Chapter 7.

MILL PROCESS AND FACILITIES

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7.1 General

Considerations presented in th preceding chapters have pointed toward the projected construction of a mill to produce 25,000 tons per year of bleached pulp from jute cuttings adopted as mill feed. The present chapter discusses the selection of processes for producing this bleached pulp taking economic factors into consideration. On the selection of the most suitable pulping process, the design of plant will be based not only on technical evaluation but also with account taken of economical considerations. The scope of the present Project is also described. The detail technical specification is presented in this chapter.

7.2 Selection of Pulping Process

In Chapter 3, the optimum pulping process is studied in relation to the main raw material and product. As a result, the soda process has been finally selected from the two alternatives; this and the sulphate process.

In the soda process, the cooking yield is rather lower than that in the sulphate process. This is caused by the decomposition of carbohydrate that occurs simultaneously with the delignification in the cooking operation. This problem has been largely solved by a new technology now coming into wide use of adding quinone compounds as additive, which accelerates the delignification while keeping the carbohydrate from decomposition and the cooking yield high. From this consideration, the soda-quinone cooking process is selected in the present Project.

7.3 Design of the Mill

7.3.1 Scope

In the preceding Section it was envisaged to adopt for the cooking by the soda process combined with quinone addition. The scope of the facilities to equip the envisaged mill is examined in consideration of the balance between investment and operation costs. As a basic rule, for a given rate of production, additional expenditure in capital equipment will be compensated by a reduction in operation costs.

In the present instance of a soda pulp mill to produce bleached market pulp, the key decisions requiring to be made in determining the scope of the facilities to equip the mill are:

- Whether or not to provide a facility for chemical recovery.
- Whether or not to provide a facility for chemical preparation.
- Degree of pollution control to be ensured.
- Scope of infrastructure pertaining to the Project.

The chemical recovery facility is an installation for recovering the soda added in the cooking process from the black liquor which is produced upon alkali elution of non-fibrous substances (mainly inorganic materials) from the feed material. The facility includes the steps of black liquor concentration, incineration of the thickened black liquor, causticizing the molten inorganic compounds, and lime recovery (for recycling into the causticizing process). This recovery system can recover 90% or more of the soda added in the cooking process. Without this system, the black liquor has to be discharged as mill waste water. In this case, it will require huge amounts of expenditure to prevent the waste water from causing environmental pollution. The additional capital cost for providing this facility, on the other hand, will be considerable, amounting to about 30% of the facility investment. For a large-scale mill this expenditure would be economically justified, and would often be indispensable from environmental protection requirements, but for a relatively small mill such as envisaged in this instance, the choice between adoption and omission of the chemical recovery facility becomes a delicate question, calling for detailed analysis of the balance between the additional outlay required for installing the facility and the savings that can be expected on the operating costs with the reduced consumption of chemicals.

To answer the present purpose of feasibility study, a cursory analysis is presented in what follows, based on a number of rough assumptions. Taking 16% of the bone dry weight of

the jute cuttings as the rate of caustic soda addition in the cooking process, and considering that 1.73 bone dry tons of jute cuttings is required for producing 1 air dry ton of product bleached pulp, the caustic soda consumption would be 1,730 kg x 0.16 = 276 kg per air dry ton of bleached pulp. Taking teh value of TK16,800 per ton of caustic soda, the expenditure for caustic soda would be 0.276 x 16,800 = TK4,636 per ton of bleached pulp. This cost value is extremely high, accounting for nearly 40 percent of the present selling price of product (TK11,400 per ton). This relatively high ratio is a reflection of the high price of soda in Bangladesh compared with other countries. Consequently, it can be stated that, as a preliminary estimate, the installation of a chemical recovery facility would appear economically justified.

The facility for chemical preparation is an installation for a supplying the chemicals used in making-up of cooking chemical and in bleaching the pulp, which are in this instance, chlorine, caustic soda and sodium hypochlorite. Chlorine is normally produced by electrolysis of industrial salts, and sodium hypochlorite by passing chlorine through caustic soda solution.

The Chittagong Chemical Complex has an electrolysis plant, which, according to the present survey, is capable of producing 4,500 tons of caustic soda and 3,900 tons of chlorine each per year (as of September 1981). The output of this plant is, however, completely absorbed by domestic demands. Besides, the additional output through plant expansion scheduled in 1984-1985 has already been reserved for certain users. Although other chemical plants were not checked for the availability of extra chlorine and caustic soda during the present survey, it is considered very difficult to locally procure sufficient amounts of chlorine and caustic soda.

For the purpose of the present project, therefore, a self-sufficient system, including a chemical production plant, should be considered.

The problems relevant to ecological and environmental protection currently required to be considered for a pulp mill concern pollution of the atmosphere and of water. Atmospheric pollution emanating from a pulp mill involves the toxic effects and odour caused by the dispersion of the sulphur contained in the chemicals and fuels released into air. The choice of the soda process for the cooking procedure in the present instance eliminates the presence of sulphur in the effluent gas, and hence atmospheric pollution is no concern of the envisaged mill. On the other hand, water pollution caused by the mill effluent requires careful consideration: The pulping processes generate organic compounds which contaminate the effluent water, which can become a serious source of water pollution, if released into the environment without proper treatment. The effluent water also contains fibrous matter which demands adequate oxygen supply for its unobstructed biological degradation. Coloured substances and a little mineral salts carried by the effluent water also require consideration.

In recent years, various types of water pollution control equipment have been developed for pulp and paper mills. Since any of these equipment does not directly contribute to the efficiency of the production line, it is important to select such equipment as minimizing the installation and operating costs and offering maximum economy. For the purpose of the present Project, the lagoon system is to be employed in view of the fact that a big tract of damp ground is available in the locality and that the primary purpose of wastewater treatment is to reduce the SS and BOD.

Infrastructure is an important factor to be considered in mill siting, and the available facilities in terms of road and rail transportation, waterway and port facilities require thorough examination. It was observed that there are no additional works except expansion of access road. This expansion work, however, is out of scope of the Project.

7.3.2 Operation of the Envisaged Mill

Twenty-four hour operation in 3 shifts is envisaged, with 330 working days a year. The mill is to be shut down during a whole day once a month for routine inspection, and also for about 3 weeks once a year for scheduled maintenance.

The above number of working days has been adopted only for purposes of calculating the capacity of the envisaged mill; it does not mean that the equipment will not stand operation beyond this limit. The mill equipment is to be run continuously 24 hours a day, but such operations as reception, unloading and storing of jute cuttings would be performed only during daytime.

7.3.3 Choice of Processing Systems and Equipment

The choice of processing systems and equipment for the envisaged mill has been based on the following principles:

(1) Mill Feed Handling Department

The jute cuttings are delivered from jute centres in the form of bales. The delivery will not necessarily be continuous and constant, and provision must therefore be made for storing a running stock in the mill.

Jute is harvested seasonally, but processing of the harvested jute at the jute centres continues all the year round, so that the jute cuttings proceeding from the operation of these centres are not generated all at once. The storage capacity at the pulp mill, consequently, need not cover more than a stock for, say, one month. Measures for minimizing detrioration of the quality of jute cuttings as pulp material remain to be studied in detail, but observation of the jute cuttings stocked outdoors for several months at the Sylhet mill indicates that extended exposure to weather has the effect of tarnishing the cuttings into a dark brown colour, evidencing appreciable deterioration of material quality.

This weathering damage must be expected to be accelerated during the wet southwest monsoon. Suitable shelters should advisably be provided to protect the bales of jute cuttings from rain. It is necessary for jute cuttings to be fed into the digester after being cut into short fibers approximately 5 cm long. Since the bale is tightly pressed and bound with jute yarn, feeding it into the digester may result in uneven cooking, hence unstable product quality. On the other hand, great difficulty is involved in mechanically breaking up for jute cuttings into shorter pieces.

This may cause mechanical trouble during actual operation.

For the purpose of the present Project, jute cutting bales are to be manually unpacked (removal of jute yarn) and broken up into about 10 cm thickness (equivalent to one stroke of the bale press) before being cut in cutter. After the cutter, the dust collecting system is provided. Complex mechanized equipment is not adapted to handling agricultural products such as jute.

This process can be applied for other jute materials as well as jute cuttings.

(2) Digester

Between the alternative modes of batch and continuous operation for the digester, the former mode, ensured by traditional globe-shaped rotary digester is adapted in this instance, by reason of the relatively modest throughput envisaged, the irregular shapes presented by the jute cuttings to be treated, and the easier operation and simple maintenance ensured by this type of digester. It requires more manual handling, but ensures stable uniform pulping. It is also less subject to machine trouble. These advantages offered by the batch-operation digester far outweigh its drawbacks of longer time required in digester charging, blowing and discharging, with consequent lower productivity. It is also applicable to the processing of other jute materials, such as jute sticks, whole jute plants, waste gunny bags, etc.

The cooked pulp is blown into the blow pit under the digester. During digestion, cooking materials such as jute must be frequently expected to form lumps which are liable to plug the pumps and obstruct transfer. This calls for the provision of a device for mechanically breaking the lumps. For this purpose, a special pump capable of breaking up lumps is to be provided at the outlet of the blow pit. Another facility requiring installation is that for removing at an early stage of processing the earth and sand contained in the feed material, and which will lower the quality of the product and also cause wear of pump impellers and other equipment. For this purpose, a cyclone separator is to be provided between the blow pit and the next process.

(3) Pulp Washers

Pulp washers are largely classified into three types: screw-press type, double-wire type, and vacuum cylinder drum type. For the purpose of the present Project, the most commonly used vacuum cylinder drum type (3-stage, countercurrent) has been selected. The screw-press type is apt to cause damage to pulp fibres, deteriorating the pulp quality. The double wire type requires costly maintenance. The specific load of the filters has to be held down to a relatively low value, on account of the small drainage rate shown by jute pulp. A specific load of say 3 tons/day per m^2 is recommended.

(4) Pulp Screen & Cleaner

Pulp screens and cleaner are to be provided to screen the pulp fed from the washer. There are two types of screen flat type and cylinder type. The flat type is poor in processing capacity per unit, hence inefficient. This type is normally used for small-capacity processes (secondary or tertiary screening). For the purpose of the present Project, the cylinder type is to be used for both primary and secondary screening stages.

To remove the earth and sand feared to be mixed in the jute as mentioned in the previous section, the provision of small diameter centrifugal cleaners is recommended. A certain separator to remove relatively large and heavy particles of stones, sand, and metals, should be installed upstream of the washer. The centri-cleaner system is recommended to be installed prior to the bleach plant.

(5) Bleaching Process

A conventional 3-stage, C-E-H sequence bleach plant is envisaged, for its advantages

of easily procurable and inexpensive chemicals required for the process, and assurance of stable and safe operation thanks to the accumulated experience available for this type of plant. Samples of bleached pulp trially produced from jute cuttings by this procedure have shown a brightness of about 80°GE.

Pulp brightness can be enhanced by chlorine dioxide bleaching, which is a sequence that has come to be widely adopted in large mills, but the generation of chlorine dioxide involves investment in an expensive facility and advanced techniques in operation.

Let us examine here the 4-stage (C-E-H-D) bleaching process which uses chlorine dioxide. The equipment cost involved amounts to about USD3-million (D-stage bleaching equipment and chlorine dioxide generator), and the operating cost reaches about Tk.250 per air dry ton of bleached pulp.

On the other hand, the test results as mentioned in Chapter 3 indicate that the brightness of pulp processed by this method is 85°GE, with no other noticeable improvement in pulp quality. Thus, the additional costs required for this process are too much for the modest improvement in brightness. Besides, the operation of this process involves certain technical problems. The final choice for this additional bleaching stage should be made taking into consideration with the consumer's preference for pulp brightness.

(6) Pulp Drier

Pulp is dried into either sheet mats or fluffs. The former is called airborne drying, and the latter flash drying. Sheet drying is more widely employed around the world. For the purpose of the present Project, a sheet drier has been selected. The flash drier blows combustion gas directly onto the wet fluffed pulp to evaporate the moisture off the pulp. Since this method has adverse effects on the pulp fibres and product quality, it cannot be recommended for the envisaged mill.

(7) Chemical Recovery

A conventional soda recovery cycle is envisaged. This cycle involves:

- Evaporators for concentrating black liquor
- An incinerator for burning thick black liquor

- A recausticizing plant for preparing white liquor for digestion
- A kiln for regenerating the lime produced in the causticizing process

For the purpose of the present Project, a soda recovery process having the same as shown above has been selected. For the purpose of the recovery of chemicals and the reduction of installation cost, it is emphasized that a incinerator is recommended for burning thick black liquor instead of a recovery boiler to be provided in the common sulphate pulp mill. This equipment is suitable for small-scale plants, since it helps reduce the installation cost and improve the plant economy.

(8) Chemical Preparation

The principal chemicals used at the envisaged mill are caustic soda, chlorine, and sodium hypochlorite. To obtain these chemicals, caustic soda and chlorine are first produced through electrolysis from industrial salt then sodium hypochlorite is produced by passing chlorine through caustic soda solution. There are three types of electrolysis process: the mercury process, diaphragm cell process, and ion-exchange membrane cell process. The last process has been selected for the purpose of the present project.

The mercury process has the advantage of producing high-purity caustic soda. However, it consumes substantial amounts of electric power and requires costly mercury. Especially, the waste of mercury causes a serious problem of pollution. For these reasons, this process is prohibited in Japan.

The diaphragm cell process also requires substantial amounts of electric power and costly equipment. Besides, the operation and maintenance of this process are more complicated than those of the ion-exchange membrane cell process.

(9) Self-Electric Power Generation

Since ample amounts of inexpensive natural gas are readily available at the mill site, it is envisaged that the electric power required at the mill is self-generated, excepting purchased power for emergency use and for lighting. The equipment is to be a combination of a power boiler using natural gas as its fuel and a turbine generator. The extraction steam from the turbine is to be used for the processes.

(10) Mill Water Treatment

Raw water is supplied from Meghna river and subjected to proper treatment. On the present survey, data about the quality of the river water for the past year was obtained from AFCC located near the mill site. As these data indicate low turbidity and hardness, clarification by conventional coagulation and sedimentation treatment, followed by filtration through gravity sand filters would be considered adequate for obtaining water of sufficient quality.

(11) Effluent Treatment

The treatment to be applied to the mill effluent before release has to be determined from ecological considerations of environmental protection. Normally, waste water from pulp mills does no harm to human beings. However, it is contaminated with organic substances, and shows high BOD/SS values. The content of inorganic matter is minimal. Thus, it is necessary to control BOD, SS, and pH of the waste-water to such a degree that no adverse effect is exerted on fishes and shellfishes. For the purpose of the present Project, the lagoon system has been selected taking into consideration the site conditions of the envisaged mill.

7.4 Process Description

7.4.1 Raw Material Handing and Storage

Bales of jute cuttings (each bale weighing about 200 kg) arriving by river and/or land are stored at the mill site. These bales are unloaded by crane, transported by hand car to the storage yard, and piled by mobile crane. The storage yard should be provided with shelter to protect the stock from rain and consequent deterioration. The storage capacity should suffice to cover mill operation during one month (approximately 4,000 tons). The stock is reclaimed from the stockpile by mobile crane, and transported to the workshop, where they are debaled by manual, then conveyed to the cutters. After the cutters, jute cuttings chips are sent to the dust filter to separate dust from filters. The dusts are transported to the boiler and the fibers are conveyed to the digester room. Two lines of feed conveyors shall be provided for the transportation to digester, each lines feeding about 6 tons per hour. Approximately 160 tons of bales are processed in a day. The unloading and storing of bales shall be performed during daytime, and the subsequent handing of those bales shall be performed on a 24-hour basis.

7.4.2 Digesting

The jute cuttings are cooked in a conventional globe-shaped rotary digester. There are six digesters divided into two lines of feeding system to perform batch operation. To this digester charge there is added the cooking liquor of soda solution, diluted with black liquor discharged from the pulp washing department which is the ensuing step.

The charged digester is then closed; it is set to rotate, driven by motor; the charge is heated up by steam to 170°C, which is the digesting temperature; this temperature is kept for 2 hours.

The digester system is designed to operate on an 8-hour cycle; providing for 3 batches per one digester to be processed during 24-hour operation. When digesting is completed, the pressure in the digester is relieved; the cover is opened to blow; the cooked jute cuttings are dropped into a blow pit under the digester; the pulp in the blow pit is diluted and circulated; the diluted pulp is passed through a cutting pump, where long fibres and lumps that had not completely defibred in the digesting stage are defibrized. The defibred pulp is pumped to the washing department via cyclone separator.

The digesting yield is envisaged to be about 55–60%, to ensure a daily output of 80 bone dry tons/day of cooked pulp.

The steam exhausted from the digester, together with the steam discharged at the time of blowing, is utilized to heat freshwater for the pulp showers.

7.4.3 Washing and Screening

The cooking liquor is separated from the pulp by counter-current washing applied in three wash-filters arranged in series. This arrangement ensures maximum washing effect, and the concentrated liquor generated in the first wash-filter is directly channelled to the liquor evaporation facility with high solid content, to contribute significantly to enhancing the efficiency of liquor recovery.

The pulp arriving from the digester department is diluted to a consistency of about 1% with black liquor from the filtrate tank of the first stage of the washing system; the diluted pulp then enters the 3-stage wash-filter. The filtrate from each of these filters is used to dilute the incoming pulp, part of the filtrate being used on the showers of the preceding filters; hot

freshwater is used for the shower of the last stage filter. The balance liquor remaining in the filtrate tank of the first stage is channelled to the recovery facility. The thick washed stock of approximately 10% consistency discharged from the last stage filter is diluted and stored in a chest. The washed stock is pumped to a screening system; the washed brown stock, controlled to about 2% consistency, passes through the first stage rotary screen; the reject from this screen is stored in a tank and sent to the secondary screen; the secondary screen accept is sent to a pre-screen chest, for a second treatment through the first stage screen. The pulp having passed through the primary screen is further diluted and sent to a 3-stages centrifugal cleaner, where the pulp is removed of sand, dust, etc.

The cleaned pulp is sent to a thickner, which raises the consistency to about 12%; this stock is stored. The storage tank has a capacity to cover 1/3 day's operation - i.e. equivalent to 25 bone dry tons of pulp. The processes hereto mentioned are all for unbleached pulp. Normally, unbleached pulp prepared through these processes is forwarded to the subsequent bleaching process. If unbleached pulp is to be shipped as a final product, a pipeline is provided to send unbleached pulp to the final pulp machine, by-passing the bleaching process.

7.4.4 Bleach Plant

The brown stock is bleached in a 3-stage system embodying the following sequence:

- Chlorination
- Alkali extraction
- Hypochlorite bleaching

The bleach plant has a capacity of producing 75 bone-dry tons per day of bleached pulp possessing a brightness of approximately 80°GE. The bleaching towers are designed with sufficient volumes to ensure the necessary stock retention times and further permit a certain range of variation thereof.

The unbleached stock in the thick stock storage is diluted in the lower part of the storage tower and then pumped to the bleach plant; immediately upstream of the tower discharge pump, the stock is further diluted with filtrate from the chlorination stage filter of the bleach plant; the diluted stock is mixed with chlorine before the chlorination stage. For this stage, chlorine gas sent from chemical preparation plant is injected, and sent to a static mixer to mix with the stock. The rate of chlorine addition is 5% of the bone dry unbleached pulp content.

The chlorinated stock is taken into an upflow chlorination tower (stock retention time approximately 1 hour at ambient temperature and 3.5% stock consistency); the stock flows up through the tower impelled by circulators; from the tower top it passes into a chlorine wash filter; before entering the filter, the stock is diluted to 1.0% – 1.5% consistency with filtrate of the stage just passed; in the wash-filter, the stock suspension is washed with hot water to be thickned.

The thick stock discharged from the wash-filter falls into a mixer, where caustic soda solution is added, and heated up by steam injection; after mixing, the stock passes into a down-flow alkali tower (retention time approx. 2 hours at 60°C and 10% stock consistency); from the alkali tower, provided at the bottom part with a propeller agitator and a ring with spray nozzles for diluting the thick stock, the stock is discharged, its consistency regulated, and pumped to a caustic wash-filter. After the caustic washer, the stock passes into the final hypochlorite stage. The hypochlorite is added to the stock downstream of the wash-filter (stock retained in the hypo bleach tower for appr. 3 hours at appr. 40°C and 10% consistency).

The rate of caustic soda addition is 2.5% in reference to bone dry pulp, and that of hypochlorite similarly 2% in terms of available chlorine.

The stock from the hypochlorite tower via discharge device is pumped to wash-filter, washed with hot water in the hypochlorite washer, and is channelled to a high density stock storage tank having a capacity representing 25 tons of bone dry pulp. The filtrate of each stage is used to dilute the wash-filter feed stock of the relevant stage. A part of the hypochlorite stage filtrate is used for feeding the shower of the chlorination stage washer. The balance remaining in the filtrate tanks in each stage is discharged into the sewer system, through which it passes into the waste water treatment facility.

Caustic soda and hypochlorite, as well as chlorine, is produced in chemical preparation plant, and are diluted for feeding respectively into the caustic extraction and hypo-bleaching stages.

The loss of pulp through the bleaching system is approximately 8%: 82 air dry tons of unbleached pulp are required for producing 75 air dry tons of bleached pulp.

7.4.5 Pulp Machine and Finishing

The pulp processed in the bleaching plant is fed into the pulp sheet machine...

First, the bleached pulp is passed between double wires from the head box. As the double wires run, the pulp is dewatered and formed into sheets. Then, the pulp sheet is subjected to a 2-stage dehydrating press, whereby the pulp consistency is approximately 45%. The pulp sheet is now sent to the drier. In the drier, the pulp makes direct contact with hot air, which causes the pulp moisture to evaporate. The hot air is produced by an air heater with steam and supplied by a fan. Exhaust air is blown out to atmosphere after heat recovery.

The pulp sheet thus dried has a mositure content of approximately 10 to 15%. It is cut into the desired lengths and piled up on layboys. Cut sheets are conveyed to the product warehouse on the conveyor system through bale weighing, pressing, wire-binding, and marking.

7.4.6 Chemical Recovery

1) Evaporation and Incineration

The black liquor from the pulp washing department is first stored in a tank; from the tank, the weak black liquor passes through a multiple-effect long-tube vertical evaporator and concentrator, where the liquor concentration is increased to approximately 40–50%.

The heat necessary for evaporation is supplied to the first effect chamber by exhaust fumes from incinerator, and from this chamber the vapour flows from one chamber to the next counter-currently.

The concentrated black liquor from the evaporating facility is sprayed into the top of incinerator where it is burned with natural gas. The volatile portions of the solids, consisting of complex compounds of soda and organic noncellulose portions of the jute, are driven off and burned. The residue, comprising chiefly carbon and inorganic soda compounds, settles down on the hearth; here the solids burn: the temperature is raised to the extent of melting the ash; this molten ash ("smelt") is continuously discharged from the furnace hearth into the dissolving tank, from where it is pumped to the recausticizing system.

Exhaust fume from incinerator enters the first effect evaporator where it is released heat through a venturi scrubber, and then they are blown out to atmosphere from chimmy.

2) Recausticizing Plant

The green liquor from the smelt dissolving tank goes through the clarifier before entering the slaker, where the lime from the lime kiln is slaked.

The purpose of the causticizing plant is to convert soda into caustic soda by treatment with calcium hydroxide:

$$Na_2CO_3 + CaO + H_2O = 2HaOH + CaCO_3$$

The causticizing reaction takes place as the liquor flows through the causticizing tanks; the liquor and sludge are sent to the clarifier where the lime sludge is precipitated and sedimented; the sludge settles off and the clear white liquor flows off continuously to pass into the digester room. The lime sludge deposited in the white liquor clarifier is pumped into the secondary clarifier; the underflow from the clarifier is sent to the lime mud filter; the sludge from the filter is conveyed to the kiln for lime reburning.

3) Lime recovery

The thickened lime sludge is burned in a rotary kiln, with heat supplied by natural gas.

The lime lost in the cycle is made up by the addition of crushed limestone to the lime mud before it enters the kiln.

After discharge from the kiln, the quick-lime is passed into a crusher to reduce any large lumps that may be present; the crushed lime is carried by conveyor to storage for reuse in the causticizing of green liquor.

7.4.7 Chemical Preparation

1) Salt purification process

Material salt is put in a dissolving tank, in which it is dissolved in industrial water and saline returned from the electrolysis cell. As a result, the saline becomes saturated solution.

To remove impurities from the saturated solution, it is added with chemicals for reaction in a reaction tank and separated sludge settles in a sedimentation tank.

Then, the saturated solution is screened through a brine filter, its pH value is regulated in a brine head tank, then supplied to the electrolysis cell. Sludge discharged from the seidmentation tank is fed to a filter, where it is separated into saline and mud. The saline is recycled into the material salt dissolving tank, and the mud is discarded.

2) Electrolysis process

Salt water is fed into the ion-exchange membrane type electrolysis cell, where chlorine gas is produced at the anode, and caustic soda and hydrogen gas from the cathode.

As the electrolysis proceeds, soft water should be supplied to the cathode.

The saline, from which chlorine gas has been separated, is returned to the salt purification process.

The chlorine gas is washed and cooled. A part of this chlorine gas is sent to the sodium hypochlorite production process, and the remaining part is passed through a drier tower using sulfuric acid. The dried chlorine gas is sent to the pulp bleaching process, and the excess chlorine gas is liquefied.

The hydrogen gas produced is blown out to atmosphere.

The caustic soda is controlled to the desired concentration before being fed to the pulp bleaching process.

3) Sodium hydrochlorite production process

Caustic soda solution is sent to a sodium hypochlorite tower with cooler through a vent gas scrubber. This tower makes caustic soda solution to react with chlorine gas to produce sodium hypochlorite of the desired concentration.

The sodium hypochlorite solution is sent to a sodium hypochlorite storage, from where it is supplied to the pulp bleaching process.

Chlorine gas which remains inactive during the reaction is returned to the vent gas scrubber to be reused for subsequent reaction with caustic soda solution.

The vent gas scrubber is designed so that it can also be used as a chlorine gas pollution control device.

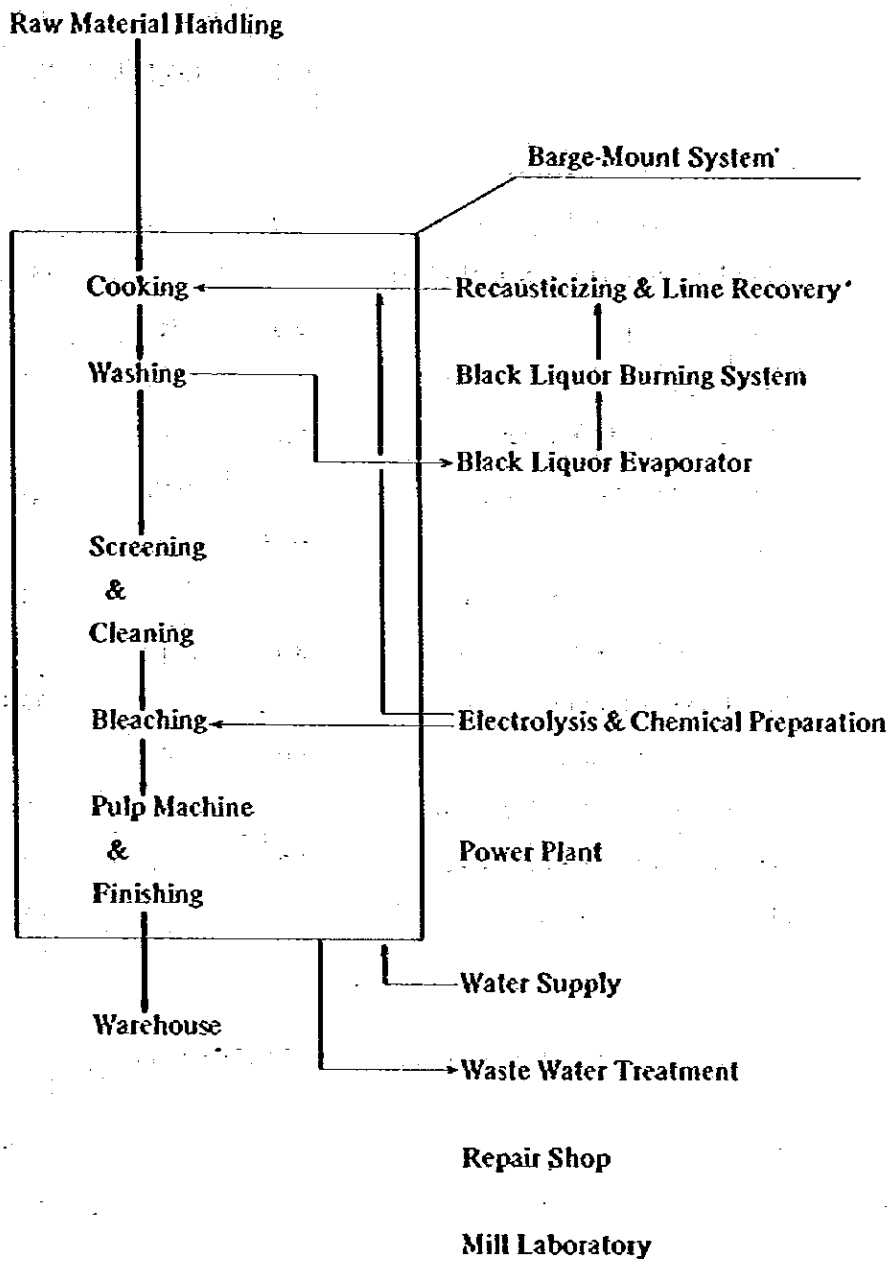
7.5 Technical Specification

7.5.1 Plant Basic Conditions

1.	Plant Capacity:	75 Air Dry Tons per Day, 25,000 Air Dry Tons on annual Process Design Base – 80 BDT/D
2.	Final Product:	Bleached Pulp for local use and export
3.	Raw Material:	Jute cuttings Provision on layout and equipment to be kept for alternative Jute materials in future.
4.	Utility Conditions	
1)	Mill Water:	From MEGHNA RIVER
2)	Electric Power & Process Steam:	Self Generation & Purchased Power from Power Development Board
3)	Fuel:	Natural Gas in ASHUGANJ Region
5.	Chemicals	
1)	Chlorine:	Self-Making
2)	Caustic Soda:	Ditto
3)	Lime Stone:	Purchased

7.5.2 Plant Basic Design

1. Process Flow Chart



2. Yield and Losses of Main Process

Yield and Losses Table on Normal Operating Rate

Description	Loss (%)	Loss (BDT/D)	Accepted (BDT/D)	
1) Jute Cutting Received			133.3	(147.8 ADT/D)
2) Storage & Handling Loss	1.0	1.3		
3) Jute Cutting Charged to Cooking			132.0	
4) Cooking Yield	43.0	56.8		
5) Pulp in Blow Tank			75.2	
6) Liquid Cyclone Reject	0.4	0.3		
7) Pulp Charged to Washing			74.9	
8) Washing Loss	0.05			
9) Pulp Charged to Screening			74.9	
10) Screening & Cleaning Reject	2.0	1.5		
11) Pulp Charged to Bleaching			73.4	
12) Bleach Shrinkage	8.0	5.8		
13) Pulp Charged to Pulp Machine			67.6	
14) Broke & White Water Losses	0.2	0.1		
15) Production of Pulp			67.5	(75 ADT/D)

Hence overall yield on Jute Cuttings = 67.5 / 133.3 = 50.6%

3. Cooking Chemical Recovery

1) Active Alkali in Cooking: 21,120 kg/D as NaOH
(16% on BD Jute Cuttings)

2) Alkali Loss in Process

In Pulp Leaving Washer:	844 kg/D as NaOH (4% on Alkali charged into Cooking)
In Black Liquor Leaks:	211 kg/D as NaOH (1% on Alkali charged into Cooking)
In Black Liquor Burning:	422 kg/D as NaOH (2% on Alakli charged into Cooking)
In Recausticizing:	633 kg/D as NaOH (3% on Alkali charged into Cooking)
Total	2,110 kg/D as NaOH (10% on Alkali charged into Cooking)

3) Make-up Chemical

Make-up Chemical: 2,110 kg/D as NaOH

4) Composition of White Liquor from Recausticizing Plant

As process is soda process, active alkali = NaOH and activity = causticity.
Assume active alkali A.A = 120 kg/m³ as NaOH.
Assume actual value is 80% causticity NaOH/(NaOH + Na_2CO_3).
Since NaOH = 120 kg/m³,
Hence NaOH + Na_2CO_3 = 120 x 1/0.8 = 150 kg/m³.
Hence Na_2CO_3 = 150 - 120 = 30 kg/m³ as NaOH.

	As NaOH	As weight chemical
NaOH	120 kg/m³	120 kg/m³
Na_2CO_3	30 kg/m³	79 kg/m³
Total Chemical	150 kg/m³	199 kg/m³

4. Utility Consumption on Normal Operation Rate

1) Steam Consumption in Process

	LP (2.5 kg/cm²G)	MP (10 kg/cm²G)
Cooking	-	11,200 kg/hr
Bleaching	1,300 kg/hr	-
Pulp Machine	-	4,500 kg/hr
Black Liquor Evaporator		300 kg/hr
Misc.	700 kg/hr	
Total	2,000 kg/hr	16,000 kg/hr

2) Electric Power Requirement

Main Pulping Process	1,600 kW
Chemical Recovery:	600 kW
Power Plant:	400 kW
Electrolysis & Chemical Preparation:	1,700 kW
Water Supply & Effluent Treatment:	500 kW
Others:	200 kW
Total	5,000 kW

3) Fuel Gas Consumption

Power Boiler:	3,150 Nm^3/hr
Black Liquor Burning:	120 Nm^3/hr
Lime Kiln:	450 Nm^3/hr
Total	3,720 Nm^3/hr
Calorific Value	8,700 kcal/Nm^3

7.5.3 Equipment List

DEPARTMENT 26 RAW MATERIAL HANDLING

26000 Design Base

(1)	Capacity	
	Unloading and storaging:	30 BDT/Hr by two unloader
	Feeding to cooking:	10 BDT/Hr two-line
(2)	Jute Cutting Bale	
	Pucca Bale:	1,300mm x 550mm x 500mm 200 kg
	Kutcha Bale:	1,300mm x 700mm x 400mm 150 kg
	Moisture:	10–15%
(3)	Operation Time	
	Unloading & storaging:	16 hours per day
	Feeding to cooking:	24 hours per day
(4)	Storaging capacity:	4,000 DBT

26101 Stationary Crane

Quantity:	Two (2)
Service:	Unloading from ship
Crane Capacity:	1,000 kg at 10,000 mm horizontal distance

26102 Hand Car

Quantity:	Twelve (12)
Service:	Transportation of Bale
Type:	Table type
Loading Capacity:	2 tons

26103 Mobile Crane

Quantity:	Two (2)
Service:	Bale handling on storage pile
Crane Capacity:	1,000 kg at 5,000 mm height
Travelling Speed:	6 km/Hr

26104 Loading Conveyor

Quantity:	Two (2)
Service:	Transportation of Jute chips to Cooking
Type:	Flat belt
Size:	2,000 mm Belt width x 20,000 mmL
Speed:	20 m/min.
Drive:	3.7 kW x 6P

26105 Inclined Conveyor

Quantity:	Two (2)
Service:	Transportation of Jute chips to Cooking
Type:	Flat belt and side wall type
Size:	2,000 mm Belt width x 110,000 mm
Inclined angle:	20°
Speed:	20 m/min.
Drive:	22 kW x 6P

26106 Cutter Feeding Conveyor

Quantity:	Four (4)
Type:	Flat belt and side wall type
Size:	1,000 mm Belt width x 10,000 mm

26107 Cutter

Quantity:	Four (4)
Type:	Rotary type
Size:	1,000 mm width

26108 Dust Filter

Quantity:	Four (4)
Type:	Drum type

26109 Dust Collecting System

Quantity:	Four (4) sets

Consist of Fans, Ducts, Cyclones and Tank.

DEPARTMENT 31. COOKING

31000 Design Basis

1)	Capacity:	80 BDT/D as Unbleached Pulp
2)	Digester:	6-Batch Digester (80 m^3 each)
3)	Density of Jute Cutting:	100 kg BD/m^3 in Digester
4)	Additive Chemicals:	Active Alkali (NaOH), 16% on BD Jute Cutting
5)	Cooking Condition	
	Pressure:	9.0 kg/cm^2G
	Temperature:	170°C
	Liquor Ratio:	6.5
6)	Cooking Cycle	
	Charging of Jute Cutting and Liquor:	150 mm
	Raising of Cooking Temp.:	120 min.
	Cooking at the Temp.:	120 min.
	Blow-down of the Contents:	90 min.
7)	Cooking Yield:	50%
8)	White Liquor:	100 g/l as NaOH

31101 Digester

Quantity:	Six (6)
Type:	Rotary Globe Digester
Volume:	80 m^3
Main dimension:	5,450 mm Inner Dia.
Material:	Body-SM41A
Drive:	Beier Cyclo Reducer, Spur gear drive
	37 kW x 8P motor
Remarks:	Insulated

31102 Hoist

Quantity:	One (1) set
Service:	Digester Cover handling
Type:	Electric hoist and Gear trolley
Capacity:	2 Tons

31103 Heat Exchanger

Quantity:	One (1)
Type:	Shell & Tube
Material:	
Tube;	Stainless Tell (SUS 304)
Shell;	Mill Steel

31201 Blow Pit Pump

Quantity:	Six (6)
Service:	Blow Pit Discharge
Type:	Sun-Cutter
Capacity:	3 m^3/min. x 12 m Head
Material:	
Impeller;	Stainless steel castings (SCS 13)
Casing;	Cast iron
Drive:	37 kW x 4P

31202 Blow Pit Pump

Quantity:	Six (6)
Service:	Blow Pit Discharge
Type:	Hydrostal
Capacity:	8.0 m^3/min. x 15 m Head
Material:	
Impeller;	Stainless steel casting (SCS 13)
Casing;	Cast iron
Drive:	37 kW x 4P V-belt drive

31203 Blow Tank Pump

Quantity:	One (1)
Service:	Blow Tank discharge
Type:	Centrifugal
Capacity:	2.5 m^3/min. x 35 m Head
Material:	
Impeller;	Stainless steel castings (SCS 13)
Casing;	Cast iron
Drive:	30 kW x 4P

31204 White Liquor Pump

Quantity:	One (1)
Service:	White Liquor Tank discharge
Type:	Centrifugal
Capacity:	1.0 m^3/min. x 15 m Head
Material:	
Impeller;	Stainless steel castings (SCS 13)
Casing;	Cast iron
Drive:	5.5 kW x 4P

31205 Black Liquor Pump

Quantity:	One (1)
Service:	Black Liquor Tank discharge to Blow Pit
Type:	Centrifugal
Capacity:	5.0 m^3/min. x 15 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	18.5 kW x 4P

31206 Black Liquor Pump

Quantity:	One (1)
Service:	Blow Liquor Tank discharge to Cooking Liquor Tank
Type:	Centrifugal
Capacity:	2.0 m^3/min. x 15 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	11 kW x 4P

31207 Black Liquor Pump

Quantity:	One (1)
Service:	Black Liquor Tank discharge to Dilute Stock
Type:	Centrifugal
Capacity:	0.5 m^3/min. x 10 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	3.7 kW x 4P

31208 Cooking Liquor Pump

Quantity:	Two (2)
Service:	Cooking Liquor Tank discharge
Type:	Centrifugal
Capacity:	1.0 m^3/min. x 18 m Head
Material:	
Impeller;	Stainless steel castings (SCS 13)
Casing;	Cast iron
Drive:	5.5 kW x 4P

31301 Blow Pit Agitator

Quantity:	Six (6)
Type:	Horizontal, Mixing
Size:	1,200 mmϕ
Material:	Mild steel
Drive:	37 kW x 4P geared motor

31302 Blow Tank Agitator

Quantity:	One (1)
Type:	Horizontal, Propeller type
Size:	1,530 mmϕ
Material:	Cast iron & Stainless steel castings (SCS 13)
Drive:	75 kW x 8P motor, V-belt drive

31303 Cooking Liquor Tank Agitator

Quantity:	One (1)
Type:	Vertical
Size:	610 mmϕ
Material:	Mild steel & Stainless steel castings (SCS 13)
Drive:	7.5 kW x 4P

31401 Blow Pit

Quantity:	**Six (6)**
Volume:	**160 m³**
Material:	**Mild steel**

31402 Blow Tank

Quantity:	**One (1)**
Volume:	**220 m³**
Material:	**Mild steel**

31403 White Liquor Tank

Quantity:	**One (1)**
Volume:	**120 m³**
Material:	**Mild steel**

31404 Black Liquor Tank

Quantity:	**One (1)**
Volume:	**200 m³**
Material:	**Mild steel**

31405 Cooking Liquor Tank

Quantity:	**One (1)**
Volume:	**65 m³**
Material:	**Mild steel**

31601 Scaffolding

Quantity:	**One (1) set**
Service:	**For Digester and Blow Pit**
Material:	**Mild steel**

31701 Piping, Valves and Fittings

One (1) set of pipes, valves and fittings for this department will be supplied.

DEPARTMENT 32. WASHING

32000 Design Basis

1)	Capacity:	80 BDT/D
2)	Washing:	3-Stage Counter Flow Washing
3)	Dilution Factor:	3.5
4)	Washer Load:	3 BDT/D-m^2

32101 Liquid Cyclone

Quantity:	One (1)
Type:	No. 11
Capacity:	80 BDT/24 Hrs.
Pulp Consistency:	2.5%

32102 3-Stage Brown Stock Washer

Quantity:	One (1) set
Type:	Vacuum Drum Washer
Capacity:	80 BDT/24 Hrs.
Drum Size:	2,750 mmϕ x 3,200 mm Face
Material:	Mild steel
	Wire cloth – SUS 316
Drive:	
3 - Drum;	Beier Cyclo Reducer
	7.5 kW x 4P motor
2 - Repulper;	Geared motor 11 kW x 4P
1 - Discharge Conveyor;	Geared motor 3.7 kW x 4P

32103 Foam Breaker

Quantity:	One (1)
Type:	Vertical type
Size:	450 mmϕ
Material:	
Rotor;	Stainless steel (SUS 304)
Body;	Mild steel
Drive:	7.5 kW x 6P motor, V-belt drive

32104 Black Liquor Filter

Quantity:	One (1)
Type:	Rotary Drum Filter
Capacity:	800 m^3/24 Hrs.
Drum Size:	1,000 mmϕ x 1,600 mm Face
Material:	Mild steel
	Wire cloth – SUS 316
Drive:	Cyclo Reducer
	2.2 kW x 4P motor

32105 Washer Blow-Off Fan

Quantity:	One (1)
Type:	Turbo-fan
Capacity:	60 Nm^3/min. x 400 m Aq.
Material:	Mild steel
Drive:	11 kW x 4P motor, V-belt drive

32106 Hoist

Quantity:	One (1) set
Service:	Brown Stock Washer and Bleach Washer Maintenance
Type:	Electric hoist and Gear trolley
Capacity:	10 Tons

32201 Washed Stock Pump

Quantity:	One (1)
Service:	Washed Stock Chest discharge
Type:	Centrifugal
Capacity:	2.5 m^3/min. x 10 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	11 kW x 4P

32202 Black Liquor Pump

Quantity:	Three (3)
Service:	Washer Filtrate Tank discharge to Wire Shower
Type:	Centrifugal
Capacity:	0.9 m^3/min. x 30 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	11 kW x 4P

32203	Black Liquor Pump	
	Quantity:	Three (3)
	Service:	Washer Filtrate Tank discharge to dilute stock
	Type:	Centrifugal
	Capacity:	5.5 m^3/min. x 20 m Head
	Material:	
	Impeller;	Cast iron
	Casing;	Cast iron
	Drive:	30 kW x 4P
32204	Black Liquor Pump	
	Quantity:	Two (2)
	Service:	Washer Filtrate Tank discharge to Stock Shower
	Type:	Centrifugal
	Capacity:	0.55 m^3/min. x 23 m Head
	Material:	
	Impeller;	Cast iron
	Casing;	Cast iron
	Drive:	5.5 kW x 4P
32205	Black Liquor Pump	
	Quantity:	One (1)
	Service:	Washer Filtrate Tank discharge to Cooking Dept.
	Type:	Centrifugal
	Capacity:	2.0 m^3/min. x 15 m Head
	Material:	
	Impeller;	Cast iron
	Casing;	Cast iron
	Drive:	11 kW x 4P
32206	Black Liquor Pump	
	Quantity:	One (1)
	Service:	Foam Tank discharge
	Type:	Centrifugal
	Capacity:	0.6 m^3/min. x 20 m Head
	Material:	
	Impeller;	Cast iron
	Casing;	Cast iron
	Drive:	5.5 kW x 4P

32207 Black Liquor Pump

Quantity:	One (1)
Service:	Black Liquor Filtrate Tank discharge to Evaporation Dept.
Type:	Centrifugal
Capacity:	0.6 m^3/min. x 30 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	5.5 kW x 4P

32208 Hot Water Pump

Quantity:	One (1)
Service:	Hot Water Tank discharge to Washer Shower
Type:	Centrifugal
Capacity:	0.55 m^3/min. x 23 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	5.5 kW x 4P

32209 Hot Water Pump

Quantity:	One (1)
Service:	Hot Water Tank discharge to Bleach Washer Shower and to dilute bleached stock
Type:	Centrifugal
Capacity:	3.8 m^3/min. x 30 m Head
Material:	Cast iron
Drive:	37 kW x 4P

32301 Washed Stock Chest Agitator

Quantity:	One (1)
Type:	Horizontal, Propeller type
Size:	1,220 mmϕ
Material:	Cast iron & Stainless steel castings (SCS 13)
Drive:	30 kW x 6P motor, V-belt drive

32401 No. 1 Washer Filtrate Tank

Quantity:	One (1)
Volume:	50 m^3
Material:	Mild steel
Remarks:	Insulated

32402 No. 2 Washer Filtrate Tank

Qauntity:	One (1)
Volume:	50 m^3
Material:	Mild steel
Remarks:	Insualted

32403 No. 3 Washer Filtrate Tank

Quantity:	One (1)
Volume:	50 m^3
Material:	Mild steel
Remarks:	Insulated

32404 Foam Tank

Quantity:	One (1)
Volume:	45 m^3
Remarks:	Insulated

32405 Washed Stock Chest

Quantity:	One (1)
Volume:	60 m^3
Material:	Mild steel

32406 Black Liquor Filtrate Tank

Quantity:	One (1)
Volume:	15 m^3
Material:	Mild steel

32407 Hot Water Tank

Quantity:	One (1)
Volume:	70 m^3
Main Dimension:	4,000 mmϕ x 6,000 mm Height
Material:	Mild steel
Remarks:	Insulated

32601 Scaffolding

Quantity:	One (1) set
Service:	For Brown Stock Washer and Foam Breaker
Material:	Mild steel

32701 Piping, Valves and Fittings

One (1) set of pipes, valves and fittings for this department will be supplied.

DEPARTMENT 33. SCREENING & CLEANING

33000 Design Basis

1)	Capacity:	80 BDT/D
2)	Screening:	2-Stage Cowan Screens
3)	Cleaning:	3-Stage Centri-Cleaner System

33101	Primary Screen	
	Quantity:	One (1)
	Type:	Cowan type or equivalent
	Material:	
	Screen Plate;	Stainless steel (SUS 304)
	Rotor;	Mild steel
	Casing;	Cast iron
	Drive:	75 kW x 6P, V-belt drive
33102	Secondary Screen	
	Quantity:	One (1)
	Type:	Cowan type or equivalent
	Material:	
	Screen Plate;	Stainless steel (SUS 304)
	Rotor;	Mild steel
	Casing;	Cast iron
	Drive:	15 kW x 4P, V-belt drive
33103	3-Stage Centri-Cleaner System	
	Type:	Bauer 606H type
	Quantity:	1st stage 24 units
		2nd stage 7 units
		3rd stage 2 units
	Material:	
	Cleaner Body;	Plastic and Ceramic
	Header;	Mild steel with SUS 304 lining
	(Inlet, Accept, Reject)	
	Reject Receiver;	Mild steel
33104	Brown Stock Extractor	
	Quantity:	One (1)
	Type:	Cylinder mould type
	Capacity:	80 BDT/24 Hrs.
	Cyliner Size:	2,000 mmϕ x 3,000 mm Face
	Material:	Parts in contact with stock to be made of stainless steel (SUS 304) and SUS 304 lining
	Drive:	Geared motor, 11 kW x 4P
		Spur gear drive

33105 Brown Stock Thickener

Quantity:	One (1)
Type:	Valveless type
Capacity:	80 BDT/24 Hrs.
Drim Size:	2,500 mmϕ x 3,000 mm Face
Material:	Parts in contact with stock to be made of stainless steel (SUS 304) and SUS 304 lining
Drive:	
Drum;	Beier Cyclo Reducer
Discharge Screw;	Geared motor, 5.5 kW x 4P

33106 Ring Pipe & Dilution Nozzles

Quantity:	One (1) set
Service:	For unbleached stock high density tower
Material:	Parts in contact with water to be made of stainless steel (SUS 304)

33201 Primary Screen Feed Pump

Quantity:	One (1)
Service:	Thickener Filtrate Tank discharge
Type:	Centrifugal
Capacity:	4.2 m^3/min. x 21 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	22 kW x 4P

33202 Primary Screen Accept Pump

Quantity:	One (1)
Service:	Primary screen Accept Tank discharge
Type:	Centrifugal
Capacity:	7.7 m^3/min. x 10 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	18.5 kW x 4P

33203 Secondary Screen Feed Pump

Quantity:	One (1)
Service:	Primary Screen Reject Tank discharge
Type:	Centrifugal
Capacity:	0.4 m^3/min. x 21 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	5.5 kW x 4P

33204 1st Stage Cleaner Feed Pump

Quantity:	One (1)
Service:	Thickener Filtrate Tank discharge
Type:	Centrifugal
Capacity:	11.4 m^3/min. x 56 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	150 kW x 4P

33205 2nd Stage Cleaner Feed Pump

Quantity:	One (1)
Service:	1st Stage Cleaner Reject Receiver discharge
Type:	Centrifugal
Capacity:	3.0 m^3/min. x 35 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	30 kW x 4P

33206 3rd Stage Cleaner Feed Pump

Quantity:	One (1)
Service:	2nd Stage Cleaner Reject Receiver discharge
Type:	Centrifugal
Capacity:	0.7 m^3/min. x 35 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	11 kW x 4P

33207	White Water Pump	
	Quantity:	One (1)
	Service:	Thickener Filtrate Tank discharge to dilute stock of cleaning system
	Type:	Centrifugal
	Capacity:	2.5 m^3/min. x 20 m Head
	Material:	
	Impeller;	Cast iron
	Casing;	Cast iron
	Drive:	15 kW x 4P
33208	White Water Pump	
	Quantity:	One (1)
	Service:	Thickener Filtrate Tank discharge to dilute stock of screens
	Type:	Centrifugal
	Capacity:	1.8 m^3/min. x 25 m Head
	Material:	
	Impeller;	Cast iron
	Casing;	Cast iron
	Drive:	15 kW x 4P
33209	White Water Pump	
	Quantity:	One (1)
	Service:	Thickener Filtrate Tank discharge to Brown Stock Washer
	Type:	Centrifugal
	Capacity:	1.5 m^3/min. x 24 m Head
	Material:	
	Impeller;	Cast iron
	Casing;	Cast iron
	Drive:	11 kW x 4P
33210	H.D. Tower Pump	
	Quantity:	One (1)
	Service:	H.D. Tower discharge
	Type:	Centrifugal
	Capacity:	1.9 m^3/min. x 40 m Head
	Material:	
	Impeller;	Cast iron
	Casing;	Cast iron
	Drive:	30 kW x 4P

33211 White Water Pump

Quantity:	One (1)
Service:	To dilute stock of H.D. Tower
Type:	Centrifugal
Capacity:	1.1 m^3/min. x 25 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	11 kW x 4P

33301 H.D. Tower Agitator

Quantity:	One (1)
Type:	Horizontal, Propeller type
Size:	920 mmϕ
Material:	Cast iron & Stainless steel castings (SCS 13)
Drive:	22 kW x 6P motor, V-belt drive

33401 Primary Screen Head Box

Quantity:	One (1)
Material:	Mild steel

33402 Primary Screen Accept Tank

Quantity:	One (1)
Volume:	60 m^3
Main Dimension:	3,600 mmϕ x 6,000 mm Height
Material:	Mild steel

33403 Primary Screen Reject Tank

Quantity:	One (1)
Volume:	15 m^3
Main Dimension:	2,000 mmϕ x 5,000 mm Height
Material:	Mild steel

33404 Cleaner Rejects Receiver

Quantity:	Three (3)
Material:	Parts in contact with stock to be made of stainless steel (SUS 304)

33405 Thickener Filtrate Tank

Quantity:	One (1)
Volume:	120 m^3
Material:	Mild steel

33406 High Density Tower

Qauntity:	One (1)
Volume:	250 m^3
Material:	Mild steel

33407 Secondary Screen Head Box

Quantity:	One (1)
Material:	Mild steel

33601 Scaffolding

Quantity:	One (1) set
Service:	For Cleaners, Thickener
Material:	Mild steel

33701 Piping, Valves and Fittings

One (1) set of pipes, valves and fittings for this department will be supplied.

DEPARTMENT 34. BLEACHING

34000 Design Basis

1) Capacity: 75 BDT/D at inlet

2) Sequence: C-E-H

3) Shrinkage: 8% based on Unbleached pulp

4) Bleaching Condition

	C	E	H
Temp. °C	-	60	40
Retention Time (min.)	60	120	180
Consistency(%)	3.5	10	10
Additive Chemicals (% on BD pulp)	6.3	2.0	2.5 (as available chlorine)

34101 Chlorine Mixer

Quantity:	Two (2), Six (6) elements each
Type:	Inline type
Capacity:	75 BDT/24 Hrs.
Material:	FRP
Accessories:	Chlorine Injector – 1 set

34102 Chlorine Washer

Quantity:	One (1)
Type:	Vacuum Drum Washer
Capacity:	75 BDT/24 Hrs.
Drum Size:	2,750 mmϕ x 3,000 mm Face
Material:	All parts in contact with stock to be made of stainless steel (SUS 317L) and SUS 317L lining
Drive:	
Drum;	Beier Cyclo Reducer 7.5 kW x 4P motor
Discharge Screw;	Geared motor, 5.5 kW x 4P

34103 Caustic Steam Mixer

Qauntity:	One (1)
Type:	Single Shaft type
Capacity:	750 BDT/24 Hrs.
Material:	
Rotor;	Stainless steel (SUS 304)
Casing;	Mild steel with SUS 304 lining
Drive:	18.5 kW x 6P motor, V-belt drive
Remarks:	Insulated

34104 Caustic Washer

Qauntity:	One (1)
Type:	Vacuum Drum Washer
Capacity:	75 BDT/24 Hrs.
Drum Size:	2,750 mmϕ x 3,000 mm Face
Material:	All parts in contact with stock to be made of stainless steel (SUS 304) and SUS 304 lining
Drive:	
Drum;	Beier Cyclo Reducer 7.5 kW x 4P motor
Discharge Screw;	Geared motor, 5.5 kW x 4P

34105 Hypo Steam Mixer

Quantity:	One (1)
Type:	Single Shaft type
Capacity:	75 BDT/24 Hrs.
Material:	
Rotor;	Stainless steel (SUS 316)
Casing;	Mild steel with SUS 316 lining
Drive:	18.5 kW x 6P motor, V-belt drive
Remarks:	Insulated

34106 Hypo Washer

Qauntity:	One (1)
Type:	Vacuum Drum Washer
Capacity:	75 BDT/24 Hrs.
Drum Size:	2,750 mmϕ x 3,000 mm Face
Material:	All parts in contact with stock to be made of stainless steel (SUS 316) and SUS 316 lining
Drive:	
Drum;	Beier Cyclo Reducer 7.5 kW x 4P motor
Discharge Screw;	Geared motor, 5.5 kW x 4P

34107 Washer Hood Fan

Quantity:	One (1)
Type:	Axial
Capacity:	200 Nm^3/min. x 60 mm Aq.
Material:	FRP
Drive:	7.5 kW x 4P motor, V-belt drive

34108 Washer Blow-Off Fan

Quantity:	One (1)
Type:	Turbo-fan
Capacity:	60 Nm^3/min. x 400 mm Aq.
Material:	Mild steel
Drive:	11 kW x 4P motor, V-belt drive

34109 Ring Pipe & Dilution Nozzles

Quantity:	One (1) set
Service:	
Caustic Tower Material;	Stainless steel (SUS 304)
Hypo Tower Material;	Stainless steel (SUS 304)
H.D. Tower Material;	Stainless steel (SUS 304)

34201 Caustic Tower Pump

Quantity:	One (1)
Service:	Caustic Tower discharge
Type:	Centrifugal
Capacity:	2 m^3/min. x 25 m Head
Material:	
Impeller;	Stainless steel castings (SCS 13)
Casing;	Stainless steel castings (SCS 13)
Drive;	18.5 kW x 4P

34202 Hypo Tower Pump

Quantity:	One (1)
Service:	Hypo Tower discharge
Type:	Centrifugal
Capacity:	2 m^3/min. x 25 m Head
Material:	
Impeller;	Stainless steel castings (SCS 14)
Casing;	Stainless steel castings (SCS 14)
Drive:	18.5 kW x 4P

34203 H.D. Tower Pump

Quantity:	One (1)
Service:	H.D. Tower discharge
Type:	Centrifugal
Capacity:	1.5 m^3/min. x 15 m Head
Material:	
Impeller;	Stainless steel castings (SCS 13)
Casing;	Stainless steel castings (SCS 13)
Drive:	7.5 kW x 4P

34204 Seal Pit Pump

Quantity:	One (1)
Service:	Chlorine Seal Pit discharge to dilute stock
Type:	Centrifugal
Capacity:	4.8 m^3/min. x 23 m Head
Material:	
Impeller;	Stainless steel castings (SCS 16)
Casing;	Cast iron with Hard rubber lining
Drive:	30 kW x 4P

34205 Seal Pit Pump

Quantity:	One (1)
Service:	Chlorine Seal Pit discharge to Wire Shower
Type:	Centrifugal
Capacity:	0.9 m^3/min. x 30 m Head
Material:	
Impeller;	Stainless steel castings (SCS 16)
Casing;	Cast iron with Hard rubber lining
Drive:	11 kW x 4P

34206 Seal Pit Pump

Quantity:	One (1)
Service:	Chlorine Seal Pit discharge to dilute stock
Type:	Centrifugal
Capacity:	4.8 m^3/min. x 23 m Head
Material:	
Impeller;	Stainless steel castings (SCS 13)
Casing;	Stainless steel castings (SCS 13)
Drive:	30 kW x 4P

34207 Seal Pit Pump

Qauntity:	One (1)
Service:	Chlorine Seal Pit discharge to Wire Shower
Type:	Centrifugal
Capacity:	0.9 m^3/min. x 30 m Head
Material:	
Impeller;	Stainless steel castings (SCS 13)
Casing;	Stainless steel castings (SCS 13)
Drive:	11 kW x 4P

34208	**Seal Pit Pump**	
	Quantity:	One (1)
	Service:	Caustic Seal Pit discharge to dilute stock of Caustic Tower
	Type:	Centrifugal
	Capacity:	1.45 m^3/min. x 35 m Head
	Material:	
	Impeller;	Stainless steel castings (SCS 13)
	Casing;	Stainless steel castings (SCS 13)
	Drive:	15 kW x 4P
34209	**Seal Pit Pump**	
	Quantity:	One (1)
	Service:	Hypo Seal Pit discharge to dilute stock
	Type:	Centrifugal
	Capacity:	4.8 m^3/min. x 23 m Head
	Material:	
	Impeller;	Stainless steel castings (SCS 14)
	Casing:	Stainless steel castings (SCS 14)
	Drive:	30 kW x 4P
34210	**Seal Pit Pump**	
	Quantity:	One (1)
	Service:	Hypo Seal Pit dischatge to Wire Shower
	Type:	Centrifugal
	Capacity:	0.9 m^3/min. x 30 m Head
	Material:	
	Impeller;	Stainless steel castings (SCS 14)
	Casing;	Stainless steel castings (SCS 14)
	Drive:	11 kW x 4P
34211	**Seal Pit Pump**	
	Quantity:	One (1)
	Service:	Hypo Seal Pit discharge to dilute stock of Hypo Tower
	Type:	Centrifugal
	Capacity:	1.45 m^3/min. x 35 m Head
	Material:	
	Impeller;	Stainless steel castings (SCS 14)
	Casing;	Stainless steel castings (SCS 14)
	Drive:	15 kW x 4P

34212 Fresh Water Pump

Quantity:	One (1)
Service:	Chlorine Injector feed
Type:	Centrifugal
Capacity:	0.4 m^3/min. x 45 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	7.5 kW x 4P motor

34213 Hot Water Pump

Quantity:	One (1)
Service:	To dilute stock of H.D. Tower
Type:	Centrifugal
Capacity:	0.85 m^3/min. x 25 m Head
Material:	
Impeller;	Cast iron
Casing;	Cast iron
Drive:	7.5 kW x 4P

34301 Chlorine Tower Agitator

Quantity:	One (1)
Type:	Horizontal, Propeller type
Size:	940 mmϕ
Material:	Cast iron with Hard rubber lining
Drive:	22 kW x 6P motor, V-belt drive

34302 Caustic Tower Agitator

Quantity:	One (1)
Type:	Horizontal, Propeller type
Size:	940 mmϕ
Material:	
Propeller;	Stainless steel castings (SCS 13)
Body;	Cast iron with SUS 304 lining

34303 Hypo Tower Agitator

Quantity:	One (1)
Type:	Horizontal, Propller type
Size:	940 mmϕ
Material:	
Propeller;	Stainless steel castings (SCS 14)
Body;	Cast iron with SUS 316 lining
Drive:	22 kW x 6P motor, V-belt drive

34304 H.D. Tower Agitator

Quantity:	One (1)
Type:	Horizontal, Propeller type
Size:	920 mmϕ
Material:	
Propeller;	Stainless steel castings (SCS 13)
Body;	Cast iron
Drive:	22 kw x 6P motor, V-belt drive

34401 Chlorine Tower

Quantity:	One (1)
Type:	Up-flow type
Volume:	95 m^3
Material:	Mild steel with Hard rubber lining

34402 Caustic Tower

Quantity:	One (1)
Type:	Down-flow
Volume:	68 m^3
Material:	Mild steel and SUS 304 lining on the top of 4,000 mm height
Remarks:	Insualted

34403 Hypo Tower

Quantity:	One (1)
Type:	Down-flow
Volume:	102 m^3
Material:	Mild steel with FRP lining

34404 High Density Tower

Quantity:	One (1)
Volume:	250 m^3
Material:	Mild steel

34405 Washer Seal Pit

Quantity:	Three (3)
Volume:	30 m^3
Main Dimension:	2,450 mmϕ x 7,080 mm Height
Material:	FRP

34601 Scaffolding

Quantity:	One (1) set
Service:	For Washer, Mixer and Towers
Material:	Mild steel

34701 Piping, Valves and Fittings

One (1) set of pipes, valves and fittings for this department will be supplied.

34702 Washer Hood & Duct

Quantity:	Three (3)
Type:	Closed type
Material:	FRP

DEPARTMENT 35. PULP MACHINE AND FINISHING

35000 Design Basis

1) Capacity: 75 ADT/D

2) Final Product

Pulp Sheet Moisture:	10–15%
Pulp Sheet Basic Weight:	1,000–1,300 g/m^2
Pulp Sheet Size:	800 mmW x 800 mmL
Pulp Sheet Bale Weight:	100–150 kg

35101 Closed Head Box

Quantity:	One (1) set
Type:	Closed type
Web Width:	1,750 mm
Material:	All part in contact with stock to be made of stainless steel (SUS 304)
Consist of:	
1 - Head box:	Closed pressure type
2 - Support stands:	Mild steel welded
1 - Pressure gauge:	Diaphragm type
2 - Base plate:	Cast iron

35102 Wire Part

Quantity:	One (1) set
Type:	Double wire press type
Wire Width:	1,750 mm
Machine Speed:	23.5 m/min.
Drive Power:	37 kW
Nip Pressure:	Pre-press max. 20 kg/cm
	Main-press max. 120 kg/cm
Consist of:	
2 - Deckle seals:	For wedge shaped inlet section
2 - Breast rolls:	Steel tube rubber covered
Various table rolls:	Steel tube rubber covered
2 - Main press rolls:	Cast steel with special rubber covered
2 - Wire guide rolls:	Steel tube rubber covered
2 - Automatic wire guide device:	Pneumatic operated
2 - Wire stretchers:	Tensioning of top and bottom wires, pneumatic control
1 - Loading device:	For the prepress section and the main press section
1 - Doctor:	Blades of plastic materials, doctor support of steel
2 - Spray pipes:	For cleaning of the wire
1 - White water trays:	For the collecting of white water from D.W.P. SUS 304 materials
1 - Frame & Wire changing device:	Welded of steel, cantilever type press with A.C. motor 37 kW including motor and reducing gear box
4 - Foundation rails:	Cast iron including foundation bolts

	2 - Oscillating H.P. showers with save all:	For top & bottom wire cleaning
	2 - Knock off shower:	For wire cloth cleaning
	2 - Water edge cutter:	For the cutting of pulp sheet edge
	1 - Cross sheet cutter:	Water nozzle type by hand operation
	Wire cloth:	One (1) set top and bottom wire cloth

35103 No. 1 Heavy Duty Press

Quantity:	One (1) set
Wire Width:	1,750 mm
Machine Speed:	23.5 m/min. on Normal operation
Drive Power:	30 kW
Nip Pressure:	Max. 225 kg/cm

Consist of:

2 - Press rolls:	Cast steel, journals of steel
1 - Frame & wire changing device:	Welded of steel, cantilever type
1 - Loading device:	Pneumatic operation type
1 - White water tray:	SUS 304 materials
Various wire rolls:	Steel tube, rubber covered
2 - Wire guide rolls:	Steel tube, rubber covered
2 - Automatic wire guide devices:	Pneumatic operation
2 - Wire stretchers:	Tensioning of the top and bottom wires, pneumatic control
1 - Regulating gear:	For the drive of the heavy duty press with A.C. motor 30 kW including motor and reducing gear box
4 - Foundation rails:	Cast iron, including foundation bolts
2 - Oscillating H.P. shower with save all:	For top and bottom wire cloth cleaning
Wire cloth:	One (1) set for top and bottom position

35104 No. 2 Heavy Duty Press

Quantity:	One (1) set
Wire Width:	1,750 mm
Machine Speed:	23.5 m/min. on Normal operation
Drive Power:	30 kW
Nip Pressure:	Max. 225 kg/cm

Consist of:

2 - Press rolls:	Cast steel, journals of steel with antifriction bearings

	1 - Frame & felt changing device:	Welded of steel, cantilever type
	1 - Loading device:	Pneumatic operation type
	1 - White water tray:	SUS 304 materials
	Various felt rolls:	Steel tube, rubber covered with antifriction bearing
	2 - Wire guide rolls:	Steel tube, rubber covered with antifriction bearing
	2 - Automatic wire guide devices:	Pneumatic operation
	2 - Felt stretchers:	Tensioning of the top and bottom felts, pneumatic control
	1 - Regulating gear:	For the drive of the heavy duty press with A.C. motor 30 kW including motor and reducing gear box
	4 - Foundation rails:	Cast iron, including foundation bolts
	2 - Oscillating H.P. shower with save all:	For top and bottom wire cloth cleaning
	Felt cloth:	One (1) set for top and bottom position
35105	Dryer Part	
	Quantity:	One (1) set
	Type:	Air borne system pulp dryer
	Web Width:	1,700 mm
	Machine Speed:	23.5 m/min. on Normal operation
	Main Dimension:	6,000 mmW x 17,000 mmL x 5,500 mmH
	Consist of:	Dryer Heat Recovery System Supply Air System Exhaust Air System Driving System Steam Drainage System
35106	Cross Cutter and Lay Boy	
	Quantity:	One (1) set
	Working Width:	1,600 mm
	Size of Pulp Sheet:	800 mm x 800 mm
	Height of Piles:	Max. 1,000 mm
	Machine Speed:	Max. 30 m/min.
	Drive Power:	11 kW for cutter & slitter 3.7 kW for table lifter 0.4 kW for sheet roll 0.4 kW for fork

	Consist of:	
	1 - Feed roll:	Steel tube with rubber covered with antifriction bearings
	1 - Rotating knife roll:	Knife of tempered steel roll body of gray cast iron
	1 - Bottom knife:	Knife of tempered steel knife body of gray cast iron Adjustable cutting angle
	1 - Conveyor device:	Transfer of the pulp sheets from Dryer to the Cross cutter by the belt
	1 - Frame:	Cutter frame of welded steel lay boy frame of welded steel
	1 - Sheet catcher folk:	Receiving the pulp sheets while finished pile move out of machine
	1 - Table lifter:	Welded steel with hydraulic unit including motor
	1 - Jogger:	Jogger plate with driving device
	1 - Control equipment:	For the cutter and lay boy
	1 - Slitter:	
35107	Baling Equipment	
	Quantity:	One (1) set
	Type:	Circulation type
	Bale Dimension:	800 mm x 800 mm x 800 mm Height
	Bale Weight:	Approx. 150 kg
	Operation Cycle:	Approx. 170 sec./bale
	Steel Wire:	2.6–3.2 mmϕ
	Consist of:	
	1 - Hydraulic baling press:	Construction of 4 poles, up and down operation including hydraulic and electric control equipment, 800 tons capacity
	1 - Scale:	Total weight of 1,000 kg and for the pulp bale weight of max. 200 kg (min. gauge indication of 1.0 kg) Size of scale; 900 x 900 mm
	8 - Carts:	Welded of steel plate with wheel Cart size; 820 mm x 820 mm
	1 - Rail:	Endless construction, steel made
	1 - Wire straightening machine & looper	
85108	Dry Broke Pulper	
	Quantity:	One (1)

35109 Hoist

Quantity:	One (1) set
Service:	Roll changing
Type:	Electric hoist and Gear trolley
Capacity:	5 tons

35201 Machine Chest Pump

Quantity:	One (1)
Service:	Machine Chest discharge
Type:	Centrifugal
Capacity:	2.4 m^3/min. x 20 m Head
Stock Consistency:	3.5%
Material:	
Impeller;	Stainless cast steel (SCS 13)
Casing;	Stainless cast steel (SCS 13)
Drive:	15 kW x 4P motor

35202 White Water Pump

Quantity:	Two (2)
Service:	White Water Pit discharge
Type:	Centrifugal
Capacity:	2.5 m^3/min. x 10 m Head
Stock Consistency:	3.5%
Material:	
Impeller;	Stainless cast steel (SCS 13)
Casing;	Stainless cast steel (SCS 13)
Drive:	11 kW x 4P motor

35203 Wet Broke Pump

Quantity:	One (1)
Service:	Wet Broke Pit discharge
Type:	Centrifugal
Capacity:	1.5 m^3/min. x 10 m Head
Material:	
Impeller;	Stainless cast steel (SCS 13)
Casing;	Stainless cast steel (SCS 13)
Drive:	7.5 kW x 4P motor

35204 High Pressure Pump

Quantity:	One (1)
Service:	Wire and Felt shower
Type:	Multi-stage Centrifugal type
Capacity:	0.35 m^3/min. x 250 m Head
Material:	
Impeller;	Stainless cast steel (SCS 13)
Casing;	Cast iron
Drive:	22 kW x 2P motor

35205 Drain Pump

Quantity:	One (1)
Service:	Felt suction tube
Type:	Vertical
Capacity:	0.2 m^3/min. x 8 m Head
Material:	
Impeller;	Stainless cast steel (SCS 13)
Casing;	Cast iron
Drive:	1.5 kW x 4P motor

35206 Vacuum Pump

Quantity:	One (1)
Service:	Lay drum
Type:	Nash
Capacity:	5.5 m^3/min. x 500 m Hg
Material:	Cast iron
Drive:	15 kW x 4P motor
Accessories:	Separate tank
	Vacuum gauge
	Silencer tank

35207 Vacuum Pump

Quantity:	One (1)
Service:	Felt suction tube
Type:	Nash
Capacity:	13 m^3/min. x 300 m Hg
Material:	Cast iron
Drive:	30 kW x 4P motor
Accessories:	Separate tank
	Vacuum gauge
	Silencer tank

35208 Dry Broke Pump

Quantity:	One (1)
Service:	Dry Broke Pulper to Machine Chest
Type:	Centrifugal
Capacity:	0.5 m^3/min. x 10 m Head
Stock Consistency:	4%
Material:	
Impeller;	Stainless cast steel (SCS 13)
Casing;	Stainless cast steel (SCS 13)
Drive:	

35209 Condensate Pump

Quantity:	One (1)
Service:	Condensate Tank discharge, to Power Plant
Type:	Centrifugal
Capacity:	
Material:	Cast iron
Drive:	

35301 Machine Chest Agitator

Quantity:	One (1)
Type:	Horizontal, Propeller type
Size:	1,220 mmϕ
Material:	
Propeller;	Stainless cast steel (SCS 13)
Body;	Cast iron
Drive:	30 kW x 4P motor, V-belt drive

35302 Wet Broke Pit Agitator

Quantity:	One (1)
Type:	Paddle type
Material:	All part in contact with stock to be made of stainless steel (SUS 304) and SUS 304 lining
Drive:	11 kW x 4P motor, V-belt drive

35304 Machine Chest

Quantity:	One (1)
Volume:	35 m^3
Main Dimension:	3,350 mmϕ x 4,500 mmH
Material:	Mild steel

35402 White Water Pit

Quantity:	One (1)
Volume:	20 m^3
Main Dimension:	1,800 mmW x 6,500 mmL x 4,000 mmD
Material:	Mild steel with SUS 304 lining

35403 Wet Broke Pit

Quantity:	One (1)
Volume:	25 m^3
Main Dimension:	1,800 mmW x 8,000 mmL x 4,000 mmD
Material:	Mild steel with SUS 304 lining

35404 Condensate Tank

Quantity:	One (1)
Volume:	30 m^3
Main Dimension:	2,000 mm x 2,000 mm x 8,000 mm Height
Material:	Mild steel
Remarks:	Insulated

35601 Scaffolding

Quantity:	One (1) set
Service:	Head Box to H.D. Press and Wet Broke Pit
Material:	Mild steel

35701 Piping, Valves and Fittings

One (1) set of pipes, valves and fittings for this department will be supplied.

DEPARTMENT 51. BLACK LIQUOR EVAPORATOR & INCINERATOR

51000 Design Base

Weak Black Liquor:	68 m^3/Hr at 6% solid
Strong Black Liquor:	40–45% solid
Evaporation:	59 kg/Hr
Weak Black Liquor Temp.:	80°C
Black Liquor Calorific Value:	2,500 Kcal/kg at dry solid
Fuel Calorific Value:	Natural Gas
	8,700 Kcal/Nm^3 at LCV

51101 No. 1 Effect Evaporator

Quantity:	Two (2), one is spare
Type:	Shell & Tube
Main Dimension:	2,700 ϕ/3,400 ϕ x 12,800 H
Material:	
Shell;	Mild steel
Tube;	SUS 304

51102 No. 2 Effect Evaporator

Quantity:	One (1)
Type:	Shell & Tube
Main Dimension:	2,700 ϕ/3,500 ϕ x 12,800 H
Material:	
Shell;	Mild steel
Tube;	SUS 304

51103 No. 3 Effect Evaporator

Quantity:	One (1)
Type:	Shell & Tube
Main Dimension:	2,700 ϕ/3,800 ϕ x 12,800 H
Material:	
Shell;	Mild steel
Tube;	SUS 304

51104 Condenser

Quantity:	One (1)
Type:	Surface Condenser
Main Dimension:	
Material:	Mild steel

51105 Vacuum System

Quantity:	One (1) set
Type:	2-Stage Steam Ejectors
Material:	Cast iron with SUS 304

51106 Stack

Quantity:	One (1)
Type:	Vertical
Main Dimension:	700 ϕ/1,500 ϕ x 20,000 H
Material:	Mild steel

51107 Venturi-Scrubber

Quantity:	One (1)
Main Dimension:	750 ϕ x 2,000 L
Material:	SUS 304

51108 Incinerator

Quantity:	One (1)
Type:	Vertical, Water Jacket
Main Dimension:	3,000 ϕ x 7,000 H
Material:	Mild steel with refractory

51109 Blower

Quantity:	One (1)
Type:	Turbo
Capacity:	15,000 Nm^3/min. x 1,800 mm Aq.
Material:	Mild steel
Drive:	150 kW motor

51110 Cooler

Quantity:	One (1)
Type:	Plate
Material:	SUS 304

51201 Weak Black Liquor Pump

Quantity:	Two (2)
Type:	Centrifugal
Capacity:	45 m^3/Hr x 15 m Head
Material:	Cast iron
Drive:	5.5 kW motor

51202 No. 3 Discharge Pump

Quantity:	One (1)
Type:	Centrifugal
Capacity:	30 m^3/Hr x 15 m Head
Material:	Cast iron
Drive:	3.7 kW motor

51203	**No. 2 Discharge Pump**	
	Quantity:	One (1)
	Type:	Centrifugal
	Capacity:	20 m^3/Hr x 15 m Head
	Material:	Cast iron
	Drive:	2.2 kW motor
51204	**No. 1 Discharge Pump**	
	Quantity:	One (1)
	Type:	Centrifugal
	Capacity:	12 m^3/Hr x 15 m Head
	Material:	Cast iron
	Drive:	1.5 kW motor
51205	**Evaporator Circulation Pump**	
	Quantity:	Four (4)
	Type:	Centrifugal
	Capacity:	300 m^3/Hr x 8 m Head
	Material:	Mild steel
	Drive:	15 kW motor
51206	**Condensate Pump**	
	Quantity:	One (1)
	Type:	Centrifugal
	Capacity:	35 m^3/Hr x 15 m Head
	Material:	Mild steel
	Drive:	3.7 kW motor
51207	**Hot Water Pump**	
	Quantity:	One (1)
	Type:	Centrifugal
	Capacity:	350 m^3/Hr x 15 m Head
	Material:	Cast iron
	Drive:	22 kW motor
51208	**Venturi Circulation Pump**	
	Quantity:	One (1)
	Type:	Centrifugal
	Capacity:	10 m^3/Hr x 25 m Head
	Material:	Cast iron
	Drive:	3.7 kW motor

51209 Strong Black Liquor Pump

Quantity:	Two (2), one is spare
Type:	Centrifugal
Capacity:	8 m^3/Hr x 35 m Head
Material:	Cast iron
Drive:	5.5 kW motor

51210 Smelt Dissolver Circulation Pump

Quantity:	Two (2), one is spare
Type:	Centrifugal
Capacity:	100 m^3/Hr x 25 m Head
Material:	Cast iron
Drive:	15 kW motor

51211 Cooling Water Circulation Pump

Quantity:	Two (2), one is spare
Type:	Centrifugal
Capacity:	50 m^3/Hr x 15 m Head
Material:	Cast iron
Drive:	5.5 kW motor

51212 Green Liquor Pump

Quantity:	One (1)
Type:	Centrifugal
Capacity:	10 m^3/Hr x 15 m Head
Material:	Cast iron
Drive:	2.2 kW motor

51301 Smelt Dissolver Agitator

Quantity:	One (1)
Type:	Horizontal
Drive:	7.5 kW motor

51401 Weak Black Liquor Tank

Quantity:	Two (2)
Volume:	400 m^3 each
Material:	Mild steel

51402 Strong Black Liquor Tank

Quantity:	One (1)
Volume:	200 m^3
Material:	Mild steel

51403 Smelt Dissolver Tank

Quantity:	One (1)
Main Dimension:	3,500 ϕ x 3,500 H
Material:	Mild steel with refractory

51404 Water Head Tank

Quantity:	One (1)
Main Dimension:	1,500 ϕ x 1,000 H
Material:	Mild steel

51601 Scaffolding

Quantity:	One (1) set
Service:	Evaporator, Condenser and Incinerator
Material:	Mild steel

51701 Piping, Valves, Fittings and Duct

One (1) set of pipes, valves, fittings and duct for this department will be supplied.

DEPARTMENT 52. RECAUSTICIZING

52000 Design Basis

White Liquor Production:	230 m^3/D
Active Alkali:	120 kg/m^3 as NaOH
Causticity:	80–85%
Make-up Chemical:	23 m^3/D at 120 kg/m^3 as NaOH from Electrolysis plant

52101	Green Liquor Clarifier	
	Quantity:	One (1)
	Type:	Unit type thickener with storage on top
	Main Dimension:	6,600 mmϕ x 8,500 mm H
	Storage Volume:	140 m^3
	Material:	
	Tank;	Mild steel
	Raking Mechanism:	Stainless steel (SUS 304)
	Drive:	
	Rake;	Geared motor 0.75 kW x 4P
	Rake-lift;	Geared motor 0.4 kW x 4P
	Remarks:	Insulated
52102	Dregs Filter	
	Quantity:	One (1)
	Type:	Vacuum drum filter and Air blow discharge
	Drum Size:	3,120 mmϕ x 1,200 mmH
	Material:	Mild steel Filter cloth – Polypropylene
	Drive:	
	Drum;	Beier cyclo reducer 0.4 kW x 4P motor
	Agitator;	Geared motor 0.75 kW x 4P
52103	Green Liquor Heater	
	Quantity:	One (1)
	Type:	Inline direct heater
	Green Liquor Capacity:	11.5 m^3/Hr, normal rate
	Stem:	220 kg/Hr at 2.5 kg/cm^2G
	Material:	Stainless cast steel (SCS 13)
52104	Lime Slaker	
	Quantity:	One (1)
	Type:	Combination type
	Mixer Tank:	1,500 mmϕ x 1,500 mm Height
	Classifier:	5,000 mm Length
	Material:	Stainless steel (SUS 304)
	Drive:	
	Mixer;	Geared motor 2.2 kW x 4P
	Classifier;	Geared motor 0.75 kW x 4P
	Remarks:	Insulated

52105 Causticizer

Quantity:	Three (3)
Type:	Vertical
Main Dimension:	2,400 mmϕ x 2,400 mm Height
Material:	Stainless steel (SUS 304)
Drive:	Geared motor 2.2 kW x 4P
Remarks:	Insulated

52106 White Liquor Clarifier

Quantity:	One (1)
Type:	Unit type thickener with storage on top
Main Dimension:	6,600 mmϕ x 8,500 mm Height
Storage Volume:	140 m^3
Material:	
Tank;	Mild steel
Raking Mechanism;	Stainless steel (SUS 304)
Drive:	
Rake;	Geared motor 1.5 kW x 4P
Rake-lift;	Geared motor 0.4 kW x 4P
Remarks:	Insulated

52107 Lime Mud Washer

Quantity:	One (1)
Type:	Unit type thickener with storage on top
Main Dimension:	6,600 mmϕ x 8,500 mm Height
Sotrage Volume:	140 m^3
Material:	
Tank;	Mild steel
Raking Mechanism;	Stainless steel (SUS 304)
Drive:	
Rake;	Geared motor 1.5 kW x 4P
Bake-lift;	Geared motor 0.4 kW x 4P
Remarks:	Insualted

52108 Lime Mud Filter

Quantity:	One (1)
Type:	Vacuum drum filter precoat type
Drum Size:	1,800 mmϕ x 1,900 mm Face
Material:	Mild steel
	Filter cloth – Polypropylene
Drive:	
Drum;	Beier cyclo reducer
	0.75 kW x 4P motor
Agitator;	Geared motor 0.75 kW x 4P

52109 Grit & Dregs Conveyor

Quantity:	One (1)
Type:	Belt conveyor
Size:	450 mmW x 10,000 mm Length
Material:	Mild steel
Drive:	Geared motor 1.5 kW x 4P

52201 Green Liquor Pump

Quantity:	Two (2), one for spare
Service:	G.L.C. discharge to Lime Slaker
Type:	Centrifugal
Capacity:	230 l/min. x 10 m Head
Material:	
Impeller;	Stainless cast steel (SCS 13)
Casing;	Cast iron
Drive:	2.2 kW x 4P motor

52202 Underflow Pump

Quantity:	Two (2), one for spare
Service:	G.L.C. discharge to Dregs Filter
Type:	Air operated diaphragm pump
Capacity:	35 l/min. x 10 m Head
Material:	Cast iron with rubber lining

52203 Filtrate Pump

Quantity:	One (1)
Service:	Dregs Filter
Type:	Centrifugal
Capacity:	20 l/min. x 10 m Head
Material:	
Impeller;	Stainless cast steel (SCS 13)
Casing;	Cast iron
Drive:	0.75 kW x 4P motor

52204 Vacuum Pump

Quantity:	One (1)
Service:	Dregs Filter
Type:	Nash

	Capacity:	4 m^3/min. x 550 mm Hg
	Material:	Cast iron
	Drive:	7.5 kW x 4P motor, V-belt drive
	Accessories:	Filtrate Receiver 250 mmϕ x 600 mmH
		Condenser Scrubber 380 mmϕ x 2,000 mmH

52205 White Liquor Pump

Quantity:	Two (2), one for spare
Service:	W.L.C. discharge to Cooking
Type:	Centrifugal
Capacity:	0.3 m^3/min. x 10 m Head
Material:	
Impeller;	Stainless cast steel (SCS 13)
Casing;	Stainless cast steel (SCS 13)
Drive:	5.5 kW x 4P motor

52206 Underflow Pump

Quantity:	Two (2), one for spare
Service:	W.L.C. discharge to Lime Mud Mixing Tank
Type:	Centrifugal
Capacity:	70 l/min. x 10 m Head
Material:	
Impeller;	Cast iron with Cr.
Casing;	Cast iron with Cr.
Drive:	1.5 kW x 4P motor, V-belt drive

52207 Weak Liquor Pump

Quantity:	One (1)
Service:	L.M.S. discharge to Smelt dissolver
Type:	Centrifugal
Capacity:	0.3 m^3/min. x 10 m Head
Material:	
Impeller;	Stainless cast steel (SCS 13)
Casing;	Cast iron
Drive:	3.7 kW x 4P motor

52208 Underflow Pump

Quantity:	One (1)
Service:	L.M.S. discharge to Lime Mud Storage
Type:	Centrifugal
Capacity:	70 l/min. x 30 m Head

	Material:	
	Impeller;	Cast iron with Cr.
	Casing;	Cast iron with Cr.
	Drive:	1.5 kW x 4P motor, V-belt drive

52209 Lime Mud Pump

Quantity:	Two (2), one for spare
Service:	Lime Mud Storage discharge
	to Lime Mud Filter
Type:	Centrifugal
Capacity:	70 l/min. x 30 m Head
Material:	
Impeller;	Cast iron with Cr.
Casing;	Cast iron with Cr.
Drive:	2.2 kW x 4P motor, V-belt drive

52210 Filtrate Pump

Quantity:	One (1)
Service:	Lime Mud Filter
Type:	Centrifugal
Capacity:	0.1 m^3/min. x 10 m Head
Material:	
Impeller;	Stainless cast steel (SCS 13)
Casing;	Cast iron
Drive:	1.1 kW x 4P motor

52211 Vacuum Pump

Quantity:	One (1)
Service:	Lime Mud Filter
Type:	Nash
Capacity:	13 m^3/min. x 500 mm Hg
Material:	Cast iron
Drive:	22 kW x 4P motor, V-belt drive
Accessories:	Filtrate Receiver 600 mmϕ x 900 mmH
	Condenser Scrubber 900 mmϕ x 2,400 mmH

52212 Overflow Pump

Quantity:	One (1)
Service:	Dump Tank discharge
Type:	Centrifugal
Capacity:	0.3 m^3/min. x 30 m Head

	Material:	
	Impeller;	Stainless cast steel (SCS 13)
	Casing;	Cast iron
	Drive:	5.5 kW x 4P motor
52401	Lime Mud Mixing Tank	
	Quanity:	One (1)
	Type:	Cylindrical tank with mixer
	Main Dimension:	2,100 mmϕ x 2,100 mm Height
	Material:	
	Tank;	Mild steel
	Mixer;	Stainless steel (SUS 304)
	Drive:	Geared motor 2.2 kW x 4P
	Remarks:	Insulated
52402	Lime Mud Storage Tank	
	Quantity:	One (1)
	Type:	Cylindrical tank with Agitator
	Volume:	19 m^3
	Main Dimension:	3,000 mmϕ x 3,000 mm Height
	Material:	Mild steel
	Drive:	Geared motor 2.2 kW x 4P
	Remakrs:	Insulated
52403	Dregs Head Tank	
	Quantity:	One (1)
	Size:	1,000 mmϕ x 1,000 mm Height
	Material:	Mild steel
	Remarks:	Insulated
52404	Acid Tank	
	Quantity:	Two (2)
	Service:	For Dregs Filter and Lime Mud Filter
	Size:	1,000 mmϕ x 1,000 mm Height
	Material:	FRP
52601	Scaffolding	
	Quantity:	One (1) set
	Service:	Lime Slaker, Causticizer, Dregs Filter and Lime Mud Filter
	Material:	Mild steel

52701 Pipes, Valves and Fittings

One (1) set of pipes, valves and fittings for this department will be supplied.

DEPARTMENT 53. LIME RECOVERY

53000 Design Basis

Quick Lime Required:	24 T/D as 80% CaO
Lime Mud Charged:	31 T/D (Dry base as $CaCO_3$)
Lime Mud Moisture:	45%
Make-up Lime Stone:	17 T/D (Dry base as $CaCO_3$)
Lime Stone Purity:	90–92% as $CaCO_3$
Fuel Calorific Value:	Natural Gas 8,700 Kcal/Nm^3 at LCV

53101	Rotary Kiln	
	Quantity:	One (1)
	Main Size:	1,900 mmϕ x 47,000 mm Length
	Capacity:	24 Tons/D of quick lime
	Material:	Mild steel with brick and castable lined
	Drive:	Main – 30 kW
		Gear unit – 1.5 kW
		Emergency – 7.5 kW
53102	Lime Stone Crusher	
	Quantity:	One (1)
	Type:	Hammer mill type
	Capacity:	1.8 Tons/Hr
	Material:	Mild steel
	Drive:	5.5 kW x 2P
	Accessories:	Hopper
53103	Quick Lime Crusher	
	Quantity:	One (1)
	Type:	Hammer mill type
	Capacity:	2 Tons/Hr
	Material:	Mild steel
	Drive:	11 kW x 2P
53104	Venturi Scrubber	
	Quantity:	One (1)
	Type:	
	Capacity:	290 m^3/min.
	Material:	SUS 304
53105	Heating Unit	
	Quantity:	One (1) set
	Service:	Natural gas fired
	Capacity:	4,420,000 Kcal/Hr
53106	Primary Fan	
	Quantity:	One (1)
	Capacity:	55 Nm^3/min. x 500 mm Aq.
	Material:	Mild steel
	Drive:	11 kW x 4P

53107 Exhaust Fan

Quantity:	One (1)
Capacity:	360 m^3/min. x 700 mm Aq.
Material:	Mild steel
Drive:	90 kW x 4P

53108 Screw Conveyor

Quantity:	One (1)
Service:	Lime mud transfer
Capacity:	3 Tons/Hr
Drive:	3.7 kW x 4P geared motor

53109 Screw Feeder

Quantity:	One (1)
Service:	Lime mud feeder
Capacity:	3 Tons/Hr
Material:	Mild steel
Drive:	3.7 kW x 4P geared motor

53110 Belt Conveyor

Quantity:	One (1)
Service:	Lime stone transfer
Capacity:	1.3 Tons/Hr
Drive:	2.2 kW x 4P geared motor

53111 Belt Conveyor

Quantity:	One (1)
Service:	Crushed lime stone transfer
Capacity:	1.3 Tons/Hr
Material:	Mild steel
Drive:	0.75 kW x 4P geared motor

53112 Screw Conveyor

Quantity:	One (1)
Service:	Crushed lime stone feeder
Capacity:	1.3 Tons/Hr
Drive:	1.5 kW

52113 Flight Conveyor

Quantity:	One (1)
Service:	Quick lime transfer
Capacity:	2 Tons/Hr
Material:	Mild steel
Drive:	2.2 kW x 4P geared motor

53114 Screw Conveyor

Quantity:	One (1)
Service:	Quick lime transfer
Capacity:	2 Tons/Hr
Material:	Mild steel
Drive:	2.2 kW x 4P geared motor

53115 Bucket Elevator

Quantity:	One (1)
Service:	Quick lime transfer
Capacity:	2 Tons/Hr
Material:	Mild steel
Drive:	2.2 kW x 4P geared motor

53116 Bucket Elevator

Quantity:	One (1)
Service:	Crushed lime stone
Capacity:	1.3 Tons/Hr
Drive:	1.5 kW x 4P

53201 Circulation Pump

Quantity:	One (1)
Service:	Lime mud
Capacity:	0.5 m^3/min. x 20 m Head
Material:	SCS 14
Drive:	5.5 kW x 4P

53202 Transfer Pump

Quantity:	One (1)
Service:	Lime mud 2% slurry
Capacity:	0.3 m^3 x 15 m Head
Material:	SCS 14
Drive:	2.2 kW x 4P

53401 Silo

Quantity:	One (1)
Service:	Crushed lime stone storage
Capacity:	35 m^3
Main Size:	2,800 mmϕ x 5,700 mm Height
Material:	Mild steel

53402 Silo

Quantity:	One (1)
Service:	Quick lime storage
Main Size:	4,200 mmϕ x 5,300 mm Height
Material:	Mild steel

53601 Scaffolding and Steel Structure

Quantity:	One (1) set
Material:	Mild steel

53701 Pipes, Valves and Fittings

One (1) set of pipes, valves and fittings for this department will be supplied.

DEPARTMENT 56. ELECTROLYSIS

56000 **Design Basis**

1) **Chlorine**

Capacity: **10,000 kg/D as 100% Chlorine gas**
Excess chlorine to be lignidized.

2) **Caustic Soda**

Capacity: **9,000 kg/D as 100% Caustic soda**
Concentration: **12%**

1. Salt Purification

56101	Portable Conveyor	
	Quantity:	One (1)
	Service:	Raw Salt
	Type:	Belt Conveyor
	Size:	400 mmW x 10,000 mmL
	Material:	Mild Steel
	Drive:	1.5 kW x 4P x 1/15 geared motor
56102	Settler	
	Quantity:	One (1)
	Type:	Vertical Thickener
	Size:	4,450 mmϕ x 3,000 mmH
	Material:	Mild steel with hard rubber lining
	Drive:	0.75 kW x 4P motor
56103	Mud Filter	
	Quantity:	One (1)
	Type:	Press Filter Type
	Capacity:	3 m^3/Hr
	Material:	
	Body;	Cast iron with hard rubber lining
	Chamber and Plate;	FRP
56104	Brine Filter	
	Quantity:	Two (2), One (1) for stand-by
	Type:	Vertical & Cylindrical
	Capacity:	8 m^3/Hr
	Material:	Cast iron with hard rubber lining
56201	Salt Solution Pump	
	Quantity:	Two (2), One (1) for stand-by
	Service:	Salt solution receiver tank discharge
	Type:	Centrifugal
	Capacity:	8 m^3/Hr x 15 m Head
	Material:	
	Impeller;	Cast iron with hard rubber lining
	Casing;	Cast iron with hard rubber lining
	Drive:	1.5 kW x 4P motor

56202	Caustic Soda Pump	
	Quantity:	Two (2), One (1) for stand-by
	Service:	Caustic tank discharge
	Type:	Centrifugal
	Capacity:	0.4 m^3/Hr x 10 m Head
	Material:	
	Impeller;	Cast iron
	Casing;	Cast iron
	Drive:	0.4 kW x 4P motor
56203	Sodium Carbonate Pump	
	Quantity:	Two (2), One (1) for stand-by
	Service:	Na_2CO_3 tank discharge
	Type:	Centrifugal
	Capacity:	0.4 m^3/Hr x 10 m Head
	Material:	
	Impeller;	Cast iron with hard rubber lining
	Casing;	Cast iron with hard rubber lining
	Drive:	0.4 kW x 4P motor
56204	Chemicals Pump	
	Quantity:	Two (2), One (1) for stand-by
	Service:	Chemical tank discharge
	Type:	Centrifugal
	Capacity:	0.4 m^3/Hr x 10 m Head
	Material:	
	Impeller;	Cast iron with hard rubber lining
	Casing;	Cast iron with hard rubber lining
	Drive:	2.2 kW x 4P motor
56205	Slurry Pump	
	Quantity:	Two (2), One (1) for stand-by
	Service:	Slurry receiver tank discharge
	Type:	Centrifugal
	Capacity:	3 m^3/Hr x 15 m Head
	Material:	
	Impeller;	Cast iron with hard rubber lining
	Casing;	Cast iron with hard rubber lining
	Drive:	1.5 kW x 4P motor

56206 Filtrate Pump

Quantity:	Two (2), One (1) for stand-by
Service:	Filtrate receiver tank discharge
Type:	Centrifugal
Capacity:	3 m^3/Hr x 15 m Head
Material:	
Impeller;	Cast iron with hard rubber lining
Casing;	Cast iron with hard rubber lining
Drive:	1.5 kW x 4P motor

56207 Waste Washing Water Pump

Quantity:	Two (2), One (1) for stand-by
Service:	Waste washing water tank discharge
Type:	Centrifugal
Capacity:	12 m^3/Hr x 15 m Head
Material:	
Impeller;	Cast iron with hard rubber lining
Casing;	Cast iron with hard rubber lining
Drive:	1.5 kW x 4P motor

56208 Filter Washing Pump

Quantity:	Two (2), One (1) for stand-by
Service:	Brine receiver tank discharge
Type:	Centrifugal
Capacity:	60 m^3/Hr x 15 m Head
Material:	
Impleler;	Cast iron with hard rubber lining
Casing;	Cast iron with hard rubber lining
Drive:	5.5 kW x 4P motor

56209 Brine Pump

Quantity:	Two (2), One (1) for stnad-by
Service:	Brine receiver tank discharge
Type:	Centirifugal
Capacity:	8 m^3/Hr x 15 m Head
Material:	
Impeller;	Cast iron with hard rubber lining
Casing;	Cast iron with hard rubber lining
Drive:	1.5 kW x 4P motor

56210	HCL Pump	
	Quantity:	Two (2), One (1) for stand-by
	Service:	HCL measuring tank discharge
	Type:	Diaphragm
	Capacity:	20 l/Hr x 5 kg/cm²G
	Material:	
	Diaphragm:	Teflon
	Casing;	PVC
	Drive:	0.2 kW x 4P motor
56211	Purified Brine Feed Pump	
	Quantity:	Two (2), One (1) for stand-by
	Service:	Purified brine tank discharge
	Type:	Centrifugal
	Capacity:	8 m³/Hr x 15 m Head
	Material:	
	Impeller;	Cast iron with hard rubber lining
	Casing;	Cast iron with hard rubber lining
	Drive:	1.5 kW x 4P motor
56212	Purified Brine Feed Pump	
	Quantity:	Two (2), One (1) for stand-by
	Service:	Purified brine tank discharge
	Type:	Centrifugal
	Capacity:	1 m³/Hr x 15 m Head
	Material:	
	Impeller;	Cast iron with hard rubber lining
	Casing;	Cast iron with hard rubber lining
	Drive:	1.5 kW x 4P motor
56401	Salt Dissolver	
	Quantity:	Two (2)
	Volume:	15 m³
	Main Dimension:	2,800 mmϕ x 4,000 mm Height
	Material:	Mild steel with hard rubber lining
56402	Salt Solution Receiver Tank	
	Quantity:	One (1)
	Volume:	2 m³
	Main Dimension:	1,400 mmϕ x 1,500 mm Height
	Material:	Mild steel with hard rubber lining

56403 Caustic Solution Tank

Quantity:	One (1)
Volume:	0.4 m^3
Main Dimension:	840 mmϕ x 900 mm Height
Material:	Mild steel

56404 Sodium Carbonate Tank

Quantity:	Two (2)
Volume:	0.4 m^3
Main Dimension:	840 mmϕ x 900 mm Height
Material:	Mild steel with hard rubber lining

56405 Chemicals Tank

Quantity:	Two (2)
Volume:	1.5 m^3
Main Dimension:	1,300 mmϕ x 1,700 mm Height
Material:	Mild steel with hard rubber lining

56406 Reactor

Quantity:	One (1)
Volume:	5 m^3
Main Dimension:	1,700 mmϕ x 2,400 mm Height
Material:	Mild steel with hard rubber lining
Accessories:	One (1) agitator
Drive:	2.2 kW x 4P motor

56407 Slurry Receiver Tank

Quantity:	One (1)
Volume:	2 m^3
Main Dimension:	1,400 mmϕ x 1,500 mm Height
Material:	Mild steel with hard rubber lining

56408 Filtrate Receiver Tank

Quantity:	One (1)
Volume:	3 m^3
Main Dimension:	1,450 mmϕ x 2,000 mm Height
Material:	Mild steel with hard rubber lining

56409	Waste Washing Water Tank	
	Quantity:	One (1)
	Volume:	10 m^3
	Main Dimension:	2,750 mmϕ x 1,800 mm Height
	Material:	Mild steel with hard rubber lining
56410	Brine Receiver Tank	
	Quantity:	One (1)
	Volume:	10 m^3
	Main Dimension:	2,750 mmϕ x 1,800 mm Height
	Material:	Mild steel with hard rubber lining
56411	Brine Head Tank	
	Quantity:	One (1)
	Volume:	3 m^3
	Main Dimension:	1,450 mmϕ x 2,000 mmH
	Material:	Mild steel with hard rubber lining
	Accessories:	One (1) agitator
	Drive:	1.5 kW x 4P motor
56412	HCL Measuring Tank	
	Quantity:	One (1)
	Volume:	3 m^3
	Main Dimension:	1,450 mmϕ x 2,000 mm Height
	Material:	Mild steel with hard rubber lining
56413	Purified Brine Tank	
	Quantity:	One (1)
	Volume:	30 m^3
	Main Dimension:	3,500 mmϕ x 3,500 mm Height
	Material:	Mild steel with hard rubber lining

2. NaOH Electrolyzer

56121 Rectifier

Quantity:	Three (3)
Type:	Thyrist former
Capacity:	600 KVA

56122 Electrolyzer

Quantity:	Three (3)
Type:	Ion Exchange Membrane Cell
Capacity:	53 Cells each set
Material:	Mild steel with hard rubber lining

56123 Transformer

Quantity:	Three (3)
Type:	Indoor
Capacity:	3,000 V – 300 A
Material:	Mild steel

56124 Washing Tower Cooler

Quantity:	One (1)
Type:	Plate type
Capacity:	12 m^3/Hr
Material:	All surface in contact with liquid to be made of stainless steel

56125 Hydrogen Gas Fan

Quantity:	Two (2), One (1) for stand-by
Type:	Turbo fan
Capacity:	130 Nm^3/Hr x 400 mm Aq.
Material:	Mild steel
Drive:	1.5 kW x 4P motor, V-belt drive

56126 Washing Tower Cooler

Quantity:	One (1)
Type:	Plate type
Capacity:	10 m^3/Hr
Material:	
Plate;	Titanium
Frame;	Mild steel

56127 Chlorine Gas Blower

Quantity:	Two (2), One (1) for stand-by
Type:	Turbo fan
Capacity:	130 Nm^3/Hr x 400 mm Aq
Material:	FRP
Drive:	1.5 kW x 4P motor, V-belt drive

56128 Pure Water Unit

Quantity:	One (1)
Type:	Ion exchange type
Capacity:	5 m^3/Hr
Material:	Mild steel with hard rubber lining

56129 Dechlorination Air Blower

Quantity:	Two (2), One (1) for stand-by
Type:	Roots
Capacity:	160 Nm^3/Hr x 0.5 kg/cm^2G
Material:	Mild steel and Cast iron
Drive:	3.7 kW x 4P motor, V-belt drive

56130 NaOH Dilute Mixer

Quantity:	One (1)
Type:	Inline, static type
Capacity:	4.5 m^3/Hr
Material:	Stainless steel

56221 Washing Water Pump

Quantity:	Two (2), One (1) for stand-by
Type:	Centrifugal
Capacity:	12 m^3/Hr x 15 m Head
Material:	
Impeller;	Cast iron with hard rubber lining
Casing;	Cast iron with hard rubber lining
Drive:	2.2 kW x 4P motor

56222 Chlorinated Water Pump

Quantity:	Two (2), One (1) for stand-by
Type:	Centrifugal
Capacity:	5 m^3/Hr x 15 m Head

	Material:	
	Impeller;	Cast iron with hard rubber lining
	Casing;	Cast iron with hard rubber lining
	Drive:	1.5 kW x 4P motor
56233	Washing Tower Pump	
	Quantity:	Two (2), One (1) for stand-by
	Type:	Centrifugal
	Capacity:	10 m^3/Hr x 15 m Head
	Material:	
	Impeller;	Cast iron with hard rubber lining
	Casing;	Cast iron with hard rubber lining
	Drive:	2.2 kW x 4P motor
56224	Treated Brine Pump	
	Quantity:	Two (2), One (1) for stand-by
	Type:	Centrifugal
	Capacity:	5.5 m^3/Hr x 15 m Head
	Material:	
	Impeller;	Titanium
	Casing;	Titanium
	Drive:	1.5 kW x 4P motor
56225	Caustic Solution Pump	
	Quantity:	Two (2), One (1) for stand-by
	Type:	Centrifugal
	Capacity:	4.5 m^3/Hr x 30 m Head
	Material:	
	Impeller;	Cast iron
	Casing;	Cast iron
	Drive:	3.7 kW x 4P motor
56226	Pure Water Pump	
	Quantity:	One (1)
	Type:	Centrifugal
	Capacity:	5 m^3/Hr x 15 m Head
	Material:	
	Impeller;	Stainless steel castings
	Casing;	Stainless steel castings
	Drive:	1.5 kW x 4P motor

56227	Dilute NaOH Pump	
	Quantity:	Two (2), One (1) for stand-by
	Type:	Centrifugal
	Capacity:	8.5 m^3/Hr x 30 m Head
	Material:	
	Impeller;	Cast iron
	Casing;	Cast iron
	Drive:	3.7 kW x 4P motor
56421	Hydrogen Gas Separator	
	Quantity:	One (1)
	Capacity:	130 Nm^3/Hr
	Material:	Mild steel with hard rubber lining
56422	Hydrogen Gas Wasing Tower	
	Quantity:	One (1)
	Capacity:	130 Nm^3/Hr
	Material:	Mild steel
56423	Hydrogen Condensate Receiver	
	Quantity:	One (1)
	Volume:	0.5 m^3
	Main Dimension:	800 mmϕ x 1,200 mm Height
	Material:	Mild steel
56424	Hydrogen Gas Safety Tank	
	Quantity:	One (1)
	Volume:	0.25 m^3
	Main Dimension:	600 mmϕ x 1,000 mm Height
	Material:	Mild steel
56425	Chlorine Gas Separator	
	Quantity:	One (1)
	Capacity:	130 Nm^3/Hr
	Material:	FRP

56426 Chlorine Gas Washing Tower

Quantity:	One (1)
Capacity:	130 Nm^3/Hr
Material:	
Body;	FRP
Internals;	PVC

56247 Chlorinated Water Receiving Tank

Quantity:	One (1)
Volume:	1 m^3
Main Dimension:	1,000 mmϕ x 1,400 mm Height
Material:	FRP

56428 Dechlorination Tower

Quantity:	One (1)
Capacity:	5.5 m^3/Hr
Material:	
Body;	FRP
Internals;	PVC

56429 Brine Aeration Tank

Quantity:	One (1)
Volume:	8 m^3
Main Dimension:	2,000 mmW x 2,000 mmL x 2,200 mmH
Material:	Mild steel with hard rubber lining

56430 Caustic Solution Tank

Quantity:	One (1)
Volume:	50 m^3
Main Dimension:	3,200 mmϕ x 6,850 mm Height
Material:	Mild steel

56431 Dilute Caustic Solution Tank

Quantity:	One (1)
Volume:	34 m^3
Main Dimension:	3,200 mmϕ x 4,650 mm Height
Material:	Mild steel

DEPARTMENT 57. BLEACH CHEMICALS PREPARATION

57000 Design Basis

1) Chlorine

Liquidizing Capacity:	4,000 kg/D as 100% Chlorine

2) Sodium Hypochlorite

Capacity:	2,000 kg/D as available Chlorine
Concentration:	35 g/L as available Chlorine

1. Chlorine Liquefaction

57101 No. 1 Chlorine Water Cooler

Quantity:	One (1)
Type:	Plate type
Capacity:	12 m^3/Hr
Material:	
Plate;	Titanium
Frame;	Mild steel

57102 Chlorine Gas Booster Blower

Quantity:	Two (2), One (1) for stand-by
Type:	Centrifugal
Capacity:	300 Nm^3/Hr
Material:	Ceramic
Drive:	15 kW x 4P motor

57103 No. 2 Chlorine Water Cooler

Quantity:	One (1)
Type:	Plate
Capacity:	4 m^3/Hr
Material:	
Plate;	Titanium
Frame;	Mild steel

57104 No. 1 Sulphuric Acid Cooler

Quantity:	One (1)
Type:	Plate
Capacity:	4 m^3/Hr
Material:	
Plate;	Alloy
Frame;	Mild steel

57105 No. 2 Sulphuric Acid Cooler

Quantity:	One (1)
Type:	Plate
Capacity:	4 m^3/Hr
Material:	
Plate;	Alloy
Frame;	Mild steel

57106 Refrigeration Unit

Quantity:	One (1)
Type:	Two-stage compressor
Material:	Mild steel and Cast iron
Drive:	One (1) – 4.5 kW motor, V-belt drive
	One (1) – 2.2 kW motor, V-belt drive

57107 Cl_2 Gas Condenser

Quantity:	One (1)
Type:	Shell and Tube type
Capacity:	170 kg/Hr
Material:	Mild steel

57108 Hoist

Quantity:	One (1)
Type:	Motor trolley
Capacity:	2 tons
Material:	Mild steel and Cast iron
Drive:	
Lifting;	3.7 kW x 4P motor
Travelling;	0.5 kW x 4P motor

57201 Feed Pump

Quantity:	Two (2), One (1) for stand-by
Type:	Centrifugal
Capacity:	1.5 m^3/Hr x 11 m Head
Material:	
Impeller;	Cast iron with plastic lining
Casing;	Cast iron with plastic lining
Drive:	0.75 kW x 4P motor

57202 No. 1 Chlorine Water Pump

Quantity:	Two (2), One (1) for stand-by
Type:	Centrifugal
Capacity:	12 m^3/Hr x 13 m Head
Material:	
Impeller;	Cast iron with plastic lining
Casing;	Cast iron with plastic lining
Drive:	2.2 kW x 4P motor

57203 No. 2 Chlorine Water Pump

Quantity:	Two (2), One (1) for stand-by
Type:	Centrifugal
Capacity:	4 m^3/Hr x 15 m Head
Material:	
Impeller;	Cast iron with plastic lining
Casing;	Cast iron with plastic lining
Drive:	1.5 kW x 4P motor

57204 No. 1 Sulphuric Acid Pump

Quantity:	Two (2), One (1) for stand-by
Type:	Centrifugal
Capacity:	4 m^3/Hr x 15 m Head
Material:	
Impeller;	Cast iron with plastic lining
Casing;	Cast iron with plastic lining
Drive:	1.5 kW x 4P motor

57205 No. 2 Sulphuric Acid Pump

Quantity:	Two (2), One (1) for stand-by
Type:	Centrifugal
Capacity:	4 m^3/Hr x 15 m Head
Material:	
Impeller;	Cast iron with plastic lining
Casing;	Cast iron with plastic lining
Drive:	1.5 kW x 4P motor

57206 No. 3 Sulphuric Acid Pump

Quantity:	Two (2), One (1) for stand-by
Type:	Centrifugal
Capacity:	4 m^3/Hr x 15 m Head
Material:	
Impeller;	Cast iron with plastic lining
Casing;	Cast iron with plastic lining
Drive:	1.5 kW x 4P motor

57207 No. 4 Sulphuric Acid Pump

Quantity:	Two (2), One (1) for stand-by
Type:	Centrifugal
Capacity:	4 m^3/Hr x 15 m Head

	Material:	
	Impeller;	Cast iron with plastic lining
	Casing;	Cast iron with plastic lining
	Drive:	1.5 kW x 4P motor
57208	Liquid Chlorine Pump	
	Quantity:	Two (2), One (1) for stand-by
	Type:	Centrifugal
	Capacity:	11 m^3/Hr x 45 m Head
	Material:	
	Impeller;	Stainless steel castings (SUS 304)
	Casing;	Stainless steel castings (SUS 304)
	Drive:	11 kW x 4P motor
57401	Sulphuric Acid Storage Tank	
	Quantity:	One (1)
	Volume:	2 m^3
	Main Dimension:	1,400 mmϕ x 1,500 mm Height
	Material:	Mild steel
57402	No. 1 Cooling Tower	
	Quantity:	One (1)
	Capacity:	410 kg/Hr
	Material:	PVC
57403	No. 2 Cooling Tower	
	Quantity:	One (1)
	Volume:	410 kg/Hr
	Material:	PVC
57404	Mist Separator	
	Quantity:	One (1)
	Main Dimension:	500 mmϕ x 3,000 mm Height
	Material:	FRP & PVC
57405	Waste Sulphuric Acid Tank	
	Quantity:	One (1)
	Volume:	1 m^3
	Main Dimension:	1,090 mmϕ x 1,150 mm Height
	Material:	Polyethylene

57406 No. 1 Drying Tower

Quantity:	One (1)
Capacity:	320 kg/Hr
Material:	PVC

57407 No. 2 Drying Tower

Quantity:	One (1)
Capacity;	320 kg/Hr
Material:	PVC

57408 No. 3 Drying Tower

Quantity:	One (1)
Capacity:	320 kg/Hr
Material:	PVC

57409 No. 4 Drying Tower

Quantity:	One (1)
Capacity:	320 kg/Hr
Material:	PVC

57410 Sulphuric Acid Mist Separator

Quantity:	One (1)
Main Dimension:	550 mmϕ x 3,000 mm Height
Material:	Mild steel

57411 Liquid Chlorine Receiver

Quantity:	One (1)
Capacity:	15 tons
Main Dimension:	1,900 mmϕ x 4,760 mm Length
Material:	Mild steel

2. Na-Hypo Preparation

57121 Circulating Cooler

Quantity:	One (1)
Type:	Plate type
Capacity:	16 m^3/Hr
Material:	
Plate;	Titanium
Frame;	Mild steel

57122 Blower

Quantity:	One (1)
Type:	Turbo
Capacity:	15 m^3/min. x 300 mm Aq.
Material:	FRP
Drive:	3.7 kW x 4P motor

57221 Hypo Tower Circulating Pump

Quantity:	Two (2), One (1) for stand-by
Type:	Centrifugal
Capacity:	16 m^3/Hr x 15 m Head
Material:	
Impeller;	FRP
Casing;	FRP
Drive:	3.7 kW x 4P motor

57222 Scrubber Circulating Pump

Quantity:	Two (2), One (1) for stand-by
Type:	Centrifugal
Capacity:	16 m^3/Hr x 15 m Head
Material:	
Impeller;	FRP
Casing;	FRP
Drive:	3.7 kW x 4P motor

57223 Na-Hypo Pump

Quantity:	Two (2), One (1) for stand-by
Type:	Centrifugal
Capacity:	3 m^3/Hr x 30 m Head
Material:	
Impeller;	FRP
Casing;	FRP
Drive:	2.2 kW x 4P motor

57421 Na-Hypo Tower

Quantity:	One (1)
Volume:	80 kg/Hr (as available chlorine)
Material:	Mild steel with hard rubber lining and FRP

57422 Vent Gas Scrubber

Quantity:	One (1)
Volume:	250 kg/Hr as chlorine
Material:	Mild steel with hard rubber lining and FRP

57423 Na-Hypo Storage Tank

Quantity:	One (1)
Volume:	20 m^3
Main Dimension:	2,800 mmϕ x 3,600 mm Height
Material:	FRP

DEPARTMENT 61. FUEL SUPPLY

61000 Design Basis

Natural Gas Total Consumption:	3,720 Nm^3/Hr
Supplied Gas Pressure:	42 kg/cm^2G
Reduced Pressure:	4 kg/cm^2

61101 Pressure Reduction Unit

Quantity:	One (1)

DEPARTMENT 62. POWER PLANT

62000 Design Basis

1)	Electric Power Generation:	5,000 kW
2)	Process Steam from Turbine Extractions	
	Medium Pressure:	11 kg/cm²G at receiver 13.5–22.5 Tons/Hr
	Low Pressure:	3.5 kg/cm²G at receiver 2.0 Tons/Hr
3)	Steam Condensate from Process:	4.5 Tons/Hr at 80°C
4)	Fuel Carolific Value:	Natural Gas 3,700 Kcal/Nm³ at LCV

1. Steam Generation

62101	Power Boiler	
	Quantity:	One (1) set
	Consisting of:	Furnace, Superheater, Gas Air Heater and Refractories
62102	Combustion Equipment	
	Quantity:	One (1) set
62103	Forced Draft Fan	
	Quantity:	One (1)
62104	Water Treating Equipment	
	Quantity:	One (1) set
	Consisting of:	Sampling equipment and chemical dosing equipment
62105	Demineralizing System	
	Quantity:	One (1) set
	Capacity:	20 Tons/Hr
62106	Deaerator	
	Quantity:	One (1) set
62107	Induced Draft Fan	
	Quantity:	One (1)
62201	Boiler Feed Water Pump	
	Quantity:	Two (2)
62202	Deaerator Feed Pump	
	Quantity:	Two (2)

62401 Feed Water Tank

Quantity:	One (1) set
Material:	Mild steel

62601 Scaffolding and Steel Structure

Quantity:	One (1) set
Material:	Mild steel

62701 Pipes, Valves and Fittings

One (1) set of pipes, valves and fittings for this department will be supplied.

2. Power Generation

62121	Turbine	
	Quantity:	One (1)
62122	Ejector	
	Quantity:	One (1)
62123	Condenser	
	Quantity:	One (1)
62124	Generator	
	Quantity	One (1)
62125	Excitation System	
	Quantity: Consist of:	One (1) Exciter and Automatic Voltage Regulator
62126	Diesel Engine Generator	
	Quantity: Service: Accessories:	One (1) For start-up and emergency Fuel oil tank and cooling water tank

DEPARTMENT 65. ELECTRICAL EQUIPMENT

65100 Electrical Equipment for Power Distribution System

65101 Supervisory panel for Turbine-Generator

Quantity: One (1) set
Type: Indoor-use metal enclosed vertical self standing type

Consisting of:
- 1 set - Frequency meter
- 1 set - A.C. voltmeter
- 1 set - A.C. ammeter
- 1 set - Power factor meter
- 1 set - Indicating wattmeter
- 1 set - Watthour meter
- 1 set - AVR
- 1 set - Control switch
- 1 set - Other necessaries

65102 Supervisory Panel for Feeder

Quantity: One (1) set
Type: Indoor-use metal enclosed vertical self standing type

Consisting of:
- 1 set - A.C. ammeter
- 1 set - Watt hourmeter
- 1 set - Control switch
- 1 set - Other necessaries

65103 Main Feeder Switchgear

Main feeder switchgear will be used for the secondary side of the turbine generator to distribute the electric power to each department.

Quantity: One (1) set
Type: Indoor-use metal enclosed vertical self standing type

Consisting of:

1 set - High voltage circuit breaker
1 set - Current transformer
1 set - Potential transformer
1 set - Other necessaries

65200 Electrical Equipment for Each Dept.

65201 High Voltage Switchgear

High voltage switchgears are provided for the primary side of high voltage transformers and the starter of high voltage motors.

Quantity:	One (1) set
Type:	Indoor-use, metal enclosed vertical self standing type

Consisting of:

1 set - A.C. ammeter
1 set - Watthour meter
1 set - Current limiting power fuse
1 set - Magnetic contactor
1 set - Protection relay
1 set - Other necessaries

65202 High Voltage Transformer

High voltage transformer will be used for transforming electric power from 3,000 V to 400 V.

Quantity:	One (1) set
Type:	Indoor-use, three phase oil immersed self cooled type
Frequency:	50 Hz
Rated Voltage:	3,000 V/400 V

65203 Load Center

Load centers are provided for the secondary side of high voltage transformer to distribute low voltage electric power.

Quantity:	One (1) set
Type:	Indoor-use, metal enclosed vertical self standing type

Consisting of:

1 set - Molded case circuit breaker
1 set - A.C. voltmeter

65204 Low Voltage Combination Motor Starter

Low voltage combination motor starter will be used for the low voltage motor starting and switching of low voltage equipment.

Quantity:	One (1) set
Type:	Indoor-use, metal enclosed vertical self standing control center type

Consisting of:

1 set - Molded case circuit breaker
1 set - Magnetic contactor
1 set - Thermal relay
1 set - Pilot lamp
1 set - Push button switch
1 set - Other necessaries

65205 Local Push Button Switch Box

Quantity:	One (1) set
Type:	Sheet steel wall mount box type

Consisting of:

1 set - Pilot lamp
1 set - Push button switch
1 set - Change over switch (if necessary)
1 set - A.C. ammeter (if necessary)

65206 Electrical Motors

1) Specification for low voltage motor

Motors rated 75 kW and below will be low voltage squirrel cage motor.

a) Standards

All equipment shall be designed and manufactured in accordance with applicable current IEC, JEM and JIS.

Low voltage power system

Nominal system voltage:	400 V
Phase:	3

Frequency: 50 Hz
Rated motor voltage: 400 V

b) Enclosure

All continuous rating motors will be totally enclosed fan cooled type, and totally enclosed type for short time rating motor.

c) Frames

All motor shall be built in JEM standard frames.

d) Insulation

The insulation system shall be JEC class E and Class F.

2) Specification for High voltage motor

Motors rated 75 kW above will be high voltage squirrel cage motor or wound rotor type motor.

a) Standards

All equipment shall be designed and manufactured in accordance with applicable current JEC, JEM and JIS.

High voltage power system
Nominal system voltage: 3,000 V
Phase: 3
Frequency: 50 Hz
Rated motor voltage: 3,000 V

b) Frames

All motor shall be built in JEM standard frames.

c) Insulation

The insulation system shall be JEC class F.

d) Rating

Continuous rating without service factor.

e) Enclosure

All motors will be drip-proof type for indoor use or totally enclosed fan cooled type for outdoor use.

3) Specification for eddy current coupling motor (EC motor)

The eddy current coupling motor will be used for the machine to control the speed.

a) Frames, rating, temperature rise and enclosure will be applied in accordance with above item 1) and 2).
Insulation class of EC coupling will be JEC class B.

b) Coupling cooling system

Coupling for low voltage motors will be applied the natural air cooling system.

c) Speed control

10 : 1	(Continuous rating)
±1%	(Accuracy)

65300 Electrical Equipment for Pulp M/C and Dryer

The pulp M/C will be driven and controlled by EC motor and pulp dryer will be driven and controlled by D.C. motor.

65301 D.C. Motor

Quantity:	One (1) set
Type:	Separately – excited shunt-wound fan mount type
Rating:	D.C. 440 V continuous
Insulation:	JEC class F

65302 D.C. Motor Control Panel

Quantity:	One (1) set
Type:	Indoor-use, metal enclosed vertical self standing type

Consisting of:
1 set - D.C. ammeter
1 set - Magnetic contactor
1 set - Thyrister control unit
1 set - Speed control unit
1 set - Other necessaries

65303 Dryer Operation Panel

Quantity: One (1) set
Type: Indoor-use metal enclosed wallmount or pole stand type

Consisting of:
1 set - Push button siwtch
1 set - Speed meter
1 set - Tension meter
1 set - Other necessaries

65304 EC Motor

Quantity: One (1) set
Type: Please, refer to 65206-3)

65305 EC Motor Control Panel

Quantity: One (1) set
Type: Indoor-use, metal enclosed vertical self standing type

Consisting of:
1 set - Molded case circuit breaker
1 set - EC motor control unit
1 set - Auxiliary relay
1 set - Other necessaries

65306 Pulp M/C Operation Panel

Quantity: One (1) set
Type: Indoor-use, metal enclosed desk type

Consisting of:
1 set - Push button switch
1 set - Pilot lamp
1 set - Speed setter

1 set - Speed meter
1 set - A.C. ammeter
1 set - Other necessaries

65400 Electrical Equipment for Lighting and Instrumentation

65401 Transformer for Lighting and Instrumentation

Quantity:	One (1) set
Type:	Indoor-use, oil immersed self cooled type
Frequency:	50 Hz
Rated Voltage:	3,000 V/200, 100 V

65402 Distribution Panel for Lighting and Instrumentation

Quantity:	One (1) set
Type:	Indoor-use, metal enclosed vertical self standing type

Consisting of:
1 set - Molded case circuit breaker
1 set - A.C. voltmeter
1 set - Other necessaries

65403 Lighting Switch Box and Lighting Apparatus

Quantity:	One (1) set
Type:	Mercury light and fluorescent light

65700 Electric Wiring Piping

All materials, designing, wiring piping works shall be in accordance with JIS, JEC, JEM. JCS and Ministerial Technical Ordinance for Electric Facilities.

Main wiring route will be cable rack on duct and branch route will be thick steel conduit pipe.

The main materials for electric wiring, piping will be as follows:

1) Cables and Wire

3.3 KV CV Cable
600 V CV Cable
600 V CVV Cable

600 V CVVS Cable
600 V IV Wire

2) Cable rack
3) Cable duct
4) Thick steel conduit pipe
5) Flexible conduit pipe
6) Each size of termination
7) Pull box
8) Grounding materials
9) Others

Where CV: Cross-linked polyethylene insulated polyvinyl chloride sheathed cable.

CVV: Polyvinyl chloride insulated & sheathed control cable.

CVV-S: Polyvinyl chloride insulated & sheathed control cable with shield assembly.

IV: Polyvinyl chloride insulated wire.

DEPARTMENT 66. INSTRUMENTATION

66000 Instrument

All necessary recorder, indicator and controller for pressure, temperature and flow are furnished to suit the requirement of automatic controlling operations of the process of the proposed mill.

i) Almost of instruments, except direct reading one, are pneumatic type.

ii) Control signal is 0.2 kg/cm² – 1 kg/cm² pneumatic signal system and the control valves and damper actuator are of penumatic driving type.

iii) Air source and electric source for instruments:
5.0 kg/cm² and above essential air and A.C. 100 V, 50 Hz, 1 phase.

66400 Instrument Panel

Quantity: One (1) set

Service:

- Power boiler
- Incinerator
- Water supply & Effluent treatment
- Cooking & Washing
- Bleaching & Screening
- Pulp machine
- Black liquor evaporation
- Recausticizing
- Lime recovery

Type: Sheet steel enclosure floor mounted self-standing cubicle type, indoor use

Each panel will be equipped with the instruments and controls and other necessaries like air set, piping and wiring etc.

66500 Pneumatic Operation Equipment for Pulp Machine

Floor mounted operator's panel will contain all pneumatic operation equipment.

66700 Piping and Wiring Material for Instruments

Instrument wiring, piping and tubing works will be done inaccordance with JIS, JEC, JEM, JCS and Ministerial Technical Ordinance for Electric Facilities.

The instrument pipes, tubes, cables from central control instrument panels to local instruments, sensors and actuators will be installed on instrument cable rack.

The major materials of piping and wiring will be as follows:

1) Cables

The cable main kind specifications will be as follows:

(1) Multi-conductor control cable

600 V	CVV cable
600 V	CVV-S cable (Sealed cable)

2) 600 V — IV Electric wire

3) Vinyl covered multi-control copper tube

JIS 6/4 ϕ

4) SGP (W) pipe

JIS 1B
JIS 1/2B

5) Thick steel conduit pipe

6) Others

DEPARTMENT 67. WATER SUPPLY

67000 Design Basis

(1) Capacity

Treated Water for Process:	9,600 m^3/D
Raw Water for Cooling Water:	18,000 m^3/D
Drinking Water:	50 m^3/D

(2) Raw Water Quality

As per attached sheet (Table 1)

(3) Treated Water: Based on TAPPI standard

Quantity:

Turbidity as SiO_2	25
Color as plantinum units	5
Total hardness as $CaCO_3$	100
Calcium hardness as $CaCO_3$	50
Magnesium hardness as $CaCO_3$	50
Alkalinity as $CaCO_3$	75
Iron (Fe)	0.1
Manganese (Mn)	0.05
Silica (SiO_2)	20
Dissolved Solids	250
Free carbon dioxide as CO_2	10
Chloride (Cl)	75

Table 7-1. Meghna River Water Analysis

	pH	Turbidity PPM/NTU	Conductivity US/cm	M. Alkali PPM as $CaCO_3$	T.T. Hardness PPM as $CaCO_3$	C. Hardness PPM as $CaCO_3$	Sodium PPM	Chloride PPM	Sulphate PPM	Silica PPM	Total Solid PPM	SS PPM
1980 Nov.	6.9–8.8	14–80	67–170	25–30	20–25	9–15						
Dec.	6.5–7.5	8–23	25–125	27–38	25–33	14–21						
1981 Jan.	6.5–7.5	6–8	28–48	32–40	8–27							
Feb.	6.9–8.3	3–9	98–118	41–55	41–46	26–28		0.4–3.9	2.3–8.0			
Mar.	7.0–8.3	3–23	120–140	48–56	36–56	19–30	7–19	2–4.6		4–6	80–125	9–37
Apr.	6.8–7.8	6–72	70–150	25–52	24–29	15–29		2–4.4				
May	6.7–7.5	24–134	62–86	30	20–28	13–17	0.6–1.3	2.5–4.6		3.8–8.1		
Jun.	6.5–7.3	18–85	54–66	25	19–21	11–14		1.9–3.8		6.5–7.5		
Jul.	6.8–7.8	10–24	42–57	25	15–16	10–16	0.5–3.5	1.0–2.0		6.2–7.4		

67101	Raw Water Pond	
	Quantity:	One (1)
	Type:	Connected with river by concrete pipe
	Material:	Concrete construction
67102	Clarifier	
	Quantity:	One (1)
	Type:	Rapid coagulation type
	Volume:	1,800 m^3
	Material:	
	Main Body;	Reinforced concrete
	Mechanical Parts;	Mild steel
	Auxiliaries:	Chemical mixing pits on inlet side
67103	Clarified Water Pond	
	Quantity:	One (1)
	Volume:	500 m^3
	Material:	Reinforced concrete
67104	Filter	
	Quantity:	Two (2)
	Type:	Sand filter, back wash type
	Capacity:	400 m^3/Hr
	Material:	Reinforced concrete construction
67105	Treated Water Pit	
	Quantity:	One (1)
	Volume:	1,600 m^3
	Material:	Reinforced concrete construction
67106	Back Wash Blower	
	Quantity:	One (1)
	Service:	Back wash for Filter
	Capacity:	4 Nm^3/min x 5,000 mm Aq.
	Drive:	7.5 kW motor

67107	Chemical Dosing Equipment	
	Quantity:	One (1) set
	Chemicals:	Alum, Lime, and Coagulant
	Consist of:	Dissolving tanks, agitators, and feeding pumps
67108	Drinking Water Treatment	
	Quantity:	One (1) set
	Consist of:	Filters, chlorinator, and pumps
67201	Raw Water Pump	
	Quantity:	One (1)
	Service:	Feed to clarifier
	Type:	Centrifugal
	Capacity:	7.5 m^3/min x 8 m Head each
	Material:	Cast iron
	Drive:	22 kW x 4P
67202	Raw Water Pump	
	Quantity:	One (1)
	Service:	Feed to Turbine condenser and others
	Type:	Centrifugal
	Capacity:	13 m^3/min x 15 m Head each
	Material:	Cast iron
	Drive:	75 kW x 4P
67203	Clarified Water Pump	
	Quantity:	Two (2)
	Service:	Feed to Filter
	Type:	Centrifugal
	Capacity:	3.5 m^3/min x 20 m Head
	Material:	Cast iron
	Drive:	22 kW x 4P
67204	Treated Water Pump	
	Quantity:	Three (3), one for stand-by
	Type:	Centrifugal
	Capacity:	2 m^3/min x 25 m Head
	Material:	Cast iron
	Drive:	

67205 Treated Water Pump

Quantity:	Two (2)
Service:	For auxiliary use
Type:	Centrifugal
Capacity:	0.5 m^3/min x 25 m Head
Drive:	

67206 Back Wash Pump

Quantity:	One (1)
Service:	Back wash for Filter
Type:	Centrifugal
Capacity:	3.5 m^3/min x 15 m Head
Material:	Cast iron
Drive:	15 kw x 4P

67207 Sludge Pump

Quantity:	One (1)
Type:	Centrifugal
Capacity:	25 m^3/Hr x 15 m Head
Material:	Cast iron
Drive:	2.2 kW x 4P

67601 Scaffolding

Quantity:	One (1) set
Material:	Mild steel

67701 Pipes, Valves and Fittings

One (1) set of pipes, valves and fittings for this department will be supplied.

DEPARTMENT 68. COMPRESSED AIR SUPPLY

68101 Instrument Air Compressor

Quantity:	Three (3), one is stand-by
Type:	Water cooled, reciprocating, oil free
Discharge Pressure:	7 kg/cm²G
Capacity:	5.5 m³/min. at suction condition
Speed:	550 rpm
Cylinder Size:	250 mmϕ
Stroke:	180 mm
Drive:	45 kW x 6P
Accessories:	One (1) receiver
	Two (2) after cooler
	Two (2) lubrication system
	Two (2) cooling system
	Two (2) protection system
	Two (2) suction filter with silencer

68102 Air Dryer

Quantity:	One (1)
Type:	Automatic, electric heating
Capacity:	11 Nm³/min
Dew Point:	-20°C at 7 kg/cm²G
Accessories:	One (1) electric heater 10.8 kW
	One (1) blower 3.1 Nm³/min x 2,000 mm Aq
	One (1) prefilter
	One (1) after filter

68103 Mill Air Compressor

Quantity:	Two (2) one is stand-by
Type:	Oil free
Discharge Pressure:	7 kg/cm²G
Capacity:	11 m³/min at suction condition
Speed:	550 rpm
Cylinder Size:	250 mmϕ x 2
Stroke:	180 mm
Drive:	90 kW x 6P
Accessories:	Two (2) receiver
	Two (2) after cooler
	Two (2) lubrication system
	Two (2) cooling system
	Two (2) protection system
	Two (2) suction filter

DEPARTMENT 69. OUTER PIPING

One (1) set of pipes, valves, fittings and supports for outer piping which connect between Pulp Mill and Water Supply, Pulp Mill and Fuel Supply, will be supplied.

DEPARTMENT 70. MILL SERVICE

The following equipment will be included in supply scope.

71. Maintenance Shop
72. Laboratory
73. Fire Protection
74. Vehicles
75. Communication Equipment
76. Office Equipment & Furniture
77. First Aid Equipment

DEPARTMENT 78. EFFLUENT TREATMENT

78000	Design Basis	
	Treatment Capacity;	9,600 m^3/D
	Waste Water Quality:	
	pH;	9–10
	SS;	500 ppm
	BOD;	700 ppm
	Treated Water Quality:	
	pH;	6–8
	SS;	45 ppm
	BOD;	80 ppm
	Treatment Method:	Lagoon Type
78101	Waste Water Receiving Pit	
	Quantity:	One (1)
	Volume:	400 m^3
	Material:	Reinforced concrete
78102	Sedimentation Equipment	
	Quantity:	One (1)
	Volume:	
	Material:	Reinforced concrete
78103	Lagoon	
	Quantity:	One (1)
	Volume:	35,000 m^3
	Dimension:	50,000 mmW x 200,000 mmL x 3,500 mmD
78104	Aerator	
	Quantity:	Seventeen (17)
	Type:	Self Floating
	Diameter:	2,500 mmϕ
	Drive:	11 kW x 4P

78201 Waste Water Transfer Pump

Quantity:	One (1)
Service:	Feed to Sedimentation
Type:	Centrifugal
Capacity:	7.5 m^3/min x 8 m Head
Material:	Cast iron
Drive:	22 kW x 4P

72202 Sludge Pump

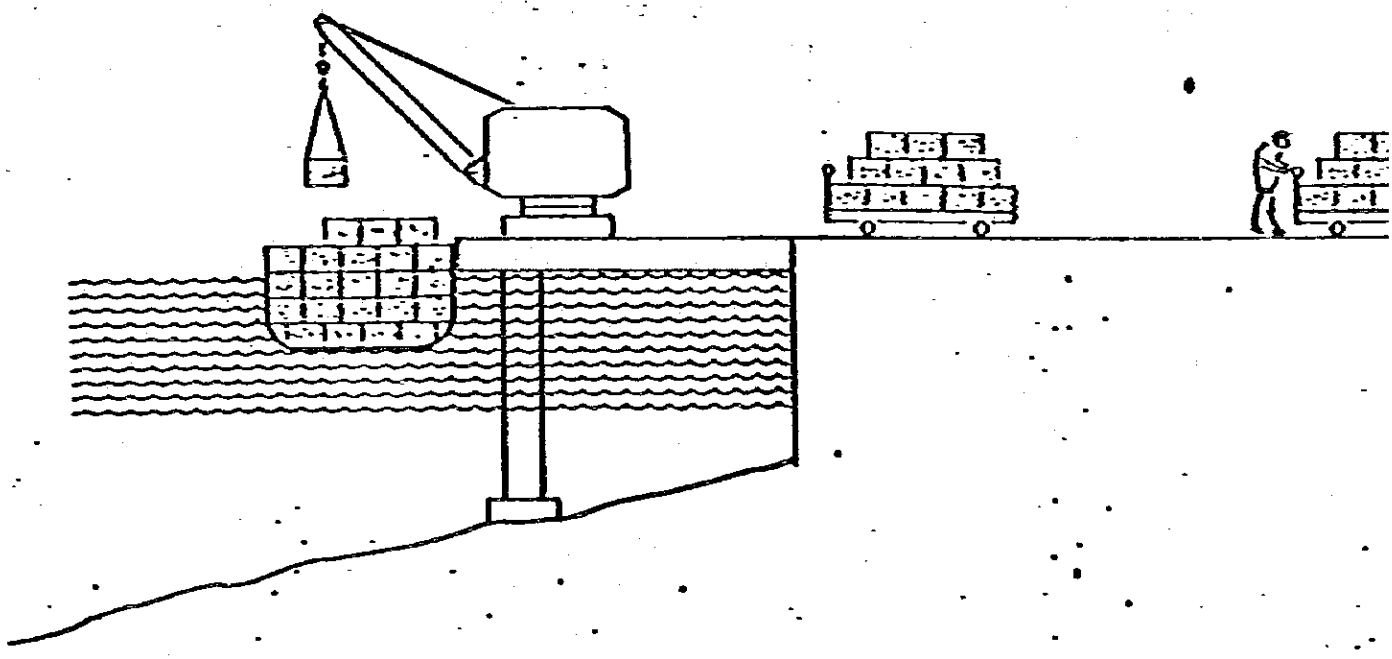
Quantity:	One (1)
Type:	Centrifugal
Capacity:	40 m^3/Hr x 15 m Head
Material:	Stainless steel
Drive:	3.7 kW x 4P

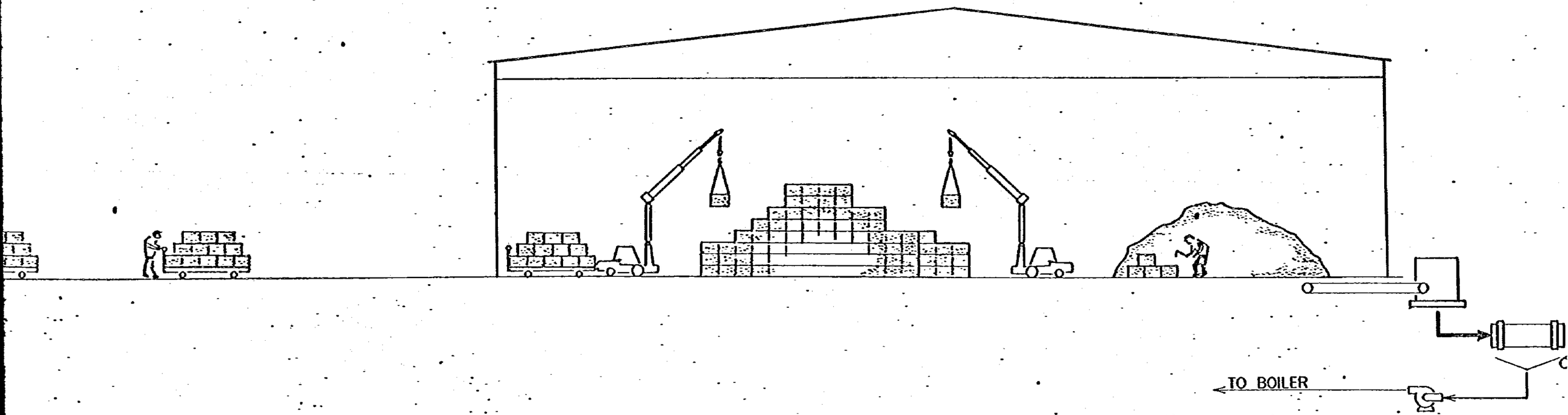
78601 Scaffolding

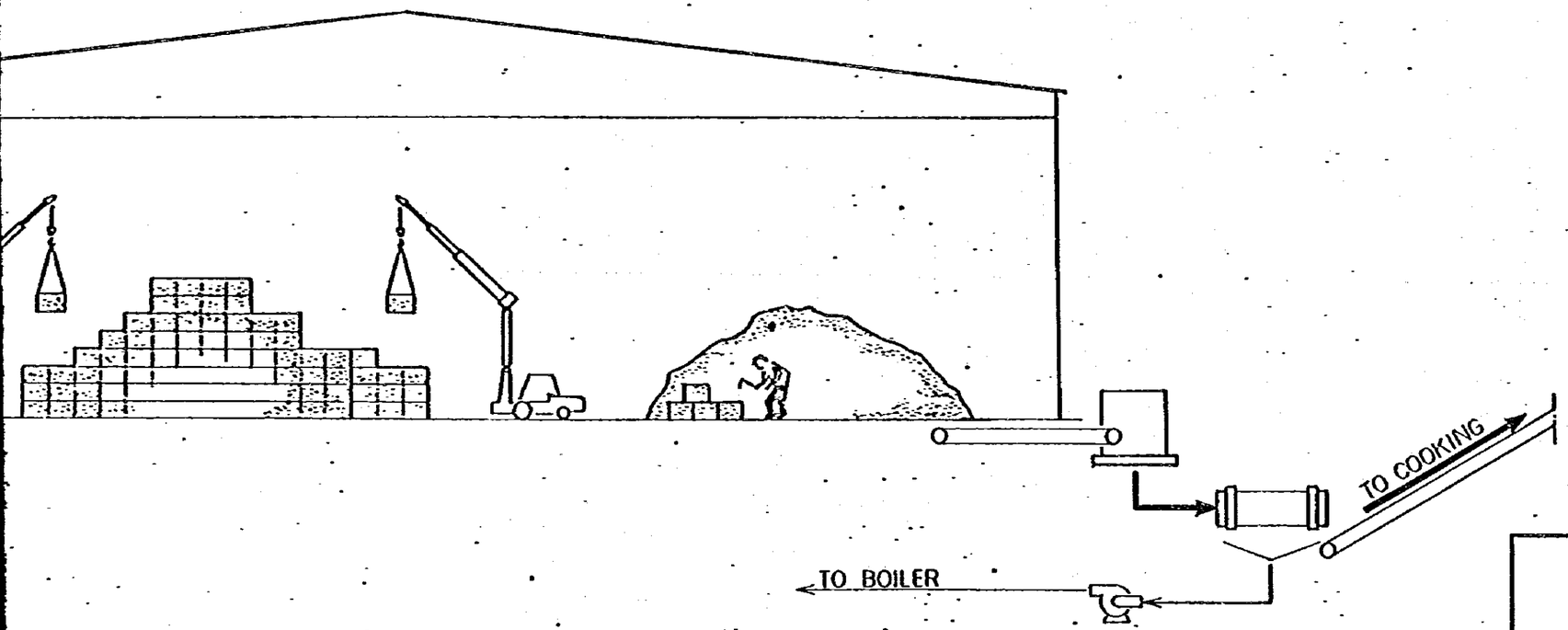
Quantity:	One (1) set
Material:	Mild steel

78701 Pipes, Valves, and Fittings

One (1) set of pipes, valves and fittings for this department will be supplied.




TO BOILER



GOVERNMENT OF BANGLADESH

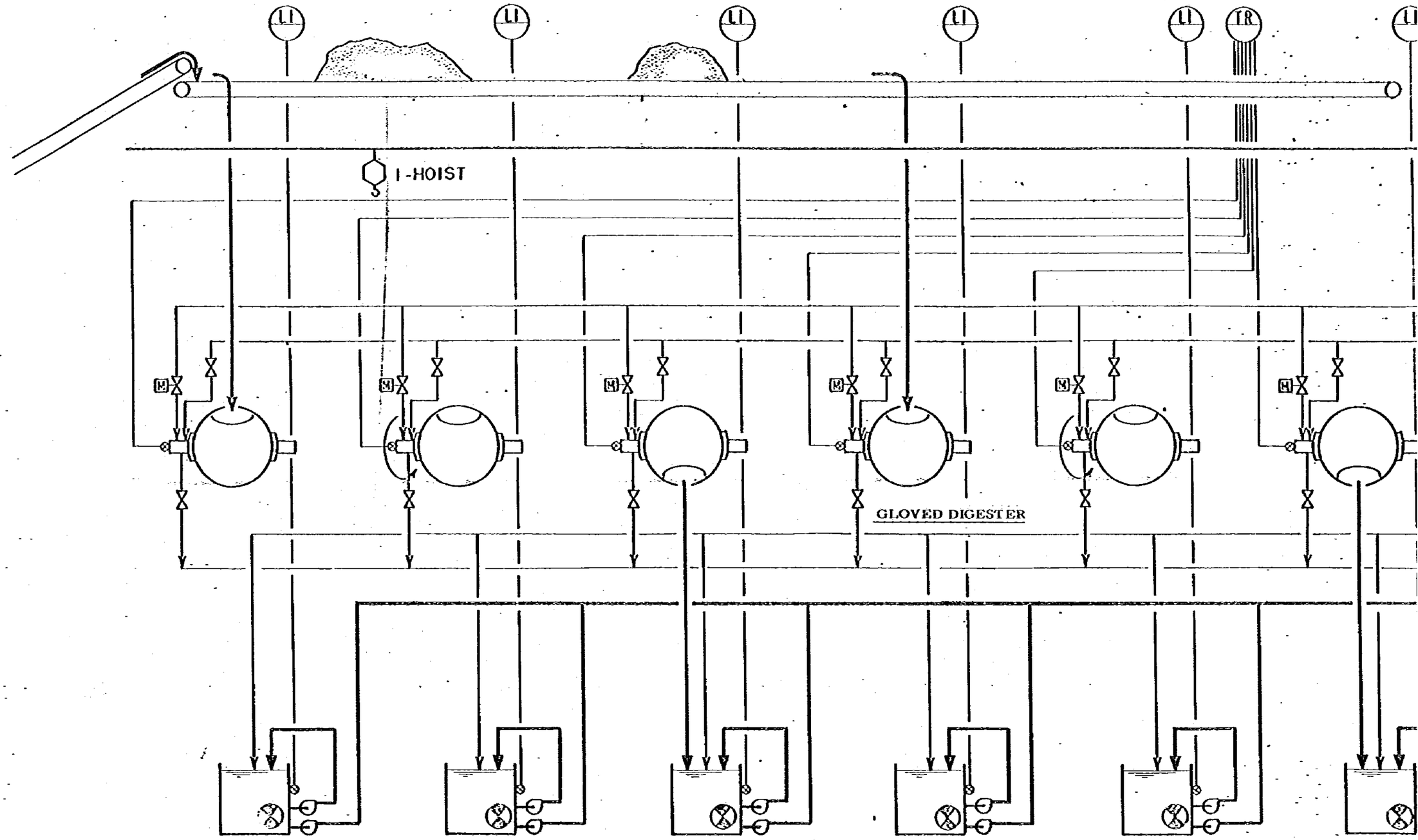
PULP MILL FLOWSHEET

RAW MATERIAL HANDLING

						STOCK NO.	CLASSIFICATION
						DRAWING NO.	
DATE	DRAWN BY	ENG CHAR	CHIEF	DEPT MGR.	MANAG		

JAPAN INTERNATIONAL COOPERATION AGENCY

A1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GLOVED DIGESTER
BLOW PIT

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FIS
LI
LI

MILL WATER

TO HOT WATER TANK

M.P. STEAM FROM POWER PLANT

WHITE LIQUOR FROM RECAUSTICIZING PLANT

BLACK LIQUOR FROM WASHING PLANT

TO WASHING

HEAT RECOVERY

BLOW TANK

COOKING LIQUOR MEASURING TANK

WHITE LIQUOR TANK

BLACK LIQUOR TANK

GOVERNMENT OF BANGLADESH

PULP MILL FLOWSHEET

COOKING

						ROSA NO.	CLASSIFICATION
Dec. 85 1981 DATE	DRAWN BY	ENG. CHAR	CHIEF	SUPV. ENGR.	MANAG.	DRAWING NO.	

JAPAN INTERNATIONAL COOPERATION AGENCY

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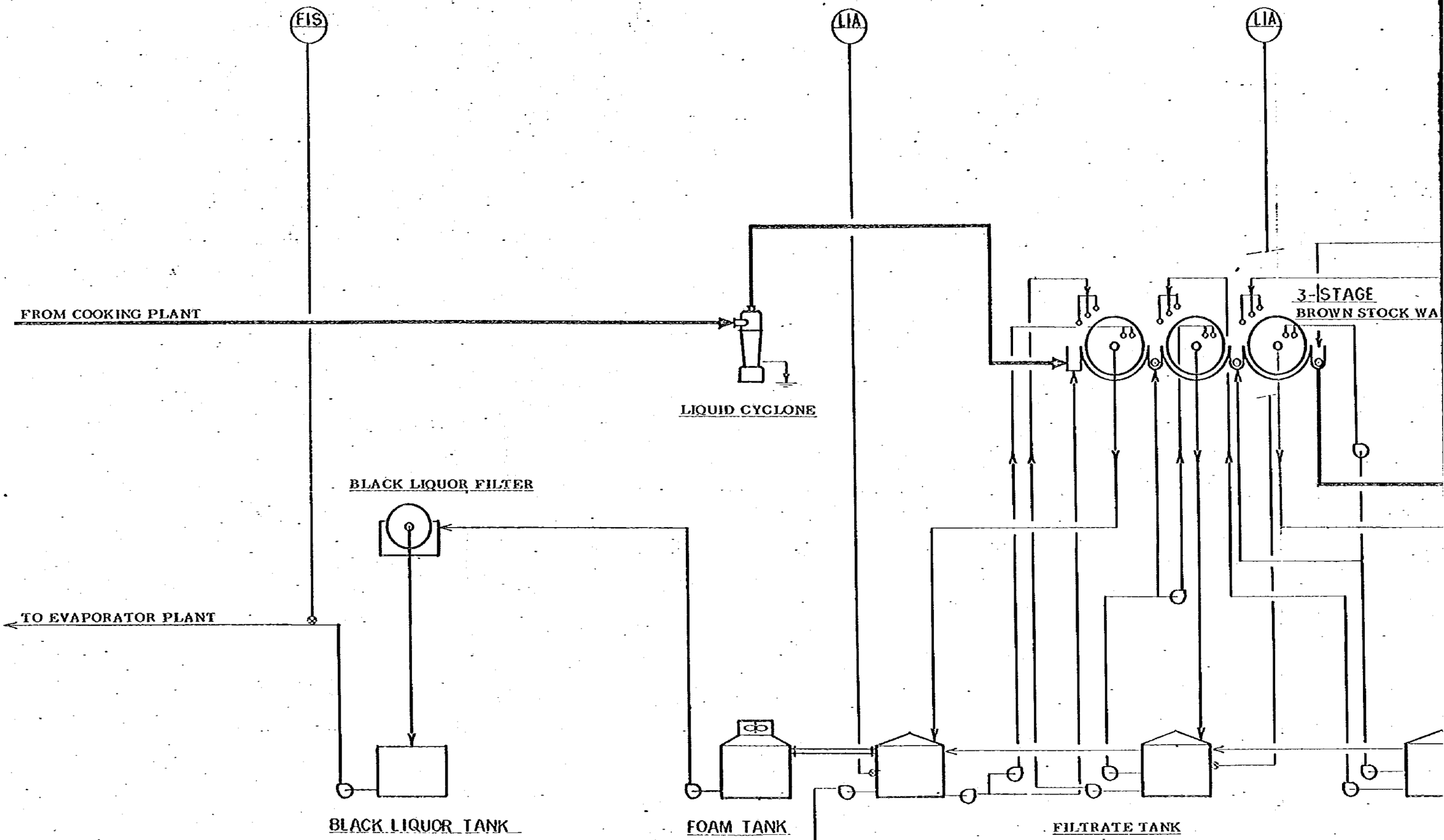
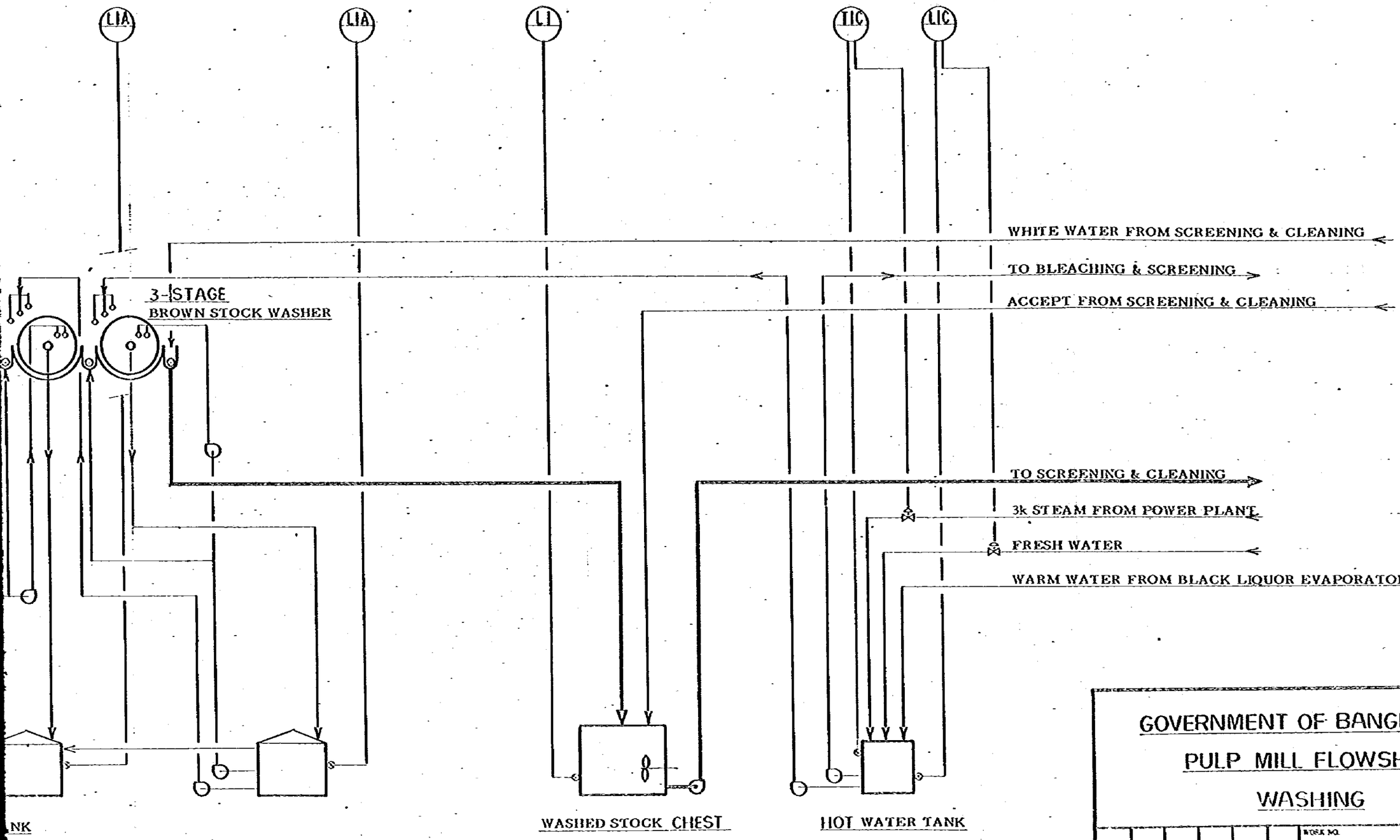

FIS
LIA
LIA
FROM COOKING PLANT
LIQUID CYCLONE
3-STAGE
BROWN STOCK WA
BLACK LIQUOR FILTER
TO EVAPORATOR PLANT
BLACK LIQUOR TANK
FOAM TANK
FILTRATE TANK
TO COOKING PLANT



GOVERNMENT OF BANGLADESH

PULP MILL FLOWSHEET

WASHING

						WORK NO.	CLASSIFICATION
Dec '82 DATE	DRAWN BY	ENG CHAR	CHIEF	ENGR MANAG	MANAG	DRAWING NO.	

JAPAN INTERNATIONAL COOPERATION AGENCY

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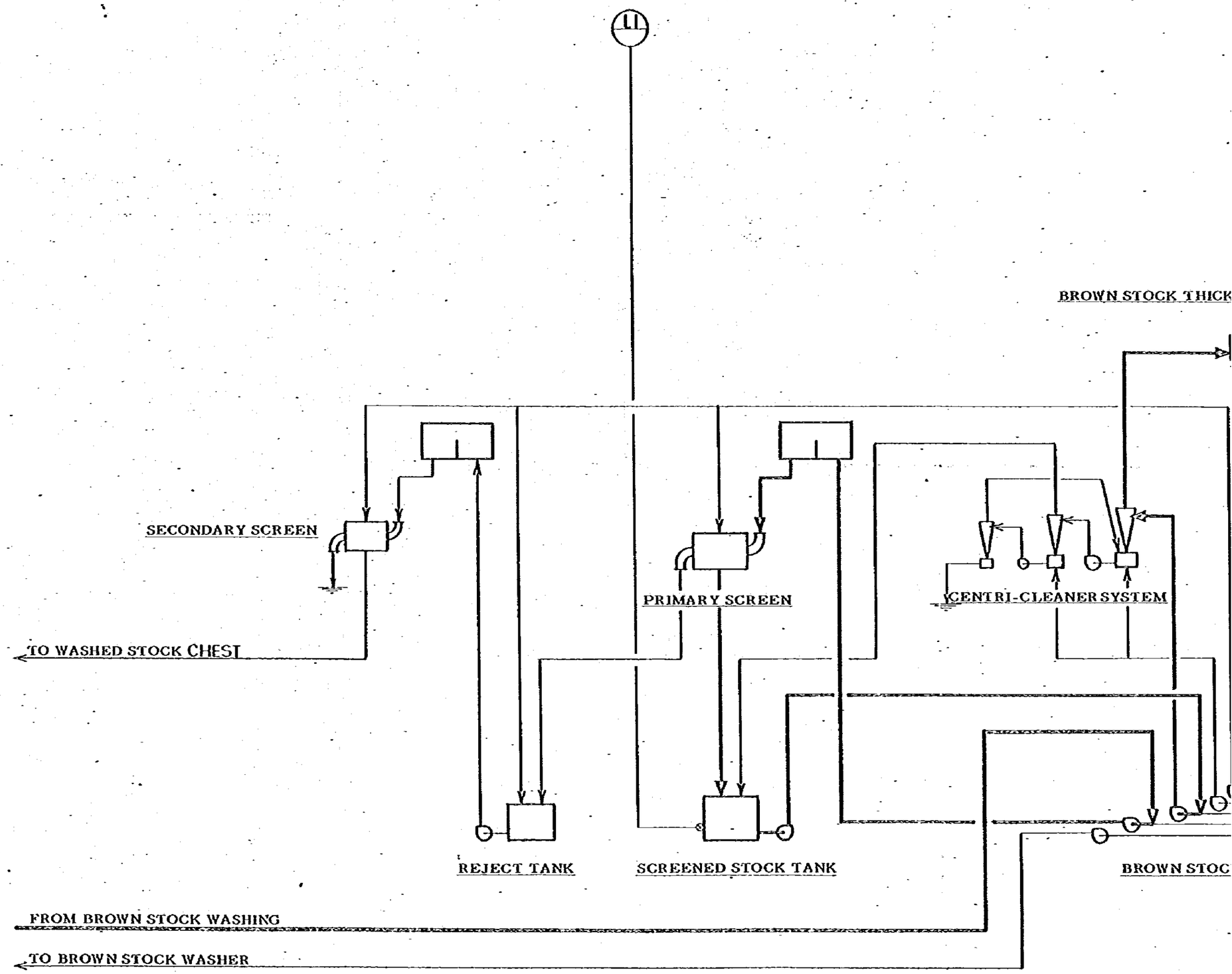
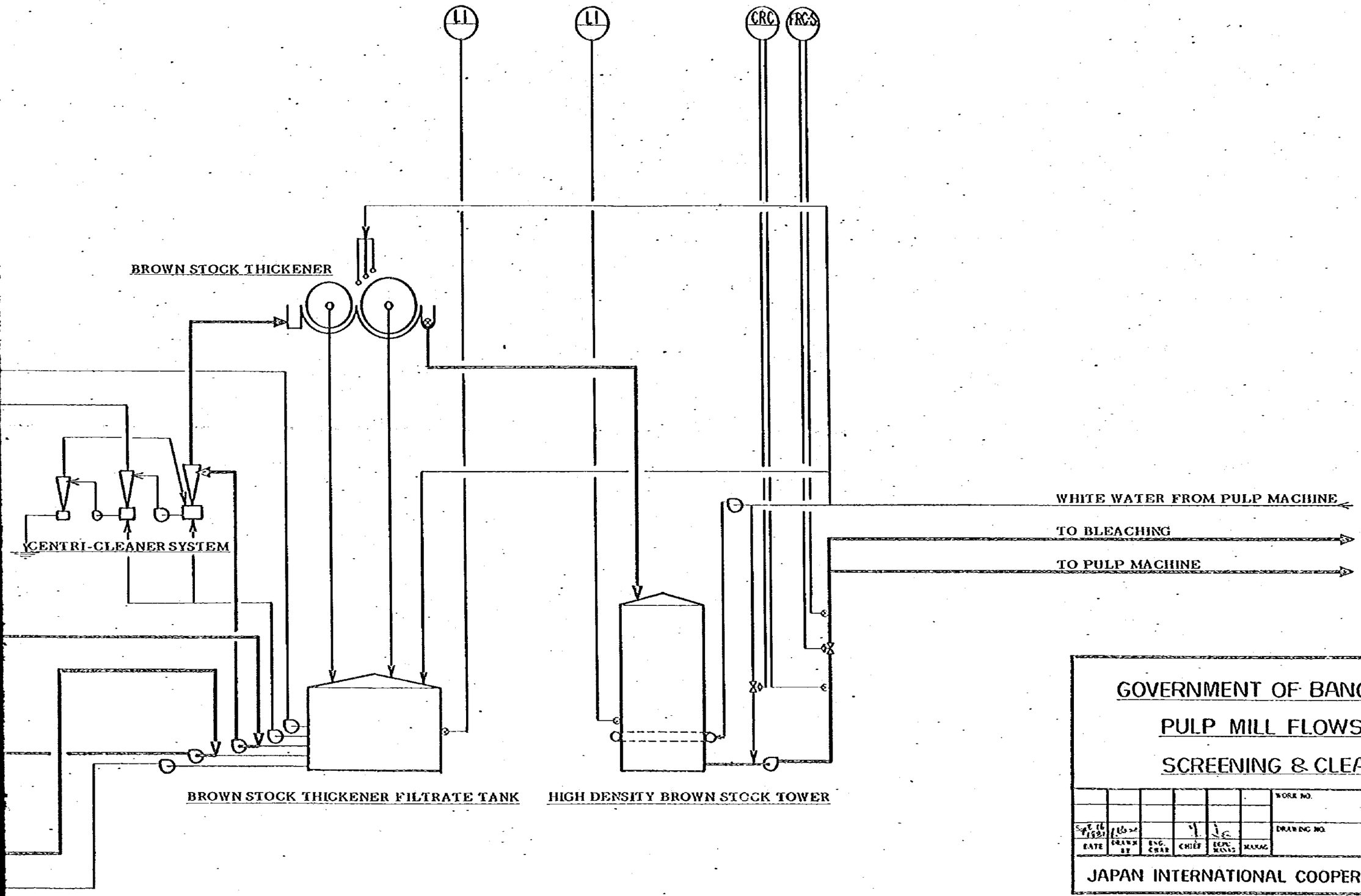

BROWN STOCK THICK
SECONDARY SCREEN
PRIMARY SCREEN
CENTRI-CLEANER SYSTEM
TO WASHED STOCK CHEST
REJECT TANK
SCREENED STOCK TANK
BROWN STOC
FROM BROWN STOCK WASHING
TO BROWN STOCK WASHER



GOVERNMENT OF BANGLADESH

PULP MILL FLOWSHEET

SCREENING & CLEANING

						WORK NO.	CLASSIFICATION
DATE	DRAWN	ENG. CHIEF	CHIEF	DEPT. MANAG.	MANAG.	DRAWING NO.	

JAPAN INTERNATIONAL COOPERATION AGENCY

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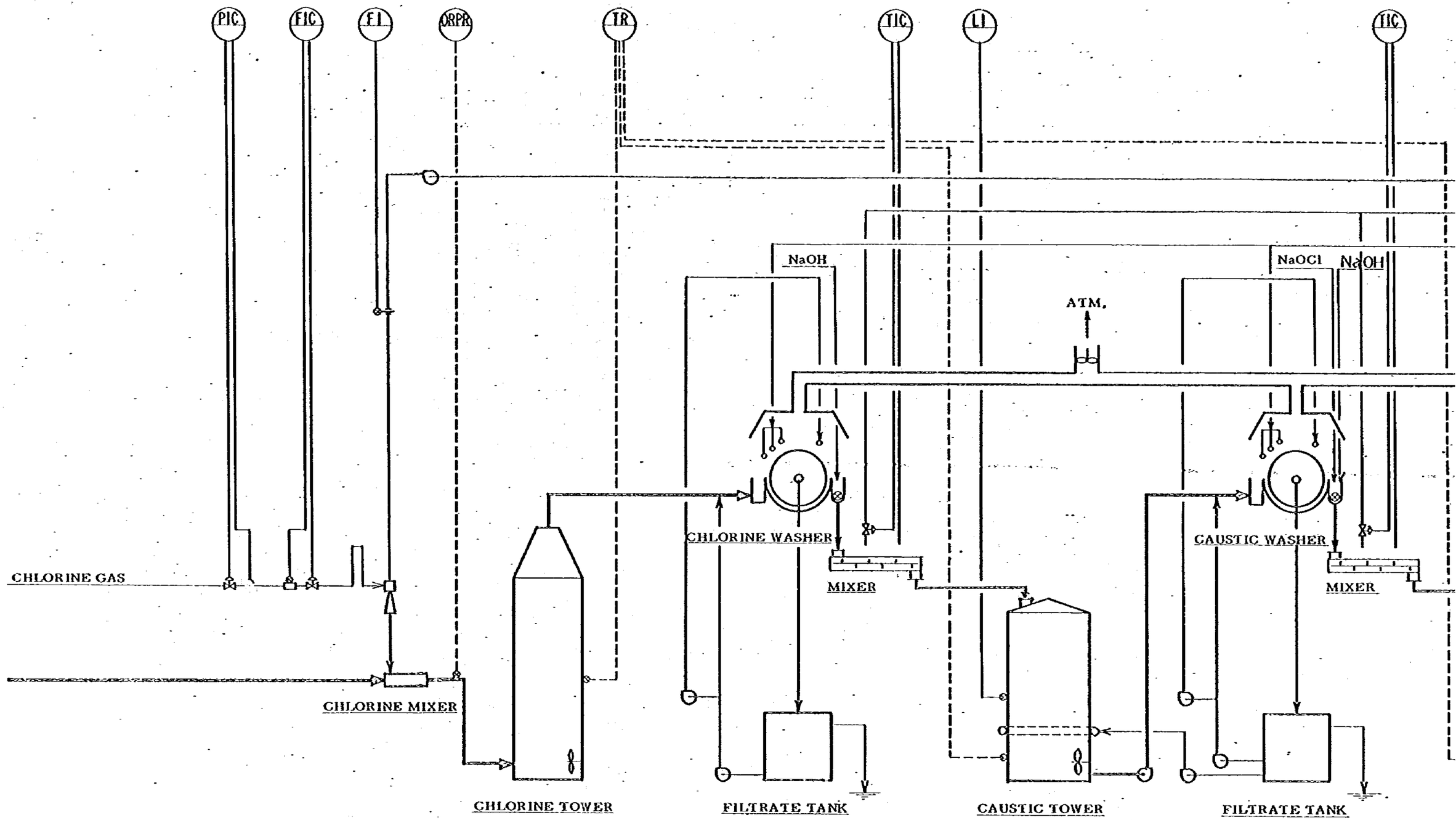

PIC
FIC
FI
ORPR
TR
TIC
LI
TIC
NaOH
NaOCl
NaOH
ATM.
CHLORINE GAS
CHLORINE WASHER
MIXER
CAUSTIC WASHER
MIXER
CHLORINE MIXER
CHLORINE TOWER
FILTRATE TANK
CAUSTIC TOWER
FILTRATE TANK

TIC
LI
LI
CRC
FIS
FRESH WATER
L.P. STEAM
HOT WATER FROM B.S.WASHING
NaOCl
NaOH
CAUSTIC WASHER
MIXER
HYPO.WASHER
TO PULP MACHINE
FILTRATE TANK
HYPO TOWER
FILTRATE TANK
HIGH DENSITY TOWER

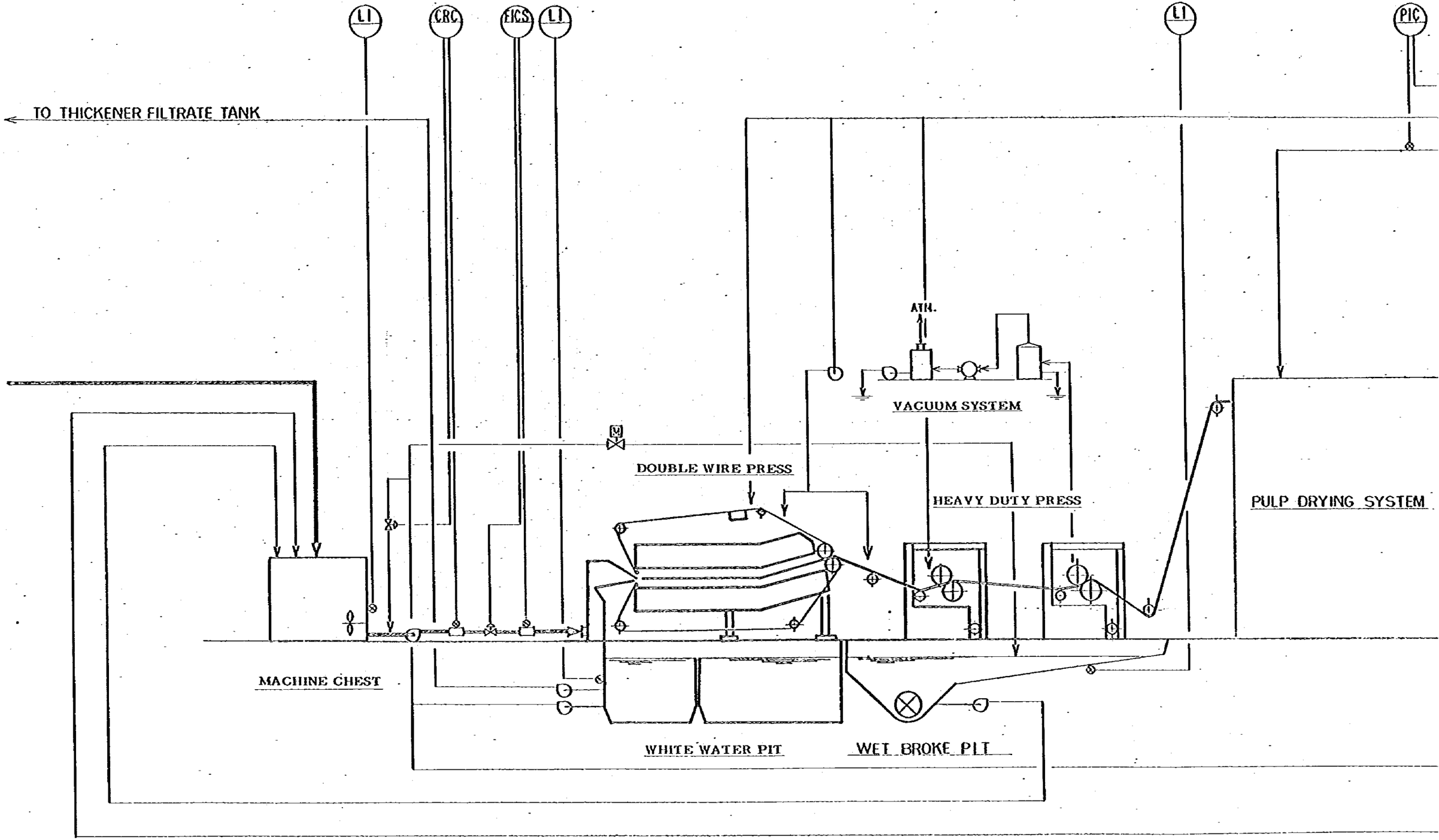
GOVERNMENT OF BANGLADESH

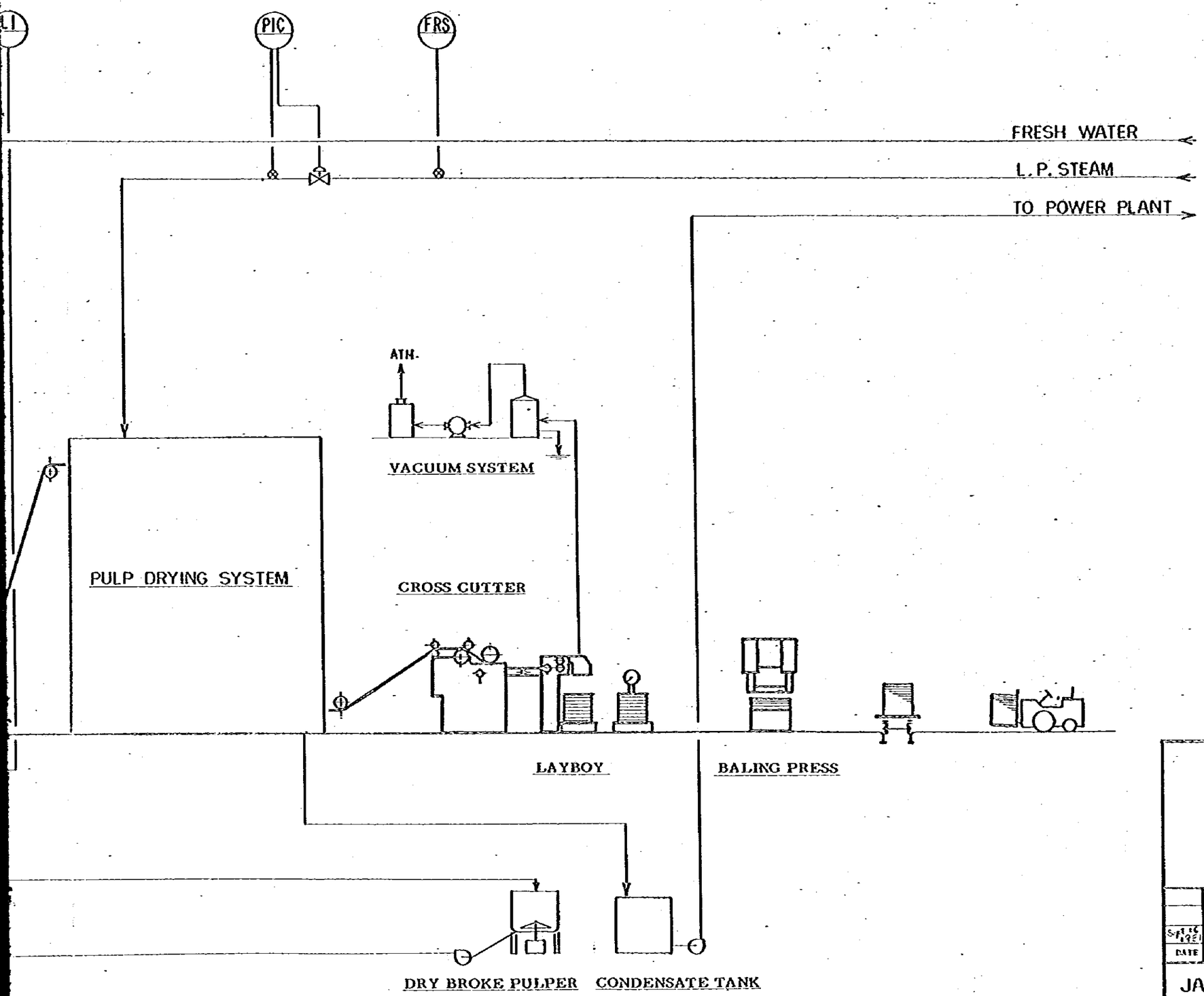
PULP MILL FLOWSHEET

BLEACHING

						ROSE NO.	CLASSIFICATION
DATE	DRAWN BY	ENG. DRAW.	CHIEF	DEPU. MANAG.	MANAG.	DRAWING NO.	

JAPAN INTERNATIONAL COOPERATION AGENCY


LI
CRC
FICS
LI
TO THICKENER FILTRATE TANK
LI
PIC
ATH.
VACUUM SYSTEM
DOUBLE WIRE PRESS
HEAVY DUTY PRESS
PULP DRYING SYSTEM
MACHINE CHEST
WHITE WATER PIT
WET BROKE PIT



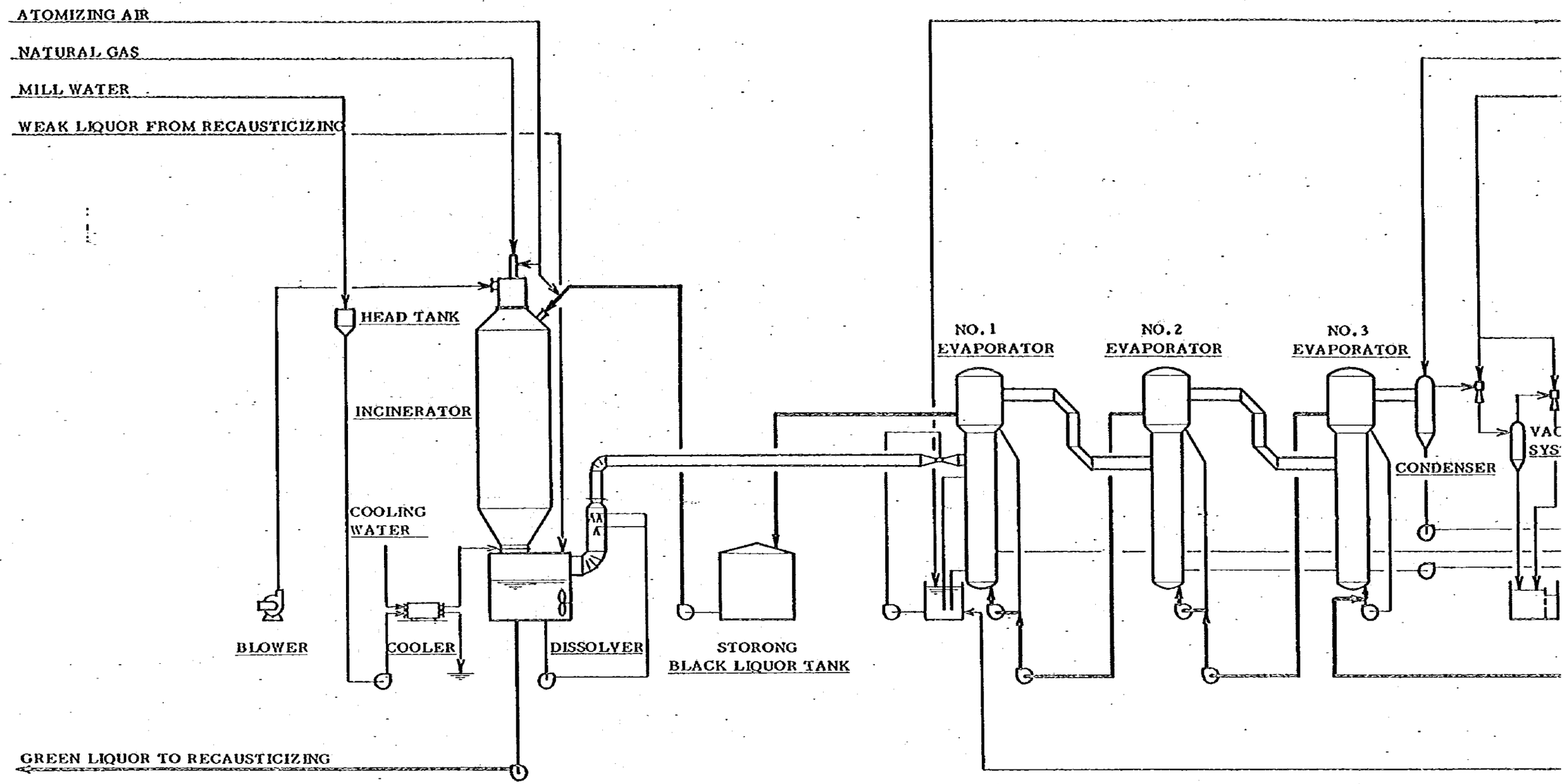
GOVERNMENT OF BANGLADESH

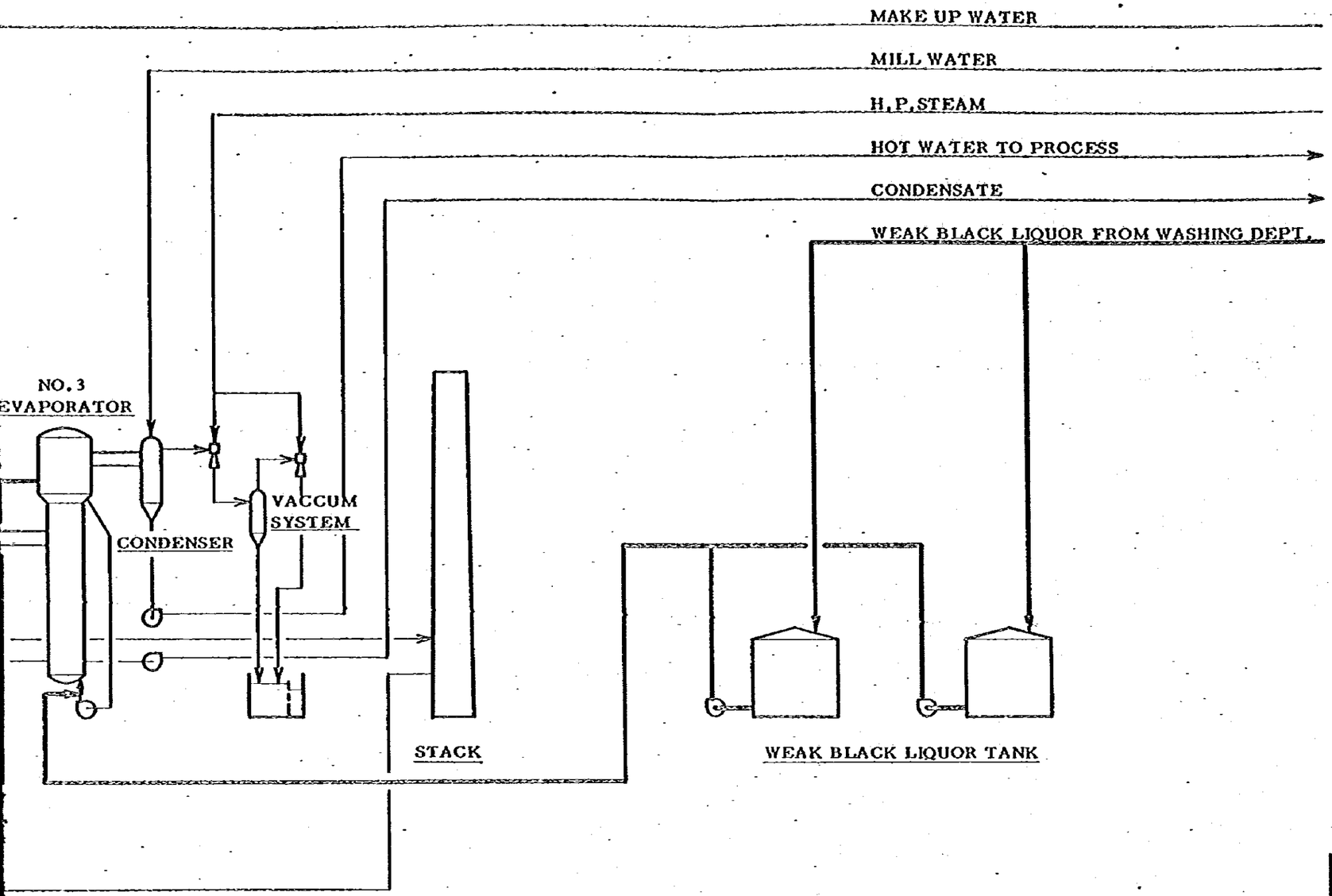
PULP MILL FLOWSHEET

PULP DRYING & FINISHING

						WORK NO.	CLASSIFICATION
						DRAWING NO.	
DATE	DRAWN BY	ENG. CHAR.	CHIEF	SUPV. ENGR.	MANAG.		

JAPAN INTERNATIONAL COOPERATION AGENCY


ATOMIZING AIR
NATURAL GAS
MILL WATER
WEAK LIQUOR FROM RECAUSTICIZING
HEAD TANK
INCINERATOR
COOLING WATER
BLOWER
COOLER
DISSOLVER
STORONG BLACK LIQUOR TANK
NO. 1 EVAPORATOR
NO. 2 EVAPORATOR
NO. 3 EVAPORATOR
CONDENSER
GREEN LIQUOR TO RECAUSTICIZING



GOVERNMENT OF BANGLADESH

PULP MILL FLOWSHEET

BLACK LIQUOR EVAPORATOR
& INCINERATION SYSTEM

						SCALE NO.	CLASSIFICATION
Dec. 19 1991						DRAWING NO.	
DATE	DRAWN BY	ENG CHAR	CHIEF	DEPT MANAGER	MANAG		

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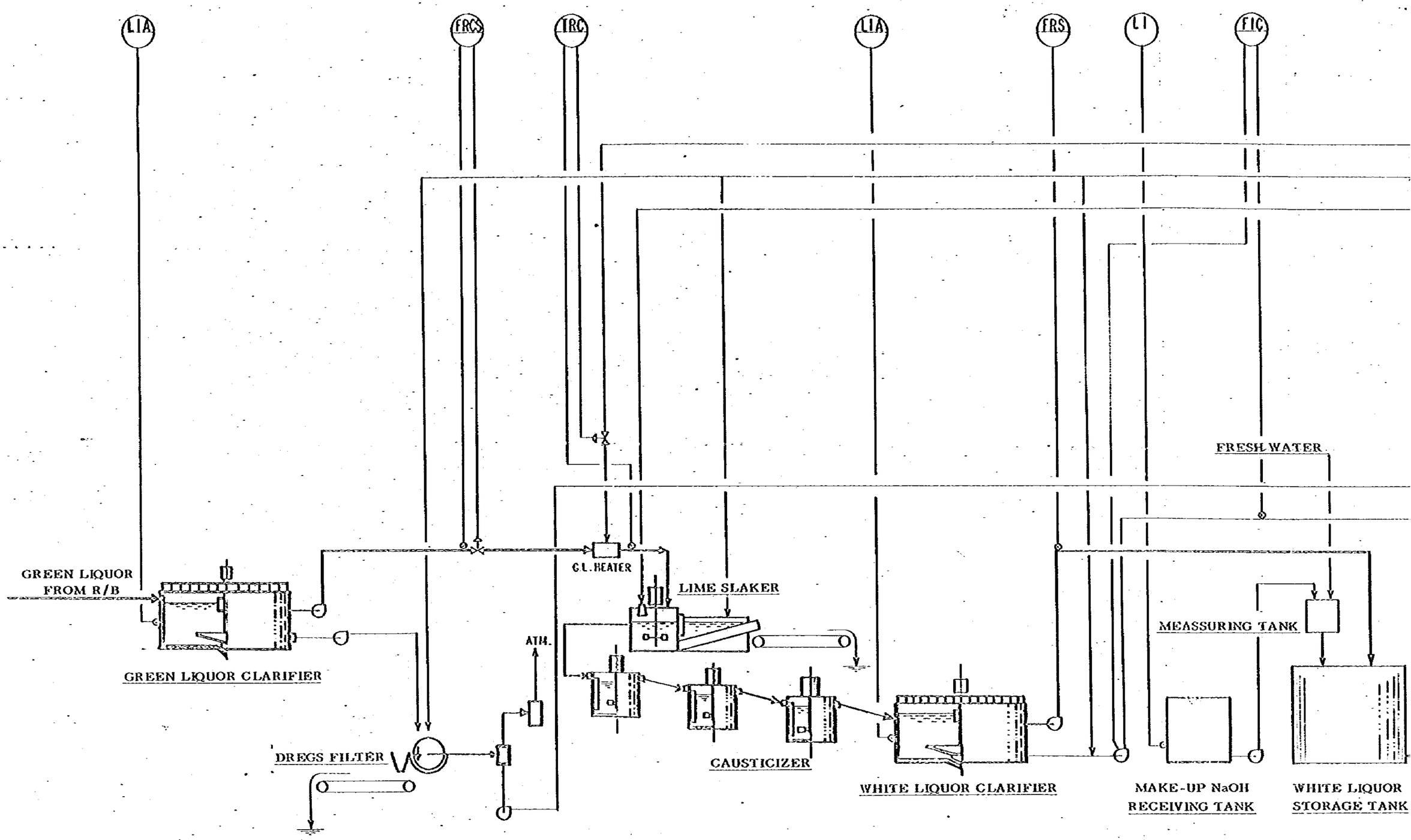
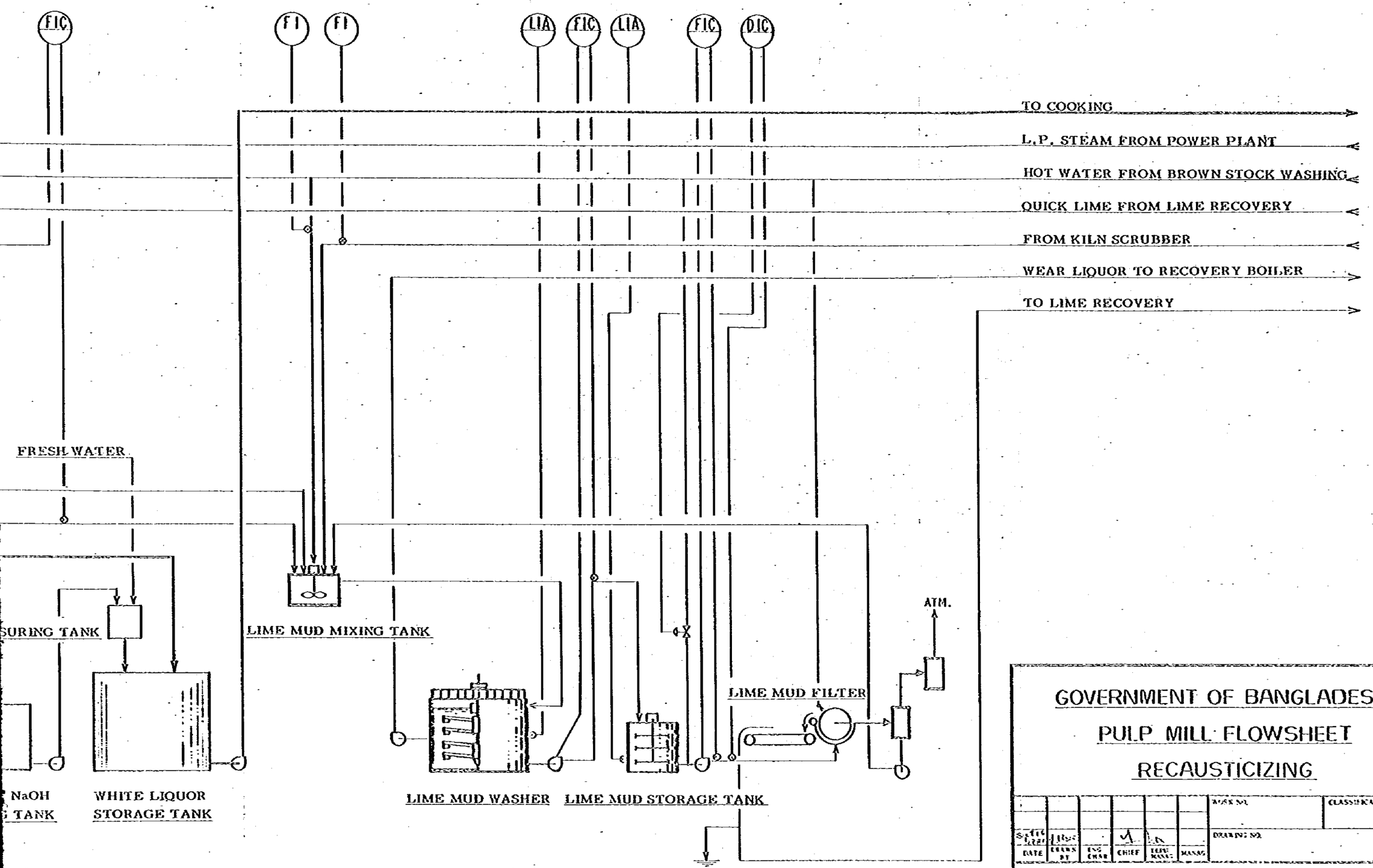

LIA
FRCS
TRC
LIA
FRS
LI
FIC
FRESH WATER
GREEN LIQUOR
FROM R/B
G.L. HEATER
LIME SLAKER
ATM.
GREEN LIQUOR CLARIFIER
DREGS FILTER
CAUSTICIZER
WHITE LIQUOR CLARIFIER
MEASSURING TANK
MAKE-UP NaOH
RECEIVING TANK
WHITE LIQUOR
STORAGE TANK



GOVERNMENT OF BANGLADESH

PULP MILL FLOWSHEET

RECAUSTICIZING

						JOB NO.	CLASSIFICATION
DATE	DRAWN BY	ENG. CHIEF	CHIEF	TEAM LEADER	MANAG.	DRAWING NO.	

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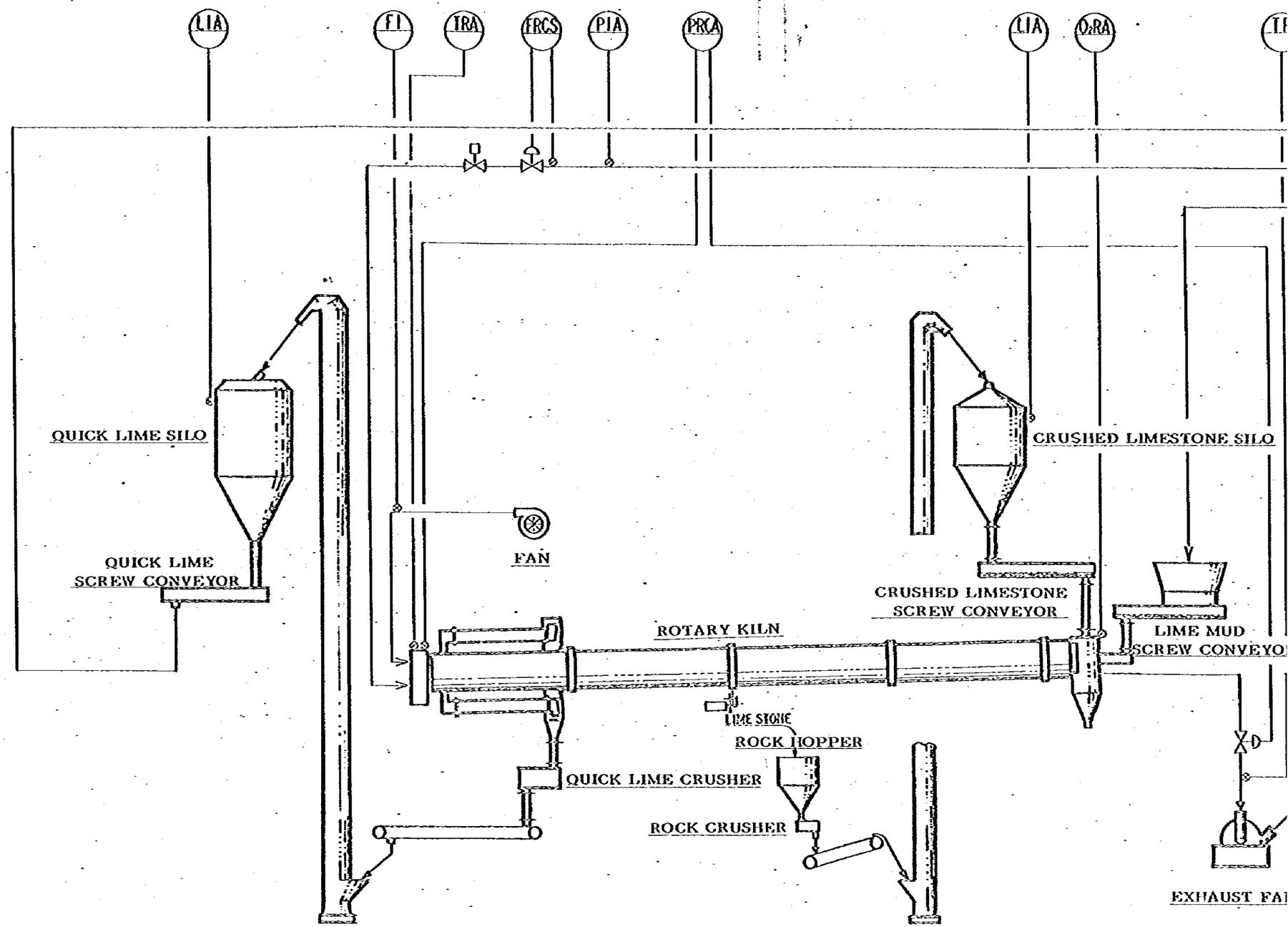
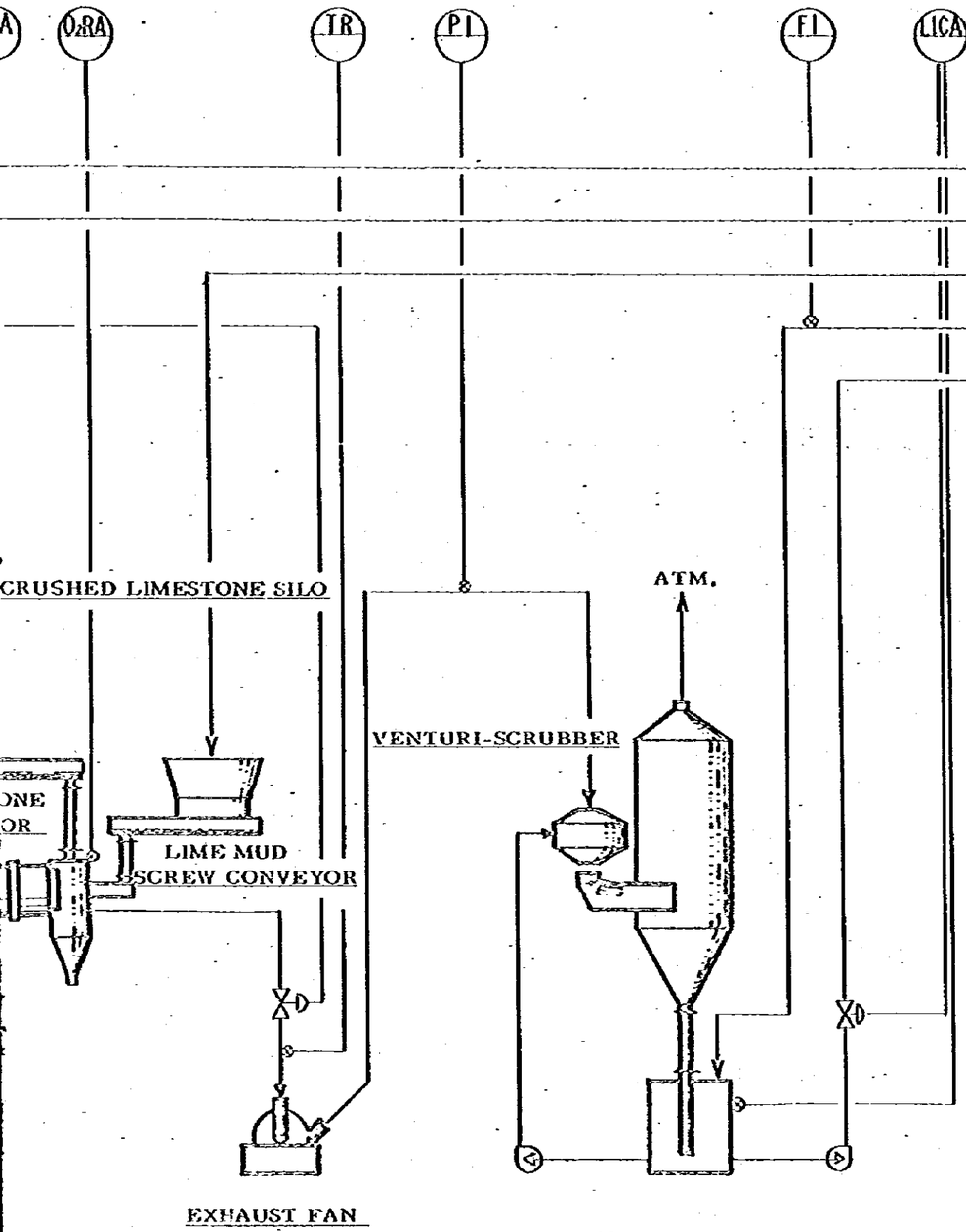

LIA
FI
TRA
ERCS
PIA
PRCA
LIA
O2RA
QUICK LIME SILO
QUICK LIME
SCREW CONVEYOR
FAN
CRUSHED LIMESTONE SILO
CRUSHED LIMESTONE
SCREW CONVEYOR
ROTARY KILN
LIME MUD
SCREW CONVEYOR
LIME STONE
ROCK HOPPER
QUICK LIME CRUSHER
ROCK CRUSHER
EXHAUST FA
QUICK LIME BUCKET ELEVATOR
CRUSHED LIMESTONE BUCKET ELEVATOR



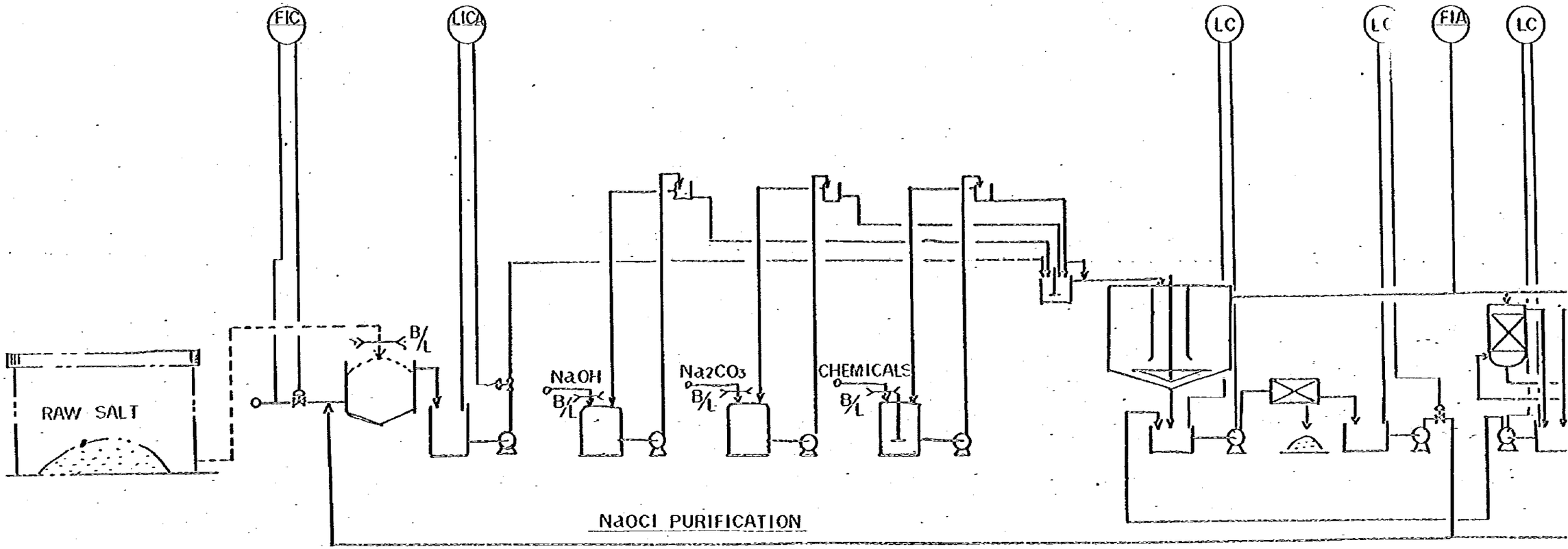
GOVERNMENT OF BANGLADESH

PULP MILL FLOWSHEET

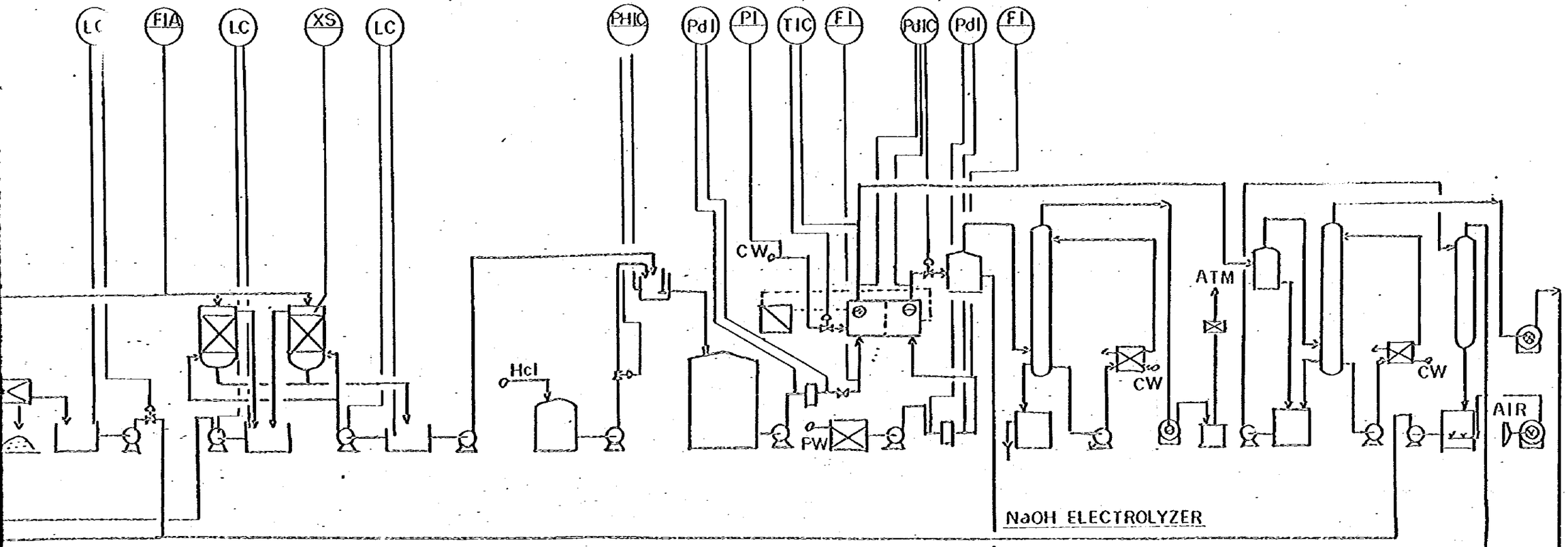
LIME RECOVERY

						WORK NO.	CLASSIFICATION
						DRAWING NO.	
DATE	DRAWN BY	ENG. CHAR	CHIEF	ENGINEER	MANAG		

JAPAN INTERNATIONAL COOPERATION AGENCY



NaOCl PURIFICATION



← TO DEPT.57 BLEACH CHEMICALS PREPARATION (NaOH SOLUTION)

← TO DEPT.57 BLEACH CHEMICALS PREPARATION

← TO DEPT.57 BLEACH CHEMICALS PREPARATION
(Cl_2 WETT GAS)

GOVERNMENT OF BANGLADESH

PULP MILL FLOWSHEET

ELECTROLYSIS

						NOTE NO.	CLASSIFICATION
DATE	DRAWN BY	ENG. CHAR.	CHIEF	DEPT. MANG.	MANAG.	DRAWING NO.	

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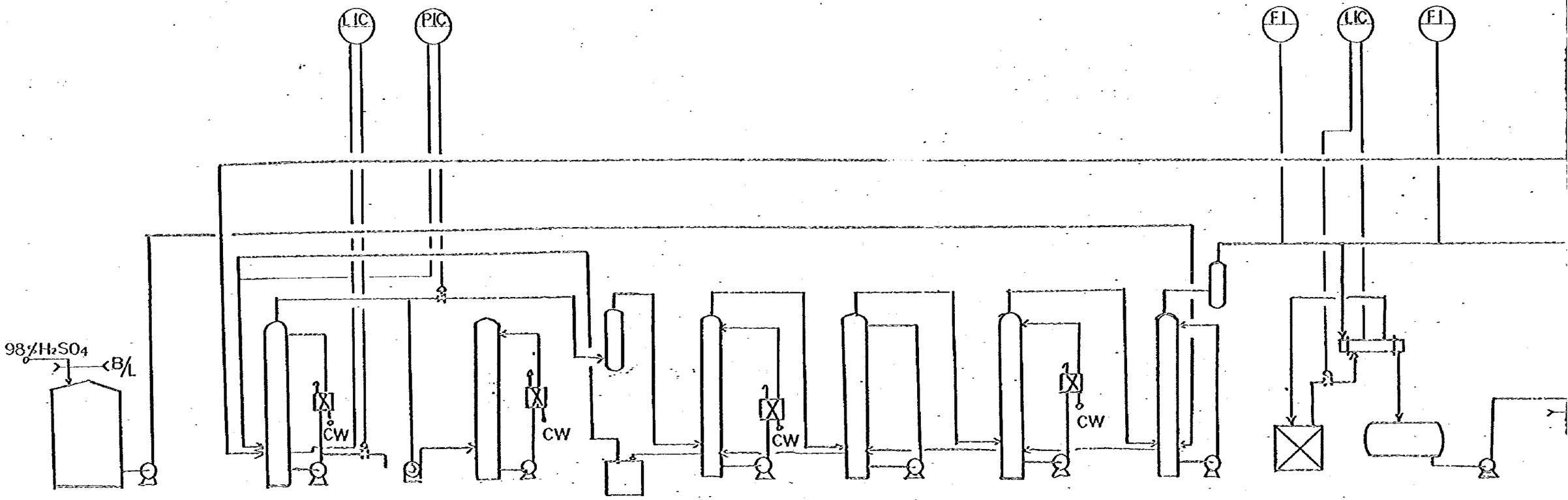
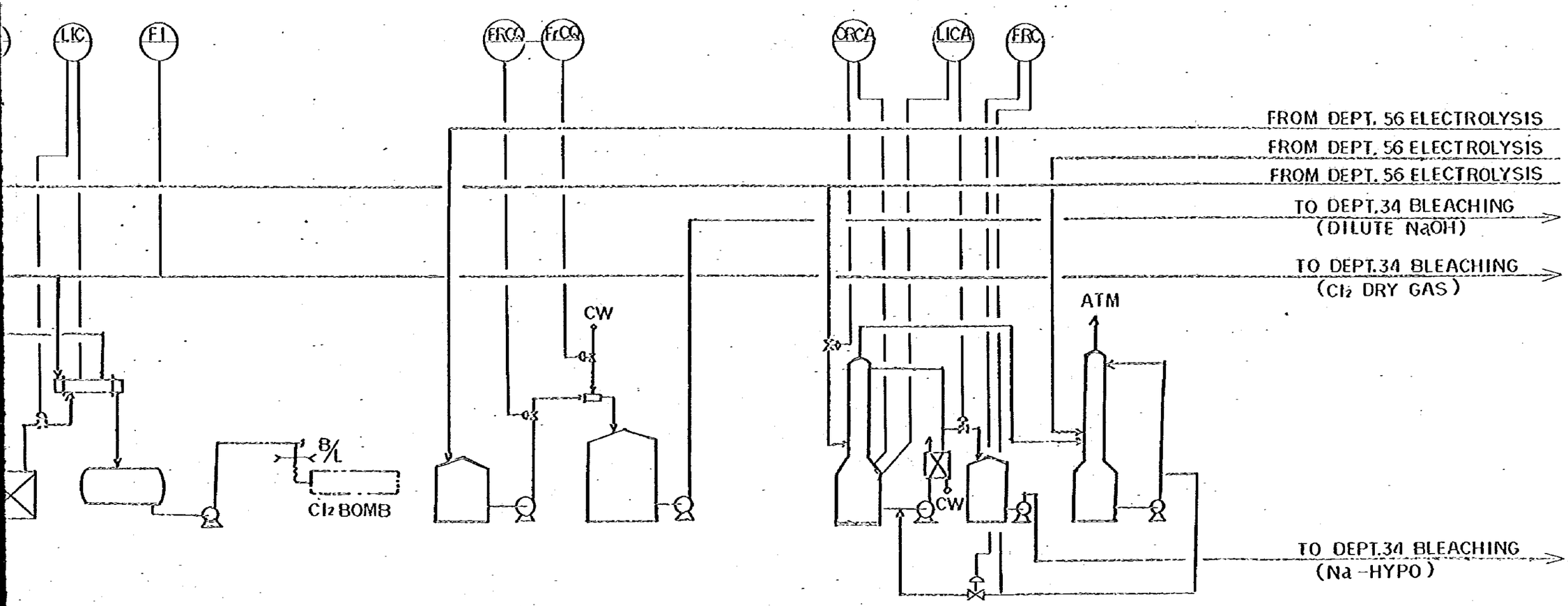


CHLORINE LIQUIDIZING



Na-HYPO PREPARATION

GOVERNMENT OF BANGLADESH

PULP MILL FLOWSHEET

BLEACH CHEMICALS PREPARATION

						DRG. NO.	CLASSIFICATION
DATE	CHKD BY	ENG. CHIEF	CHIEF	DEPT. MANAGER	MANAG.	DRAWING NO.	

JAPAN INTERNATIONAL COOPERATION AGENCY

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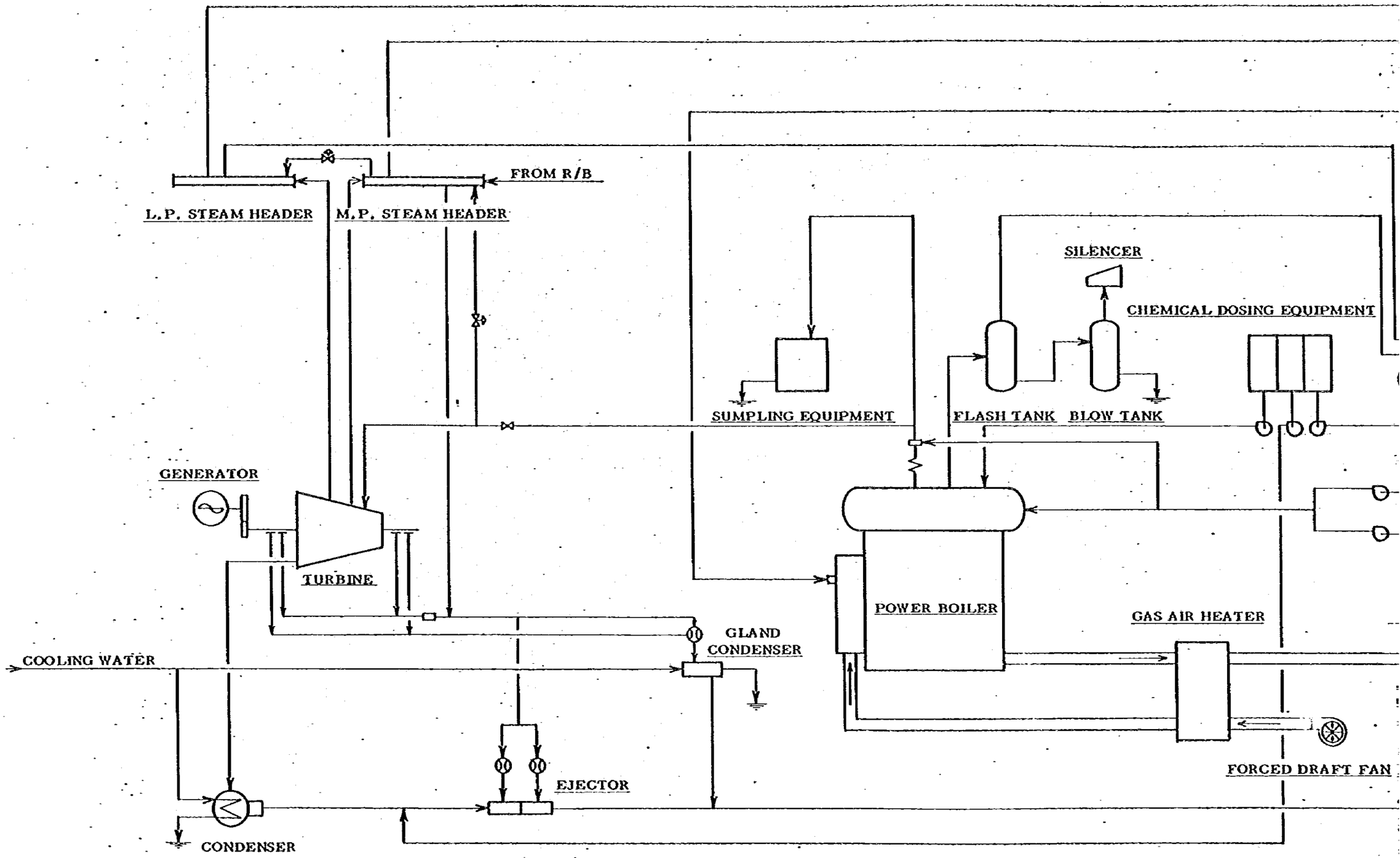
FROM R/B
L.P. STEAM HEADER
M.P. STEAM HEADER
SILENCER
CHEMICAL DOSING EQUIPMENT
SUMPLING EQUIPMENT
FLASH TANK
BLOW TANK
GENERATOR
TURBINE
POWER BOILER
GAS AIR HEATER
GLAND CONDENSER
COOLING WATER
EJECTOR
FORCED DRAFT FAN
CONDENSER

TO PROCESS

TO PROCESS

NATURAL GAS

CONDENSATE FROM PROCESS

FRESH WATER

HEMICAL DOSING EQUIPMENT

DEARETOR

NK

BOILER FEED WATER TANK

DEMINERALIZING SYSTEM

AS AIR HEATER

INDUCED DRAFT FAN

STACK

FORCED DRAFT FAN

GOVERNMENT OF BANGLADESH

PULP MILL FLOWSHEET

POWER PLANT

						WORK NO.	CLASSIFICATION
						DRAWING NO.	
DATE	DRAWN BY	ENG. CHAR.	CHIEF	DEPT. MANAG.	MANAG.		

JAPAN INTERNATIONAL COOPERATION AGENCY

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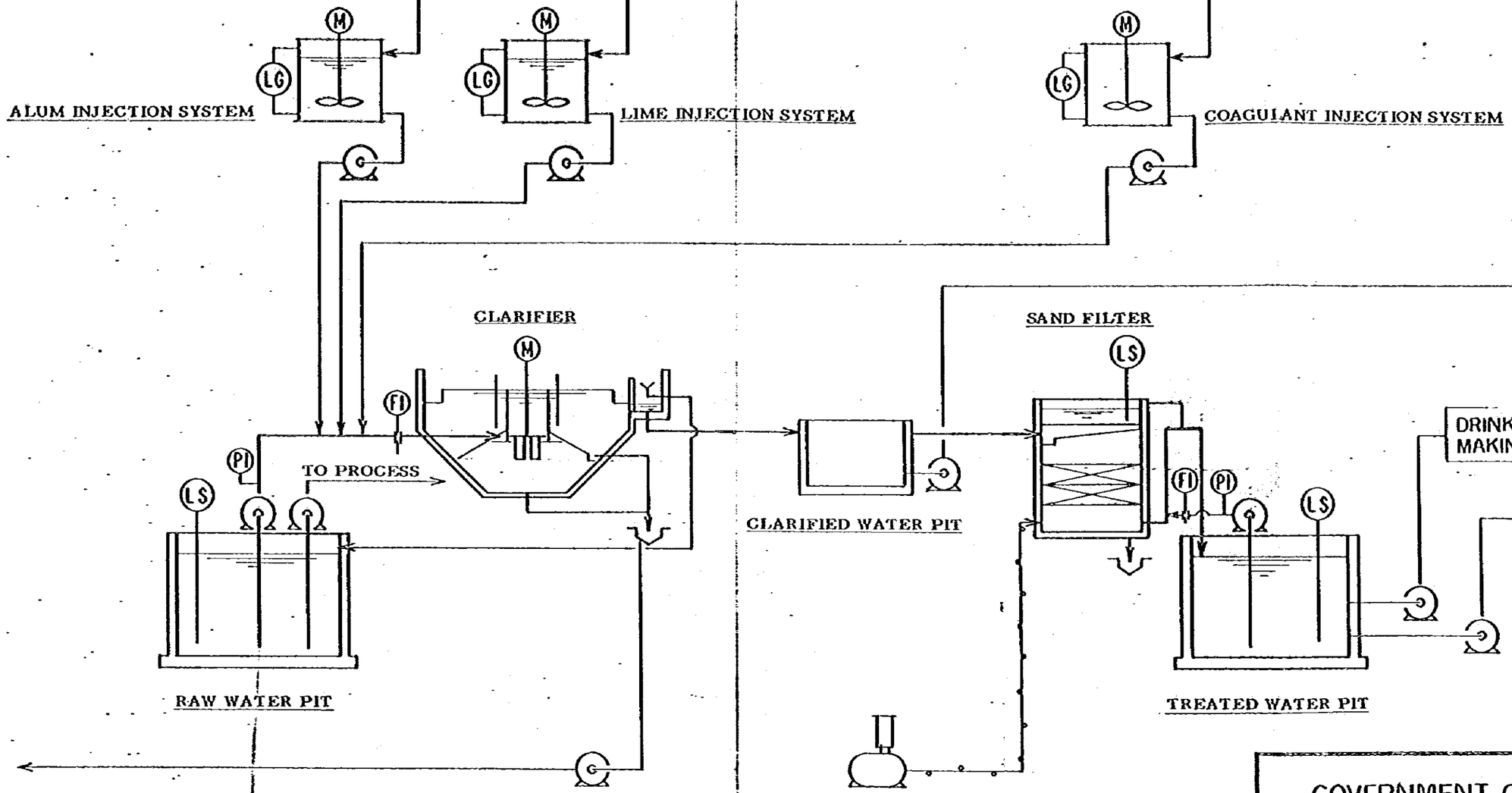


GOVERNMENT OF BANGLADES

PULP MILL FLOWSHEET

WATER SUPPLY

						WORK NO.	CLASSIFIC
						DRAWING NO.	
DATE	DRAWN BY	ENG CHKR	CHIEF	DEPT MANAG	MANAG		

JAPAN INTERNATIONAL COOPERATION A

ALUM INJECTION SYSTEM

LIME INJECTION SYSTEM

COAGULANT INJECTION SYSTEM

CLARIFIER

TO PROCESS

RAW WATER PIT

CLARIFIED WATER PIT

BACK WASH BLOWER

SAND FILTER

DRINKING WATER MAKING SYSTEM

TO PROCESS

TREATED WATER PIT

GOVERNMENT OF BANGLADESH

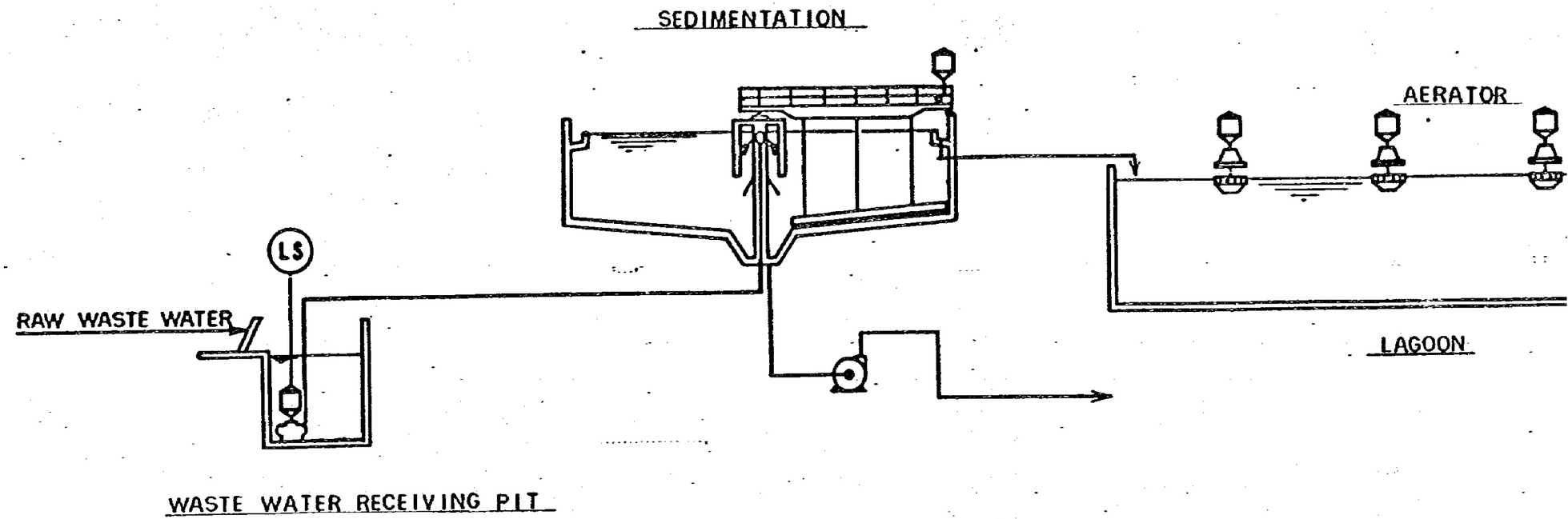
PULP MILL FLOWSHEET

WATER SUPPLY

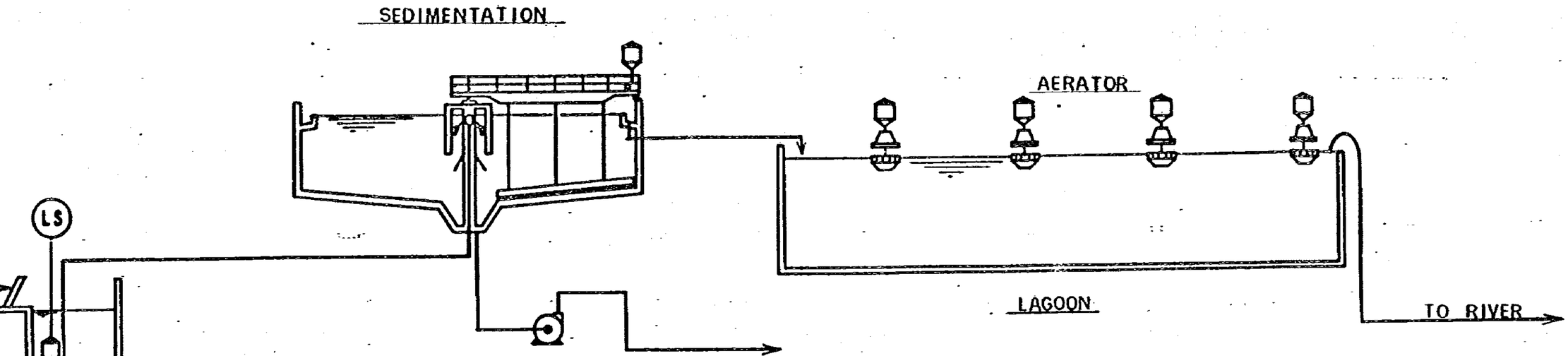
						WORK NO.	CLASSIFICATION
						DRAWING NO.	
DATE	DRAWN BY	ENG CHAR	CHIEF	DEPT MANAG	MANAG		

JAPAN INTERNATIONAL COOPERATION AGENCY

A2



WASTE WATER RECEIVING PIT



GOVERNMENT OF BANGLADESH

PULP MILL FLOWSHEET

EFFLUENT TREATMENT

						WORK NO.	CLASSIFICATION
						DRAWING NO.	
DATE							

JAPAN INTERNATIONAL COOPERATION AGENCY

A2

Chapter 8.

MILL CONSTRUCTION AND OPERATION

Chapter 8. MILL CONSTRUCTION AND OPERATION

8.1 Construction Method

When constructing a plant usually, the main equipments and some parts are imported, and they are assembled, installed, piped and wired at the site. However, the construction schedule of the plant constructed by this method tends to be delayed because of the severe climate in the construction site, uncertain obtainability of the materials and mqchinery, difficulty in collecting skilled workers, insufficient construction machinery, and difficulties of schedule control in developing countries. To solve such problems, the shipbuilding companies in Japan commercialized so-called barge mount method, where the plant is installed on a barge and delivered to the site for installation.

In the survey of this time, the workability in the rain season from April to September and problems during the construction works at the site was studied. As the result, as explained and studied in the appendix, it is proved that the barge mount method is recommendable as the construction method. By employing the barge mount method, the following merits are obtained;

The difficulty in the works during the long rainy season can be avoided.

Schedule control as well as quality control is well performed.

Since the main equipments are manufactured and assembled in technically advanced countries, the high technique can be applied.

After the equipments are installed on the barge, enough inspection and tests can be carried out before shipping to the site.

Since the plant itself is packaged in a complete installation and transported to the site on one platform, instead of being devided into small unit and dozen of shipments as in the conventional method, the customs clearance, inland transportation, storage at the site are performed smoothly and the contingency is less required.

As the result of the above merits, the construction period is shortened, which makes

possible earlier starting of commercial production of pulp.

However, there will be still some works at the site even if the barge mount method is employed. For example, the construction of some equipments on the ground, setting of the barge to the foundation of the site, the connection works between the barge and the equipments on the ground will be necessary. However, when compared with the conventional method, the difficulty and the volume of works to be performed at the site are very little. In addition, number of supervisors to be despatched to the site during construction stage can be minimized.

As explained above, if the barge mount method is employed, the delay factors of the plant construction schedule is removed, and higher quality of the plant can be obtained, and therefore, the troubles during the test run of the plant are limited to the minimum, the operation is started smoothly, and the plant can reach the expected full operation earlier. The plant construction period is, as described in Section 8.6, 36 months from the contract date to the complete installation, and 3 month for the test run, that is, it is possible to start the operation within 39 months.

8.2 Delivery of Equipment

The plant equipment manufactured and assembled at shop will be carefully inspected and tested prior to shipment. The plant equipment are shipped on the sea up to Chittagong Port, customs clearance will be made at this port and the equipment will then be shipped to the mill site along Meghna river.

Although it was judged during the preliminary study that Meghna river permits navigation of barge, detail investigation of water depth, river width, flow velocity and so forth is required for making final judgement. Furthermore, it is necessary to select a season with best weather conditions for shipment of equipment on the sea and on the river.

8.3 Civil Engineering Work and Foundation Work

Details of the foundation ground are not known because geological survey has not yet been executed. It is considered, however, that it will be suitable to adopts pile foundations for principal structures of the pulp mill and to adopt direct foundations for auxiliary structures as judged from the existing exploration data described in Chapter 6.

Cast-in-place concrete piles are mainly used in Bangladesh. These piles are of the maximum length of 30 m, of mean pile diameter of 30 to 60 cm and of the maximum diameter of 100 cm. As large accomplishments on piles of these dimensions are observed, it is judged that the engineering level of local constructors is considerably high. Therefore, it will be possible for local constructors to construct pile foundations of cast-in-place reinforced concrete piles of diameter around 40 cm and length 15 to 20 m (the depth at which bearing stratum is distributed).

For direct foundation method, it is usual in Bangladesh that levelling is made by manual excavation and then reinforced concrete is placed. It is judged that direct foundation will be easily constructed like pile foundations with the engineering level and accomplishments of local constructors. For the earth work, it is necessary to draw up a time schedule considering the rainy season and to plan a technical guidance and execution management system.

8.4 Building Plan

Steel skeleton structure is adopted for the mill building, as large spans are required due to its functions, and sheet metal is used for the roof. Although reinforced concrete structure is partly used, administration building and so forth will be of structures mainly composed of bricks and so forth according to local methods.

8.4.1 Outline of Building Facilities

The planned floor space and structure are shown in Table 8-1.

8.4.2 Structure Plan

1) Truss structure using pipes are used for buildings such as the mill building which require large spans, in order to accomplish weight reduction of materials with workability at site taken into account.

2) Soil bearing capacity foundation is used as much as possible for buildings and machinery. But reinforced concrete piles are used under unavoidable circumstances depending on the building weight, machinery weight or situation of land preparation.

Table 8-1. Buildings

No.	Building or Facility Name	Structure	No. of Stories	Total Floor Space (m^2)
1	Raw Material Storage	Steel	1	21,600
2	Product Warehouse	Steel	1	5,000
3	Pulp Mill	Reinforced concrete	2	4,000
4	Turbine/Generator Room, Evaporator, Boiler, T/G Control Room & Electric Distributon	Reinforced Concrete	2	936
5	Dregs Filter, Mud Filter & Lime Crusher Room	Steel	3	156
6	Recausticizing, Kiln Control Room	Steel	2	288
7	Chemical Preparation Room	Steel	1	432
8	Chlorine Filling Room	Steel	1	432
9	Pump & Water Supply Control Room	Reinforced Concrete	2	300
10	Maintenance & Spare Parts	Steel	1	750
11	Mill Office & Laboratory	Reinforced Concrete	2	900
12	Garage	Steel	1	300
13	Gaurd House	Brick	1	6
14	Guest House	Brick	1	150

3) Seismic force of horizontal seismic coefficient 0.1 and wind force of flow velocity 60 m per second are taken into account as external forces.

8.4.3 Materials to be used

Although steel, roofing materials, steel fittings and so forth will be imported, reinforcing bars, cement, bricks, aggregate and so forth will be locally procured to the most possible extent.

8.4.4 Electrical Facilities

1) Transmission lines running near the site will be extended and led into the site.

2) Substation facility:
A substation equipment will be provided in the site for conversion into the power system required in the mill.

3) Trunk facility:
Facility for distributing necessary power to each building from the substation facility will be provided. Underground cable system will be adopted for safety and appearance.

4) Lighting and receptacle facility:
Illumination and power outlet facility required for each building, each room and outdoors.

8.4.5 Water Supply and Drainage Facilities

1) Water supply:
A deep well will be excavated in the site, water will be pumped out of it with a submerged pump, grit settling will be made in water reservoir, water in the water reservoir will be pumped up to an elevated water tank and is supplied to each building.

2) Water drainage:
Soil water (water out of water closets) will be treated with a septic tank provided for each building before discharge to the side ditch. Miscellaneous sanitary sewage

(water out of wash basins and showers) will be directly discharged to the site ditch. Wastewater from the kitchen will be run through a grease trap before being discharged to the side ditch.

3) Septic tank facilities:
Individual treatment, long time aeration type septic tanks will be used. The tank bodies will be made by cast-in-place reinforced concrete.

8.4.6 Airconditioning and Ventilation Equipment

The office, laboratory and control room for each building will be airconditioned with package type airconditioners.

8.4.7 Lodging

Thirty houses for employees will be constructed on the land adjacent to the mill site. It is planned that they will also be used as the lodging for foreigners during construction of the mill building and equipment erection works.

8.5 Erection Work

Works for construction of temporary facilities such as temporary office and temporary warehouse as well as for provision of power, water, air and so forth required for construction works will be executed prior to commencement of erection of plant equipment.

It is necessary that related mill buildings and foundation works are completed by the time of beginning of erection work. In addition, machinery and vehicles for construction, work materials and consumables should be prepared in advance.

It has been found out as a result of the study made this time that machinery and vehicles for construction can be prepared in Bangladesh to a considerable extent. Therefore, planning should be made to temporarily bring in only the machinery and special equipment and tools requried for erection which are not available in the country from outside of the country and to re-export them after completion of works, with availability in the country carefully checked out of those possessed by the customer and those which may be diverted from other projects.

Manpower of a large volume, both skilled and unskilled, is required during the period of works. There is no problem regarding employment of unskilled workers, because availability of unskilled workers is sufficient in Bangladesh. However, it is necessary to employ foreigners to make up lack of skilled workers and also as administration staff, work supervisors, engineering instructors and so forth including a site manager for management and guidance for execution of works.

Erection of equipment will be completed in a period of 34 months after conclusion of contract, and completion of work and take-over of the mill will be accomplished in a period of 36 months after adjustments, tests and no load running, as shown in the implementation program indicated in Section 8.6.

8.6 Implementation Programme

The time up to the commencement of production from investment decision is included in the period of implementation of the project. Main stages such as conclusion of contract, design, manufacture, works at site and trial running are included in this period. Stages such as purchase of land, land preparation, civil engineering and construction works, employment and training of mill workers, and preparation for operation such as arrangement of feed and chemicals also require progress in the mean time, before commencement of production.

The implementation program for this project is shown in Fig. 8-1. Construction of the plant will be accomplished in 36 months after signing of contract until completion of works at site. After a period of trial operation of three months on completion of works, it will become possible to commence the mill operation in the 40th month.

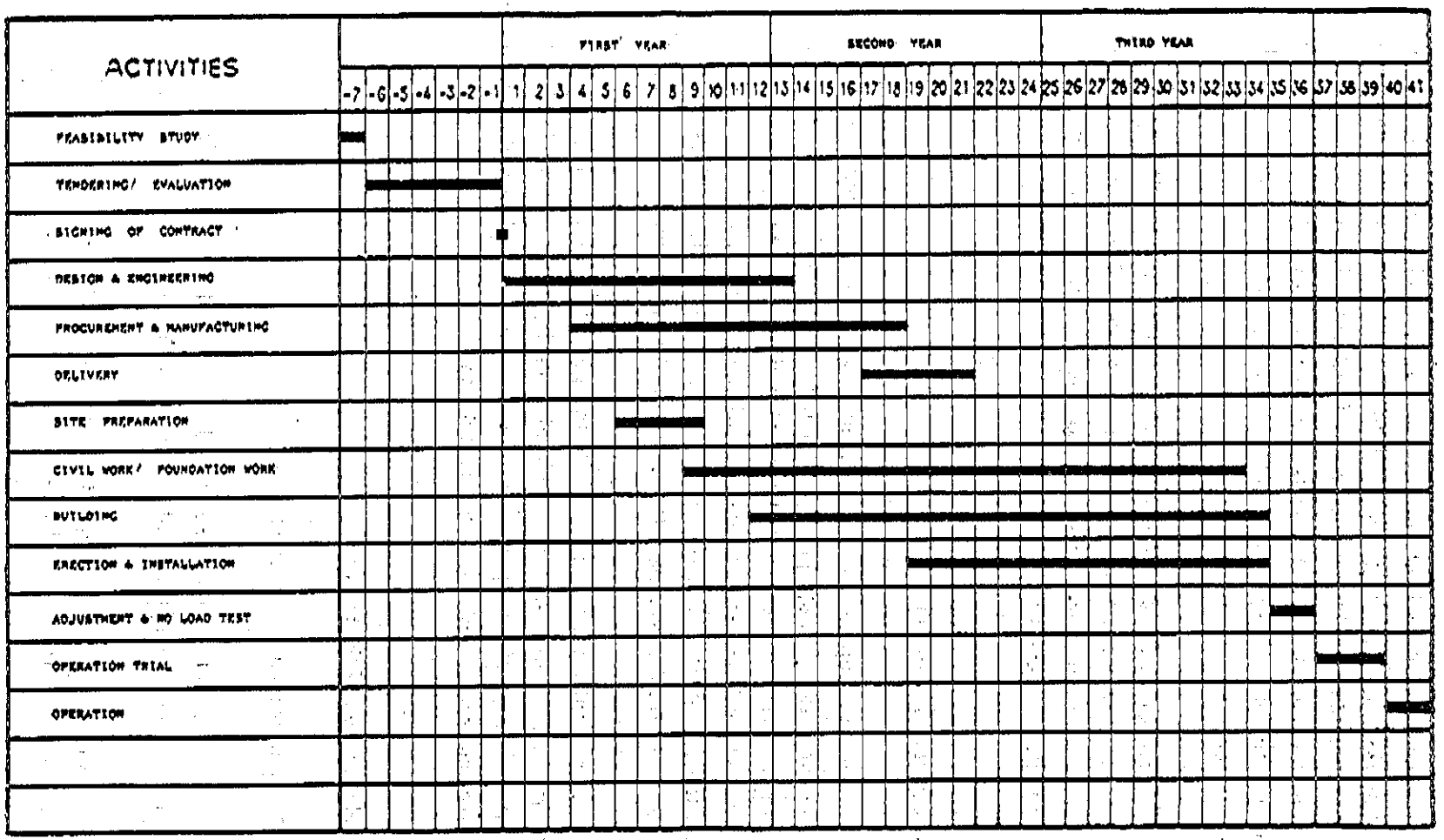
8.7 Impelmentation of the Project

8.7.1 Implementation Structure

This project is promoted and implemented by BCIC, which is one of public corporations under the supervision of the Minstry of Industry (MOI).

BCIC is a government operated public corporation that manages 28 mills including pulp and paper mills. It was established in 1976 through merger of three public corporations

Fig. 8-1. Implementation Program



(Bangladesh Fertilizer Chemical & Pharmaceutical Corporation, Bangladesh Paper and Board Corporation and Bangladesh Tanneries Corporation).

The Planning Commission acts as the organ for inspection of this project, and the External Resources Division under the control of the Ministry of Finance acts as the organ for procurement of foreign currency for implementation of the project.

8.7.2 Financing Plan

The following program was indicated by BCIC regarding raising of investment funds for implementation of this project.

1) Debt/Equity ratio

40% from equity
60% from long-term loan

2) Long-term loan borrowing conditions

Interest rate:	11.5% per annum
Repayment:	10 year/10 installments Repayment of principal by fixed installments
Period in which repayment of principal is exempt:	3 years after commencement of operation

3) Short-term loan borrowing conditions

Interest rate:	15.0% per annum

8.7.3 Form of Contract

The form of contract of this project is turn key basis.

8.8 Scope of Project

The scope of the mill equipment and construction is limited to inside of the fence of the mill site. In other words, design, manufacture, supply and construction of all articles inside of the fence will be made.

8.8.1 Land Preparation

Purchase of land and preparation of the purchased land will be made. The selected mill site will be divided into the plant area and the residential area. The land in the mill area will be banked so that its reference point is of a height that is higher by 3 m than the highest water level in the river during the rainy season, and embankment work will be executed along the river.

8.8.2 Civil Engineering Works

The following works are involved inside of the mill fence only.

- Gates and fence
- Roads and drain ditches in the site
- Jetty
- Foundation works for outdoor facilities and equipment
- Foundation works for buildings
- Concrete structures (chests, pits, etc.)
- Water intake work
- Lagoon for wastewater treatment

8.8.3 Building Works

Besides construction of building inside of the mill fence, auxiliary equipment such as airconditioning equipment, lighting fixtures and sanitary installations are included, and in addition, foundation works for indoor facilities and equipment are also included.

The main buildings are as follows:

- Raw material storage
- Product warehouse
- Pulp mill

- Chemicals recovery process control room
- Power plant
- Chemical preparation plant
- Pump room & water treatment control room
- Wastewater treatment control room
- Maintenance workshop and spare parts warehouse
- Office and laboratory
- Houses

8.8.4 Erection & Installation Works

Unloading, storage, hauling in the site, erection and installation of the machinery equipment and materials brought into the mill site will be executed.

The following works are also included:

- Piping work
- Electrical work
- Instrumentation work
- Heat insulation work
- Printing work

8.8.5 Machinery & Equipment

All the machinery and equipment will be brought to the mill site after the stages of design, manufacture, inspection, packaging and transportation. Marine transportation, customs clearance for entry into Bangladesh and domestic transportation (mainly by making use of rivers) are also included for imported articles.

The scope of supply of machinery and equipment is as follows as classified by process and purpose of use:

- Raw material handling equipment
- Cooking equipment
- Washing, screening and cleaning
- Bleaching equipment
- Sheet making & finishing equipment

- Chemical recovery equipment
- Power generation equipment
- Power receiving and distributing equipment
- Electrical & instrumentation equipment
- Chemical preparation equipment
- Mill water treatment equipment
- Wastewater treating equipment
- Compressed air supplying equipment
- Outdoor piping
- Machinery maintenance equipment
- Laboratory equipment
- Motor vehicles used in the site
- Fire fighting equipment
- Intra-office telephone equipment
- Emergency medical care equipment
- Equipment for clerical work

8.8.6 Consulting Works

The following works are also involved for promotion and implementation of the project, and the expenses required for these works are included as preoperation cost in the total investment cost (Chapter 9).

1) Survey and investigation

Final survey and investigation will be made based on the result of this feasibility study. The detail survey of the site will be the main object of this survey.

2) Tender, evaluation and contract

Draw-up of tender specification, evaluation of bid documents, signing of contract and so forth are involved.

3) Implementation of project

Consultation for implementation of the project is involved after signing of the contract.

4) Employment and training

Training of mill personnel such as mill operators is required. Twenty (20) local mill personnel mainly composed of mill operators will be trained outside of the country for a period of six (6) months for this project. Furthermore, mill personnel will be employed and will receive field training on the mill prior to commencement of operation.

5) Start-up

Test trial of a period of three (3) months is scheduled for this project. Trial running instructors from outside of the country will give instructions to local operators in this period. The number of instructors to be dispatched from outside of the country is planned as ten (10) persons.

8.8.7 Working Capital

The following should be included in the working capital for the mill.

1)	Accounts receivable:	One-month value of annual sales
2)	Product inventory:	One-month value of the volume sold per year
3)	Spare parts:	One-year volume
4)	Raw materials:	One-month volume
5)	Industrial salt:	One-month volume
6)	Limestone:	One-month volume
7)	Chemicals:	Three-months volume
8)	Auxiliary materials:	Three-months volume
9)	Accounts payable:	One-month value
10)	Cash:	Two-months value of fixed operating cost

Spare parts required for operation for one year as well as cash of a value equivalent to the working capital excluding spare parts are required as the initial working capital to be prepared prior to commencement of oepration.

8.9 Mill Operation

Manpower, main raw material, auxiliary raw materials and utilities are required for operation of a pulp mill. It is expected that employment of workers is easy because manpower availability is good in Bangladesh. However, workers should include those who have specialized knowledge and sufficient experience. Required auxiliary materials are industrial chemicals used for cooking and bleaching in pulping processes. As the main raw material, that is, jute cuttings, was already described in Chapter 3. Manpower, auxilairy raw materials and utilities will be described in this chapter.

8.9.1 Manpower

1) Present situation

Bangaldesh is one of the leading counntries in the southwest Asia in which pulp and paper industries have made development. Approximately 9,000 persons are engaged in pulp and paper industries at the present time. The number of employees of main mills are as follows:

- Karnaphuli Paper Mill 3,550
- Khulna Newsprint Mill 2,350
- Sylhet Pulp and Paper Mill 1,200
- North Bengal Paper Mill 840

Almost all the equipment are made outside of the country, and many of them are from West Germany and Scandinavian countries. But they are operated only by Bangladesh workers. Unskilled workers are available in abundance in Bangladesh and there is no problem for employment. Particularly in and around cities such as Dacca and Chittagong, manpower is abundant and there is no fear of occurrence of shortage. Sending of skilled workers to Middle East for work is conspicuous these days and it is said skilled workers are insufficient in Bangladesh. Accordingly, it is said reduction of engineering capacity in the country has become a problem.

Qualified operators of a specified number having experience are required for operation of a pulp and paper mill. Although skilled workers of this kind are working at existing mills in Bangladesh, it is considered that their absolute number is insufficient when a new mill is constructed. Accordingly, it is necessary to improve the skill of workers through training. It is also important to carry out guidance and training during construction and test run period under supervisions of specialists dispatched from the contractor and consulting company during construction of the mill and test run of the plant.

2) Grades

The grades and present monthly salaries of pulp and paper mill workers in Bangladesh are as follows:

Grade	Monthly salary (Tk.)	Class
I	3,000	Mill superintendent
II	3,000	Chief engineer
III	2,500	Division manager
IV	1,800	Officer, section manager
V	1,000	Assistant engineer
VI	800	Foreman
VII	650	Mechanic
VIII	500	Operator, welder
IX	350	Assistant operator
X	300	Miscellaneous worker, peon

3) Number of required workers

The organization and personnel plan for this pulp mill are shown in Table 8-2. The number of persons required as classified by grade can be totalled as follows:

Table 8-2. Organization and Personnel Plan

			Personnel plan						
		Grade	IV	V	VI	VII	VIII	IX	X
Mill Superintendent	Administration Div.	General Affairs & Personnel Sec.	1	2	3	5	8	7	30
		Accounting Sec.	1	2	3	3	0	0	0
		Material Sec.	1	2	3	3	0	0	0
		Sales Sec.	1	2	3	3	0	0	0
	Engineering Maintenance Div.	Laboratory	1	2	3	4	9	0	8
		Engineering & Maintenance Sec.	1	7	0	20	22	0	10
	Production Div.	Pulp Process Sec.	1	5	14	25	65	58	234
		Raw Material Dept.		(1)	(2)	(4)	(12)	(6)	(130)
		Cooking & Washing Dept.		(1)	(4)	(4)	(8)	(8)	(16)
		Screening & Bleaching Dept.		(1)	(2)	(2)	(8)	(8)	(16)
		Sheet Making & Finishing Dept.		(1)	(4)	(12)	(28)	(28)	(40)
		Chemical Preparation Dept.		(1)	(2)	(2)	(8)	(8)	(32)
		Power & Utility Sec.	1	5	20	21	33	52	100
		Evaporation Dept.		(1)	(4)	(4)	(4)	(8)	(16)
		Recausticizing Dept.		(1)	(4)	(4)	(8)	(12)	(24)
		Boiler Dept.		(1)	(4)	(4)	(8)	(12)	(20)
		Power Dept.		(1)	(4)	(4)	(4)	(8)	(16)
		Water Supply & Waste Water Treatment Dept.		(1)	(4)	(4)	(8)	(12)	(24)

Grade	Department			Total
	Administration	Laboratory & Engineering	Production	
I	1	0	0	1
II	1	0	0	1
III	2	0	0	2
IV	4	2	2	8
V	8	9	10	27
VI	12	3	34	49
VII	14	24	46	84
VIII	8	31	98	137
IX	7	0	110	117
X	30	18	334	382
Total	87	87	634	808

8.9.2 Auxiliary Raw Materials

1) Industrial salt

Industrial salt is a raw material for manufacturing caustic soda and chlorine consumed in the pulping process. Sodium hypochlorite for bleaching is produced through reaction of manufactured caustic soda and chlorine.

- o Caustic soda

Caustic soda is used for replenishment of cooking chemical and for bleaching pulp, and is also used as a raw material for sodium hypochlorite. It is also used by a small quantity for water treatment, waste water treatment, boiler feed water treating chemical.

- For replenishment of cooking chemical:
  When the rate of addition of caustic soda is assumed as 16% of the bone dry raw material jute cuttings, caustic soda of 272 kg is required for producing one air-dried ton of bleached pulp. As this caustic soda is recovered by 90% replenishment of 10% that is, caustic soda of 27.2 kg is required.

– For bleaching of pulp:
When the rate of addition of caustic soda in the bleaching process is assumed as 2.5% of the bone dry unbleached pulp and when the weight of the unbleached pulp required per one air-dried ton of bleached pulp is 0.98 ton in bone dry weight, caustic soda of 24.5 kg is required for producing one air-dried ton of bleached pulp.

– For producing of sodium hypochlorite:
When the rate of addition of sodium hypochlorite in the bleaching process is assumed as 2.5% (as effective chlorine) of bone dry unbleached pulp, sodium hypochlorite of 24.5 kg (as effective chlorine) is required like the case of the preceding paragraph. The weight of caustic soda required for producing sodium hypochlorite of this weight is 27.6 kg. With caustic soda of a small bolume used for water treatment, etc. added to the weight calculated above, the total weight of caustic soda required for the mill is about 80 kg per one air-dried ton of bleached pulp.

o Chlorine

Chlorine is used for bleaching of pulp and for producing sodium hypochlorite. Besides, a small volume is used for sterilization at the time of manufacture of potable water. Its main consumption is as follows.

– For bleaching pulp:
When the rate of addition of chlorine in the bleaching process is assumed as 5% of bone dry unbleached pulp, chlorine of 49 kg is required for manufacturing one air-dried ton of bleached pulp.

– For producing sodium hypochlorite:
The required weight of sodium hypochlorite is 24.5 kg, as effective chlorine, per one air-dried ton of bleached pulp as described earlier, and the weight of chlorine required for producing it is 24.5 kg. With chlorine of a small volume used for treatment of potable water added to the weight calculated above, the total weight of chlorine required for the mill is 74 kg per one air-dired ton of bleached pulp.

o Price and required volume of industrial salt

Caustic soda of 80 kg and chlorine of 74 kg are required for the process as unit consumption as described earlier. The chemical composition of the industrial salt which can be

procured in Bangladesh is as shown in Table 8-3 according to the result of the study made this time.

Its domestic sales price at the present time is Tk. 1,000 per ton (ex-factory).

Table 8-3. Chemical Composition of Industrial Salt

	(Weight %)
NaCl	94.61
KCl	0.31
$CaSO_4$	0.28
$MgSO_4$	0.95
$MgCl_2$	1.20
Insolubles	2.83

When calculation is made based on the result of chemical composition analysis of the industrial salt available in Bangladesh, locally produced industrial salt of about 120 kg is required per one air-dried ton of product pulp.

2) Quinone

Quinone is used as an auxiliary for cooking chemicals, and its rate of addition is 0.05% of bone dry raw material, that is, 0.85 kg per one air-dried ton of bleached pulp. As this chemical is not manufactured in Bangladesh, it should be imported.

3) Limestone

Limestone is used as the material for lime used in the recausticizing plant. The lime slurry produced as a result of reacausticizing reaction is burned in a kiln, and is regenerated and recovered as quick lime.

Limestone is used for replenishing the loss of lime which occurs in this recovery cycle. This replenishing rate is 50 to 60 kg per ton of air-dried pulp with sulphate pulp in general, but it is slightly larger for soda pulp, and the unit consumption is estimated as about 90 kg in this project.

Besides domestically produced limestone, limestone imported from India is also used at existing pulp and paper mills in Bangladesh. As a result of the study made this time, it was found out that limestone imported from India is used by a large quantity, its purity is around 90 to 92% and its sales price in Bangladesh at the present time is Tk. 1,400 per ton (ex. factory). When its purity is taken into account, the required weight is about 100 kg as unit consumption.

4) Other chemicals

Besides the chemicals described above, chemicals of many kinds are consumed including flocculant for water treatment, pH control chemicals for waste water treatment, chemicals for boiler feed water treatment, cleaning chemicals for boiler, and auxiliary chemicals used for electrolysis equipment. But their annual consumption is of a minor quantity.

The required cost of chemicals (including quinone) excluding industrial salt and limestone at the present time is assumed as USD 1.7 per ton of air-dried pulp.

8.9.3 Utilities

1) Mill water

Water of a large volume is consumed at a pulp and paper mill compared to a mill of other industry. It is estimated that consumption of process water is about 100 tons average per ton of bleached pulp in general. Process water of 7,000 tons per day and cooling water (used in the form of raw water without treatment) of 18,000 tons per day will be consumed at the envisaged mill of this project. The water required for these purposes will be taken from the river running near the mill site, and ther is no problem in the flow rate or quality of water in this river as already described in Chapter 6.

2) Process steam

The steam consumed in the process of this mill is as following in this plan.

Process	Consumption (ton per day)	Required steam (ton per ton of pulp)
Cooking process	270	3.6
Bleaching process	30	0.4
Pulp sheet drying process	110	1.5
Others	20	0.3
Total	430	5.8

The steam for these processes is extracted from the generator turbine and is fed to required process with its pressure suitably reduced.

3) Electric power

The electric power consumed in the whole mill is as following in this plan.

Process	Consumption (KWH per day)	Required power (KWH per ton of pulp)
Pulp manufacturing process	38,400	512
Chemicals recovery process	14,400	192
Power generation	9,600	128
Chemical preparation process	40,800	544
Water and waste water treating processes	12,000	160
Others	4,800	64
Total	120,000	1,600

The unit consumption of electric power at a pulp mill is 800–900 KWH per ton of pulp in general, and the consumption of this mill is twice as much as this general value. This difference comes from the fact that electrolysis equipment in chemical preparation process,

cooling water pumps and aerators in water and waste water treatment processes and power generation equipment are provided. The entire power required for the mill is supplied from the self-owned power generator.

4) Fuel

Locally produced natural gas will be used as the fuel consumed in the entire mill, as already described in Chapter 6. The consumption of natural gas in this project is as follows:

Equipment	Consumption (Nm^3 per day)
Power generation boiler	75,600
Black liquor incinerator	3,200
Kiln	10,700
Total	89,500

This consumption is equivalent to 33 MMBTU per ton of pulp. The present price of natural gas is Tk. 15 per MMBTU. This gas is supplied under a pressure of 42 kg/cm^2.

5) Auxiliary materials and consumables

Besides auxiliary raw materials and utilities described in the preceding section, various materials and utencils are required at a pulp mill, although their quantity is minor. They are as follows:

Materials for packaging of product
(Packing paper, wire, etc.)

Materials for maintenance of machinery
(Lube oil, cleaning chemicals, paint, etc.)

Consumables in machinery (Wire cloth, etc.)

The cost of these materials at the present time is assumed as USD 7 per ton of pulp.

Chapter 9.

CAPITAL REQUIREMENT

Chapter 9. CAPITAL REQUIREMENT

9.1 General

In this chapter, the total investment required for the Project of constructing a jute pulp mill of 25,000 tons per year capacity of bleached pulp produced using jute cuttings as raw material is described. The Project scope covers all machinery and equipment and off-site facilities as described in Chapter 8. In the total cost required, the cost of land, pre-operation cost, interests during construction, and initial working capital are included as well as the construction cost of the mill. Estimation of the cost has been made based on that the plant will be constructed on the turn-key lumpsum basis and the award of contract will be done on 1st October 1982.

The foreign exchange rate is fixed to USD1.00 = ¥230, or Tk. 19.00.

9.2 Plant Cost

9.2.1 Equipment and Machinery

The cost of the production and auxiliary equipment are paid by the foreign currency, and the engineering fee for the equipment is included in this item. The cost of the equipment is USD39,037,000 (FOB).

9.2.2 Erection of Equipment

This expense is composed of the cost of the field works such as transportation, storage, erection, assembly of the plant equipment arrived at the mill site and the cost of the machine and materials necessary for the field works. The erection cost is USD3,102,000 for foreign currency and USD1,434,000 for local currency.

9.2.3 Site Preparation

The site preparation cost for the mill site is USD117,000 for foreign currency and USD900,000 for local currency.

9.2.4 Civil Work and Building

The cost of the civil works, foundation work, concrete work, and the building work is USD6,834,000 for foreign currency and USD4,383,000 for local currency.

9.2.5 Marine Transportation and Insurance

The marine transportation and insurance cost for the import goods such as the plant equipment, machinery and materials necessary for the field works is USD4,063,000. This will be paid by foreign currency only.

9.2.6 Import Tax

The import tariff on the import goods for this plant is 6.5% of the import price (CIF). This is US$3,104,000, which will be paid by local currency.

9.2.7 Inland Transportation

The inland transportation cost of the import equipment and materials, from the import port (Chittagong) to the mill site is USD599,000. This will be paid by local currency.

9.2.8 Contingency

The contigency for the plant equipment, and their transportation and import tax, and erection works of the machinery is 3%, and for site preparation, civil and building works is 5%. That will make USD2,175,000.

9.2.9 Summary of Plant Construction Costs

The above plant construction costs are summarized in Table 9-1.

9.3 Purchase Cost of Land

The purchase cost of the land is USD137,000, and is paid by local currency.

Table 9-1. Plant Cost

(1,000 USD)

Items	Foreign Currency	Local Currency	Total
Equipment & Machinery	39,037	0	39,037
Equipment Erection	3,102	1,434	4,536
Site Preparation	117	900	1,017
Civil Works & Buildings	6,834	4,383	11,217
Ocean Freight & Insurance	4,063	0	4,063
Import Tax & Duties	0	3,104	3,104
Inland Transportation	0	599	599
Contingency	1,786	389	2,175
Total	54,939	10,809	65,748

Table 9-2. Preoperation Cost

(1,000 USD)

Items	Foreign Currency	Local Currency	Total
Preinvestment Studies	107	55	162
Tendering & Evaluation	224	56	280
Project Implementation	257	45	302
Recruitment & Training	198	136	334
Test Trial	165	0	165
Contingency	48	15	63
Total	999	307	1,306

9.4 Pre-operation Cost

Various expenses are required before starting the operation of the factory. Those expenses are shown in Table 9-2.

9.5 Initial Working Capital

The following working capitals are required before starting the operation of the mill:

1) Spare parts: USD1,335,000
2) Cash (Working capital excluding spare parts): USD2,923,000

9.6 Interest during Construction

The interest are calculated according to the investment schedule (Section 9.7) during the construction period. Annual interest rate is assumed to be 11.5%.

9.7 Investment Schedule

Table 9-3 shows the investment schedule during the construction period.

Table 9-3. Expenditure Schedule

(1,000 USD)

Items	-4 ('82)	-3 ('83)	-2 ('84)	-1 ('85)
Plant Cost	3,296	33,177	23,699	5,576
Land Acquisition	137	0	0	0
Preoperation Cost	486	90	98	632
Interest during Construction	0	270	2,584	4,405
Initial Working Capital	0	0	0	4,258
Total	3,919	33,537	26,381	14,871

9.8 Total Investment Cost

The total investment cost required is shown in Table 9-4.

Table 9-4. Total Investment Cost

(1,000 USD)

Items	Foreign Currency	Local Currency	Total
Plant Cost	54,939	10,809	65,748
Land Acquisition	0	137	137
Preoperation Cost	999	307	1,306
Sub-total	55,938	11,253	67,191
Interest during Construction	-	-	7,259
Initial Working Capital	1,757	2,501	4,258
Total			78,708

Note: It is expected that the long-term loan for this Project will be advanced to BCIC through the Government of Bangladesh.
Repayment of the interest during construction will be therefore made in local currency.
A part of the interest during construction described in the above table should be arranged and payed in foreign currency.

9.9 Increase in the Capital Cost due to Delay in Implementation

In order to start commercial operation in January 1986 as assumed for this cost estimates, it is necessary that the award of the general contract will be made at least by October 1, 1982. An additional contingency would be necessary if the implementation should be delayed. The following tabulation shows the increased investment cost required for an event where the implementation is delayed by six months and one year.

As to the annual escalation rates, 7% for the foreign and local currency portion have been applied in this tabulation.

1) Capital requirement in case of 6-month delay

(1,000 USD)

	Foreign	Local	Total
Construction Cost	57,896	11,647	69,543
Interest during Construction	-	-	7,513
Initial Working Capital	1,818	2,589	4,407
Total			81,463

2) Capital requirement in case of 1 year delay

(1,000 USD)

	Foreign	Local	Total
Construction Cost	59,854	12,041	71,895
Interest during Construction	-	-	7,767
Initial Working Capital	1,880	2,676	4,556
Total	61,734	14,717	84,218