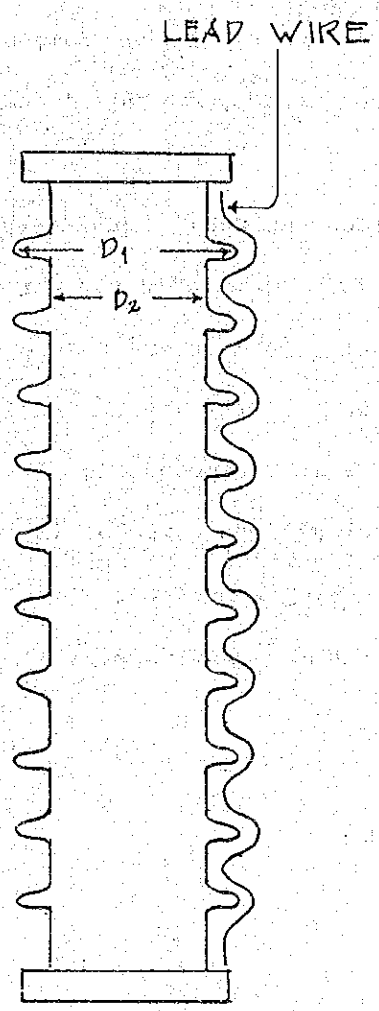
t = Thickness of compound (mm)

S = Surface area m^2

Q = Necessary Quantity in litter (l)

If no surface area of the insulator is given in the catalogue of the lightning arrester it can be known by the following manner.

Fig. 5E-34 MEASUREMENT OF SURFACE AREA



(1) Measure the leakage distance by lead wire L (m)

(2) Measure the diameter D_1 and D_2(m)

(3) Then calculate the surface area.

$$Dm = \frac{D_1 + D_2}{2}$$

$$S = L \times 3.14 \ (m^2)$$

D_1 : max. diameter (m)

D_2 : min. diameter (m)

L : leakage distance (m)

Recoating

Since amoeba action of silicon compound willdeteriorate in time, old silicon compound should be removed and newly recoated.

Lifetime of silicon compound depends upon the environmental conditions, however, we experienced an example which lasted one (1) year in worse environment than at Malaya.

Therefore, annual recoating of silicon compound on the lightning arresters is recommendable.

The life out of silicon compound is indicated by corona on the arresters in rainy conditions and immediate recoating of the compound is required accordingly.