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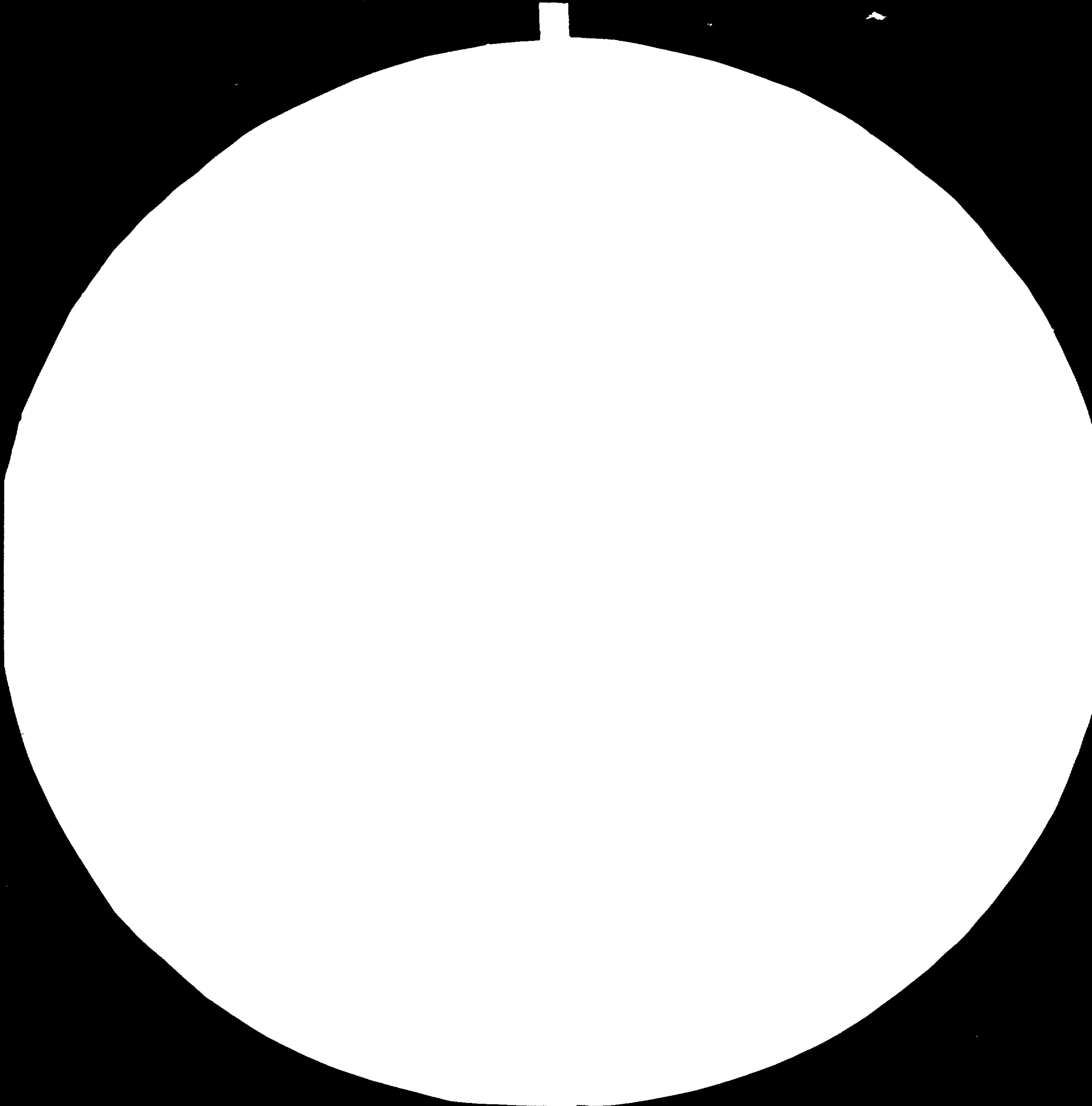

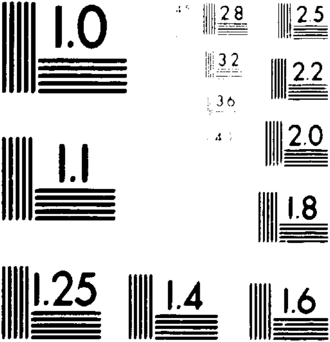
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12 December 1984
English

Ethiopia.

CONSULTANCY TO ETHARSO FIBREBOARD PLANT .

SI/ETH/84/802

ETHIOPIA

Terminal report*

Prepared for the Government of Ethiopia
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Louis Marenzi,
Consultant in the production of fibreboard

United Nations Industrial Development Organization

Vienna

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Explanatory note

The currencies mentioned in this report with their abbreviations and parities used are the following:

2.1o	Ethiopian Birr (B)	= 1 Dollar USA (US$)
3.1o	German Marks (DM)	= 1 US$
21.6o	Austrian Shillings (öS)	= 1 US$

Mention of certain equipment supplies does not imply any recommendation on the part of UNIDO.

For the sake of expendiency, for most items only quotations from Austrian suppliers have been sought. Within the limited scope of this report, it has not been possible to establish complete lists of potential suppliers.

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1. Preface and summary

This report is the result of a request made by the Government of Ethiopia to the United Nations Development Program (UNDP) requesting that an expert in fibreboard production advise ETHARSO, a state-owned fibreboard factory, on possible improvements in the production process.

The request was made by cable on April 2, 1984. The consultant, Mr. Louis Marenzi, arrived in Addis Ababa on May 2? and left on June 10, 1984.

The consultant's duties were to:

- assess the current facilities and performance of the ETHARSO Fibreboard Plant, including a technical assessment of the existing equipment and layout,
- analyze the national fibreboard market (past and trend),
- draw up a rehabilitation and development program for ETHARSO on the basis of the above, providing detailed description and an estimate of the inputs necessary for the realization of his recommandations (i.e., investment costs, training programs, etc.).

In this report, the different problems that ETHARSO has to face are analyzed one by one and solutions are proposed. Investments with a foreign currency cost of US$ 80,000 and a roughly estimated local cost of 75,000 Birr are proposed. This capital outlay could be recuperated by the improved operation of ETHARSO in about one year. Some more general considerations are made on the long term outlook for ETHARSO, in particular with regards to a new fibreboard project.

The raw material supply of ETHARSO represents a very special problem which could best be solved by the creation of a new eucalyptus plantation at a cost of the order of 300,000 Birr. Such an undertaking is, however, outside the consultant's and even ETHARSO's competence.

It should be stressed that the collaboration with ETHARSO's staff was excellent and that a large part of the proposals and recommandations contained in this report was in fact made by them.

2. Assessment of present situation

2.1. Introduction and historical background

In a report that deals mainly with technical problems and which will interest people who are already familiar, at least to some extent, with the situation of ETHARSO, a reference to geographic and economic data of Ethiopia does not seem necessary. On the other hand, a brief summary of the factory's history may be of interest.

The ETHARSO (Ethiopian Hardboard and Softboard Factory) plant is located in Addis Ababa, about 8 km from the city center in a south-westerly direction. It can be reached over a narrow and rather bad road; it has no railway connection. ETHARSO was established by private Italian interests, at first as a general wood-working shop and parquetry plant. The fibreboard plant was added in 1969. Together with a hardboard plant in Egypt, based on rice straw, which was erected in the same year, it was Africa's first fibreboard plant outside South Africa. (Madagascar followed in 1970, Tanzania in 1972 and Kenya in 1975.) Becker & van Hüllen, a West German manufacturer of hydraulic presses, supplied the production equipment as well as the engineering.

The design of the plant was altered already before it was completed. In particular, the number of daylights in the hot press was increased from 3 to 5. The rated capacity of the plant was then indicated as being of 10 t/day. (As will be shown later, this does not correspond to reality.)

After the revolution of 1974, the fibreboard plant was nationalized, while the adjacent wood-working shop and parquetry plant remain in private ownership. The personnel of the fibreboard plant, however, is largely still the same, and the change of ownership caused no break in the continuity of operations, maintenance etc. The nationalized plant became part of the Ethiopian Woodworks Corporation which groups together many wood-working industries. Very recently the Ethiopian Government deicided to place ETHARSO under the responsibility of the Ministry of Construction, and this decision should have become effective by August 1984. The change of responsibility may mean a new impetus to the drive to have the plant reconditioned and modernized.

2.2. Description of the plant

The main production equipment is housed in a simple rectangular hangar. The boiler house is directly attached to this hangar, the administrative building being separate.

The raw material is wood which is delivered exclusively in the form of small diameter eucalyptus roundwood. The wood is stacked loosely in the open air. No washing or debarking is done prior to chipping in a drum chipper. The chips are taken up to a chip bin by a chain conveyor. From the bin the chips fall into the infeed of a Defibrator unit. The coarse fibres from the Defibrator are blown by the discharge steam up into a diluting vat where some water is added. This rough pulp slurry is refined in a conical refiner. The refined pulp is diluted manually - the consistency regulator is not operating - and stored in a pulp vat. The mat forming is done in a special deckle-box machine. A wet fibre mat is formed on an endless wire sieve which carries it to a dewatering press. The compacted and dewatered wet mat is lifted up pneumatically and placed on caul plates which go into the charging rack. This rack is of very special design. It has 10 daylights of which half are for charging, half for discharging. Charging and discharging of the boards is thus taking place on the same side of the hot press. This solution reduces investment but causes a certain lengthening of the press cycle. The hot press has 5 daylights and is heated with water. The dry boards coming from the hot press are not remoistened in the existing conditioning chamber which is not operating, but go directly to the trim saw where they are trimmed to their final size of 4' x 8' (1,22 x 2,44 m).

The plant is also equipped for the production of softboard. When softboards are produced, the wet fibre mats coming from the dewatering press are loaded not onto the caul plates, but onto supports which are then pushed into special racks on wheels. Each of these rack carriages can take 25 wet boards. The carriages are then rolled on rails into the dryer which can hold two carriages at a time. To complete the drying and to eliminate the warping that has occurred in the drying the softboards coming from the drier undergo a pressing in the hot press at reduced pressure. Originally the plant was also capable of producing acoustic tiles. The softboards were cut into pieces of 1' x 1' or 2' x 2' and sound-absorbing holes were drilled into these tiles with a special machine. This drilling machine has never worked in a really satisfactory manner and is now in need of repair.

To provide the plant with heat in the form of steam and hot water, an oil-fired smoke tube boiler was originally provided. As its capacity is barely sufficient, a second-hand wood-fired boiler was recently installed. It produces only steam and is meant to supply only the Defibrator unit.

At this point, it seems necessary to stress the fact that many features of the ETHARSO plant are unique in the world. Becker & van Hüllen have never before or after delivered a similar plant, the experience with ETHARSO being evidently considered unsatisfactory. Becker & van Hüllen did not even submit a quotation for the fibreboard plant in Kenya when they were asked to do so in 1971. Many operations in the production process show clearly that they have been adapted or even invented ad hoc, and in spite of improvements introduced by the factory's personnel this uniqueness of the plant causes many problems which will be analyzed in detail in chapter 3.

2.3. The market situation

Although an analysis of the national fibreboard market was included in the terms of reference, no proper market study could be made by the consultant. However, the market situation is known to the factory's personnel who has operated it for the last fifteen years and it was considered that the consultant should devote his limited time to the more pressing technical problems of ETHARSO.

The sales price is controlled by the Government. It is 9.05 Birr (4,30 US$) ex factory without sales tax for a sheet of 4' x 8' x 1/8" (1220 x 2440 x 3.2 mm). ETHARSO is the only fibreboard factory in Ethiopia and fibreboards are not imported. There is some competition from similar products, in particular from plywood, but all concerned agreed that at the present price level the factory could sell at least twice its production.

The export markets would in practice be limited to Djibuti where ETHARSO would enjoy a considerable transport cost advantage over international competitors who produce better boards at lower prices thanks to economies of scale and other favorable factors. It has not been possible to obtain detailed import statistics of Djibuti. The overall value of imports in 1979 was 31,477 million Djibuti francs equivalent to 174 million US$ at that time. That was more than the imports of, e.g. Burundi, and corresponded to 30% of the imports of Ethiopia. Djibuti is therefore not to be neglected as an export market. There should be outlets for both cheap hardboard, for example in the construction of provisional houses for refugees, and for high price products such as acoustic tiles which would be purchased mainly by the expatriate population. Altogether, the fibreboard market of Djibuti may be of the order of a few hundred tons per year. Prices should be at the general international level of about US$ 5oo per ton (or m^3) c.i.f. for standard hardboard.

2.4. The raw material supply

While markets are not a primary concern of ETHARSO, the raw material supply certainly is Ethiopia, which had large parts of the country, in particular the well-watered highlands, covered with forests, now seems to have only 3% of its area under forest cover, and at the present rate of deforestation all forests will have disappeared in less than 20 years. Addis Ababa has had wood supply problems almost from its foundation in 1889 and only the establishment of eucalyptus plantations since about 1900 has enabled it to become the permanent capital of Ethiopia.

So far, ETHARSO has been able to obtain small diameter eucalyptus roundwood at a cost of 22 Birr per stacked cubic metre on a forest road about 50 km from Addis Ababa. This price must be considered very favorable. There are some problems due to the irregular issuance of wood allocations to ETHARSO. When an allocation is delayed, the cut wood remains in the forest for too long a time. It is then too dry and causes problems in the production process (see chapter 3.3.).

In addition, there is strong competition for this eucalyptus wood, in particular from households in Addis Ababa which need wood for cooking, and ETHARSO has been requested to look for other raw material sources. The possible solutions to the raw material problem are discussed in chapter 3.2.

3. Problems and possible solutions

3.1. Generalities

A major actual and even bigger future problem, the irregular and uncertain wood supply, has already been mentioned. In addition, there is a host of problems linked to the old age of the equipment, its not always satisfactory design and to a shortage of spares. Finally, there is the economic problem of the high cost of imported fuel oil.

The overall goals of ETHARSO may be listed in the following order:

- increase production so to satisfy demand, as far as possible
- reduce the production cost
- improve the product quality.

To increase the production, the obvious first step is to reduce the down time caused by machine failures. At present, over 25% of the total annual working time is lost because of breakdowns.

The main trouble spots are discussed in detail in the subsequent portions of this chapter. A major renewal of the plant has been considered by the staff of ETHARSO for some time. The correspondence with Becker & van Hüllen, the original overall supplier, has brought no results as this company has been in financial troubles for some time and is now dissolved. The West German firm Voith, Heidenheim, the manufacturer of the present Defibrator unit and conical refiner of ETHARSO, has made a quotation for the pulp preparation part of the plant in May 1981. This quotation can be summarized as follows:

chipper,chip transport etc.,with spares,f.o.b.	869.110 DM
defibrator and refiner,with spares,f.o.b.	1.109.000 DM
engineering	150.000 DM
	2.128.110 DM

or 700.000 US$ at today's exchange rates.

With transport and installation, even without the loss of production during the erection period, this would mean a cost of more than a million dollars of the chipping and pulping section alone, at prices of 1981. This proposal is clearly devoid of interest.

A much more interesting offer has been made in April 1982 by the China National Machinery Import and Export Corporation which quoted a price of 927.800 US$ f.o.b. for a complete hardboard plant with a capacity of 10 - 12 t/day. This quotation will be discussed more in detail in chapter 6. The cost of any rehabilitation program of ETHARSO must be measured against this proposal for a new plant.

A word of caution seems necessary in relation to the effects that can be expected from any equipment rehabilitation program: The production capacity of 10 t/day which is stated in the original documents supplied by Becker & van Hüllen is clearly unrealistic. Apart from other possible limiting factors, the hot press cannot in any way produce 10 t/day of hardboard. It has only 5 daylights and a loading/unloading system which makes it impossible to load and unload simultaneously. 7 pressings per hour or a press cycle of about 8.5 minutes for hardboards with 3.2 mm (1/8") thickness is a maximum with this equipment. The hourly production of boards with the dimensions 4' x 8' x 1/8" is then:

9.5 kg/boardx5 boards/pressingx7 pressings/h = 332.5 kg/h

In 24 hours, counting 10% downtime as universally adopted to calculate the nominal production capacity, the production is

332.5 x 24 x 0.90 = 7.182 kg or about 7.2 tons.

The presence of a softboard dryer does not really increase the production capacity, expressed in t/day, of the plant. As described more in detail in chapter 3.10., the softboards have to go through the hot press and the length of the pressing cycle is about the same for softboard as for hardboard. The production capacity of the plant remains therefore limited as calculated above.

In the following, the different problems of ETHARSO are treated in the order in which they present themselves in the material flow of the production process.

3.2. Irregular and uncertain wood supply

The present wood supply situation has already been described. ETHARSO has been under pressure to develop an alternative raw material source already for some time. In 1982, a consultant for FAO, Mr. Elias L.C.Nnabuife, made a study called: "Ethiopia, case study on the use of wood and other residues for compressed boards", in which he treated the problems of ETHARSO extensively and made production tests with wheat straw and senbelet (a local grass used for traditional thatching) at the ETHARSO plant.

These tests showed that the boards produced from straw, in particular from senbelet straw, had excellent bending strength, but that the drainage in the forming machine was unacceptably slow. Because of a lack of time and means no attempt was made to solve this problem. (Possible solutions could be different fiberizing and refining conditions or washing of the pulp to remove the fines.)

The study concluded that the ETHARSO plant should be rehabilitated and should continue to employ eucalyptus and wood residues from other wood-working industries, while a new plant with a capacity of 10 t/day, equipped for the utilisation of straw, should be established in Arsi Province (about) 100 - 200 km southeast of Addis Ababa).

On the basis of this previous study, the following options were investigated:

- utilize straw
- utilize waste (mainly sawdust and small offcuts) from other wood industries
- utilize logging waste from the forest
- secure an eucalyptus plantation for the exclusive use of ETHARSO
- establish a new eucalyptus plantation owned or controlled by ETHARSO

To get additional information on the utilisation of straw for the industrial production of hardboards, a telex was sent from Addis Ababa to Sunds Defibrator of Sweden, the world's most experienced manufacturer of fibreboard producing equipment, asking for information on the production process with straw, for the approximate cost of the equipment that would be required to switch ETHARSO from wood to straw, and for references. Defibrator's extensive telex reply, dated 6.6.1984, is reproduced as annex 1. Its contents are not encouraging. Defibrator evidently has no reference for the utilisation of wheat straw, and it must be assumed that wheat straw is not used anywhere in the world for hardboard production on an industrial scale. The indicated price for a 40 t/day plant designed to utilize rice straw is very high at 70.000.000 Skr (8 million US$ at present rates, about 9 million US$ at the rate of June, when the telex was sent) for the supply of the production equipment. The smallest Defibrator unit alone without the other equipment that would be needed for the utilisation of straw, such as a straw cutter and a pulp washing machine, would cost 3.5 Mio Skr (about 400.000 US$). The cost of the conversion of ETHARSO from wood to straw, based on this information, would be about 500.000 US$ for the purchase of the equipment alone. With transport, installation etc. the cost would be of the order of 1 Mio. US$, without considering the loss of production caused by this conversion.

It should be noted that even for rice straw, no reference in the form of an operating plant is indicated by Sunds Defibrator. UNIDO knows of only one plant utilizing rice straw, and that is the hardboard plant of El Nasr Hardboard Co. in Faraskour, Egypt, which was installed by an East German firm in 1969/70. In spite of expensive machinery including elaborate pulp washing installations it has never worked in a satisfactory manner.

From all this information one must conclude that the technical problems involved in the industrial utilisation of wheat straw for hardboard production are not yet solved.

Nevertheless, the availability of straw was investigated in order to ascertain whether it would be worthwhile to pursue the straw option further, make tests with different straws, obtain technical assistance in this matter etc. Senbelet straw is already in short supply because of its irregular availability and the heavy demand for it as a roofing material. Wheat straw could at present be purchased from some large state-owned wheat farms which are at a distance of about 100 - 200 km from Addis Ababa. Straw is extensively employed as fodder, as fertilizer (by ploughing it into the ground) and as a building material for traditional houses, and around the capital all straw is utilised in some way. Straw would therefore not be an overly cheap raw material, just as wood waste whose cost is analysed later in this chapter.

In a visit to FAWDA (Forestry and Wildlife Conservation and Development Authority) it was learned that this organisation, which is responsible for the establishment and management of the state-owned forests, has made promising tests on the transformation of wheat straw into charcoal briquettes. It is planned to install charcoal making units in the major straw producing areas. If these plans are implemented, the available wheat straw would be quickly absorbed by this utilisation, as there is a large demand, in particular in Addis Ababa, for charcoal. With charcoal production, the transport costs are minimised and ETHARSO would hardly be able to compete with the charcoal kilns in the purchase of straw. One must conclude that the utilisation of straw for hardboard manufacture is no viable solution to the raw material supply problems of ETHARSO, for four main reasons:

- The technical problems are not yet solved. ETHARSO would have to assume a difficult pioneer role.
- Switching from wood to straw would require an investment of the order of 1 million US$ with equipment from Sweden.
- Straw would not be cheap because it is not available near Addis Ababa and its bulk results in high transport costs.
- Even at a considerable distance from the capital it may not be available in the near future if the charcoal briquetting projects are implemented.

The utilization of waste wood from other wood industries has also been investigated.

No tests have been made on the technological aptitude of these wastes as raw materials for fibreboard production. It is common knowledge, however, that the utilization of mixed tropical hardwoods as the raw material for fibreboard (or particleboard) production is problematic. An important aspect of fibreboard production is the control of the pH value of the pulp. There is no automatic pH adjustment at ETHARSO and a change in the composition of the raw material mix would provoke a change in the pH value unless it is measured manually and corrected. With forest waste, where the species may be known, one may try to treat the different species separately or to keep the species mix at fairly constant proportions, but with sawdust and other small waste, for example from a furniture factory, this is not possible. Some hard and durable woods may be difficult to fiberize under normal conditions. The situation would be better in a plywood mill where only a few species, generally not too hard ones, are employed.

One must also consider that sawdust gives rather short fibres and produces a high percentage of fines which reduce the speed of drainage in the forming machine. Sawdust is also likely to contain much dirt which may damage the feeding screw or the milling discs in the Defibrator.

One must conclude that, from the technological point of view, waste from other wood industries is a rather inferior raw material and that ETHARSO should be ready to pay a considerably higher price for eucalyptus roundwood than for waste wood.

There is, however, another interesting utilization for industrial wood waste at ETHARSO and that is as fuel. This question is discussed more in detail in chapter 3.16. At present, the main boiler consumes only fuel oil which is expensive and has to be imported. In the small wood-fired auxiliary boiler only eucalyptus roundwood is burned so far. Any substitution of fuel oil or eucalyptus roundwood with waste wood from other industries would be of great interest.

Two areas could be interesting sources of wood waste: Addis Ababa itself, where there are several wood-processing industriels belonging to the same statal holding company as ETHARSO, that is the Ethiopian Woodworks Corporation, and Jimma, Ethiopia's main forest industry centre which is connected to Addis Ababa by a tarred road of 335 km.

In Addis Ababa only some wood industries were visited. The particleboard factory ECAFCO reprocesses its sawdust and trimmings and burns its sander dust in the steam boiler, thus having no excess wood waste.

The Addis Ababa plywood factory of Ethiopian Enterprises (the same company operates another plywood factory in Jimma) utilises its waste in the steam boiler and allows the workers to take the excess waste wood which they can either use themselves or sell as fuel wood for which there is a ready market in Addis Ababa. Its production is about 2.000 m3 of plywood per year. Because of the age of the equipment - the factory was installed in 1962 mainly with second-hand machinery - the efficiency of the boiler and of steam utilization is not high and so there is not much excess waste available. However, ETHARSO may be able to negotiate the purchase of some waste from this company.

The most promising situation was found at Wanza Woodworks. This factory produces doors, windows and other timber products and obtains annually about 4oo tons of sawdust and shavings as a by-product. This waste is allocated to the factory personnel at a nominal price. The waste from Wanza Woodworks is hardly suitable as fibrous raw material, but it would be an interesting fuel, although its quantity is far from being able to satisfy the potential consumption of ETHARSO.

In Jimma the plywood factory of Ethiopian Enterprises was visited. It produces about 5,000 m3 of plywood per year and an appreciable quantity of waste wood could be available in spite of the presence of a wood-fired steam boiler, but at present quite understandably no effort is made to economize fuel wood. The purchase price of the waste wood in Jimma should be low, not more than 20 Birr per ton. The transport from Jimma to Addis Ababa could be done by the nationalized KATANA road transport company which charges 0.125 Birr per ton-kilometre if the return trip is not empty, as can be assumed for Jimma-Addis Ababa, and if the full load capacity of 22 t of a truck with a trailer is utilized, as it would be with wood.

The transport cost would then be 335 x 0.125 = 41.875 B/t. Without return freight, for example if there is an urgent transport and KATANA cannot find a return freight quickly enough, there is a 35% surcharge which would bring the transport cost to 56.50 B/ ton.

With purchase and handling the waste wood from Jimma would cost, under favorable transport conditions, about 65 - 70 Birr per ton delivered at the ETHARSO plant. At present ETHARSO buys eucalyptus smallwood at 22 Birr per stacked cubic metre, which is equivalent to about 40 Birr per ton, and has transport and handling costs of the order of 20 B/t, for a total cost of about 60 B/t on the factory site.

The conclusion is that waste wood from Jimma would have almost the same cost as the eucalyptus presently purchased if it is made available by the plywood factory at a low price. As the present eucalyptus supply is running out for ETHARSO and the company must look for wood farther away at a higher cost, the possibility of obtaining waste wood from Jimma is interesting and should be pursued. The quantity available will depend on the measures that the plywood factory will take to economize fuel wood.

After some tests have been made, the waste from the plywood factory may be utilized as fibrous raw material because only few species are utilized. However, any wood waste from Jimma will be interesting for ETHARSO when some changes are made on the steam boilers (see chapter 3.16).

As a fuel, about 4 kg of roughly air-dried wood are equivalent to one litre of fuel oil which costs 53.5 cents. This means that wood at a cost below 12 cents per kg or 120 Birr per ton is an interesting fuel alternative to oil, while the cost of waste wood from Jimma would be only about 70 Birr per ton, as calculated above.

While the quantity of available industrial wood waste is thus uncertain, large quantities of waste wood are available in the forest, on the site of logging. The main logging area for the wood industries in Jimma lies at a distance of about 100 km from that town. The transport from there to Jimma must be costed at about 40 cents per ton-kilometre, or 40 Birr per ton. With a cost of about 20 B/t of the wood on the forest road, 10 B/t for different handlings and 42 B/t for the transport Jimma - Addis Ababa, the total cost would be 112 B/t at the ETHARSO factory, or just below the equivalent cost of fuel oil.

One may conclude that the utilization of logging waste is financially marginal. The different cost factors would have to be determined in a more precise and reliable way before such an action is undertaken on a major scale. However, if ETHARSO runs out of wood or of fuel oil, logging waste would be the raw material source of last resort.

A eucalyptus plantation owned by or reserved for ETHARSO would be an ideal solution. Unfortunately there is strong competition for the existing eucalyptus plantations. The plantations that are relatively close to Addis Ababa are exploited for fire wood, while charcoal is made in the more distant plantations. The countryside around Addis Ababa has almost no natural forest left and the existing eucalyptus plantations are over-exploited. The government agency that is responsible for the establishment and management of wood plantations, FAWDA (Forest and Wildlife Conservation and Development Authority) has received from the African Development Bank a loan for the establishment of 15.000 ha of plantations for fuel wood and is negotiating with the World Bank about the rehabilitation of 10.000 ha out of the existing 25.000 ha of old plantations. FAWDA's plans for the future foresee 25.000 ha of old rehabilitated plantations, the 15.000 ha to be financed by ADB and 30.000 ha of other new plantations giving a total of 70.000 ha of plantations for fuelwood for the supply of Addis Ababa.

These figures are impressive compared to the requirements of ETHARSO which needs for its fibre supply about 3.000 m^3 (solid) of eucalyptus per year, the product of only about 200 ha on a permanent yield basis. Compared to the fuel wood needs of the Addis Ababa population which is growing rapidly towards 2 million, even the production of the future 70.000 ha, which will be of the order of 1 million m^3 per year, will be insufficient. An additional volume will come from small peasant plantations, agricultural wastes, charcoal from more distant places etc.) There is practically no hope that FAWDA will hand over to ETHARSO any of its eucalyptus plantations.

The best long term solution of the raw material problem of ETHARSO is evidently the establishment of a new plantation by the company itself. Even rather close to Addis Ababa, there is no lack of stony hills which are unsuited to agriculture but which should be reforested. Within a radius of about 100 km from Addis Ababa, these areas will be covered by FAWDA's programmes. Outside this radius, suitable land would be available. On financial and economic grounds, the plantation should be undertaken without hesitation. To cover its present fibrous raw material needs on a permanent yield basis ETHARSO would need a eucalyptus plantation of 200 ha. The cost of establishing the plantation should be of the order of US$ 750 per ha, based on the experience in other low-cost countries. An investment of 315.000 Birr (i.e. US$ 150.000) would thus be sufficient to create a solid raw material base for ETHARSO which would enable the company to plan its production properly and avoid the over-drying of the wood which causes problems in the production process.

This figure of roughly 150.000 US$ must be compared to the cost of converting ETHARSO to the utilisation of straw, which has been evaluated in this same chapter at roughly 1 million US$ even without considering the loss of production. These are, of course, very rough figures, but the ratio of 7 to 1 is high enough to cover any errors in evaluation.
The economic cost of establishing the plantation, based on appropriate shadow prices, would even be much lower than the financial cost indicated above. (It is estimated that half the population of Addis Ababa is unemployed or severely under-employed.) The effect of establishing a wood plantation on employment is evident; the availability of household fuel for the rural areas would be increased as twigs and leaves would be left for the local population; the plantation wood have a beneficial ecological impact.

What is preventing the implementation of this evident solution to the raw material problem is primarily the unresolved problem of land tenure. Even FAWDA, the public organisation in charge of governemental wood plantations, is gravely hindered by the limited availability of land without tenure problems. Private ownership of land has been abolished, but there is no specific legislation regulating the administration and use of forests. Peasant associations are intended to play a major role in the establishment of forest plantations, but the rights and duties of the peasant associations and of the Government agencies involved in wood plantations are not clearly defined. This unclear situation contributes to the overcutting of national forests and prevents the establishment of woodlots which would not only be socially, economically and ecologically desirable, but be good business for the communities that establish them.

To give any advice in this matter is clearly outside the consultant's terms of reference and field of competence. He can only insist that ./.

every effort should be undertaken by ETHARSO and by the controlling Government agency, now the Ministry of Construction, to create the opportunity for establishing a wood plantation controlled by ETHARSO, perhaps in cooperation with a peasant association.

The problem of fuel wood is treated in chapter 3.16 . It would evidently be advantageous if ETHARSO could establish a wood plantation that is large enough to provide wood not only for its requirements of fibrous raw material, but also for use as a fuel.
The following conclusions may be drawn from this chapter. No time, money and efforts should be wasted on the utilisation of straw. It would bring about technological risks and high costs but no security about future supply. Industrial waste from Addis Ababa and other localities, Jimma in particular, should be procured whenever possible. Even if this waste is employed only as fuel, it would make more eucalyptus available as fibrous raw material. If ETHARSO cannot satisfy its wood needs from eucalyptus and industrial waste wood, the utilisation of logging waste from the forest must be investigated more in detail. Energetic efforts to establish a new eucalyptus plantation controlled by ETHARSO should be undertaken without delay by ETHARSO's staff and by the Ministry of Construction. These efforts may include finding an appropriate site for the plantation, establishing contacts with peasant associations or even helping to create them, obtaining the required licences, securing the financing etc.

3.3. Over-dried wood

As told in the preceding chapters, the fibrous raw material supply of ETHARSO is somewhat irregular and sometimes the eucalyptus smallwood is already well dried when it arrives at the factory. Several problems arise when this happens.

The chipper is working harder and the life of the blades is certainly reduced, although the chipper is powerful enough - which is to say that the overall capacity of the fibreboard factory is small enough - to produce the required quantity of chips even when the wood is dry. The Defibrator unit, however, has serious problems with over-dried wood. The chips are rigid and not easily compressed by the feeding screw. The screw gets blocked or the bolts holding it break, and this is one of the major causes of interruption in the production preocess. Even when the Defibrator manages to fiberize these dry chips, the resulting pulp is coarse and stiff. It tends to float on the diluting water, forms an irregular fibre mat and finally produces boards of irregular thickness and lower quality. The over-dried wood is thus a very serious problem.

A long term solution has already been presented in the preceding chapter, namely the creation of a new eucalyptus plantation for ETHARSO. Before ETHARSO ever gets wood from this future plantation, which may not be before some 10 years, an interim solution must be found. One solution will be the purchase of a new Defibrator with a larger pre-heating vessel. Through a longer steam treatment the over-dried chips can be remoistened and softened. The implementation of this solution, however, is also some time off and even then there might still be a problem with the feeding screw.

A cheap and ready solution would be to soak the roundwood in ponds. Some tests have been made in this sense by putting the wood in water-filled drums for a few days. The results confirmed the experience that had already been gained by ETHARSO's staff. After a soaking of more than one day, the surface of the wood became black and black fibres were visible in the finished boards. A shorter soaking produced no appreciable technological improvement, as the moisture would not penetrate into the interior of the roundwood. The darker colour and black spots on the boards are considered a major flaw by the consumers of the boards.

A different solution, the washing of the chips, was therefore studied. Only a short contact between water and wood would then be necessary and there would be no appreciable darkening of the fibres, as has been ascertained by some simple soaking tests with rather dry chips. The washing of the chips could at the same time bring a solution to the problem treated in the next chapter, the frequent breakdowns of the chain conveyor.

The envisaged installation is shown on the sketch attached as annex 2. The accident-prone chain conveyor would be eliminated. The chips coming from the drum chipper would be transported to the soaking trough by a simple belt conveyor. From the trough, the chips mixed with water would be pumped by an open flow pump to a vibrating sieve on the roof of the factory. The sieve would separate the chips, which would fall into the existing chip bin, from the water, which would flow back to the soaking trough.

To implement this scheme, ETHARSO would have to import an open flow pump of appropriate size and the rubber belt for the conveyor. The steel structure of the belt conveyor and the vibrating sieve could be built locally by one of several private metal-working shops in Addis Ababa.

A suitable pump would be, for example, the pump type 100 W 250 EFN from the Austrian manufacturer Pumpenfabrik Ernst Vogel G.m.b.H.A photocopy of the corresponding quotation is enclosed as annex 3. The price for the pump and the motor, installed on a base plate, delivered to the forwarding agent in Vienna, would be 56.500 ÖS (2.700 US$).

This pump has an open flow of 100 mm diameter and would thus be capable of handling even the largest chips coming from the chipper. In order to have this large opening and at the same time the required pressure of 20 m water column (the static height is 12 m), the pump must have a capacity which is, at about 85 m3/h, in excess of the needs of ETHARSO. With a chip content of 5%, 85 m3/h would transport about 4 m3 of wood per hour. The pump would therefore work only a few hours per day.

The rubber belt for the belt conveyor transporting the chips from the chipper to the soaking trough would need a length of about 20 m, while a width of 400 mm would be appropriate. A rubber belt with suitable profiles for an inclined belt conveyor, for example the type D of the Austrian manufacturer Semperit, would cost 600 öS per current metre ex works. To have a complete reserve belt, 40 m would be needed, at a cost of 24.000 öS (1.150 US$) ex Austrian works.

This home-made solution is certainly cheaper than buying a complete chip washer from abroad. A chip washer from China, probably the cheapest supplier, would cost 8.400 US$ c.a.f. Assab, as can be seen from the quotation enclosed as annex 4.

3.4. Break-downs of the chain conveyor

At present, the chips are moved from the chipper to the chip container on the roof of the factory by a chain conveyor. It removes the chips under the chipper on a horizontal path of a few metres length and then goes up vertically to a height of 12 m. This chain conveyor is subject to considerable wear and needs frequent repairs. Sometimes the chain breaks and collapses into a heap at the bottom of the vertical branch. The repair is then difficult and time-consuming.

The choice of a chain conveyor to bring a very limited quantity of chips - about 400 kg or 2 m3 per hour - to an elevation of 12 m does not seem right. A belt conveyor would have been cheaper, easier to maintain and repair, and would consume less electric power. If the chip washing unit described in the preceding chapter is not installed for some reason, the cheapest solution to the chain conveyor problem would consist in moving the chipper away from the production hangar and to install an inclined belt conveyor that would take the chips directly from under the chipper up to the chip container. Such inclined chip belt conveyors are installed, for example, in the fibreboard factories in Madagascar and Kenya. The conveyor would have to have a length of about 26 m (at an angle of 30^{o}), with a rubber belt length of 54 m. With a spare belt, the total belt length would be 108 m, at a cost of 64.800 öS (3.000 US$) ex Austrian works. Another solution would be to leave the chipper in its present place and to install two belt conveyors that would transport the chips up to the chip silo in a kind of zig-zag.

3.5. Stoppages or breaks of the Defibrator feeding screw

This problem has already been mentioned in connection with the problem of over-dried wood, and it would certainly be reduced by the installation of the chip washing unit.

The danger of over-sized chips would be eliminated by installing an appropriate vibrating sieve after the chipper. Such a sieve can be built locally in Addis Ababa. For the design, one could look at similar sieves installed in other factories. If the chip working unit is installed, the soaking trough would have a sieve that would retain over-sized chips. The over-sized chips could be taken out manually from time to time and returned to the chipper.

To modify or reinforce the feeding screw of the Defibrator seems impossible. This Defibrator was built in 1935 by Voith, Germany, which means that it was already 34 years old when it was installed in Ethiopia. It must be one of the first Defibrator units ever built. (The Asplund Defibrator process was invented in 1931.) With almost 50 years of service, a machine that is subject to such intensive wear and abrasion must be considered a true museum piece. As this machine presents other problems which are analysed in the two following chapters, there is really no way around the purchase of a new Defibrator unit.

Three quotations have already been obtained. The one from Voith, Germany, dated May 1981, has already been mentioned in chapter 3.1. It indicates a price of 1.109.000 DM (365.000 US$) for the Defibrator with spares, f.o.b. German seaport.

Another quotation is contained in the telex from Defibrator, Sweden, dated 6.6.1984, which is enclosed as annex 1. The price for the Defibrator unit is 3,500.000 Skr (about 400.000 US$).

Finally, there is the quotation from the Chinese National Machinery Import and Export Corporation dated 30.6.1984 which is attached as annex 4. The smallest quoted Defibrator unit, the QM6, costs 34.000 US$ c.a.f. Assab, the largest, the QM9, 84.000 US$. Before a decision about the purchase of a Defibrator unit is taken, more detailed information must be sought on the Chinese equipment. A paper published by UNIDO in its revised edition on September 30, 1981, "Technology and equipment of a small-scale wet process hard fibreboard (hardboard) plant" by Chian Yinglin[1] describes briefly 3 types of Defibrators in the following manner:

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1) UNIDO Document IB/WG.335/3 Rev.1

<u>Charcteristics of defibrators currently produced in China:</u> (198o)

Item / Type	QM 6	QM 8	QM 9
Disc diameter (mm)	600	800	900
Power (kW)	110	245	275
Production capacity (t/day)	12-18	18-25	18-26
Fibre freeness (sec)	15-20	15-20	18-25

The QM 6 produces only rough pulp which has to be refined before being utilised, while the QM 9 has a disc with two different grinding zones, one with a coarse and the other with a fine profile, and produces refined pulp in a single operation. As the cone refiner installed at ETHARSO works properly and as the required vats, pumps and pipes for two stage pulp preparation already exist , the cheap QM 6 refiner may be the best solution for ETHARSO. The cost advantage of the Chinese equipment compared to Swedish or German equipment is such that the choice is obvious. It should be stressed that the Chinese have much experience in the construction of small scale fibreboard making equipment as in China there are over 200 small-scale fibreboard plants. Many of them have two QM 6 Defibrators and this machine may have been produced in several hundred items. While Sunds Defibrator of Sweden are the inventors of the Defibrator process and still the largest manufacturers of fibreboard making equipment, they have certainly sold only a few items of the smallest Defibrator unit which is described in the quotation cited above.

From the quotation of Voith Germany one may also deduce that it would cost much more to have the old existing Defibrator repaired than to buy a new one from China. The purchase of a new Defibrator unit from China should have a high priority in the rehabilitation program of ETHARSO.

3.6. The pressure packing on the Defibrator is consumed quickly

The pressure packing on the shaft of the fiberizing disc of the Defibrator is consumed quickly. The reason is that the packing employed is not the high quality asbestos-graphite packing that is required, but a packing found in local commerce which offers more friction and therefore becomes hot while it is not perfectly heat-resistant. The reason for the choice of this packing lies in insufficient foreign currency allocations to ETHARSO, while the personnel of ETHARSO knows the technical problems and possibilities perfectly well. Purchasing the asbestos-graphite packing would probably be much cheaper from China than from Germany, but to get the suitable material may involve efforts that are out of proportion with its cost. Together with a new Chinese Defibrator an adequate supply of these consumable parts should be purchased and it would then be easy to place new orders. In the present situation the consultant cannot give any advice of value to ETHARSO's staff who is trying to obtain the required foreign currency allocation to purchase appropriate packings from Germany.

3.7. High steam consumption of the Defibrator

ETHARSO has no means of measuring the steam consumption of the Defibrator unit. When the Defibrator is supplied with steam only by the wood-fired small boiler (see chapter 3.16), the steam consumption may be estimated very roughly from the wood consumption of this boiler. During the sojourn of the consultant the small boiler was unfortunately not operating. It is evident, however, that a considerable amount of steam is wasted in the Defibrator discharge, while it would be essential, for reasons of economy and of steam boiler capacity (see chapter 3.16), to economize steam wherever possible.

The discharge of the Defibrator is made in such a way that there is no special discharging valve, but just an opening in the casing of the fiberizing mill, from where the fibres are blown in a pipe to an elevation of about 3 m and discharged there in the coarse pulp vat. In this transport of the fibres, steam is the transporting medium, and with its high heat content it is evidently an expensive medium compared to air or to water. Part of the heat of the steam serves to heat the coarse pulp and so to provide a reasonably warm fine pulp, an important factor in the rapid and even forming of the fibre mat. Much of this steam, however, is lost into the atmosphere of the factory building and contributes, by its heat and moisture, to make working conditions more difficult.

This arrangement is unusual and may be explained by the fact that the Defibrator unit was built in 1935, as already mentioned. More modern Defibrators normally have a special discharge valve which discharges the fibres by gravity into the coarse pulp vat. If a new Defibrator is purchased, the whole arrangement should be reexamined in accordance with the advice given by the manufacturer of this machine. If this purchase is not possible, good advice is difficult. ETHARSO's personnel has already tried to reduce the section of the steam outlet of the Defibrator, but this measure led to an obstruction of the pipe carrying the fibres to the coarse pulp vat. A new coarse pulp vat would have to be built under the Defibrator so to allow the discharging of the fibres by gravity. It should then be possible to reduce the section of the discharge opening of the Defibrator without causing any plugging. It is not easy to estimate the total cost of this measure and impossible even to estimate the saving of steam without carrying out tests that would cause an interruption of production and thus be very expensive. In this situation, it is not possible to say whether this modification is economically justified.

If the purchase of the new Defibrator is not realizable, this problem should be reexamined and some tests should be carried out.

3.8. Consistency regulator not operating

The consistency regulator that should regulate automatically the consistency of the pulp in the fine pulp vat is not working. The consistency is adjusted by hand on the basis of the thickness of the wet fibre mats that are produced in the mat forming machine and of the compressed boards that come out from the hot press.

The consultant's experience with small fibreboard plants that do not work in a really continuous manner because of a batch type operating system or because of frequent interruptions is that it is extremely difficult to make an automatic consistency regulator work, while with the slow production rhythm the feedback from the mat forming and pressing section to the pulp preparation section is fast enough to minimize losses caused by an inappropriate consistency of the pulp, in particular when the personnel is accustomed to this type of operation. It is therefore certainly best to maintain the existing procedures.

After a major rehabilitation of the plant including the purchase of a new Defibrator it may be useful to improve the consistency control. As the operation will still be batch-type, one may try to employ a partly manual system. The existing consistency regulator would then be used only to measure the consistency, while the necessary addition of water would still be regulated manually.

3.9. Uneven thickness of fibre mats in the forming machine

The mat forming machine, as already stated in chapter 2.2., consists mainly of a deckle box with a moving endless screen. The fibre mats are weaker on the edges, in particular on the two shorter edges, and particularly more on the edge where the moving wire sieve enters the deckle box. While the weak zones along the long edges are not grave as they are almost entirely cut away in the trimming process, the weaker zones along the shorter edges are longer and leave the finished board with relatively fragile short edges.

Several possible explanations of this phenomenom where investigated without success. Hydraulic resistance in the suction system underneath the wire belt was excluded after it was found that there were large and unobstructed passages for the water that is sucked off.

An uneven distribution of the pulp in the trough was rejected after it was found that agitating the pulp in the trough manually had no effect.

A lack of tightness in the seals around the deckle box could not be directly observed but remains a possiblity.

Experience has shown that the uneveness is more severe with rough pulp and when no alum has been added to the pulp, but this knowledge has given no clue why the edges are so weak.

A possible empiric solution to this problem might be an adjustment of the holes in the perforated plate. The moving wire sieve is supported by a perforated metal plate, 4 mm thick, which in turn rests on a grid-like structure. The holes in the perforated plate have a diameter of 10 mm and are distributed evenly at a distance of 27mm. It is evident that additional perforations or an increase in the diameter of the holes in a certain part of the plate would increase the suction there and thus produce a thicker spot in the fibre mat. By boring additional holes at the ends of the perforated plate, where the weak parts of the fibre mats are formed, one should be able to compensate this effect. It will probably not be possible to obtain a perfect compensation for all conditions, such as different freenesses of the pulp, but a certain improvement could probably be achieved. However, no tests were made in this sense as they would require considerable time and an interruption of production and possibly lead to permanent damage on one of the expensive perforated plates.

3.10. Lack of capacity of the hot press

The hot press has 5 daylights, an improvement over the original plan calling for 3 daylights, and has thus a capacity that is limited to about 7 tons of hardboard per day, as shown in chapter 3.1. The capacities of the pulping section and of the mat forming machine are slightly higher, about 8 - 9 tons per day. This capacity could be fully utilized if it were possible to produce softboard at the same time as hardboard, but in softboard production the hot press is needed as well and the production capacity remains therefore limited to about 7 ton/day.

At present, when only hardboard is produced, as is normally the case, the mat forming machine produces the 5 mats for one charge of the hot press in 6 - 7 minutes. These boards are placed into the loading basket. The mat forming machine then stands idle for 1.5 - 2 minutes while the hot press is unloaded and then reloaded. As already explained, loading and unloading is done with the same basket having 10 openings, and it is therefore not possible to load and unload at the same time. At least one additional fibre mat per charge of 5 mats could be produced by the mat forming machine. This would mean an increase of overall production of 20%. A corresponding increase of the press capacity would thus be very convenient and highly profitable. Several ways of achieving this goal have been studied.

A special unloading basket would be an obvious solution. The duration of the loading operation could then be reduced from about 2 minutes to about 1 minute. During this one minute of the loading operation, an already formed fibre mat could be waiting on a transport caul, ready to be pushed into the loading basket. At present, there is no waiting position for more than one fibre mat. An unloading basket with 5 daylights could certainly be built locally by a local machine shop under the supervision of the technical staff of ETHARSO.
The pitch of the daylights in the hot press is 160 mm (100 mm spacing and 60 mm platen thickness). The unloading basket would therefore have only 800 mm of operating height. With cheap and plentiful labour as in Ethiopia, it would not even be necessary to install a lifting and lowering mechanism for the unloading basket. A drawing-out beam would have to grasp all 5 transport cauls at their mushroom-shaped appendices at one time and draw them out from the hot press and into the unloading basket. From there, they could be extracted manually with a simple lifting table or a similar device. The return of the transport cauls together with the pressing sieves from the unloading side to the loading side would be done manually on a roller path, as in the case in small fibreboard plants in Madagascar and Kenya.
Another possibility would be to increase the number of daylights in the hot press from 5 to 6, without a fundamental change in the loading/unloading system. However, an additional heated platen, without a modification of the press frame and the hydraulic rams, would reduce the height of the openings between the heating platens from 100 to 73 mm. (500 mm total actual opening minus 60 mm for the thickness of the new heating platen leaves 440 total opening,

which,divided by 6 gives 73 mm for each opening.) In each opening there is a polished press plate of 4 mm thickness which is, of course, not perfectly flat against the heating platen. The clear opening would then not be sufficient to receive the transport cauls, which are not perfectly flat, carrying the press sieves and the fibre mats. As the press was originally foreseen for only 3 daylights, the clear opening is already reduced to the bare minimum with 5 daylights. In order to increase the number of daylights of the hot press, it would therefore be necessary to reduce the thickness of the press head or of the press base and install new hydraulic cylinders and rams to increase the stroke from 500 to 600 mm, as the present cylinders and rams have just the required length for a stroke of 500 mm. These modifications would be costly and entail a long interruption of production on the whole factory. The idea of increasing the number of daylights of the hot press was therefore abandoned.

A very different solution of the same problem would be to install an additional light press that would take care of the production of softboard and medium density board. The existing heavy hot press would thus be reserved for hardboard production alone.

With this special softboard press the mat forming machine would have to operate in a special manner to utilize its full capacity. After five hardboard mats have been formed, one softboard mat would be produced while the existing hot press is being unloaded and reloaded. The softboard mat would then be extracted sideways from the hardboard making line and be loaded onto a softboard drying rack. In this way of operating it would not be possible to prepare a different pulp for hardboard and for softboard. This does not seem to present major problems, the only difference between hardboard and softboard pulp being used at ETHARSO is that for softboard production more additives are added, in particular wheat flour. (Normally softboard is made with much more refined pulp presenting a freeness of 18-20°SR or about 25 Defibrator seconds.)

These additives, however, can be poured directly into the deckle box when it is filled with pulp. Before adopting this operation, one should analyse the white water to determine the quantity of wheat flour lost in the process.

The additional press would evidently add to the flexibility of the whole plant. It would be used for the production of medium density board by putting the wet fibre mat directly into this press and drying it at a pressure of 10 - 15 kp/cm^2 (on the mat surface). One may also try to use it for the tempering of hardboards. Some tests would have to be made after the press has been installed. Presently hardboards are not tempered, as the softboard drier, which is intended to serve also as a hardboard tempering chamber, has problems which are described in chapters 3.12 and 3.13.

An unused press at the Jimma plywood factory of Ethiopian Enterprises Ltd. was examined for its suitability as a second press at ETHARSO. Unfortunately, no plant or technical descriptions were found. The press was installed in 1969 or 1970 and has served for a few years for the production of chipboard. It was idled when the competition from the larger chipboard factory of ECAFCO in Addis Ababa became too strong. The plywood factory in Jimma was then still under Italian ownership and management, and only some old workers remember the functioning of this press.

The press was manufactured by the Italian firm Berlasso of Terenzano, province of Udine. It has two daylights, a platen size of 180 x 370 cm and a steam heating system. The hydraulic system seems to have been operated at a maximum pressure of 300 kp/cm^2. With eight pistons of 300 mm diameter this would mean a specific pressure of 25 kp/cm^2 on the surface of the boards. The hydraulic system was fed with high pressure water by a group of three pumps: a centrifugal pump for fast closing, and two piston pumps. The piston pump for the highest pressure is missing. It was apparently utilized for another press.

In relation to the needs of ETHARSO this old chipboard press has heated platens hich are about twice as large as required. This would lead to a continuous waste of heat of which there is a shortage at ETHARSO and which is expensive to generate (see chapter 3.16.). The absence of the last stage pump, on the other hand, may be without importance as only a pressure of about 12 kp/cm2 is required on a surface of slightly over 3 m^2. A hydraulic pressure of about 75 kp/cm2 would then suffice, and this pressure in the hydraulic system may be reached by the available piston pump. The two daylights would be well suited to the needs of ETHARSO as they would give a certain spare capacity.

Altogether, the old particleboard press in Jimma is certainly not ideal for ETHARSO because of the excessive surface of the heating platens which would cause a considerable loss of thermal energy. The consultant has therefore looked for a new press which would be made to measure for ETHARSO. The Austrian firm Maschinenfabrik Langzauner GmbH has given a price estimate which is enclosed as annex 5. The press would have two daylights and a platen size of 2,550 x 1,350 mm, large enough to accomodate spacer bars when boards of low density are produced directly from the fibre mats. The maximum pressure is 400 t, equivalent to about 12 kp/cm2 on the surface of the boards. It would have its own oil-hydraulic drive and be equipped for heating with hot water from the existing steam boiler. The estimated price of this press would be 640,000 öS (30,000 US$).

If at a later date a switch to electric heating seems desirable (see chapter 3.16.) one would have to install a thermic oil unit with electric heating which would cost about 135,000 öS (6,400 US$). If the oil-hydraulic drive is not ordered and the press is attached to the existing water-hydraulic system, the price would be reduced by about 30,000 öS (1,500 US$), but such an economy seems small compared to the operational advantages that an independent oil-hydraulic drive would bring.

If this press is too expensive, one may opt for one of the cheaper and lighter presses which are produced in series be installed in general purpose wood-working shops. In the Langzauner production program, a suitable press could be the type LZT 160. It would have three daylights, a platen size of 2500 x 1300 mm and a pressure of 5 kp/cm^2 on the boards are common. It could be ordered with direct electric heating in the press platens. Maximum platen temperature would be 150°C. With this press, it would not be possible to produce medium density fibreboard, as both the specific pressure and the platen temperature would be too low, but it would be well suited for the production of softboard, which would in any case be the main purpose of the second press at ETHARSO. Its price would be 283,000 öS (13,000 US$) exworks.
The choice between the more expensive but more versatile press and the cheaper press will depend ultimately on the availability of foreign currency.

Of course, it may be possible to obtain more favorable quotations from other suppliers. Machine manufacturers from Eastern Europe and from Asia, in particular from China, may have lower prices although the lighter of the two presses from Langzauner seems quite cheap.

The conclusions on this chapter may be drawn as follows:

The installation of a special unloading device is an interesting possibility. Its main attraction is that it could be done without a foreign currency allocation . It would require only a short interruption of the production.

A special softboard press would present the advantage of giving the factory more flexibility. The cheap light press for the production of softboard alone would cost only about 13,000 US$ plus transport and installation. A more powerful press which could produce also medium density fibreboard would cost about 30,000 US$ plus transport and installation. A choice between these two possibilities will have to be made on the basis of the availability of foreign currency and of the production and sales program of ETHARSO.

Increasing the number of daylights in the hot press should not be considered as it would be an expensive solution if the loss of production is taken into account. The dismantling and re-installation of the old press from Jimma should be considered only if no foreign currency allocation can be obtained for the purchase of a new light press. There are all kinds of technical risks with such an old press which has not worked for more than 10 years. With all additional costs this press would not be cheap and would carry the permanant handicap of heat losses due to the excessive surface of the heating platens.

3.11. High pressure water leaks on hot press rams

The hot press has four main pistons with a diameter of 400 mm and 2 closing pistons with a diameter of 80 mm. There are conspicuous high pressure water leaks at the gaskets of the main cylinders, and smaller leaks on the closing cylinders. These leaks have two main reasons:

- The rams are worn out and their rough surface causes a rapid consumption of the gaskets.

- With Becker & van Hüllen no longer existing, ETHARSO cannot get the proper rubber pressure gaskets.

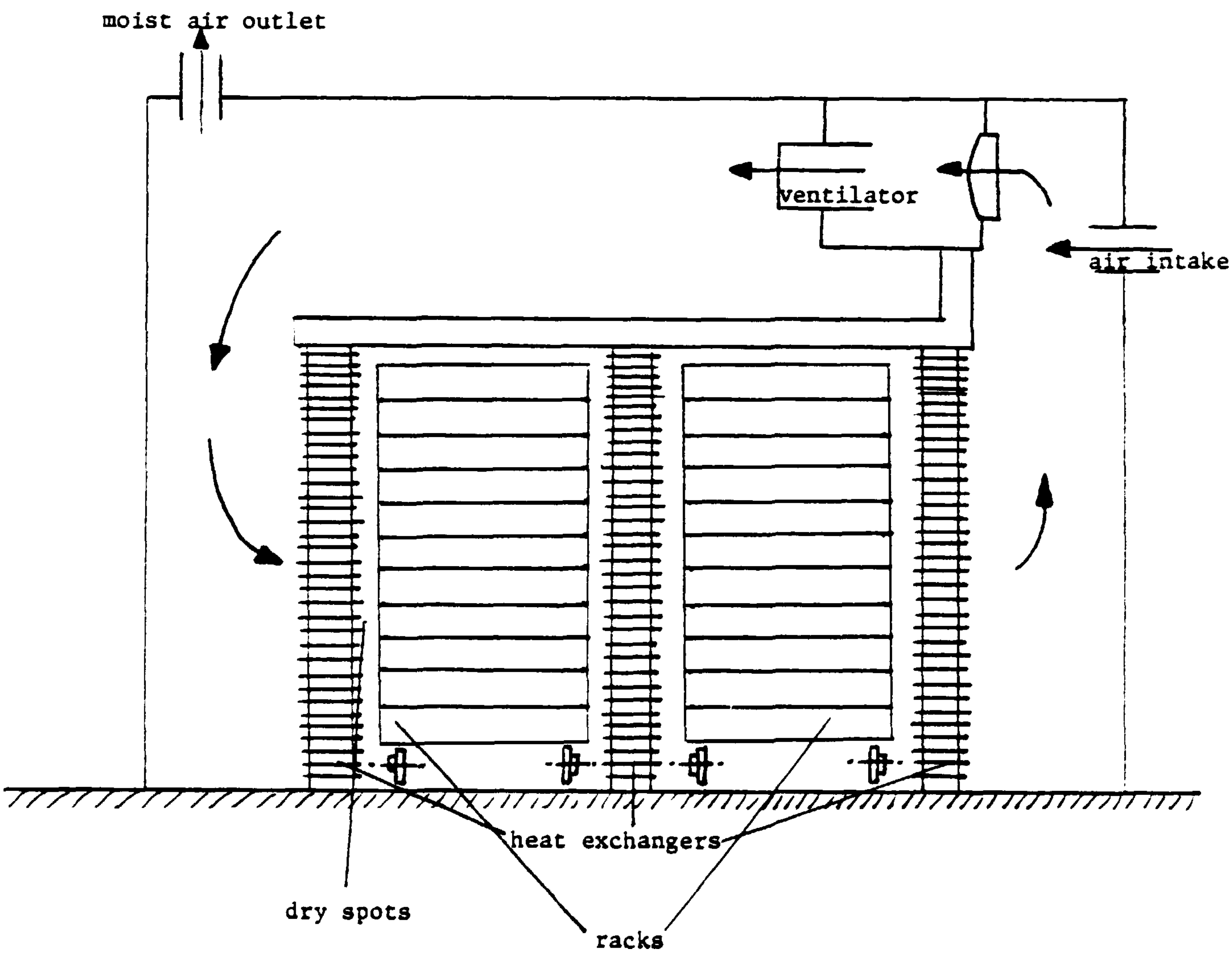
To improve the surface of the rams, the normal procedure would be to have them rectified and re-chromed. Such an operation must be done rapidly to minimize the loss of production. A workshop capable of doing this kind of work seems to have existed in Asmara, but it may now no longer be operating and it would be too difficult to transport the rams from Addis Ababa to Asmara. This solution is therefore considered impossible by the staff of ETHARSO. To send the rams abroad for rectifying and re-chroming would take a long time. New rams cannot be obtained from Becker & van Hüllen and so a different supplier of rams was sought.

It turned out to be impossible to get a quotation for the rams from a general purpose foundry and for the rubber gaskets from a manufacturer of rubber articles, as they would not have the required expertise for these very specialized products. A manufacturer of hydraulic presses, J. Dieffenbacher G.m.b.H. of Eppingen, West Germany, was therefore contacted and a quotation for both the rams and the gaskets was obtained. Dieffenbacher has a production program that is very similar to Becker & van Hüllen's. In particular, Dieffenbacher supplied the heated daylight presses and the dewatering presses for the fibreboard plants in Kenya and in Madagascar. The total price quoted for 4 new main rams for the hot press and for a complete set of gaskets for all the cylinders of both the hot press and the de-watering press is 12,817.86 Birr (4,135 US$), as can be seen from the quotation enclosed as annex 6.

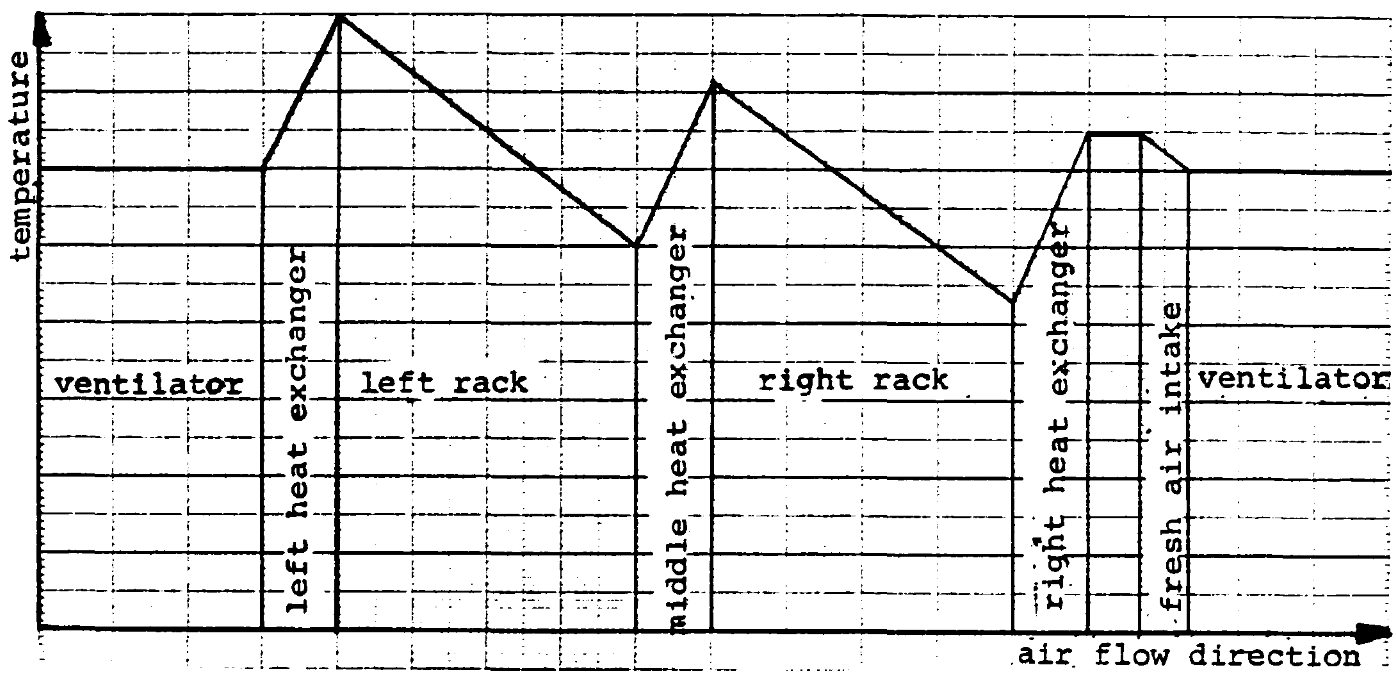
One must presume that rams and gaskets from a press manufacturer like Dieffenbacher are more expensive than those from a general purpose foundry and a specialized rubber manufacturer, and that West German supplies are more expensive than those from Eastern Europe or Asia. On the other hand, ETHARSO possesses only very vague layout plans for the presses and obtaining spares from someone who is not familiar with Becker & van Hüllen's technology would present grave risks. Considering the urgency of these supplies, Dieffenbacher may be considered an appropriate supplier, at least at present. A cheaper supplier of gaskets, which are consumable parts, may still be found later.

3.12. Uneven softboard drying

The boards coming out from the softboard drying chamber are unevenly dried. The following sketch shows the schematic disposition of the drier and the spots were the boards are the driest.



The explanation for this phenomenom lies evidently in the disposition of the heat exchangers. The drying air, after passing through the two racks loaded with wet softboards, passes through the heat exchanger at the sight of the sketch and then through another heat exchanger at the left before coming in touch again with moist boards. The temperature of the air in the course of its circulation will therefore rise and fall as shown schematically, taking into account that the intake of fresh air is very limited.



The first rack thus receives hotter and drier air than the second rack, and the air close to the left heat exchanger will be the hottest. In effect it is there that the softboards are the driest. To obtain a more even drying, one may turn off or turn down considerably either the left or the right heat exchanger, or one may turn down moderately both of them.

These measures will, of course, reduce the drying capacity of the drier, but if a new light press with 2 daylights is installed, the press can assume a larger part in the drying. To avoid the loss of capacity, the heat transfer of the middle exchanger would have to be increased, but this seems difficult to achieve. An additional electric heating element in the center of the drier would be feasable, but its operation would not be economic in the present price situation (see chapter 3.16.).

Another helpful measure would be to reduce the number of boards in one rack. As of now 25 boards are charged into each rack with a spacing of 6 cm. The necessary steel supports restrict the air passage, in particular when the boards are warped in drying. If only every second slot of the rack was charged with a board, there would a much larger air passage, the air flow would be faster and the difference in air temperature and moisture would be smaller between the left and the right side of the drier. This measure would again reduce the capacity of the drier. Tests would have to determine the extent of this reduction. There would only be 24 boards per charge instead of 50, but the drying would be faster.

At present, the softboard drier has a certain excess capacity. In 3 hours it dries 2 loaded racks, that is 50 boards, to a degree that they must be taken out for the final drying in the press. (If the boards are completely dried in the drier, it is difficult to flatten them in the press.) It operates only when there is a specific demand for softboard. If softboard is produced together with hardboard as outlined in chapter 3.10., one softboard panel would be produced in each cycle of the hot press, that is every 8 minutes. The production of softboards would thus be 7.5 boards per hour. This quantity could be handled by the drier even if only 12 boards are charged per rack and if the drying time remains 3 hours as it is now with 25 boards per rack. In effect, the production of the drier would then be 24 boards per 3 hours or 8 boards per hour. At this rhythm, there would be no time for the tempering of hardboards in the drying chamber. Most hardboards are not tempered anyway, and a certain reduction of the drying time of softboards will certainly be possible so to make the drying chamber available for hardboard tempering from time to time. (See also next chapter.)

3.13. Burning of softboard in drying and of hardboard in tempering

On several occasions during the drying of softboards and the tempering of hardboards a spontaneous ignition has occured in the softboard drier(which serves also as a hardboard tempering chamber. The burning started at the left side of the chamber and this problem of ignition is clearly linked to the problem treated in the proceeding chapter. With a more even heat distribution the danger of spontaneous ignition will be obviously be reduced.

Another measure would be to reduce the operating temperature. The easiest way of doing this would be to supply the drying chamber with hot water not from the main boiler which works at a pressure of 20 bar and a corresponding temperature of 211^{o}C, but from the small wood-fired boiler which works at a pressure of about 10 bar and a corresponding temperature of about 180^{o}C.

Of course, it would be useful to equip the chamber with temperature sensors connected with an alarm system. Not to equip the chamber with such a device must even be considered an engineering mistake that was committed by the original supplier. ETHARSO's staff has already contacted a local firm that seems capable of installing sensors and an alarm.

In the drying of softboard, it should be relatively easy to eliminate the danger of ignition, as the softboards are not completely dried and only the irregular drying analysed in the preceding chapter makes ignition possible.

The case is different for hardboard tempering. If the temperature is too low, the tempering is without practical effect. At the appropriate temperature, an exothermic reaction may easily set in which provokes a rapid rise of temperature and may lead to ignition. Modern tempering chambers are therefore equipped with sensitive automatic temperature controls. In the case of ETHARSO, the installation of the temperature sensors will reduce the danger of ignition, but not eliminate it. This danger would be avoided altogether if the tempering was done not in the drying chamber, but in the light hot press. Some tests will have to be made to determine the effectiveness of this procedure which is unusual in hardboard production. A very similar process is, however, applied in particle board manufacture . To improve the surface of particle board so that it will be suitable for direct printing, the board is re-pressed at high temperatures (200 to 400°C) in a platen press for a few seconds. In hardboard production the temperatures are much higher than in particle board production and a temperature considerably above 200°C would be required to obtain a tempering effect in such a short time. It is possible, however, that a certain tempering effect will be achieved by re-pressing the boards at 200°C or slightly above for some minutes.

With the additional heated press, the existing hot press will no longer be the main bottleneck in the production process and it will be possible to increase the pressing time slightly. At present, the pressing time is reduced to the bare minimum that is required to avoid blisters and delamination in the boards. With slightly longer pressing, the quality of the boards should be improved and the need for tempering should be reduced.

3.14. Hardboard warps in application

With the present shortage of boards of all kind, customers do not complain about the quality of the boards. It is known, however, that ETHARSO's hardboards have a tendency to warp when they are applied on a frame, for example as flush door skins, in furniture making or as ceilings. The reason seems to be that the boards are not re-moistened at the factory. They are therefore sold with a very low moisture content and they tend to absorb moisture from the atmosphere. This makes them expand, and the expansion leads to warping when the boards are fastened on rigid frames.

In other countries, carpenters often splash water on the rough side of hardboards before fastening them on a frame, but in Ethiopia this procedure may not be known. In any case, it would be preferable to give the boards the appropriate moisture content, about 8 - 10%, before they are sold.

ETHARSO has a board conditioning chamber which was certainly rather expensive, but whose operation has been stopped because of many technical troubles. To repair and improve it would certainly be expensive and this was not seriously considered. It would be sufficient to have a very simple moistening machine that sprays a controlled quantity of water on the screen (back) side of the boards. Such a machine, an improved version of the ones that exist in Madagascar and Kenya, is shown on the sketch attached as annex 7. It could be produced locally in Ethiopia. Only the spraying nozzles, whose total cost will not exceed 100 US$, will have to be imported. The cost of this machine, if produced locally, must be determined in collaboration with qualified local firms. Purchased from West Germany, it would cost about 12,000 - 15,000 DM (4,000 - 5,000 US$) ex works.

3.15. Perforating machine for acoustic tiles not operating

ETHARSO was originally equipped for the production of acoustic tiles. Softboards were divided into squares of 1' (30.5 cm) or 2' (61 cm) width. The edges were cut at an angle of 45° with a rather simple circular saw and holes were bored in the board. These holes did not penetrate the full thickness of the boards, as they were intended to improve sound absorbtion without affecting the good thermal insulation properties of the boards. The holes were made on a special machine manufactured by the German firm A. Knoevenagel GmbH of Hannover (Postfach 3404, D-3000 Hannover 1). This machine has a line of 400 drills and a table with an automatic advance mechanism which pushes the board forward by an appropriate distance after one line of holes has been drilled. The drills, which are driven with a system of pulleys and gears, are smooth and hollow, rather like the simple hand tools that are used to punch holes into leather or plastic.

The problems are mainly two:

a) The drills get hot which makes them lose their tempering. They are then dulled quickly and have to be re-sharpened frequently.

b) The bearings of the drills are simple ball bearings which are not designed to support an axial effort. Several of them are completely damaged and would have to be changed.

These two problems are evidently linked. The plug (in rock drilling it would be called a carrot) that is cut out of the board by the hollow drill is not expelled easily but remains stuck in the hollow drill. To expel it, the drill has to be pushed with great force against the board in the next drilling operation and this causes the heating of the drills through friction and the excessive wear of the ball bearings. After a few lines have been drilled, the hollow drills have to be cleaned by hand which is very time-consuming.

The consultant has informed Knoevenagel about these difficulties and asked for advice. He has also advanced the idea of substituting the hollow drills with massive drills which would not become plugged. Massive drills are, however, generally not suitable for the drilling of softboard as the fibres tend to wrap around the drill and they are then torn out and not cut cleanly. The result are irregular holes which are unacceptable in acoustic tiles. Knoevenagel would have to find the most appropriate type of drill through drilling tests on softboards supplied by ETHARSO. Four pieces of 30 x 30 cm would be sufficient. This information has already been passed on to ETHARSO.

One may hope that Knoevenagel will be able to propose a drill that will not get plugged. The damaged bearings and gears could then be changed quite easily. Otherwise, the machine would have to be equipped with a mechanism that ejects the plugs automatically after every drilling operation. Such a major modification seems, however, difficult to implement. A very different approach to this problem would be to prepare softboards with finer pulp, that is with shorter fibres. These boards would be more homogeneous in structure and easier to perforate. Considering the high value of acoustic tiles, it would be worthwhile to produce a special type of softboard for their manufacture. Softboard would then be produced from time to time in a special production run of a few hours' duration, not just in between hardboards as described in chapter 3.10.

It would be useful to prepare some samples of these finer softboards soon and to have them tested by Knoevenagel.

3.16. Problems with the steam boilers

The steam boilers present several problems which are linked and are better presented in a single chapter.

As already briefly described in chapter 2.2., ETHARSO was originally equipped with an oil-fired smoke tube boiler. It operates at a pressure of 20 bar and supplies steam for the Defibrator unit as well as hot water for the press. It was manufactured by the German firm Wilhelm Küsters of Aachen which unfortunately has ceased to exist. As its capacity was barely sufficient and because of the high price of fuel oil, a second-hand wood-fired locomotive-type boiler was purchased locally some years ago and installed at ETHARSO. It is connected so far only to the Defibrator unit which it supplies with steam. This boiler was manufactured by the German firm Buckan R.Wolf A.G., Neuss-Grevenbroich.

The main problems caused by these boilers are three:

a) The main boiler has frequent breakdowns. The smoke tubes tend to leak. Several of them had to be shut off which leads to a decrease of the steam output. Spare tubes have only recently been ordered and they have not yet arrived.

b) As the main boiler is equipped only for the burning of fuel oil, this is the main fuel. It is expensive at 53 cents (Ethiopian) per litre.

c) The capacity of the two boilers together is sufficient for the present operation. With a second heated press it will be critical.

These problems are clearly linked. An obvious solution would be to install a new boiler capable of burning not only fuel oil, but also other fuels such as waste wood. Other, less expensive solutions must, however, not be neglected.

For the reduction of the number and duration of breakdowns of the main boiler a very positive contribution should be the planned major replacement of the smoke tubes. The old tubes have a deposit of scale which isolates them from the water and causes their overheating. When a smoke tube has been burnt, it has to be shut at the end plates by welding. Of course, the closed-down tube is then lost for steam production. The replacement of the old tubes will be undertaken very soon and it will be possible to see its result.

The problem of the high cost of fuel oil must evidently be examined both from a technical and an economic point of view. The possible substitutes for fuel oil are, in the case of ETHARSO, wood and electric energy.

The availability of wood has been analysed in chapter 3.2. For heating purposes, considering the lower efficiency of a wood-fired boiler, about 4 kg of air-dried wood are needed to replace 1 l of fuel oil. The wood must therefore not cost more than 12 cents per kg, all handling costs included, to be an interesting alternative. Waste wood can be brought to ETHARSO at a considerably lower price. In the future, one may hope that cheap plantation wood will also be available. The substitution of wood for fuel oil would therefore be interesting for ETHARSO and even more so for the national economy.

The technical problems of burning wood waste, in particular sawdust, in the main boiler have therefore been investigated. The German manufacturer of the oil burner, Körting Hannover A.G. of Hannover, and Eisenwerke Baumgarte of Bielefeld, West Germany, the firm that has taken over the business of the extinct firm Küsters, have been contacted.

To equip the boiler for the burning of sawdust, it would be necessary to install a forced draught ventilator, and a special pre-combustion chamber would have to be added. (So far, the boiler works with over-pressure provided by the fan of the oil burner.) The ventilator would have to be rather powerful, as the smoke tubes are not conceived for the large volume of gases that comes with the combustion of wood. Even with this measure, the output of the boiler would be lower than with oil firing. As the boiler capacity is another critical point, this solution, which seems unsatisfactory anyway, must be abandoned.

Attention was then given to the possibility of increasing the capacity of the second, smaller, locomotive-type boiler which is equipped for the combustion of wood. It has a firing grate in the combustion chamber, smoke tubes and an overheater with water tubes. The heating surface is 24.06 m2 measured on the water side and 22.64 m2 measured on the fire side. The overheater, which is presently employed as a water pre-heater, has an additional heating surface of 25 m2. The boiler has no forced draught. To install a ventilator blowing air under the firing grate would be easy and cheap, but create problems. The combustion chamber would then operate with over-pressure, and it would not be possible to feed in wood of any size while the fan is blowing. A suction ventilator providing forced draught is clearly the solution. The technical manager of ETHARSO and the consultant looked for a suitable second hand ventilator in Addis Ababa but could not find any. However, the plywood factory of Ethiopian Enterprises in Addis Ababa operates a similar boiler equipped with a forced draught ventilator which could be used to produce a similar one locally. The wood would be charged manually. Logs would be loaded onto the grate, while sawdust and small waste could be introduced through a chute which would have to be built. This seems the best solution to increase the capacity of the wood-fired boiler. It should then be able to satisfy at least a third of the heat requirements of the plant.

This estimate is based on the following considerations. The main boiler supplied by Küsters, which is just sufficient when it is operating efficiently, has a heating surface of 84 m^2. The small boiler has a heating surface of 47 m^2, that is more than half that of the main boiler, but its specific output would be somewhat lower as the fuel would be wood. One may also assume a specific productivity of 15 kg/h of steam per m^2 of heating surface for this type of boiler. The steam output of the boiler would then be about 700 kg/h while the main boiler has a rated capacity of three tons of steam per hour and an actual capacity that is probably not more than 2 t/h. The 700 kg/h of steam are much more than sufficient for the Defibrator whose consumption seems to be of the order of 300 - 500 kg/h. They would also be sufficient for the new light press alone, but maybe not for both these heat consumers.

The small boiler would thus supply the Defibrator unit, as at present, and be connected to another heat consumer which may be the drying chamber on the small hot press. The operating pressure of this boiler, at 13 atmospheres effective pressure, would be slightly low for the main hot press.

A better utilization off this wood-fired boiler would evidently not solve the problem of the high cost of fuel oil in a complete manner, but it may well correspond to the present limited supply of fuel wood.

A better long term solution would be the purchase of a new boiler capable of utilizing both wood and fuel oil. A price estimate has been obtained from the Austrian boiler manufacturer Josef Bertsch G.m.b.H. of Bludenz. It is attached as annex 8. The price for the complete boiler, including the oil burner, the wood combustion chamber and the forced draught ventilator would be 1,399.000 öS (65.000 US$) ex works. It would have a capacity of 4.5 tons of steam per hour, enough to satisfy the heat requirements of the whole plant even with a second press. With transport and installation, the cost of the new boiler would be of the order of 100.000 US$ if the present ancillary equipment in the steam plant can be used. Before any decision on the purchase of a new boiler is made, the availability and cost of fuel wood must be ascertained.

A completely different solution to the problem of high fuel cost would be the introduction of <u>electric heating</u>. Ethiopia is a country with a shortage of fuels, but with abundant hydroelectric potential.

Some years ago, the public company in charge of electric power production and distribution, EELPA, encouraged higher electric energy consumption by offering special rates for heating purposes. (For example, the Hilton Hotel in Addis Ababa has switched from a fuel-oil fired boiler to an electric one.) At present, special heating rates are no longer offered. The normal tariff for a maximum demand of more than 500 kW, which means feeding at 15 kV, is the following:

- tariff on maximum demand:

first 50 kW	12 B/kW/month
next 200 kW	10 "
balance over 250 kW	8 "

- tariff on consumed energy:

first 200 kWh/kW max.demand		9 c/kWh
next 200	"	8 "
balance over 400	"	7 "

In the case of ETHARSO, the average real cost would be about 10 cents per consumed kWh. (The present contract of ETHARSO with EELPA is slightly more favorable with an average cost of 8 - 9 c/kWh.) At this tariff, electric heating would be almost twice as expensive as heating with fuel oil. One kWh corresponds to 860 kcal, while one litre of fuel oil contains about 9,500 kcal. Because of losses incurred in the steam boiler, only about 9 - 10 kWh are required to replace one litre of fuel oil. Where direct electric heating without a heating medium such as water or oil can be applied, this ratio may come down to 8 kWh/l. At a cost of 10 c/kWh and 53 c/l of fuel oil, electric heating is clearly more expensive.

This situation may change in 1987, when the 150 MW hydroelectric project at Melka Wakena is scheduled to come on stream. It will obviously be in the interest of the national economy to fully utilize this hydroelectric capacity by replacing imported fuel oil, and EELPA may again offer special rates for heating purposes.

The present tariff, however, rules out any switching of the existing steam boilers to electric heating. The only realistic candidate for electric heating would be the new light press. If the cheaper one of the 2 presses is chosen (see 3.10.), it could be ordered straight away with direct electric heating incorporated in the heating platens. The required electric power would only be 28 kW. The installation would be easier and the new press would not be subject to the deficiencies of the existing two old steam boilers. This additional electric power could be drawn from the existing feeding connection of ETHARSO and its cost would be not more than 8 c/kWh, as it would be in the favorable range of the binominal tariff formula. With direct heating, only 8 kWh are needed to replace one litre of fuel oil, at a cost of 64 cents against 53. The extra cost would thus be 11 cents per 8 kWh, or 38.5 cents per hour of operation of the new press at full capacity. At 300 working hours per month (at full capacity), the extra cost of electric heating is about 12o B/month. This seems a modest price for the added security and facility of operation. If, on the other hand, the more powerful press is chosen, which would require a special electric heating unit costing 6,400 US$, heating with hot water is an obvious choice unless there is a clear lack of capacity in the steam boilers.

The possible solution of the problem of high fuel oil cost have an obvious influence on the problem of insufficient capacity. The planned repair of the main steam boiler will help as all smoke tubes will then be effective again and they will be free from scale.

An elegant solution would be to reduce the steam consumption. The steam and hot water pipes as well as the major consumers are quite well insulated and no significant gains can be made on this point. The steam consumption of the existing Defibrator unit, which has been discussed in chapter 3.6. is certainly much higher than that of a modern one, but any modification seems practically impossible. A new Defibrator would alleviate the steam supply problem. The other main heat consumers are the drying chamber and the hot press (in the future: hot presses). To improve their thermal efficiency seems difficult.

The installation of a forced draught ventilator on the small boiler and the repair of the main boiler should bring about a sufficient increase of heat output capacity even for the increased output that can be obtained with the second press. To install a third steam boiler does not seem necessary in the present situation. Equipping the existing small boiler with an oil burner would certainly increase its capacity, but lead to higher operating costs. These measures should be considered only if the forced draught on the second boiler does not bring the expected results.

3.17. Summary of proposed investments

Because of the great number of interlocking problems which have been briefly analysed in the preceding chapter, it seems necessary to resume the proposed measures and their cost.

A very high priority should be given to the creation of new eucalyptus plantation controlled by ETHARSO. Its surface should be at least 200 ha, 400 ha if possible. The cost of a 200 ha plantation will be of the order of 200,000 - 400,000 Birr.

The proposed chip washing and transporting unit would have a foreign currency cost of about 5,000 US$, plus a considerable local cost that will have to be determined in cooperation with local metal-working shops.

The purchase of a new Defibrator unit seems unavoidable The Chinese QM 6 would cost only 34,000 US$ f.o.b. Assab and it should suffice for ETHARSO's needs. It may be useful to have a Chinese fitter for its installation. He may add 3,000 US$ to the foreign currency cost. The local currency cost of transport and installation would be low.

The purchase of an additional hot press is recommended. A press of adequate characteristics would cost about 33,000 US$ c.a.f. If foreign currency is limited, a lighter press costing about 15.000 US$ c.a.f. would still be interesting. If no foreign currency is available, an unloading basket for the existing hot press should be built locally, at a cost yet to be determined.

New rams and gaskets must be purchased for the existing hot press and only gaskets for the de-watering press. Their total cost is DM 12,817.86 (4,135 US$) ex works F.R.Germany or close to 5,000 US$ delivered.

In the drying chamber, temperature sensors should be installed by a local firm which has already been contacted by ETHARSO, at a cost to be determined.

A board moistening machine is no necessity, but it would be useful. It could be built locally, at a cost to be determined. As a guideline, one may consider that it would cost 4,000 - 5,000 US$ if purchased in Germany.

The contacts with Knoevenagel, the supplier of the machine producing acoustic tiles, should be pursued in order to make tests and finally to obtain a quotation for the repair of this machine. The success of this operation is still in doubt and no cost can yet be established.

The problems created by the steam boilers will be alleviated by the major overhaul of the main boiler that has already been started by ETHARSO by ordering the smoke tubes. The second boiler should be equipped with a locally built forced draught ventilator whose cost will have to be determined.

Not considering the establishment of the eucalyptus plantation, whose legal status is still completely uncertain, the recommended investments can be summed up as follows:

	foreign currency US$	local currency Birr
chip washing and transportation	5,000	appr. 20,000
new Defibrator unit	37,000	" 10,000
second hot press	33,000	" 10,000
rams and gaskets	5,000	" 10,000
temperature sensors	--	" 5,000
moistening machine	--	" 10,000
forced draught ventilator	--	" 10,000
total	80,000	appr. 75,000

4. Economic justification of proposed investments

In consideration of the great uncertainty in the investment costs, only a very simple economic evaluation of the different investments will be made in this chapter.

It is quite evident that the establishment of a eucalyptus plantation with the special purpose of supplying ETHARSO is economically justified. A comparison with other alternatives, in particular with straw, has already been made in chapter 3.2. , and in the long run the plantation is a necessity.

The installation of the chip washing unit must be evaluated with more caution. The present situation with the accident-prone chain conveyor is clearly unsatisfactory, but the proposed unit is not the only possible solution.

- ETHARSO may be able to obtain fresh eucalyptus wood more regularly in the future.
- With the wood-fired boiler improved and working regularly, a selection of the wood could be made, with the drier wood going to the boiler.
- The new Defibrator unit may be able to produce good pulp out of fairly dry wood.

The much cheaper solution of simply replacing the chain conveyor by one or two belt conveyors may then be chosen. It seems therefore advisable to wait for the results of the improvement of the wood-fired boiler and of the installation of a new Defibrator before taking a decision on the chip washing unit.

The purchase of a new Defibrator would be a very profitable investment. The present old Defibrator is the main cause of production stops which add up to 25% of operating time.

A loss of production of at least 200 t/y worth about 200,000 Birr/year may be attributed to the bad state of the old Defibrator. A new QM 6 from China would cost about 50,000 U$ or about 100,000 Birr installed. This cost would be recuperated in the internal market in less than a year, as consumptions such as raw material, fuel and electricity are not the main factors in production costs. To recuperate the foreign currency outlay of about 40,000 US$ ETHARSO would have to export 130 tons of hardboard at a price of 30 US cents/kg. This quantity would be made available in about 8 months by the increase of production due to the new Defibrator.

In these evaluations, improvements of board quality and reductions of steam and power consumption are not even taken into consideration.

The additional hot press should, in theory, increase the production by 20% as 6 boards will be produced in one cycle instead of five. In practice, other limiting factors will then appear more clearly than now, but an effective production increase of at least 10% or 200 t/year may be assumed, with a value of about 200,000 Birr. As the new press will cost only about 40,000 US$ (84,000 Birr) installed, its cost will be recuperated in less than a year. Regarding the foreign currency balance, the same consideration may be applied as for the Defibrator unit. If foreign currency is limited, the lighter one of the two presses offered, at a cost of about 18-20,000 US$ (40,000 Birr) installed, will be very profitable even if it brings about only a very limited increase of production.

The purchase of pressure gaskets for the two presses is a necessity. ETHARSO cannot count on the local availability of gaskets of any type in the future, and inadequate gaskets are certainly expensive in the long run. The only decision to be made is about replacing the old rams with new ones. These 4 rams cost 9,280 DM (3,000 US$) ex

German works. Their installed cost will be much higher as a considerable interruption of production must be considered. With 3 productive days lost, their installed cost would be of the order of 10,000 US$. This cost will, however, be recuperated in a reasonable time. One complete set of gaskets for the 4 main cylinders of the hot press costs 2,603.44 DM ex German works or at least 1,000 US$ installed. If these gaskets last 2 months with the new rams and only one month with the old ones - a conservative assumption - the 10,000 $ investment will be recuperated in 20 months through the economy of gaskets.

The temperature sensors for the drying chamber will not cost more than a few thousand Birr. Their installation is not a necessity in softboard production, in particular if the operation of the drying chamber is changed as recommended in chapter 3.12. , either by reducing the heat transfer of one heat exchanger or by loading only 12 boards (instead of 25) on each rack. For hardboard tempering, temperature sensors are almost indispensable to be able to work at the high temperatures (150 to 180°C depending on the properties of the boards) which produce the desired tempering effect. The decision about the sensors could be taken with more certainty after tests have been made with this modified operation of the drying chamber. If tempered hardboards are to be produced and if the tempering is to be done in the drying chamber (see chapter 3.1o.), temperature sensors should certainly be installed.

The board moistening machine would have no direct impact on local sales and thus its installation could not be justified financially if only the local market is supplied. If exports to Djibuti are undertaken, as recommended, the moistening machine should certainly be installed as the warping of the boards may give ETHARSO a bad reputation in a competitive market and considerably reduce its export possibilities.

The overhaul of the perforating machine for acoustic tiles would certainly be profitable considering the high value and the export potential of this product. Unfortunately, no technical solution of the problem has been found yet and the cost of the overhaul cannot even be estimated. To pursue the contacts with Knoevenagel and to make tests is certainly in the interest of ETHARSO.

The cost of the forced draught ventilator for the wood-fired boiler is also still unknown, but there can be little doubt about the profitability of this investment. It will bring about a better and more reliable operation of the whole plant in which the heat supply risks to become the limiting factor if the recommended investments are undertaken, and a substitution of expensive imported fuel oil by cheap local waste wood.

Altogether, the recommended investments add up to a foreign currency cost of about 80,000 US$ and a local cost of not more than 100,000 Birr, not considering the creation of a new eucalyptus plantation. With these investments ETHARSO should be capable of functioning for several more years with an output of 7 - 8 tons per day. In comparison, a new plant with a capacity of 10 t/day would cost over a million dollars in foreign currency, including transport and installation, and not less than 2 million Birr in local costs. In the present situation, when construction materials in general and fibreboards in particular are scarce, keeping ETHARSO in operation with a relatively modest investment program is certainly in the interest of the national economy. The new plant will take several years to start production as so far no project study has yet been made. On the other hand, the proposed investment will be recuperated in about a year. They will bring about an increase of production of the order of 500 t/year through more reliable operation and increased production capacity. On the internal market, this production is worth about 500,000 Birr (240,000 US$), on export markets about 150,000 US$ ex works. The added value created by the factory will be not less than half the sales value and a recuperation of the investment in about a year may thus be anticipated.

5. Training of personnel

Most of the personnel of ETHARSO has been working at the factory since its start-up in 1969. The fact that the factory has kept operating through all these difficult 15 years at a reasonable level of production demonstrates by itself the high skills of the personnel, and this report contains little advice on process improvements which can be made without additional investments, but concentrates on locating appropriate suppliers for the unavoidable investments.

To send ETHARSO's staff abroad for training would achieve little under these circumstances. However, a technical co-operation between East Africa's fibreboard factories would be beneficial to all concerned. ETHARSO, Sokoro Fibreboards Ltd. of Kenya and Fibreboards Africa Ltd. of Tanzania could easily collaborate. To include PANOMAD S.A. of Madagascar would be difficult because of language problems.

A practical way of starting this cooperation would be for the two leading technicians of ETHARSO to spend one week each in Elburgon, Kenya, and in Arusha, Tanzania, at the respective fibreboard factories. Travelling expenses would be limited to two return air tickets Addis Ababa-Nairobi (by Ethiopian Airways) and to two return bus tickets Nairobi-Arusha.

Sokoro Fibreboards Ltd. belongs to the private Timsales Group (Timsales Ltd., P.O.Box 18080, Nairobi).

UNIDO could establish the necessary contacts for an informal arrangement of such an information visit. Fibreboards Africa belongs to the state-owned Tanzania Wood Industry Corporation (P.O.Box 9160, Dar-es-Salaam) and an official approach should be made. UNDP in Dar-es-Salaam may be able to help.

The plant in Kenya has a rated capacity of 24 t/day but operates at about 15 t/day. Its process is even more batch-type than ETHARSO's. Pulp preparation is not done in a Defibrator unit which works continuously, but by cooking the chips by batches in spherical digesters and then grinding them in a refiner. The mat forming is done in two forming presses which are different from ETHARSO's. The hot press has 16 daylights and produces boards of 4' x 8' net dimensions. There is no tempering, remoistening is done on a simple water spraying machine as described in chapter 3.14.

The plant in Arusha, on the other hand, is of the conventional continuous type, with the pulp prepared by a Defibrator unit and a refiner and with the mat formed on a Fourdrinier machine. The hot press has 20 daylights; there is a tempering and a conditioning chamber. The rated capacity is 30 t/day, but average daily output is certainly much lower.

These two factories would certainly also profit from the proposed collaboration.

6. Long term outlook for ETHARSO

ETHARSO is far from being an ideal fibreboard plant. Its equipment is old, its original design not very good, it is located far from the raw material sources, waste water disposal will probably become a problem in the future. In any investment decision about ETHARSO the question of the longer term outlook arises and the consultant has been asked while in Ethiopia to treat this point in his report and to give some information on alternatives, in particular on a future new fibreboard plant.

In the immediate future, there is no practical alternative to keep ETHARSO going as well as possible with limited investments, as shown in chapter 4. The existing plant is, however, not capable of satisfying the fibreboard demand of the country and the best way to satisfy these present and future needs should be studied immediately. The considerations of this chapter can evidently be no substitute for a proper feasibility study on a new project.

Such a feasibility would probably start by evaluating the present and future market for fibrebaords and its substitutes. The outlook for fibreboard in Ethiopia is certainly good. It competes mainly with thin plywood and the raw material supply for plywood production will certainly become more and more difficult in the next years, although eucalyptus globulus (white eucalyptus) is increasingly employed. While eucalyptus reach a sufficient size for pulping, as in fibreboard production, in about 6 years, at least twice that time is required to obtain peeler logs. As described in chapter 2.4. , the present plantation programs are not even sufficient to cover the fuel wood needs of the population and wood-working factories will have to depend on their own plantations.

The type of fibreboard with the greatest market potential should be ordinary hardboard. This is the lowest in cost of the boards produced per area, the overriding consideration in a poor country like Ethiopia. Softboard will continue to find a market, but this market may perhaps be left to ETHARSO.

Medium density fibreboard is certainly not the right type of fibreboard to be considered for production in Ethiopia. It is basically a high quality and expensive alternative to parcticleboard in furniture making and it would therefore find only a very limited market in Ethiopia. Worldwide,current hardboard production exceeds MDF production by a ratio of about 5:1. The smallest available MDF production equipment would have a capacity of 80 t/day, completely out of proportion with Ethiopia's needs. The production of MDF requires a large quantity, about 10% in weight, of imported synthetic resins.

The optimum capacity of the new hardboard plant would then have to be studied. The smallest available equipment, already mentioned in chapter 3.1., would be of Chinese origin, have a capacity of 10 - 12 t/day and cost close to 1 million US$. It would have a finished board size of 2.000 x 1.000 mm. Other equipment with a capacity of up to 30 t/day, producing boards of the standard size of 2.440 x 1.220 mm (8' x 4'), is also available from China. Quotations could be obtained from the China National Machinery Import and Export Corporation with whom ETHARSO is already in touch. Regarding other potential suppliers of fibreboard producing equipment, the consultant knows of no one who could combine low prices with experience in any way like the Chinese. (There are over 200 small fibreboard factories in the P.R.of China, and only a few in the rest of the world.)

The location of the new plant will have to be studied carefully. There are two basic possibilities:

- adjacent to the existing ETHARSO plant
- close to the raw material supply.

The main drawbacks of ETHARSO's location have already been mentioned: distance from the raw material sources, possible future problems with waste water disposal. The advantages would be proximity to the main market, all kinds of facilities (technical, administrative, transport etc.) offered by the capital, and, most of all, ETHARSO's experienced personnel who would greatly facilitate the installation and start-up of the new plant and thus lead to a considerable economy in investment.

It seems probable, however, that a new location will turn out to be more favorable when all factors are considered. The new location should not only be close to the raw material supply, but also have a transport infrastructure, an electric energy supply, water supply and disposal facilities. A careful site analysis will have to be made.

During the short sojourn of the consultant in Ethiopia and because of the many pressing problems of ETHARSO, it was not possible to study the project of a new fibreboard plant and therefore only these general considerations can be given in this report. A new project would have to be the subject of a special study.

7. Conclusions

ETHARSO has to face many problems and without some investments it will not be able to continue operating for many more years.

The following investments are recommended, in order of priority:

	foreign currency US$	local currency Birr
1. Import rams and gaskets for the existing presses	5,000	appr. 10,000
2. Have a forced draught ventilator for the second steam boiler built locally		" 10,000
3. Import a new Defibrator unit from the Peoples Republic of China	37,000	" 10,000
4. Install temperature sensors in the drying chamber		" 5,000
5. Import a light hot press	33,000	" 10,000
6. Build a chip washing and transporting unit made largely of local components	5,000	" 20,000
7. Have a board moistening machine built locally		" 10,000
total	80,000	appr. 75,000

To solve the raw material supply problem of ETHARSO, every effort should be undertaken by ETHARSO's staff and by the controlling government agency, which is now the Ministry of Construction, to give ETHARSO the opportunity to create its own eucalyptus plantation. The corresponding cost may be roughly estimated at 300,000 Birr, but no more precise recommandations can be made on this important matter which was outside the consultant's competence and terms of reference.

The long term outlook for ETHARSO is doubtful. A new fibreboard plant would be justified already now and it may better be located close to the raw material supply. The implementation of such a project is, however, at least several years off and it would be a great mistake to neglect ETHARSO and wait for the new fibreboard plant to materialize. Any new fibreboard project would have to be the subject of a special feasibility study.

Annex 1

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19026 DEFIBR S

1984-06-06 TELEX NO 1824

KN/MFH/LW

ETHARSO-ADDIS ABABA

RE: DEFIBRATION OF WHEAT STRAW

YOUR TELEX OF 84 05 24.

WHEAT STRAW IS NOT A COMMON RAW MATERIAL FOR FIBERBOARD, HOWEVER, IT CAN BE PROCESSED IN A SIMILAR WAY AS, FOR EXAMPLE, BAGASSE, WHICH IS USED AT MANY PLACES AS RAW MATERIAL FOR NOT ONLY FIBERBOARD, BUT MOSTLY FOR PULP AND PAPER.

WE HAVE RECENTLY OFFERED A COMPLETE FIBERBOARD PLANT BASED ON RICE STRAW AS RAW MATERIAL WITH A CAPACITY OF 40 TONS /22 H. TOTAL PRICE FOR COMPLETE MACHINERY SUPPLY IS SEK 70,000,000.-.

THIS PLANT CAN WITHOUT ANY CHANGES BE USED FOR WHEAT STRAW AS WELL.

FOR THE VERY LOW CAPACITY, 8 TPD, MOST OF OUR STANDARD KEY EQUIPMENT IS TOO BIG.
HOWEVER, BY USING OUR SMALLEST PARTS WE HAVE PUT TOGETHER A DEFIBRATOR UNIT FOR WHEAT STRAW WITH A CAPACITY OF APPROX. 25 TPD, WHICH CAN BE OPERATED ALSO IN THE RANGE OF 8 TPD. THIS WILL MAKE IT POSSIBLE TO PRODUCE FIBER FOR 24 H IN ONE SHIFT SAVING MAN-POWER.

THE DEFIBRATOR UNIT, WHICH OPERATES UNDER STEAM PRESSURE, IS EQUIPPED WITH A HORIZONTAL PREHEATER AND PRODUCES PULP WITHOUT NEED FOR SECONDARY REFINING.
HORIZONTAL PREHEATER IS THE ONLY TYPE OF PREHEATER THAT CAN BE USED FOR WHEAT STRAW, WHICH IS IMPORTANT TO KEEP IN MIND.

COMPLETE DEFIBRATOR UNIT INCLUDES, DRIVE AND ELECTRIC MOTORS AS WELL AS STEAM PRESSURE CONTROL SYSTEM.

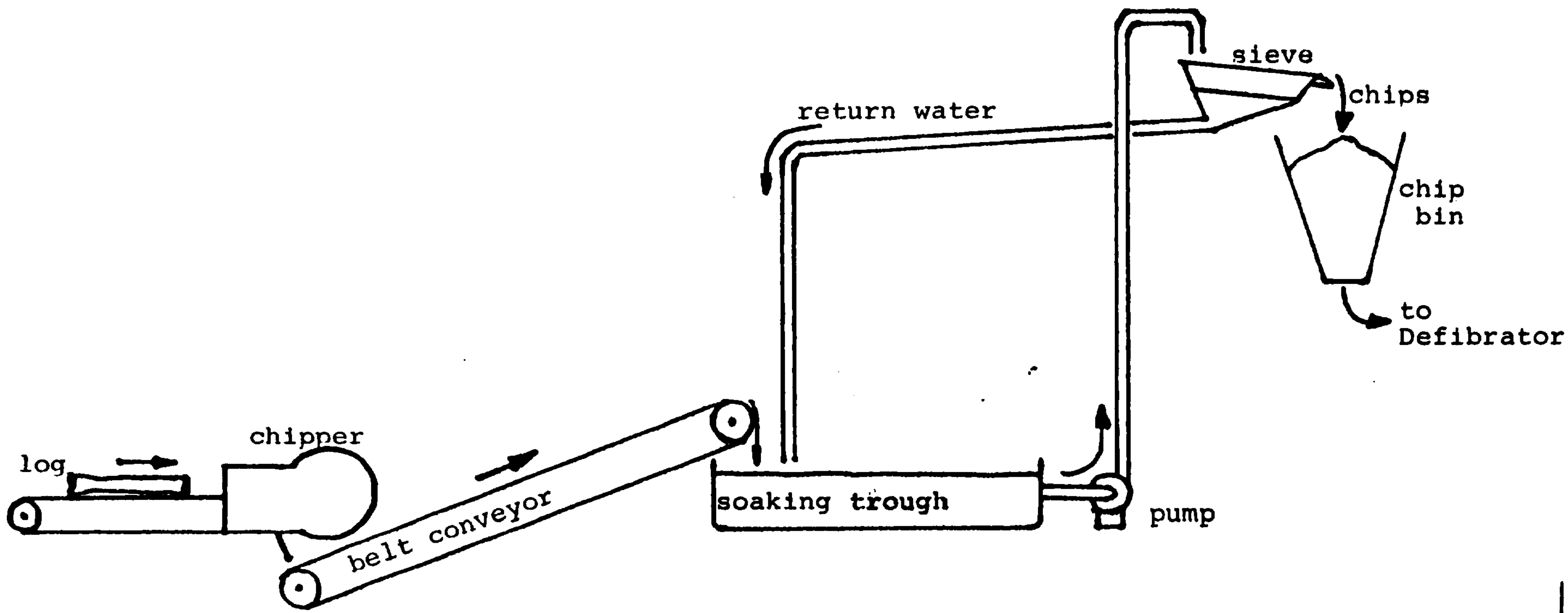
PRICE	SEK 3,500,000.-
STEAM CONSUMPTION APPROX.	700 KG/TON OF FIBER
EL.ENERGY CONSUMPTION APPROX.	100 KWH/TON OF FIBER (200 KWH/TON INSTALLED)
WATER CONSUMPTION (COOLING) APPROX.	10 L/MIN.

WE ARE AWARE OF THE FACT THAT BOTH THE COMPLETE PLANT AND THE DEFIBRATOR UNIT MIGHT BE A SIZE TOO BIG FOR YOUR DEMAND, BUT IF YOU, IN SPITE OF THAT, STIILL IS INTERESTED, PLEASE GIVE US YOUR COMMENTS AND WE WILL BE PLEASED TO SEND YOU MORE FORMAL OFFERS WITH COMPLETE DOCUMENTATION.

BEST REGARDS
SUNDS DEFIBRATOR
KJELL NILSSON

19026 DEFIBR S+
21063 ECAFCO ET
WELLL RECD+ ?*******
6EYES PLS TKU+ TKS+ BYE+

Chip washing and transporting scheme



Annex 3

Translation of quotation from Ernst Vogel

Please find enclosed the technical specification (of the pump). We confirm the delivery conditions as follows:

The price of Austrian Shillings 56.5oo,- is valid for delivery to the forwarding agent in Vienna. Delivery time is 6 months. Payment is 1/3 as down payment and 2/3 at delivery.

Annex 4

中国机械进出口总公司
CHINA NATIONAL MACHINERY IMPORT & EXPORT CORPORATION

Xijiao, Erligou, Beijing, China
P. O. Box No. 49, Beijing
Cables: MACHIMPEX BEIJING
Telex: 22242 CMIEC CN
22328 CMIEC CN

In reply please quote
Our Ref. No. 867/1154
Date: June30,1984.

ETHIOPIAN HARDBOARD & SORTBOARD FACTORY
P.O.BOX5516
ADDIS ABABA
ETHIOPIA

Dear sirs,

We have received your letter No. EH.oo3/1706 dated May28,84 with thanks.

Now we are pleased to quote the separate prices of vorious types of Defibrator for your selection:

QM 6 DEFIBRATOR US DLRS 34,000-C F ASSAB
QM 6b DEFIBRATOR US DLRS 5o,000-C F ASSAB
QM 9 DEFIBRATOR US DLRS 84,000-CIF ASSAB
CHIP WATER WASHER US DLRS8,400- CIF ASSAB

SHIPMENT: within 6 months after receiving your L/C.

The validity of this quotation will be up to the end of september,1984.

LOOKING FORWARD TO Y UR REALY APPLY.

CHINA NATIONAL MACHINERY
IMPORT & EXPORT CORPORATION

Annex 5

Translation of the quotation of Messrs.
Langzauner Gesellschaft m.b.H.

Our offer estimation is the following:

1 Hydraulic hot platen press
Type LZT 400
Pressing surface 2550 x 1350 mm
Total pressing power: 400 t
Hot platen: steel hot platen 2550x1350x50mm drilled, prepared with distributor for an existing hot water connection
Max. heating temperature approx. 300°C
Single daylight-opening 350 mm
Hydraulic system: 8cylinder for operating height 350 mm
Hydraulic unit: 2-step-system low/high pressure with automatic specific pressure regulation
Safety equipment: Emergency power cut-off mechanism - both sides A.S. 560,000

Optional extra for two-stage press also with hot water distribution system A.S. 80,000

Prices do not include tax

Because of the high pressing power of this installation, we recommend in all cases a hydraulic system.

Annex 6

Translation of quotation from Dieffenbacher

Payment conditions: Cash against invoice, net

Packing: -

Validity of prices: ex works Eppingen, without packing, and without installation

Time of delivery: 1o - 12 weeks

Pos.	quant.	unit	ordering-no.	price per unit	total
			for main cylinder of hot press		
1	4.oo	set	9.o3oo-2587 set of sealing gaskets, 4oo interior customs tariff:4o14 982	574,oo	2.296,oo
2	4.oo	piece	9-o8oo-8488 scraper 4oo interior customs taroff: 4o14 982	76.86	3o7.44
3	4.oo	piece	DM. 4oox735L ram, hard-chrome plated	2.32o.oo	9,28o.oo
			for closing cylinder of hot press		
4	2.oo	set	9-o1oo-4225 set of sealing gaskets 8o interior weight: about 1 kg/set	33.88	67.76
5	2.oo	piece	9-o1oo-6482 scraper 8o interior customs tariff: 4o14 982	8.1o	16.24
			for main cylinder of dewatering press		
6	4.oo	set	9.o2oo-396o set of sealing gaskets 18o interior customs tariff: 4o14 982	181.29	725.16

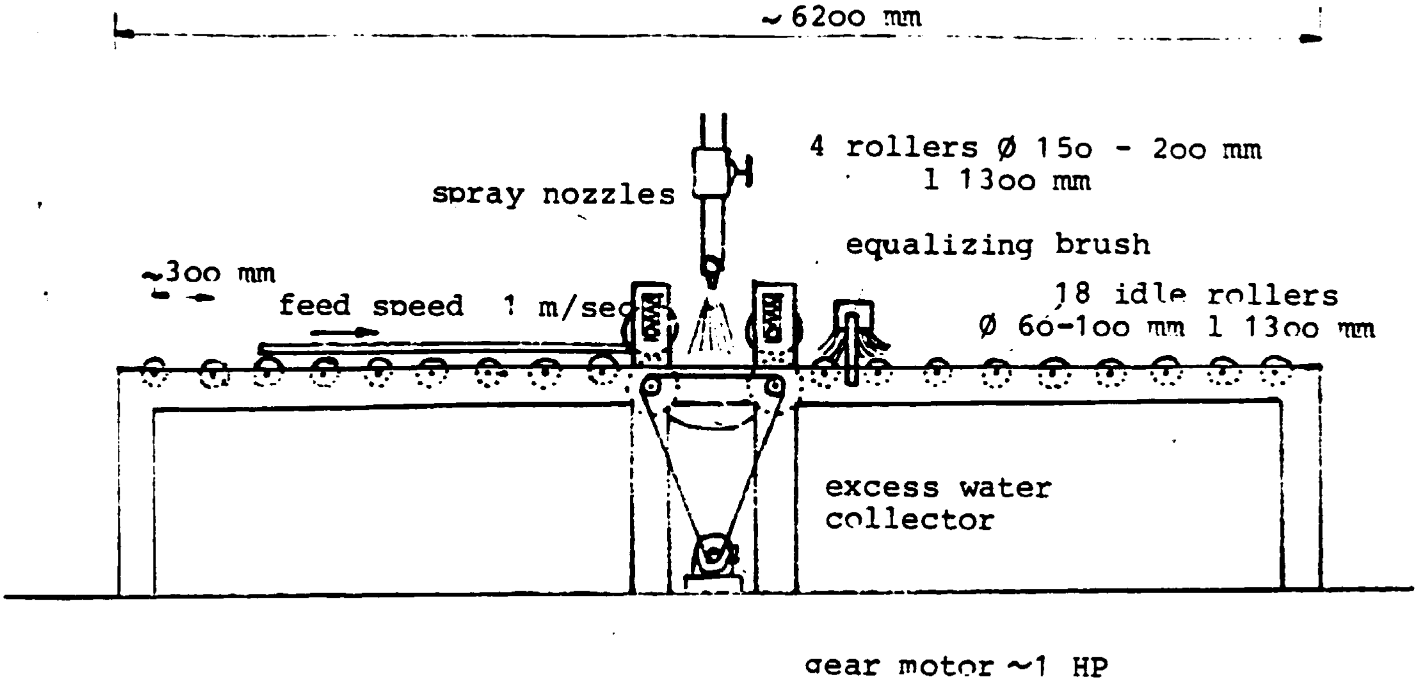
second page of
translation from
Dieffenbacher

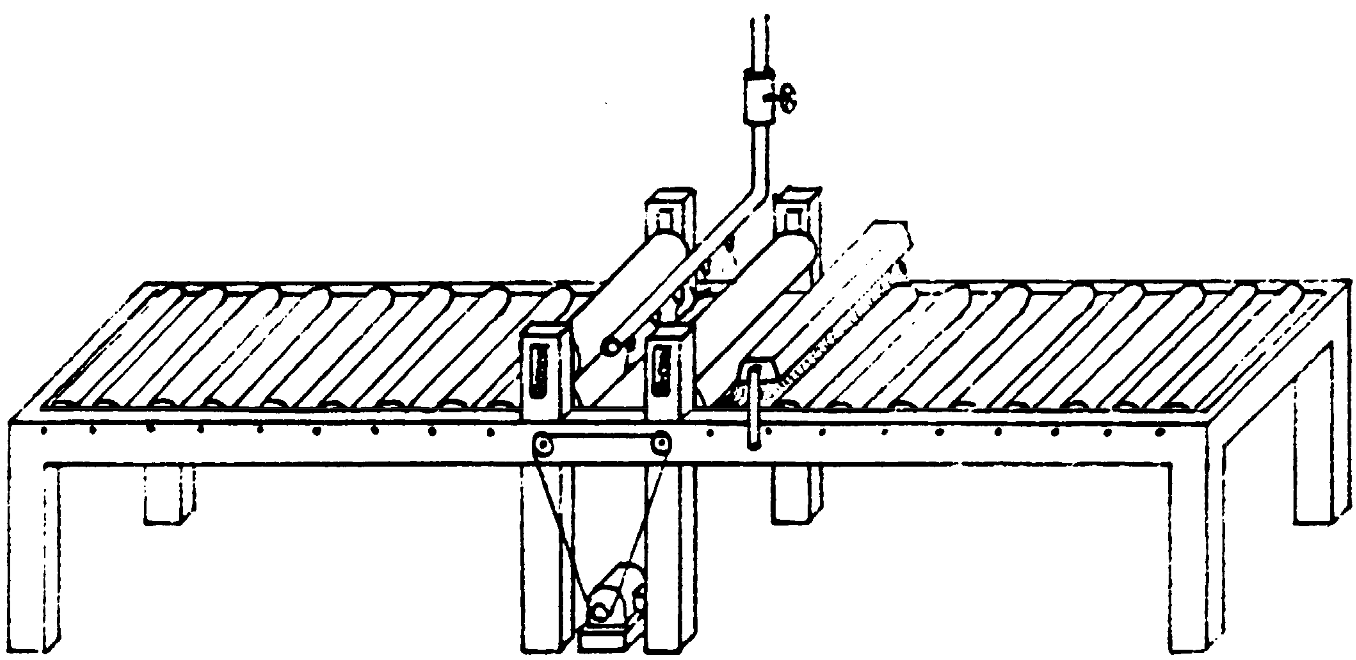
pos	quant.	unit	ordering-no.	price p.unit	total
7	4	piece	9-o8oo-1882 scraper 18o interior weight: about .35o kg/pc. customs tariff: 4o14-982	21.o4	84.16
			<u>for closing cylinder of dewatering press</u>		
8	2	set	9-o1oo-361o set of sealing gaskets 4o interior	14.16	28.32
9	2	piece	9-o2oo-3517 scraper 4o interior	6.39	12.78

total value of quotation 12,817.86

Deutsche Mark

Annex 7





Sketch of Board Moistening Machine

Annex 8

Translation of quotation from Josef Bertsch

Estimate quotation for steam boiler plant 4.5 to/h, 2o bar

1) steam boiler apt for 1oo% oil or wood firing, consisting of: coarse and fine armatures, insulation, additional heating surface, water infeed and water level control

   estimate price: öS. 84o,ooo.-

2) oil burner

   estimate price: öS. 73,ooo.-

3) firing installation for solid fuels, with manual feeding

   estimate price: öS. 35o,ooo.-

4) forced draught ventilator

   estimate price: öS. 136,ooo.-

validity of price: estimate price ex works, exclusive of sales taxe

time of delivery: about 6 - 7 months or according to agreement