No. 5 boiler. As for blades which are not severely damaged by wear, balance adjustment was made only 0.3 times a month.

b) Since there are 2 primary fans for each one of the 7 boilers of 14 fans and each one of the fans has 10 blades, the total time of repairs is extremely long.

c) This table only shows the time of repairs in 1991. The time of repairs is not increasing together with an increase in the number of boilers' operating hours and the number of repair cases by welding does not tend to increase. For instance,

	Boiler No. 1	Boiler No. 7
Fan A	3,063 h - 3 times	3,376 h - 8 times
Fan B	2,983 h - 8 times	3,408 h - 3 times

In above table, the left figure indicates boiler's operating hours of fans and the right figure indicates time of repairs of balance adjustment/hard surfacing blades by welding.

Fans used for Boiler No. 5 are severely damaged by wear while fans used for Boiler No. 4 are not severely damaged.

Table 4-2-26 Situation of Primary Fan Maintenance at the 4th Thermal Power Station

Numeral : Operating time (hr)
△ : Blade replacement
○ : Balance adjustment
◉ : Balance adjustment after padding
□ : Other repairs

Boiler	Generator	Month of previous replacement	1991									
			1	2	3	4	5	6	7	8	9	10
1	A	5	– ○	–	526	661	380	433 ◉	570	–	493 ◉	
	B	5	– ○ □	–	510 ○ □	600 ○	380	440	555 ○○◉	–	498	◉
2	A	6	518	624	57	–	58 △	189 ○	457 ○	334 ◉	83	
	B	6	518	620 ◉	57	–	58 △	192	452 ◉	314 □○◉	83	
3	A	2	588 ◉	293 ○	288	123	348 ○	– △	352 ○	396 ◉ □	316 ◉	◉ ○
	B	12	595 ○	278 □	288	123	336 ○ □	– △	351 ◉	408 ◉	316 ◉	◉ ○
4	A	—	308 △	391 ○	702	675	412 △	–	– △	–	372 ○	
	B	—	236 △ □	385 ○ □	687 ◉	675	410 ○ △	–	– △	–	375	□
5	A	7	671	667	631 ○	657 ○ ◉	277 ◉	259 △	220 ○	453 ◉	415	○ ◉
	B	9	647 □	667	614 △ ○	649 ○◉◉	284	259 △	219 ◉	443 ◉ ◉	407 ◉	○ △
6	A	10	626 ◉ △	446 ○	186	212 ○	293	337 ◉ △	400 ◉	20	0	0 △
	B	12	638	436 ○ □	186	215	293	358	393 ○ △	20		△
7	A	10	578 ○	292 ◉◉□	270 ◉	275 ○	539	597 ◉	21 ○	91	713	◉
	B	7	581	314	272 ◉	278	539	604	16 ◉	91	713	◉

(Note: Obtained from the 4th Thermal Power Station in October 1991)

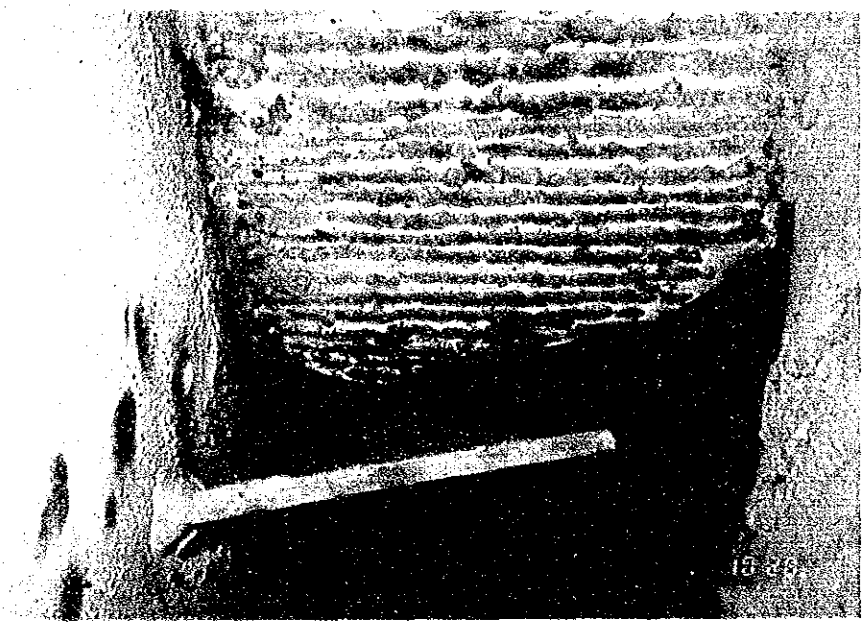


Photo-1 Primary Fan Blades (Heavily worn out)

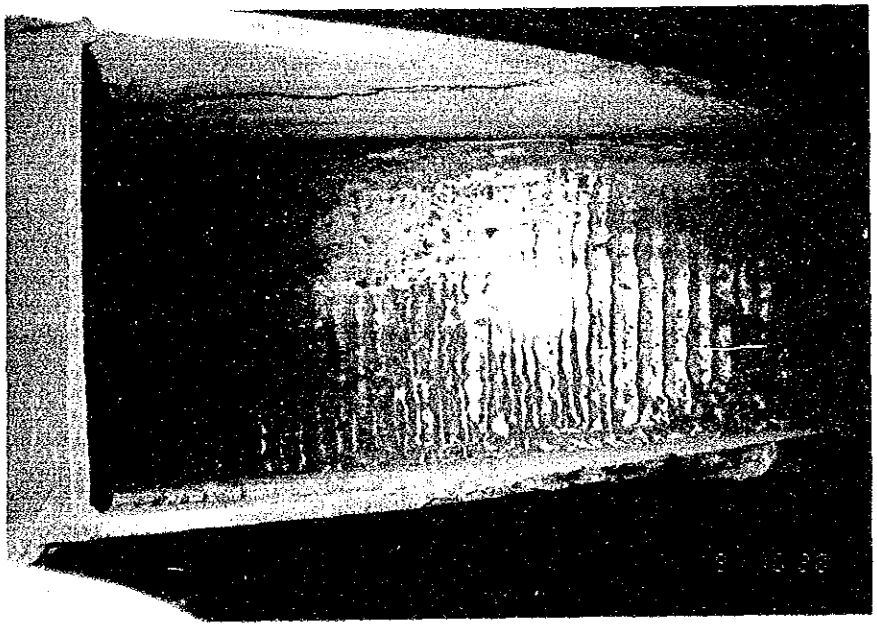


Photo-2 Primary Fan Blades (Worn-out)

Fig. 4-2-18 Photographs of Site Conditions

Photo-3 Primary Fan Blades (Heavily worn out)

(4) Coal handling system

The number of accidents and shut-down hours in the coal handling system are shown in Table 4-2-27. Especially, the number of shutdown hours was large, standing at 200 and 240 in March and October, 1991 respectively. Foreign metal materials in coal cut off conveyers, and it took a long time to repair them. If there was a No. 1 magnet separator, the accidents could have been avoided.

Table 4-2-27 Number of Accidents and Number of Shut Down Hours in the Coal Handling System

Years	1990												1991									
Months	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10
No. of Accidents (times)	2	3	0	0	0	1	0	0	0	2	0	2	5	2	2	2	0	0	0	1	2	1
No. of shutdown hours (hr)	47	57	0	0	0	27	0	0	0	57	0	42	51	42	200	35	0	0	0	22	18	240

Date of investigation: November 1991

Fig. 4-2-19 Photograph of Site Condition: Damage in Coal Conveyer Belt

4.2.8 Study of Contents Requested

A study will be made on contents requested for materials and machinery to be supplied from the current operating (maintenance) conditions of the equipment of the 4th thermal power station.

(1) Ash slurry pipe and valves

1) Ash slurry pipes

The 2 lines of ash slurry pipe, ø426 x 12t x approx. 3.2 km/line, for the unit No. 1 through 6 were plugged up with the scaling inside the pipes, so that the boiler operation had to be suspended. However, the pipes were cut and scales were removed by hammering during a 5 month period from March to July 1991. As the result, they are operated soundly as of Nobember 1991.

Two other lines for unit No. 7 and 8, ø325 x 12t x approx. 3.7 km/line, were additionally installed in November 1989. With the duration of service being short (In particular, one line has seldom been used), the scaling inside the pipe is minimal.

It is considered from the foregoing that the supply of ash slurry pipe will be not necessary. However, some kind of measures will be necessary in future to remove the scales.

2) Valves

Full closure is impossible due to the wear of outlet valves of the ash slurry pump. Since the pump cannot be completely isolated by the valve, hindrance is brought to the maintenance of the pump itself.

Since the outlet valves of ash slurry pump for unit No. 1 through 6 are used for level control, hole is opened in the lower portion of disks and seats of valves due to wear.

It is considered, therefore, that all outlet valves (10 units) will have to be replaced with new ones.

The inlet valves, though the wear is little, have possibility to be impossible to fully close due to the growth of scale on the valve seat and inside the body. But replacement of inlet valves is not necessary for the time being.

The valves for the unit No. 7 and 8 were additionally installed in November 1989. Despite short duration of service, the outlet valves of the ash slurry pump are already in a state similar to that of unit No. 1 through 6, so it will be necessary to replace 6 valves.

As at present, no trouble is observed on other valves.

(2) Feedwater pipe and valve for ash treatment

In the fly ash disposal line, there is only one line of booster nozzle feed water pipe for the ash slurry channel installed inside the main building of power station. Consequently, ash disposal must be suspended when cleaning the nozzle pipe, and thus hindrance is caused for the operation and maintenance.

It is considered necessary, therefore, to install an additional line as a back-up line to enable cleaning of pipe during the normal operation, to have a total of 2 lines.

(3) ESP hopper ash level sensor

There are a variety of ash level sensors; mechanical type, electrical type and ultrasonic type. However, the rubber bellows type installed at present is the most simple type and easy to maintain if it functions normally. The limit switch onward are normal. The repair is possible by the hand of the power station. It is concluded, therefore, that the replacement of rubber bellows will be most appropriate. Since a slight anxiety is held about its operation, the use of an air hammer will be considered for only the hopper accumulating much ash.

(4) Vacuum car for dust removal

To improve the availability factor of an ESP, the ash from the hopper must be surely discharged. The causes of pluggage in hopper with ash are complex. Though the removal of plugged ash is now done by manpower, the workability is extremely poor since the works are performed upstairs and indoor. Efforts will be made in the project to solve the problem of ash pluggage as much as possible. However, no guarantee can be given for its complete removal.

Furthermore, pulverized coals are accumulated in the boiler room due to their leak from the holes eroded of pulverized coal system. Gas is also leaked from the boiler gas duct. Ashes are accumulated due to their dispersion from the ash slurry channel and other sources. Damage is caused frequently on electric systems by washing to clean these ashes, and thus hindrance is caused to the safety and maintenance.

It is considered necessary, therefore, to procure vacuum cars for dust removal as well as pipings to clean around the boiler room and ESP hopper room, to enable to perform periodical cleaning of the boiler room and the ESP hopper room and for efficient removal of ash from the ESP hopper when it is in trouble.

(5) Ceramics Tile

The 4th thermal power station is the latest with its No. 1 unit starting operation in August 1983. Despite that, the frequency of repair to cope with the wear of the pulverized coal feed system is so high and abnormal. If any hole was born on the system to leak out pulverized coal, it must be repaired without fail since the air will flow into the system to cause the danger of fire and explosion, even if the hole was not of such big to cause immediate suspension of the boiler.

It is very important for the power station to improve the availability factor of the pulverized coal system and reduce

the great amount of labor put into repair works. The major causes of wear are conceivably the inclusion of foreign materials in coal and the entire system made of mild steel only. In Japan, wear resistant cast iron has been used for the places where intensive wear is predicted. The recent trend is to take it over with ceramics tile.

Cast iron is hard, but weak against impact. So, it cannot be used for this power station frequented with explosions since it will crack or its joint gets shifted to cause the burst of pulverized coal. It is considered, therefore, that the use of ceramic tiles to counter against the wear of the pulverized coal system will be most suitable.

(6) Abrasion resistant lined steel clad plate

Ceramics is the most effective means as a countermeasure for wear. Depending on the working temperature, however, there are places, on which the installation by adhesive is impossible owning to the problem of heat resistance. Although there is an alternative method of fastening with bolts, it will require an extensive amount of labor to fasten 20 mm square ceramics piece by piece with bolts. Beside, the resistance to wear of the bolt itself will become an issue to be examined.

It will be practical to use for such locations abrasion resistant lined steel clad plate. Such plate will be suitable and appropriate for locations with high temperature, like the mill outlet pipe. However, if the temperature allows, the bonding of ceramics tile will be more desirable.

(7) Welding rod for primary fan blade

As for the request for supply of welding rods for the primary fan blades, similar measures are taken also in Japan for the same type of fans. The request appears appropriate under the present conditions where the supply of welding rod from the ex-Soviet Union tends to delay. However, satisfactory results

have been increasingly obtained nowadays in the bonding of ceramics tile as a measures to improve the resistance to wear of the fan blades. It will be necessary, therefore, to compare ceramics in detail with the combination of wear resistant steel plate and welding rod which is described in the following section.

(8) Wear resistant steel plate (for primary fan blade)

Ordinary steel plate, CT-3 equivalent to JIS SS-411, is used for the primary fan blade. Its resistance to wear being small, hard facing is done at present by Mongolian as mentioned in (7) above. Therefore, when the hard facing by wear resistant welding rod as mentioned in Section (7) is worn down to the base metal, the wear is accelerated to shorten the life. If the base metal of the fan was changed to material having a high resistance to wear, it will prolong the life of fan and reduce the range and frequency of the subsequent hard facing. Such change, therefore, will be appropriate for the improvement of availability factor. However, it will have to be compared with ceramics tile as described before.

(9) Magnetic separator

As regards foreign materials included in coal, proper removal should desirably be exercised just after digging coal at the mine, or the digged coal be washed, before delivery to the station. The only alternative available on the power station side at present is to rely upon the magnetic separator. It will be desirable to install a separator on the receiving side of coal in addition to two other separators from the viewpoint of reducing wear of pulverized coal system and protecting the belt of coal handling system. This request appears reasonable.

(10) SO_2/NOx meter

The installation of the measuring instrument was strongly requested by the national environment control commission of

Mongolia. However, the power station proposed to delete it on the ground that the predicted emission of SO_2 and Nox is considerably low judging from analytical values of coal in use and that the results of measurement cannot be fed back to the operation.

As the result of consultation with the Mongolian side, it was considered appropriate under the present conditions to allocate the cost of this instrument saved to the supply of other urgently required maintenance parts even though the instrument may be required in future, for the reasons that the urgent task at the moment is to bring the boiler and the ESP into normal conditions as far as possible and that considerable amount of labor and costs of constant maintenance are required for the upkeep and control of the measuring instrument, for example, the standard gas for the calibration of the instrument.

Further, the emission of SO_2 can be calculated from the sulphur content in coal while the same of NOx can be somewhat predicted from the calculation of nitrogen content and combustion temperature.

(11) Instrument for dust measurement

It is indispensable for the reduction of dust, a cause of air pollution, to maintain the performance of the ESP. It is necessary, for that purpose, to measure the concentration of dust at the gas ducts at its inlet and outlet and check the performance periodically.

The concentration of dust at the outlet and inlet gas ducts was once measured by the ex-Soviet Union to confirm the performance of a boiler while it was in trial operation after construction. The performance management of ESP has been required while air pollution has recently deteriorated, but there are no measuring instruments. Therefore the request is reasonable.

Since there are no dust concentration measurement holes at the No. 1 to 4 outlets and inlets of ESP and the No. 5 to 8 inlet

gas ducts and no measurement footing at the No. 1 to 4 inlet gas ducts, they should be installed.

		Measurement holes	Measurement footing
Inlet	N1 - N4	No existence	No existence
	N5 - N8	No existence	Existence
Outlet	N1 - N4	No existence	Existence
	N5 - N8	Existence	Existence

(12) Dust-proof/explosion-proof lighting equipment

In order to maintain and improve the availability factor of the power station, it is necessary to grasp the operating conditions of equipment and perform the most adequate maintenance. The inside of the main building of the 4th thermal power station is extremely dark as compared with that in Japan. There is often no lighting in the power station main building except the turbine room due to a lack of bulbs and the existence of damaged facilities. There are approximately 36,000 lighting fixtures in the power plant at present, 15,000 of which are alight. According to the information in February 1992, Incandescent lamps (60, 100, 150, 200, 300, 500, 1,000 W) and mercury lamps (250, 400, 700, 1,000 W) are used for lighting at the power station. Dust-proof/explosion-proof lighting equipment is intalled in dangerous places with combustible coal dust. Fluorescent lamps (40 W) and incandescent lamps are used in management buildings such as control rooms, offices, etc. It is impossible to walk or grasp the situaiton of the equipment's operation without flash lights. It is especially dark from the pulverized coal bin outlet level to the inside of the boiler house downstairs, around the boiler burner, at the ash

treatment room of the ESP hopper, around the pit and the ash slurry pump. The darkness is a cause to delay the discovery of defective locations like the leak of pulverized coal. Deteriorated environments lead to other troubles, helping to form a vicious cycle. The situation presents a problem in securing safety at the time of making patrol. One of the causes of the damage to lighting equipment is the practice of washing to remove fine particles and ash depositing around the boiler. Because this practice could lead to burning of motors and malfunction of impairment of control devices, we requested immediate discontinuation. This request was considerd appropriate, in view of the safety of insepction patrols as well.

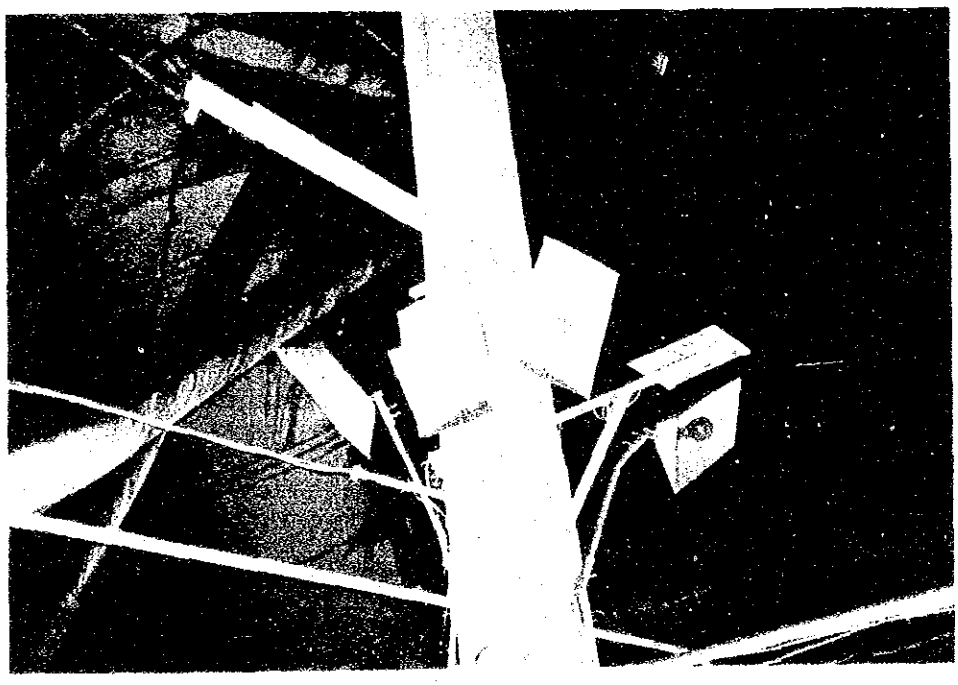


Fig. 4-2-20 Photograph Showing Site Condition of Illumination Damaged

4.2.9 Study of Necessity of Technical Cooperation

Problematical points existing in the maintenance management system in achieving the goals of the rehabilitation project will be sorted out in order, and an examination will be made of the way technical cooperation should be to suit with the actual conditions of Mongolia, based on the results obtained therefrom.

(1) Problems posed by present maintenance management setup

The style of the present maintenance setup in Mongolia is mainly of "Break-down Maintenance" where the repair will be made only when any accident takes place to impede the continuous operation of the boiler. Accordingly, the periodical inspection based on the time management concept is considered a matter of second priority. Hence, it can be said that the situations in Mongolia quite differ from those of thermal power stations in Japan where sophisticated equipment diagnosis technique for condition based maintenance of the power station are already in actual service.

1) It is often found in the building that the pulverized coal accumulates in the space around the boiler and mill, and that fly ash is deposited around the rear side of the boiler and the underside of the ESP, as well as all spaces on top of the boiler, building beams to even floors with thickness of several millimeters deep.

This is because the pulverized coal and fly ash might have been blown out through some holes or openings which have taken place due to certain causes in the boiler equipment.

This kind of accumulation is self explanatory that the maintenance personnel are apt to consider "The accumulation has nothing to do with the improvement of the availability factor of the boiler." Of course, they understand that "Certain boiler accidents are caused by the accumulation itself." However, the problem is not there but they do not

understand that "Cleaning inside the building is indispensable for the health of the maintenance personnel as well as it largely contributes fundamentally to the improvement of the availability factor."

2) A lot of accumulation of the pulverized coal and fly ash in the building may also imply that the maintenance personnel are again apt to think that "It is not a problem for the operation of the boiler to have something that blows out from inside of the boiler equipment from time to time." It may be a large problem to admit even "blowing out" in addition to the accumulation. This can be ascertained by the fact that plenty of steam, water or drainage is still leaking or blowing out out of the boiler equipment. This can also be easily observed if an overall inspection of the boiler is conducted. In addition, since much of the boiler equipment possess negative pressure like for example the pulverized coal feed system or the ESP, etc. that are the direct objects of the present rehabilitation plan, any gaps or openings which have taken place in the equipment due to certain causes can absorb the surrounding air instead of blowing it out. Such absorption of air does not attract attention more than its blowing out. However, it can still cause accidents such as pluggage due to temperature drop or fires in the system. It is known that the occurrence of trouble is mostly found during the routine plant patroll even in Japanese thermal power stations with sophisticated monitoring instruments.

In view of the above situation and the present poor conditions in the Mongolian power station, it can be said that any deterioration or failure in the system or equipment is almost impossible to find in the early stage because for example the noises which signal any malfunctions in operation are already extremely difficult for the maintenance personnel to catch in the building, to say nothing of the problem concerning the security of the maintenance personnel.

3) It is too dark in the building

This is probably because many of the lights are already broken, and in addition, spare bulbs to be delivered from the ex-Soviet are not enough. To add to the problem, the staff at station may have in mind a concept that "Darkness scarcely has anything to do with the improvement of the availability factor." Accordingly, it can be said that the condition in the station is in such a poor state that any trouble in the facilities is extremely difficult to find beforehand like the condition stated in 2) above, to say nothing of the problem concerning the security of the maintenance personnel who are always working in it. Again, it has been observed that the maintenance personnel are apt to pay attention only to their stepping or walking but not to the surrounding facilities. These facts inversely affect the earlier discovery of trouble in the facilities which leads to a decrease in the availability factor.

4) The accumulation of fine powder such as pulverized coal or fly ash can be removed by suction or water wash type devices. Presently, the latter is in use, while, on the other hand, there is a lot of electrical equipment and accessories such as motors, cables or instruments using electricity. These electrical appliances must be covered up completely prior to washing. However, the washing is conducted without any covering in Mongolia. Hence, problems are posed in that many accidents occur or deterioration caused by short-circuits due to water in the electrical equipment and accessories resulting again in a decrease of the availability factor. In Japan, washing is not used because of difficulty in completely covering. Under the circumstances, it is strongly warned that washing should immediately be avoided and manual or suction type removal shall be employed at once.

(2) Basic concept of technical cooperation of Japan needed for the time being

It is understood that there exists a Mongolian style of maintenance management mostly suitable for Mongolian people. In view of this, it would be probably efficient neither to suddenly change in a short period the present setup or management style prevailing in the Mongolian power stations nor to force them to provide a Japanese style or concept, in order to solve the problems stated in (1). It may, for example, take a long time even just to discuss and to draw a conclusion for a problem of whether about 1,400 employees are really all necessary or not for the power station. Moreover, it is virtually not necessary for the time being in view of one of the final goals of the rehabilitation, the improvement of the availability factor. Accordingly, it is necessary to have due consideration to how the technical cooperation of Japan should meet the present state prevailing in Mongolia under perceiving the Mongolian style as it is now. Taking into account the above situation, the basic concept of technical cooperation becomes as follows.

On the other hand, maintenance system can be classified into preventive maintenance (maintenance in advance, predicting possible failures) and break-down maintenance (maintenance after the occurrence of accidents due to failures), the latter of which is now, in Mongolia, prevailing in the power station, followed by time based maintenance (maintenance at regular time intervals) at first and by condition based maintenance on simple diagnosis (maintenance by simple diagnosis of conditions through awareness of abnormality) next. Condition based maintenance utilizing sophisticated equipment diagnosis technique, being widely adopted in thermal power station in Japan, is not performed in Mongolia.

The foregoings are summarized as follows:

(0) ..... Mainly, in use

(1) ..... Next to (0), in use

(2) ..... Next to (1), in use

(3) ..... Next to (2), in use

Maintenance system			Present condition in Mongolia	Present condition Japan (for reference)
Preventive maintenance	Time based maintenance		(1)	(1)
	Condition based maintenance	On simple diagnosis through daily inspection and repair	(2)	(2)
		On sophisticated equipment diagnosis technique	-	(0)
Break-down maintenance			(0)	(3)

Taking the above conditions into consideration, the basic concept of technical cooperation is defined as follows:

1) In the technical cooperation, an emphasis will be placed on giving advice to all staff of the power plant to improve the environmental conditions for boiler equipment. Being a kind of awareness improvement for all staff, such improvement shall never be completed in a short-term education, but preferably be realized step by step in accordance with the current practice of the station.

2) Next, emphasis will be placed in giving technical cooperation to assure that the performance of daily inspections and repairs will be put into orbit as a habitual work.

First, the existing measuring instruments will be put into reliable conditions by the hands of the Mongolian side. The value of vibration, temperature, pressure, etc. will be periodically measured and recorded for sure to find out the extended and size of the failures. Records are now taken at present as a daily work, however, are unhappily not fully utilized for maintenance.

3) Once the habitual work of daily inspection and repair of (1) and (2), will be established in the power station, the third step will be to give advice on the setup of a proper system for condition based maintenance on simple diagnosis. When implemented, the said maintenance will begin to play as "(0)" and break-down maintenance will be put in "(2)".

4) Although it is said the time based maintenance to perform periodical inspection and repari is not very effective for complicated equipment like boilers, it has used to form a mainstream of preventive maintenance. The maintenance system will be positioned in "(1)", to make the maximum use of the Mongolians' experience long accumulated to this date in their own way.

   The adoption of condition based maintenance by use of the sophisticated equipment diagnosis technique is not seemingly riped for Mongolian and it should not be placed in the center of technical cooperation. Presently, Mongolia is in no condition to receive the introduction of such a maintenance system, and not much effect can be expected for such a vast cost spent therefor.

5) Even if optimum materials and machinery were sent and the rehabilitation work was executed timely, they will not prove very effective in achieving the final goal of "improving the availability factor" unless the present conditions as described in 1) above are improved.

   The improvement of 1) takes time. It can never be completed overnight. It will be necessary for Japan to

give a kind of technical cooperation which will positively serve in the endeavor to draw close to the goal even a step.

To attain this, however, it is necessary for both the Japanese and Mongolian sides to fully exchange opinions and discuss with each other in order to deepen mutual understanding. For this purpose, however, mutual efforts to cope with the difficulties are needed.

(3) Specific items necessary for technical cooperation

Described hereunder are specific items necessary for technical cooperation based on the principal concept presented in paragraph (2) above.

1) Recognition in the importance of environmental improvement inside the power station

Inform them that the current bad environment in power plant is leading to the outbreak of new trouble, and that the same is hampering an early discovery of trouble in the equipment.

2) Recognition in the importance of daily inspection and repair

Assist them in recognizing the importance in daily inspection and repair for the preservation of a good environment and the prevention or minimization of accidents (preventive maintenance).

For the successful achievement of these items, it will be effective to give a collective education to all staff members of the power station on the maintenance business by Japanese experts, and give their representatives an opportunity to actually see and compare the conditions of maintenance of power plants in Japan.

4.2.10 Basic Policy for Implementation of Project for Cooperation

As to the implementation of this project, it is considered that it is adequate to consider the grant aid from Japan because the effect and feasibility of the project as well as the capability of the country to implement, etc. are already reconfirmed through the above study, and in addition, the effect to be obtained from the project can meet the concept of the grant aid. Accordingly, it has been decided to start studying the outline of the project in the following pages and to conduct the basic designs. However, as stated in 4.2.8 Study of Contents Requested, it is still necessary when considering the details of the plan to partially modify by adding certain necessary materials to the requirements.

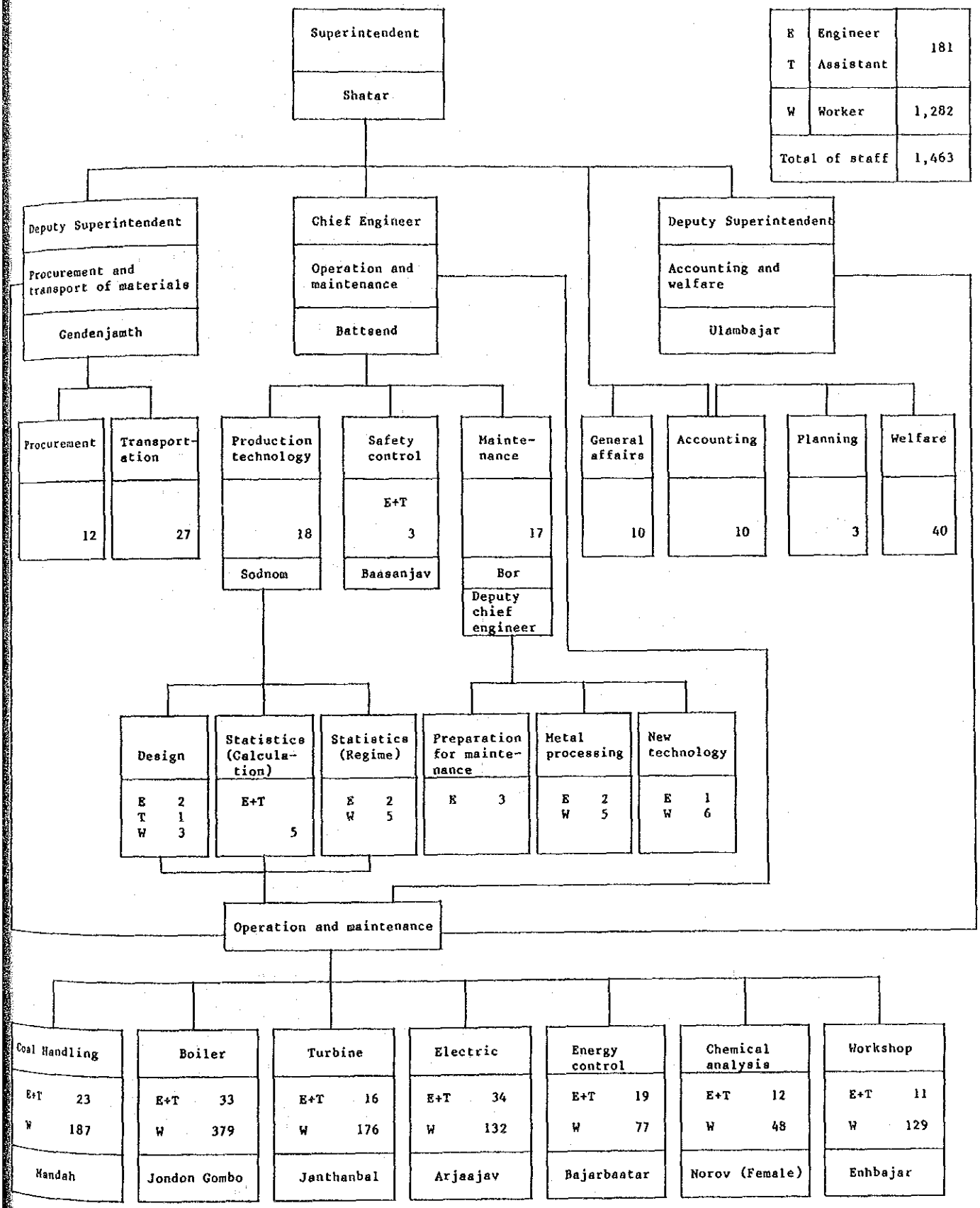
4.3 Outline of Project

4.3.1 Executing Agency and Structure

As described in Chapter 4, Section 2, the executing agency of the project is the Ministry of Fuel and Energy of Mongolia. The Energy Policy Council will follow up, and its Chief Engineer Jigjiddorj will assume the responsibility. As regard the structure, the current maintenance system of the 4th thermal power station has an adequate execution capability viewed from the points of both technical level and manpower. From Japan side, Consultant and experts as required from manufactures will be sent for the purpose of assuring smooth implementation of the project.

Shown below again is the structure of the 4th thermal powr station:

Table 4-3-1 Structure of the 4th Thermal Power Station



4.3.2 Plan for Further Development of Project

As stated in Chapter 5, paragraph 5.4.5, this Project is scheduled to be completed in Japanese Fiscal Year 1994. The present Project includes the supply of the long life parts as well as the parts which need replacement in a short period.

In view of the above and in order to establish the fundamental power plant operation system, it is quite necessary to carry out the operation of the thermal power stations in the efforts of the Mongolia itself by establishing an appropriate system to receive the necessary expenses institutionally obtainable from tariff system of energy generated from the power station itself and to purchase all necessary materials, machinery consumable or the like from the ex-Soviet Union, East Europe or Western countries including Japan.

4.3.3 Components of Project

Basic design concerning supply of materials and machinery through the grant aid project from Japan must be prepared with regard to the following:

(1) Measures against pluggage in ash treatment system

1) Inside the ESP

2) Associated equipment of the ESP

3) Vacuum car for dust removal

4) Ash treatment system

(2) Measures against wear of pulverized coal feed system

1) Pulverized coal feed system

2) Primary fan

3) Magnetic separator

(3) Atmospheric pollution measurement

1) Dust concentration measurement

(4) Supplemental measures for station maintenance

1) Materials and machinery necessary for maintenance as supplemental measures for (1) and (2) above, as well as for the improvement of the environment of operation and maintenance in the entire power station.

4.3.4 Operation and Maintenance Plan for Further Development of Project

As for the maintenance service to be conducted after completing the project, it is recommended that the Mongolian side will, as a rule, undertake it by making good use of the present operation and maintenance service setup for the current power station and carry out the necessary operation of the station and periodic maintenance, routine maintenance, daily inspection, etc. In addition, the specific recommendation will also be described in the following scheme, with respect to the present operation and maintenance management for modification, which details will be summarized in Section 5.5.

(1) General

1) Inspection of measuring instruments

2) Management of coal

3) Thorough inspection of equipment outside rehabilitation project

4) Preparation of patrol manual

5) Confirmation of prohibition of washing, and performance of dry cleaning

(2) An investigation into the actual conditions of operation, maintenance and management of the following equipment has indicated the necessity for improvement in particular with

respect to the frequency of their inspection and control items. It will be necessary, therefore, to review these items by equipment.

1) Motor-driven reducer for ESP's collector/discharge electrode

2) Air slider canvas

3) Ash level sensor rubber bellows

4) Pumps for ash treatment system

5) Scale measurement of ash slurry pipe and feedwater pipe for ash treatment

6) Primary fan

7) Dust concentration measuring instrument

8) Lighting equipment and replacement of lamp

(3) Follow-up on the use of materials and machinery supplied in the Project.

Inspection and preparation of records will be necessary as to the materials and machinery supplied from Japan to examine and assess the effect of the supply.

4.4 Technical Cooperation

(1) Dispatch of experts from Japan

It is our understanding after due consideration to the state of 4.2.9 (1) in Mongolia and in compliance with the basis of (2) that the dispatch of experts from Japan is necessary. The time of dispatch is preferably in the summer when the load of power stations is comparatively low.

. 2 persons x 4 weeks

. Training items

- Actual conditions of Japanese power stations on whole
- Maintenance conditions in Japanese power stations

It is also our understanding in view of the present state in the Mongolia where only Mongolian language is spoken that the minimum necessary instructions can only be given effectively in a group teaching style with an appropriate interpreter for the Japanese experts.

(2) Training in Japan

For better understanding of the situation of (1) in Mongolia as compared to that of Japan, training at Japanese power stations must also be conducted. It will be ideal if the trainees possess English understanding capabilities. More importantly, it is important that the proposed trainees will be the type of people who are to play central roles in the operation and maintenance of the 4th thermal power station. The time of training is preferably in summer when the load of the power stations is comparatively low.

. 4 persons x 2 weeks (boiler department):
Scheduled in late April 1993

. 4 persons x 2 weeks (electrical department):
Scheduled in late May 1993

. Training items

- Actual conditions of Japanese power stations on whole
- Maintenance conditions in Japanese power stations

(3) Application

Mongolian side shall submit the application for above (1) and (2), in time, at least six (6) months prior to the events.

CHAPTER 5 BASIC DESIGN

CHAPTER 5 BASIC DESIGN

5.1 Design Policy

The design policy for the rehabilitation project shall be as described below:

(1) Basic policy and supply of materials and machinery

1) The object of the rehabilitation project was squeezed down to the measure against the wear of equipment used in the pulverized coal feed sytem of the boiler. The boiler itself, turbine generator and auxiliary machinery of the plant are of course important equipment to assure the improvement of the availability factor. However, they were put outside of this goal, based on a judgement that no procurement can be done in Japan and their urgency is comparatively low.

2) An examination will be made of factors to satisfy the condition that the electrostatic precipitator should be electrically charged and operated as much as possible while the boiler is in operation for the purpose of reducing dust in the smoke emitted from the power station's boiler. Such an exercise will be included in the rehabilitation project.

3) The equipment in the power station is very complicated and will be incorporated into a complex control system and be operated under its mutual interrelationship. Only supplementary measure for maintenance can be supplied from Japanese side.

The availability factor is not always expected to improve with the rehabilitation of 1) and 2). Therefore, minimum necessary maintenance parts in other fields will be supplied to make 1) and 2) effective, taking the result of discussions with the Mongolian side into consideration.

(2) Technical transfer on rehabilitation work

The object facility is presently under operation as the main power station, so that the rehabilitation work must be executed by the timely suspension of 8 boilers in turn. The effective timing being considerably liquid, Japan is in no position to make its adjustment. It is a fact, on the other hand, that maintenance work has already been executed on the Mongolian side in their own way, and that there are no adequate records to show the progress of such work. It will be desirable, therefore, to leave effective execution of the field work in the hands of the Mongolian side.

Taking such conditions into consideration, it will be desirable to execute the work under the self-imposed control by the Mongolians. The work requires no particular technical transfer since there are additions or extensions of maintenance work having been performed to this date by Mongolian hands. As regards the adhesion of ceramics, the pre-treatment of the surface to be adhered is important. With respect ot this aspect, however, guidance has already been given by Japanese experts in Nobemver 1991.

For specific materials and machinery like the vacuum car for dust removal and the dust meauring instrument, however, it would be desirable if guidance could be rendered on their usage even for a limited period of time. Moreover, congestion of work will occur in a certain period of time. It will be necessary, therefore, to monitor the progress of work on a periodical basis while holding consultations on the issue and to provide assistant supervisory service to assure the rehabilitation proejct will be completed within the planned period.

It will be desirable also to send engineers for the inspection of work and for the examination of subsequent countermeasures, on completion of the rehabilitation project.

(3) Education on maintenance

Eductaion will be necessary. As an effective education, taking the receiving system on the Mongolian side into consideration, it will be necessary to start a first step for this purpose, with the widespread recognition that improvement of environment with an emphasis on the improvement of the environment around the boiler's peripheral equipment is closely related to the reduction of accidents, namely the improvement of the availability factor.

(4) Operation and maintenance management plan after implementation of rehabilitation project

Since the operation and maintenance management plan is very important for the rehabilitation project, the key points will be compiled in a sectione 5.5.(2). They should hopefully be implemented by the Mongolian side.

5.2 Study of Design Conditions

In the examination of conditions for the basic design of the rehabilitation project, it was essential to determine materials and machinery which will simultaneously meet with the following principles:

(1) The highest priority shall be given to measures against wear of the coal pulverized coal feed system for the boiler in the rehabilitation project.

(2) Measures shall be taken to recover ESP performance and solve the pluggage of the ash treatment system.

(3) Measures shall be limited to the supply of materials and machinery related to the improvement of the working environment, in particular to those related toward the goal of the rehaiblitation project, such as the measures for preventive maintenance of equipment covering all the equipment in the power plant and the disposal of dust.

(4) The boiler, turbine, generator and other major equipment will be excluded from this basic objective.

The principal items were determined as follows from the foregoings:

(1) Measures against pluggage of ash treatment system

The ESPs have been maintained and operated by Mongolian side. At the beginning of the investigation, a prospect was held so that the ESP would be somehow put fully into service if efforts were concentrated for the cleaning of ash disposal pipes, and materials and machinery were supplied to some degree. The subsequent investigation disclosed, however, that the ash pluggage of the air slider and the trouble of motor-driven reducer for rapping device was unexpectedly intense and the supplies of their associated materials from the ex-Soviet Union were difficult. Therefore, the priority in rehabilitation was changed to their replacement.

According to the request from the Mongolian side, ash slurry pipes were to be installed additionally, one line each, from No. 1 and No. 2 pits to the ash disposal pond, on the ground that ash disposal could not be smoothly coducted due to the clogging of the slurry pipe with scale even when the electrostaitic precipitators were put into service. The ash slurry pipes were cut into halves over a period from March to July in 1991 to mechanically remove the scale inside, which produced unexpectedly good results. Based on the result of a three-month operation, which was concluded in October, additional installation of ash slurry pipes would be unnecessary.

Furthermore, the scale pluggage of the feed water line of the ash treatment system was found quite intense. Anxiety is still held despite the execution of pipe cleaning in hydrochloric acid, which was conducted by the Mongolian side. Consideration will, therefore, be given for the supply of materials and machinery for the installation of a spare line. With respect to the ash slurry valves, it has been concluded that an increase in their quantity would be desirable in consideration of findings of subsequent investigations since the wear by ash slurry is very intense and the supply from the ex-Soviet Union has become unexpectedly difficult.

It has been observed that ash often accumulates in the hopper of the ESP for a combination of causes. It has been concluded that the best solution to assure operation of the ESP will be the combination of vacuum cars for dust removal and cleaning pipes for ash disposal from the hopper as it concurrently serves for the cleaning of the boiler area and ESP hopper room.

(2) Measures against wear of pulverized coal feed system

It was convinced that the best solution for improvement in the availability factor for the boiler would be to take measures against wear of the pulverized coal feed system with materials from Japan, and discussion was held with the Mongolian side to identify specific objects for such measures.

Those suffering from the most severe wear, among others, are the blades of primary fan and 90° pulverized coal pipe bend.

For the measures against wear, patching up with steel plates and welding with hard welding rods have already been done by Mongolian side consuming a considerable amount of labor and cost.

As a result of study, a conclusion has been reached that adhesion of ceramics tile will be best on the work area.

For areas suffering from the most severe wear as mentioned above, Japanese products most stable in quality will be supplied as assembled products.

The adhesive should be selected in accordance with temperature conditions of object equipment in operation. To specify the temperature conditions is difficult. Normally, the temperature is below 100°C throughout the entire system. It was disclosed, however, that the temperature rises to approximately 150°C in the mill and its outlet at the time of start or purging.

(3) Atmospheric pollution measurement

Measurement of dust in boiler flue gas at boiler outlet is the object.

It was said that measurement had been taken by the Russian at the time of taking over of one boiler of seven existing boilers. However, no such record was available. Some of the boilers are not equipped with even measuring holes. The installation of the holes was left with the Mongolian side. A decision was made to supply instruments necessary for measurements of dust since it should usually be done in a coal firing boiler. It is also the strong request of the National Environmental Control Committee.

(4) Supplemental measures for plant maintenance

Since supply conditions from the ex-Soviet Union is extremely unstable, it was decided to mainly select materials and machinery, satisfying the following conditions:

1) The procurement of some of the materials and machinery for the power station from the ex-Soviet Union has already been pushed forward with financial assistance from the United States. Such materials and machinery in scheduled for procurement shall be avoided.

2) Normally every year procurement is made by the power station to the ex-Soviet Union. Such materials and machinery which are apparently going to be obtainable in near future, judging from past results and the progress of negotiations, shall be avoided.

3) Materials and machinery shall be related to the "improvement in the availability factor of the boiler" and the "improvement in the availability factor of the ESP", goals of the present rehabilitation project.

4) Materials and machinery shall be limited to those having urgency for the power station, which will be surely used within one year.

5) Materials and machinery shall, of course, be those made in Japan applicable to the poer station made by ex-Soviet Union.

6) Materials and machinery shall be those to contribute to the improvement of the environment of the entire power station, related to the overall maintenance which can be a back-up and effective for 3) above.

5.3 Basic Design

5.3.1 Measures against Pluggage in Ash Treatment System

(1) Inside the ESP

The causes of reduction of collection efficinecy of the ESP are shown in Fig. 5-3-1 (1).

It can be judged from the figure that the elimination of ash pluggage inside the hopper will be an effective means to improve the availability factor of the ESP and its collection efficiency. An urgent task in order to achieve this purpose will be to secure stable operation of the fly ash disposal system, in particular the restoration of air slider function and the normal operation of the hammer drive device of collecting and discharge electrodes.

The air slider is installed under the hopper of ESP. Since the slider as ash treatment equipment is closely related to the ESP, its description will be given hereunder:

1) Ash pluggage inside hopper

The ash pluggage inside the hopper shall be prevented and the method of pluggage removal shall be streamlined by executing the following 3 measures:

(a) Replacement of canvas for air slider

The decline in the air slider performance is apparently due to pluggage by secular deterioration and due to the opening by sulphuric acid corrosion caused by heavy oil ash and by scratches with the steel pipes at the removal of ash pluggage, judging

from the damage conditions of the canvas (metal screen) presently in use. Therefore, the function of the air slider shall be recovered by replacing the canvas.

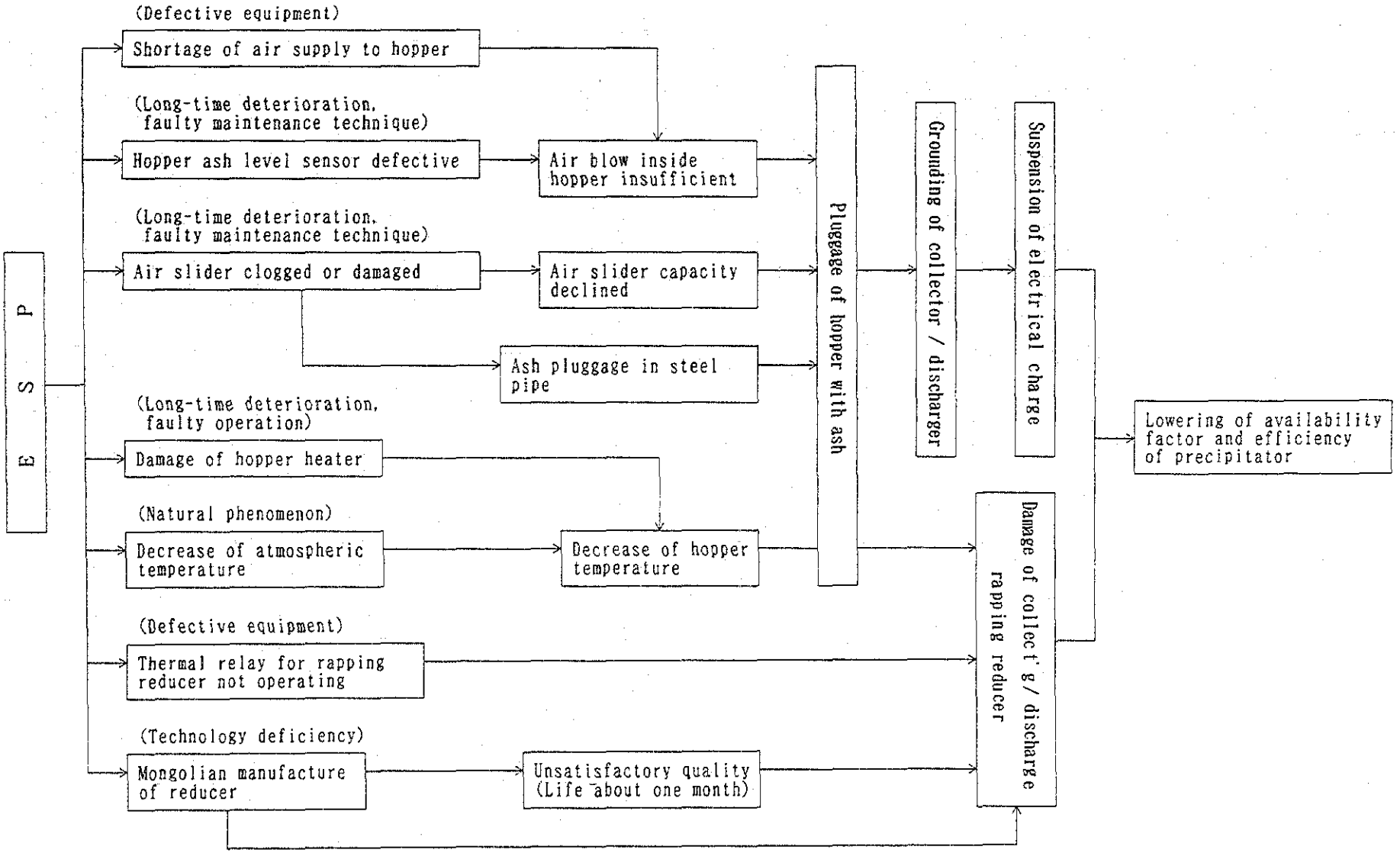


Fig. 5-3-1 (1) Causes in Reduction of Collection Efficiency of Electrical Precipitator

a) Examination of material

The textiles manufactured in Japan presently for the air slider canvas consists of three types, polyester, nylon and aramid. They are entirely different from those presently made in the ex-Soviet Union. The canvas made of aramid shall be adopted, considering its heat-resisting temperature as shown in Table 5-3-1 (1). Because of its resistance to heat, aramid fiber is widely used for the filtration of solids from gas up to 200°C. Though the fiber is excellent in its strength and dimensional stability, it tends to be eroded by the acidic gas under the presence of moisture so that one has to be cautious about this point. That is, care shall be exercised to assure that heavy oil ash will not accumulate on the canvas for a period of duration at an early stage of the boiler operation.

Table 5-3-1 (1) Specification Comparison for Air Slider Canvas

Type / Item	Polyester	Nylon	Aramid	Description
Standard	TR-312	NY-324	CN-330	
Threshold temperature for use	130°C	100°C	200°C	
Resistance to sulphuric acid	△	x	x	
Resistance to aqueous ammonia	x	△	△	
Calcium chloride	o	x	△	
Mineral oil	o	o	o	

(Legend) o: Usable △ : Usable at low density and low temperature;
x: Impossible to withstand

b) Examination of quantity

Quantity

(1) For 13.5 m and 10.5 m long

Amount of equipment = 3 units each/unit

Quantity to be supplied = 60 sheets each

For initial replacement	
3 sheets/unit x 8 unit	= 24 sheets
For replacement two years later	= 24 sheets
Annual replacement ratio	
24 sheets x 0.25 x 2 years	= 12 sheets
Total	60 sheets

(2) For 6.0 m long

Amount of equipment = 2 units each/unit

Quantity to be supplied = 50 sheets each

For initial replacement	
2 sheets/unit x 8 unit	= 16 sheets
For replacement two years later	= 16 sheets
Annual replacement ratio	
16 sheets x 0.5 x 2 years	= 18 sheets
Total	50 sheets

(b) Renewal for hopper ash level sensor

An examination was made in Table 5-3-1 (2) to determine whether the level sensor should be of a totally new type or the replacement for the existing Russian make. Considering the case of maintenance in Mongolia, the paddle type will be the best. It was decided, however, to replace the existing ones in accordance with the examination results by the table.

The rubber bellows (pads) of the hopper ash level sensor of Russian make presently used has thermally hardened possessing a low resistance to heat, and the function of the level sensor has already been lost.

Therefore, the function will be recovered by replacement of the entire quantity. Furthermore, the rubber below supporting rod will be modified to enable fine adjustment of positive recovering force with a spring to assure better functioning of the sensor.

a) Material .... Silicone Rubber

Silicone product shall be adopted due to the high thermal stability in a broad range from -100°C to 250°C and excellent resistance to aging, weatherability and resistance to chemicals. The ambient temperature at the proposed installation point is normally in a range from 100 to 150°C. Table 5-3-1 (3) shows a comparison of rubber quality.

b) Quantity .... 1 m x 2 m x 5 t .... 20 sheets

Table 5-3-1 (2) Comparison of Ash Level Sensors

	Existing rubber bellow type for replacement	Paddle type for renewal	Vibration detection type for renewal
Function	When ash accumulates to a specified level, the bellow will be pushed by its weight to actuate the switch.	When ash accumulates to a specified level, ash will come into contact with the paddle to stop its movement and actuate the switch.	When ash accumulates to a specified level, the emitted sound wave will be reflected to actuate the switch.
Cost ratio	1.0	1.2	2.6
Certainty of detection (detection medium)	Nearly certain (elasticity of bellow)	Certain (mechanical)	Certain (sound wave)
Ease of installation	Easy	Requires some work	Same as the left
Ease of adjustment	Easy (since the type is existing)	Adjustment is not required practically	Adjustment required
Ease of maintenace	Easy	Wears down	Easy
Problematical points	To confirm the operation of rubber bellows	Always in rotation	Emitted at all times

Table 5-3-1 (3) Comparison of Characteristics of Rubber Used for Ash Level Sensor

Item \ Name	Silicone rubber (Q)	Fluoro rubber (FKM)	Synthetic natural rubber (IR)	Note
Hardness Tensile strength Elongation Impact resilience	30 - 90 - 100kg/cm^2 500 - 50% ◎	40 - 90 - 200kg/cm^2 500 - 100% △	30 - 100 - 250kg/cm^2 1000 - 100% ◎	Unit-JIS-A
Resistance to wear Heat resistance Cold resistance	◎～△ 200 -70 - -120°C	◎ 250 -10 - -40°C	◎ 70 - 80 -50 - -70°C	Highest service temperature
Price ratio	1.0	2.5	0.1	

(c) New installation of air hammer

The purpose of the installation of the level sensor is to discharge ash from the outlet of the hopper by giving a sort of shock to the ash accumulated in the hopper through signal from the level switch. As for the method of giving shock, an air blow type shocker have been installed as existing equipment. To assure the discharge of ash from the hopper, air hammers will be newly installed in the front 2 rows (equivalent to 6 hoppers for a boiler) for operation by changeover (or simultaneously).

The reason for specifying the front two rows is the large possibility of accumulating a lot of ash in that area. Also, the reason for double installation along with the existing air blow is that the shock effect is slightly faulty despite the desire to effectively utilize the ones existing as far as possible.

Shown in Table 5-3-1 (4) is a comparison with the ones existing. A conceptual scheme of the air hammer is shown in Fig. 5-3-1 (2).

Table 5-3-1 (4) Comparison of Air Shockers

	Existing device of air blow	New installation of air hammer	Remarks
Function	Level switch will actuate solenoid valve, and air will be blown into the hopper to give shock to ash therein	Level switch will acatuate solenoid valve, and shock will be given from the outside of the hopper	
Ease of installation	Unnecessary (existing)	Easy	
Certainty of operation	Certain	Certain	
Shock effect	Slightly faulty	Certain	
Adjustment of shock force	Impossible	Possible	
Selection of installation point	Necessary to re-confirm the existing location	Necessary to investigate	
Air pressure required	5 - 6 kgf/m^2	6 - 7 kgf/cm^2	Connect to compressor of page 5-22

The quantity to be installed shall be 4 units for each hopper, namely, 6 hoppers/a boiler x 4 x 8 boilers + 8 spare units = total of 200 units.

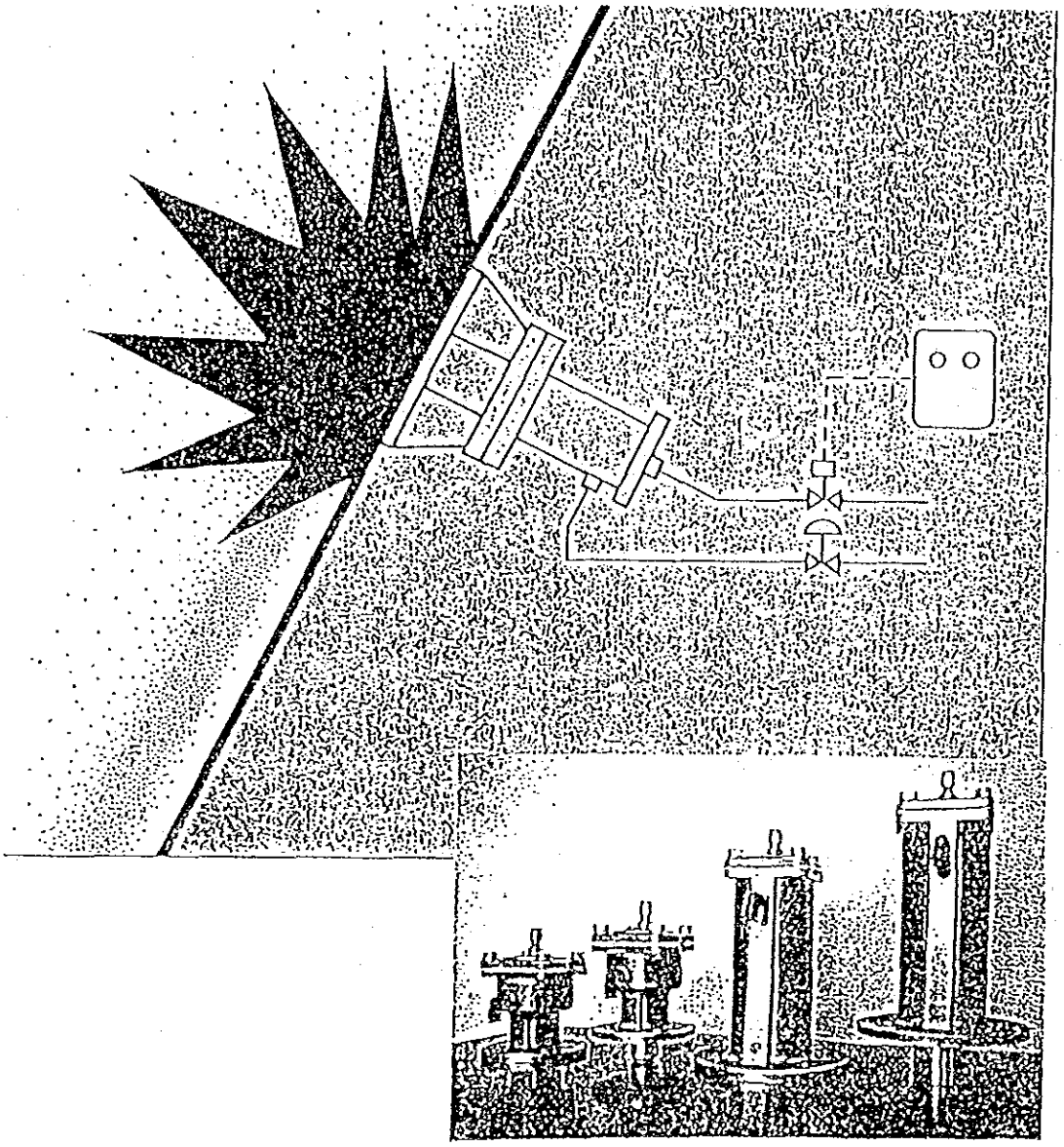


Fig. 5-3-1 (2) Conceptual Scheme of Air Hammer

(d) New installation of ash removing apparatus for air slider

The ash in the hopper will drop down intermittently for transfer to the air slider. Steel pipes are used to remove ash when the air slider is plugged with ash, causing the opening of canvas. An ash removing

apparatus including an air compressor will be installed to prevent the opening and solve the shortage of ash blow air when the ash level sensor is actuated.

An air source device has been already installed in the power station as a common house facility and the piping is laid out from there. However, the air pressure is as low as 1.5 to 2 kgf/cu.cm. The cause of such low air pressure itself should be checked out and proper maintenance should be made. For the time being, a separate air source shall be supplied exclusively for the prevention of ash pluggage of ESP. The device is temporary by nature. No ash pluggage will occur if the distribution with the floating air pressure of air slider were adequately adjusted.

a) Three package compressors (1.1 m^3/min x 7.0 - 8.5 kgf/cm^2) shall be installed, one each for boiler No. 1 to 3, 4 to 6, and 7 and 8. Each compressor shall be kept in the ESP hopper room. Being of a portable type, they will not require any foundation work.

b) Air source (quantity and pressure) shall be secured by installing air headers connected to the compressors (350ø x 10 m) in each ESP hopper room

c) Air nozzles (couplers) shall be installed at an interval of approximately 1 meter on the top cover of each air slider, and they shall be connected to the air source for operation as the need arises. While the ESP is in operation, the air source will be used to blow air into the hopper or to drive the air of the shocker.

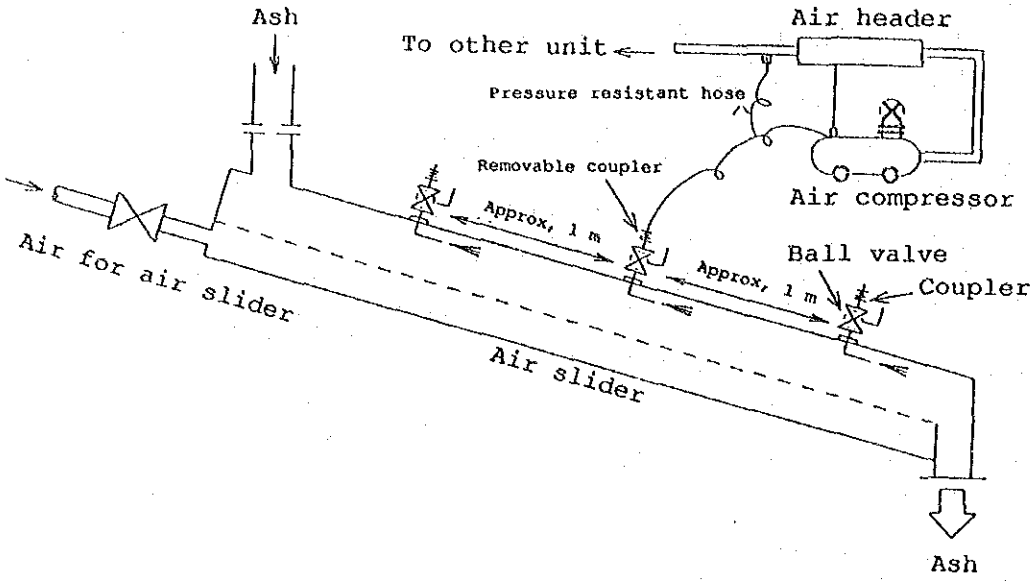


Fig. 5-3-1-(3) Schematic Drawing Showing the Process of Removal of Ash Plugged at Air Slider

(2) Associated equipment of ESP

Troubles in the motor-driven reducer for rapping device for collecting electrode and discharge electrode topped among the causes of suspension of the electrostiatic precipitator. The reduction gears of the motors made by the ex-Soviet Union and Mongolia, as substitutes for the former, are weak against hyperload and break down easily since they are based on the planetary gear system. It would be appropriate if the whole quantity (140 units) excluding the Unit #8 could be replaced with a Japanese make, out of the total installed motors, 160 units (20/unit x 8 units). That is, the quantity to be supplied will amount to 140 units + 20 units for spare = 160 units.

Prior to the replacement of the Russian makes (or Mongolian makes) with Japanese makes, it will become necessary to conduct some detailed investigation to suit with local conditions, including the adjustment of installation point and hammering force.

(3) Vacuum car for dust removal

Two vacuum cars for dust removal will be supplied for efficient removal of ash adhering to the inside of the ESP hopper or for ash pluggage in the short term upon periodic inspection or upon start-up after a long suspension.

The interior of the plant house of the power station is thickly covered with pulverized coal and dust, centering around the vicinity of the boiler, which presents not only an inferior environment for operation and maintenance, but also worsens the operating environment for facilities. Moreover, they are washed clean once in a while so that electrical installations are adversely affected by the water. The vacuum cars will prove to be effective for the improvement of such conditions.

Air volume ..... 90 - 100 m^3/min
Air pressure ..... 450 - 740 mmHg
Capacity ..... 5,000 to 7,000 liters
Engine type ..... Diesel (11-ton car)
Dust collecting ..... Changeover system (dry or wet)

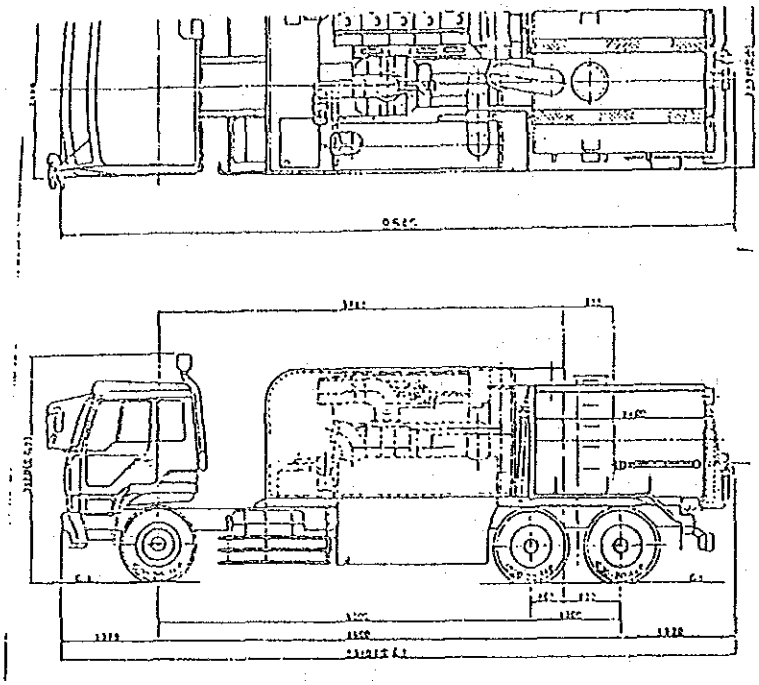


Fig. 5-3-1-(4) Schematic Outline of Vacuum Car for Dust Removal

(4) Ash treatment system

The major defective parts of the ash treatment system can be broadly classified into the followings:

Major defective parts	Ash disposal line	Feed water line
Pumps	Wear of impeller, casing, etc.	Scaling
Valves	Wear of valve seat, etc.	Scaling
Piping	Scaling	Scaling

Measures for device are shown in Table 5-3-1-(5). The ash disposal system onward is discribed under the columns, "Measures" and "Supply of materials and machinery", of the table, which consist in essence of the following 3 items.

1) The scaling in each system is unavoidable by nature of the sytems. No particular hindrance will be caused for operation of the boiler if the condition of scaling were periodically checked and cleaning executed whenever necessary by installing a spare line.

2) Considering pluggage of slurry and the scaling, it will be necessary to prevent the sedimentation and hardening of slurry as well as dead water by periodically executing changeover operation in the pump's operation control. Based on the situation, 1 week or thereabouts will be an appropriate frequency for the periodical changeover of each pump.

3) In the maintenance of each equipment, a strict execution of preventive maintenance is requested to prevent the occurrence of trouble, instead of conducting repair work. In consequence, it will be necessary to fully understand that preventive maintenance is the best way to keep the long lives of devices.

Table 5-3-1-(5) List of Troubles in Ash Treatment System and Countermeasures Therefor

System	Devices	Trouble item	Particulars of trouble	Measures	Supply of materials and machinery	Remarks
Bottom ash line	Screw conveyor	Bite-in of foreign substance	Operation is suspended due to the bite-in of iron substance	Repair is impossible while the boiler is in operation. Execute repair work whenever necessary.	None	
		Oil leak from reduction motor	Oil leak due to the loosening of mounting bolts of reduction motor	(Ditto) Obligate inspection and maintenance as preventive measures before occurrence of damage to devices.	None	
	Illumination of devices	Illumination around bottom hopper is insufficient.	Illumination of device is insufficient (nearly pitch-black), so that it is impossible to check whether devices are in good condition or not.	Reinforce illumination facility to secure adequate illuminance to grasp the condition of devices	. Supply of illumination facility	
Fly ash line	Air slider	Decline of performance	Canvas for air slider is clogged up, or opening is caused.	Replacement of canvas and obligate the periodic inspection and maintenance	. All canvas for air slider .. for 2 years	
	ESP hopper	Ash level sensor inside hopper is defective.	Malfunction of rubber bellows of ash level sensor from deterioration and hardening.	Replacement of rubber bellows, and obligate the preventive replacement by prior inspection New installation of air hammer	. Silicone rubber bellows in all quantity ... for 2 years . Air slider .. 200 units	
		Heating device	Being of electric heater type, the wire is burnt and broken through the use while the boiler is in operation.	Strictly obligate proper operation control, non-use while the boiler is in operation	None	
	Air slider hopper	Shortage of air source, its volume and pressure at occurrence of ash clogging	Air blow at actuation of ash level sensor, and air to remove ash clogging of air slider are in short supply in both volume and pressure, thus failing in serving their purposes.	. Secure air supply by new installation package compressor and piping. . Improve the efficiency of ash removal operation by installing coupler type air nozzles on the top cover of air slider at an interval of one meter	Package compressor ... 3 units Piping ... 1 set	

System	Devices	Trouble item	Particulars of trouble	Measures	Supply of equipment and materials	Remarks
Feed water line	Ash slurry channel of fly ash line	Impossible to clean booster nozzle feed water pipe	Impossible to repair water feed pipe when it was plugged with scale since it consists of one line.	Increase booster nozzle feed water pipes to two lines to enable to stop a line for repair	Pipe and valve: 350A ... 1 set 65A ... 1 set	
	. Feed water pump suction pipe . Ash slurry channel booster nozzle feed water pipe	Formation of scale inside pipe	Scale is formed quickly inside the feed water pump suction pipe, necessitating removal at a rate of once a year or thereabout and thus affecting the operation and maintenance. The ash slurry channel booster nozzle feed water pipes are of small diameter, and their cleaning by hydrochloric acid is impossible because of the system so that they tend to get plugged with scale.	Supply an electric motor type scale removing device in combination with the flexible hose and cutter. - for large diameter - for middle diameter	Removing device ... 1 unit Cutters for large diameter (300φ to 1,200φ) ... 3 sets Cutters for medium diameter (60φ to 300φ) ... 5 sets	
Pressure gages for inlet and outlet of pumps	Pressure gage	Lack of pressure gages for each pump	Some of the pumps are not equipped with pressure gages at the inlet and outlet, and even if equipped the indication is not reliable due to the pluggage of detection tubes. Consequently, it is impossible to manage the operation of devices, such as grasping operational conditions of pumps and increasing pressure drop due to scaling of pipes, etc.	Replace all the pressure gages at outlets and inlets of pumps such as the feed water pump (4 units), feed water booster pump (5 units) and ash disposal pump (6 units). Also replace detection tubes with ball valve type straight pipe with diameter of 1/2B to enable them to be cleaned.	Pressure gage ... 1 set Detection tubes ... 1 set	
Cleaning device around boiler ESP	Cleaning pipe	Fouling of boiler room with accumulation of pulverized coal, and fouling of ESP hopper room with ash	. The scattering and accumulation of coal dust in the boiler room have caused environmental inadequacy and fire safety hazards etc. . Ash infiltrates into electric panels and other devices in ESP room to cause damage to such devices.	Install cleaning pipes in the boiler room and ESP room, and carry out cleaning systematically jointly with the aforementioned vacuum cars for dust removal, for the conservation of surroundings, prevention and early detection of trouble in devices.	Boiler room cleaning pipe ... 1 set ESP hopper room cleaning pipe ... 1 set	

System	Devices	Trouble item	Particulars of trouble	Measures	Supply of materials and machinery	Remarks
Ash disposal line	Slurry pit water level control	The wear of valve is accelerated and the operator is constantly assigned by the valve.	Since pit level is constantly observed and controlled through manual operation of the ash slurry pump outlet valve for both No. 1 and No. 2. . Constant standby of operators . Wear of pump outlet valve is accelerated.	Achieve no-man control of pit level for both No. 1 and No. 2 by installing make-up water control valve into feed water line and wear resistant valves into outlet of ash slurry pumps. Strictly obligate full open operation of pump outlet valves to prevent the wear of valves.	Piping (200A) ... 2 sets . Constant level valve (200A) ... 2 units . Wear resistant valve (400A) ... 2 units . Wear resistant valve (300A) ... 2 units . Stop valve (200A) ... 4 units Level gage (100A) ... 2 sets	
	Outlet valves for ash slurry pump	Impossible to fully close outlet valves because of their wear and opening	Impossible to fully close because of wear and opening caused by secular deterioration and control use for the level of the pit water, making the isolation of pump difficult and delaying repair work.	Reinstate to normal valve condition by replacing outlet valves of No. 1 and No. 2 ash slurry pump. Strictly observe fully closed or fully open operation of valves in case of performing maintenance of pumps without hindrance.	No. 1 ash slurry pit pump: . Outlet valve (400A) ... 11 units No. 2 ash slurry pit pump: . Outlet valve (300A) ... 7 units	
	Gland packing for ash slurry pump	Use of inadequate specification packing	The life of the gland packing is shortened and the gland sleeve is prematurely damaged, heightening its frequency of replacement, since non-specified gland packings are used due to the shortage of specified packings.	Supply gland packings of adequate size matching with the slurry. . length: 3 m/roll . size: for No. 1; 27 x 27 mm No. 2; 22 x 22 mm	For No. 1 ash slurry pump ... 20 rolls For No. 2 ash slurry pump ... 20 rolls	
	Ash slurry pipe	Formation of scale inside pipe	Scale is quickly formed in outdoor slurry pipes from the ash slurry pump outlet to ash disposal pond. Removal is necessary at least once every year.	Both the main pipes and spare pipes for No. 1 pit were cut, open and mechanical removal was performed during March to July, 1991, so that no problem exists at present. A periodical check will be necessary for such removal.	None	

5.3.2 Measures against Wear of Pulverized Coal Feed System

The following are conceivable as the causes responsible for abnormal wear of the pulverized coal feed system:

(1) Ordinary mild steel (equivalent to SS41) is used for all pipes including their bends. Instead, materials highly resistant to wear like Cr cast iron are used for the bends in Japan.

(2) Coal contains a lot of foreign materials such as stones and pieces of metal. They are pulverized and flown through the pipes at a high speed. To worsen the matter, the pulverized coal system is not equipped with any device to remove stones or metal pieces. It can be well anticipated that the interior of the mill and mill bowl will be worn at a considerably high speed.

(3) Since the electrostatic precipitator is not normally operated, a great amount of ash finds its way into the pulverized coal system which utilizes the combustion gas of the boiler to dry coal. This accelerates the wear of pulverized coal pipes.

(4) The flow speed of pulverized coal transported by the primary fan is very fast, which is seemingly due to the non-adjustment of unbalanced flow speed among the pulverized coal.

1) Measures against wear of pulverized coal feed system

(a) Examination of wear resistant materials

Materials having resistance to wear, like Cr cast iron, are used in Japan for portions where intense wear is predicted as in the pulverized coal system. For portions where intense wear is predicted, such as the burner nozzle and pulverized coal pipe bend, measures are taken to withstand wear by means of bonding ceramics. Since, mild steel is adopted for such portions resistance to wear is almost equivalent to zero.

Though there are a variety of methods to give resistance to wear for the pipe bend, the portions with intensive wear will be lined with ceramics tiles for reasons enumerated below: Table 5-3-2-(1) shows a comparison of wear resistant materials.

a) Ceramics are the hardest and have a long life. Fairly satisfactory results have been obtained by thermal power stations in Japan.

b) Being weak against impact, special cast iron will crack at the 4th thermal power station where small explosions occur at times. (If a ceramic lining were used, the shock would be absorbed to a certain extent by mild steel and adhesive.) There is also a danger of pulverized coal spurting out when a shift occurs in the coupling with straight pipe.

c) Ceramic is the lightest and easy to handle. It will not require any additional support, and is easy to transport.

d) Unless the bend is cut open and checked, its accurate range of repair will not be known since the internal damage is very complicated. Being of small piece sized 20 mm aquare, ceramic will enable flexibility irrespective of the conditions of internal face.

e) A tendency is observed among thermal power stations in Japan that wear resistant cast iron is to be replaced with ceramic tiles bonded to ordinary steel for application to locations where wear is expected to occur.

Table 5-3-2-(1) Comparison of Wear Resistant Materials

	Ordinary steel pipe (reference)	Cr cast iron pipe	Ceramics tile	Special metal lined clad steel
Hardness (Vickers hardness)	HV 130 - 300	HV 620	HV 1350	HV 620
Relative wear	17	9	1	9
Weight (per m^2)	78 kg/m^2 (Thickness 10 mm)	78 kg/m^2 (Thickness 10 mm)	22 kg/m^2 (Thickness 6 mm)	94 kg/m^2 (Thickness 12 mm)
Cost ratio (per m^2)	1.0	1.8	14.0	2.0
Characteristics in application	-	A special joint is required for junction with the straight pipe. Welding is impossible.	By bonding. Meticulous care is required for surface treatment. Pipes bonded with tiles can be welded.	By welding or bolt mounting. Additional support is required because of its extra weight.
Measures against wear	-	Build-up welding impossible. Must be replaced.	To be replaced. However, resistance to abrasion is so high as to make such replace-ment unnecessary.	Build-up welding is possible.

(Note) In case of boilers, ceramics tiles are bonded half around ordinary steel pipe, which should be taken into account when comparing the cost and weight.

(b) Examination of application location

Judging from the conditions of repair as described in Chapter 4, the locations to which measures against wear should be taken shall be where the flow of pulverized coal bumps hard against, namely, the following:

a) Pulverized coal pipe at mill outlet
b) Cone of classifier
c) Pulverized coal pipe at classifier outlet
d) Inlet of cyclone separator
e) Primary fan blades
f) Pulverized coal pipe bend

According to Mongolian person responsible for maintenance, the priority as seen from the frequency and extent of repair will be as follows:

e-f-b-a-c-d

This also indicates the priority to be given for execution.

Shown below is the order in areas requiring measures against wear. (e) is excluded since it is not executed at site.

f-a-c-b-d

This also indicates the order of detailed design to be prepared with care before execution. Since ceramics tiles are expensive, an extra care will be required in the selection of locations requiring bonding as the area becomes larger.

At any rate, all the above locations will require execution to improve the availability factor of the boiler (to reduce the shut down of the boiler due to

trouble in the pulverized coal feed system). As regards (e), a separate study will be made in 2) as it involves a high speed rotor. All other items will be studied in 1) in a package.

(c) Examination of ceramic material

Materials with ample hardness and toughness are selected for those having resistance against wear. Generally, in the characteristics of ceramic for mechanical purpose, there are mechanical properties, thermal properties, electrical properties, optical properties and chemical properties, in which the properties required as materials resistant against wear of boiler are the mechanical and thermal properties. After all, alumina sintered is the one rich hardness and toughness. It is typical as one possessing high hardness at a high temperature.

Nitride silicon with a high bending strength, toughness and resistance to impact is desirable for application to locations which are likely to be exposed to external pressure and impact. A comparison of mechanical and thermal properties is shown in Table 5-3-2-(2).

Table 5-3-2 (2) Comparison of Ceramic Materials

	Alumina	Silicon nitride	Silicon carbide	Aluminum nitride
Density g/cm^3	3.6 - 3.9	2.7 - 3.2	3.1	3.3
Coefficient of thermal expansion 10^{-6}·C	7 - 8	3.2 - 3.6	4 - 5	4.6
Coefficient of thermal conductivity W/m·k	17 - 25	17 - 29	40 - 80	150 - 250
Modulus of elasticity 10^5MPa	3.0 - 3.8	2.3 - 2.7	3.8 - 3.7	3.2
Hardness HV, RT1200°C	2000-2100	1600-2100	2000-2500	1200
Bending strength MPa, RT	340 - 780	490 - 980	590 - 780	300 - 400
Compressive strength MPa	1960-2940	1960-3920	-	2250
Practure toughness MN/m$^{3/2}$	3 - 6	4 - 9	2 - 4	3.5
Resistance to thermal impact Tc°C	200 - 300	600 - 900	300 - 500	600
Limit in working temperature °C (in air)	1700	1200	1400	1000

Based on the foregoing, alumina ceramic will be selected mostly for the wear resistant material, its specification is as listed below:

Main component: Al_2O_3 (alumina) 92%
Highest working temperature: 1,400°C

The ceramic shall be sized 20 x 20 x 6 mm.
Considering the ease of work, however, a portion equivalent to 0.4% shall be sized 20 x 10 x 6 mm.

(d) Selection of adhesive

The following 2 adhesives are best suited to bond ceramic against the steel plate: Table 5-3-2-(3) shows a comparison of the both.

Epoxy type is a typical adhesive used in the bonding of practically all materials while silicone type is made up by combination of inorganic compounds and organic ingredients.

There are 2-liquid type used by mixing with hardener, and a single liquid type readily mixed with hardener. The single liquid type will be desirable for field use in the present rehabilitation project since one will be freed from bothering the mind about the mix proportion.

. Epoxy type
. Silicone type

From the point of its resistance to heat, the epoxy type would better be used for locations with ambient temperatures below 100°C. Its adoption was favorably considered from the viewpoint of cost. It has been decided, however, to use the silicone type with exception of some special cases, considering the temperature at times goes up to 150°C at the exit of the mill though it will be very limited time-wise like when starting the boiler, and the temperature also rises locally due to frequent small fires and explosions in the pulverized coal system as a whole. The epoxy type will be used for the primary fan blades and for pulverized coal pipes with a 90° bend. The silicone type is widely used in the chemical industry, electronic information industry, automobile industry and construction industry.

Table 5-3-2-(3) Comparison of Adhesives for Ceramics

		Epoxy type	Silicone type	
Major ingredient		Organic	Inorganic + organic	
Appearance		L.R	S	L: Liquid P: Paste S: Solid
Method of hardening		Hardening at room temperature/ thermal hardening	Hardening at room temperature	
Working characteristics	Heat	+	0	0: Depends on situations +: Necessary -: Unnecessary
	Pressure	-	+	
	Time	+	+	
Resistance	Shearing	gg	g	e : Particularly excellent gg: Fairly excellent g : Excellent
	Peeling	g	-	
	Heat	g (Hardening at room temperature: - 100°C) (Thermal hardening: - 190°C)	e (- 250°C)	
	Hot water	-	-	
	Acid	-	g	
	Alkali	-	g	
Cost ratio		1.0	8 - 10	

The epoxy type adhesive will be used for the primary fan blades and the pulverized coal pipes with a 90° bend. The reasons are as follows:

a. Bonding will be conducted under strict control in Japan.

b. The temperature will never rise over 100°C at both locations. Hardening at room temperature will be sufficient for the primary fan blades. For the pulverized coal pipes, however, the resistance against heat will be increased by adopting thermal heat bonding in consideration of the outbreak of small fires or explosions.

c. Satisfactory results were obtained in thermal power stations in Japan.

d. Widely used as a satisfactory adhesive in Japanese factories.

e. Low price

f. Adhesive force is stronger than that of silicone type adhesive.

(e) Application of ceramic tile to mill outlet pipe

The lining with a special metal lined clad steel plate (Refer to Table 5-3-2-(1)) was considered in the beginning as measures against wear of the mill outlet pipe. For the reasons given below, however, the lining with ceramic tile was finally adopted:

a) If the silicone type adhesive were used, it will withstand heat up to 250°C. (The special metal lined clad steel plate was to be used since the epoxy type adhesive originally planned will not withstand the heat at the mill outlet, which goes

up to maximum of 150°C. It was revealed, however, that the silicone type adhesive can be used safely).

b) Ceramic tiles are harder and longer in life as compared with the special metal lined clad steel plate. (The Vickers hardness of ceramic tile is HV1350 as against HV620 of special metal lined clad steel plate.)

c) The ceramic tile lining weighs approximately 1/5 the special metal lined clad steel plate.

The unit weight of the ceramic tile lining for mill outlet is 355 kg (5,680 kg for eight boilers) while the same of special clad steel plate lining is as heavy as 1,587 kgs (25,392 kgs for eight boilers).

If lined with the special clad steel plate, each outlet pipe will require a support for the weight, giving a considerable burden to the surroundeing structures.

Considering the cost of transportation, the cost of both will be the same.

(f) Examination of location of execution and quantity of ceramic tiles to be supplied

a) Mill outlet pipe

Ceramic tiles will be lined in 30° bends immediately after the mill outlet where the wear in the most conspicuous. A conceptual drawing showing the execution area of mill outlet pipe is presented in Fig. 5-3-2-(1). Though the pipe has an outside diameter as large as 1.62 m, only half of the internal face will be lined in principle as shown in the figure.

The lining area amounts to 16 m^2 per piece. Since the mill outlet pipe of 8 boilers number 16 pieces, the total lining area will amount to 256 m^2.

b) Classifier

The lining will be given to the lower half of the internal cone of inlet, which is marked with the most severe wear. Shown in Fig. 5-3-2-(2) is the conceptual drawing of execution area of the classifier.

The lining area amounts to 7.5 m^2 per piece. Since there exist 16 units for 8 boilers, the total lining area will amount to 120 m^2.

c) Classifier outlet pipe

The lining will be given to the upper half of the 50° bend of the outlet pipe, where the wear is the most severe. Shown in Fig. 5-3-2-(3) is the conceptual drawing of the execution area of the outlet pipe.

The lining area amounts to 10 m^2 per piece. Since there exist 16 pieces for 8 boilers, the total lining area will amount to 160 m^2.

d) Cyclone separator

The lining will be limited to 90° portion of the side wall at the entrance, where the wear is the severest. Shown in Fig. 5-3-2-(4) is the conceptual drawing of the execution area of the cyclone separator.

The lining area amounts to 6.2 m^2 per unit. Since the power station has 16 units, the total lining area will amount to 100 m^2.

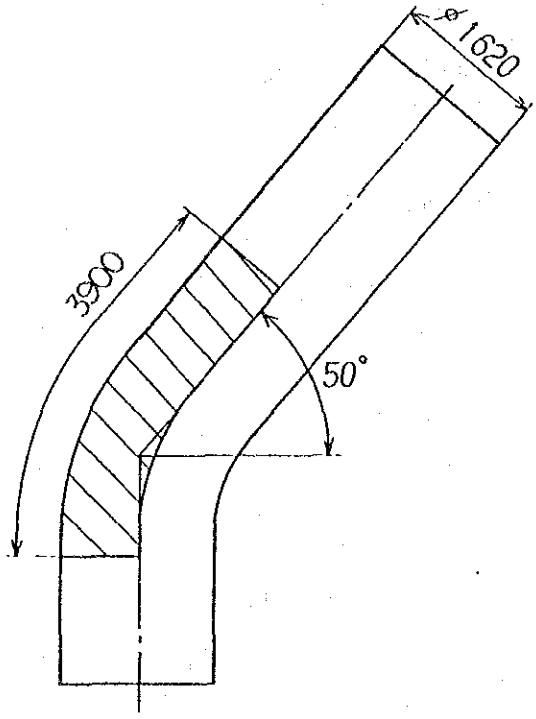


Fig. 5-3-2-(1) Conceptual Drawing Showing Execution Area at the Outlet of the Mill

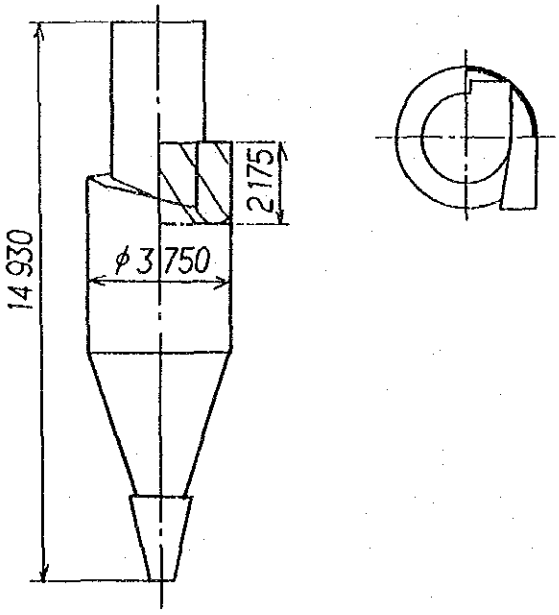


Fig. 5-3-2-(2) Conceptual Drawing Showing Execution Area for Classifier

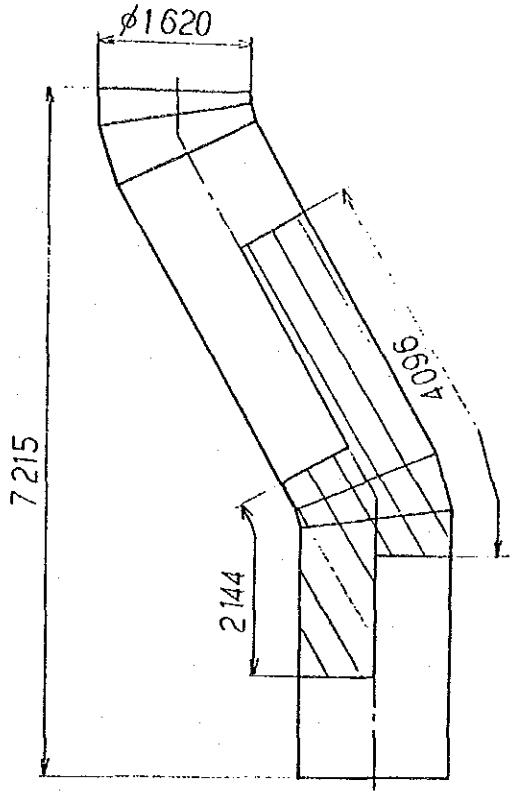


Fig. 5-3-2-(3) Conceptual Drawing Showing Execution Area for Classsifier Outlet Pipe

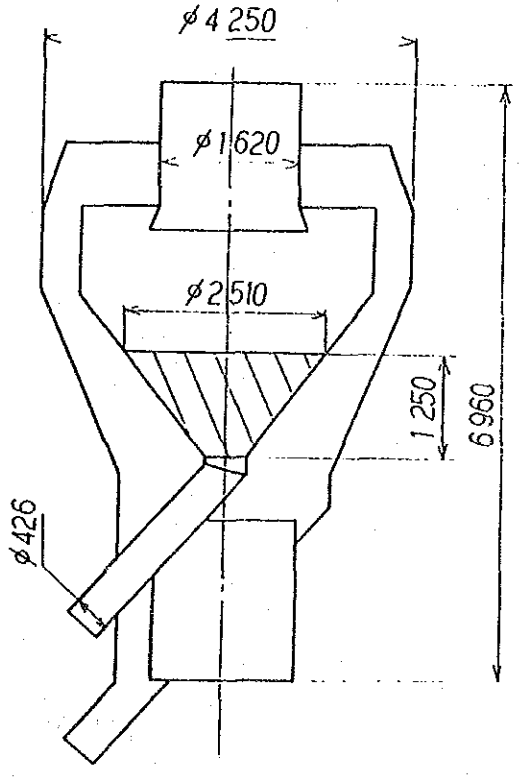


Fig. 5-3-2-(4) Conceptual Drawing Showing Execution Area for Cyclone Separator

e) Pulverized coal pipe

With respect to bends having angles greater than 30° and thus having intensive wear, the lining will be given only to the outer half of the internal circumference of pipe. A conceptual drawing showing the execution of lining is shown in Fig. 5-3-2-(5).

With respect to bends not modified (that is, normal bends), the lining will be given from 50 mm ahead of the inlet to 200 mm past the outlet. (For 30° bends only, the lining will be extended to 550 to 700 mm from the outlet. To the plane of projection of inlet pipe).

For those box-shaped after modification (namely, plate type bends), the lining will be given to the curved face of the external periphery and up to 2 rows of tiles on the side.

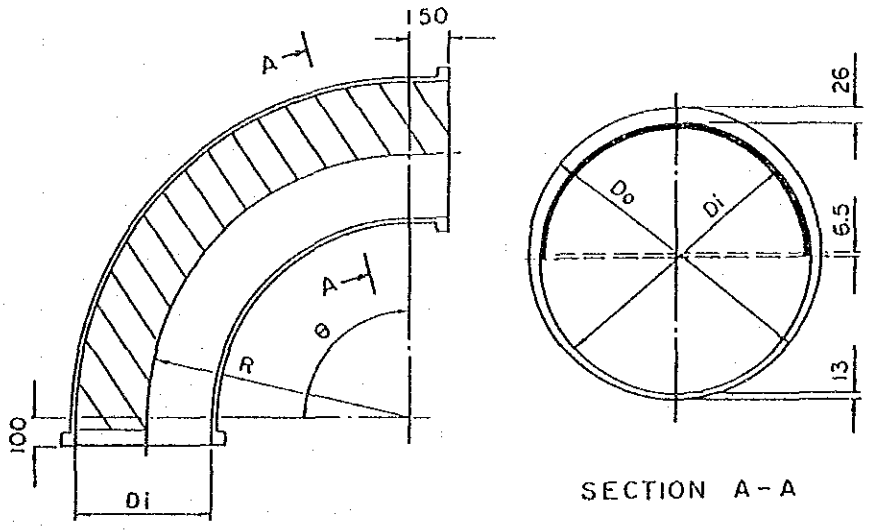
For only 90° bends, completed linings will be supplied from Japan for the following reasons:

1) All the lining work could be completed within the period of a month-long periodical maintenance. However, it will not give much time allowance. The time schedule will become adequate if the 90° bends where delivered in the form of completed products. (It would suffice if the lining were given to a little less than 60 pieces a month).

2) In the case that completed linings are supplied, a problem lies in the dimensional consistency with existing piping. Because only 56 linings are needed in all boilers, there will be little difficulty in obtaining

detailed data concerning dimensions, amounts, etc.

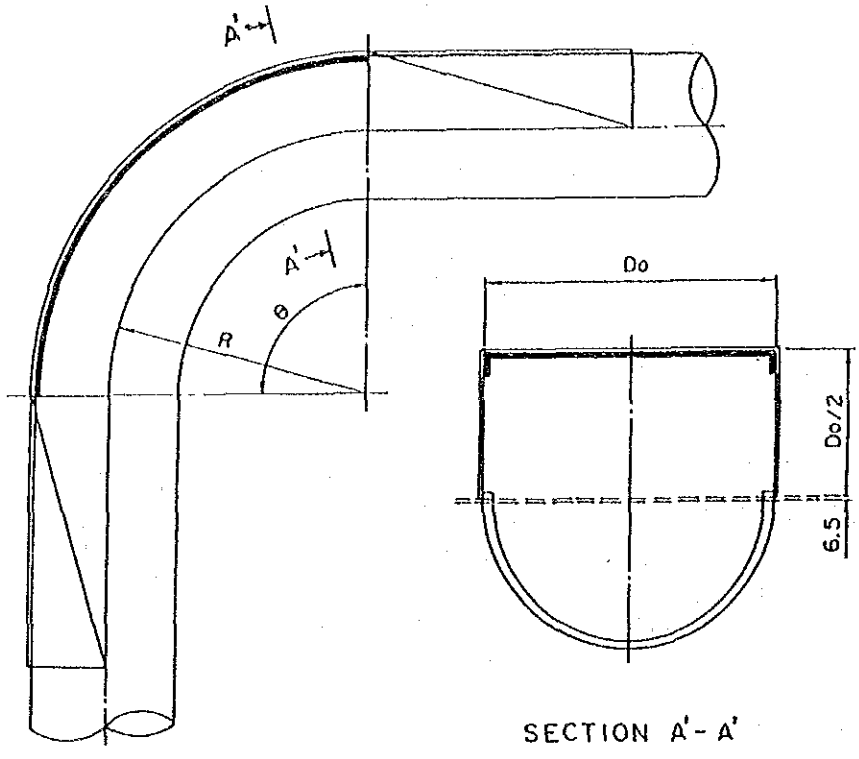
3) A high quality is demanded since the angle is the most severe among other conditions. The quality can be guaranteed if they were manufactured at a factory in Japan under adequate control.



(Unit: mm)

Caliber / Code	ø425	ø478	ø530
Di	405	458	510
Do	444	497	549
R	800	900	1,000

Fig. 5-3-2-(5) Conceptual Drawing Showing Execution Area for Normal Bend of Pulverized Coal Pipe



* Each dimension is the same as the normal bend.

* When the station was constructed, all bends consisted of curved pipes. Later, however, those plentiful with pulverized coal leaks were modified to plate type to assure easy repair.

Fig. 5-3-2-(6) Conceptual Drawing Showing Execution Area of Plate Type Bend of Pulverized Coal Pipe

f) Quantity of supply of ceramic tile and other adhesive materials

The ceramic tile areas from a. to e. total 949 m^2. Adding a little allowance to it, 1,000 m^2 of ceramics tile will be supplied.

The following materials will become necessary for the bonding of these tiles at the site:

Table 5-3-2-(4) Areas Requiring Ceramic Lining for Bends

Angle \ Caliber		ø425		ø478		ø530	
		Standard area	Quantity	Standard area	Quantity	Standard area	Quantity
72°C	Normal	0.64	22 (5)	0.80	23	0.97	60 (12)
	Modified bend	0.66	3	0.82	43	0.99	5 (3)
60°C	Normal	0.55	21	0.69	6	0.83	26
	Modified bend	0.55	4	0.68	27	0.83	4
45°C	Normal	0.44	9	0.54	14	0.66	59 (1)
	Modified bend	0.41	1	0.51	28	0.62	0
30°C	Normal	0.48	16 (2)	0.62	14	0.75	38
	Modified bend	0.28	2	0.34	22	0.41	2
Lining area		42.4 m^2		114.2 m^2		156.3 m^2	
Total lining area		313 m^2					

*1 Bends for which linings were executed as an emergency measure in the winter of 1991 are not included. The quantity is shown in parentheses.

*2 90° bend pipes are not included here since they will be supplied in the form of a completed product.

Table 5-3-2-(5) Quantities of Bends (Number of Pieces)

Caliber / Angle	ø425	ø478	ø530
	Unit Nos. 1 to 3	Unit Nos. 4 to 8	
90°	7	3	4
72°	22	6	16
60°	11	5	6
45°	14	2	12
30°	12	4	8
25°	6	4	2
Total	72	24	48

a. Adhesive

Silicone type

Since 24 liters were required in the bonding of 20 m^2 odd of tiles in the urgent measure (December 1991), it will suffice if 3,000 kgs were supplied.
Quantity close to this amount will be supplied in standard drums of the manufacturers.
Deacetone type (Non-corrosive type)

b. Cleaning agent

Nonpoisonous, incombustible type

Based on the actual consumption in the urgent measure, 3 kiloliters will be supplied.

Quantity close to this amount will be supplied in standard drums of the manufacturers.

c. Primer

Agent for surface treatment for adhesive. Based on actual consumption in the urgent measure, 100 liters will be supplied.

d. Spray-type cleaning agent

Based on actual consumption in the urgent measure, 2,000 pieces of 400 g to 500 g/pieces will be supplied.

e. Grinder disk

In the urgent measure, the surface treatment of 20 m^2 required 250 sheets. According to a calculation based on the actual consumption, the project will require 12,500 sheets. It will be cut down to 12,000 sheets (100 mmø x 10,000 sheets, 180ø x 2,000 sheets), considering some loss in the beginning.

2) Measure against wear of the primary fan

Wear of the primary fan blades has been caused by impact of solids like pulverized coal and ash contained in carrier gas against the blades, which brought about their erosiion. The following 4 items can be considered countermeasures:

(a) Minimize the contents of solids in carrier gas

(b) Slow down the speed of carrier gas to lessen the energy of impact

(c) Change the blade material to those having resistance to wear.

(d) Reduce the revolution of the fan as far as possible to lower the peripheral velocity of blades and lessen impact energy.

Applicability of the above measures will be examined hereunder:

(a) Reduction of solid contents of carrier gas

The cyclone separator is the one related to solid contents in the system concerned. Shown in Table 5-3-3 are the measured values (by a Russian research institute) on #6 boiler-A system, immediately after the commencement of operation in November 1989 as against the designed pulverized coal density at the inlet of the said separator, 0.271g/m^3N and the density at the outlet, 0.261g/m^3N (designed collection efficiency 90.4%).

Both of them fell below 90.4%, designed value, indicating the designed performance has never been achieved from the very beginning of construction.

Table 5-3-3 Density of Pulverized Coal at the Inlet and Outlet of Cyclone

Time	Density of pulverized coal at inlet (g/m^3N)	Density of pulverized coal at outlet (g/m^3N)	Collection efficiency (%)
1	266.4	54.5	79.5
2	223.3	40.5	81.9
3	212.0	36.8	82.6

The measurement of pulverized coal density was conducted by the Russian side at the request of the Mongolian side. It was conducted only on #6 boiler,

and actual conditions of other boilers are unknown. However, the data in the table was taken shortly after the commencement of the operation and as such free from the effect of wear. It is presumed, therefore, that other boilers were in a similar condition, or the collection efficiency was much lower due to wear and deterioration. The modification and additional installation of the cyclone will develop into a major modification requiring a review of the entire pulverized coal feed system, and thus deviate from the scope of grant aid, so that they will be set apart from consideration.

The semi-storage bin system is adopted in the pulverized coal feed system. In order to prevent coal dust explosions, the oxygen density of carrier gas is suppressed below 16% (actual 8 to 12%) by sucking the flue gas from the outlet of the induced draft fan, as part of the gas to carry pulverized coal, with the gas circulation fan. It is suspected, however, that the ash mixed in from the system will be contributing the wear because of a low availability factor of the electrostatic precipitator. Therefore, improvement of the ESP availability factor through the project will prove to be useful for prevention of wear.

(b) To lower the velocity of carrier gas

The blowing speed of pulverized coal into the furnace at 4th thermal power station is said to be approximately 32 to 33 m/s. However, there are no available records of measurement. Although the outlet pressure of the primary fan is designed to be 230 to 280 mmAq, the fan is actually operated at 300 to 400 mmAq to prevent plugging of the pulverized coal pipe at the outlet of pulverized coal bin, which suggests the possibility of the velocity of the entire

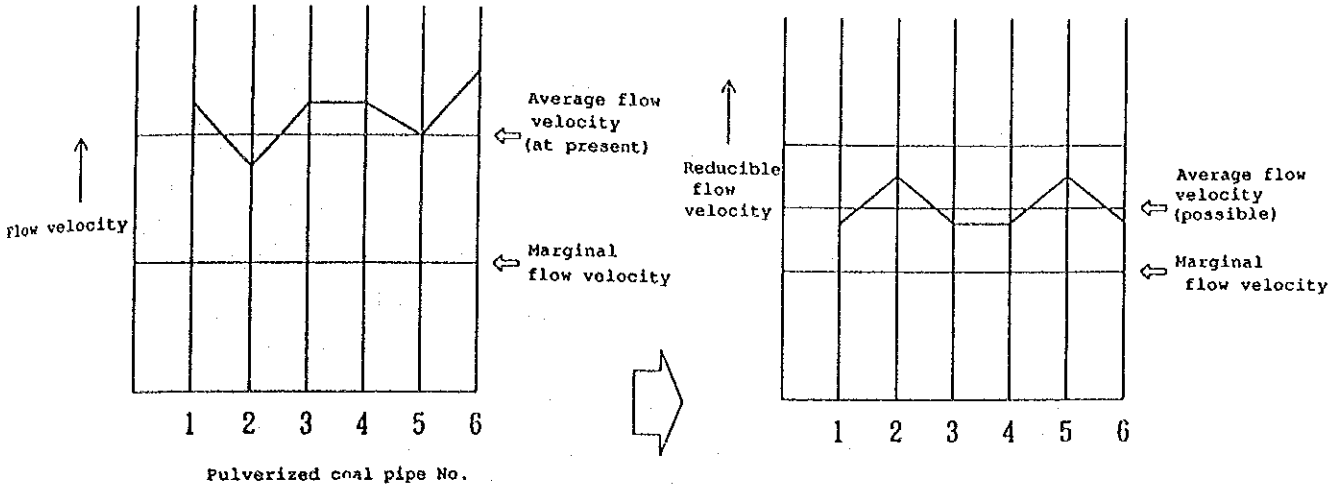
system being increased. Further, no adjustment of velocity is made at the orifice despite the length of pulverized coal pipes, 6 pieces per line, is respectively different. The primary fan is operated with the damper at its outlet fully opened. It is presumed from these facts that the operational conditions will be as described below:

. The inline velocity of each pulverized coal pipe will widely vary since the outlet pressure of the primary fan is constant, the outlet damper is fully opened and the length of pulverized coal pipes is different.

. The probability of pluggage with pulverized coal is high in a pipe having the lowest velocity when the inline velocity is irregular. To avoid such plugging, it will be necessary to boost the lowest velocity to a level higher than the marginal speed for plugging. That is why the outlet pressure of the primary fan was increased from 230-280 mmAq, designed pressure, to 300-400 mmAq. Consequently, the average velocity has become considerably high.

As the countermeasure,

. Adjust the opening of damper at the outlet of the primary fan to regulate the velocity of each pulverized pipe constant, remove the irregularity and lower the velocity to the vicinity of the marginal speed for pluggage (the lowest speed before adjustment).



It will be necessary to achieve the purpose to install a velocity adjusting damper treated for resistance to wear at the outlet of the primary fan.

However, no measurement has ever been made of the inline velocity of pulverized coal pipes, and the proposed countermeasure is still a matter of conjecture. Therefore, twelve pieces of wear resistant damper will be supplied for a boiler on a trial basis. If it proves to be effective, the Mongolian side will hopefully proceed with the modification on its own.

(c) To change the blade material to one having resistance to wear. Though the measure is a sympotomatic treatment and it can never be a drastic measure, it would still be the best method for the current project where the improvement of the basic system is not allowed. Wear-resistant steel plates and welding rods were among the requested items. An examination on them will be made hereunder, including ceremics tile that have substantial durability.

a) Combination of wear-resistant steel plate and welding rod

The blade material, CT-3, (equivalent to JIS SS400) presently in use at 4th thermal power

a) Combination of wear-resistant steel plate and welding rod

The blade material, CT-3, (equivalent to JIS SS400) presently in use at 4th thermal power station, will be changed to a wear-resistant clad steel plate in consideration of the ease of maintenance. The change will result in improvement in the wear resistance of the clad plate to approximately 50 times as compared with SS400.

Furthermore, the welding rods will be changed to those which have an wear resistance of approximately 20 times more (an estimate) as compared with T-590, a Russian make presently in use.

The above data, however, is a simple comparison. As it will vary according to different conditions, the performance will have to be verified with actual use.

The frequency of balance adjustment due to wear at present is 1.2 times/month to 0.3 times/month. Even if the performance of welding rods against wear were discounted to about 70%, the frequency could be reduced to 1/(1.2/20x0.7) = 1 time/12 months. Though the frequency of maintenance can be substantially reduced, a long life cannot be expected. Aiming at a life of 3 to 4 years, the quantity of supply will have to be added to enable blade replacement two times.

b) Blade lined with ceramic

A described in the paragraph dealing with pulverized coal pipes, the technological progress

in ceramics has been remarkable in recent years. A steady increase has been observed in its application for meaures against fan blades wear, and its reliability enhanced.

With respect to wear resistance, results show the hardness is approximately twice than that of special metal lined clad steel. A life lasting several years can be expected though it is unreasonable to expect a permanent life, so it appears practically unnecessary to have spares.

Therefore, the quantity of supply will be set by amount of equipment, 2 units/boiler x 8 boilers + spare, 2 units = 18 units. With respect to the ceramic lining to the fan blades, ceramic-lined rotors will be supplied in the form of a assembled product, unlike the ceramic lining at the site for pulverized coal pipes, because the possibility of peeling by centrifugal force exists in case of site lining.

c) Conclusion

A comparison of wear-resistant steel plate plus welding rods and ceramic lining revealed that there is practically no difference in cost, if the condition of supply were the same as aforementioned. So, the ceramic-lined blades will be supplied.

When supplying rotors in the form of a assembled product, a detailed investigation and consultation with the Mongolian side will be necessary to assure that they will fit snugly with shafts in the field at the stage of detailed design and pre-order investigation. Moreover, balance tests will be required in Japan for the manufacture of the

rotors so that a shaft necessary therefor will have to be manufactured.

(d) To reduce revolving speed of fan

It has been empirically proven that the wear of rotor blade is proportional to the cube of the circumferential speed of a blade. Though the method is effective, it cannot be adopted for the project as it will necessitate a basic review of the system.

3) Magnetic separator

As described in Paragraph 3 of Chapter 4, the coal handling system of 4th thermal power station is equipped with magnetic separators only at 2 stages, so insufficient for complete removal of foreign magnetic substances. The separator is normally required at three stages. In particular, non-installation at the "receiving line" means the line is completely unfortified against trouble from foreign magnetic substances. Owing to this, damage is sustained by the conveyor belt, and small fires and explosions are caused in the pulverized coal system with the intrusion of unremoved magnetic substances. It is necessary, therefore, to additionally install magnetic separators on the conveyors at the rate of a unit per conveyor, 2 units in all, to remove foreign substances. The installation points shall be those shown on Fig. 4-2-9. The approximate specification shall be as follows:

. Type : Automatic discharge type
. Capacity : 1,000 t/h
. Width of conveyor: 1,400 mm
. Conveyor speed : 1.6 m/s
. Power source : 220V

5.3.3 Measurement for Environmental Pollution

The atmospheric pollution measurement at a power station covers flue gas (SO_2, NOx, dust), waste water, vibration and noise.

Instruments requested for the atmospheric pollution measurement consisted of SO_2/NOx meter and dust concentration measuring instruments As a result of consultation, however, it was decided to supply the dust content measuring instrument.

The total quantity of dust exhausted from a stack is determined by the performance (collection efficiency) of the ESP.

The performance control of the ESP consists of simultaneous mesurement of dust concentration in the flue gas duct at the inlet and outlet of ESP, and confirming the collection efficiency. The power station does not possess any dust concentration measuring instrument necessary therefor, so that the supply was decided, judging the request is reasonable.

Partial environmental measurement facility for dust concentration is yet to be improved (measurement holes and measuring stages are to be installed in the gas duct at the inlet and outlet of the ESP). Therefore, a proposal was made to complete such improvements untill delivery of the measuring instruments. The Mongolian side agreed to it.

In the measurement of dust concentration contained in flue gas, a series of complicated procedures, such as suction, drying, cooling and weighing of dust, are required after completion of moisture measurement in order to be set on dry base. Velocity measurement for uniform velocity suction and analysis of gas composition for any O_2 correction are also required so that experienced personnel are required. There are several employee among the power station engineers, who experienced the measurement of dust concentration, as assistants, when the ex-Soviet Union conducted the measurement during the period of trial operation after construction. Therefore, measurement will be possible if technical transfer were made on

basic knowledge and measuring techniques for a short period upon delivery of the measuring instruments.

The dust content measuring instruments to be supplied are as detailed below:

(1)	Device to measure moisture contents in flue gas	2 sets
(2)	Device to measure velocity of flue gas	2 sets
(3)	Device to analyze gas composition	2 sets
(4)	Device to collect dust from flue gas	2 sets
(5)	Device to weight collected dust	1 set
(6)	Spare consumables (for 3 years)	1 set

Improvement in the surroundings as described below are necessary for the measurement of dust concentration. The work should be completed by the Mongolian side before the arrival of the measuring instruments. The dimensions of the measurement hole are shown in Fig. 5-3-3.

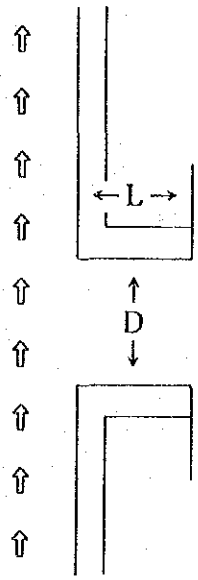
(1) Installation of measurement hole

. Gas duct at inlet and outlet of #1 to #4 ESP

. Gas duct at inlet of #5 to #8 ESP

(2) Installation of measuring stage

. Gas duct at outlet of #1 to #4 ESP



L mm	D mm
50	75
100	100
150	200

Fig. 5-3-3 Dimensions of Gas Duct Measuring Hole at Inlet and Outlet of ESP

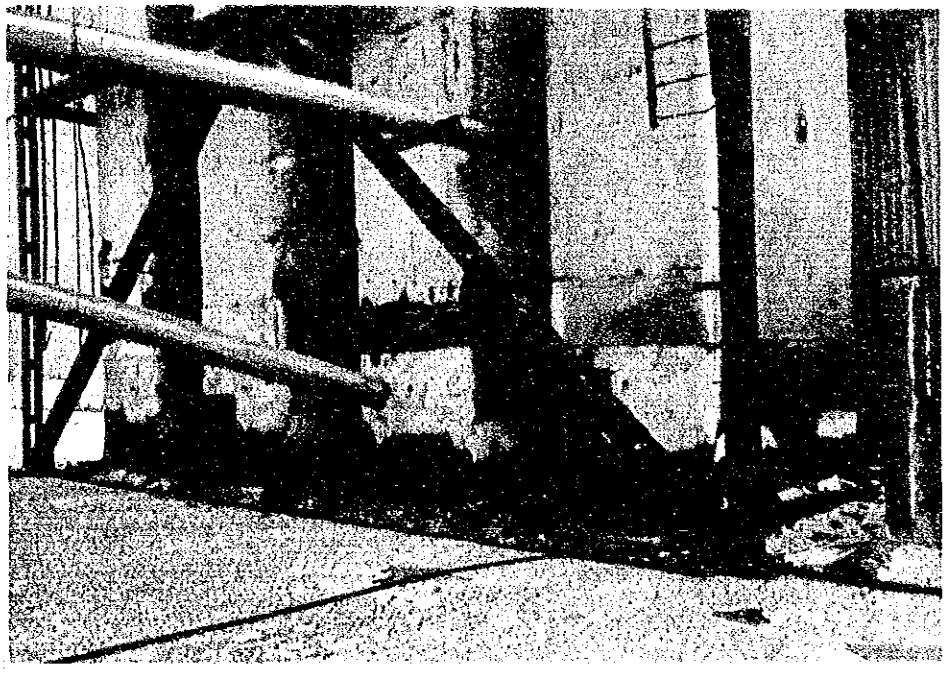


Photo 1 Gas Duct at Inlet of #5 ESP

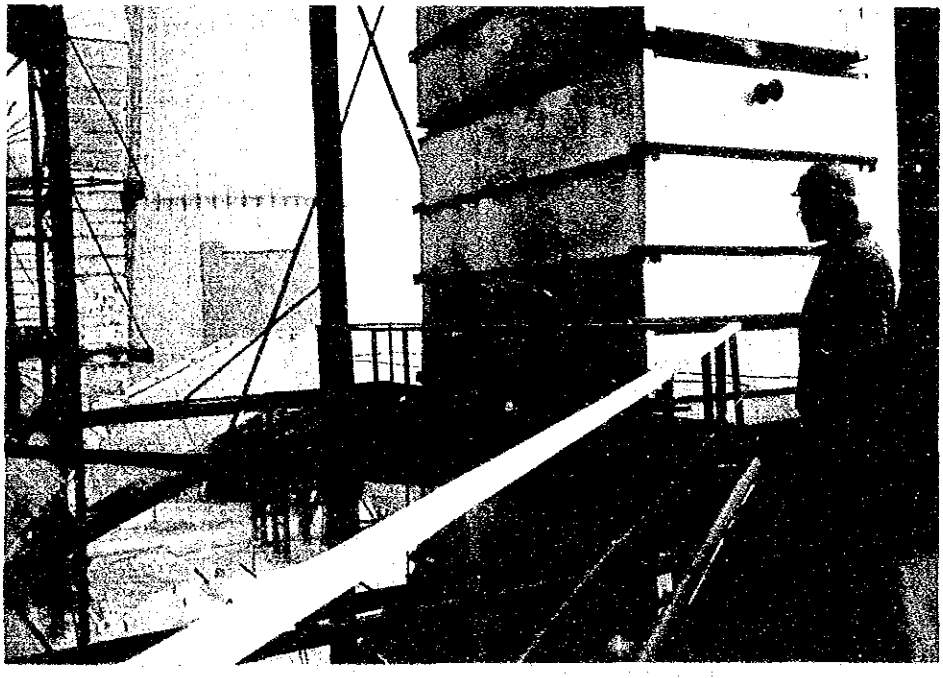


Photo 2 Gas Duct and Footing for Measuring at Outlet of #7 ESP

Fig. 5-3-4 Photographs of Site Conditions

5.3.4 Supplementary Measures for Station Maintenance

In order to improve the maintenance environment of the entire power station, the supply of the following materials and machinery will be considered as an auxiliary measure for the maintenance of equipment, based on the request from Mongolia and the results of the investigation.

(1) Those requests from the Mongolian side (for improvement of availability factor of power station)

No.	Mongolian request		Item and specification	Items examined for adoption in rehabilitation project			
	Item	Quantity		Results of examination	Effect	Quan-tyty	Advisa-bility
1.	Condensate pump for steam turbine station, and driving motor for the same	18	Horizontal shaft type 80 - 120 t/h Suction: 0.05kgf/cm^2 Discharge: 15.5kgf/cm^2 Condensate temperature below 160°C	. Not in accord with the objective . Detailed inquiries are necessary as to the installation and specification of device	X	-	X
2.	Feed water control valve N.D.: 100mm N.D.: 250mm N.D.: 20mm	 4 4 16	Pressure: 230kgf/cm^2 Temperature: 250°C System: Electrical	. Not in accord with the objective . Detailed inquiries are necessary on valve specification . Japanese makes are difficult to match	△	-	X
3.	Phosphate injection pump for boiler	16	Pressure: 250kgf/cm^2 Capacity: 25 l/h Piston or diaphragm type with motor	. Japanese makes could be used somehow . Adopted as it is important for boiler operation	o	14	o

(Note) For the "Effect" column, enter 0 if judged positive for the improvement of availability factor of the power station, X if not and △ if difficult to tell either.

No.	Mongolian request		Item and specification	Items examined for adoption in rehabilitation project			
	Item	Quantity		Results of examination	Effect	Quan-tyty	Advisa-bility
4.	Oil pump for mill	6	Pressure: 6kgf/cm^2 Capacity: 70 l/min Gear type (with motor)	. Japanese makes could be used somehow . Very useful for solution of mill trouble	o	6	o
5.	Sluice valve for steam (13k)			. Japanese makes could be used somehow			
	N.D.: 800mm	12	Pressure: 25kgf/cm^2 Temperature: 250-300°C	. Strongly requested by Mongolian side	△	6	o
	N.D.: 500mm	12	Pressure: 25kgf/cm^2 Temperature: 250-300°C	. Not in accord with objective	△	6	o
	N.D.: 400mm	12	Pressure: 25kgf/cm^2 Temperature: 250-300°C	. Supply a small quantity as sample. If effective, arrangements shall be made by Mongolian side	△	6	o
6.	Sluice valve for steam (6K)			. Japanese makes could be used somehow			
	N.D.: 200mm	2	Pressure: 25kgf/cm^2 Temperature: 160-200°C	. Strongly requested by Mongolian side	△	2	o
	N.D.: 100mm	2	Pressure: 25kgf/cm^2 Temperature: 160-200°C	. Not in accord with objective	△	2	o
	N.D.: 80mm	2	Pressure: 25kgf/cm^2 Temperature: 160-200°C	. Supply a small quantity as sample. If effective, arrangements shall be made by Mongolian side	△	2	o

No.	Mongolian request		Item and specification	Items examined for adoption in rehabilitation project			
	Item	Quantity		Result of examination	Effect	Quantity	Advisability
7.	Thickness measuring instrument of scale inside tube	1	-	. Difficult to sell the instrument as it utilizes radiation . Not indispensable though it suits for objectives . Expensive	O	-	X
8.	Portable tachometer (Vibration indicator is concurrently used as tachometer)	4	-	. One unit was supplied for the urgent work in winter of 1991 . Though it suits for objectives, the primary fan alone numbers 16 units . There are vibration indicators of Russian make, though old-fashioned	O	-	X
9.	Valve seat face grinder (Portable type)	2	For valves with calibers ranging from 100 to 200mm	. Unmatched with the objectives . Valve usage should be examined first	△	-	X

No.	Mongolian request		Item and specification	Items examined for adoption in rehabilitation project			
	Item	Quantity		Results of examination	Effect	Quan-tyty	Advisa-bility
10.	Coal scale for conveyor	2	For installation of conveyors Maximum capacity: 1,000t/h	. Unmatched with the objectives . There is no reliable coal scale . The meter will mark the first step for the education of power plant management	o	2	o
11.	Boiler drum level gauge	8	Drum pressure: 150kgf/cm^2 Site facing type (dual color type)	. An important measuring instrument for monitoring boiler operation, though not in direct accord with objectives	o	8	o
12.	Mini-computer (Data logger)	1	Compilation and calculation of operation records	. Preparations yet incomplete for use, about the method of taking records and the unification of forms. . Expensive	X	-	X

No.	Mongolian request		Item and specification	Items examined for adoption in rehabilitation project			
	Item	Quantity		Results of examination	Effect	Quantity	Advisability
13.	Transceiver for communication inside the station	60	For communication between central control room and operators at various posts. For multi-channel use. (15 persons x 4 shifts). Used inside the power plant building. Charging type.	. Will help improve mutual communication among power plant operators, and contribute to the improvement of operation and maintenance technique	o	60	o
14.	Insulation tape	1 set	For business (Used for cables, motors, etc.)	. Will help improve the availability factor as the tape can be used for a lot of purposes at present . Inexpensive	o	1 set	o
15.	Motor-driven grinder (portable type)	-	. Size: 100mm in diameter . 360V, 50Hz . With 400 carbon brushes	. Six units were supplied for the urgent winter work, 1991, and later, six more additional units were supplied . Two units were damaged in grinding 20 sq.m. of seramics in the above mentioned work . Necessary also for the rehabilitation project	o	50	o

No.	Mongolian request		Item and specification	Items examined for adoption in rehabilitation project			
	Item	Quantity		Results of examination	Effect	Quan-tyty	Advisa-bility
16.	Portable clamp meter	10	. Electric current measurement . For 0.4kV	. Necessary for the rehabilitation project since a considerable number of devices are connected to 0.4kV motors . The meter is free from damage	o	10	o
17.	Portable voltage indicator (Digital multi-meter)	10	. Two meters per group . For 380V	. To be a multi-meter . There are a lot of applications at present	X	-	o
18.	Resistance meter (Megger)	10	. For measurement of motor insulation . For 500V and 1,000V	. Same as 16, above . For maintenance in general	o	10	o
19.	Remote heat sensor for high tension transmission line	1		. Unmatched with objec-tives . Expensive	X	-	X

No.	Mongolian request		Item and specification	Items examined for adoption in rehabilitation project			
	Item	Quantity		Results of examination	Effect	Quantity	Advisability
20.	Dial calipers	3	Maximum measuring dimensions 200mm	. There are a lot of applications at present . Inexpensive	o	2	o
21.	Frequency and voltage measuring instrument	1	Digital type	. There are a lot of applications at present . To be covered by 17	o	-	X
22.	Measuring instrument to locate damaged section of underground cable	1		. Unmatched with objectives	X	-	X
23.	Transformer	1	5000A, for maintenance and test	. Unmatched with objectives	o	6	o
24.	Low voltage water gage	2	For deacrator (10K), display type Length: 1,500mm Glass tube, 18mm in diameter	. An important gage for operation, though unmatched with objectives . Important for feed water control to boiler	o	2	o

No.	Mongolian request		Item and specification	Items examined for adoption in rehabilitation project			
	Item	Quantity		Results of examination	Effect	Quantyty	Advisability
25.	Hydrochloric acid tank	4	Capacity, 15 tons	. Unmatched with immediate objectives	X	-	X
26.	Copying machine For A4 size For A2 size	 2 2		. Very effective at present for driving home operational instructions and for exchange of information	 o o	 2 1	 o o
27.	Graphite packing	1 set	For high temperature, high pressure steam and water	. There are many applications at present	o	1 set	o
28.	Hot air dryer	5	Capacity, approx. 3 kW single phase, 220 V Approx. 1.0 m^3/min	. Already supplied one dryer for the urgent work in 1991 winter . Drying time can be shortened if used for drying the adhered ceramics tiles	o	5	o
29.	Drill - motor driven (with 20 drill sets)	20	Max. drilling dia.=16mm Single phase, 220 V	. To be used for the project . Two (2) air-operated drills only are in use	o	20	o

No.	Mongolian request		Item and specification	Items examined for adoption in rehabilitation project			
	Item	Quantity		Results of examination	Effect	Quan-tyty	Advisa-bility
30.	Digital multi-meter . Yokogawa 7531-01 or equal . Yokogawa 7532-02 or equal . Yokogawa 2447 or equal . Yokogawa 7543 or equal (stationary type)	 4 20 30 2	 Accuracy 0.25% for laboratory use Accuracy 0.5% for field use Accuracy 1 - 2% for field use Accuracy 0.04% for laboratory use	. All are not in use, but of essential for instrument calibration . Yokogawa 2447 shall be changed to Yokogawa 7536-01 because of its function of auto-power off . Yokogawa 7543 shall be changed to Yokogawa 7541-01 because of its stationary type more suitable for power station	o	 4 20 30 2	o
31.	Cutter for plate - motor driven	5	Max. plate thickness: 4 mm Single phase, 220 V	. To be changed to the cutter for max. plate thickness 3.2 mm in order to avoid special order . Now not in use	o	5	o
32.	Pipe cleaner for ash removal - motor driven	4	For small diameter pipes of I.D. 15 - 100 mm Single phase, 220 V	. Mainly to be used for air-preheater tube cleaning (48 tubes per boiler) . Effective for ash hardened in the tube	o	4	o

No.	Mongolian request		Item and specification	Items examined for adoption in rehabilitation project			
	Item	Quantity		Results of examination	Effect	Quantity	Advisability
33.	Submerged pump - motor driven	5	Approx. 50 m^3/h x 10 mh 3 phase, 380 V Throw-in type	. Suitable for water drain removal	o	5	o
34.	Fork lift	2	Capacity, 3 ton	. Suitable for transport of heavy materials for maintenance	o	2	o

(2) Items necessary for the rehabilitation project (Items requested from the Mongolian side are listed in (1))

No.	Item and specification	Quantity	Reason for adoption
1.	Grinder disk, 100mm in diameter	10,000 sheets	For surface treatment for ceramic bonding 250 sheets were used for approximately 20 m^2 of a bonding area for measures in the winter, 1991. Arrangements are already made for an additional 200 sheets.
2.	Portable grinder	-	(Requested from the Mongolian side. See Item No. 15 (4.1).)
3.	Plasma cutter 360V, 50Hz Approx. 11kVA	3 units	Three units were already given in the measure done in the winter, 1991. But, an addition supply is needed for the project.
4.	Dust protective goggles and masks	25 each	Twenty-five each were supplied for the 1991 winter measures. But additional supply is necessary for the project.
5.	Form for vibration recorder (For VIBROPOROT-30)	5 packages (50 rolls)	The vibration recorder supplied for the 1991 winter measures will be re-used for the project. However, the printer forms will run short since the supplies then given were to cover immediate need.

No.	Item and specification	Quantity	Reason for adoption
6.	Chain block Capacity 800kgf	3 units	Quantities are in short supply, though possessed by the Mongolian side. They will be used for the removal and installation of pulverized coal pipes for ceramic bonding.
7.	Wire for works 1/2" dia. 3/4" dia.	 2 rolls 2 rolls	 Ditto Ditto
8.	Cleaning agent	3 kl	Were rather in short supply in 1991 winter measures, so supply enough.
9.	Spray type cleaning agent	2,000 pieces	Judged necessary based on the implementation of urgent measures.
10.	Auxiliary devices for work Lever type lift: 6 units Ventilator with hose: 4 units Slinger: 10 pieces	1 set (as required)	Used in a pair with Item No. 6 above. (Execution at site took time in 1991 winter since the item is not possessed by the Mongolian side).
11.	Holders for welding electrodes	20 pieces	. Mongolian makes were used in the 1991 winter measures. Since they were found dangerous, 15 pieces were additionally ordered. . Additionally ordered since they are not consumables, and are low-priced.

No.	Item and specification	Quantity	Reason for adoption
12.	Welding rod (electrodes) for carbon steel	4,000 kg	. The rod can be widely used for the installation of pulverized coal pipe bend after ceramic bonding, feed water pipe and dust suction pipe.
	for hard surfacing	1,000 kg	. Effecitve for crusher blade, IDF blade, GRF blade and other small worn parts
13.	AC electric welding machine	5 units	Three units were supplied in the 1991 winter measures. An additional unit will be supplied since the estimated welding work under the project will be more than 60 times the measures. Any shortage will be covered by welding machines on hand by the Mongolian side.
14.	Ultra-sonic thickness gauge	2 units	Necessary for checking of wear of boiler component.
15.	Grinder disk ø180 mm	2,000 sheets	For surface treatment for bonding ceramics. (50 sheets were used in the winter 1991. Arrangements are already made for additional 50 sheets.)

(3) Items judged necessary from results of investigation

No.	Item and specification	Quantity	Reason for adoption
1.	Insulation material or silicon rubber sealant (commonly called 'putty'). Heat-resistant paste, non-combustible, non-corrosive, fast drying, fast hardening	1,300 kg	The power station is in a dangerous state for in its operation and maintenance with steam, water, combustible gas, coal ash and pulverized coal there is a lot of leakage everywhere due to the shortage of maintenance parts. All these leaks will be stopped as an urgent measure with the sealant (commonly called 'putty') which also proved to be effective in power stations in Japan. The operation, maintenance environment and economy of the power station will be greatly improved.
2.	Portable electric cleaner for business operations 360V, 50Hz Approx. 5 m^3/min 2,000mmAq	8 units	The cleaner will be supplied at a rate of 1 unit per boiler. The power station centering around the boilers is covered with pulverized coal in the front and coal ash in the back from the top of the boiler to the ground surface. At times they are washed down with water, but the water is triggering trouble in the electrical systems. It is hoped some major environmental improvement will be achieved for operation and maintenance.

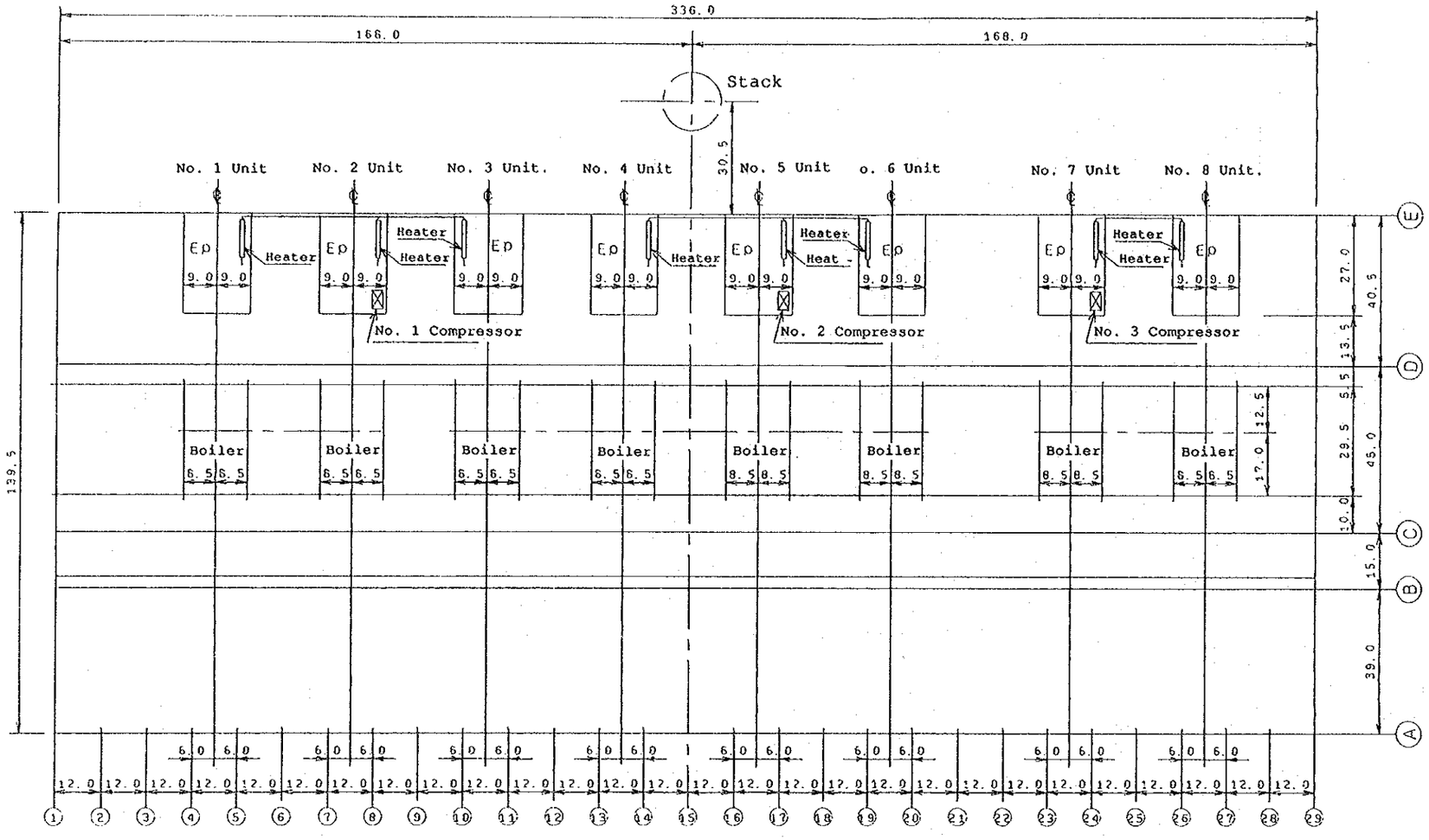
No.	Item and specification	Quantity	Reason for adoption
3.	Portable flashlight Rechargeable type, dust-proof and explosion-proof (waterproof) type	100 units	Safety fixtures. Though owned by the Mongolian side, they are in short supply. They shall be used for the time being by half of the maintenance personnel (approximately 140 persons in all). Improvement in maintenance efficiency is expected.
4.	Lighting equipment		Generally, the inside of the power station building is dark. Substantial improvement is expected through the supply in maintenance efficiency and the environment for operation and maintenance.
		48 pieces	Ceiling lamp for boiler room Mercury lamp fixture for 1000W ceiling lamp (with lamp and stabilizer)
		78 pieces	Pulverized coal storage and others 400W increased safety explosion-proof bracket type mercury lamp fixture (with lamp and stabilizer)
		48 pieces	Around pulverized banker 250 W increased safety explosion-proof bracket type mercury lamp fixture (with lamp and stabilizer)
		20 pieces	Around coal pulverizer 250W dust-proof type mercury lamp fixture for road illumination (with lamp and stabilizer)

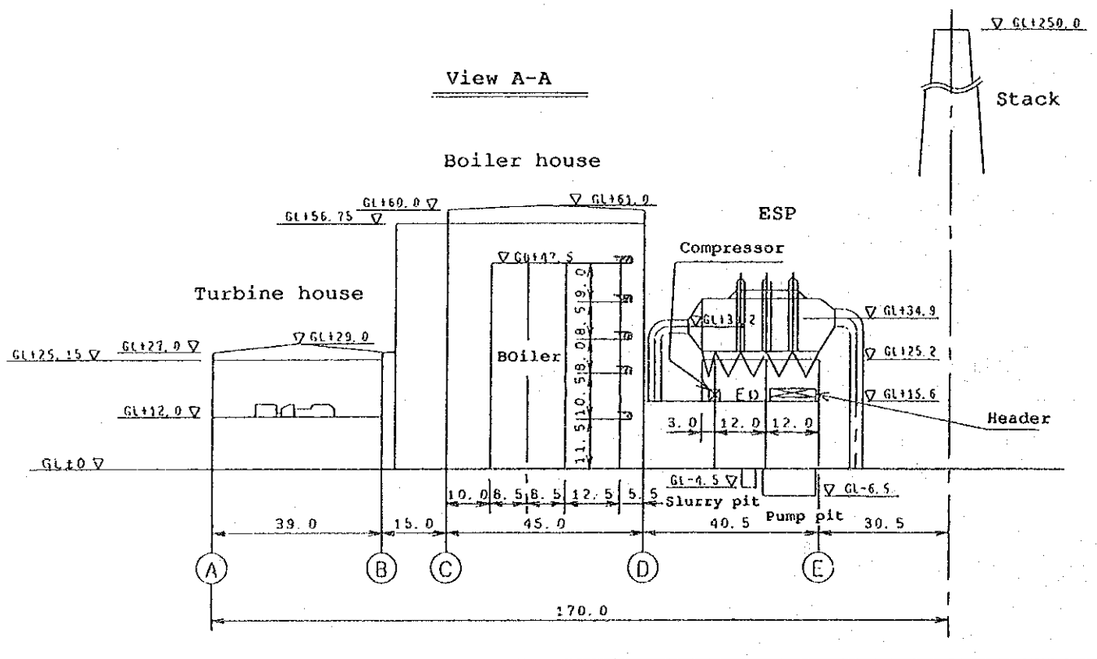
No.	Item and specification	Quantity	Reason for adoption
	(Continued)	20 pieces	400W dust-proof type mercury lamp fixture for road illumination (with lamp and stabilizer)
		428 pieces	Spare mercury lamp bulb (200% spare) High voltage mercury lamp (250, 400, 1000W)
		3.6 km	Electric wire HIV 2mm^2 Yellow, green, red and black, 900m each
		100 pieces each	Spare incandescent lamps 100,150,300,500W
5.	Portable calibrator Yokokawa 2422 or equivalent Single phase, 220V, with adapter	2 units	Used for the calibration of measuring instruments as multimeters to be used in the field. They will transmit standard current and voltage.

5.3.5 Basic Design Drawings

The basic design drawings consist of the following:

Drawing No.	Title of Drawing	Fig. No.
M-1	The main transmission line in Mongolia	Fig. 2-2-1
M-2	General layout map of the 4th thermal power station	Fig. 4-2-1
M-3	Location and dimensions of ESP	Fig. 4-2-5(1)(2)
M-4	Flow chart of ash treatment system	Fig. 4-2-5(3)(4)(5)(7)
M-5	Flow chart of ash disposal line	Fig. 4-2-5(6)
M-6	Layout of ash disposal pond	Fig. 4-2-5(8)
M-7	Flow chart of pulverized coal feed system	Fig. 4-2-7
M-8	Bird's eye view of coal handling system	Fig. 4-2-9
M-10	Ash pluggage condition in hoppers	Fig. 4-2-10(1)
M-11	Malfunction condition of rapping device	Fig. 4-2-10(2)
M-12	Distribution of defective places on air sliders	Fig. 4-2-10(3)
M-13	pH and temperature of water of ash treatment	Fig. 4-2-10(5)
M-15	Places of heavy wear in pulverized coal feed system	Fig. 4-2-12
M-16	Causes of reduction of collection efficiency of ESP	Fig. 5-3-1(1)
M-17	Conceptual drawing showing execution areas for measures against wear	Fig. 5-3-2(1)(4)
M-18	Layout map of compressor and air header	-
M-19	System diagram of ash treatment system	-
M-20	Feed water piping for ash slurry channel booster nozzle of fly ash line	-
M-21	Section of ash level gage for ESP hopper	-
M-22	Piping for cleaning of around boiler and ESP	-
M-23	Flow control damper at outlet of primary fan	-





LOCATION	DATE	DESCRIPTION	BY
REVISION			

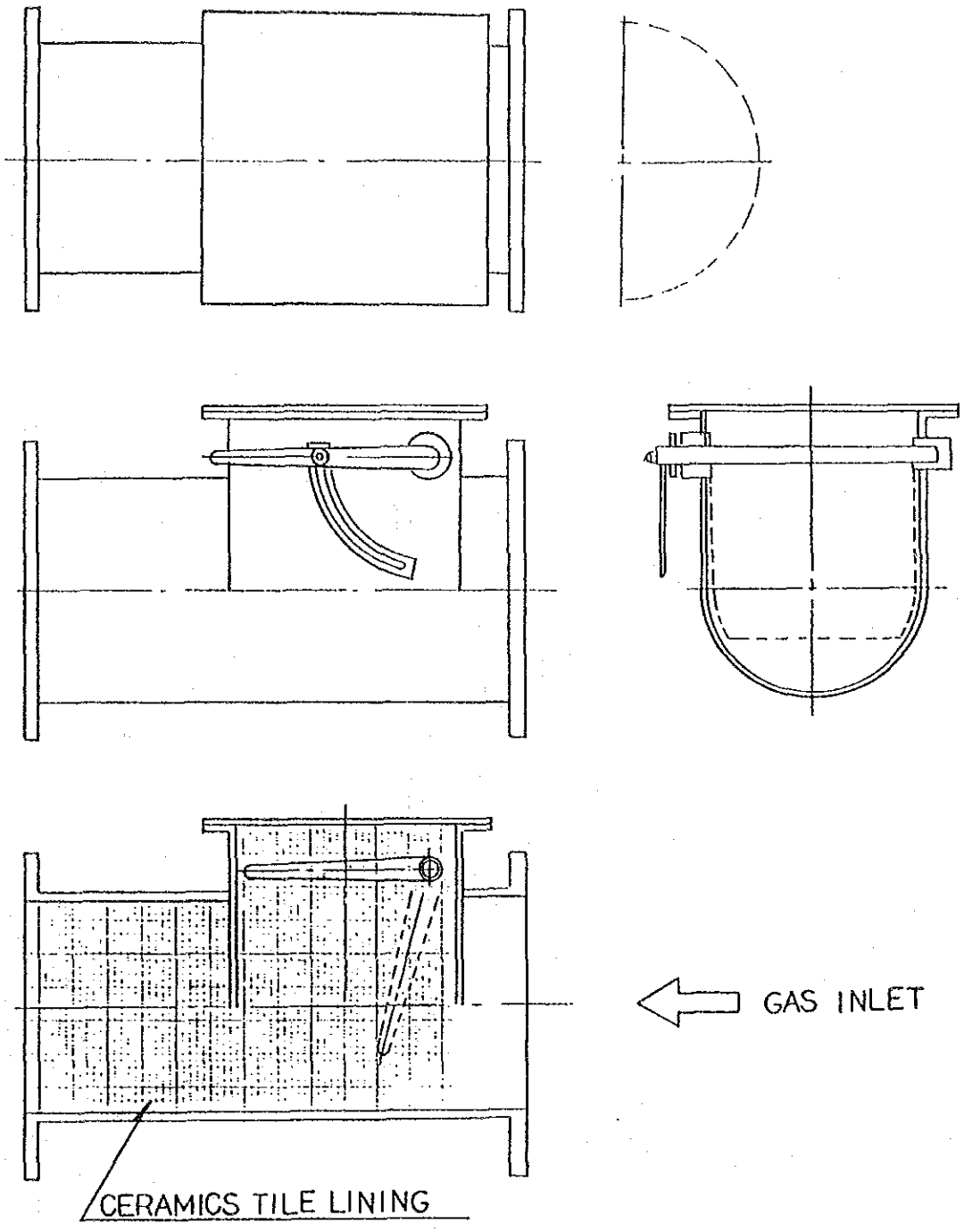
Mongolia, 4th Thermal Power Station

Air slider pluggage removal facility
Compressor·Header Layout

EPDC INTERNATIONAL LTD
TOKYO JAPAN

D. P. : SUBMITTED:
T. R. : RECOMMENDED:
C. A. : APPROVED:

A4



No.4 THERMAL POWER ST.

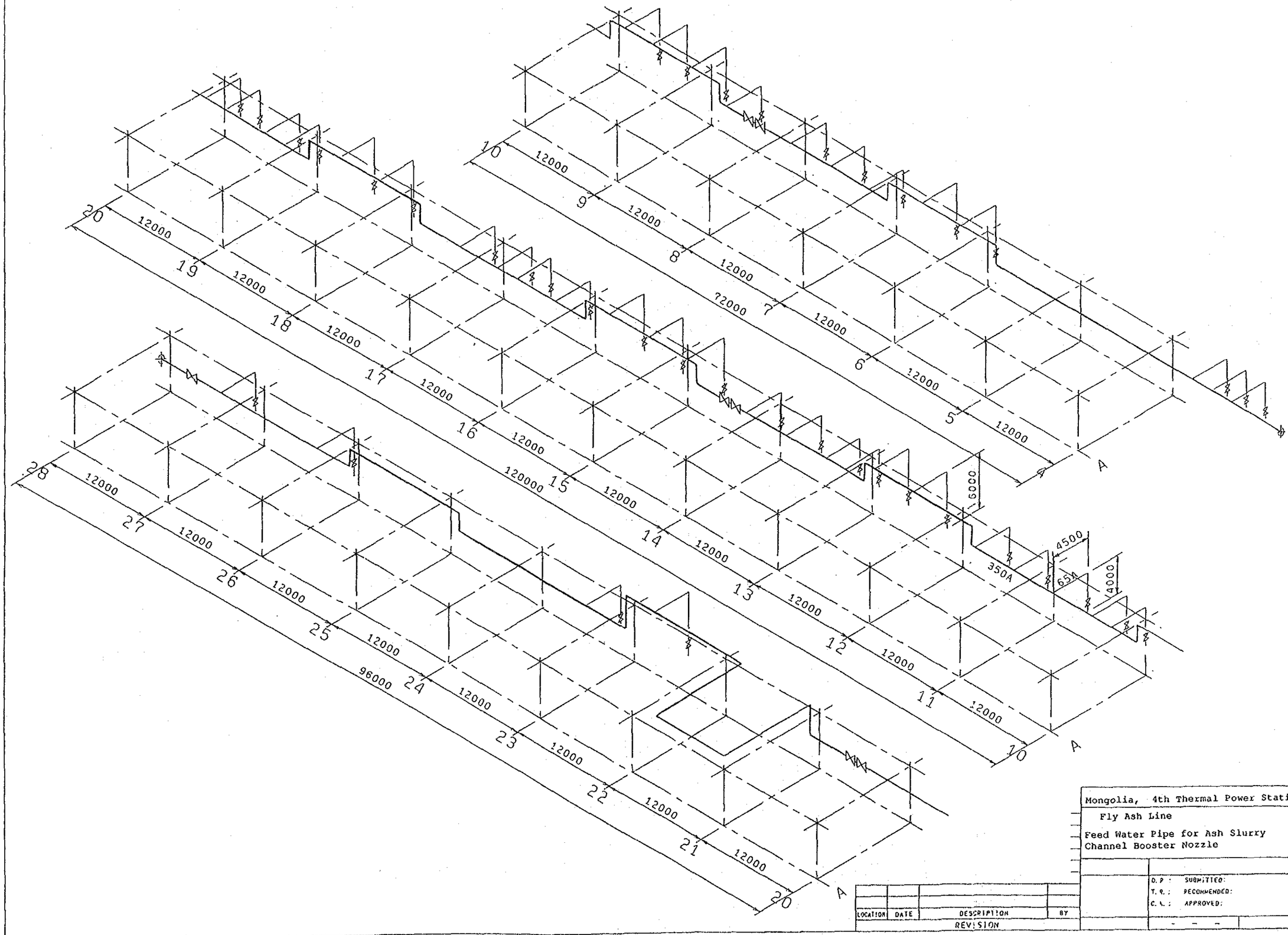
GAS SPEED CONTROLL DAMPER

5-74

LOCATION	DATE	DESCRIPTION	BY

REVISION

D.R.; SUBMITTED;
T.R.; RECOMMENDED;
C.K.; APPROVED;



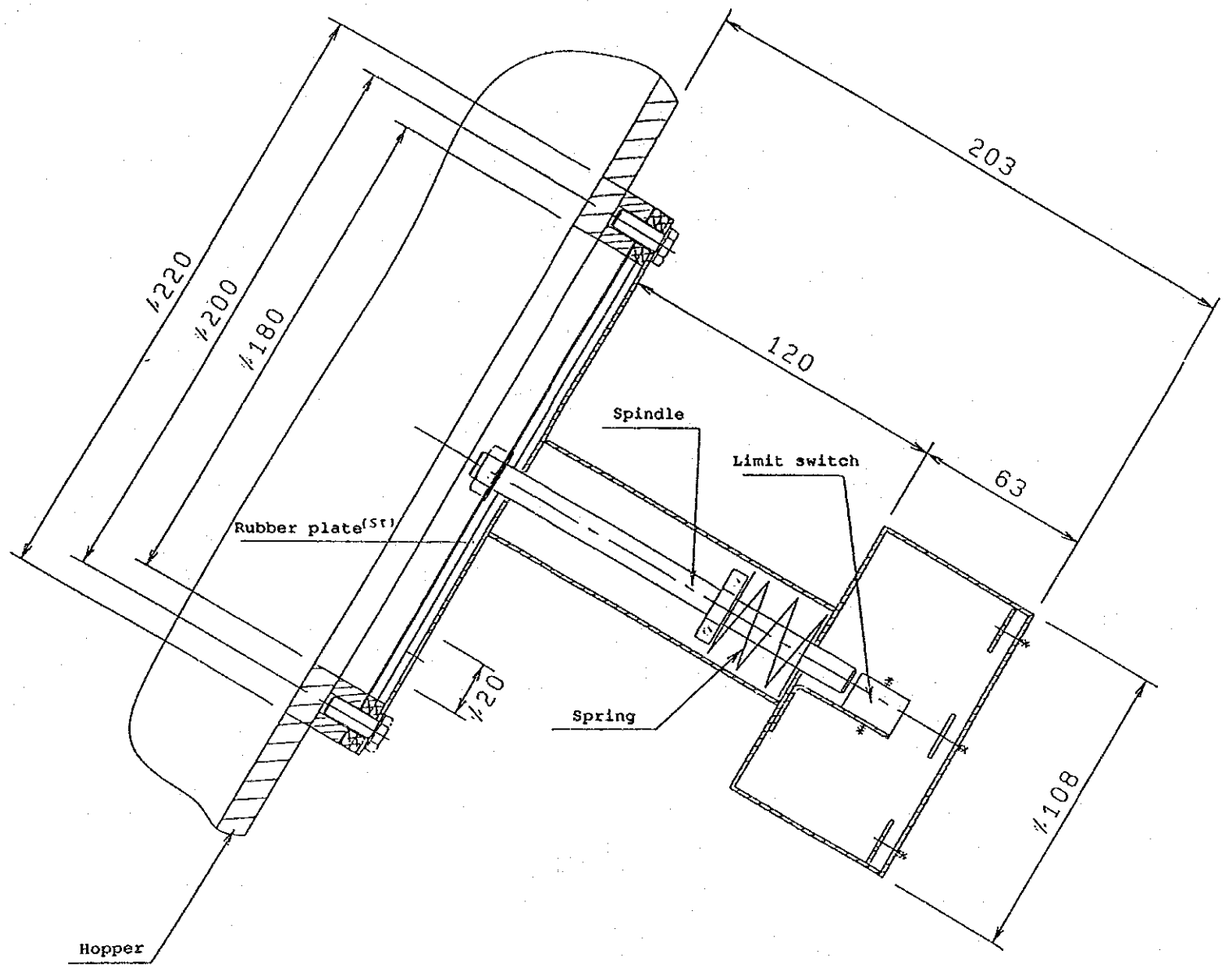
LOCATION	DATE	DESCRIPTION	BY
		REVISION	

Mongolia, 4th Thermal Power Station

Fly Ash Line

Feed Water Pipe for Ash Slurry Channel Booster Nozzle

D. P. : SUBMITTED:
T. R. : RECOMMENDED:
C. S. : APPROVED:

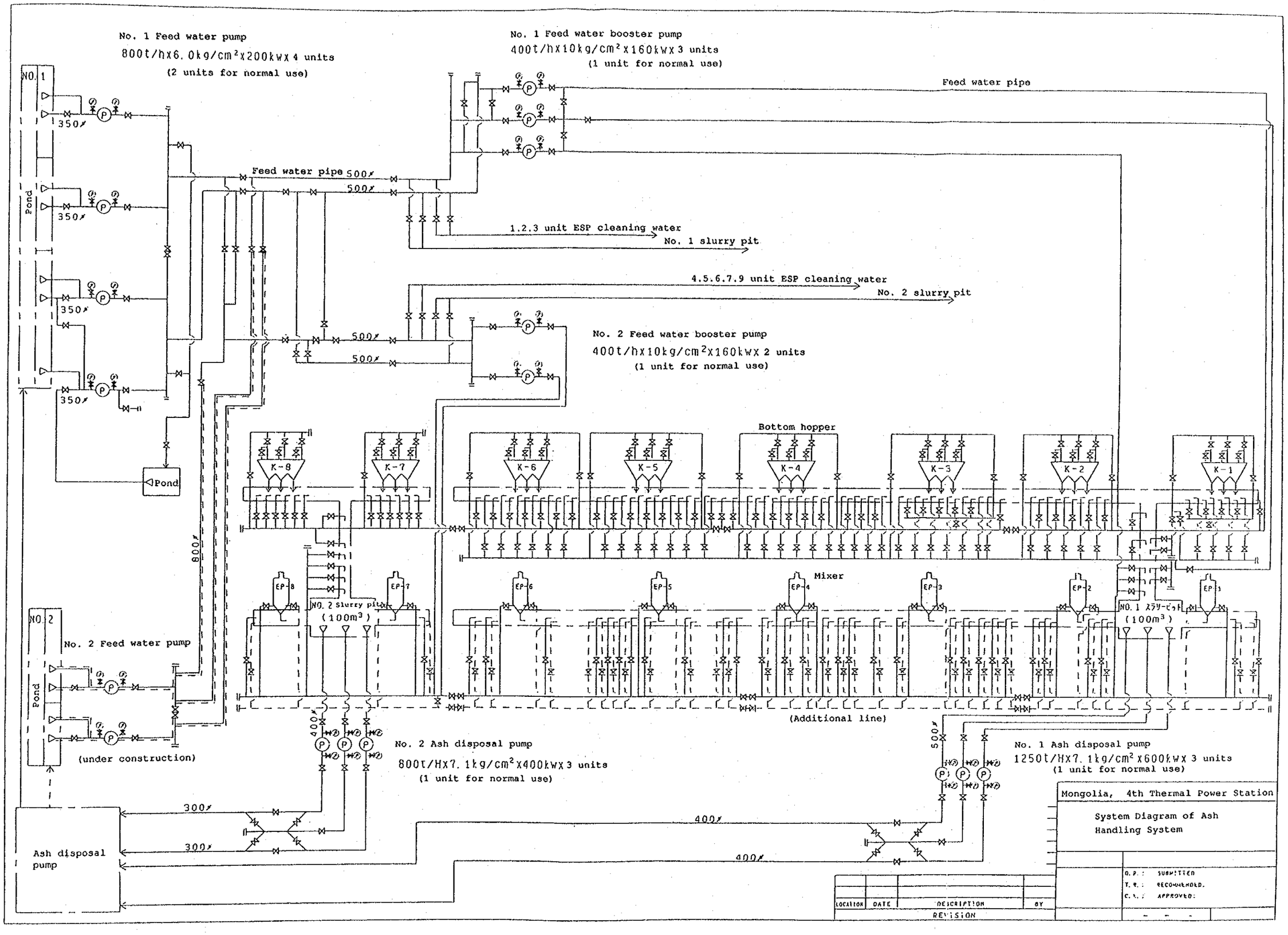


Mongolia, 4th Thermal Power Station

Ash Level Sensor for EP Hopper

LOCATION	DATE	DESCRIPTION	BY
		REVISION	

D. P. : SUBMITTED.
T. R. : RECOMMENDED:
C. S. : APPROVED:


No. 1 Feed water pump
800t/hx6.0kg/cm²x200kwx4 units
(2 units for normal use)
No. 1 Feed water booster pump
400t/hx10kg/cm²x160kwx3 units
(1 unit for normal use)
Feed water pipe
NO. 1
Pond
350
Feed water pipe 500
500
1.2.3 unit ESP cleaning water
No. 1 slurry pit
4.5.6.7.9 unit ESP cleaning water
No. 2 slurry pit
No. 2 Feed water booster pump
400t/hx10kg/cm²x160kwx2 units
(1 unit for normal use)
Bottom hopper
K-8
K-7
K-6
K-5
K-4
K-3
K-2
K-1
EP-8
EP-7
EP-6
EP-5
EP-4
EP-3
EP-2
EP-1
Mixer
NO. 2 Slurry pit
(100m³)
NO. 1 スラリーピット
(100m³)
800
NO. 2
No. 2 Feed water pump
Pond
(under construction)
(Additional line)
400
No. 2 Ash disposal pump
800t/Hx7.1kg/cm²x400kwx3 units
(1 unit for normal use)
500
No. 1 Ash disposal pump
1250t/Hx7.1kg/cm²x600kwx3 units
(1 unit for normal use)
300
300
400
400
Ash disposal pump
Mongolia, 4th Thermal Power Station
System Diagram of Ash Handling System
LOCATION
DATE
DESCRIPTION
BY
REVISION
O.P.: SUBMITTED
T.P.: RECOMMENDED
C.T.: APPROVED