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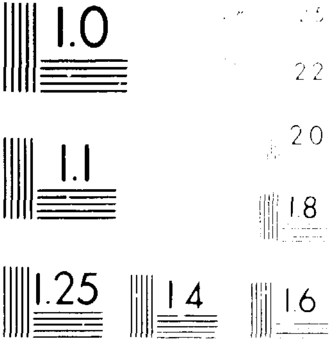
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30 March, 1984
English

DPR Korea

KRAFT PAPER PRODUCTION IN THE HYESAN KRAFT PAPER MILL

SI/DRK/83/801/11-01/32.I.E.

THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

First Mission Report

Prepared for the Government of D P R K
by the United Nations Industrial Development Organization,
executing agency for the United Nations Development Programme

Based on the work of O. Nilsen,
adviser on kraft paper production

United Nations Industrial Development Organization
Vienna

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1 SUMMARY

This is a report on the mission performed by Olav Nilsen in the Democratic People's Republic of Korea (DPRK) in February and March, 1984 at the request of UNIDO. The purpose of the mission was to study the kraft paper manufacturing at the Hyesan Kraft Paper Mill and the paper converting units, and to give recommendations how to improve the paper quality.

The conclusion was that the Kraft Paper Mill does not produce a good high-quality sack kraft paper for a number of reason, although the fibrous raw material, pine, seems to be very good. The paper strength properties are somewhat inferior, and the appearance, evenness, and pureness are not satisfactory for making good sacks.

Cement sacks for export purposes are today manufactured of a combination of imported sack kraft paper and paper from the Hyesan Mill. The previous problems of broken sacks on the export market have with this combination been solved.

After twenty years of operation the mill is more ore less worn out as the maintenance has been insufficient due to lack of spare parts. The main recommendation is therefore to reconstruct the mill. Some of the machinery and equipment must, however, be replaced by modern designs in order to improve the sack kraft quality. The reconstruction and modernization must be carried out simultaneously. In order to find a good base for a final decision it is recommended that a pre-engineering study should be made, which should also include investment cost calculations. Prior to such a study, the future mill capacity should be decided and the availability of fibrous raw material established.

Some equipment can and should be installed as soon as possible. However, first of all the mill staff and operating crews should try to improve the paper quality as much as possible in accordance with the suggestions made in this report.

2 INTRODUCTION

2.1 Project Background

The services to be performed can be summarized as follows:

(a) to study production conditions and raw materials used at the Hyesan Kraft Mill;

(b) to evaluate sack kraft paper properties;

(c) to make technical recommendations on improving paper strength and general performance of cement sacks;

(d) to prepare fellowship training programme;

(e) to study paper converting unit to advise on performance of machinery.

The main reason for the DPRK Government's request for aid was the great number of sack breaks. The assistance was asked for in 1982.

2.2 Project Duration

The project started on 1984-02-22 when the expert was briefed by UNIDO in Vienna. The arrival at Pyongyang took place two days later. The UNDP office there was visited before the departure by train to the paper mill on 1984-02-28. The travelling time from Pyongyang to Hyesan City was about 17 hours.

The mill visit lasted until March 7th.

The sack manufacturing plant and the cement filling station at Sun Chen were visited on March 8th.

On March 12th the Ministry of Building Materials was informed of the observations.

The travel back from Pyongyang started on March 13th and the post-briefing in Vienna took place on March 15th, when the handwritten, but uncompleted report was presented.

2.3 Pulp and Paper Mill Data

The Hyesan Kraft Paper Mill is the only kraft paper mill in DPRK. It is situated 320 km NE of Pyongyang at the boarder to China. The mill was constructed in 1961 - 63 and was started up in 1963. It consists of a sulphate mill with a chemical recovery system and one paper machine. The entire mill was built and set up by Chinese suppliers. The target was 20 000 tonnes of kraft paper per year corresponding to a capacity of about 70 tonnes per day. During its lifetime it has never been modernized, nor rebuilt.

At present the annual production is only 15 000 tonnes, 5 000 tonnes of which are ordinary wrapping paper and 10 000 tonnes sack kraft for cement sacks. 200 300 tonnes annually of screen rejects are collected, refined and taken up on a wet lab machine and sold out.

The mill is administered by the Ministry of Building Material Industry, Central District, Pyongyang, DPR of Korea.

2.4 Miscellaneous

The mill and its running conditions are described more or less in detail in the next chapter in order to provide the necessary background for understanding the recommendations. Some detailed data are also given as a base for possible later discussions regarding new machinery.

The co-operation with the counterpart from the Ministry has been excellent. The Hyesan Mill technical leaders have been very open regarding the mill conditions and the discussions have been meaningful. The contact could have been even more fruitful if the language barrier had not existed. Language misunderstandings occurred frequently.

The UNIDO expert had the possibility to study the mill in detail and most of the departments were visited.

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3 DESCRIPTION OF THE HYESAN PULP AND PAPER MILL

3.1 Wood Yard and Debarking Stations

All the wood arrives by railway. It is unloaded by one of three traversing cranes covering the entire wood yard.

The logs are mostly delivered in 8 m lengths. As the crane length is more than 16 m, two lines of logs can be stored under each crane.

There are two different systems for debarking. The first one is located in the wood yard itself and consists of three units. Each unit has two parts, one with a number of wheels on which the log to be debarked rotates. The other part is the debarking machine itself, which moves on rails alongside the log with the rotating, debarking device touching the log. It is an enormously big machine and the result is very poor. It takes 8-10 persons to put the log in place and take it out again. Logs with a diameter exceeding 15 cm are meant to be barked in this machine. Only one debarker was in operation. The other two are probably out of function.

On the other side of the debarkers described there is space for storing debarked logs, which can be handled by the above mentioned cranes when necessary.

The other debarking system consists of a drum debarker. The smaller logs with a diameter of less than 15 cm are cut into 1,2 m long pieces in order to get full debarking effect in the rotating drum debarker. At the time for the visit this debarker was not in operation. Therefore also small dimension logs had to be debarked with the debarker described above, but the result was very poor.

Mostly the softwood and the hardwood bundles are delivered separately but also mixed supplies occur. The necessary separation is not easy and is probably not always made.

All wood looks fresh and has a very good appearance. The logs are very straight and have few branches. The yearrings show that the growth during spring and summer is considerable, but less important during the winter season. This speaks for good tear strength properties.

Some pine is stored in the wood yard for a nearby saw-mill. Astonishingly the waste wood from this or any other saw-mill is not used as raw material for the pulp mill.

3.2 Chipping, Screening and Chip Storage

There are two parallel lines for chipping and screening. As the chippers have sloping intakes, the logs have to be cut into smaller pieces. As mentioned, the small diameter logs are cut before entering the drum debarker, but on the line for already debarked logs it is not necessary to cut too small pieces, which can happen as it is the saw operator who decides how long the cut pieces should be. It is therefore suggested that the 8 m logs should be cut into three pieces only, that are equally long.

Neither the cutter nor the screen (only one line in operation during the visit) are adequate with regard to chip quality and chip size. Oversized chips are improperly sorted out. This is to some extent remedied by manual outtake of over-sized chips from the band conveyor after the screening. The sorting job is carried out by two persons.

Oversized chips are otherwise processed in a disintegrator, but with poor result.

After the screens, there is only one band conveyor system bringing the chips to either one of totally three vertical concrete silos with a volume of 270 m^3. As there is only one conveyor system, hardwood and softwood cannot be chipped simultaneously.

The chippers allow log diameters up to 25 cm. Oversized logs are therefore cut into one meter lengths and the split into smaller dimensions with a special machine.

3.3 Pulp Mill

3.3.1 Digesters

There are three digester of 50 m^3 each. They are equipped with a black liquor circulating system. The heat exchangers are, however, in desperate need of repairs, as many tubes have eroded and have therefore been removed. This situation can be one reason for quality variations as the circulation system is disturbed.

The digesters are equipped with steam filling devices in order to compact the chips in the digester.

Each cook gives 4,2 tonnes of pulp (90 per cent), and it is possible to make 4 - 5 cooks per day and digester.

Hardwood and softwood are cooked separately. The pulp is blown to two blow tanks of 150 m^3 each. The pulp from the wing digesters can only be blown to one blow tank respectively, but the middle one has a three-way valve so the pulp can be blown to either of the blow tanks.

The chip moisture content is not measured. It was suggested by the UNIDO expert that a box of a certain volume should be prepared. During the filling of the digester, samples should be taken out and weighed on a scale. The weight would then give the average moisture content when knowing the oven dry weight, which should be rather constant.

There is an instrument panel, and the digester recorders were apparently still working, although the diagram paper and the ink had not been renewed for some time.

The cooking cycle for softwood is as follows:

Chip filling	minutes	30
Steaming (3-4 bar)	"	100
Pressure (8 bar)	"	100-130 at 170 ^{0}C
Blowing (6,5 bar)	"	10
	Totally	4-4,5 hours

Regarding the time cycle there is not much to say. The steaming and pressure times can be reduced. The pressure time can be increased by changing the alkali value from 16 per cent to 18 per cent.

Other cooking conditions are as follows:

Alkali	Na_2O	kg	1 100
	Na_2S	kg	25-30
White liquor		g/l	60-90
Chips		ton	8,6
Chip moisture content		%	42
Permanganate number ($kMnO_4$)			132-143

From these figures an extremely low sulfidity is calculated, namely only 2 per cent, which in other words means that this is much more of a soda pulp plant than a sulphate pulp mill. The very low sulfidity is probably caused by the fact that the chemical recovery system is not working. Ordinary sack kraft pulp shall have a sulfidity of 30-35 per cent. This figure will give a higher yield and improved strength. Sulfidity figures between 5-20 must be avoided due to high risks of corrosion.

3.3.2 Blow Tanks

The blow tanks are provided with vertical agitators at the bottom. These agitators are, however, not in operation due to destroyed bearings caused by leaking water.

The consistency is 11-14 per cent, which is decreased by strong black liquor at the outlet. The discharge is made via a junk remover, one for each blow tank and with a very complicated piping system, to the discharge pump. It is possible to use either pum for discharge. As the system does not work well and it is impossible to blend hardwood and softwood pulps with each other in fixed proportions, it will have to be rebuilt. However, an admixture of hardwood pulp to the sack kraft pulp is for the time being of no interest, as the sack kraft pulp should not include hardwood fibres. Since ordinary kraft paper of 50 per cent hardwood is still to be produced, a new system for blending the two different pulps should be designed. The blending should take place at the pressure sides of the pumps. In order to obtain good results there must be both consistency and flow controls.

The level recorders for both blow tanks are out of order. The levels are now measured manually.

Between the digesters and the blowtanks there are one intermediate tank for white liquor and two tanks for black liquor, probably one for softwood and one for hardwood pulping.

3.3.3 Coarse Screening

The pulp is pumped from blow tanks to the coarse screen (a vibrating flat screen, Johnson type). There are two screens, but only one is in operation. A third one has been dismantled. The reject amount is as high as 4-5 per cent of the totally charged raw material. This reject is refined in two stages and is then dewatered on a wet lab machine. The web is manually cut and folded at this machine and is later on delivered to another mill or repulped, when ordinary kraft paper is manufactured. The refined rejects can be pumped to the fine screening and therby be used for paper making.

Totally 300 tonnes per year is taken up by the wet lab machine, and about 100 tonnes out of those are repulped when ordinary kraft paper is manufactured.

Also the reject from the fine screening is mixed with the Johnson reject. The fine screen reject contains big pieces, which means that the Johnson screen does not work properly.

The process is shown on a flow sheet presented in <u>Appendix 1</u>.

The mill has reconsidered the enduse of the fibre wastes. Instead of selling the waste, it will be used for board manufacturing. The structural works for such a plant are already under way.

3.3.4 Washing Plant

The vibration screen accept goes direct to the washing plant, which consists of four wash filters dimensioned Ø 2,6 x 2,6 = 20 m^2. The speed is three rotations per minute. Earlier it was possible to control the speed between 0.5-3 rpm, but the variable speed control system has been damaged and cannot be used. It should be understood that the rotating speed of the drum determines the thickness of the pulp layer.

The pulp is diluted direct after the filter. There are spreaders after drums 1, 2 and 3 to break up the pulp web and force it to the next filter drum, but the system works very badly before the third and fourth drums. On drums 1 and 4 nice filter cakes are formed, which is not the case on drums 2 and 3. Before these drums black liquor is added by means of hoses. The showers do not seem to work properly. On the last drum cold water was being used, since hot water normally comes from the chemical recovery plant, which was not in operation at the time.

Only the riding roll on the fourth filter was in operation. The others were damaged.

There are no vacuum pumps, but one has discussed to install such ones. It should be noticed that the pulp would then be packed harder and the washing might be more difficult.

In order to achieve a good pulp washing result, the following should be considered:

As many shower pipes as possible should be installed.

The washing liquor to be used should be as hot as possible.

A continuous cake must be formed on the filter drum.

The dilution liquor should be injected before or at the spreaders.

3.3.5 Fine Screening

After the last filter drum in the washing plant, the pulp is diluted and pumped to a flume, where the pulp can be directed to three open rotating screens in parallel. Only one screen was in operation; one was somewhat dismantled and the third one is probably for stand-by.

The screen accept is first dewatered in two ordinary slushers and is subsequently pumped to a drum filter for further dewatering to a consistency of about 12 per cent. The pulp is diluted to around 3,5 per cent with paper machine white water in the discharge chest. The filtrate is led direct to the effluent sewer.

The screen reject contains very large particles as well as first-class long fibres. This reject is mixed with the reject from the flat vibrating screen. In other words, there is no secondary screen for taking care of the good fibres. These long fibres are first-class raw material for sack kraft paper.

Previously there was a secondary screen but this has, for some reason, been dismantled. As it is necessary to have a secondary screen, it is suggested that a pressure screen should be installed instead of the old one.

Wet and dry broke from the paper machine is pumped and mixed with the virgin pulp at the two slushers mentioned above.

3.4 Chemical Recovery Plant

The chemical recovery plant was not in operation during the visit, since it was being repaired. It has been idle for about one month but was scheduled to start within one week or two.

The evaporation plant has five steps and totally eight units. The evaporated black liquor has a dryness of 50 % and 38^0 Beaumé.

The black liquor is burnt in one of three ovens. The green liquor received is transformed with lime to white liquor in the causticizing plant.

There is no lime kiln for restoring lime ($CaCO_3$), so lime has to be purchased at heavy costs from far away. It was suggested that a feasibility study should be made to see if it is worthwhile to invest in a lime kiln. If the lime mud has been stored, it can be used in the kiln, and it should not be necessary to buy lime in the near future.

There are two storage tanks for black liquor of 500 m^3 each, which is enough for one week's pulp production.

3.5 Stock Preparation

3.5.1 Refining

There is only one refiner stage, which consists of nine conical refiners, two of which are smaller and are not in use due to insufficient hydraulic capacity. Of the main seven refiners, five are normally in operation coupled in series. The motor power for each of the large refiners is 280 kW. The smaller refiners have 115 kW motors

With five refiners fully loaded, the specific power demand is almost 500 kWh per tonne of production, which must be regarded as very high compared to Scandinavian standard. The measured freeness after refining is only 18^{0}SR!

The piping at the refiners also admits refining in parallel.

There is one large refiner after the machine chest, but this one is no longer in operation as it has been damaged.

The bar width in the refiner stator is 10 mm and at the rotor outlet 23 mm with a grove of 3 mm in the middle. At the refiner inlet the rotor bar width is 15 mm.

The refining is done at three per cent consistency, pH 7-8, and 2 kg/cm^2 pressure. Higher consistencies have been tried, but the refiners then had a tendency to plug.

The refining degree is determined by measuring the drainage resistance with a Schopper Riegler (^{0}SR) apparatus. This is a method for determining the dewatering property of the stock rather than the degree of beating, as the stock is diluted with white water from the wire section. In order to measure the fibre length one Bauer Mc Net fractionator should be used.

Consistency, level, and flow controls have never been installed. All the measuring has to be done manually without any instruments, not even with kW meters at the refiners.

The headbox consistency is tested regularly in the laboratory.

A flow diagram of the stock preparation is shown in Appendix 2.

3.5.2 Chemicals

Rosin is added before the refining and alum after the refining. Both these additives for the stock sizing are added unnecessarily early in the process.

The consumption of rosin is 15 and of alum 40 kg per tonne of produced paper. The alum figure is very high. Large quantities of alum can make the sack kraft paper brittle.

Rosin size and alum are delivered in blocks and diluted at the mill. The methods are very old-fashioned.

No other chemicals are used in the paper making process. It has been discussed to use starch as an additive to improve the paper strength.

3.5.3 Short Circulation System

Having been refined the stock is diluted on the suction side of the mixing pump. The diluted stock passes a centricleaner set and two pressure screens in parallel before entering the headbox. It is a very odd way to make double screening with one pump, which can only have negative effects on the quality. Further on the rejects are added to the rejects from the pulp mill screening units, which means that long good fibres can leave the system with the pressure screen rejects.

At the beginning the mixing pump characteristics were 720 m^3 per hour and 2,9 kg/cm^2 pressure head. The mixing pump is driven by an AC motor. The performance decreases, however, in course of time due to deterioration of the pump wheel. The pump wheel deterioration is most certainly caused by cavitation as the valve in the pump suction pipe is rather much throttled in order to decrease the flow. Another negative result by throttling this valve is that the pressure before the centricleaners is reduced.

The cleaning effect in the existing cleaners and pressure screens cannot be sufficient for good sack kraft paper.

3.6 Paper Mill

3.6.1 Paper Machine Room

The paper machine building has been made in two floors and one mezzanine floor. The operating floor is about six meters above the bottom floor which is on ground level.

On the operating floor most of the secondary equipment has been installed, such as centricleaners, pressure screens, machine drive, winder and packing facilities. On the mezzanine floor the heat recovery and ventilation systems are located.

One traversing crane covers the operating floor outside the mezzanine.

3.6.2 Paper Machine

The paper machine can be looked upon as a conventional sack kraft paper machine from the late 50's, but compared to European standards somewhat out of fashion at that time. It comprises an open wooden headbox, a fourdrinier wire section, an open transfer to the press section with three open presses, a drying section with 29 drying cylinders and six felt dryers, one cooling cylinder, calender stack, and pope roller. The drying section is covered with an open hood.

Unfortunately there are no acid-proof nor stainless steel parts in the paper machine. The machine frames are heavily painted and they might be eroded underneath the paint. Even information plates have been painted and are not always readable.

Standing on the tender side of the paper machine looking in the process direction, the machine is to the left.

The standard paper basis weight is 80 g/m^2.

3.6.3 Headbox

The headbox (outlet box) is an open wooden construction with two rectifier rolls, one out of which at the inlet not being rotating due to motor failure. The motor was never replaced. The rotation of the other rectifier roll was once reversed and it was said that the result had improved.

The inlet consists of a manifold system. The outlet (the lip) is made of copper sheets. The upper sheet has a number of adjustable screws to correct the calper across the machine direction. The outflow is, however, rather flushing and is therefore difficult to adjust.

There are foam-damping showers, but they were not in operation.

One rectifier roll motor should be purchased immediately in order to have the roll running. It might improve the formation.

3.6.4 Wire Section

The wire section is only 10,8 m between centerline breast roll and couch roll. It consists of one forming board (seems to be merely a plank), 22 table rolls the first 10 of which are supplied with deflectors, 7 dry suction boxes, suction couch, riding roll. There is an open transfer to the press section.

The covers on the forming board and suction boxes are made of wood and seem to be of inferior design. They also seem to be in a bad condition. The friction against the wire seems to be high and the suction effect insufficient. The dry line was fluctulating over the width of two boxes, which might be caused by a fault in the vacuum system.

Bronze wires with 60/60 threads per inch are used. The are purchased mainly from USSR, Japan, and China. The wire consumption was said to be 17 items per year, which is extremely high. The target is to produce 1 205 tonnes of paper on each wire. It is obvious that this target is not reached.

The wire costs could be considerably reduced by plastic covers on the wire rolls, suction boxes and forming board. The table rolls should be replaced by foils and vacuum foils. It would then be possible to use plastic wires.

There are no deckles attached to the headbox, so some of the stock leaves the wire. Furthermore there are no shut down showers, so the edge reams follow the wire over the first return roll.

Wire section data:

Wire dimensions	3,6 x 24 m
Couch roll diameter	800 mm
Riding roll diameter	350 mm
Wire return roll diameter	271 mm
Table roll diameter	168 mm
" " length	3 790 mm

It was said that the poor dewatering effect sets the limit of the production. The sources of poor dewatering can be listed as follows:

- too much refining
- too low stock temperature
- insufficient equipment
- poor suction effect
- insufficiently cleaned wire
- wire tension

3.6.5 Press Section

There are three felted presses. The first one is a suction press with a stone top roll. The other two presses are solid presses with hard rubber covers. There are open draws between the presses.

The web follows the felt after the first press but the other two presses are provided with paper rolls after the nip. However, the web is laid down on the felts afterwards.

The suction roll has a diameter of 740 mm. All the other press rolls are of Ø 650 mm. Other press data are:

	Linear Pressure kg/1cm	Vacuum mm Hg	Sheet Dryness after Press %	
1st press	20-25	450	24-28	4 measures
2nd press	25-30		27-32	"-
3rd press	30-40		28-36	"-

At the delivery a number of spare rolls were supplied, but today there are no spares left, which of course is a very bad situation, as there is no grinding machine available in the mill or the near surroundings. The nearest grinder is at a paper mill 500 km away. The paper machine has to be more or less shut down when a press roll has to be ground. The rolls are probably in a good condition, but they are by no means regularly ground.

There are no felt conditioners at all, such as showers or felt suction boxes. On the other hand the felts are taken out and cleaned after a production of 850 tonnes. They can be cleaned twice before being taken out definitely. Totally 25 felts per year should be used. Only one type of felt and basis weight is used for all the three presses. The felt basis weight is 850 g/m^2, which is very low, even for the first press.

It could not be checked which linear presses were used.

3.6.6 Paper Machine Dry End

There are 29 drying cylinders divided into three drive groups with the following number of cylinders: 10 + 10 + 9. The last group also contains a cooling cylinder. There are two felt dryers attached to each group, one for the top felts and one for the bottom felts. In the two last groups the bottom felt dryers are not in operation due to broken bearings, which has resulted in very wet drying felts in these positions.

Drying cylinder dimensions are Ø 1 500 x 3 500 mm, thickness of shell 25 mm. They were controlled by water pressure at 5 kg/cm^2 before delivery. The distance between centerline bearings is 4 300 mm. The condensate removal is made by means of a syfon rotating with the cylinder and with a spade-formed intake.

The felt drying cylinders have the same diameter as the drying cylinders, namely 1 500 mm.

The drying cylinders are equipped with slots on the front side for a rope-carrying system. There is also some other equipment for this system, which is not being used and is maybe not needed now as the machine speed is low.

The cylinder bearings are oiled by an oil circulation system.

The length of the top felts is 34 m each and the bottom felts are 39 m except the first one which is 38 m. All felts used are made of cotton.

The cooling cylinder and the pope roll are cooled with cold water, which means that water condenses on the outside of the shell and moistures the paper web. This moistening effect is of course a disadvantage to the paper quality.

There is a very heavy machine calender. The king roll diameter is 700 mm, queen roll and top roll 500 mm. Between these there are five smaller rolls. The paper passes through the bottom nip but only with the load of the queen roll weight. In other words, there is no forced load. The sack kraft paper should not be calendered at all. It is always a disadvantage with a calender stack in a sack kraft paper machine due to the very long run between the cooling cylinder and the pope roll. The best way is to take out the calender stack and replace it by some extra drying cylinders.

The pope roll diameter is 1 100 mm and, according to the specification, allows tambour rolls of 1 800 mm.

The heat recovery system is located on the mezzanine floor. As the fans and heat exchangers are located within concrete structures, there was no opportunity to inspect them. However, it is obvious that the condition is not good. The hot air distribution system is not in operation and the machine hood has definitely seen its best days.

3.6.7 Paper Machine Drive

The drive consists of one length shaft driven by one DC-motor. The transfers to each drive unit are made by belts over conical wheels for speed adjustments and gearboxes. There are no extra DC-motors so all units are driven by the length shaft system.

The motor data are 400 kW, 0-460 volt and speed range 20-320 m/min. The AC/DC transformer is a Leonard system for 560 kW and 6 000 volt. The DC-motor is covered by a plastic tent due to the bad air conditioning system. Cold air is mixed with hot air which gives a very moist atmosphere.

The max speed possible today is 170 m/min. The main reason for this limited speed is the poor dewatering effect on the wire section. For quality reasons sack kraft paper is manufactured at lower speeds namely 120-140 m/min. Generally wrapping paper is made in the speed range of 160-170 m/min.

The remote controlling of the machine drive sections is out of order. Thus the operators have to walk to the drive side and manually adjust the speed for the section in question.

The speedometer is out of function, so the paper machine speed is estimated by means of the voltmeter indication.

3.6.8 Broke Handling

The paper machine is supplied with one couch pit with agitator and a repulper under the calender stack and pope roller. Their performance was said to be satisfactory.

Reems from the winder are blown directly to the dry end pulper.

Broke from the coach pit and from the broke pulper is pumped directly to a broke chest in front of the paper machine and thereafter pumped to the dewatering slushers in the pulp mill. This is, of course, a very odd system and might explain some of the problems with the uneven paper quality. The wet section broke should be added after the refining.

3.6.9 White Water System

The WW system was not investigated but it was obvious that there was no real system working any longer. The fibre losses must be enormous compared to mills which are equipped with adequate fibre recovery systems. It was said that there was once a fibre recovery system but this had for some reason been abandoned.

3.7 Finishing

3.7.1 Winder

The tambour rolls are cut and rewound in the winder into three rolls at a time with the dimensions 80/90 x 120 cm. The winding performance is good even though the roll ends are somewhat uneven.

There are no facilities for automatic control of the web tension during the winding operation. It is the cleverness of the operator that decides the shape of the rolls. He adjusts the mechanical break by means of a remote-controlled oil-powered servo motor.

No rewinder has been installed.

3.7.2 Wrapping

The rolls are weighed and manually wrapped direct after the winder. The wrapping paper is taken from the last tambour roll produced. There are only two layers of wrapping paper used. The width of the wrapping paper sheets is adequate to cover the entire area of the roll ends after folding. Wooden plugs keep the wrapping fastened to the roll core. Small plates of paper can also be glued over the plugs. These plugs are manufactured within the mills but the cores have to be purchased.

A common way today is to put steel-bonds on the roll edges and thus deliver the rolls without any wrapping paper except the top layer in the roll itself.

There is no special warehouse for the rolls. It was said that they were more or less brought direct to railway waggons.

3.8 Paper Mill Laboratory

The laboratory is very small and has no air conditioning. The equipment is very limited and consists of the following apparates:

One very small balance scale for testing the basis weight. Probably this scale gives wrong results. It is estimated that the weight shown is ten per cent too high (85-90 g/m^2 instead of 80 g/m^2). The size of the sheet weighed is 20 x 25 cm. The sheets are taken out from the back, middle and front of each tambour roll.

The sheets used for weighing are cut in 15 mm strips (three strips in each direction) and tested for the tensile strength (breaking length). The apparatus has been manufactured by Shimadzu Seisakusko and it does not show the stretch value.

There is a Mullen tester for testing the Burst factor.

For testing the porosity a Schopper type apparatus made in DDR is used.

One analysis scale for manual operation.

Further on there is an electrical dryer used for quick results when dryness is tested. There is also a big oven for drying samples.

The consistency in the headbox (0,45 - 0,50%) and the freeness after refining (18 ^{0}SR) are regulary tested. The alum consistency is also tested (1,3 ^{0} Baume).

It is obvious that the few and inferior testing apparates are of little or no help for controlling the paper quality.

There is also a lab in the pulp mill, but this was not visited.

3.9 Service Facilities

3.9.1 Workshops

The mechanical workshop is very small. It has only a few small lathes and a bigger one. There are also some other common machines. In the millyard outside the workshop there are two steelsheet bending machines.One of these is operated manually. The forging facilities are also located out-doors.

The electrical workshop was not visited, but it was said to be very poorly furnished. There is no instrumentation workshop in existance.

In different departments there are also smaller workshops which also include minor common spare parts and consumer materials.

There is no warehouse for spare parts as there are no such items to store.

With the poor maintenance facilities there is no possibility to repair quickly major or even minor damages. A typical example is the chemical recovery plant which had to be idle over six weeks for repairs.

As there is no grinding machine the paper machine press rolls have to be sent to another paper mill for grinding. Normally the press roll will be away for 2-3 months.

3.9.2 Steam Supply

Steam is purchased from the community. There are two incomming pipes, one for 13 kg/cm^2 and one for 5 kg/cm^2. These pressures are reduced within the mill to 8 and 1,8 kg/cm^2 respectively.

The condensate is delivered back to the steam supplier. It was estimated that the losses are around 30 per cent.

When the chemical recovery plant is in operation it is producing steam at 5 kg/cm^2. This steam is used in the evaporation plant.

3.9.3 Water Supply

The raw water is taken from the river Ab Rock Kang by four pumps, two of which are stand-by. The quantity used is 25-27 000 m^3/day part of which is delivered to a nearby textile mill.

Each pump has a capacity of 720 m^3/h but this cannot any longer be obtained as the pumps are becoming more or less worn out.

The stationary coarse screen in the river does not function well and the mill is interested in finding a better solution.

The raw water is pumped to a tank. From there it can be separated into two parallel lines, first a tower for chemical treatment and thereafter a number of parallel cells. The water enters at the bottom of the cell and leaves at the top. However, there are no chemicals available for flotation and there are some difficultes with sand in the cleaned water. Especially in the rainy season there are problems. It was suggested to use both lines and throttle the valves to the first few cells in order to get the same flow through each cell in operation.

On the other hand the consumption of water within the mill can most certainly be decreased.

Where it is necessary to have clean water, special water filters can be installed locally.

3.9.4 Electrical Supply and Distribution

The electricity is delivered from sources outside the mill.

The standard frequency in DPRK is 60 Hz, but all motors are for 50 Hz. For this reason four motor generator sets have been installed to transform the incoming electricity from 60 to 50 Hz. Three sets are normally running.

3.9.5 Pressurized Air

There is no central station for producing pressurized air. Each department which needs pressurized air has its own compressor and tank.

3.9.6 Environmental Protection

There is no treatment whatsoever of effluent waste waters. It was, however, said that there are plans to install a station together with the community for external cleaning of waste water. It should, however, be investigated to which degree the waste water outlet can be decreased by improved internal closure of the white water systems and reuse of the cooling water.

3.10 General Observations and Remarks

During the visit to Hyesan the UNIDO expert made some observations regarding the general conditions of the paper mill, which must be looked into, even if the conditions do not directly affect the paper quality, but indirectly. The following observations are worth reporting and remarking.

> The machine room ventilation is disturbed by poorly insulated windows and leaking steamjoints. Ice-cold and hot air meet and cause a foggy and moist athmosphere on the drive side of the paper machine. (The machine drive motor is shelted by a tent in order not to be wet). This can disturb and influence the paper drying and there is a vital risk for deterioration of the machinery and the structural material. It is therefore suggested that a program should be started to repair windows and other structural matters and to purchase material to prevent all steam leakages. It is also suggested that the insulation of pipes should be repaired where necessary.

Many of the electric boxes are in a poor condition which can cause motor stops or accidents. Some couplings and cables are not supported. As electrical parts are manufactured within DPRK a program should immediately start to clear up the electrical situation. It was namely reported that electrical stops often occurred.

Many instruments were not working or were damaged. The instrument technicians should be requested to overhaul all instruments and make a list of the actions needed for restoring the equipment, and should then purchase what is necessary.

The lighting is very poor and it should by all means be improved. A later reconstruction of the mill would probably be carried out around the clock and a perfect lighting would then be needed. The main purpose is to enable a check of the paper web in the machine, and to avoid accidents.

Safety arrangements will have to be improved. Some places are direct dangerous, especially when it is dark.

A very great advantage is that the tidiness is first-class. It is very clean everywhere and there is not very much junk lying around.

4

4 SACK MANUFACTURING PLANT AND FILLING STATION

All the kraft paper sacks for DPRK' s cement mills are manufactured in a plant attached to the cement factory at Sun Chen about 70 km south of Pyongyang. The plant has two tube machines and ten machines for sewing the tubes at both ends. The machines were supplied by Japanese manufacturers in 1976.

The plant is running in two eight-hour shifts per day six days per week. The capacity was said to be 200 000 sacks per day corresponding to 60 million sacks per year based on 300 operating days per year.

The following types of sacks are manufactured:

		No of Plies			
Trade Mark	Purpose	Hyesan	Import	Total	Note
-	Domestic	4	-	4	
Dear	Export	3	2	5	
Cum Gang	Export	4	2	6	only for Sun Chen

Earlier either Hyesan paper or imported paper was used for the sacks to be exported. At that time there was much trouble with the sacks made of Hyesan paper only, so a change was made resulting in a combination as shown in the table above. This combination was decided after some tests and the mill staff is now satisfied with the result, as there are very few claims with the export sacks. It was said that only one of a thousand is broken during the transportation.

Compared to European standards the number of plies is very high. The reason is the very many loadings and unloadings, as the sacks are not transported on pallets.

When looking at the tube machine operation it is obvious that the Hyesan paper did, as expected, not behave very well. The imported paper on the other hand has a good appearance and behaves well.

Other disadvantages of the Hyesan paper is the very high basis weight compared to the imported paper, which has a weight of only 70 g/m^2, and the very dark colour. The brighter imported paper is therefore used in the outer layer in order to have a good-looking background to the trade marks. The inner layer is also imported paper.

The plant has no apparatus for paper testing. If there is a reason, some sacks are drop tested. A sack has to withstand 20 drops from one meter to be found satisfactory. This number of drops shall correspond to the anticipated number of sack handlings before the end-use. When drop tested the sacks have always the trade mark on the top side, i e the side opposite to the pasted side. The sacks never break in the sewed ends, nor where the paper is pasted. The breakages are mostly to be found across the fibre orientation.

The sacks are filled with cement in a rotating unit. The empty sacks are attached manually and filled during rotation. The filled sacks are automatically kicked out onto a conveyor. They are then transported on a number of band conveyors direct to railway waggons where they are manually sorted.

The filling time is about 20 seconds, i e the time for one rotation in the cement filling unit. With such a long filling time the paper porosity is not important. However, some cement blows out during the filling.

There is no press to flatten the filled sacks as they are not stapled on pallets.

5

5 PAPER QUALITY

5.1 Testing of Paper Sacks

In April-May 1983 paper sacks made of paper from Hyesan were tested at two different laboratories in Europe, namely:

Clupac Inc, Zug, Switzerland and
Österreichisches Holzforschungsinstitut, Vienna, Austria

The testing results differ very much between the institutes and between the different plies within each sack. The institutes tested only one sack each and the sacks were probably not from the same paper rolls.

Clupac were rather positive in their comments regarding the strength properties but negative regarding the air resistance (porosity), the paper appearance and the sack manufacturing. Clupac felt that the paper was made from recycled fibers. They gave a great deal of advice regarding sack manufacturing. The main advice in paper manufacturing was to improve the stretch values as well as the tear properties.

The Austrian institute found the paper rather bad and said that it was inferior in quality compared to Austrian standard. It was further said that the paper was a mixture of softwood and hardwood fibres, but did not contain any recycled fibres. The report did not give any comments on the sack appearance. The very low stretch values and the low porosity were said to be the main faults.

It is interesting to note that the test values from both institutes show that low porosity values correspond to rather good strength and stretch values.

5.2 Laboratory Tests in March 1984

5.2.1 General

The UNIDO expert took the following samples from Hyesan for testing in Sweden:

about one kilo of chips,

about one kilo of screened pulp,

one paper sheet from across the machine direction.

The chips have not been tested as the amount was too small for cooking. Instead the following remarks have been made by Swedish expertise:

There are too many small and thin chips, and in addition there are some thin and long chips.

The chips have been crushed somewhat during the chipping.

These two problems are caused by wrongly attached flying knife and bed knife.

The amount of bark particles in the sample was considerably high.

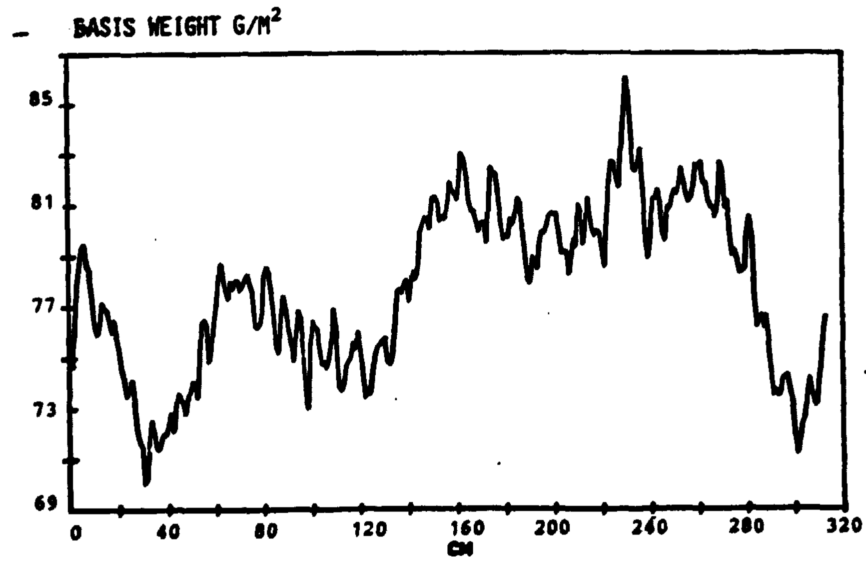
5.2.2 Result of Pulp Testing

As the laboratory tests will take some time, the results will be sent out later on. However, the following tests have already been made:

Kappa No	42,4
Amount of hardwood	3 %
Viscosity	1 070 kg/dm^3

5.2.3 Result of Paper testing

The paper testing results will be made later on. So far the basis weight profile has been tested in a basis weight analyzer (β-ray measuring device). The result was very discouraging as the basis weight varies between 70 - 86 g/m^2 according to diagram shown below.



5.3 General Remarks Regarding Sack Kraft Paper Quality

It is not only the paper strength characteristics which are decisive to the quality of the sack kraft paper. It is most important that the paper is flat and even. In order to provide for good behaviour in the tube machines, there shall be no variations in basis weight and moisture content. The paper shall always be of the same quality so that each ply in the sack will have almost the same structure. All plies in the sack will then work together when the sack is filled and when it is dropped. Should, for instance, the outer layer have a higher moisture content, it will shrink when being dried. The entire load will then be on the outer layer, which will most certainly break.

The Hyesan paper is not even and is therefore inferior for making sacks. The reason for this is manifold. The defects arise already when the stock is formed and dewatered on the wire because of inferior equipment, insufficient washing and probably too much refining. The faults continue in the press section, where the felts are too thin and the linear pressure is low. Further on the felts are not conditioned. In the dry end some felts are too moist, especially the last two bottom felts. On the cooling cylinder the paper bottom side is moistended by condensate on the cylinder and finally the paper is slightly calendered.

The paper should have a good appearance and be rather light in colour. The latter characteristic only to obtain good coulours when trade marks are printed. The Hyesan paper is very dark probably due to poor washing.

Regarding strength characteristics it is important to have good values in all directions (square oriented paper) and not only in the length direction (length oriented paper).

It has been found that the most important value is the strech value, which means the elongation of the paper at rupture. Therefore most sack kraft paper mills have installed HC refining and Clupac units. It should be pointed out, though, that good stretch values can be obtained without the installations mentioned. After proper refining a piece of paper will have very good stretch values if it can dry and shrink freely after forming and pressing. In the paper machine, however, the paper web is drying under tension from drying felts and the drying cylinders which are carrying the web through the dryer section. Especially the shrinking in the lengh direction is hampered but not so much in the cross direction. At the edges the shrinking is less hampered than in the middle. Therefore the stretch values at the edges are better than those in the middle regarding the cross direction, as the felt tension is weaker at the edges. The stretch values can be improved if the drying process can be increased in the free slopes. This can be done with very hot air blowing onto the paper web between the cylinders and the web should not be straighten too much. With such hot air blowers (called pocket ventilation) it is also possible to control the moisture profile across the paper web.

Another way of obtaining better strength properties is to cook chips from the wood waste at the saw mills. The random fibres in the logs are superior. This is also a way to obtain additional fibrous raw material.

When a good sack kraft paper is produced there are some possibilities to decrease the paper weight in each sack, namely with a lower basis weight or less number of plies. That is a better way than trying to use secondary fibres like waste paper or hardwood pulps. It would therefore be much better to utilize the rejects from the coarse sceens in the pulp mill after proper treatment.

Finally it should be repeated that the pulp quality must be even. Some of the problems are due to inferior treatment in the woodyard, pulp mill and washing plant.

6

6 DISCUSSION OF TECHNICAL MATTERS

6.1 General

The Hyesan Pulp and Paper Mill has been in operation more than twenty years without major or even minor reconstructions or modernizations. Machines and parts of machinery have been taken out of the production lines when the original sets of spare parts have been used. New spare parts were never ordered from the suppliers. To some extent spares are made within the country.

As the mill is more or less worn out, it must first of all be reconstructed and put in order again. It makes no sense to put in new costly machinery and equipment for paper quality improvements, when part of the existing machinery may break down any minute and cause stop periods of months.

One way to find an opening is to make a preengineering study in order to elaborate a reconstruction plan which shall include new equipment for quality improvements. Such a study would also establish the necessary investment costs, which could be separated into costs of reconstruction works and modernization installations. A detailed time schedule should be included. The study should be carried out under the leadership of a consultant with participation of mill personnel, the original suppliers as well as another supplier of the reconstruction equipment. The new machinery could either be purchased from manufacturers after bidding or as an export credit from a country supplying first-class machinery.

A preengineering study would take around four months, 3-5 weeks of which at the mill. In the study a detailed training program should be included.

Before the suggested study starts the future capacity should be decided. Today the production figures are below the original nominal production of 20 000 tonnes per year. On the other hand there is much extra capacity available in most departments and there would not be great extra costs if the nominal capacity after reconstruction would be 30 000 tonnes per year, which corresponds to the capacity of the sack manufacturing plant and the future requirement of cement sacks. The investment costs of the reconstruction should be compared to the costs of imported sack kraft paper. It should of course, be investigated whether the natural resources regarding fibrous raw material are adequate.

The paper mill capacity of 30 000 tonnes net and 320 operating days would mean around 107 tonnes per 24 hours considering a time efficiency of 0,93, and six per cent of broke. This corresponds to a paper machine speed of 290 m/min. The pulp mill capacity would have to be around 102 tonnes a day (90 %) including losses of four per cent, which means that it should be necessary with an additional digester.

Primarily it is the wood handling system, the stock preparation and the paper machine which are to be modernized. In the continuing of this chapter the suggested rebuilds will be described more in detail. <u>The necessary reconstruction of process machinery will not be dealt with in this chapter but it must be understood that these parts are of vital importance when aiming at improving the quality.</u>

6.2 Wood Handling

The existing system for debarking, chipping and screening should not be reconstructed but replaced due to the very inferior debarking and chipping results. The existing system is also very odd as the logs are to be cut before chipping which causes fibre losses and fibre damages by the saw.

With the existing equipment the screening and rechipping results are bad. Even though there is personnel around to take out oversized pieces by hand, the result is by no means satisfactory for making an even and good pulp.

There should be one line only for debarking, chipping and screening, as there is no need to separate the log dimensions any longer.

The new debarking machinery should consist of one log debarker possibly with a second one as stand-by. The feeding system has to be arranged in a special way. The debarker should be of the Cambio type which has been in operation satisfactorily for many years in many places. An alternative is a full length log tumbling debarker.

The chipper should be of a type which is fed horizontally, which means that the logs need not be cut beforehand. The chips would be blown by the fan power from the chipper wheel to a new vertical screen with first-class screen plates. Oversized chips would be treated in a new rechipping unit and brought back to the screen.

The existing building is large enough for installation of the new equipment, but it would be necessary to improve the machine layout. The existing conveyors could be reused.

It is needless to mention that a new chipper should be able to process logs with a diameter of 0,5 meter or more. The saw and the wood splitter may remain if there should still be oversized logs in the future.

The chipper room should be heated during winter time. It is therefore necessary to make insulation improvements. Ice and snow must be removed from the logs before chipping.

6.3 Refining

The existing refining at low consistency in conical refiners and at only one stage is far from the best installation in order to make good sack kraft paper. It is therefore suggested that the refining process should be rearranged which, of course, can be done in different ways. The easiest way is to use some of the existing refiners in a second refiner stage. The refiners which are in the best condition could be selected. As there is no need for a machine refiner, this should be taken away.

A new first refiner stage should consist of one or two disc refiners (in series) with a proper pump and piping installation to allow pulp consistencies around five per cent. Another chest has to be installed between the two refiner stages.

A more advanced type of refining is the HC-refining which takes place at 30-35 per cent consistency. Such an installation needs an additional press, which should be located after the existing dewatering filter. The stock from the press has to be transported in a screw conveyor to the refiner. The stock after refining drops direct into the chest, which can be rather small but should have a very good agitator. The water from the press and part of the water from the filter will bypass the HC-refiner into the chest.

It is necessary to install consistency controllers in order to obtain an even stock. Some other instruments and controls are to be installed, such as kW-meters for the refiners, level controls, flow controls for an even quoting of dry and wet brokes respectively, and chemicals.

The suggested refining process is shown in the attached diagram (Appendix 3). Note that the HC refining is shown there. Further to be seen are the short circulation process and a proposed fibre recovery system. It is suggested that the existing 125 m^3 chests vill be used for wet end dry and brokes respecitvely in order to gain storage capacity. The refiner and machine chests can be rather small as they are not ment for storage but only for good mixing purposes.

6.4 Short Circulation System

In order to improve the appearance of the sack kraft paper and to allow a low consistency in the headbox, which is important for the strength characteristics and paper flatness, it is necessary to renew the entire short circulation system. When designing the new system it is important to look at the piping and the fact that a rebuild should not be undertaken without considering the entire white water and fibre recovery systems, which however belong to the reconstruction part of the object.

The new process should be as follows. The stock is pumped from the machine chest to the suction side of the centricleaner pump. Accepted pulp from the cleaners goes to the suction side of the mixing pump. On the pipe to the headbox there should be one pressure screen with a junkbox but no reject outflow.

There should be three centricleaner stages and the reject from the last stage should include no good fibres.

The new machine chest pump and mixing pump shall have controlled variable speed drives.

6.5 Paper Machine

The quality of the sack kraft paper can be improved by a lot of measures regarding the paper machine. Each measure contributes a little, but without these small contributions the situation might be hazardous.

As already mentioned, good sack kraft quality does not only refer to the strength properties, but also porosity and flatness of the paper are important. Many items of the improvements suggested below have with the flatness to do. It is also very important that the felts and wires are kept in good condition during their entire life time. Otherwise the paper quality may decrease with the life length of the machine clothing.

The following equipment should be renewed or added:

Headbox
Forming board

Foils instead of table rolls
Suction boxes
Pocket ventilation
High pressure showers in the wire and press sections

Further on the presses should, if possible, be improved so a higher linear pressure could be obtained. It is necessary to install conditioning items such as felt suction boxes including vacuum pumps. Special press felts for sack kraft paper manufacturing must be purchased. The press felt suppliers must come to the mill for technical discussions.

In any case, new spare rolls for the press section have to be purchased. It is then recommended that the new spare for the bottom roll should be made with drilled blind holes which will give a much better dewatering effect. It might also be possible to drill the existing rolls. As said before it is essential that at least the spare roll will be made for higher linear pressure. The supplier must be consulted.

It is suggested that the felt dryers will be dismantled in order to exhange the cotton felts for wires. The suggested pocket ventilation will partly dry the wires especially in the first dryer section but the main purpose is to dry the paper in the open draws and most concentratedly in the area where the paper web shrinks most i e the dryness between 60-80 per cent. The temperature of the cooling water for the cooling cylinder and the pope roll must be controlled, which can be done by a water circulation system. The left over felt dryers can maybe be used as drying cylinders, now or later. This depends on the necessity to increase the mill capacity.

The wire-shaking equipment is not used and should therefore be put in operation or be dismantled. With a rebuilt machine, however, it will be obsolete due to a very low consistency (0,18 per cent).

An important question is how the wire section should be prolonged in order to allow very low headbox consistencies.

A possible installation of a Clupac unit will be very costly and is therefore not recommended now. It can, however, be discussed at a future modernization.

6.6 Paper Mill Laboratory

In order to control the paper sack quality and to make adequate operations in the process it is absolutely necessary that the machine tender has a basis weight scale and a porosity tester, type Gurley. He shall from each tambour roll take a strip across and form sheets for weighing, so he will know the weight across. Based on the porosity value he can adjust the refining. Note, however, all the porosity values must be obtained from across the sheet. Further on the machine tender shall test the sizing through ink tests.

It is suggested that a bigger test room should be used and that this room should be air conditioned at 50^0RH and 23^0C. New apparates to be installed are:

- basis weight scale
- tensile tester (breaking length and stretch)
- tester for measuring the tear
- tester for measuring the porosity (Gurley)
- tester for measuring the stiffness
- thickness meter

In the lab there could also be a laboratory beater, a sheet former and a dryer. This equipment should, of course, not be in the conditioning room.

As already mentioned the lab results are for steering the process but they are also very important for classifying the paper manufactured. If the paper does not fulfil the requirements it can be used for other purposes in order not to risk cement sack ruptures. In other words each roll should be tested.

6.7 Other Itmes

The reconstruction and modernization of the Hyesan Pulp and Paper Mill include many other items to be seriously considered. First of all a positive statement, viz that the crews working in the process lines will certainly live up to the new equipment without any major problems. However, a new quality minded interest should be created, especially into the machine tenders and the laboratory personnel. The key process personnel has to be trained for new equipment and quality responsibility.

What must be thouroughly improved on the other hand is the maintenance organization. The standard today is very inferior and must be tremendously improved. The maintenance mechanics must learn much about overall services and how to handle new equipment. There must be adequate spare parts well maintained under strict control in warehouses, and new spares should be requisitioned in time.

There must be electrical and instrumentation workshops with necessary facilities and knowledge how to maintain and repair all sorts of failures which may occur. The instrumentation shops shall have apparatus for necessary testing of instruments, recorders and regulators. It is also necessary to train the key personnel, which might possibly be done within DPRK, i e in other modern paper mills.

Another positive fact is that the machinery has a basically good frame. The digesters, the washing plant and the paper machine seem to be in a good condition excluding all parts dealt with in Chapter 3. Rolls and cylinders in the paper machine look good and so does the paper machine drive. One drawback is that there are no or very few items in the wet end made of acid-proof material.

The piping in the mill is made of soft iron. The new piping in the stock preparation and before the paper machine must be of acid-proof steel. It is therefore necessary to have trained welders for a possible reconstruction. The reason for the high quality material is that the parts of the new items connected with stock and white water will be made of acid-proof material. The aim is to obtain a good paper quality throughout the life-time of the equipment.

7

7 EDUCATION AND TRAINING

The following information was given at discussions held on February 28.

As a rule the technical universities give basic lectures on the pulp and paper technology. In the places where there are major industries in this branch, there is also high level education, especially regarding pulp and paper production.

At Sariwon, about 75 km south of Pyongyang, there is a pulp and paper institute where education is given. Furtheremore there is an institute of newsprint technology at the newsprint mill of Nam Hung north west of Pyongyang, close to the boarder of China.

In the program made in advance for the UNIDO expert no visits to any school or research institute within DPRK had been planned. It was not possible to change the program during the visit, not even at Hyesan where the only high level professional forestry college and the Forestry Research Institute are situated.

It should have been very useful to the expert to speak direct to engineers, professors and students in order to get a general idea about the level of education to enable him to make firm recommendations on a fellowship training programme. Such discussions were not possible at the Hyesan Mill as there was no engineer who could speak English or German.

Regarding a possible modernization of the mill in order to produce an up-to-date paper quality it is necessary to hire qualified, high level educated paper engineers, who should be trained at a modern sack kraft paper mill abroad. Language proficiency is then essential.

In Sweden there is a training program every year named

> Advanced International Training Programme in
> Pulp and Paper Technology

at the Training Centre of the Swedish Forest Industries at Markaryd. This training started already in 1969 by order of the UNIDO. It is herewith suggested that DPRK should apply for one or two candidates for next year's training, which will probably start in March 1985. The present applicants have a very high technological background as well as knowledge of English, which is the training language.

At this moment it is not possible to draw up a training programme, as the background data are missing. It is, however, the hope that the next part of the split mission admits the adequate visits and gives the necessary information.

8

8 RECOMMENDATIONS

8.1 General

In the following a series of recommendations are given. They are divided into three sections, the first one of which is for actions to be taken more or less immediately. There are a number of suggestions which can be executed with no or minor costs. There are also some recommendations for studies and discussions to be carried out, which later on will lead to some changes in the set-up of machinery and machine clothing.

In the second section some short-term improvements are recommended which involve additional costs for spare parts and repairs to improve the existing pulp and paper plants.

The proposal for the final stage, i e the modernization of the mill, is discussed in the third section. This modernization, the purpose of which is to improve the sack kraft paper quality, shall not be carried out without a reconstruction of the mill. The reconstruction works to be done are not discussed in detail here as they were not studied thoroughly enough. These long-term improvements do include a proposal to produce additional 10 000 tonnes of sack kraft paper.

8.2 Actions to Be Started Immediately

8.2.1

In order to prevent the mill from further deterioration, it is strongly recommended to start building up the basic maintenance organization including personnel, workshops and a store of minor spare parts, especially for electrical and instrumentation maintenance. Some specific actions to be taken are described in Chapter 3.10.

8.2.2

One technician from a wire and felt supplier should visit the mill and give firm advice regarding wire and felt qualities. At least the last two dryer section bottom felts should be exchanged for plastic wires soonest possible.

8.2.3

Technicians from the original supplier should soonest possible visit the mill and give advice how to reconstruct the mill and state the costs of equipment and erection.

8.2.4

As sawmill waste is a very valuable fibrous raw material. It should be investigated how it can be used at the mill for pulp making.

8.2.5

The following are recommendations for actions which can be taken by the process engineers and operators:

Cut the 8 m logs in three equal lengths.

Adjust the flying knife and bed knife in the chipper to improve the chip quality.

The sulfidity should be increased to 30 - 35 per cent.

Decrease the refining power gradually and with careful attention to the strength properties of the paper and dewatering on the wire.

Evaluate the results to find out if the use of alum could be decreased.

Find a way to throttle the flow to the headbox after the cleaners and open the valve at the pump.

Install a motor for the first rectifier roll (perforated roll).

Install a meter stick in the headbox in order to measure the outflow velocity and compare it to the wire speed. This is one way to control the speed ratio which should be close to one in order to obtain a square oriented paper.

Correct the basis weight profile across the machine direction.

The following actions to be taken in order to decrease streaky formation:

Possible Cause	Suggested Remedy
Improper speed of the perforated roll.	Adjust the speed of the perforated roll.

Stock build-up behind the slice.	Clean off by hand but, if necessary, shut down the machine and wash the head-box.
Uneven setting of the slice lip.	Line up the slice.
Incorrect slice setting.	Adjust the slice to alter the water removal at the breast roll.
Grooved slice lip.	Report and have repaired on the first shut-down.
Forming board not level.	Level the forming board.
Uneven tension on the wire, indicated by a crooked seam, especially when the wire is old.	Have the rolls checked for alignment before installing a new wire.
Ridged wire.	Find the reason for the ridge and correct. Rub out the ridge with a spoon bottle or some wellrounded object.
Vibrating table roll.	Lower the roll from the wire and notify the Tour Foreman.

Unevenly worn suction boxes.	Remove one suction box at a time for resurfacing.
Stock build-up on a suction box.	Check for stock build-up and remove.
Accumulation of fibres on land area of supporting baffle blocking the drainage.	Clean baffles.

8.3 Rebuilds and Extensions for the Near Future

8.3.1

The most important spare parts to be purchased so as to get process machinery in order. Here is some advice regarding the most urgent actions:

New tubes in the heat exchanges at the digesters.

Repair of the blow tank agitators.

Reconstruction of the washing plant (see Chapter 3.3.3).

New material in forming board and suction boxes. Possibly also some vacuum foils to be installed instead of corresponding table rolls.

New bottom press rolls made for future higher linear pressure. The rolls should be blind drilled.

Other minor and major suggestions which should be made by the machinery suppliers.

8.3.2

A new laboratory according to Chapter 6.6 should be designed and testing apparatus purchased.

8.3.3

Increase the maintenance possibilities through procuring machinery and other items. It should be considered whether to install a good roll grinding machine, preferably if a number of nearby mills could use the same machine.

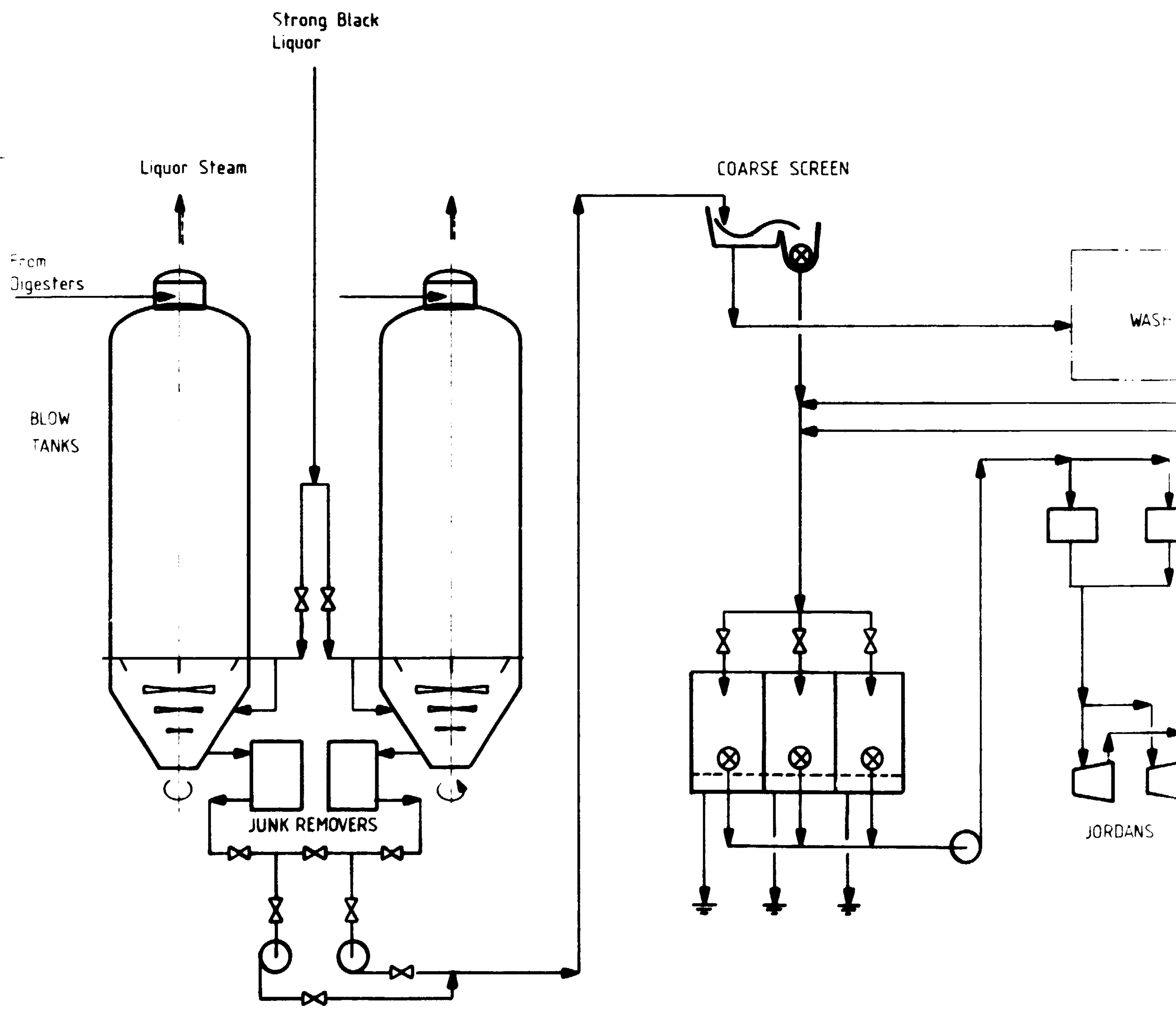
8.4 Long Term Improvements

The recommendations given in Chapters 8.2 and 8.3 do not guarantee first-class sack kraft paper. There are many other improvements to be done, but these require investments of machinery and equipment which have to be imported. It is recommended that at least the following machinery should be installed to improve the paper quality.

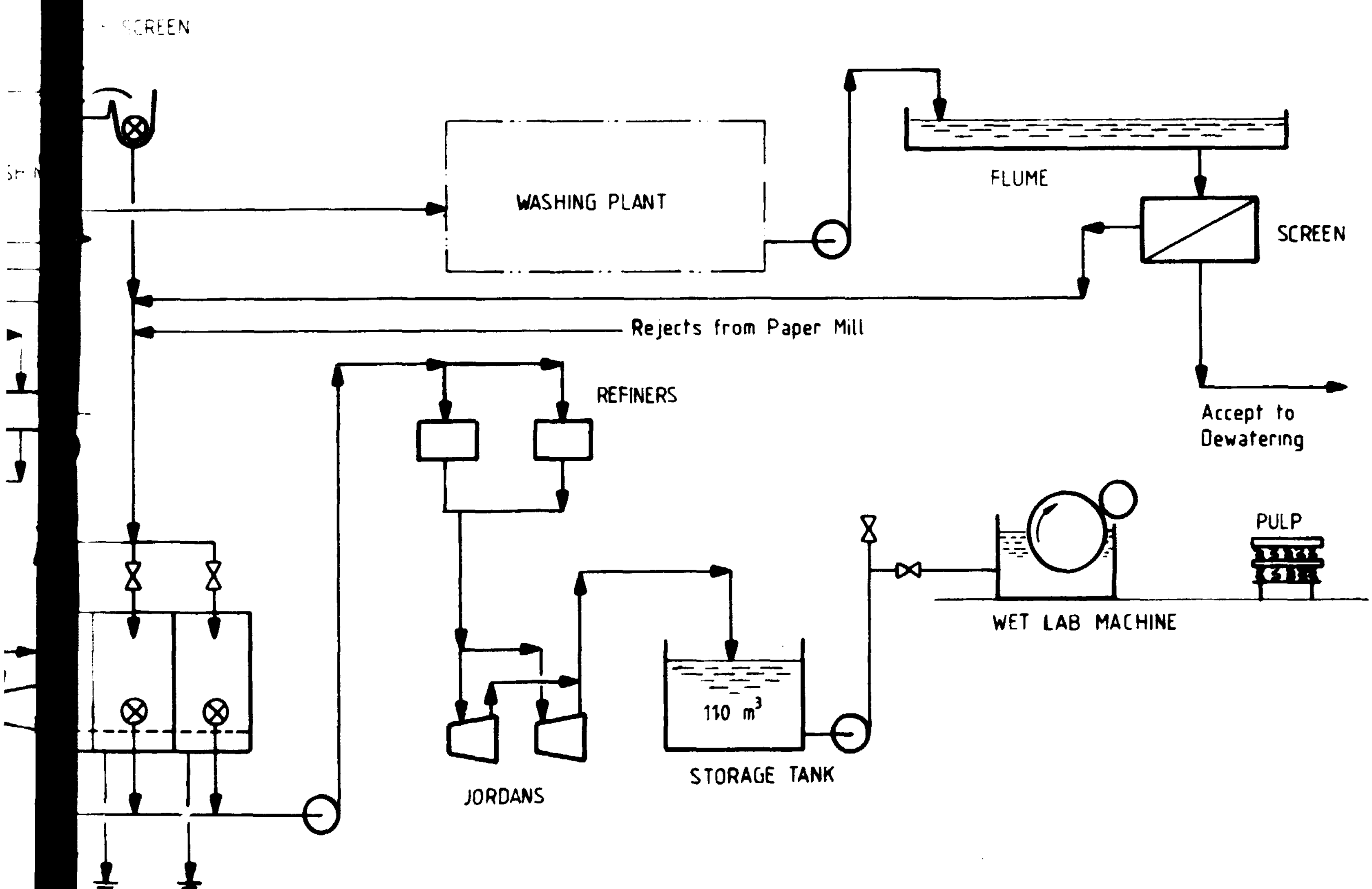
One log debarker
Horizontal chipper
Chipper screen
Secondary screen in the pulp mill
Two-stage refining
Centricleaners
Pressure screen
Headbox
Pocket ventilation
Fibre recovery system

It is also recommended that the nominal production rate should be increased at the same time as the modernization takes place, since there is a potential capacity excess in the machinery. The extra investment costs of a production of 30 000 tonnes per year will be marginal. At this production level it will not any longer be necessary to import sack kraft paper. The investment might be paid off in one to two years. This type of venture is strongly in accordance with the Juche ideals.

Before any major installations are decided upon for sack kraft paper quality improvements, a program for the necessary reconstruction must be made. It is therefore recommended to make a study in order to determine the amount of all machinery, equipment, spare parts, piping and cabling which are to be used for the reconstruction and the modernization. The study should also include investment cost calculations and time schedule. Before the suggested study is carried out the desired nominal production should be decided upon and the amount of available fibrous raw material should be established.

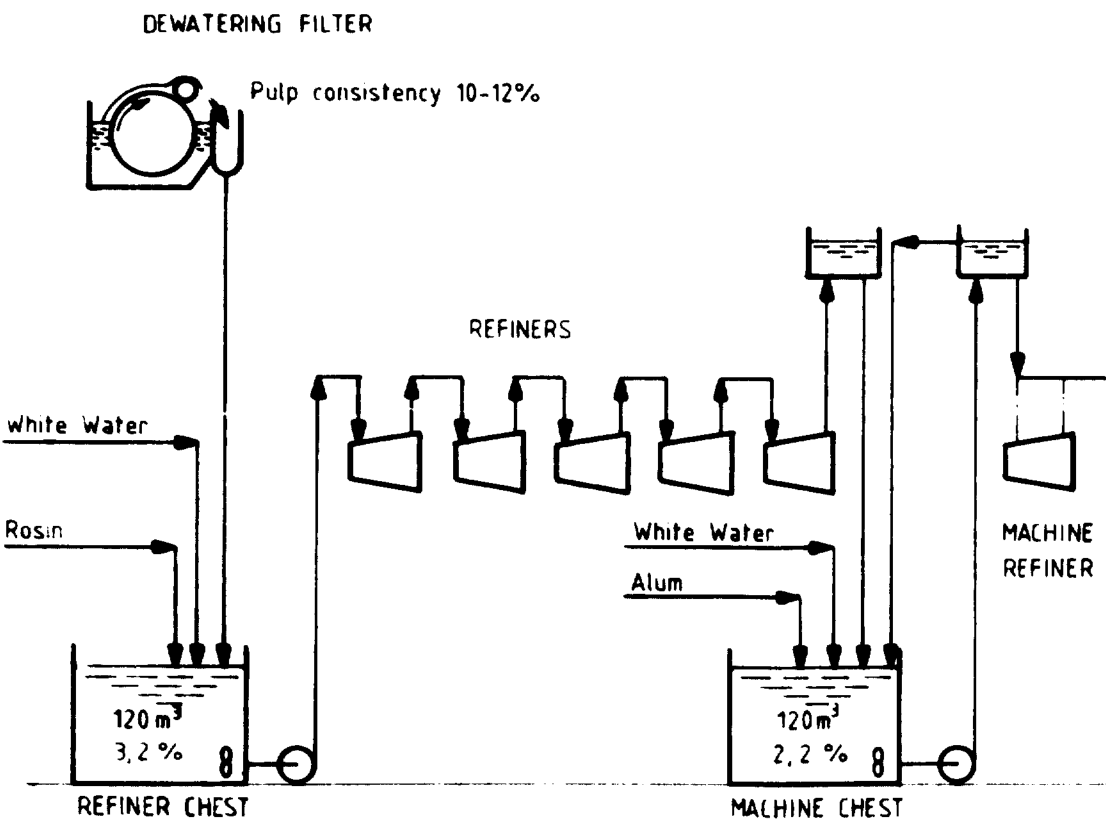

Strong Black
Liquor
Liquor Steam
COARSE SCREEN
BLOW
TANKS
JUNK REMOVERS
JORDANS

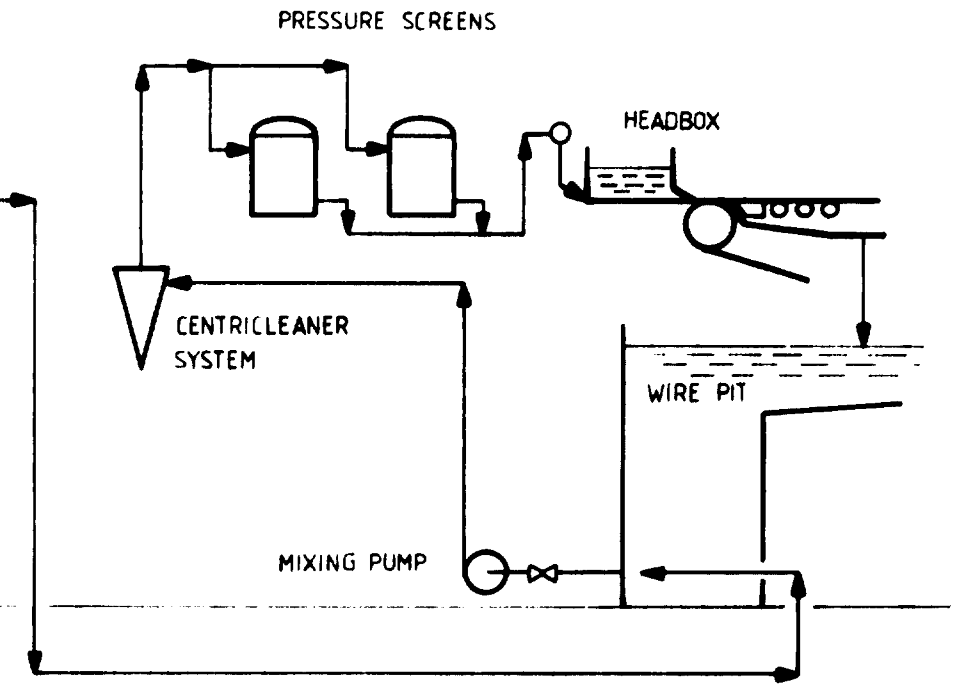
SECTION 1

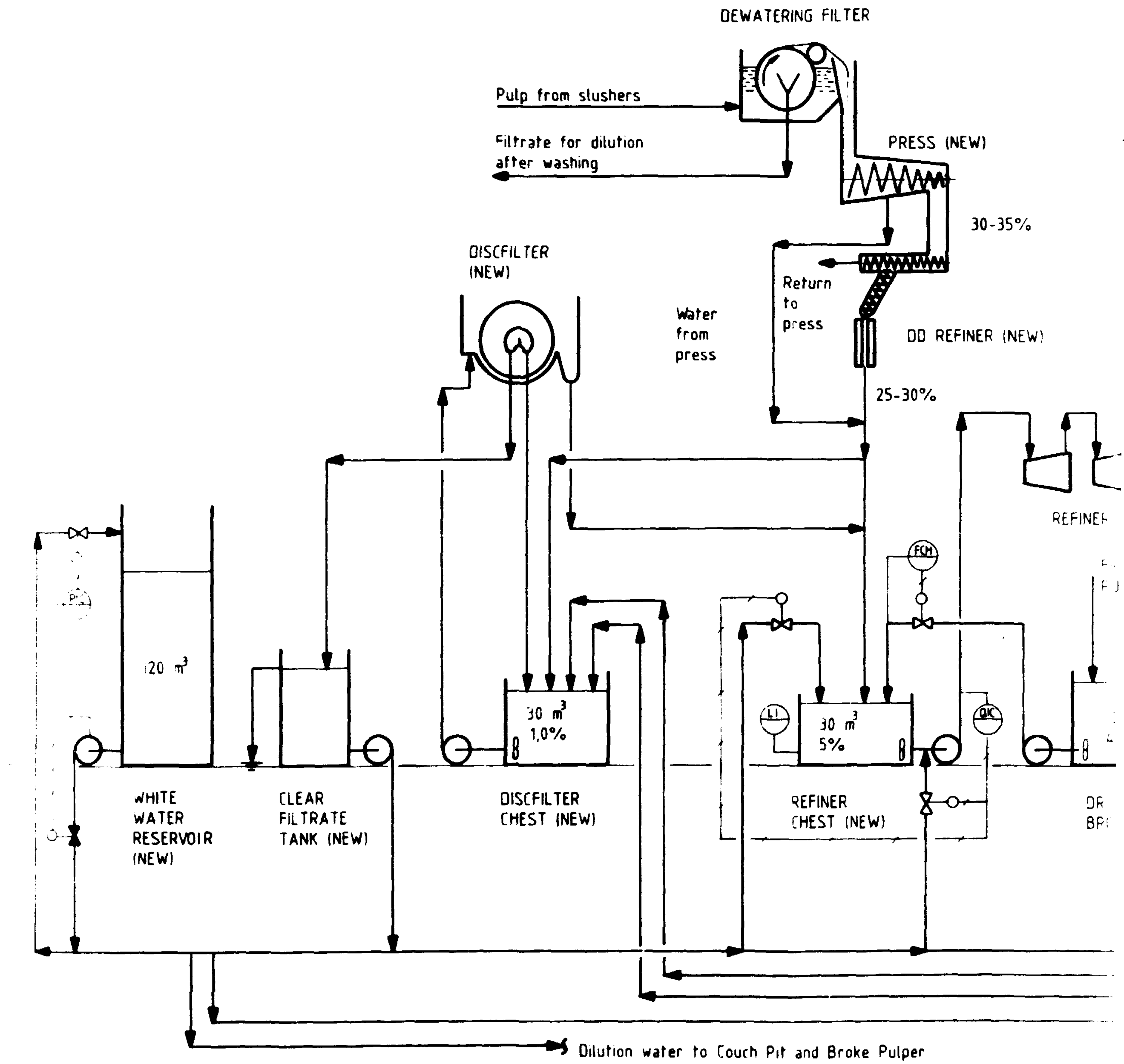

WASHING PLANT
FLUME
SCREEN
Rejects from Paper Mill
Accept to Dewatering
REFINERS
PULP
WET LAB MACHINE
110 m³
STORAGE TANK
JORDANS

SECTION 2

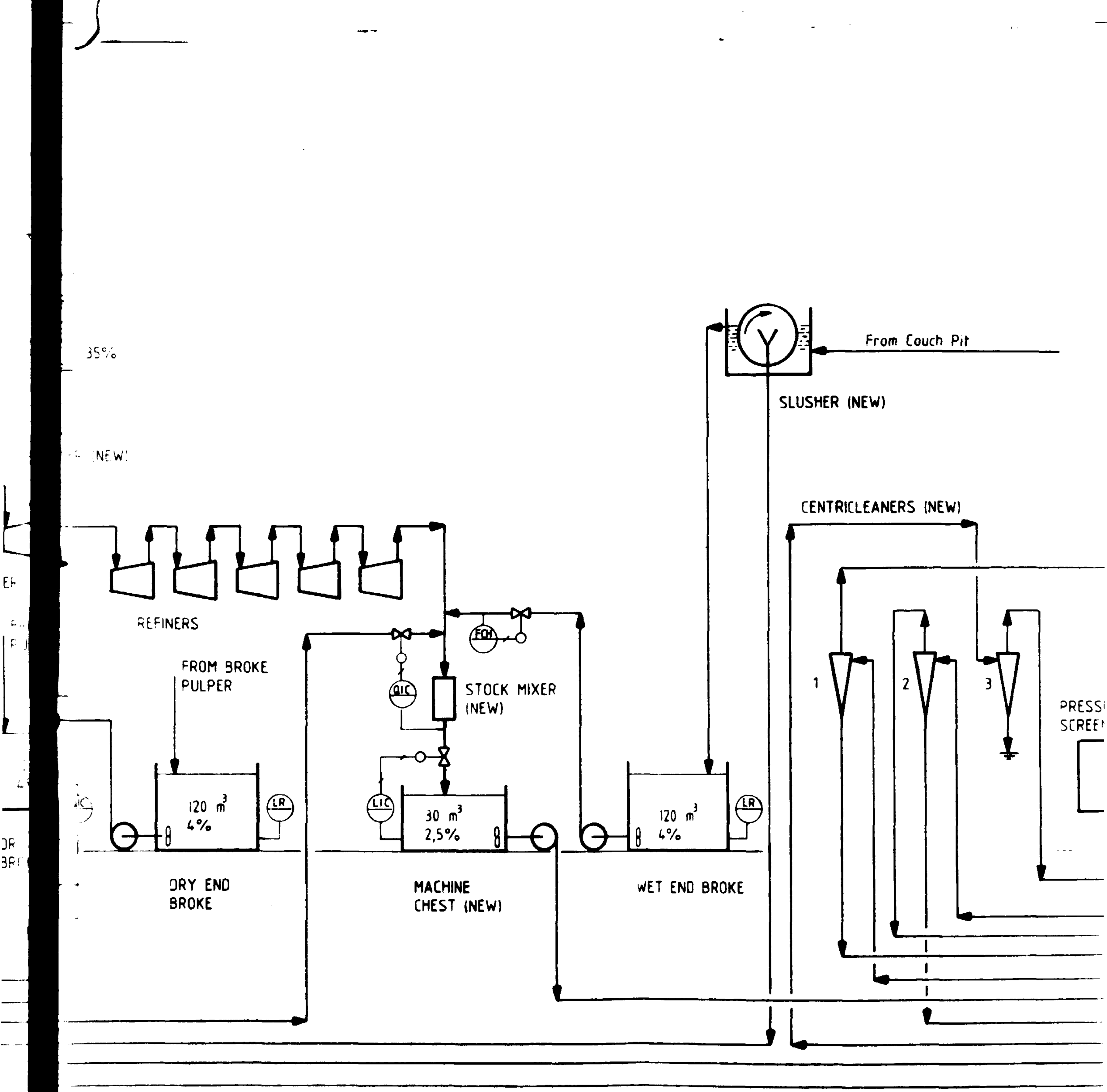
STOCK PREPARATION




PRESSURE SCREENS
HEADBOX
CENTRICLEANER
SYSTEM
WIRE PIT
MIXING PUMP

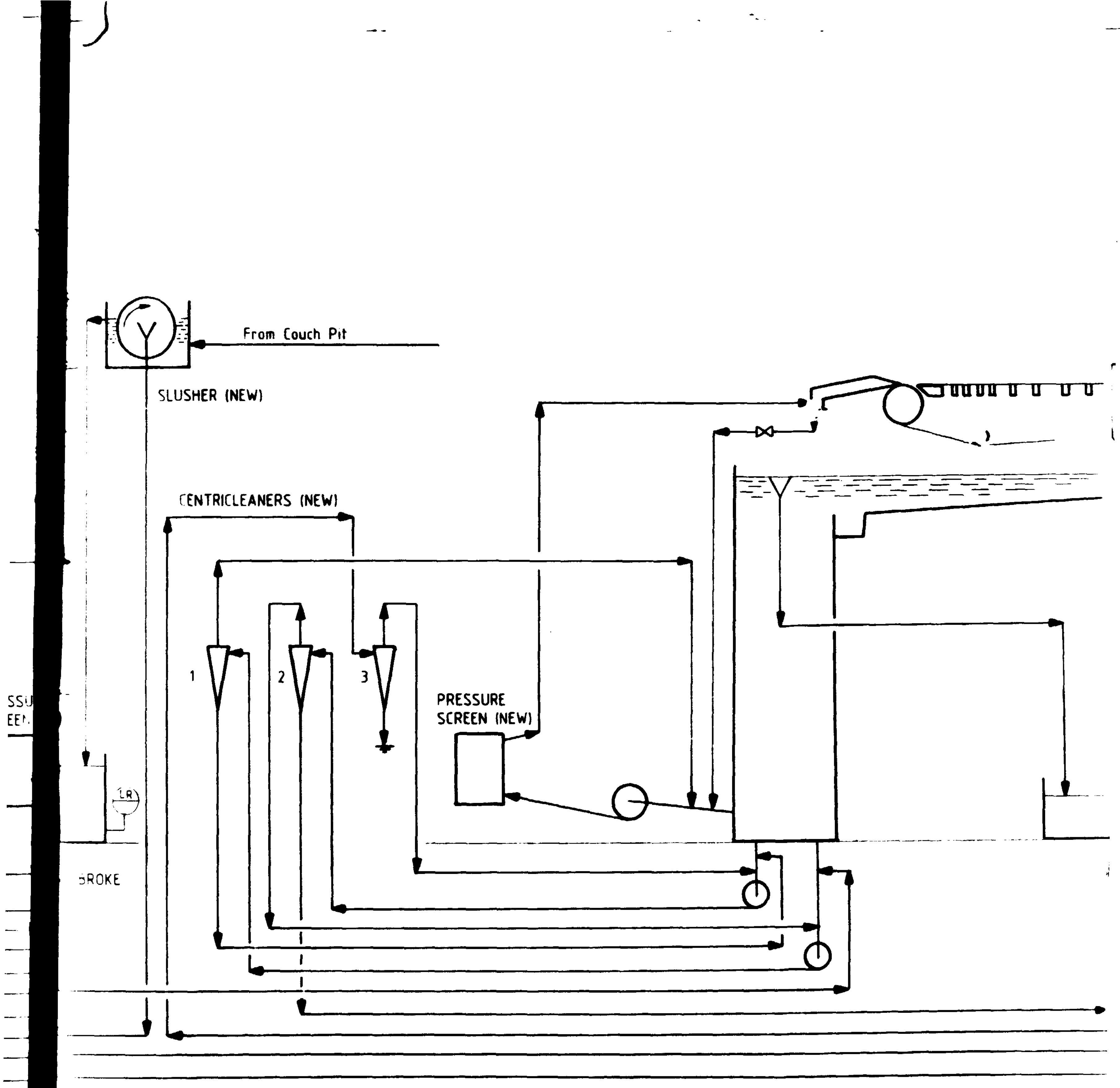

DEWATERING FILTER
Pulp from slushers
Filtrate for dilution after washing
PRESS (NEW)
30-35%
DISCFILTER (NEW)
Water from press
Return to press
DD REFINER (NEW)
25-30%
REFINER
120 m3
30 m3 1,0%
30 m3 5%
WHITE WATER RESERVOIR (NEW)
CLEAR FILTRATE TANK (NEW)
DISCFILTER CHEST (NEW)
REFINER CHEST (NEW)
Dilution water to Couch Pit and Broke Pulper

SECTION 1



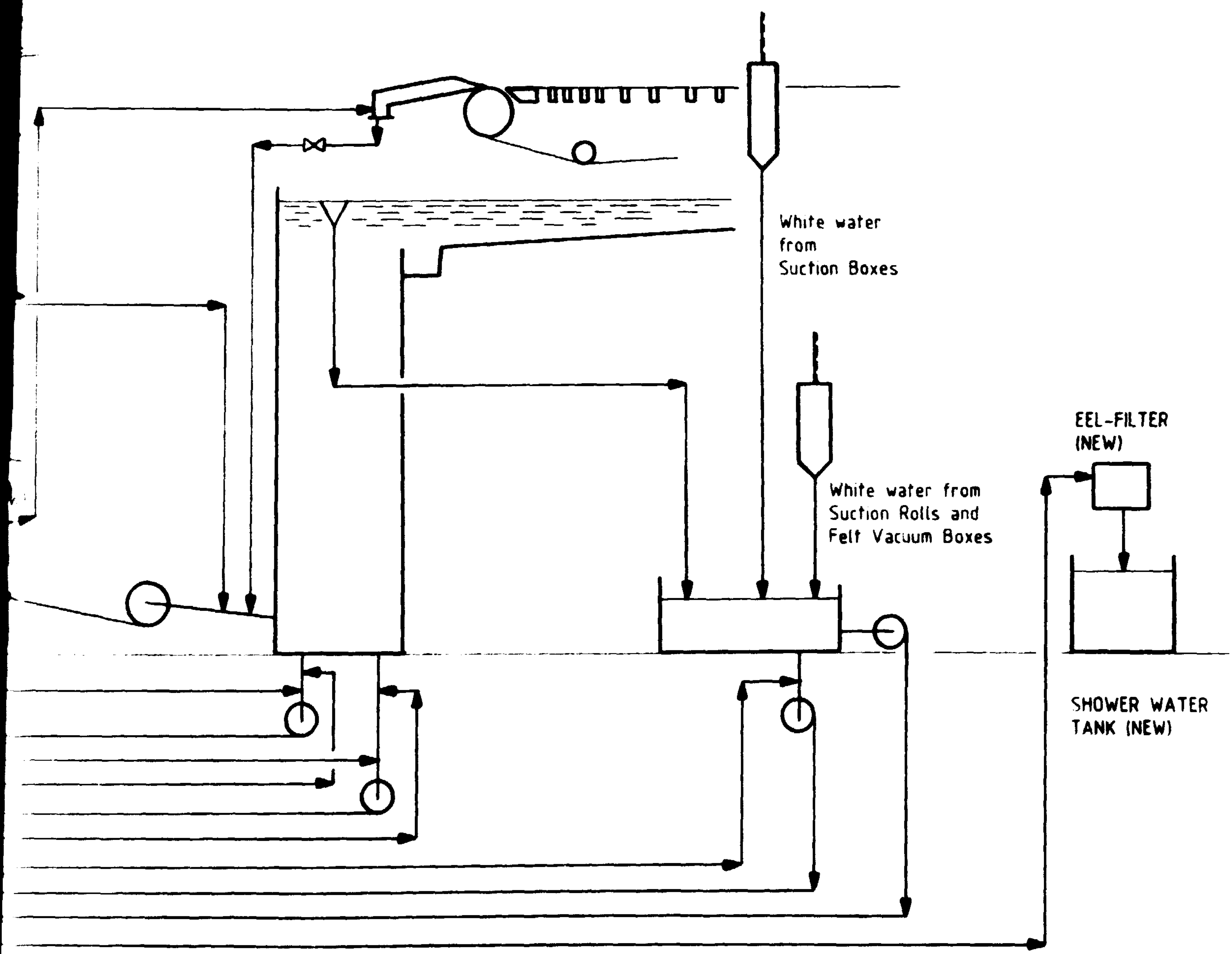
35%
(NEW)
From Couch Pit
SLUSHER (NEW)
CENTRICLEANERS (NEW)
REFINERS
FROM BROKE PULPER
STOCK MIXER (NEW)
QIC
FQH
LIC
LR
120 m3 4%
30 m3 2,5%
120 m3 4%
1
2
3
PRESS SCREEN
DRY END BROKE
MACHINE CHEST (NEW)
WET END BROKE

SECTION 2



From Couch Pit
SLUSHER (NEW)
CENTRICLEANERS (NEW)
1
2
3
PRESSURE
SCREEN (NEW)
LR
BROKE

SECTION 3


White water
from
Suction Boxes
White water from
Suction Rolls and
Felt Vacuum Boxes
EEL-FILTER
(NEW)
SHOWER WATER
TANK (NEW)

SECTION 4