v. Arrangement of Working Environment:

The present poor environment of the power plant is one of the reasons which hamper the motivation and discipline of plant personnel. It seems to be clear that without repair of gas leaks and insufficient lighting to make inside of the building bright and clean vitality of the personnel might not be expected.

4.2.2 Training

1) Training Program

JICA team pays much respect to the NAPOCOR's earnest effort for training of personnels such as good Training Program, Emergency System S.O.P. (Standard Operating Procedures), the plan for Training Center, etc.

JICA team heard that Emergency System S.O.P. was completed in December 1981 and applied to 150 NAPOCOR employees for 5 months to obtain successful results as expected.

Table 4-5 SUMMARY REPORT ON TRAINING PROGRAMS

(Seminars Conducted to MMRC Employees)

Year	MTP	Rockwell	GSTP	Tegen	TDS	CMD	Others	Total
1980	121	161	96	104	41	22	36	581
1981	70	79	102	66	22	18	53	410

Until last year, one month classroom training by the trainers consisting of Sr. Control Engineers/Operator A was given at Gardner/Snyder Thermal Plant as refresher training to the operators from various thermal power plants of NAPOCOR. After that one-on-one based O.J.T. by one class senior personnel to lower class operator has been exercised.

But, from June of this year new training system to give classroom training to all shift members for four(4) hours just before they start their shift service is being given at Malaya Power Station for four (4) months. JICA team observed the actual training several times and was deeply impressed by their earnestness in spite of that it is being done everyday. The text was also well prepared but it seems regretful that not all trainees have their own text.

The training schedule is as follows:

On Shift Refresher Course on Thermal Plant Operation

Session	Topic
1	Climate Building, Auxiliary Equipment Operation/System
2	Station & Control Air System
3	Condensing System
4	Fuel Oil System
5	Combustion Air & Gas System
6	Feed Water System
7	Condensate System
8	Co_2 & Water System
9	Water Conditioning System
10	Generator Oil Sealing System
11	Lubricating Oil Conditioning System
12	Lakewater Services
13,14	By-Pass System
15	Once-Through Boiler -- Design-Construction Features
16,17	- Why and How of Performing the Start-up Procedures during Cold/Hot Start & Quick Restart
18	- Why and How of Performing the Shutdown Procedures during Normal & Emergency Shutdown

Session	Topic
19,20,21	- Reacting Quickly/Correctly to Troubles
22-29	M-2 Boiler
30-33	M-1 Steam Turbine
34,35	Why and How of Doing the Established Procedures & Precautions to Observe when Starting the M-1 Turbine during the Following Conditions: Cold Start, Hot Start, Quick Start
36	Location of Components/Accessories & Controls of M-1 Turbine
37	Why and How of the Procedures/Precautions to be Observe when Shutting Down M-1 Turbine during Normal Shutdown, Emergency Shutdown
38,39	Reacting Quickly to Troubles
40-49	M-2 Turbine
50	Generator & Excitation System
51	Procedures in Generator Operation
52-55	Operational Monitoring System
56-58	Controls
59-62	Emergency System

This training system was observed to include brain-storming, case-study, discussions, etc. and NAPOCOR intends to apply this training system to all thermal power plants.

2) Recommendation

a. Since it seems that no training plan is made for the maintenance personnels of mechanical and control/instrumentation section which is deemed to have need for reinforcement, training of these people by proper NAPOCOR trainer or by outside lecturer from manufacturer, etc. will be recommendable in order to upgrade those personnel's capability.

b. Textbooks are not well utilized in spite of much effort devoted for their preparation. It is recommended to distribute them to all trainees. JICA team is scheduled to prepare and submit the textbooks. They are intended to present the theoretical explanation for operation and maintenance of power plants. JICA team expects that they will serve as good materials for the training of NAPOCOR people.

c. It will be particularly effective to visit modern factories and/or thermal power plants abroad, to observe the operating conditions and to learn the current techniques and technology.

It is recommendable to dispatch key engineers in the field of schedule management, machinery and control/instrumentation maintenance and chemical, which presently involves many problems. These people will contribute much to train other NAPOCOR personnels as trainers.

d. NAPOCOR is very earnest for training, however, thorough and complete training is inevitable to improve the present situations and the responsibility should be borne by managers. Continuous improvement of the training method will be needed to avoid mannerism. An example will be shown for reference.

These training programs should serve to encourage NAPOCOR personnel's will for self-development and to feel themselves self-satisfaction through their actual jobs.

4.2.3 Training Center

NAPOCOR is now planning the construction of a training center at Bagac, Bataan and it is scheduled to be completed in May, 1984.

In addition to the training for thermal power plant operation, operation simulators for hydraulic power plant, substations and transmission lines are programmed, and it will also be provided with a training simulator for thermal power plant together with the following programs presenting a sophisticated training center.

a. Plant Operators' Training 25 days, 5 months OJT (number of participants per year -- 200; includes hydro, geothermal & diesel plants)
b. Mechanical Maintenance Training Program 25, 5, 200
c. Electrical Maintenance Training Program 25, 5, 200
d. Instrumentation & Control Training Program 25, 5, 200
e. Non-Destructive Test Training Program 2 weeks, 2, 100
f. Corrosion Control Training Program 2 weeks, 2, 100
g. Coal Handling & Storage Training Program 2 weeks, 2, 100
h. Pollution Control Training Program 2 weeks, 100
i. Welders Training Program 25 days, 5 mos., 200
j. Fuel & Turbine Oil Analysis Training Program, 2 weeks, 100

Rapid progress of technology and skills of operators will be attained after the completion of this training center and its earliest commissioning is eagerly expected.

The simulator will be programmed on the basis of Snyder-2 unit and automatic boiler control (ABC) is said to be based on Bailey NW-90. As NAPOCOR possesses four (4) same type once-through boilers and is having many troubles with them, training of operators through this simulator will be quite effective.

It is not yet clarified what kind of programs are involved, however, JICA team is sure that it should include the programs for start and stop procedure and emergency operation.

For the moment, it is recommendable to organize a team for each power station and provide 2 weeks training to them to enable quick learning of operating skills. Existing operators are already accustomed to the actual system, they may get good understanding on the simulator in short time and good result can be expected. And, since they are not familiar with automatic operation, this simulator will be much useful for getting technique of automatic operation and troubleshooting.

4.2.4 Skill and Discipline of Personnel

JICA team was impressed and would praise that much efforts are exerted by power plant personnels of NAPOCOR to maintain the stable operation of the power plant through the team's actual observation of power plant and seeing actual plant start-up operation and maintenance works. But the facts that significant controls and instruments for power plant operation, such as automatic boiler control (ABC), monitoring instruments, etc. are out of order, and that patrol around the boiler is hampered because of the boiler gas leaks and lighting failures, seems to show the lack of wills of plant person-

nels on the improvement of these defects. The observations that defects on the instruments caused impurity of boiler water causing the damages on boiler tubes and turbine indicate the significance of instrument maintenance.

Boiler gas leaks, as far as it is limited within small quantity, can be repaired even during the plant operation. All defects should be mended at the initial stage of the trouble before they become serious, and complete and perfect repairs and inspection/confirmation during the scheduled overhaul should be carried out.

Various recommendations/advices are proposed from various parties, however, their practice is of the most importance. Improper schedule management of scheduled overhaul seems to put the power plants into critical conditions.

As far as this kind of matters are concerned, provision of advices/recommendations by JICA team is very difficult. Because these matters are closely related to the country's nationality, customs, culture, etc.

But, it could be said at least that it is indispensable to establish discipline of personnels to solve the problems and to improve the current critical situations. To make this possible, it is essential that the managers should be well informed about the works and actual plant conditions and the plant operation/maintenance works should be carried out under the manager's good instructions. At the same time, continuous training of personnels should be implemented accordingly.

TTable 4-7 TRAINNING METHOD

Time	Purpose of Training	Items and Contents	Duration	Methods/ Text	Trainer	Remarks
At assignment	To instruct the outline of work in power station and to give knowledge on the new job	1. Outline of the power station 1) Organization 2) Details of the job, part of the job 3) Situation in the electric network 4) Outline of facilities 2. Outline of the Boiler, Turbine, Generator 1) Main flow 2) Properties of steam/water 3) Kinds of fuel and its properties/combustion 4) Material selection, corrosion/errosion 3. Outline of automatic control 1) Basic instruction on elec. and instrumentation 2) Control system of B-T-G 3) How to read sequence 4) Concept of each interlock 4. Outline specification of B.T.G and attendant facility	2-4 weeks	•Desk study •Training text books •Desk study & field explanation with schematic diagrams	•Assistant chief/ staff	•Actual field observation will be included.
1 month after assignment	To promote experience and interest based on own experience and leadership of seniors, and	1. Main points of machinery/ equipment operation 2. Main points of supervisory, record & its necessity 3. Proficiency of handling, operation, maintenance 4. Actual example of each kinds of control	3 months	•Actual observation study (man to man) •Training text books & handling standards	•Work leader	•Full time trainer will be available all the time. •Examination will be applied to check the effects of training.

Time	Purpose of Training	Items and Contents	Duration	Methods/ Text	Trainer	Remarks
	to give self-awakening in the job	5. Work standard and practice of ordinary work 6. Handling way of rotating machineries 7. Outline of anti-pollution facilities				
4-6 months after assignment	To give further knowledge based on actual experience in actual plant and give enough practice for regular operator	1. Details of B.T.G and attendant facilities 2. Details of Control, Protection & Monitoring System 3. Detailed handling methods based on each standard 4. Actual observation in periodical inspection plant 5. Actual join in start-up/trial run after periodical inspection	6 months	Ditto	·Work leader	·Examination will be applied and re-training will be done on insufficient items
Occasionally 1 time/ 1-2 months for each items	Step up of operation technology for abnormal and/or emergency conditions	1. Main points for equipments, machineries check/inspection 2. Main points on plant start up and shut down 3. Review on past records of troubles and failures 4. Review on improvement of handling and safety 5. Establish training program and actual training on assumed troubles and failures	Occasionally 1-2 hours	·Gathering education ·Discussion style	·Assistant chief/ work leader/ staff	

Time	Purpose of Training	Items and Contents	Duration	Methods/ Text	Trainer	Remarks
		6. Establish of knowledge on high pressure fluids and hazardous goods 7. Important point education on each unskillfulness points 8. Establish and modification of handling standard				
10-15 years after assignment	To give necessary knowledge required for leader of the place of work	1. Leadership and its way for their subordinates 2. Improvement measures of job 3. Keeping measure of safety, sufficient circumstances 4. Review on example of troubles, failures 5. Management/countermeasure on abnormal/emergency stage	3 days	•Gathering education •Discussion style •Publication style	•Chief/ assistant chief	

4.3 PROCUREMENT

Although the earnest and serious efforts are devoted by the relevant personnels of NAPOCOR to facilitate quick and reasonable procurement of the spare parts and materials necessary for the maintenance and overhaul works of the thermal power plants, the present procurement system involves some fundamental problems such as long procurement time and some wrong equipment and/or material deliveries which do not satisfy the technical requirements, etc.

Therefore, the procurement system, currently adopted in NAPOCOR as described in the JICA Report of Preliminary Survey of the Rehabilitation Program, is being changed into new computerized system.

In order to grasp the outline of the procurement, the background and descriptions on the new procurement system are set forth as follows:

4.3.1 Procurement Market

1) Domestic Market

The equipment and materials listed in Table 4-8 are manufactured in the Philippines and available in the domestic market.

2) Foreign Market

The equipment and materials unavailable in the Philippines other than those available in the domestic market are procured in the foreign market by bidding or by direct order to the original suppliers.

Table 4-8 EQUIPMENT/MATERIAL LIST AVAILABLE IN THE PHILIPPINES (for power plant use)

Air Conditioner	Electric Fan
Heater	Television
Battery	Bulb
Electric cable	Circuit breaker
Conduit	Flourescent light
Floodlight	Fuse
Plug, Rec.	Motor starter (low voltage)
Welding machine	Transformer (up to 300 kVA)
Acetylene gas	Low pressure pipe
Nitrogen gas	Oxygen
Stainless steel belt	Reinforcing bars
Cement	Electrode, (welding)
Paint	Iron plate
Valves (low pressure)	Wire
Gasket	Packing
Insulation	Pump

4.3.2 New Procurement System

The following new procurement systems are taken from the preparation of the procurement schedule to the delivery of the equipment from the coming 1983.

1) Procurement Planning

The procurement planning process is composed of four modules:

a. Procurement schedule preparation

b. Procurement prequalification and quotation file build-up

c. Procurement schedule validation/authorization, and

d. Procurement schedule reprogramming.

The process is designed to anticipate the requirements of the power plants.

The first module involves the planning of the items to be procured at the power plant. The "Procurement Schedule" form, attached hereto, provides for a listing of items to be procured for specific activities grouped under (1) Operating Requirements, (2) General Plant items, and (3) Work Order items. The schedules are aligned towards budget appropriation for the responsibility centers and coursed through the regional channels of approvals to the Regional Finance Office and the Regional Administrative Office (Finance and Procurement).

The second module involves the formulation of corporate standards for procurement items, the qualification of suppliers and the build-up of the quotation file. Least prices are used in third module. The base data gathered are also used in the commitment of purchases.

The third module provides the authorization and clearances necessary to commit the listed items for procurement. The Regional Finance Office acts as a clearing house performing (1) clearance of items to be approved by external agencies, (2) preparation and monitoring of request for authorization to be coursed through the appropriate levels of approvals, and (3) validation of procurement schedules against budgetary appropriations and approved request for authorization.

The fourth module provides for changes which may require reprogramming of the validated procurement schedules. These include (1) change in the responsibility center's activities, and (2) increase in the prices of items.

2) Procurement Processing

The procurement processing is composed of the following modules:

a. Processing of purchase requisition

b. Inspection and acceptance of deliveries

c. Preparation of general voucher

d. Preparation of emergency purchase

e. Release of items to responsibility centers.

The first module triggers the purchase process. Data from the purchase requisition are entered to the system with the purchase order as the final output. The system module checks internally through its computer files if the corresponding items requisitioned have been authorized for purchase, and accesses the quotation file for preparation of the purchase order. If items are not available within the region but available in the other regions or head office, a

"Request/Authorization to Purchase and Deliver" is printed out by the module.

The second module provides for documentation of delivery, inspection and acceptance of item by the property officer or custodian, through the "Inspection and Acceptance Report". Data on the transaction are entered into the system.

The third module involves the preparation of the Cash/General Voucher. The print out of the Cash/General Voucher is triggered off by the second module and the signal that all supporting documents necessary for consummating the transaction have been fulfilled.

The fourth module provides for emergency purchase -- a mechanism for checking if the items are locally available and if quotations are current in the module. The module also signals that reprogramming of the procurement schedule due to emergency purchase is necessary.

The fifth module is a facility for cross entries in the accounting process. Since all items were entered as the accountability of the property officer or custodian, the module provides for clearing of those accountabilities once the items have been released, delivered and accepted by end-users. The facility also provides for charging of costs to responsibility centers and specified accounts. These entries are activated by the "Requisition and Issue Voucher" and/or the validated "Shipping Report".

4.3.3 Problems in the Present Procurement System

1) Procurement takes long time and on time deliveries of the equipment and materials are not always met causing long shut-down time of the plants and extension of overhaul period, etc.

2) The delivered goods sometimes do not satisfy the required specifications.

3) There are some cases in which the fundamental performance guarantee of the plant by the original supplier cannot be secured because of the bidding system or improper specifications attached to the purchase order.

4) The inspection and testing system for receiving the delivered spare parts are not still adequate.

4.3.4 Recommendations and Advices

In order to solve the problems mentioned in the preceding subchapter 4.3.3 the following recommendations and/or advices are proposed:

1) Advices on the New Procurement System Planned by NAPOCOR

The new computerized NAPOCOR procurement system will be useful and effective measures to improve the long procurement time, provided that it will be well prepared and properly applied and in actual operation of this system it is necessary to consider the following:

a. In order to follow the procurement schedule and to minimize the emergency purchase, good procurement planning for regular maintenance and overhaul is quite important. The new table of organization of the plants currently proposed to the NAPOCOR management will be effective for this purpose.

b. And also restrictions of the emergency purchase, which is required to meet the immediate need of the plant repair caused by accidental troubles, should be minimized as far as practicable.

Now, emergency purchase system is actually functioning to procure consumables such as welding rods, H_2 gas, for generator, etc. but, it seems that such things can be purchased regularly by forecasting monthly or annual need of power plants.

Therefore, it is recommendable to use the emergency purchase system for the procurement of equipment/materials needed for the emergency repair works of the power plant of accidental trouble.

2) Preparation and Review of Technical Specifications

a. Technical specifications are one of the most essential documents for the procurement and perform decisive functions to manage the quality, performance, price, inspection, delivery conditions, etc. of the goods to be purchased. The preparation of the technical specifications are being done by the plant maintenance section; however, due to the manpower drain out to abroad of highly experienced engineers, some fundamental problems are encountered in spite of the earnest effort exerted by the plant personnel. Therefore, immediate assignment of this work to the existing centralized technical group with highly qualified engineers like rehabilitation task force seems to be essential to review the technical specifications relating to critical items prepared at the plants.

At the same time continuous training of the plant maintenance personnel to brush up their engineering capability will be recommended accordingly.

b. Standard technical specifications - In order to avoid the incompleteness of the technical specifications to be accompanied with the procurement schedule, establishment of standard specifications or forms of the equipment/materials are recommendable. And, at the same time, standard prequalification list of reliable and reputable manufacturer/suppliers also are to be necessary to simplify the bid evaluation works in order to secure reliable and stable operation of the plant. This prequalification table should be reviewed every year to restudy its adaptability. The prequalification table of suppliers should also include the original manufacturers which should be always adopted for major and essential equipment/materials.

The standard technical specifications shall cover the following as the minimum requirement.

(1) For equipment, facilities, instruments and/or fittings:

(a) Original technical specifications and drawings of the equipment

(b) Design conditions including environmental conditions

(c) Required performance

(d) Quantity

(e) Quality of materials

(f) Applicable standard

(g) Painting

(h) Inspection, testing and records

(i) Necessary drawings and data to be submitted

(j) Delivery conditions such as delivery schedule, delivery place, packing system, transportation, etc.

(k) Relevant drawings such as installation drawings, piping diagram, schematic diagram, etc.

(l) Definite scope of supply

(m) Responsibility of coordination if such is required with the other supplier

(n) Guarantee conditions

(2) For materials:

(a) Original technical specifications

(b) Quantity

(c) Quality of materials

(d) Applicable standard

(e) Painting

(f) Inspection, testing and records

(g) Necessary drawing and data to be submitted

(h) Delivery conditions such as delivery schedule, delivery place, packing system, transportation, etc.

(i) Definite scope of supply

(j) Responsibility of coordination if such is required with the other supplier

(k) Guarantee condition

All the requirements mentioned in the above items (1) and (2) are not always applicable to every equipment or materials but, all technical specifications should refer to all said items and should cover all necessary items.

3) Monitoring of Delivery Schedule

It is also recommendable to have a continuous delivery schedule monitoring function in the regional center which monitors each critical timing point, such as the time for the purchase requisition, purchase order, inspection and testing, delivery, etc., in order to coordinate the time of equipment/material delivery and plant maintenance/overhaul schedule prepared by the plants.

4) Unit Price System

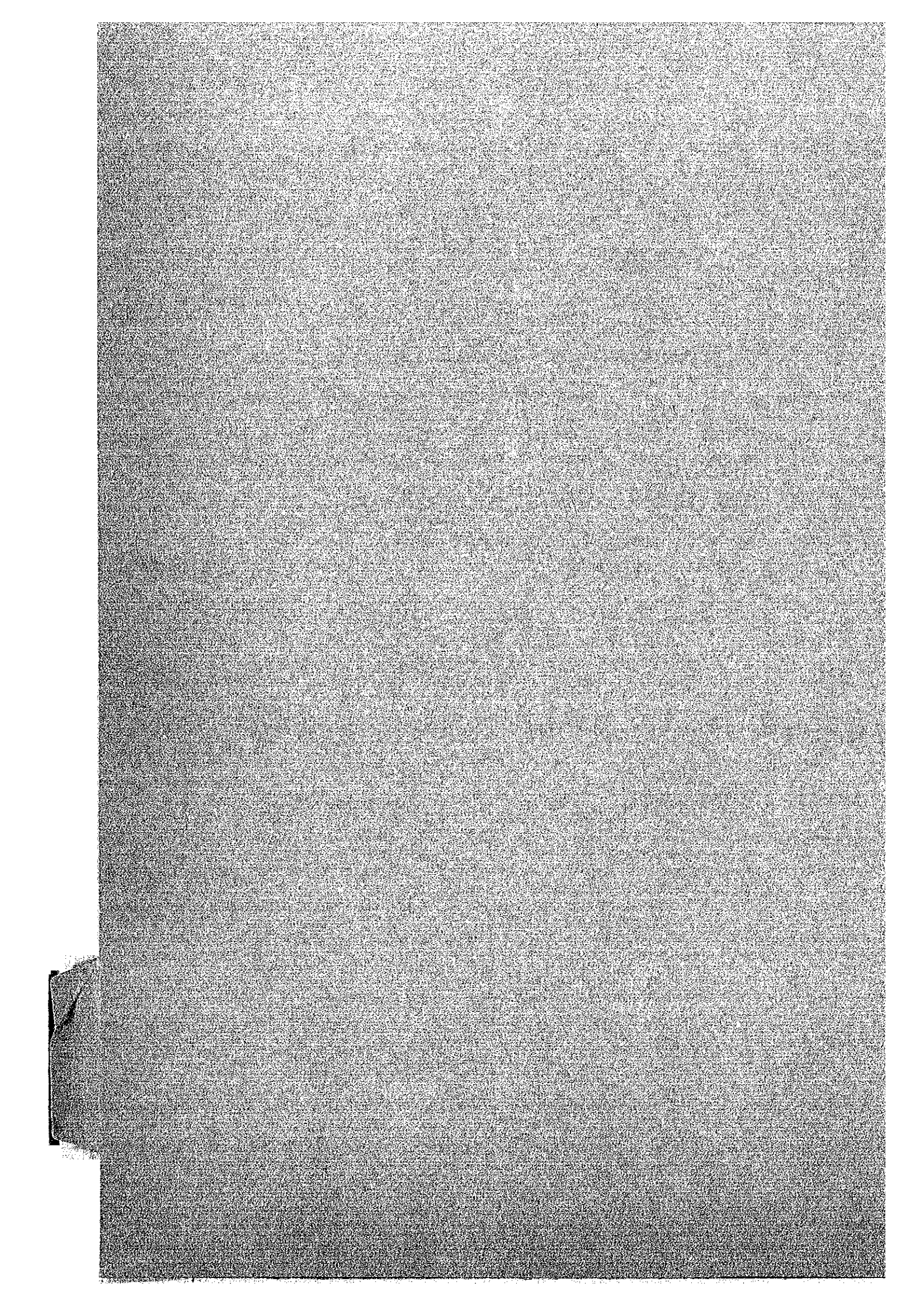
Unit price system is recommendable for equipment/materials to be procured from original manufacturers and comparatively small equipment and materials to which bidding system is not applicable or not suitable in order to minimize the time for procurement, to get good performance/guarantee of the plant or to keep the price within reasonable level. Much attention and care should be paid for deciding the basic unit price to keep it at reasonable price levels by widely investigating the prices of similar or equipment ones.

5) Dispatch of Procurement/Finance Personnels

It is also advisable to dispatch procurement finance personnels abroad to observe and study the procurement and material management systems in the foreign electric power utilities and/or some of the leading manufacturers.

Because improvement of procurement system and material management system is indispensable for integrated and overall rehabilitation of the thermal power plants which ensures the timely delivery of spare parts and avoid misuse of materials supporting the short and reliable overhaul.

5. REHABILITATION OF POWER PLANTS



5. REHABILITATION OF POWER PLANTS

5.1 MAJOR SPECIFICATION OF POWER PLANT EQUIPMENT

5.1.1 Gardner Power Plant Equipment

1) Boiler Equipment

a. Boiler Proper

		Unit No. 1		Unit No. 2	
₀ Type		Drum		Once-Through Benson Type	
Steam pressure					
*Design pressure	psig(kg/cm^{2}g)	2,180	(153.27)	3,425	(240.8)
*Final Superheater outlet	psig(kg/cm^{2}g)	1,800	(126.56)	2,770	(194.76)
*Reheater outlet	psig(kg/cm^{2}g)	530	(37.26)	544.3	(38.27)
Steam temperature					
*Rating temperature	°F (°C)	1,005	(540.5)	1,005	(540.5)
*Economizer inlet	°F (°C)	451	(232.8)	481	(249.4)
*Reheater inlet	°F (°C)	645	(340.55)		
*Reheater Outlet	°F (°C)	1,005	(540.5)	1,005	(540.5)
*Superheater outlet	°F (°C)	1,005	(540.5)	1,005	(540.5)
Evaporation					
*Boiler MCR	lb/h (t/h)	1,065,000	(483.07)	1,675,485	(760.0)
*Unit 4/4 load	lb/h (t/h)	978,194	(443.70)	1,494,270	(677.8)
Superheater					
*Primary Superheater					
Type		Convection		Horizontal Continuous Tube Type	
Heating surface	ft^2 (m^2)	31,500	(2,920.4)		

Gardner

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

Gardner

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

Gardner

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

Gardner

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

Gardner

		Unit No. 1	Unit No. 2
*Driver - Type		G.E. explosion proof motor coupled by a falk type coupling	
- Capacity		200 HP (149.2 kW), 1200 rpm	250 kW, 1800 rpm 440 V, 60 herz

Constant differential fuel oil pump

*Type		Centrifugal, vertical 2 stages
*Capacity & number of pump	gal/min(m^3/h)	215 (48.82) x 1 set
*Discharge pressure	psig(kg/m^2g)	915 (64.33)
*Suction pressure	psig(kg/m^2g)	740 (52.03)

Light fuel oil pump

*Type		No. A6DB-137 SCREW
*In/outlet pressure, capacity & number of pump	psig(kg/m^2g)	17 in Hg/259(0.59/18.2)
	gal/min(m^3/h)	27.8 (6.31) x 2 sets
*Manufacturer/erector		IMO - DE LAVAL
*Driver - Type		G.E. explosion proof motor
- Capacity	HP (kW)	7.5 (5.6)
*Manufacturer/erector		General Electric

	Induction motor
	7.5 (5.6)

Gardner

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

f. Boiler Draughting Equipments

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

Gardner

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

Gardner

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

Gardner

		Unit No. 1	Unit No. 2
Motor driven feed water pump			
*Type & number of stage		8" HH-BFI, horizontal barrel type 9 stages	HDGr 55S/7 stage centrifugal, motor drive
*Capacity & number of pump	g/m(m^3/h)	1,328 (301.6) x 2 sets	1,631 (370.5) x 2 sets
*Total head & revolution	psi (m)/rpm rpm	3,025 (2,134) 3570	3,585 (2,520) 4870
*Manufacturer/erector		Pacific Pumps	KSB
*Driver - Type			Totally enclosed fan cooled
- Capacity & number of motor	kW	3,100 x 2 sets	4,400 x 2 sets
- Manufacturer/ erector			Siemens

h. Feed Water Heaters Equipment

No. 1 LP feed water heater			
*Type		Horizontal U-tube L.P. size 34-35B	Vavl 115.4/470, horizontal U-tube, 4 pass
*Heating surface area & number of heater	ft^2 (m^2)	5.056 (469.7) 1 set	4,740 (440.3) 1 set
*Material of heating tube		Admiralty	St. 35.8 Seamless Steel