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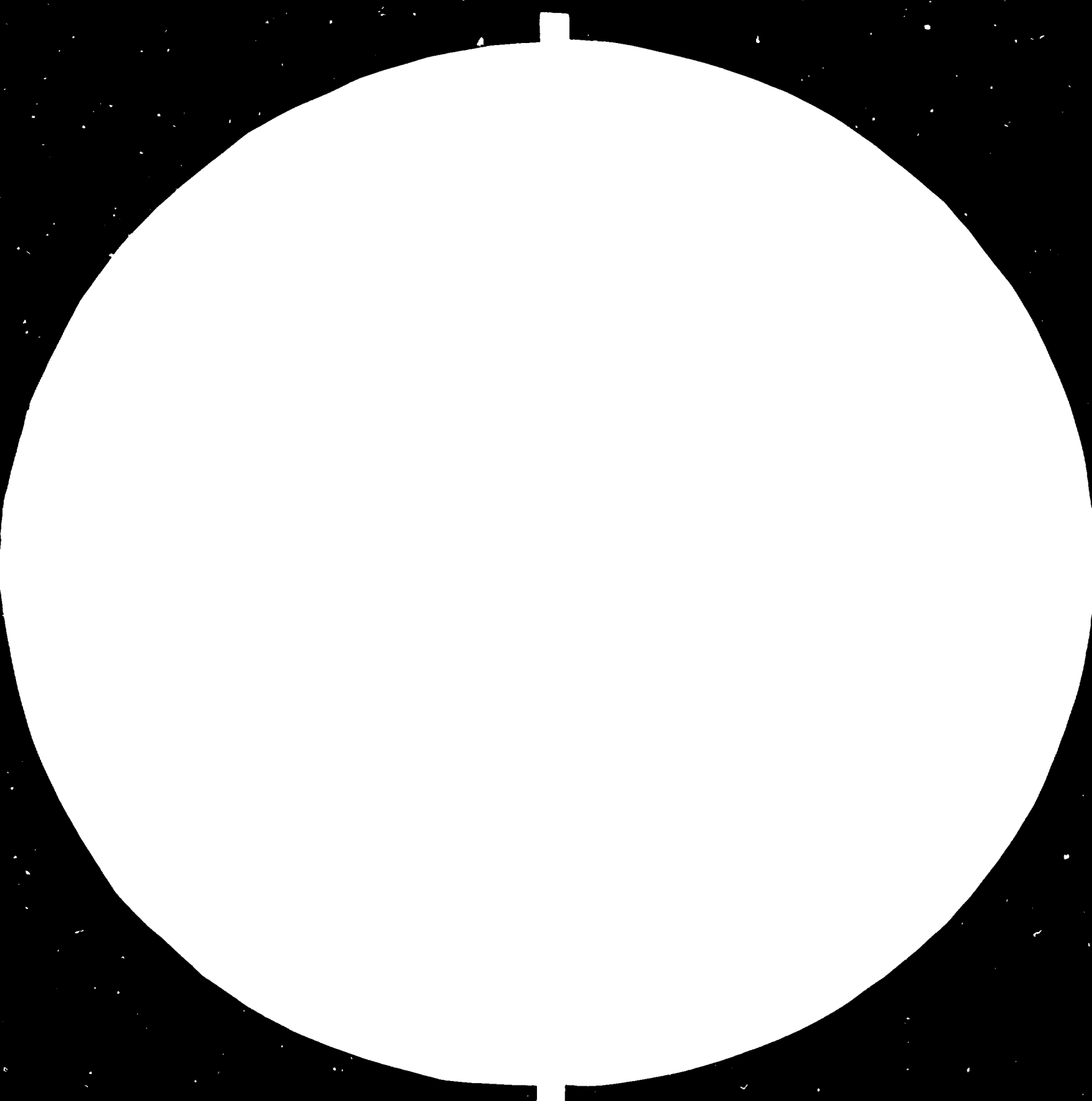

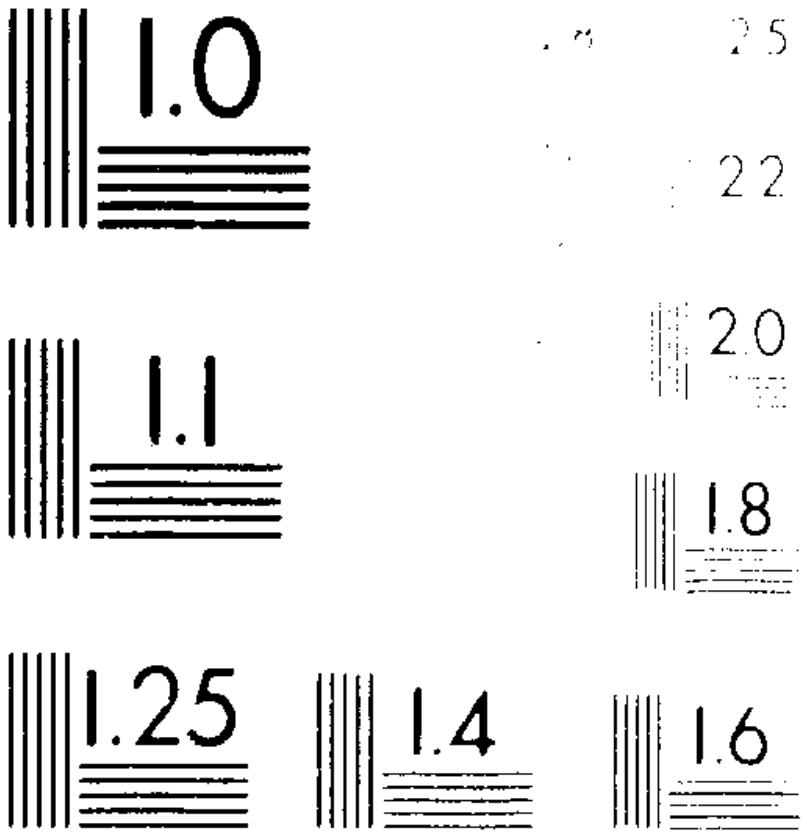
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DPR Korea.

KRAFT PAPER PRODUCTION IN THE HYESAN KRAFT PAPER MILL

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

[redacted]

THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

Second Mission Report

Prepared for the Government of DPRK
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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FOREWORDS

The expert's counterpart, Mr Zang Bong Un, and the interpretor, Mr Zo Ho Sung, were the same as on the first mission.

At the Hyesan Pulp and Paper Mill Mr Li Chung Sik and Mr Se Dong Hyon were the hosts.

The UNIDO expert herewith thanks them all as well as the UNDP office for the valuable assistance and co-operation.

1 SUMMARY

The subject of the second mission to the Hyesan Pulp and Paper Mill in the Democratic People's Republic of Korea was to confirm how the recommendations given after the first mission had been followed.

Some of the recommended improvements concerning the process had been made and were reported to be satisfactory. On top of that, the mill had planned and carried through a couple of installations on their own initiative to improve the paper quality. This looks very promising for the future.

On the other hand, no actions had been taken in ordering either good machine clothing or essential spare parts. The endeavour to repair and make own spareparts might have increased.

The cleaning up actions regarding electrical cabling, motorboxes, transmissions and safety devices had been started but there are still some actions to be taken. Unfortunately nothing had been executed in order to introduce good lighting conditions or to renovate structural matters, such as stairs, window insulations, floors etc.

There were very few possibilities given to establish an adequate project for a good fellowship training program.

The next mission to the Hyesan Pulp and Paper Mill should include continuous studies at the mill for at least a period of six months. During this period the adviser (or advisers) should assist the mill management for improvements of the pulp and paper quality, production and maintenance. The aim should also be to improve the skills of engineers and operators.

There is a wish by the Ministry of Building Material to modernize the mill. In order to do that an intensive preengineering study has to be carried out, which

should include the investment cost calculations. The study should also deal with the future capacity, production rates and fibrous raw material resources.

In order to minimize the risks of a costly modernization program, the mill should, at first hand, be fairly well reconstructed. This can be done by purchasing necessary spare parts from China. Another solution would be to install second-hand, but modern equipment and machinery. This can be a quicker way to fully refurbish the mill and with far lower investment costs and almost no risks, if the planning is first class.

For any further missions to DPRK or any project work there, it is herewith requested that the program for the visit can be decided upon beforehand.

2 INTRODUCTION

2.1 Project Background

The purpose of the second mission was to follow up the results of the recommendations for immediate actions given in the first mission report of 30 March, 1984. Another object was to give more direct recommendations regarding fellowship training program of pulp and paper-millengineers. A further prospect could be to prepare necessary project proposals.

Unfortunately, all the measures recommended after the first mission had not been taken. Therefore the mill remains in rather an unacceptable condition and the paper quality is still inferior. However, the UNIDO expert was given the impression that the overall condition of the mill had been improved even though it seemed as if the capacity was poorly utilized.

The possibilities of preparing a training program are still not adequate, since the expert was not allowed to make the necessary studies at the training centres as suggested in the first mission report. Two universities in Pyongyang were visited but the result was not satisfactory.

In the first mission report it was recommended that a representative of the Chinese company, that had supplied the machinery should make a visit to the mill in order to prepare a specification with prices of spare parts. This had not been done even as there is a working force from the Chinese pulp and paper machinery supplier at Haeju City, where they are erecting a pulp and paper mill. Details about this mill were not available to the expert.

Before the mill visit, the UNDP- office tried to come into connection with the chief engineer of the Chinese group. They visited the Chinese embassy but it was not possible to establish a contact at that time due

to the Chinese 35- year celebrations. It would have been very useful if the Chinese chief engineer could have joined the mill visiting team.

In the first mission report it was also pointed out that fabrics (dryer wires) should be used instead of cotton felts, especially in the last dryer sections. For that reason a suitable supplier should have been consulted. No actions in this respect had been taken.

A great deal of the information given in the present report has been supplied by the technical leaders at Hyesan and by the counterpart.

2.2 Project Duration

The second mission of the project started on 1984-09-14 when the expert was briefed by UNIDO in Vienna. The arrival at Pyongyang took place 1984-09-18. The UNDP office there was visited as well as the Kim Il Song University and the Kim Chak Polytechnical University.

Studies at the Hyesan Pulp and Paper Mill were undertaken between 1984-09-26 and 1984-10-01 which includes the train travelling time.

In the second mission the Ministry of Building Material had included almost only visits to some popular recreation places. The expert strongly objected to this program, and at a meeting on 1984-09-20 in the presence of UNDP it was further pointed out that the second mission should be meaningful to the project. The program could however, only be partly changed. The visit to the Hyesan Mill could be made on September 25th instead of October 2nd. At the meeting it was also decided that Mr Li Song U of the UNDP office should participate in the visit to Hyesan in order to make it more worthwhile.

A handwritten draft was given to the UNDP office before the departure on 1984-10-05. Chapter No 1 had

not been completed at that time.

The debriefing took place on 1984-10-08 in Vienna. One copy of the revised handwritten draft was handed over to UNIDO.

2.3 Mill Organization

The mill organization chart is presented on the next page. The names of the technical officers have also been included.

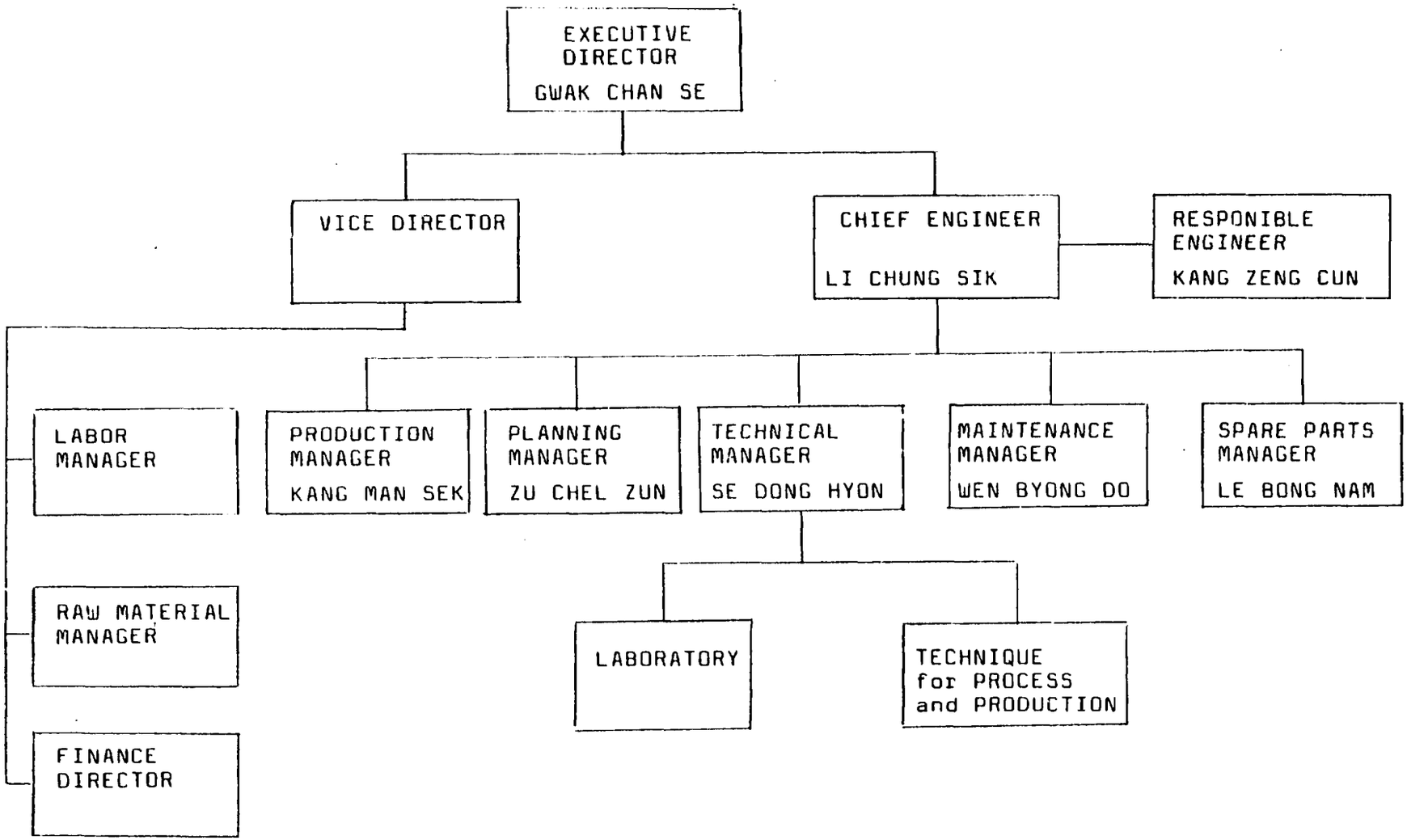
The organization system shown on the chart is the common one for the mills within DPRK.

The technical leaders which collaborated during the mill visit were:

- Mr Kang Zeng Cun, Responsible Engineer, who is in charge of the introduction of new techniques.
- Mr Se Dong Hyon, Technical Manager, who is the chief of the laboratory and the technique for production and processes. Mr Se was also present at the first mission.

Mr Li Chung Sik, Chief Engineer and second to the Executive Director was participating of the first mission but was not present this time due to other assignments in Pyongyang. Mr Li is in charge of all technical processes and the production.

This section is written for possible future purposes.


EXECUTIVE DIRECTOR
GWAK CHAN SE
VICE DIRECTOR
CHIEF ENGINEER
LI CHUNG SIK
RESPONIBLE ENGINEER
KANG ZENG CUN
LABOR MANAGER
PRODUCTION MANAGER
KANG MAN SEK
PLANNING MANAGER
ZU CHEL ZUN
TECHNICAL MANAGER
SE DONG HYON
MAINTENANCE MANAGER
WEN BYONG DO
SPARE PARTS MANAGER
LE BONG NAM
RAW MATERIAL MANAGER
LABORATORY
TECHNIQUE for PROCESS and PRODUCTION
FINANCE DIRECTOR

2.4 Miscellaneous

The first mission report arrived to the Hyesan Pulp and Paper mill more than two months after edition. There are some corrections to be made in that report, namely:

- page 3.12 line 3 from the bottom. It should be 5m instead of about 6m.
- page 3.14 line 7. It should be caliper.
- page 3.15 line 11. It should be knock-down showers.
- page 3.21 line 7 from the bottom. It should be steel-bands.

After the first mission some books, broschures and laboratory reports have been supplied to the Ministry of Building Material, which have been forwarded to the Mill or the Wood Research Institute of Hyesan. The following main material has been delivered.

- Operating manual entitled Operating Difficulties on Fine, Kraft and Speciality Paper Machnes 1979 TCPPA.
- Alcaline Pulping, a compendium by Carl Gustav Geijer and Sven Erik Dahl, Sveriges Skogsindustriförbund.
- Debarking machinery brochures
  Cambio
- Laboratory equipment brochures.
- Lab reports
  Frövifors AB for pulptest
  Fiskeby AB, Skärblacka for paper test.
- Specification for a second hand kraft paper machine.

3 THE MILL STATUS

3.1 General

In the first mission report the Hyesan Pulp and Paper Mill was described briefly as well as the processes including some data. The main description will not be repeated in this second mission report, which means that the reader of this report must be familiar with the first report. However, some details will be more outlined as, at the last mission, it was easier to inspect some departements due to better daylight and improved conditions. It was also easier to reach some specific machinery at some locations which were heavily flooding at the first mission. On the other hand some departements and locations where not visited at all due to lack of time and the fact that the mill was shut down most of the time. The chemical recovery system was not in operation at all.

The text in this chapter will also deal with actions which have been taken since the last visit.

The mill was not running on the arrival. It was started on 1984-09-28 but was stopped later that afternoon and was not started since. During the few hours of operation, ordinary kraftpaper was produced.

In order to have some material for continuing the work at the home office, the expert requested some drawings or the possibility to take photos of some vital items. Both these subjects were declined. In order to prepare for the preengineering project all the necessary material must be available.

3.2 Woodyard, Debarking and Chiphandling Systems

The woodyard storage area was almost empty this time. Two of the three debarkers, both overhead cranes as well as the drum debarker was told to be in good working order. This machinery was not in operation at the visit.

There are two conveyors to transport the logs from the

woodyard on to the conveyors leading to the sawing operations, where the logs are cut into smaller lenghts.

The logbundles are lifted onto the first mentioned conveyors by the woodyard overhead cranes. These cranes as well as the conveyors are in a good shape and need not be replaced for the time being. It must, however, be said that these conveyors are very primitive. There are two of them, one for 8m logs and one for 4m logs. The latter is used for logs to the drum debarker only. The drumdebarker is situated very close to the woodyard, which means that the chain conveyors before and after the sawblade are very short. At the side of the saw there is a splitter machine for splitting logs of too big diameter.

The drum dimension is ø 3m x 12m, in other words much too small for debarking dry wood. There is a system of steampipes for deicing logs in wintertime, but it looks inefficient, and probably consumes unnecessarily much steam.

For the time being nothing should be done with the system described. In the future, when good one-log debarkers are in operation, the drum debarker can be used for stand by purposes.

The chainconveyor for 8m logs is very long. The holders for carrying the logs are equipped with small wheels, one on each side of the holders. Many of these wheels are missing, which means that the wearing of both the beams and the holders must be heavy. It also makes an irritable noise. Some holders are also missing. The mill workshop should start immediately to put the conveyor back in its original shape, since it can be used also in the future as new debarkers should be attached to this conveyor.

In the first report it was recommended that the 8m logs should be cut into three pieces only, but this had not been followed. The request was now repeated

and trials were made. Naturally it will be more dangerous with longer logs when they fall into the duct, but on the other side there should be no people working at the duct. The operator shall be at the control table and only leave this position when trouble occurs. Before then the conveyor must be stopped.

The chip quality seemed to have been improved compared to the chipcollection from the first mission. It was said that the knives (four pieces on the rotor) are changed every six hours and that they are ground by hand in between. The knives are manufactured within the mill of common blacksteel. They are machine-groung on a grinding machine in a room close to the chipcutters. There was also a second grinding machine which will be converted to a knifegrinder later on. The grinder for the sawblades is also situated in the grinding room.

Both chipscreens were in operation but the main flow of chips was directed to the smallest screen, which was totally overloaded. The unwished result is that good chipsizes are also directed to the disintegrator. It is, however, not easy to change the installation. Instead the logcharge to the chipper must be controlled to suit the chipscreen capacity.

The desintegrator was working rather satisfactorily this time. The desintegrated chips are returned to the screens by means of an elevator.

There are plenty of long sticks rejected from the screens, which are used as fuel to fire an oven right beside the screenoperators.

The ducts were often plugged due to the heavy overload.

The accepted chips are transported to the chipsilos via bandconveyor-elevator- and finally another bandconveyor above the three silos. The chips can be directed to any silo by adjusting scrappers. The out-

feed from the silos is regulated with a mobile screw conveyor which feeds a bandconveyor system to the hippers above the digesters. Each digester is filled direct from the conveyor. The filling time is about 15 minutes.

There is a movable chainsystem in the bottom of the silos which is used when the chips are frozen together.

All those systems after the screens described above were said to work satisfactorily.

The sawdust from the saws are transported to a nearby plant for extraction of alcohol.

To summarize the wood and chip handling systems, the following has to be said:

- The outside debarkers must be replaced by one or two one log debarkers type Cambio or similar. If there are two debarkers one can be foreseen as stand by.
- The drumdebarkers including saw, chipper and chipscreen will in the future be used as stand by for the one log debarkers.
- The main chipper, chipscreen and desintegrator should be replaced. The new chipper should be of the horizontally type for full length logs.
- The chipper knives should be changed only when a need for that, which means that the operators must be trained to observe the structures of the chips when the knives have to be changed.
- The conveyor systems work properly but the maintenance must be improved. Some belts in the rubberbelt conveyors should be replaced.
- The moisture content should be measured according to earlier recommendations.
- With new machinery the dust problems will decrease and the working team can be reduced. The ope-

rators can thus be housed in a ventilated controlroom, which can be heated with steam radiators or electrical heaters.

- For the time being, i.e. before any reconstruction, the workers must be taught operative discipline.

3.3 Pulp Mill

3.3.1 Digester House

The main problem in the digester house are the heat exchangers attached to the digesters for heating the circulating cooking liquor. No pain should be spared to solve this problem and actions have to be taken immediately.

The sulphidity has been increased according to the recommendations and the results was said to be good. The pulp strength properties and the brightness have been improved.

For each digester there are two recorders, one of which for temperature and one for pressure. They are working, except for one which is being repaired. The recorders are of the very old type with round diagrampapers, which should be changed every day, but this is not done as there is a shortage of diagram papers. Instead the ink colour is changed every day. If the recorders are used for controlling the digesting process, there must be adequate supply of diagram papers. At worst, also the back side of the diagram paper can be used.

Three other recorders of the same type are out of use. Two of them should record the level in the two blowtanks, but the level transmitters were continuosly plugged and have been dismantled. New transmitters of better design should be ordered and installed. The third recorder is meant for the steam flow and also this one should be used.

The blow tank agitators are still out of order. These agitators are provided with vertical shafts and located in the bottom of the blowtanks, which means that there will be a hard pressure on the bearings when the tank is full. A third, similar agitator is used in the storage tower after the washing and screening plants. Also this agitator is out of order. All three items are now being repaired. The prime adjustment will be to avoid leaking liqour to come into the bearings in the gearbox.

The odd system for emptying the blowtanks is still in operation. The pump was changed some time ago and the one now used is made of stainless steel.

There are two ventilator fans on the top floor of the digester house, one for the digester plant and one for the washing plant. They are only used in wintertime.

On the top floor there is also a condenser connected to all digesters in order to recover terpentine. The maximum output is 0,8 kg/ton pulp. The average figure is far lower and naturally at zero when hardwood is cooked.

The insulation of the tanks is in a bad condition, and parts of it have fallen off. New insulations should be fitted where necessary.

3.3.2 Coarse Screening and Pulp Washing

There are still only two coarse screens one of which is in operation and the other standing by. The function of the latter is not good, however.

The four refiners for handling the coarse screen rejects were said to be in a bad shape and to have bad performance. There is probably no idea to restore these refiners. An improvement would be to have only one discrefiner which should be fed directly from the coarse screens without any water dilution. A screw

conveyor should be installed to handle the screen rejects direct to the new refiner. The main reason today for bad performance is the great amount of water, and maybe something can be done in this respect with the existing system.

With a good system, including screening after refining, the coarse screen rejects could be used in the kraft paper.

The function of the washing plant was much better this time. Rather proper fiber cakes were formed on all four filters and the manual work had been decreased to only one person at the last filter, who worked there only temporarily using the hose to spread black liqour. All showers had now been installed and were in operation, even if some of them were a little plugged on the driveside. The agitators after the 1st, 2nd and the 3rd filters were now operating. Before the first filter there is no agitator at present but according to the drawings there should be. If one is available it should thus be installed.

Fresh, cold water is still used in the showers on the fourth filter, but it was said that provisions were under way to connect the showers to a hot water system. None of the riding rolls were operationable and the variable speed drive was still out of function. The promise was given that the riding rolls and the variable speed drive motor shall be repaired.

Another problem is the troublesome foam which is formed after the three first filters. It is obvious that the problems originate from air leakages in the system, and most probably in the joints between the moving and stationary parts at the filter black liqour outlets. The discs have been repaired many times and the screws holding the discs are also worn and do not fit. Advise was given how to solve the matter. An alternative would be to ask the supplier company the

best way to solve the problem, maybe with a new, improved design.

It was said that there is an insufficient amount of black liquor for dilution after the filters, which results in too high pulp consistencies. At the time for the visit only one of the black liquor tanks were flooding, but by no means heavily. The problems will most certainly be solved as soon as the air leakages have vanished. When there is less air in the liquor, the pumps will do a better work.

Unfortunately the black liquor pump suction pipes are unbelievably improperly designed. They are long with small diameter and have some times more than one elbow or valve. Such installations must create problems, especially when the liquor is hot and contains air. These conditions will cause cavitation problems in the pumps. It was also stated that the pumps are worn.

There is also a tendency to control the flow with the shut off valve on the pump suction side. This is a very bad practice and it adds to the problems. Information must be given to the workers how to operate and control the process machinery.

The drop legs from the filters to the black liquor tanks have been properly designed. There should be no need to install vacuum pumps. The main task is to get rid of the leakages. On one of the droplegs black liquor was streaming. The leak could not be found. This leak and others must be tightened.

The liquor consistency was said to be 9,5° Be after the first filter, 6-7 after the second and 3-4 after the third.

The mill's technical manager is of the opinion, that the washing capacity will not allow a through flow corresponding to a production of no more than 20.000 tonnes/year. With a properly maintained washing plant

the production can most certainly be higher.

3.3.3 Fine Screening and Dewatering

These departements were not visited due to lack of time. However, the slushers and the dewatering filter seemed to be in a good condition.

As said in the previous report, the screening plant has to be modernized. This could easily be done if second-hand machinery could be purchased. There is fully modern, but used equipment for sale.

3.4 Paper Mill

3.4.1 Refining

Only four out of the seven refiners were in operation. The consistency was raised to four percent but there are too many problems to maintain this consistency. Once again, the pump installations are very improper.

The installation in the refining departement is by no means up-to-date, and should be completely rebuilt. In order to make the right decision how to select the proper process machinery, it is necessary to make laboratory tests. This can be part of a preengineering project.

It also has to be pointed out that different wood species can have some effects on the refineing caraterithics. This means that it is necessary to calculate or decide how much of each species arrives in the woodyard.

3.4.2 Short Circulation System

The centricleaner system has been reconstructed and together with the pressure screens the process operates satisfactorily. The consistency has been improved and is now 0,35 percent instead of 0,5 percent. The result was said to be better strength caracteristics. The paper cleanness has, however , not been improved.

There is still much to be done with the reject systems.

The mill is now trying to reach 0,3 percent consistency in the headbox. The stock is indeed very cold, probably due to the use of so much fresh water in the process. The water flows have been decreased to a great extent. The basement floor was not any longer flooded as was the case before.

The agitator in the machine chest was in operation but the consistency seemed to be very low.

Once again there are too long and complicated suction pipes to the stock pumps. When consistency controls are installed in the system and higher consistencies are required, the pumps have to be properly fitted. It is also likely that all the pumps in the short circulation system should be replaced. This will be the case with a complete rebuild of the system which is necessary for both strength properties and cleanness.

Two other improvements have been made, one of which is for the process and the other one for safety reasons. The old wooden tank for dilution of alum has been replaced with one of stainless steel. It was reported that the consumption of alum has been decreased considerably without any problems with the sizing.

The safety improvement is that some of the old and dangerous wooden stairs have been replaced by new ones in steel workmanship.

3.4.3 Paper Machine

The defoaming shower system in the headbox was not in operation. Maybe the showers were plugged. As the foaming tendencies are very grave, the shower system must be functioning. If there are problems with impurities, filters should be installed.

A levelmeter has been engraved inside the headbox in order to calculate the outflow speed. The paper machine

speedometer is, however, still out of function. It was said that only the V-belt for the speedometer drive is missing. Why not order such a transmission belt and put the thing in operation. A reliable speedometer must be at hand.

The first rectifier roll is still not in operation. The roll has to be repaired and the motor had already been repaired according to statement.

Glad to say, only one of the table rolls was not rotating, but the on the other side, the suction boxes are in a bad condition indeed.

The riding roll seems to work satisfactorily. The web removal from the wire is straight and does not fluctuate.

The wire return rolls have cupper covers and seem to be unworn.

Bronze wires are still used. The wire is very poorly stretched, probably due to the inferior suction box covers.

The couch agitator was not in operation as the shaft was broken. A new shaft is under preparation.

The wire return water is heavily foaming. At a possible rebuild there must be a water silo beside the wire part on the drive side in order to avoid foaming. There is sufficient space for that, both on the operation floor and on the ground floor.

The vacuum pumps have been installed in the basement on both sides of the paper machine as well as under the wire part. Usually one tries to concentrate the vacuum pumps to only one location.

Some of the vacuum pumps were not in operation and it was said that the pumps are generally in a bad condition. The vacuum in the first press e.g. is only 280 mm Hg.

All three press felts are too wet as no suction boxes bave been installed.

The dryer felts, at least the bottom felts, are indeed worn. The bearinghouse for the first bottom dryer felt's feltdrying cylinder is still dismantled and accordingly the dryer felt runs wet. Obviously must the feltdryer be put into operation soonest possible.

Two of the dryer felts are woven by plastic threads. This is very uncommon and it is probably no improvement at all. Four additional felts of this type are kept in stock. It is once again recommended that open fabrics should be used and that experts from the suppliers must visit the mill in order to give the right advice. It was reported that the qualities were decided upon at the start up of the mill, and since then only one supplier representative has visited the mill. It is quite obvious that there are reasons enough for the very bad situation. Experts from the suppliers in question or others must visit the mill and thereafter give advice what felt and wire types should be introduced.

All feltguides are out of order which means that all guidance must be manual. Preparations should be made to put those guides operationable again.

The surface of the cooling cylinder and the pope roll are severely worn.

The reams from the winder are blown to the pulper underneath the pope roll by means of two fans, one for each tail. One of the fans was temporarily out of order, but the other fan was capable of blowing both strips. Otherwise this system and also the dry end pulper are working properly. There is a small rectangular broke chest beside the pulper. The chest has no agitator which means that the consistency must be very low. It is important to maintain a high consistency when refining the dry end broke.

It was said that the winder is not working satisfac-

tory. When the paper has a good flatness and the cross direction basis weight level is improved the winder conditions will most certainly be good.

The operation floor was filled with wrapped paper rolls to a great extent. The reason is that there are no paper roll storage facilities at hand. It is very inconvinient for the operating personnel as well as for the rolls themselves, which can be wetted and also destroyed. It should be worthwhile to examine the possibilities for paper roll storage. In the future when the paper mill capacity is fully utilized or the production may be twice as high, it will be essential to have such storage.

There are two recorders in the paper mill, both of them for steam, namely to record the steamflow and the steam temperature. The fluctuations were incredible. If there are any controls at all, they must be out of function, and must therefore be overhauled.

There are two piston compressors complete with coolers. They are located in a space of their own at the dry end of the paper machine room. One of the compressors had been dismantled for repairs.

3.4.4 Paper Machine Room

The working conditions at summer time were naturally more favourable than in the winter. Precautions for next winter had not been taken. Maybe the steamleakages in the dry end were not so frequent, but they have to be tightened and the windows must be insulated before the winter.

The roof has an underseeling so it might be well insulated.

Some measurements were recorded:

- ℄ length between outer concrete columns= 6m
- height between operation and ground floors = 5m

- ℄ length between breastroll and couch roll= 11m
- ℄ " " " " 1st drying cyl = 21.4m
- total machine room width 18m
- ℄ width between main coloumns 13.0 m

There are three rows of windows on the tender side but only the lowest row has windowpanes. The other rows have been blindfolded. One row is above the crane beams and two below. There is no reason for not opening windows to the daylight. They can be designed to filter the heat from the sun.

There are only six lamps on the operating floor and they are all on the tender side. They have no reflectors.

In the basement and the drive side there are no lamps at all. There is no excuse for not installing proper lighting which is absolutely necessary for operating, maintenance and safety reasons. After discussions it was said that new efforts would be made to install lamps. It is herewith suggested that lamps should be installed on every column or every second column right under the crane beams on the tender side and on the drive side above the paper machine wet end. Additional lamps must be installed on the drive side so it will be possible to look through the dryer section, to observe the paper stretch and adjust the draws. Also the tender side and drive side in the basement must have proper lighting.

One evening during the last visit the expert wanted to have a look on the bottom dryer felts and it took a considerable time before a lamp was mobilized and put into function. It is therefore also suggested that a number of additional wall sockets should be installed in the building.

3.5 Chemical Recovery System

The recovery system was not in operation during the visit. The overall system is not exactly in a good con-

dition. It seems that mostly the auxiliary equipment such as pumps, vacuum pumps, heat exchangers, instrumentation are the weakest links in the chain.

There are two storage tanks for black liquor from the washing plant. Each of them has a volume of 400 m^3 which means a considerable storage capacity. The consistency is around 9,5° Be.

The evaporation plant has five steps and with two stand by items for the fourth and fifth step. The black liquor has after the evaporation a consistency of 27° Be. The intermediate storage capacity after evaporation is 2x 80 m^3.

Some soap is extracted. The quality is not good and it is used for internal purposes only. The system has been started up recently.

There are three Calcinating Kilns only one of which was in operation at the time. The black liquor is received into a rotating drum where it is met by the hot gases from the burner. The extracted green liquor is cooled in a tank under the burner.

The hot gases are passing a boiler having heated the black liquor in the rotating drum. The steam produced has a low pressure. Before entering the chimney the exhaust gas is used in a second stage evaporater where the black liquor is increased to 30° Be. The evaporater design is of disc type.

The calcinating takes place in a number of tanks.

The function of the lime filter was said to be insufficient.

It is obvious that the entire recovery plant is ready for an overhoul. The black liquor burning system should be replaced by an ordinary recovery boiler. There is space enough if one of the existing burners will be dismantled.

3.6 Service Facilities

The sevice facilities were not inspected at all. On the other side no actions have been taken to improve the maintenance systems as was strongly recommended in the first report. As it might be difficult to organize a good system for the time being it might be better to build up a new organisation within a possible preengineering project. This does not mean that no spare parts should be purchased now; quite the contrary, the necessary spares should be ordered soonest possible.

3.7 General Observations and Remarks

As said earlier some improvements have been made. Some dangerous wooden stairs have been replaced with steel structures. Safety devices for transmissions and couplings have been installed and only a few unprotective units were observed.

It was also observed that the v-belt drive transmissions had properly been adjusted with one exception, namely the v-belt drive for the chipper. Some of those v-belts were too long.

The floors are at many places in a rather bad condition and should be repaired. Some concrete and steel stairs should also be repaired.

It seemed that some electrical improvements had been done but once again it must be mentioned that the lighting conditions are indeed poor.
There are quite a few motors missing. It seems that all the original Chinese motors have to be repaired, as domestically manufactured motors are too big and thus do not fit in on common baseplates. This condition seems odd as motorsizes have decreased quite a lot during the years due to improved design. There is now an international standard in existence which means that different manufactures have the same outer dimensions

for each power, which also is standardized.

The building structures seem to be in a good condition and should therefore be suitable for a rebuild of the mill. The matter must naturally be investigated now or at the latest during a preengineering phase in order to make the necessary repairs.

The pulp and stock chests are of an oldfashioned design. The pulp mixing efficiency is low and the possibility to maintain a high consistency, i.e. 5-6 percent can be neglected. It is therefore necessary to replace some of the chests with a new type combined with good agitators, especially in the paper mill.

The odd type of valves used today should be replaced with up to date equipment.

There is one set of blue print drawings inclusive flow-sheets, layouts, structural, machinery etc. from the mill supplier. It seems as if they cover the entire installation. The drawings are technically excellent but the blueprints have with the time been much worn. Before a possible preengineering phase at least two sets of new blue prints should be ordered from the original supplier. They should be translated into English, as there is now only Chinese text.

3.8 Production

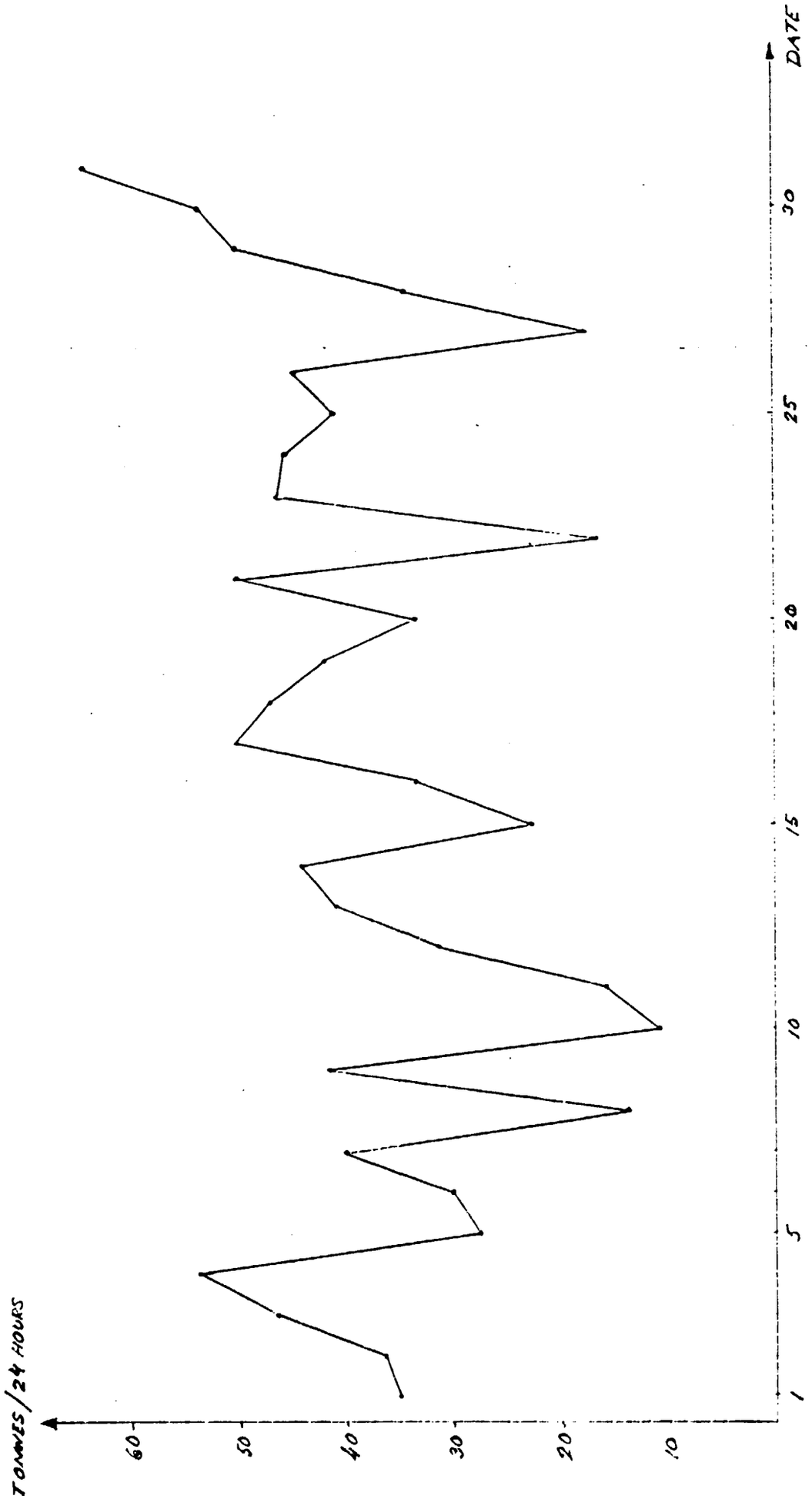
The designed max speed of the machine is 320m/min which means a capacity of 118 tonnes/day with the basis weight of 80gr/m^2. With an efficiency of totally 80% and 320 operating days the yearly production should be 30.200 tonnes. Compared with Scandinavian conditions an efficiency of 80 percent is a very low figure even when the number of operating days is 350. The actual total efficiency today is extremly low, even when maximum speed of 170m/min is considered corresponding to 64.5 tonnes/24 hours. With an actual production of 15.000 tonnes annually the efficiency is only 72.5 percent.

Production statistics were asked for and the journal for the month of May was presented. The total production during that month was 1189,9 tonnes, 1033 tonnes of which kraft paper, 110.4 tonnes sack kraft, 27,1 tonnes box paper, 14,8 tonnes unsized, 8.7 tonnes floor paper, 9.7 tonnes notebook paper, 24.8 tonnes newspaper and 19 tonnes packing paper. As seen there was very little sack kraft paper manufacured that month. It is surprising how many paper grades there are in the production program.

On the diagram next page the daily production throughout the month have been drawn. The curve shows distinctly the difficulties to maintain a constant production. The consumption of chemicals was 1189 tonnes sulphate, 28 tonnes soda and 62 tonnes wet web pulp.

Many products are manufactured from the waste paper. The following quantities were reported for May. Cut paper 6.9 tonnes, packing paper for welding electrodes 0.7 tonnes, sand paper sheets 45.400 pieces, envelopes 297.000 pieces, sealing board paper 25 tonnes and water unabsorbent paper 17.700 m^2. The departments for manufacturing all these items were not visited.

In order to increase the capacity to a production of 30.000 tonnes/year digester will have to be added. If not the washing capacity can be increased, a new washing plant has to be considered. The paper machine capacity can easily be increased as there is a sufficient number of drying cylinders. The capacity of the recovery plant is very difficult to estimate.


TONNES/24 HOURS
60
50
40
30
20
10
1
5
10
15
20
25
30
DATE

4 PULP AND PAPER QUALITY

At the the first mission some pulp and paper samples were collected and later on tested in Sweden. The tests had not been concluded when the first report was issued. The pulp test results are presented on the next two pages and are concentrated and commented on in the text underneath.

The pulp sample was taken from the dewatering filter and and somewhat dried for the long transport. It was tested at the Frövifors mill after beating in a laboratory beater type Wennbergs. The test results have been compared with Frövifors standard pulp according to the table below. The tests have been made at 25° SR and 45° SR respectively.

	25°SR		45°SR	
	Hyesan	Frövi	Hyesan	Frövi
Beating time, Rev	4300	4900	8500	8500
Tensile index	116	100	125	108
Burst index	7.8	7.3	8.4	8.0
Tear index	8.6	11.0	7.8	10.0
Berndtsen	-	-	15	-
Porosity, Gurley	~100	20	very high	140
Density	710	700	730	740
Klemm	18	20	10	10
Dewatering time	5.6	5.0	8.4	6.6

The Hyesan pulp has better tensile and burst caracteristics which however are not so important for cement bags. The tear index is on the other side declining very rapidly as soon as the beating takes place. The initial tear index is very high and some research work must be done in order to find out the extremely rapid drop in tear index. Usually the tear index first increases when the beating action is started and thereafter declines. Another matter already discussed are the porosity values. The Hyesan paper is tight, i.e. not letting air pass through easily. This is another effect to be studied in order to find the most suitable bea-

FRÖVIFORS BRUK AB

Pulp evaluation report

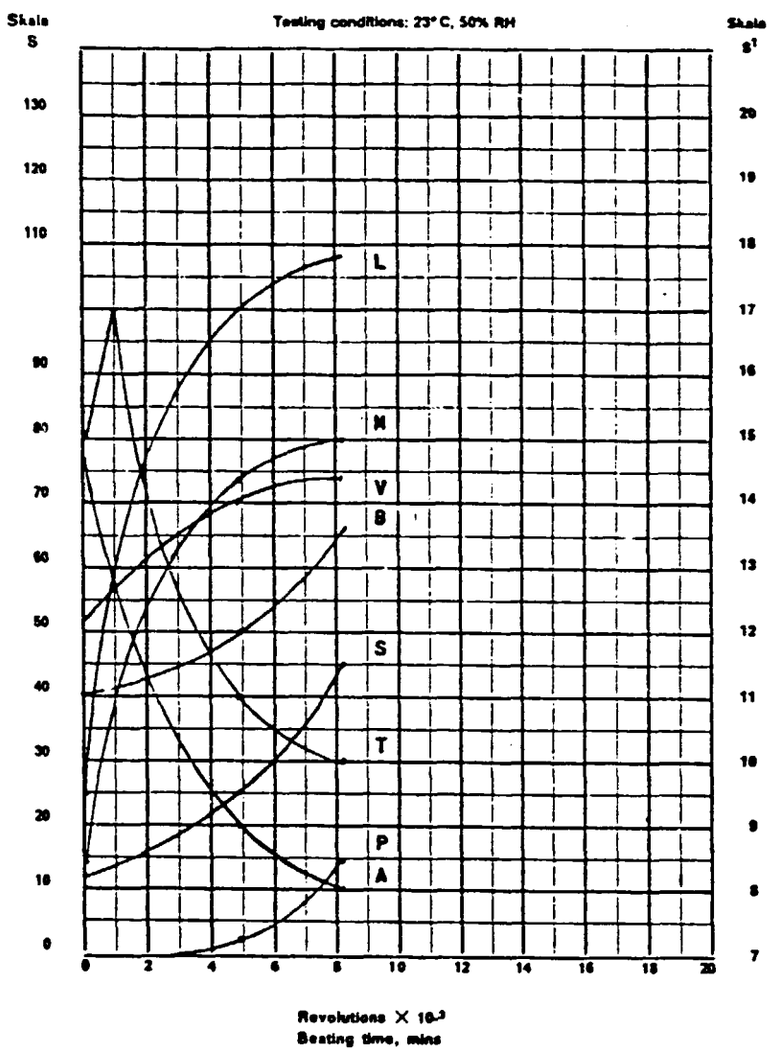
Beater: PFI Date January 1984

Quality: FF 60 FD

Manufactured: Average

Machine: UM 3

Hardwood	%	10
Clorine number (Roe)		6,1
Kappa number	SCAN	37
Ash content	%	0,65
Conductivity	mS/m	12,0
Shives	mg/100 g	100
Ethanol extr.	%	
Dichlormethane extr.	%	
pH-cold water	SCAN	7,0
pH-warm water	BS: 231	7,5
Sodium	mg/kg	600
Calcium	mg/kg	1600
Brightness	% ISO	28,0



Beating time mins; Rev.			0	4900	8200					
Slowness	S = S	°SR	12	25	45					
Tensile index	L = S	kNm/kg	25	100	108					
Burst index	M = S×0.1	MN/kg	1,4	7,3	8,0					
Tear index	T = S¹	Nm²/kg	15,0	11,0	10,0					
Bergman number	M×T×0.01									
Air permeability, Bendtsen		cm³/min								
Gurley number	P = S×10	s	-	20	140					
Density	V = S×10	kg/m³	520	700	740					
Absorptivity, Klemm	A = S	mm/10 min	77	20	10					
Dewatering time in sheetform	B = S×0.1	s	4,0	5,0	6,6					

Remarks:

FRÖVIFORS BRUK AB

Pulp evaluation report

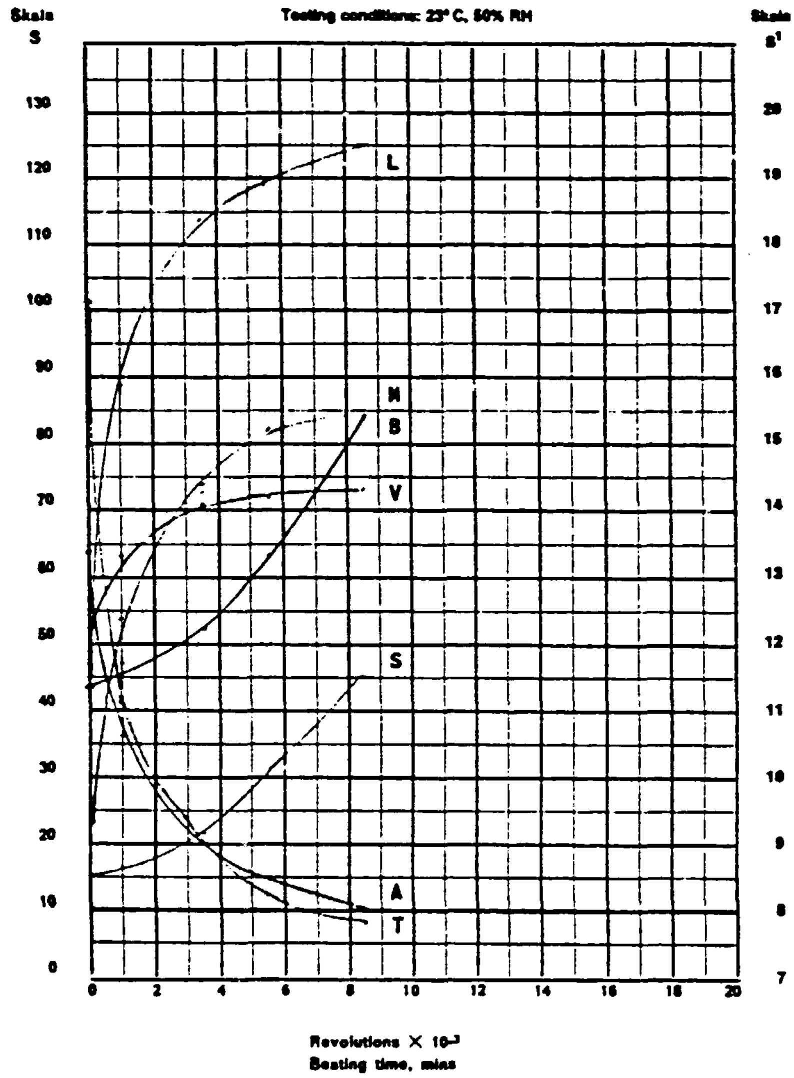
Beater: PFI **Date** 29/3 1984

Quality: Koreansk barrmassa

Manufactured:

Machine:

Hardwood	%	3
Clorine number (Roe)		
Kappa number	SCAN	43,2
Ash content	%	
Conductivity	mS/m	18,3
Shives	mg/100 g	
Ethanol extr.	%	
Dichlormethane extr.	%	
pH-cold water	SCAN	
pH-warm water	BS: 231	9,8
Sodium	mg/kg	462
Calcium	mg/kg	
Brightness	% ISO	23,3



										Interpolated	
Beating time mins; Rev.			0	1000	3500	6500	8500			4300	8500
Slowness	S = S	°SR	15	16,5	21,5	31	45			25	45
Tensile index	L = S	kNm/kg	45	89	114	119	125			116	125
Burst index	M = S×0.1	MN/kg	2,3	5,4	7,4	8,2	8,4			7,8	8,4
Tear index	T = S¹	Nm²/kg	17,1	11,1	9,0	8,2	7,8			8,6	7,8
Bergman number	M×T×0.01										
Air permeability, Bendtsen		cm³/min	2250	750	190	60	15				
Gurley number	P = S×10	s	-	10	56	238	-			~100	-
Density	V = S×10	kg/m³	520	632	703	713	728			710	730
Absorptivity, Klemm	A = S	mm/10 min	64	36	20	15	10			18	10
Dewatering time in sheetform	B = S×0.1	s	4,4	4,7	5,2	6,3	8,4			5,6	8,4

Remarks: Utagen på ett silerifilter, har därefter fått lufttorka

ting process and refiner equipment.

It was reported that the sulphidity had been increased and the results were promising. The pulp strength was increased and the brightness improved.

Paper strips across the machine width were taken out for tests in Sweden at both missions. At the first mission sack kraft paper was manufactured and on the second mission ordinarie kraft paper.

The paper has been tested by Fiskeby AB, Skarblacka Mill and the test results are presented on the following two pages and are commented on underneath.

- The hardwood content in the sack kraft paper is nil as was also reported by the mill. The ordinairy kraft paper contents more than 75 percent hardwood which of course is very high and which explains the lower strength caracteristics. According to the mill the hardwood content should be only 15 percent. This shows the difficulties to maintain a good proportion.
- The basis weight profiles are in both cases irregular indeed.
- The porosity is much lower on the ordinairy kraft paper, only 22 seconds compared to 36 seconds for the sack kraft. This might explain that the tear index is fairly good compared to the sack kraft paper.

It is once again documented that the paper has very poor stretch values, both in the length as well as in the cross directions. The values should be almost twice as good to be compared to the Swedish standard.
In this respect much can be improved on the paper machine itself i.e. low consistency in the headbox, proper press felts and dryer fabrics. The dry end of the paper machine hasonly three drive sections, which means that the dryness process is hampered, i.e. the web is

FISKEBY
Fiskeby Aktiebolag

RAPPORT / UTREDNING
MEDDELANDE
PM

Avd. ort	Utskriftsdatum	Projektnr
Division Papper och Massa, Skärblacka	1984-04-19	

Tjänsteställe, utfärdare	Reg nr
Teknisk service, K Gustafson	EUD 220/84

Distribution

R Lilja
E Lindvall
A Ljunggren
B-I Svensson
B Wegner
L Svensson, HK
L Ahlén, HK

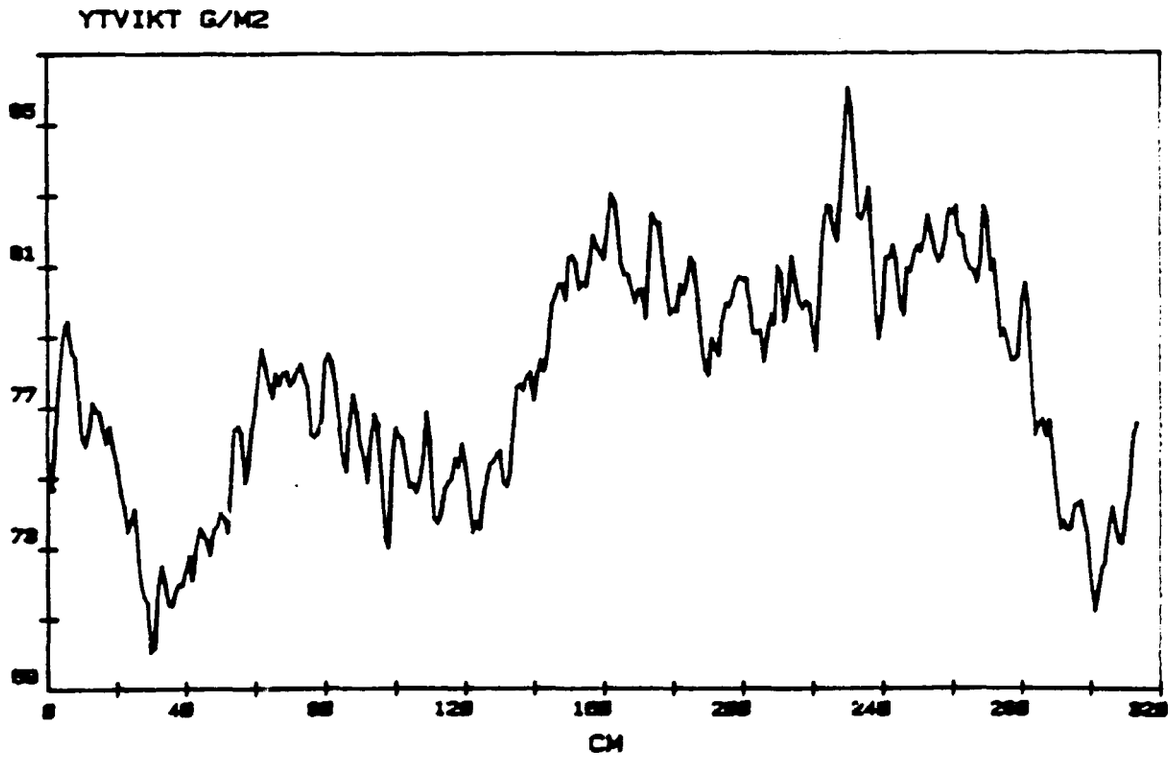
Ola Nilsson, Celpap AB

Nyckelord
Säckpapper
Celpap
PM 9

Ärende

Undersökning av säckpapper tillverkat vid Hyosan Pulp and Kraft Paper Mill, Nordkorea. Prov från Celpap via Bengt Wegner.

	Framsida	Mitten	Baksida
Ytvikt, g/m^2	71.9	76.6	76.9
Luftresistens, s	32	37	38
Dragindex, längs, kNm/kg	97	100	104
" , tvärs. "	40	42	43
" , T/L, %	41	42	41
Töjning, längs, %	1.5	1.6	1.6
" , tvärs, %	3.0	2.8	3.4
Brottarbetsindex, längs, kJ/kg	0.91	1.01	1.06
" , tvärs, "	0.82	0.83	1.05
Rivindex, längs, mNm^2/kg	8.5	9.3	9.2
" , tvärs, "	9.7	10.7	11.0
Cobb, ös, g/m^2	17	17	16
" , vs, "	20	19	19



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FISKEBY
Fiskeby Aktiebolag

☐ RAPPORT, ~~UNDERSÖKNING~~
☐ MEDDELANDE
☐ PM

Avd. ort	Utskriftsdatum	Projektnr
Division Papper och Massa, Skärblacka	1984-10-25	

Tjänsteställe, utfärdare	Reg nr
Teknisk service, K Gustafson	EUD 541/84

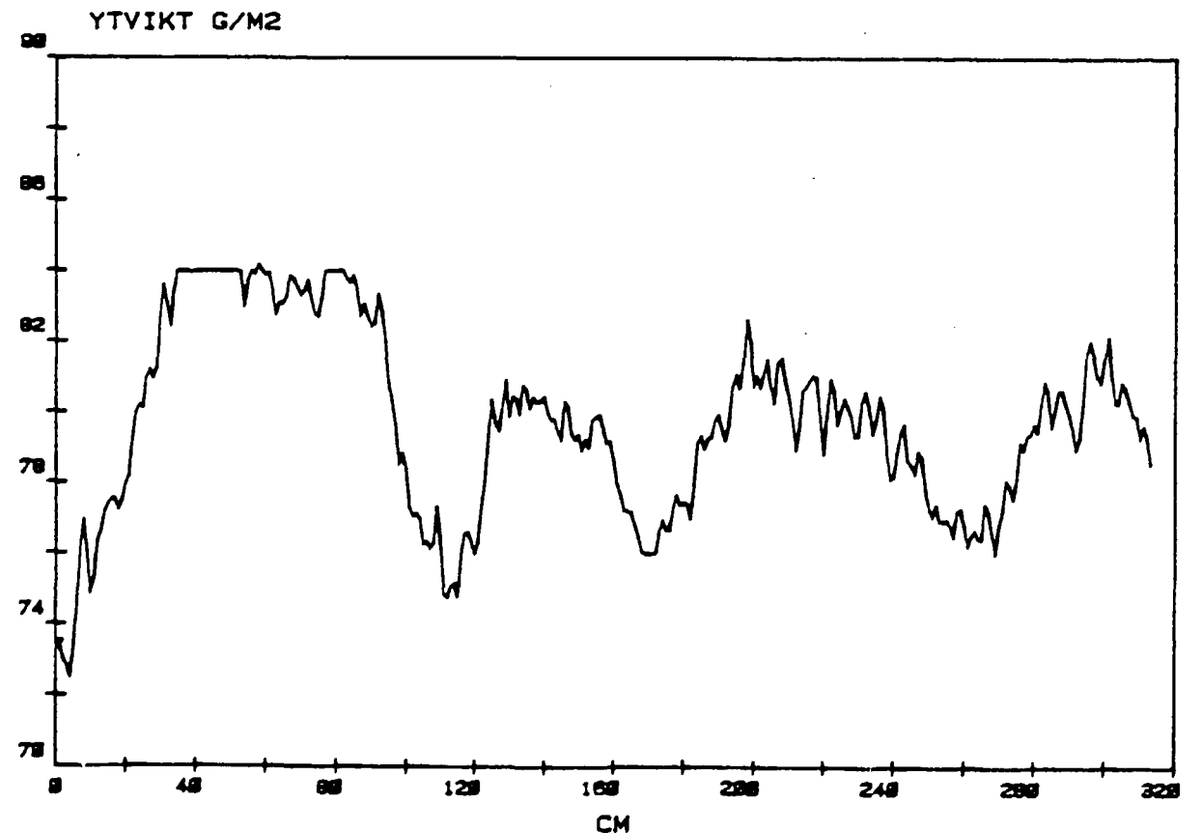
Distribution

R Lilja
E Lindvall
A Ljunggren
B-I Svensson
B Wegner
L Svensson, HK
L Ahlén, "
Ola Nilsson, konsult

Nyckelord
Säckpapper
PM 9

Ärende
Undersökning av säckpapper tillverkat vid Hyosan Pulp and Kraft Paper Mill, Nordkorea.

	Framsida	Mitten	Baksida
Ytvikt, g/m^2	82,6	77,8	77,8
Luftresistens, s	21	22	24
Dragindex, längs, kNm/kg	69	73	68
" , tvärs, "	37	40	37
" , T/L, %	53	55	54
Töjning, längs, %	1,4	1,4	1,4
" , tvärs, "	2,5	2,7	2,3
Brottarbetsindex, längs, kJ/kg	0,60	0,63	0,57
" , tvärs, "	0,63	0,77	0,59
Rivindex, längs, Nm^2/kg	8,2	8,6	8,1
" , tvärs, "	8,5	8,2	8,0
Cobb, ös, g/m^2	41	36	41
" , vs, "	68	67	64



H 376 1 2000 74-05

dried under tension instead of free drying. When the paper web is dried without tension it schrinks and therewith obtains good stretchvalues which is indeed important for cement paper sacks.

The importance of having a good basis weight and moisture profile was pointed out. Therefore it was suggested that samples across the paper should be cut with length of 15 cm corresponding to the distance between the set screws on the headbox outlet.

The appearance of the papersheet coming out of the dry end seemed to be slightly better then last time. The flatness might have been improved a little but both edges are too wrinkled up for a half meter width.

Mr Pak Zong Ung from the Wood Chemical Research Institute at Hyesan City had been invited to a meeting. He described how tests had been made at Sun Chen with two types of Hyesan sack paper qualities. As to the quality; the only difference was in the moisture content in the paper, namely 5 percent and 8- 10 percent. Sacks were made entirely by Hyesan sack kraft paper in 5 plies and with the different moisture contents. Before reaching the railway waggons 30-40 percent of sacks made of the dry paper were broken compared to only ten percent of the others. The high moisture content is obtained by a watering device fitted to the calender stack. The water is atomized with pressurised air and thus forming a nice mat of water onto the top side of the paper. This device is nowadays always in operation due to the good results obtained.The water flow in each section of the width can be manually adjusted.

Based on the tests Hyesan has given the following guaranties for drop tests from the height of one meter: 80 percent of the sacks shall be intact after 8 drops (5 plies) and 11 drops (6 plies) respectively.

5 FIBROUS RAW MATERIAL

In order to receive some information regarding fibrous raw material, the mill officers were interviewed as it was not possible to meet with any forestry officers. There could thus be no discussions regarding affore station, fertilizing, forest stand and inventory techniques, felling and transports.

The following species are used in the mill and are also the main species in the forests of the province.

1. Larch (Larix Leptolepis Gordon)
2. Fir (Abies Sachalinensis Masters)
3. Spruce (Picea Jezdensis Carr or Eli Ayonskya)
4. Birch (Betula Maximowicziana Regel)
5. Popplar (Populus Maximowiczii Henry)

Nos 1,2 and 3 are softwoods and around 90 percent of the logs coming to the mill consist of these species. The softwood amount in the forests was said to be around 80 percent.

The tree recirculation time is 30 years which is very favourable compared with Scandinavian corditions.

The forestry area is around 650.000 hectares. The felling is around one million m^3 per year which corresponds to only 1.5 m^3/ hectare and year. It was, however said that the felling could be increased to at least 1.2 million m^3 when a planned railway is ready.

The wood supply from the Ryanggang Province is to about 55 percent delivered to mills outside the province. The distribution in m^3/year is as followes:

1. Demand within the province
   - -Hyesan Pulp and Paper Mill 120.000
   - -Wiyon Sawmill 200.000
   - -Other sources 100.000
2. Supply to customers outside the province
   - -Kilju Viscose Pulp Mill 250.000
   - -Other sources 300.000

By "other sources" in the table above is meant a number of smaller sawmills and manufacturing plants for pit props, furniture, building material etc.

The Wiyon Sawmill is situated only 8 km north of the pulp and paper mill. The wood residues are used as rawmaterials for two neighbouring plants, namely one for producing alcohole and one for producing tannin. Probably all the residues are meant for these two plants.

The distribution amounts of softwood respectively hardwood to the sawmill was not known. The sawdust from the pulp and paper mill is delivered to another alcohole plant at Hyesan.

The Kilju viscose cellulose plant is situated in the North Hamgyong Province immediately south of the 41° latitude. It produces around 40.000 tonnes of viscose pulp per year. Only softwoods are used as fibrous raw material.

6 DISCUSSIONS

6.1 Remarks Regarding Further Reconstruction Works

There is a mill in operation for manufacturing sack kraft paper but unfortunately with inferior quality in spite of very good fibrous raw material. The production rate is far below the designed capacity due to improper maintenance. Furthermore there is an expanding cement industry which needs increased amounts of paper bags for packing the cement. The sackpaper is today mainly imported, which should not be the case with a sack kraft paper mill with an annual production of 30.000 tonnes of good quality kraft sack paper. A precondition is naturally adequate supply of softwood.

It is surprising to observe how such an important mill has been so neglected and how one now is so keen to modernize it with aid funds. A fully rebuild with modern, new machinery and equipment will be very costly. Such a step will also involve an intensive training program and still be risky when considering today's situation. The question has therefore been raised to make a very low investment by installing secondhand, but still fully modern, machinery and equipment. Another advantage with such a solution is the possibility of making a quick reconstruction of the mill. Other advantages can be the training facilities as dismantling and erection can be made by teams from DPRK.

In the first mission report a modernization program was discussed. It was said that the modernization program should be carried out after the reconstruction of the mill in order to minimize risks. When using secondhand machinery the two objectives can be attained simultaneously; instead of procuring spare parts for old machinery secondhand machinery can be acquired at a lower price and still yield better performance.

Until a decision is made, the mill must continue the reconstruction with material and equipment which are available within the country, such as structural and electrical items. As can be foreseen, there should not be many changes in outer walls,floors, stairs etc. at a possible future reconstruction of the mill. Therefore there should be no reason for not starting the repair work now and installing proper lighting. It is well known that good working conditions and properly maintained machinery will increase production and the quality will automatically be improved.

In the first mission report it was said that a preengineering study must be carried out in order to make an accurate investment cost calculation. This is still of immediate interest, but the extent can be considerably reduced if appropriate second-hand machinery is available.

6.2 Actions to Be Carried Out

Pending any major decision and in order to make decisions, some actions have to be started or carried out:

- amore detailed study to penetrate all the problems within the mill including the supply of material, electricity, steam, water and chemicals. These items will be dealt with in this section.
- a study trip by a selected group to an industrialized country with well advanced sack paper mills. Further details will be outlined in section 6.3.
- a fellowship training program (see section 6.4)

In order to help and assist the technical staff in the mill a well experienced kraft pulp and sack kraft paper engineer should be assigned for a period of at least six months. His duties can be manifold. First

of all he has to look at the daily problems and try to make necessary adjustments, in other words "trouble shooting". The duties will involve suggestions for purchasing spare parts, machine clothing, minor machinery and equipment.

The expert can also start and continue a training program within the mill in order to improve the skill of engineers, operators and mechanics. If possible, production manuals can be written. He has to organize the maintenance and make it as effective as possible.

The tasks should also included exploration of all necessary measures to be taken at the foreseen pre-engineering study.In other words, no details should be overlooked before the the final reconstruction.

6.3 Study Trip

It has been expressed on many occasions the necessity to make a study trip to a country with well advanced technology regarding sack kraft manufacturing.

If Sweden is chosen the study group should consist of maximum four persons in order to maintain low costs and simplify travelling, as using a rented car for the transports is the most attractive way.

The study trip can include 2-3 sack kraft paper manufacturing mills, two sack manufacturing plants, one cement factory, the Markaryd Training Center and the Swedish Forestry Research Institute. Workshops for manufacturing the machinery for pulp and paper mills can also be included. It might also be possible to examine second-hand machinery.

The above program could be executed in 8-10 days including weekends.

If the study group wants to choose another country for the study, a visit to Austria or CSSR where sack kraft paper is manufactured. Two countries can also be chosen. Sweden can be the first hand choice due

to the training center or research institute and much advanced sack kraft paper manufacturing units.

The author of this report shall be happy to arrange a possible study trip in Sweden and also serve as the group leader from arrival to departure of the team. He can also assist if any other country will be visited.

At least one of the team members should be well advanced in speaking German or English including technical terms in the field of pulp and paper manufacturing. Otherwise there will most certainly be many misunderstandings and the opportunities will be poorly utilized.

6.4 Training Program

It is still not possible to make any firm recommendations for a fellowship training program. The main reason for that is that there have been very few possibilities for the UNIDO expert to make the necessary research studies. It is not known on which standard level the engineers are or how effective the education is. Further more the knowledge of the English and German languages is unknown to the expert. As engineers have been educated and trained in the GDR there must be a number of German speaking engineers. Many English books are at hand for lectures and instructions, so probably a great amount of students can at least read and maybe understand spoken English. Due to the lack of experience in listening to and talking English, it seems as if very few students are capable to make themselves understood. The level of textbooks and availability of qualified teachers of the English language is certainly not very high.

Even if there are many hinders, the training should not be neglected. The only way remaining for education and training in the western hemisphere is to select the team to be sent there by interviews and tests.

6.5 Other Remarks

The result of both missions could have been much more useful if it had been possible for the counterpart to arrange meaningful study trips to other pulp and paper mills, machinery factories, research institutes, as well as schools and training centres. It is of utmost importance to find out the overall industrial level in order to make the right conclusions, decisions and recommendations for the future of the Hyesan Pulp and Paper Mill, which cannot be looked upon as well maintained mill. If this mill should be considered to be the average standard, the reconstruction works should be in accordance with that.

The preconditions were a split mission of one month on two occasions. It is then most surprising that the study time at the mill was decided to be so short. There are no possibilities of giving firm advice for either main-machinery or the different details by only making one incomplete roundtour in the mill. The UNIDO-expert was in this respect most displeased and powerless in making changes in already stated program.

The Koreans show great hospitality in taking visitors to all sorts of museums, grand buildings, monuments and holiday resorts. This is naturally very much appreciated, but it must be undersood that experts coming to the country want to make the best of the mission in order to deliver a valuable report. A trip to a recreation resort for a week after some months work would be much more appreciated.

The difficulties mentioned above were already discussed in the first mission report, so there should have been an oppurtunity to make an improvement of the program prior to the last visit.

Much time was spent in discussions how to ask for funds even though it was not the purpose of the mission to ma-

ke any cost calculations. It is not even possible to make any rough estimates regarding investment costs due to the very short time spent at the mill.

7 RECOMMENDATIONS

7.1 General

It is once again recommended to make the mill reconstruction work step by step. The work, already commenced and which has given such good results, has to be continued. Some of the items to be carried out are summarized in section 7.2. It should be understood that this work has to be initiated and carried out by the Ministry and the Mill.

As there might be technical and training problems, it is herewith recommended that one or two well advanced pulp and paper makers should be at disposal of the mill management to carry out the items in section 7.2 and to survey the entire mill in order to find out all the weak links in the long chain. Where possible, measures have to be taken. When not possible, the items have to be listed for measures in the suggested, final reconstruction. One of the main tasks should also be to organize the maintenance. It is herewith recommended that actions be started as soon as possible to recruit one or two experts.

Before any reconstruction and modernisizing work can be feasible, it is necessary to make detailed investment cost calculations. It is therefore recommended that a preengineering study should be carried out, which in text, flowsheets and drawings will describe the process and the actions to be taken for the reconstruction and modernization work. The report should include laboratory test results as well as studies regarding fibrous raw material resources and quality. The preengineering study can be carried out by the engineers mentioned above together with experts in forestry,design, electricity and instrumentation. The team must include members from the Ministry and the Mill, especially engineers for structural matters and cost analyses.

The preengineering study should also penetrate the pos-

sibilities for a higher production rate, now or in the future.

7.2 Actions to Be Taken Immediately

In order to improve the pulp and paper quality and to some extent increase the production the following items have to be executed. A more detailed text has been presented earlier in this report or in the first mission report.

- Repair of the log conveyors.
- Cut the 8m logs into only three pieces and rearrange the operation to be fully safe.
- Improve the chip handling process in all phases by training the workers to better procedure discipline.
- The chip moisture content to be measured continuously and the liqour charge will be corrected due to measured chip moisture.
- The inserts for the digester heat exchangers to be replaced with superior material.
- Get ready the adjustments of the vertical agitators in the blowtanks and storage tower..
- Study the possibilities to supply the reject refiners with not diluted coarse screen rejects.
- Increase refining consistency with proper pump installation.
- Repair the variable drive of the washing plant, put the riding rolls in operation, tighten the filter joints as well as other possible leakages in order to still improve the washing process. If possible reinstall pumps for a more favoruable intake. Connect hot water to the showers on the last filter.
- Repair and start the first rectifier roll in the headbox.

- Start the shower system in the headbox.
- Purchase proper machine clothing with recommendations from suppliers visiting the mill. No other procedures for purchasing should be considered. The paper quality is too much depending on the right type of machine clothing.
- Correct the basis weight profile across the paper machine direction as to advice given.
- The felt dryer cylinder bearings must be repaired.
- Vacuum pumps should be repaired.
- Procure adequate number of diagram papers.
- To the greatest intent try to repair the once installed instrumentation and transmitters. Local specialists and suppliers to be contacted for carrying out this.

In order to prevent the mill from further deterioration and to improve working conditions, at least the following actions have to be taken:

- Repairing of structural items like windows, floors, stairs, insulation.
- Continue to reinstall electrical equipment including motors in order to minimize electrical faults.
- Improve the lighting conditions in the entire mill. This cannot be delayed any longer.

Arrangements shall already now be made for purchasing spare parts for the most vital machinery. A specification cannot be a part of this report as there are no reports available what machinery is causing the most frequent problems. Therefore it is once again recommended to have an expert from the suppliers who, together with the mill technicians, will carry out a specification with detailed prices.

There is some equipment which should be purchased as soon as possible in order to improve and control the

paper quality.

- One log debarker
- Forming board and vacuum box covers of plastic or ceramics.
- Felt suction boxes and vacuum pumps for these items to be installed on all three presses.
- Laboratory test apparatus to measure tensile strength + stretch, porosity type Gurley and the tear index.

Sooner or later, the mill has to issue standards for equipment such as pumps, valves, pipes, electrical and instrumentation components etc. If there are general standards these should be studied.

It is herewith also recommended that the mill should write a monthly report at the beginning of every month which should be translated and sent to the UNDP office, to UNIDO and to the UNIDO expert. The latter could thus give further recommendations as the work proceeds. It would also be possible in due time to decide on the problems that may arise.

7.3 Further Recommendations

For the time being there are no possibilities to give any further recommendations. The suggested assistance to the mill and the preengineering study will result in recommendations whether major rebuild and modernisation shall be implemented or not. If the study should find it feasible to restore the mill, the details will be outlined in the report.

One item, however, which could be carried out is an adequate storage room for paper rolls.