OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

RESTRICTED

DP/ID/SER.B/62
[illegible] July 1979
Original: English

07130

ASSISTANCE TO THE PARTICLE BOARD PLANT AT MOJKOVAC

IS/YUG/78/017

YUGOSLAVIA

TERMINAL REPORT

Prepared for the Government of Yugoslavia by the
United Nations Industrial Development Organization,
executing agency for the
United Nations Development Programme

United Nations Industrial Development Organization

United Nations Development Programme

ASSISTANCE TO THE PARTICLE BOARD PLANT AT MOJKOVAC

IS/YUG/73/017

YUGOSLAVIA

Project findings and recommendations

Prepared for the Government of Yugoslavia by the
United Nations Industrial Development Organization,
executing agency fo the United Nations Development Programme

Based on the work of H. Mueller-Eckhardt, consultant

United Nations Industrial Development Organization
Vienna, 1976

Explanatory notes

The monetary unit in Yugoslavia is the dinar (Din). During the period covered by the report, the value of the dinar in relation to the United States dollar was $US 1 = Din 18.05.

A full stop (.) is used to indicate decimals.

A comma (,) is used to distinguish thousands and millions.

Besides the common abbreviations, symbols and terms, the following have been used in this report:

f.b.	finished board
DIN	Deutsche Industrie Norm

ABSTRACT

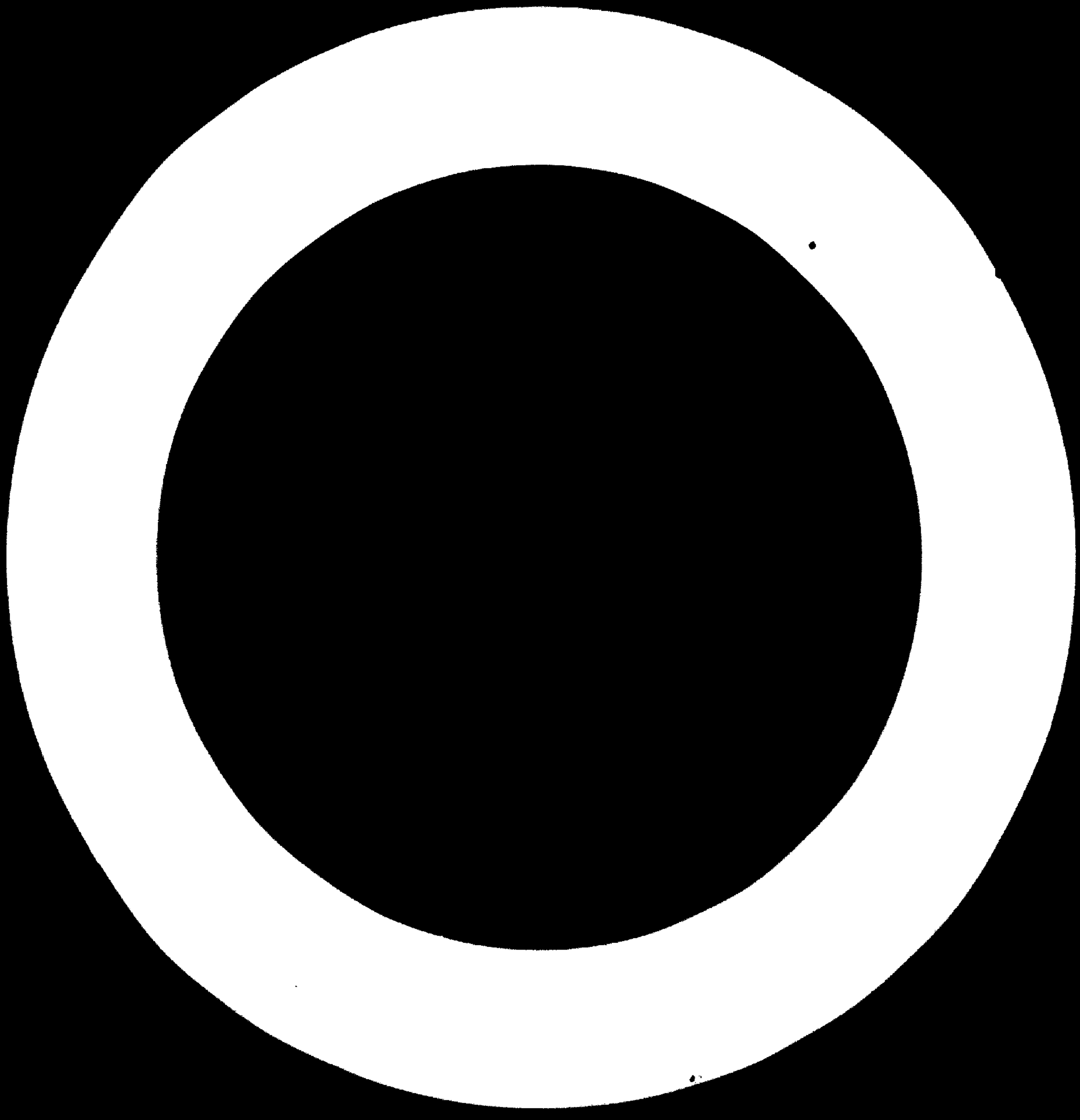
At the request of the Government of the Socialist Federal Republic of Yugoslavia to the United Nations Development Programme (UNDP), an expert in the production of particle board was sent on mission to give technical assistance to the factory at Mojkovac. The United Nations Industrial Development Organization (UNIDO) was the executing agency.

The expert arrived at Mojkovac on 6 June 1976 and left on 20 July 1976. The objectives of the project were to assist the management of the plant, upgrade production technology, increase productivity and improve the quality of products.

The expert concluded that the situation at the factory is such that possibilities for plant performance improvement are limited to a minimising of annual losses. The reasons for these losses are low plant efficiency and high production costs, and he recommended that overhaul, repair and replacement of old and worn out machinery be carried out. Also, production and quality controls should be reinstated.

The recommended improvements would be economically justified as the capital expenditure of Din 5,000,000 in 1976 has a payback period of approximately one year.

The expert reported that the only way to achieve profitable production of the plant is by a complete reconstruction and a considerable increase of its maximum production capacity.



CONTENTS

Annexes

Page

Figures

INTRODUCTION

At the request of the Government of the Socialist Federal Republic of Yugoslavia to the United Nations Development Programme (UNDP), an expert in the production of particle board was sent on mission to give technical assistance to the factory at Mojkovac. The United Nations Industrial Development Organization (UNIDO) was the executing agency. The expert arrived at Mojkovac on 6 June 1976 and left on 20 July 1976.

In 1975 the particle board factory at Mojkovac suffered losses of approximately Din 7,000,000; production costs were approximately Din 36,000,000 but the sales value was approximately Din 29,000,000. In order to locate the causes of these losses, the expert investigated the present state of plant machinery, maintenance procedures, production and quality control, plant efficiency, raw material consumption, production costs, and made cost/profit calculations. He discovered that the causes are low plant efficiency and high production costs.

The expert made recommendations for technical improvements leading to upgraded plant efficiency and production cost structure. It was recommended to overhaul, repair and replace old and worn out plant machinery and to reinstate production and quality controls.

However, the expert reported that the situation of the factory is such that possibilities for plant performance improvement are limited to a minimising of annual losses. The recommended improvements would be economically justified as the capital expenditure of Din 5,000,000 in 1976 has a payback period of approximately one year.

The expert concluded that the only way to achieve profitable production of the plant is by a complete reconstruction and a considerable increase of its maximum production capacity.

I. SUMMARY AND RECOMMENDATIONS

Summary

In 1975 the particle board factory at Mojkovac suffered losses of approximately Din 7,000,000. Production costs were approximately Din 36,000,000, but the sales value was approximately Din 29,000,000.

The reasons for these losses are low plant efficiency (1975: 61%, first half of 1976: 57%) and high production costs.

In order to locate the causes of this situation, investigations into the present state of plant machinery, maintenance procedures, production and quality control, plant efficiency, raw material consumption, production costs, and cost/profit calculations have been carried out.

Based on the results of these investigations it was possible to make recommendations for technical improvements leading to upgraded plant efficiency and production cost structure, and to calculate the economic results which could reasonably be expected after implementation of all recommendations.

The very strained economic situation of the Combine does not allow major changes in the plant at this stage, and therefore only those technical recommendations were to be considered which would improve the situation under given production conditions.

The results of the investigations may be summarised as follows.

Machinery: Almost every key machine in the plant was found to have technical defects due to the worn-out state of the equipment. These defects result in uneconomic preparation and usage of raw material, and deficiencies of the end product. The worn-out state of machinery leads to constant breakdown of machine parts followed by stoppages of production.

Maintenance: The procedures in operation are adequate, but there is a serious lack of special spare-parts for machinery from abroad, which is the major part of the equipment. This shortage of special spare-parts results in unusually long repair time, which in turn is one of the main reasons for the low efficiency of the plant and its high economic losses.

Production control: Practically no production control is carried out because of the damage to, or lack of, necessary technical equipment. This results in uneconomical production procedures and wastage of raw material, which is another main reason for the economic losses of the factory.

Quality control: No quality control at all has been carried out since August 1975 owing to defective or non-existent laboratory equipment and lack of personnel. An acceptable quality standard of the end product is only ensured by adopting a very high density level of the boards. This complete lack of quality control is indirectly causing high economic losses.

Plant efficiency: In 1975 plant efficiency was only 61% and in the first half of 1976 only 52%. Approximately 85% of the total down-time was caused by break-downs of mechanical equipment necessitating long repair sessions (lack of special spare-parts). The low efficiency of the plant is the main reason for the economic losses of the factory.

Raw material consumption: The consumption of wood is excessively high, whereas the average adhesive consumption is only slightly above normal considering the old-fashioned blending system and worn-out state of machines in operation. The costs for these raw materials represent approximately 80% of the total average direct production costs per cubic meter of finished board. Their high consumption is another main reason for the economic losses.

Cost profit analysis:

(a) The average production costs per cubic meter of finished board are so high that the break-even point would theoretically be reached at 150% of nominal plant efficiency. Even if plant efficiency could be improved to 100%, the factory would suffer economic losses of approximately Din 4,000,000 at this production cost level;

(b) Even after improvements of production costs and plant efficiency which could reasonably be expected when all recommended actions have been taken, the factory will still suffer losses, but they will be reduced by approximately 93% of the present level. Under these improved conditions the break-even point would be reached at 85% of nominal plant efficiency.

To expect a constant plant efficiency of more than 80%, even under improved conditions, would be unrealistic considering the age and worn-out state of the plant's machinery.

Plant reconstruction:

(a) The only way to achieve profitable production is a complete reconstruction of the plant and a considerable increase in its production capacity;

(b) Such a reconstruction is indicated not only by the above-mentioned facts, but also in view of the Combine's current situation and future planning:

- the recent opening of the railway connexion to Mojkovac has decisively improved the economic possibilities of the Combine;
- the capacity of all production units will be increased considerably;
- a great part of an increased particle board production will be needed for the production of the other units of the Combine.

Recommendations

To improve the current situation in the factory, it is recommended:

1. To overhaul and repair all plant machinery in order to improve production performance and permit proper production control.

2. To replace the machines for the blending station so as to reduce adhesive consumption and improve process performance.

3. To re-introduce an adequate production control to permit reduction of production costs.

4. To re-introduce a proper and reliable quality control in order to permit production of good quality board at minimum production costs.

5. To purchase necessary spare-parts from abroad to permit reduction of repair time and thus improve plant efficiency and its economic performance.

In order to make the particle board factory profitable and to secure its future, the following recommendations are given:

6. A complete reconstruction of the plant should be decided upon as soon as possible by the general management and relevant government authorities.

7. When this decision has been made, a detailed pre-investment study for the whole project should be carried out to ensure optimum technical and economic plans being made for the reconstruction of the plant.

8. Assistance should be requested from international organisations to secure the necessary independent technical assistance for a fast implementation of this project (preparation of pre-investment study, evaluation of offers etc.).

II. FINDINGS

The particle board factory of the Combine "Vukman Krušćić" is part of an integrated wood industry complex consisting of:

One sawmill
One particle board factory
One veneer production unit
One parquetry production unit
One production line for house elements

The Combine has 542 employees of which 370 are working in production and 72 in administration. The Combine's turnover in 1975 was Din 70,747,742.

The particle board factory was planned and erected in 1961 by Siempelkamp (Federal Republic of Germany) in co-operation with Ivo Lola Ribar (Yugoslavia), and adopted the "Schnitzler-System" for production of three-layer board with a capacity of approximately 60 m^3/22 hours of finished board (19 mm, density 650 kg/m^3). Reconstruction took place in 1972 (flaking department, preparation and press line) and in 1974, when a fourth daylight was installed in the old press, so that the maximum production capacity today is 75 m^3/22 hours (19 mm, 700 kg/m^3).

After 15 years uninterrupted production of approximately 345 working days per year, technical problems have accumulated with serious consequences for the economy of the factory and the Combine as a whole. In 1975 the losses of the particle board factory amounted to Din 6.9 million.

The reasons for economic losses of a production unit are always complex, and to find out the real reasons for losses it is necessary to carry out detailed investigations into all relevant technical and economical components involved in the process. Therefore the following studies had to be carried out:

(a) An assessment of the state of existing mechanical equipment;

(b) An assessment of production control and an analysis of results;

(c) An assessment of quality control and an analysis of results;

(d) An analysis of the reasons for down-time of the plant;

(e) A study of maintenance procedures and their efficiency;

(f) An analysis of production statistics and economic results, based on figures for 1975 and 1976.

Based on the results of the above investigations it was possible to discover the reasons for losses, to recommend the necessary action to be taken to improve production efficiency and production cost structure, and to determine the limits of profitability of this factory after implementation of the recommended improvements.

Knowledge of these figures and results will help the management of the Combine to decide what actions are to be taken for future development of the factory.

III. PRODUCTION

The product

The factory produces a three-layer board with two fine surface layers (S-layers) and a medium-coarse core layer (C-layer). The size of the finished board is 1,750 x 3,600 mm. Owing to the high density of beech (Fagus silvatica) as raw material the nominal specific weight of the board ranges from 700 kg/m^3 for 19 mm up to 760 kg/m^3 for 10 mm thickness.

The board is suitable for furniture production and, because of the fine surface, is good for laminating and veneering.

The technological properties of the board are expected to meet the requirements of the relevant DIN standards.

Raw material

Wood: For the S-layer mainly coniferous roundwood, split wood and sawmill residues (trimmings and slabs). For the C-layer only beech roundwood, split wood and branches. With the increasing shortage and rising prices of coniferous wood, more and more beech is being used for the S-layer.

Only a small part of the residues from the other production units in the Combine is used for the production of particle board, the rest is needed for the thermal power plant. According to the general management no changes can be considered because of high oil prices.

Adhesive, hardener, and their preparation: Urea formaldehyde resin is delivered to the factory as liquid raw adhesive with 68.5-69% solid resin content, pH = 8.0, specific weight about 1.3 kg/dm^3, free formaldehyde content 0.33%, and a maximum shelf-life of three months.

The adhesive is prepared using separate formulae for the S-layer and C-layer. The preparation formulae for adhesive and hardener solution are adequate for the given climatic conditions at Mojkovac, the production process and the pH (approximately 5)[1/] of the wood material used. The formulae are shown in annex I.

Additives: No paraffin emulsion is used to improve swelling and absorption properties of the board.

1/ Figure obtained from plant management.

Mechanical equipment

The wood material is transported to the plant by a manually loaded and unloaded truck. In accordance with the Schnitzler-System for the mat-forming process the flake material is prepared in two separate lines for S-layer and C-layer. The different stations of the plant are shown in the production flow scheme (figure I) and comprise the following equipment:

(a) S-layer flakes preparation line

- Two Hombak PRZ 28 flakers, pneumatic transport of the flakes to the
- wet-flake silo, capacity approximately 25 m^3, with Weiss extraction device. Pneumatic transport to the
- drier I; Ponndorf SP 12 H rotation bundle drier, steam-heated. Conveyor belt to the
- drier II, Ponndorf SP 6 H, steam heated. Vibration conveyor trough to the
- Pallmann PSKM-12 refining mill. Pneumatic transport to the
- Allgaier TMSH 2000 classification screen, which is out of operation and bypassed. The material goes unclassified to the dry-flake bunker for S-layer.

(b) C-layer flakes preparation line

- Klöckner 250 x 500 hogger. Transport of chips by conveyor belt to the
- wet chip silo, capacity approximately 30 m^3, with Weiss extraction device and vibration trough, feeding the
- Pallmann PZ 12 flaker. Pneumatic transport to the
- Ponndorf TH 110 steam-heated rotation bundle drier. Pneumatic transport directly to the dry-flake bunker for C-layer without any classification as the Niagara screens, which should be used after the drier, have been taken out of operation.

(c) Blending station

- Industrie Companie horizontal dry-flake bunkers for S- and C-layer material, capacity approximately 25 m^3 each, equipped with transport belt, dosing drums, and discontinuous weigh-scales,
- Drais blenders for S- and C-layer, old system spreading the adhesive via nozzles with compressed air.
- Drais adhesive preparation unit, automatic system with separate dosing cylinders for liquid adhesive, water, hardener solution and paraffin emulsion, and the mixer unit. Separate container for prepared S-layer and C-layer adhesive

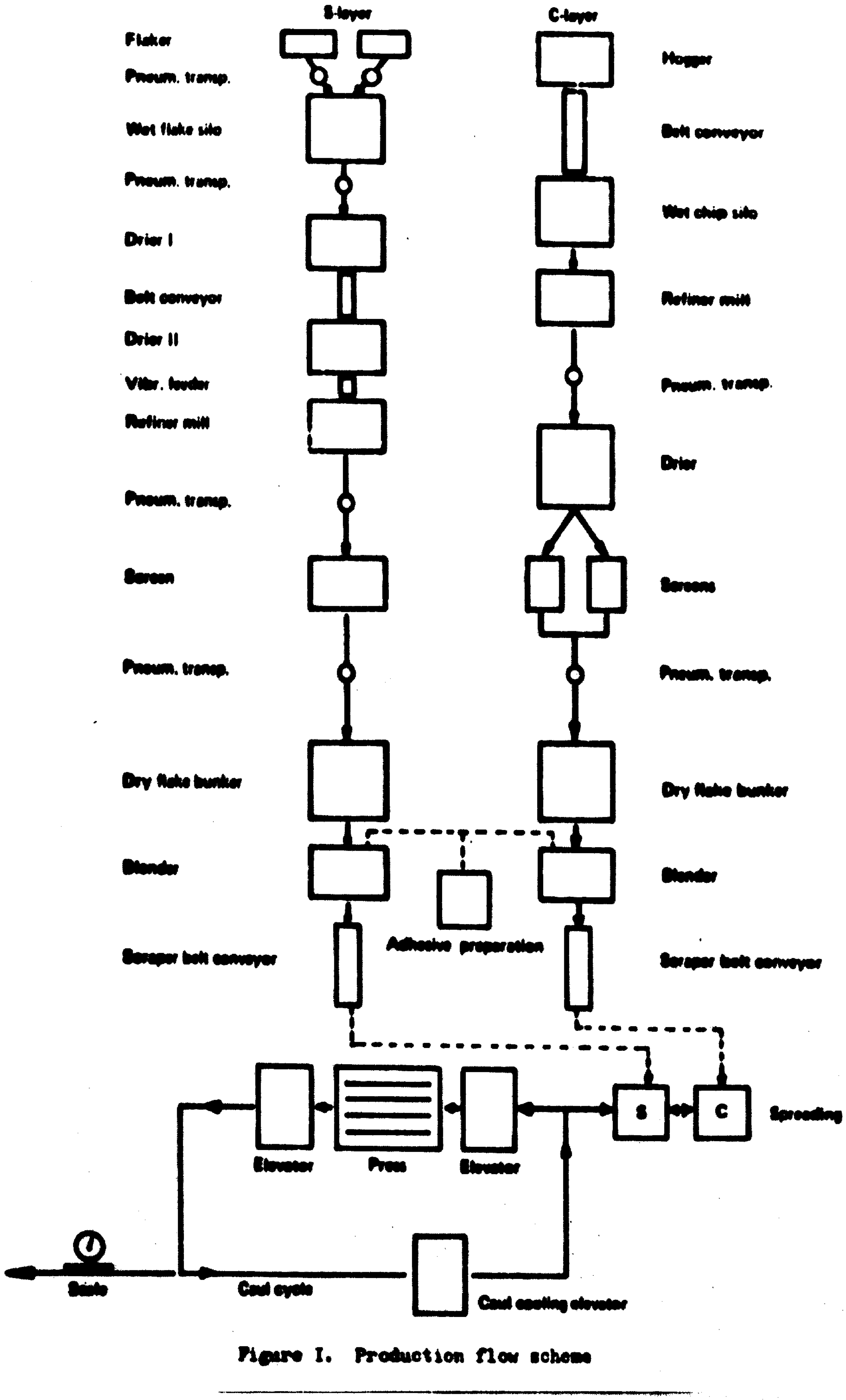


Figure I. Production flow scheme

- scraper conveyor belts for transportation of the blended material to the
- Industrie Companie mat-forming stations, equipped with new Würtex spreader drum system and batch weigh-scales (volumetric and gravimetric spreading).

(d) Hydraulic press line

- Caul system, reversible, moving under the mat-forming station, with elevators for 4 cauls for loading and unloading of the press. A caul cooling elevator for 6 cauls is installed in the caul return line, but is not in operation.
- Siempelkamp hot press, steam-heated, 4 daylight, no simultaneous closing device, with hydraulic high-pressure and low-pressure plant.

(e) Weighing, trimming and sanding

- After separation from the cauls the boards pass a
- control weigh-scales for constant control of the raw board weight directly after pressing. After cooling and curing in intermediate storage the boards are trimmed on a
- non-automatic trimming saw and fed directly into the Cremona four drum sander.

IV. FINDINGS AND DEFICIENCIES AT THE PLANT, AND RECOMMENDATIONS

Findings

All the mechanical equipment of the plant is old and worn out and frequent breakdowns occur causing long down-times of production.

Management procedures in the factory are adequately organized as is the operation report system (daily, weekly, monthly) which gives all the necessary information for plant performance control, raw material consumption and cost control. Work performance in the factory needs improvement.

Owing to plant layout and the installed machinery, the whole production process is labour-intensive causing high fixed production costs.

The capacities of the machines installed are balanced, with the exception of the two S-layer Ponndorf driers whose total capacity should be approximately 20% higher in order to allow a proper ratio of S- and C-layer material for the production of 10 and 13 mm board. In order to partly compensate this shortfall, less material for the surface layer of thin board is used than is calculated in the standard board specifications (annex II) and the amount of core layer is increased accordingly.

Accumulated dust affects the proper functioning of the machinery and represents a very high fire risk. The factory should be thoroughly cleaned.

Approximately 15% of the storage hall and curing storage area is occupied by scrap, causing shortage of intermediate storage space for the boards to cool down and cure. Consequently insufficiently cooled and cured boards are taken for sanding.

Deficiencies of mechanical equipment

Surface layer flake preparation

Wood is dumped into deep mud at the side of the flakers. Stones and sand go with the wood into the flakers, damaging the knives and reducing their cutting-edge life.

Immediate laying of concrete or bitumen flooring is recommended. Such flooring should also be laid at the chipping station for core layer material.

Hombak flakers PRZ 28: The cutter heads are worn out with the result that mainly coarse splinters and a disproportionately high percentage of dust is produced. This non-homogenous material dries unevenly and reduces the already insufficient capacity of the driers. The cutter heads must be overhauled by a specialised company.

The ampere meters, which are necessary for indirect control of the flake quality produced, are broken. They must be replaced.

The Weiss extraction device: This device, a part of the wet-flake silo, is worn out and causes production stops. The machine must be completely overhauled.

Ponndorf SP 6 H and SP 12 H driers: To make maximum use of their drying capacity, sliding doors should be installed at the outlets in order to extend the drying time of the flake material.

All thermometers and manometers are broken and must be replaced urgently to enable a proper control of the drying process.

The rubber of the conveyor belt between the driers is torn and must be replaced.

Pallmann PSKM 12 refining mill: The grinding elements and the Conidur screen are worn out and damaged, which causes a disproportionately high percentage of dust in the flake material. These machine elements must be replaced.

Allgaier TMSH 2000 classification screen: The screen should be put back into operation in order to reduce the high amount of dust in the flake material.

Core layer flake preparation

Klöckner hogger 250 x 500: The ampere meter is broken and must be replaced. The Weiss extraction device of the wet-chip silo is worn out and causes frequent stoppages of production. The machine must be overhauled completely.

Pallmann PZ 12 flaker: The knives are changed only once per shift. It is recommended that they be changed twice per shift in order to reduce dust. An ampere meter is missing and should be installed.

Ponndorf TH 110 drier: The additional heating unit for hot air and its inlet pipe are completely broken and out of operation. This unit is needed for the drier to reach its full capacity, especially in winter. The unit must be repaired and put back into operation.

All thermometers and manometers are broken and must be replaced to enable a proper control of the drying process to be maintained.

The insulation of the steam pipes is either badly damaged or non-existent. It must be replaced to avoid waste of energy.

Adhesive station and blenders

Dry bunkers for S- and C-layer material: The batch weigh-scales of both bunkers do not close properly and prevent the exact dosing of flake material for the blenders. They must be adjusted.

Drais adhesive preparation unit: The feeding pump for the hardener solution is out of order and the hardener is added manually which can lead to serious errors. The pump must be repaired immediately and put back into operation.

Scraper conveyor belts: These are worn out and cause down-time constantly. The distribution of the blender material over the width of the mat-forming machines is inadequate which causes irregular mat formation and then irregular distribution of specific weight over the finished board area. They must be replaced by new twin screw conveyors.

Drais blenders: These date from 1961 and work according to the old technology (spreading of adhesive through nossles with compressed air). As they have to be cleaned constantly they cause down-time of production and high labour costs. The nossles are often obstructed which leads to an irregular distribution of the adhesive on the flakes during the blending process. The actual adhesive consumption is at least 5% higher with this type of machine than it would be with the modern turbo-blenders.

The blending process is one of the key operations of the plant and influences decisively its production costs and profitability. Therefore, it is strongly recommended to replace the whole adhesive preparation system, the blenders, and the scraper conveyor belts by new equipment. This will considerably reduce production down-time, lower energy and labour costs, reduce the consumption of adhesive and hence improve the economy of the plant. The replacement should be done as soon as possible.

If the management decides to reconstruct the whole factory in the near future and increase its capacity, the above-mentioned new equipment should be chosen with capacities high enough to permit its further usage in the reconstructed plant.

A draft for inquiries with necessary technical specifications has been prepared (see annex XII).

Mat-forming station

In order to check the quality of the mat-forming operation, density distribution and thickness have been tested on unsanded boards which revealed great deviations of specific weight and thickness over the board.

This is mainly caused by the inadequate performance of the mat-forming machines. Other reasons are the disadvantages of the reversible caul system with its discontinuous mat-forming process.

For improvement of the mat-forming operation it is recommended to replace the scraper conveyor belts and to adjust the batch weigh-scales (they do not close properly) and the spreading drums. A meticulous inspection and cleaning of these machines must be carried out every day.

Hydraulic press plant

A few months ago the frames of the press broke and the whole press plant was then completely overhauled including the hydraulic system.

The caul transport system is not operated with a sufficient number of cauls (11 instead of 17). Therefore the caul cooling elevator has been taken out of operation. Consequently the temperature of the cauls is too high when going into the mat-forming process, which causes pre-drying of the material and pre-polymerization of the adhesive in the surface layer next to the caul. This results in a soft surface on one side of the boards after the pressing operation.

It is recommended to purchase 20 new cauls and to put the caul cooling elevator back into operation as soon as possible.

Weighing of the board after pressing

In this factory the board weigh-scales, which come after the press, are the most important controlling device in the production line to avoid unnecessarily high raw material consumption, which in turn leads to economic losses.

The scales are broken and must be overhauled and put back into operation as soon as possible.

Trimming and sanding station

There is no auxiliary equipment installed in this station (scissors-lifts, turning machine, roller conveyors etc.) and the operations are labour-intensive.

The trimming saw is non-automatic and does not allow recovery of trimming waste material for the core layer line because there are no cutter heads for direct chipping of the trimming material.

It is recommended to replace the trimming machine with a modern one and install necessary auxiliary equipment in this station, for which detailed quotations are with the management.

Maintenance and spare-parts

The routine preventive maintenance and repair system in operation at the factory is adequate (manning, planning of work, stoppage reports etc.), and sufficient spare-parts from the local market for routine repair work are kept in stock. However, there is a shortage of special spare-parts for repair of machines from abroad, which form the major part of the equipment installed. Consequently, necessary repairs take too long and cause long down-time of production which is the main reason for the low efficiency of the plant.

It is, therefore, absolutely essential that the efficiency of repair work is improved and this is dependant on the ready availability of the special spare-parts.

It is strongly recommended that special spare-parts be purchased for the machines from abroad as soon as possible according to the detailed lists and quotations which are with management. All technical details have been discussed and the necessary action should be taken immediately.

Production control

The production control in this factory is inadequate owing to the lack of technical equipment.

Valid standard board specifications for each board thickness were not available and have been prepared (see annex II).

The following production factors are controlled:

Moisture content of flakes before and after blending, with an electrical moisture controller

Press temperature, pressure and pressing diagram at the control panel of the press plant

Thickness of each board after pressing, at the four corners of the board

In order to permit an acceptable standard of production control under the given conditions in this plant, it is essential that at least the following production factors are also controlled:

Performance of flakers and mills to avoid high dust production with dull knives

Moisture content of wet flakes before drying

Performance of the driers to make maximum use of their limited capacities (in-going and out-going heating temperature, pressure, temperature of fumes at fume outlet)

Ratio of surface to core layer material spread

Weighing of board after pressing

The control of board weight directly after pressing is the most important production control station in the factory and permits the immediate recognition of deviations from nominal production process data so that immediate action can be taken to locate and eliminate the source of failure.

Only by re-introduction of a proper and reliable production control will it be possible to reduce production costs, to improve plant efficiency and to reach the maximum possible output of good quality board at minimum costs without jeopardizing the quality of the end product.

The applied shift report system gives the following production figures:

Consumption of wood (separately for S- and C-layer) in m^3 (stacked) per shift

Consumption of raw adhesive in kg/shift

Production of board (m^3 finished board) per shift and thickness produced

Down-times during each shift and their reasons

Report on sanding operation (m^3 finished board sanded of each quality (Extra, I, II, and III))

The system is adequate under given conditions and allows a sufficiently accurate plant performance and cost control.

Quality control

No quality control at all has been carried out since August 1975 when the laboratory technician left the factory.

The existing laboratory equipment is insufficient to carry out all necessary tests and is either out of order or needs adjustment (Wolpert Testing Machine, pH-meter, precision scale).

Several tests have been carried out by the expert in order to determine the specific weight of, and weight deviations within, a board and between different boards. Typical examples of the test results are shown in annex IV.

Owing to lack of proper instruments, it was not possible to produce exact figures but the figures obtained are reliable enough to establish the following facts:

1. The average specific weight of the boards is generally too high compared with the standard board specifications for the corresponding board thickness (average of the tests: 19 mm 736 kg/m^3, 16 mm 745 kg/m^3, 13 mm 768 kg/m^3, and 10 mm 792 kg/m^3).

2. The very high specific weight of the boards produced leads to the conclusion that the quality is good and the technological properties fill the requirements of DIN standards, although this could not be tested.

3. The boards are generally thicker on one long side than on the other, and on the head short side than on the other (seen in production direction).

4. The specific weight over the board is uneven, following the above mentioned thickness variances.

5. There are limited variances of specific weight between different boards but no distinct tendency could be established.

It can be assumed that the density variances result mainly from the inaccurate performance of the mat-forming machines, but another possible source could be an inaccuracy in the press after repair of its broken frames. It is therefore recommended that in order to check the accuracy of the press the same tests be carried out as mentioned above after implementation of the necessary adjustment to the mat-forming machines.

Without any production control (weight of boards) or quality control being carried out, a very high density is, of course, the only guarantee that board of an acceptable quality is being produced but the surplus specific weight of the boards must be reduced, without jeopardising their quality, to the level quoted in the standard board specifications, as this will considerably improve the economy of the plant. This, however, is only possible if a proper quality control is carried out.

Recommendations

1. To permit a correct and reliable quality control to be made the existing equipment should be overhauled and repaired and new equipment be installed without delay. A list of equipment to be purchased is given in the next chapter.

2. The following minimum tests should be carried out as a routine in the factory, as soon as personnel and equipment are available:

(a) Quality of raw adhesives

Solid rosin content

Viscosity

pH

Gelly strength test

(b) Control of prepared adhesives

Viscosity

Gelly strength test

(c) Quality of flake material

Size and thickness of flakes

Fraction (dust percentage)

pH

(d) Control of finished board properties

Specific weight (density)

Thickness variations (in each board and between boards)

Bending strength

Tensile strength

Moisture content

Swelling and absorption (only if paraffin emulsion is applied)

The plant management is acquainted with all test methods and working principles to be applied for carrying out the above-mentioned laboratory tests. All DIN standard forms and suitable laboratory test report forms are available. Details have been discussed with management wherever needed and small changes in the reporting system have been recommended.

3. There is a complete lack of statistical control of faults occurring at the sanding station. This control is also important as it allows the detection of deficiencies in the production process (open areas on surface - pre-polymerisation; unsanded areas - curved platens of the press or defective cauls; core layer showing - unbalanced sanding or incorrect surface layer mat-forming etc.). A regular control system should be introduced at the sanding station for which a quality control form has been prepared (see annex V).

V. COST OF NECESSARY IMPROVEMENTS

According to the general management the financial situation of the Combine is very strained, and therefore only those replacements, overhaul and repair works can be considered which directly or indirectly improve the efficiency of the plant and decisively reduce consumption of raw material.

The costs of carrying out the necessary improvements are estimated on actual prices from recent quotations or on information received from the general management.

Investment costs[1/]		Din (approximate)
(a) New blending station equipment (as per specifications in annex II)		
Machinery ex-works abroad	1,750,000	
Transportation, installation, import duty of 25%	440,000	
Installation 15%	260,000	
Cooling water station	250,000	2,700,000
(b) Laboratory equipment		
1 direct moisture meter with infra-red drier		
1 laboratory circular saw		
1 direct reading laboratory precision scale		
2 thickness control gauges		
1 viscosimeter		
1 laboratory drying oven		
1 manometer with pitot tube (control of pneumatic system)		
equipment for test of gelly strength time, swelling and absorption		80,000
(c) Flooring		
Approximately 2,500 m^2 bitumen or concrete flooring		550,000
Contingency margin		170,000
		3,500,000

1/ Grouping of costs according to the general management.

Overhaul and repair costs	Din
(a) 20 new cauls	420,000
(b) Overhaul of Hombak cutter heads (through specialized company)	200,000
(c) Special spare parts from abroad for foreign machines	400,000
(d) Overhaul of board weigh-scales (through specialized company)	20,000
(e) Manometers, thermometers, ampere meters etc. for production control	30,000
(f) Overhaul of mat-forming station (through specialized company)	40,000
(g) Overhaul and repair of laboratory equipment (through specialised company)	30,000
(h) All other work, as specified in the chapter "Deficiencies of mechanical equipment"	300,000
Contingency margin	60,000
	1,500,000
Total capital required	5,000,000

VI. ANALYSIS OF PRODUCTION STATISTICS AND ECONOMIC PERFORMANCE RESULTS

For the evaluation of plant efficiency and cost structure under current conditions, statistics for output, down-time and raw material consumption have been prepared and analysed. For the assessment of plant profitability, both under current conditions and conditions which can reasonably be expected after the implementation of recommended improvements, two cost/profit calculations and break-even point analyses have been prepared.

The calculations are based on actual figures from the company's statistics for 1975 and the first half of 1976. Their results give a clear picture of the over-all situation of this particle board factory.

Production statistics

Output

In 1975 the total output was 14,870 m^3 of finished board (f.b.) with the following thickness distribution:

10 mm = 27%	16 mm = 23%
13 mm = 14%	19 mm = 36%

The output in the first half of 1976 reached 5,599 m^3 f.b. and had approximately the same thickness distribution (see annex VI).

Based on this actual thickness distribution of board to be produced and 345 working days/year with 22 hours effective production per day, the possible maximum output of the plant is 23,800 m^3 f.b. per year and 3.1 m^3 f.b. average production per hour.

The finished board is sorted and sold in four qualities: Extra, I, II, and III (rejects). In 1975 and the first half of 1976 the percentage of qualities produced was: Extra and I = 89% (1976: 87%), II = 7% (1976: 9%), and III = 4% (1976: 4%).

The factory is manned with 92 employees directly connected with production (4-shift system). On an average they work 50 weeks a year, 45 hours per week. This equals 8.7 man hours/m^3 f.b. based on the annual maximum output of 23,800 m^3. Based on the output of 1975 the labour input reached 13.9 man hours/m^3 f.b.

Down-time

The total effective production time in 1975 was 7,678 hours and the down-time in this year was 3,031 hours, i.e. the plant efficiency (utilization) was 61%. When in production, an average output of 3.1 m^3 f.b. per effective production hour was reached, i.e. the nominal (100%) output of the plant.

For the first half of 1976 the corresponding figures are: plant efficiency = 52% and output per effective production hour = 3.1 m^3 f.b. For further details see annex VII.

An analysis of the recorded reasons for production stops in every daily down-time report has been carried out for the time from 1 January to 30 June 1976 which showed that approximately 85% of the total down-time was caused by breakdowns of machinery in the plant. The remainder was due to power failure, shortage of steam, lack of raw adhesive, or other reasons beyond plant control. These reports also confirm the repeated observations of the expert at the site during the last two months that necessary repair work of defective machines from abroad takes an excessively long time. This is mainly due to lack of an adequate stock of spare-parts from abroad for these machines.

The records show further that breakdowns are not concentrated on one specific part of the plant's mechanical equipment but occur indiscriminately, with the exception of the scraper conveyor belts at the gluing station and the extraction devices of the wet-flake silos which turn up repeatedly in the reports. This confirms the fact that after 15 years of uninterrupted production the plant machinery is now worn out.

Raw material consumption

The total consumption of wood, raw adhesive (69% solid resin content) and hardener in 1975 was as follows:

Wood:	47,290 m^3	(stacked)
Raw adhesive:	1,572,887 kg	
Hardener:	7,611 kg	

Referring to the 1975 total output of 14,870 m^3 f.b., these figures correspond to the following average consumption per m^3:

Wood:	3.2 m^3 (stacked) per m^3 f.b.
Adhesive:	106 kg (raw) = 73.9 kg solid resin/m^3 f.b.
Hardener:	0.51 kg per m^3 f.b.

The corresponding figures for the first half of 1976 are:

Wood:	3.1 m^3 (stacked)
Adhesive:	109.8 kg (raw) = 76.6 kg solid resin
Hardener:	0.41 kg per m^3 f.b.

For further details see annex VIII.

The wood consumption is extremely high and it is hardly possible that the recorded figures correspond to reality. The consumption recorded is based on the number of trucks unloaded at the flaking stations, i.e. loading volume of truck (m^3) x number of trucks delivered = wood consumption. There is no check on whether the trucks are loaded to 100% of their capacity. The introduction of a tight control was recommended and was carried out in June 1976. The wood consumption dropped to 2.5 m^3 (stacked) per m^3 f.b.

The average adhesive consumption of 106 kg (1975) and 109.8 kg (1976) per m^3 f.b. is not extremely high considering the relatively high amount of dust in the flake material and the old type of blenders in operation, but it can surely be reduced to an average of 99.5 kg raw adhesive per m^3 f.b. (see standard board specification, annex III) after the recommended installation of the new glue station equipment, improvemet of flake preparation, and re-introduction of proper production and quality controls.

Cost profit calculations and break-even point analysis

The cost/profit calculation for 1975 is based on actual figures from the company's balance sheet and shows the following (production 1975: 14,870 m^3 of finished board):

			Dinar
1.	Direct costs/m^3 f.b.	=	1,606.65
	Fixed costs/m^3 f.b.	=	787.29
	Total costs/m^3 f.b.	=	2,393.94
2.	Total production costs	=	35,597,957.00
	Total sales value	=	28,668,083.00
	Loss in 1975	=	6,929,874.00

For further details see annex IX.

The break-even point analysis (see figure II) illustrates the serious economic situation:

(a) The total production costs/m^3 are so high that the break-even point would be reached at approximately 150% of the theoretical maximum output of the plant;

(b) Even if the plant's efficiency could be improved to a maximum of 100%, the factory would still suffer losses in the range of Din 4,000,000 at this production cost level.

It follows that this situation can only be improved by bringing down production costs and simultaneously increasing the plant's efficiency. This can only be accomplished if all improvements recommended are carried out.

Under the improved conditions it is realistic to expect a reduction of wood consumption of approximately 25%, a reduction of adhesive consumption of approximately 6%, and an increase of plant efficiency to a maximum 80%. A goal of constant plant efficiency higher than 80% is not realistic considering the age of the plant.

A reduction of fixed costs, especially labour costs, is not possible owing to the circumstances according to the general management, but they will be kept at approximately the same level in the near future.

Therefore the following cost/profit calculation has been prepared with reduced direct material costs based on raw material consumption figures in line with the standard board specifications, and on present purchase prices with all other costs unchanged.

The possible economic performance to be expected after implementation of all recommended improvements, based on 80% of the nominal plant output i.e. 19,040 m^3 f.b. per year and the price level of 1975/76, is as follows:

		Dinar
Total sales value	=	36,747,200
Total production costs	=	37,211,050
Expected loss per annum	=	-463,850

For further details see annex X.

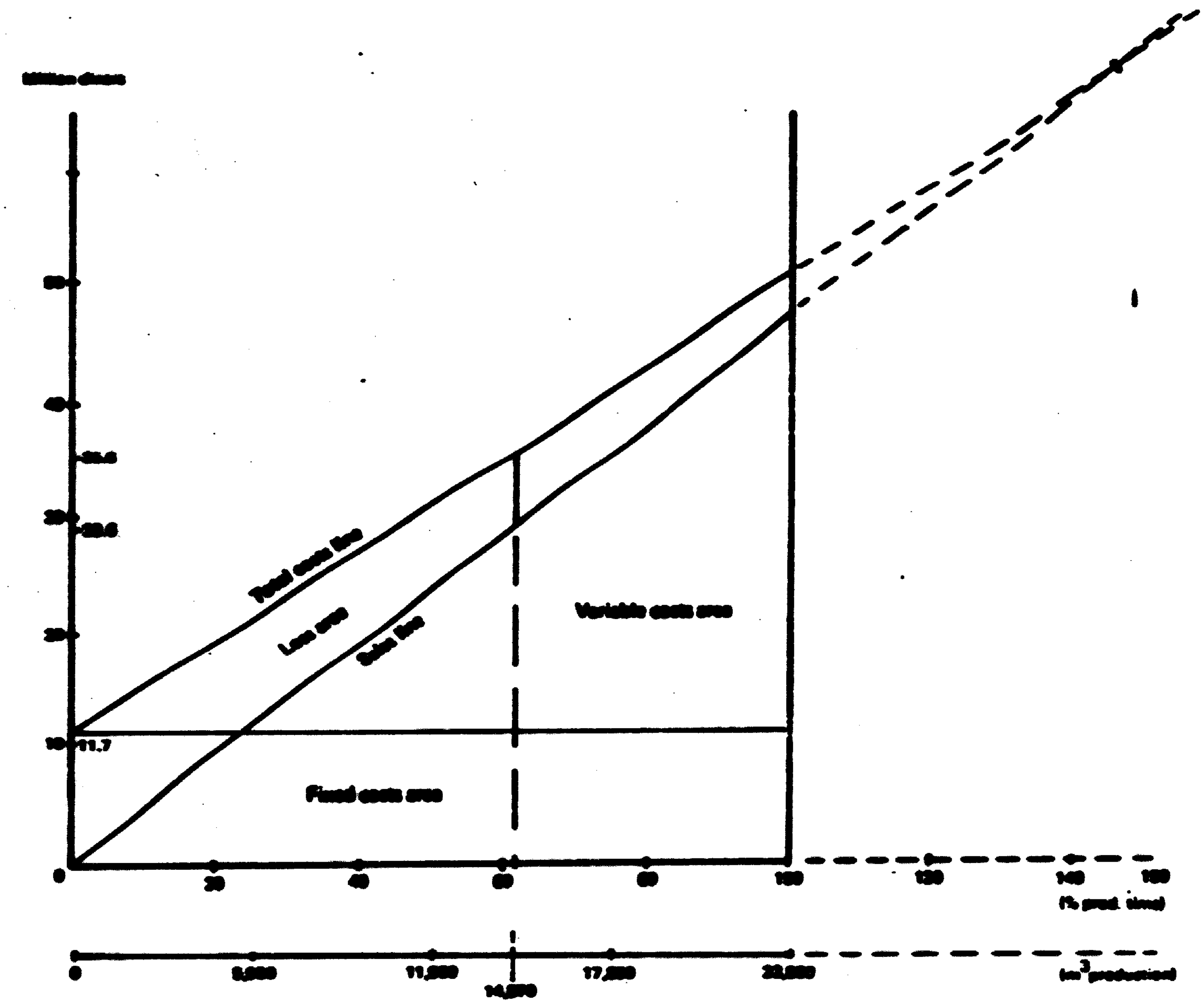


Figure II. Break-even point analysis for 1975

The break-even point analysis (see figure III) illustrates the results, and the following can be stated:

1. Even under improvements of production conditions which can reasonably be expected, the factory will still suffer economic losses.

2. The losses will be approximately Din 460,000 against Din 6,930,000 in 1975, i.e. a reduction of annual losses by approximately 93%.

3. The break-even point is reached under improved conditions at 85% of 100% plant efficiency.

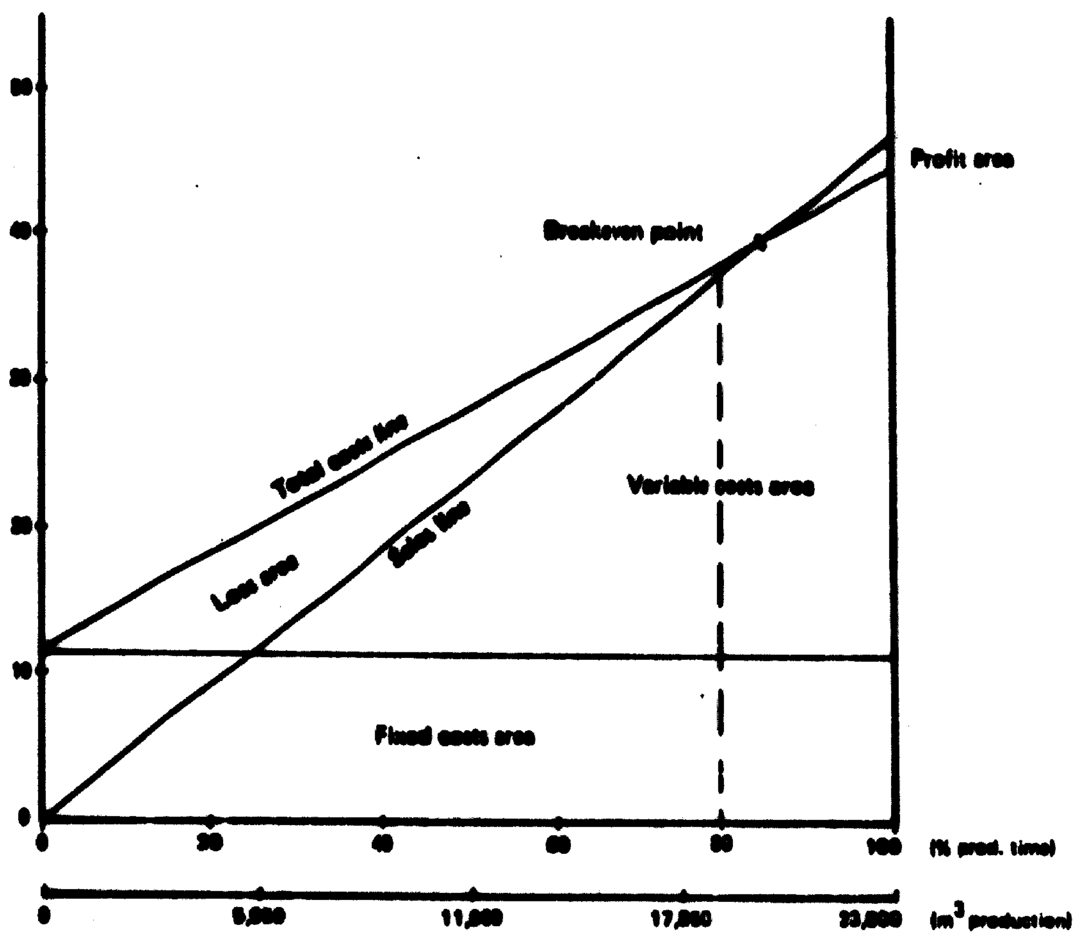


Figure III. Break-even point analysis for possible result after implementation of improvement

VII. CONCLUSIONS

1. The possibilities for improvement of the economic situation of the factory are limited to a minimizing of annual losses.

2. Even with the attainable figure of 80% plant efficiency and raw material consumption reduced to standard board specification level, the factory will suffer losses and no profit can be expected.

3. A comparison of the cost/profit calculations shows that by implementation of all recommendations a reduction of annual losses at approximately 93% could be reached.

This relation of 93% relative result improvement will remain valid even for the near future, as wages and prices are index regulated for this industry by the Government.

4. The recommended improvements would be economically justified as the capital expenditure of Din 5,000,000 in 1976 has a payback period of approximately one year.

5. The only way to achieve profitable production is a complete reconstruction of the plant and a considerable increase of its maximum production capacity.

Annex I

PREPARATION OF ADHESIVE AND HARDENER SOLUTION

Preparation of adhesive in summer is done according to the following formulation:

1\. Surface layer

	65 kg	(50 l)	raw adhesive (69% solid resin)
+	27 kg	(27 l)	water
+	1 kg	(1 l)	hardener solution
	93 kg	(78 l)	prepared adhesive

i.e. a concentration of 47.8% with 44.5 kg solid resin content.

2\. Core layer

	78 kg	= 60 l	raw adhesive (69% solid resin)
+	20 kg	= 20 l	water
+	3 kg	= 3 l	hardener solution
	101 kg	= 83 l	prepared adhesive

i.e. a concentration of 52.9% with 53.4 kg solid resin content.

The hardener solution is prepared in summer as follows:

	100 kg	ammonium chloride (NH_4Cl)
+	88 kg	ammonium hydroxyde (NH_4OH) 25%
+	622 kg	water
	810 kg	= litre hardener solution

In winter the amount of NH_4OH is reduced by one-half.

The formulae for preparation of adhesive in winter are as follows:[a]

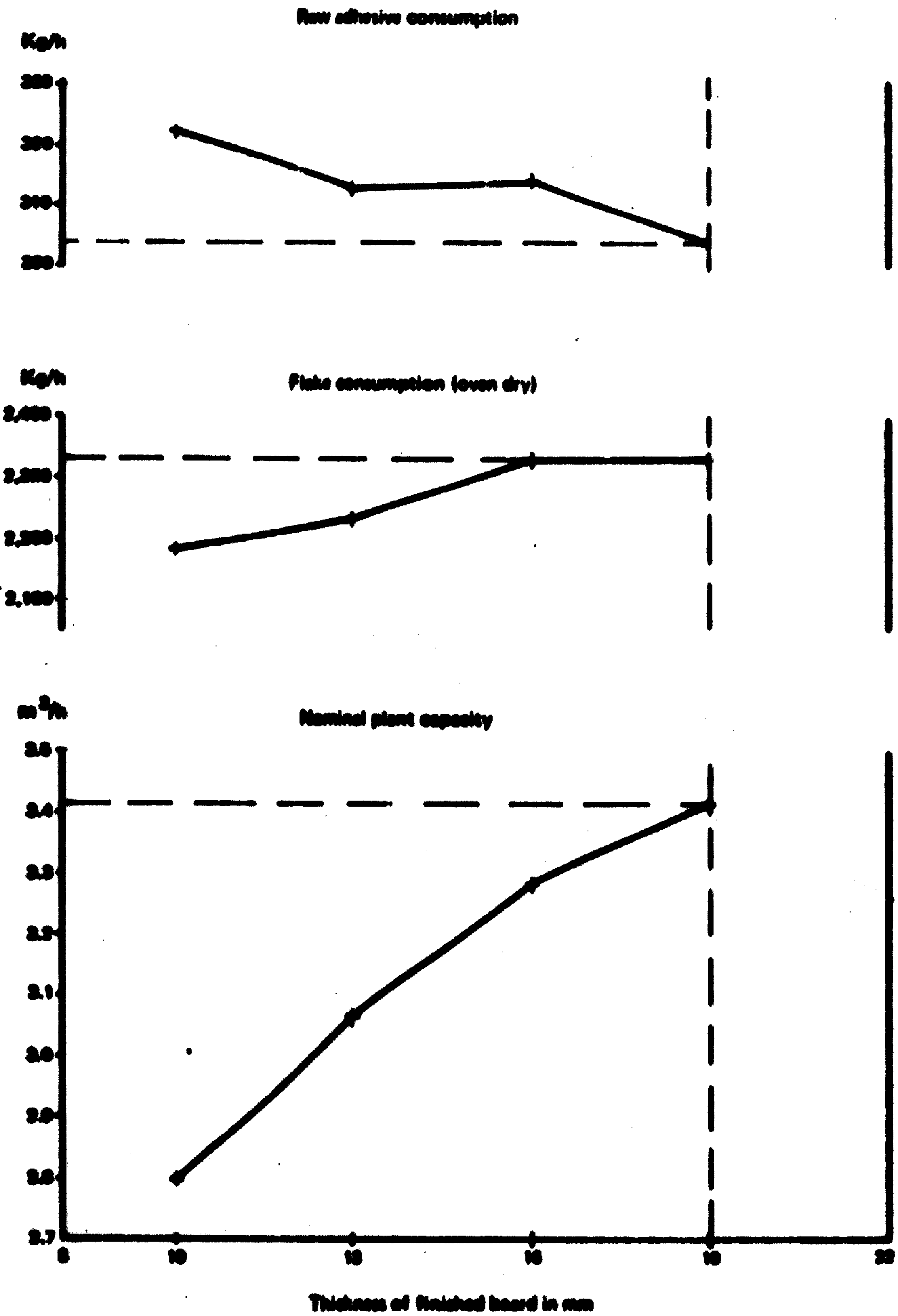
Surface layer		Core layer
65 kg = 50 l	raw adhesive	78 kg = 60 l
+ 24 kg = 24 l	water	+ 17 kg = 17 l
+ 1 kg = 1 l	hardener solution	+ 3 kg = 3 l
90 kg = 75 l	prepared adhesive	98 kg = 80 l

[a] Formulation for winter was received from the plant management.

Annex II

STANDARD BOARD SPECIFICATIONS

1. Nominal plant capacity:	75 m^3f.b./22 hours, = 3.41 m^3f.b./hour, based on 19 mm board thickness with a density of 700 kg/m^3
2. Type of board:	Three layer board
3. Raw material: (a) wood	for surface layer mainly coniferous wood and beech for core layer only beech
(b) adhesive	Urea formaldehyde resin, raw adhesive with 69 % solid resin content
4. Thicknesses produced:	only 10, 13, 16 and 19 mm
5. Rough board size:	1,800 x 3,710 mm
6. Rough board area:	6.678 m^2
7. Finished board size:	1,750 x 3,660 mm
8. Finished board area:	6.405 m^2
9. Number of press openings:	4
10. Quality standard applied:	to be in accordance with DIN standards 68 761 52 361 52 362 52 364 52 365


Raw adhesive consumption
Kg/h
Kg/h
Flake consumption (oven dry)
2,400
2,300
2,200
2,100
m³/h
Nominal plant capacity
3.5
3.4
3.3
3.2
3.1
3.0
2.9
2.8
2.7
Thickness of finished board in mm

11. Technological figures for production:

Item	Unit	10 mm	13 mm	16 mm	19 mm
Net board thickness f.b.	mm	10	13	16	19
Sanding allowance	mm	1.5	1.5	2.0	2.0
Raw board thickness	mm	11.5	14.5	18.0	21.0
Specific weight (density)	kg/m^3	760	740	720	700
Net board weight finished moisture u = 8 %	kg	48.6	61.6	73.8	85.2
Raw board weight moisture u = 8 %	kg	58.3	71.6	86.5	98.1
Raw board weight oven dry (basis u = 8 %)	kg	54.7	66.3	80.1	90.8
Wood flakes oven dry of raw board (basis 10 % solid resin, average)	kg	50.0	60.5	73.0	83.0
Surface layers part of wood flakes oven dry	%	60	50	40	35
Core layer part of wood flakes oven dry	%	40	50	60	65
Surface layers part of wood flakes oven dry	kg	30.0	30.2	29.0	29.0
Core layer part of wood flakes oven dry	kg	20.0	30.3	44.0	54.0
Capacity / pressing (finished board)	m^3	0.256	0.333	0.410	0.487
Heating time	min	4	5	6	7
Loading + unloading of press	min	1.5	1.5	1.5	1.5
Time for one press cycle	min	5.5	6.5	7.5	8.5
Number of pressings/hour	-	10.9	9.2	8.0	7.0
Number of pressings/working day (22 hours effective time)	-	240	202	176	154
Capacity per hour (finished board)	m^3	2.79	3.06	3.28	3.41
Capacity per hour (finished board)	metric tons	2.15	2.26	2.36	2.39
Capacity per working day (finished board)	m^3	61.4	67.3	72.2	75.0
Capacity per working day (finished board)	metric tons	47.3	49.8	51.9	52.5

Item	Unit	10 mm	13 mm	16 mm	19 mm
Number of boards per hour	-	43.6	36.8	32	28
Number of boards per working day	-	959	809	704	616
Total flakes per hour oven dry	kg	2,180	2,226	2,336	2,324
Flakes for surface layers per hour, oven dry	kg	1,308	1,113	934	813
Flakes for core layer per hour, oven dry	kg	872	1,113	1,402	1,511
Flakes for surface layers per hour, with moisture u = 5 %	kg	1,373	1,168	981	854
Flakes for core layer per hour, with moisture u = 4 %	kg	907	1,158	1,458	1,571
Surface layers: solid resin per hour (12 % of dry flakes)	kg	157	133	112	97
Core layer: solid resin per hour (7.5 % of dry flakes)	kg	65	83	105	113
Total raw adhesive per hour (solid resin content = 69 %)	kg	322	313	314	304
Raw adhesive per m^3 f.b.	kg	115	102	96	89
Solid resin per m^3 f.b.	kg	79.4	70.4	66.3	61.4
Moisture content of surface layer material after blending	%	16–18	16–18	16–18	16–18
Moisture content of core layer material after blending	%	12–14	12–14	12–14	12–14
Temperature of the press	°C	150	150	150	160
Working pressure of the press	kp/cm^2	250	250	250	250

Annex III

DRAFT OF ENQUIRIES FOR NEW GLUING EQUIPMENT

Re: Quotation for gluing equipment - particle board production

Dear Sirs,

You are hereby requested to send us your quotation for the following equipment:

Complete gluing station, comprising

2 Turbo blenders, for preparation of surface and core layer material

4 twin screw conveyors, for loading and unloading of the blenders, lengths approximately 4 m.

1 automatic preparation unit, complete, for separate dosing of raw adhesive, water, hardener solution and paraffin emulsion, for separate preparation of adhesive for surface and core layer.

1 electrical control panel

The capacity and layout of the equipment has to be based on the following data:

Capacity of the plant: 19 mm = 3.41 m^3/h, density 700 kg/m^3
(finished board) 10 mm = 2.80 m^3/h, density 760 kg/m^3

Flake material: 19 mm: for surface layer 813 kg/h (oven dry)
for core layer 1,511 kg (oven dry)
10 mm: for surface layer 1,308 kg (oven dry)
for core layer 872 kg (oven dry)

Wood: 80-90% Beech (*Fagus silvatica*)
20-10% coniferous wood

Blending: (a) Raw adhesive has approximately 68.5–69% solid resin content, specific weight = 1.3 kg/dm^3 (Urea formaldehyde adhesive).

(b) Application for surface layer material approximately 12% solid resin, based on atro flakes.

(c) Application for core layer material approximately 8% solid resin, based on atro flakes.

Alternatively, we would like to have the prices for the same equipment but with a capacity of

8 m^3 finished board/hour,
based on 19 mm, density 700 kg/m^3.

Furthermore, we ask for all technical data for the cooling-water equipment which is needed for the Turbo-blenders and which will be purchased locally.

Please quote the prices separately for each item and indicate your earliest delivery time.

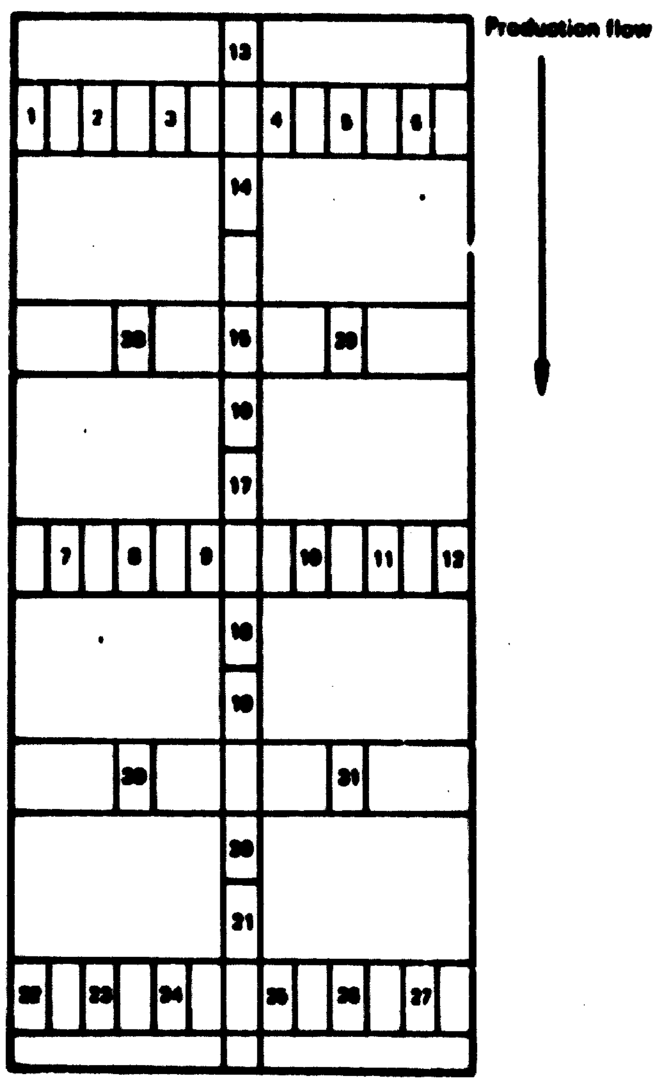
Yours faithfully,

Annex IV

DENSITY DISTRIBUTION TESTS

A. Density distribution tests over each board

1. Scheme for sample cutting:



2. Test results

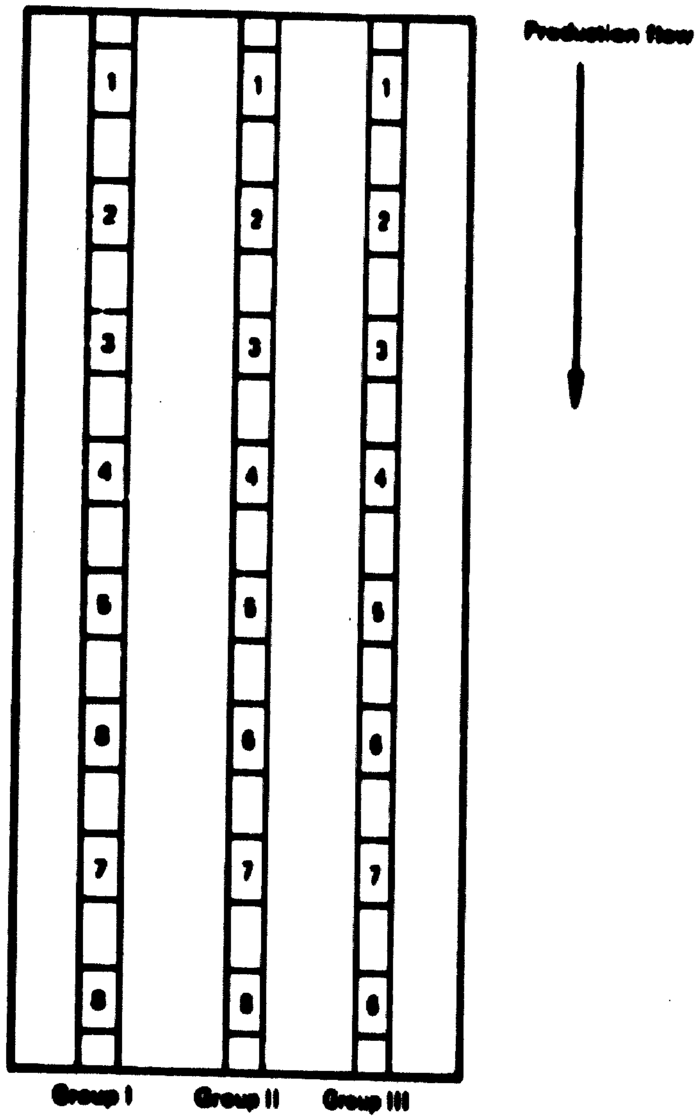
Board tested: 21 mm unsanded

Sample No.	Dimensions (mm) L	W	Thickn.	Vol. cm3	Weight gr.	Density Kg/m3
1	184.5	147	20.5	55.6	367	660
2	184	145	20.5	547	388	709
3	184	135.5	21.0	524	382	729
4	184	151	21.3	592	470	794
5	184	147	21.5	582	452	777
6	184	146.5	21.4	577	413	716
7	199	143	20.3	578	378	654
8	199	150.2	21	628	455	725
9	199	155	21.5	663	524	790
10	199	145	21.6	623	494	793
11	199	149.5	22.0	655	488	745
12	199	59.6	22.7	269	198	736
13	206	151.5	21.7	677	522	771
14	189	151	21	599	470	784
15	190	146	21.3	591	465	787
16	153	140	21	450	345	767
17	198	153	21	636	491	772
18	206.5	150	21.5	666	515	773
19	206	150	22	680	490	721
20	207	159	22.1	727	563	774
21	194	160	21.9	680	546	803
22	207	151	20	625	454	726
23	207	145	20.7	621	462	744
24	207	153	21.7	687	532	774
25	206.5	155	22.2	711	562	790
26	206	145	22.5	672	545	811
27	207	143.5	22.9	680	502	738
28	190	147.7	20.3	570	379	665
29	190	149.8	21.5	612	462	755
30	205	145.2	20.8	619	445	719
31	204	145	22	651	535	822

Medium density of the board: 752 kg/m3

B. Density distribution tests between the boards

1. Scheme for sample cutting:



2. Test results

Board tested: 18 mm unsanded

Samples Group/no.		Dimensions (mm) L	W	Thickn.	Vol. cm3	Weight gr.	Density Kg/m3
I:	1	99.6	87.0	18.1	158	105	663
	2	101.0	91.2	18.4	170	121	712
	3	102.5	89.0	18.5	170	121	712
	4	103.0	93.1	18.2	175	124	710
	5	104.0	93.0	18.2	177	125	708
	6	104.6	95.4	18.5	185	129	700
	7	105.0	93.0	18.2	178	132	749
	8	101.5	90.6	18.5	171	132	779
II:	1	98.2	87.5	18.3	158	117	739
	2	98.8	91.5	17.5	159	120	753
	3	99.8	89.1	17.8	159	112	707
	4	100.3	93.0	17.8	167	119	713
	5	100.0	93.0	17.8	166	125	753
	6	100.0	95.5	17.6	168	124	738
	7	101.5	93.3	17.7	168	125	744
	8	102.0	90.4	17.9	168	127	756
III:	1	100.0	88.6	18.5	164	120	731
	2	99.6	93.3	18.0	167	121	725
	3	99.4	89.2	18.0	160	120	749
	4	99.5	93.1	17.7	164	124	756
	5	99.6	93.0	17.5	163	127	778
	6	99.3	93.0	17.3	160	120	749
	7	99.6	93.0	17.4	162	116	715
	8	101.5	91.5	17.5	163	129	791

Medium thicknesses

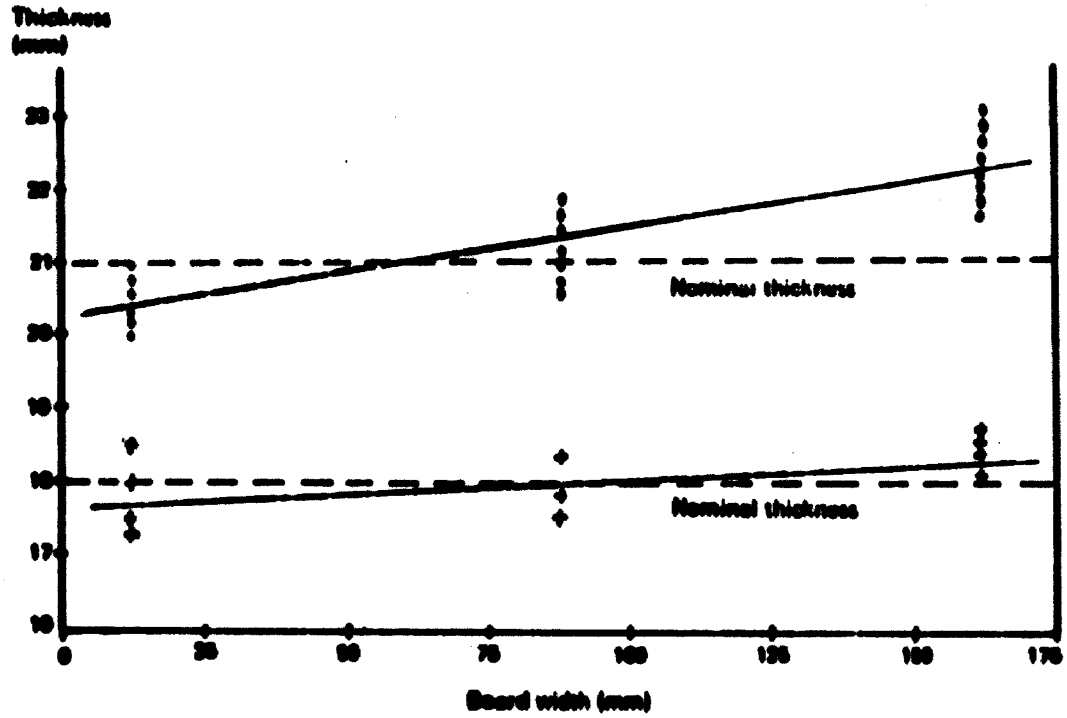
Group I: 18.3 mm
Group II: 17.8 mm
Group III: 17.7 mm

Medium densities

Group I: 717 kg/m3
Group II: 738 kg/m3
Group III: 749 kg/m3

Medium density of the board: 735 kg/m3

C. Thickness distribution as per test results A.2. and B.2.



Annex V

QUALITY CONTROL FORM FOR SANDING STATION

Date Shift Board thickness mm

Board quality	Faults	No. of boards	%
Extra/I	No faults		
II	Wrong dimensions		
	Open areas of surface		
	Damaged through handling		
	Adhesive patches		
	Weak corners		
	Crude edges		
	Unsanded areas		
	Core layer showing		
	Thickness too low		
	Sanding defects		
	Other faults		
III	Splitting		
	Other faults		
	Total boards sanded		100

....

sign, Controller

Annex VI

TOTAL BOARD PRODUCTION AND THICKNESS DISTRIBUTION, 1975 AND 1976

A. Total board production and thickness distribution in 1975

Month	10 mm (m^3)	13 mm (m^3)	16 mm (m^3)	19 mm (m^3)	Total (m^3)
Jan.	—	150	381	483	1,014
Feb.	295	—	192	377	864
March	232	222	184	879	1,517
April	544	199	234	405	1,382
May	143	413	381	641	1,578
June	523	—	147	909	1,579
July	436	140	127	307	1,010
Aug.	440	186	559	—	1,185
Sept.	938	—	—	—	938
Oct.	445	327	497	—	1,269
Nov.	—	394	314	612	1,320
Dec.	—	—	460	754	1,214
Total	3,996	2,031	3,476	5,367	14,870
Average/year	27 %	14 %	23 %	36 %	100 %

Total production in 1975 = 14,870 m^3 f.b.

B. Total board production and thickness distribution in 1976

Month	10 mm (m^3)	13 mm (m^3)	16 mm (m^3)	19 mm (m^3)	Total (m^3)
Jan.	—	—	—	185	185
Feb.	—	—	125	612	737
March	378	—	194	221	793
April	3	274	577	490	1,344
May	949	—	—	—	949
June	50	403	478	660	1,591
Total	1,380	677	1,374	2,168	5,599
Average/year	25 %	12 %	24 %	39 %	100 %

Total production 1.1. – 30.6.1976 = 5,599 m^3 f.b.

Annex VII

DOWN-TIME, 1975 AND 1976

A. Down-time in 1975

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	-	14	rep.	10	-	12	3	8	18	3	12	9
2	8	15	-	22	-	8	7	2	9	7	2	4
3	12	17	16	4	22	20	8	20	13	11	10	3
4	14	9	4	7	13	12	22	5	9	7	1	6
5	4	5	12	12	11	10	21	-	2	5	1	3
6	13	8	7	-	12	8	17	8	6	13	9	1
7	14	5	11	6	8	11	3	10	11	4	1	11
8	16	12	11	1	14	2	2	1	21	3	5	6
9	17	10	22	2	11	3	8	19	22	6	11	3
10	9	15	5	5	7	6	19	11	22	2	8	7
11	2	22	9	2	5	4	21	13	22	6	5	10
12	11	2	10	4	9	9	22	18	22	-	5	9
13	8	2	-	22	1	10	22	8	20	12	2	4
14	10	2	3	2	4	1	8	10	11	3	8	2
15	6	16	7	6	11	5	14	16	4	10	3	12
16	5	4	6	7	8	4	22	4	4	11	-	4
17	6	8	-	2	8	7	6	2	6	13	13	9
18	18	14	2	22	4	2	10	11	2	12	17	6
19	16	6	2	8	3	4	14	15	9	10	12	13
20	7	8	2	10	8	16	8	2	4	12	8	2
21	14	5	6	4	18	7	4	2	12	12	5	8
22	3	12	7	5	20	7	14	11	1	1	12	8
23	3	16	7	3	-	10	10	18	9	6	12	4
24	2	repair	4	5	2	8	-	12	4	22	12	5
25	5		4	11	1	6	8	8	1	10	17	closed for maintenance
26	17		-	16	4	4	16	2	4	17	15	
27	2		5	16	5	4	8	5	1	18	19	
28	12		1	10	4	10	8	10	4	13	12	
29	15		7	3	-	2	2	8	20	13	22	
30	13		4	5	-	6	18	6	10	12	22	
31	12		13		12		9	4		9		
Total	294	227	187	232	235	218	354	269	303	283	281	149
Effect. prod.hrs (22/day)	660	506	638	660	660	660	682	682	660	682	660	528
Down-time in %	45	45	29	35	36	33	52	39	46	41	43	28

Total effective production hours in 1975: 7,678 hrs
Total down-time in 1975: 3,032 hrs

Average down-time in 1975: 39 %

B. Down-time in 1976

Day	January	February	March	April	May	June
1	closed for maintenance	22	12	9	repair press	6
2		22	6	3		17
3		22	11	3		2
4		22	11	5		2
5		22	2	2		9
6		22	6	9		4
7		22	22	8		16
8		22	18	7		8
9		22	4	9		4
10		22	7	16		3
11		4	3	6		1
12		3	3	19		3
13		11	4	4	12	11
14		12	5	2	3	5
15		12	3	6	-	8
16		14	3	9	3	1
17		21	4	1	6	3
18		19	3	4	-	2
19		2	repair power station	6	-	4
20		2		3	8	1
21	12	15		3	4	9
22	14	8		3	5	-
23	10	-		2	-	2
24	16	10		-	6	-
25	8	22		9	3	4
26	22	6		22	5	1
27	22	-		22	-	2
28	22	11		22	1	2
29	22	3		22	6	15
30	22			22	15	-
31	22				4	
Total	192	395	413	258	301	145
Effective production hours(22 hrs/day)	242	638	682	660	638	660
Down-time in %	79	62	61	39	47	22

Total effective production hours: 3,520 hrs

Total down-time: 1,704 hrs

Average down-time: 48 %

Annex VIII

RAW MATERIAL CONSUMPTION, 1975 AND 1976

A. Raw material consumption in 1975

Month	Production finished b. (m^3)	Raw adhesive consumption (kg)	Wood consumpt. m^3(st.)	Raw adhesive /m^3f.b. (kg/m^3)	Solid resin /m^3f.b. (kg/m^3)	Wood/ m^3f.b. m^3(st.)
Jan.	1,013.6	124,173	3,303	122.5	84.5	3.3
Feb.	864.4	86,350	3,281	99.9	68.9	3.8
March	1,516.6	153,441	4,724	101.1	69.7	3.1
April	1,381.8	128,605	4,066	93.1	64.2	2.9
May	1,577.7	154,738	4,918	98.1	67.7	3.1
June	1,579.3	181,981	5,080	115.3	79.5	3.2
July	1,010.1	106,057	2,804	105.0	72.4	2.8
Aug.	1,185.3	131,797	3,774	111.2	76.7	3.2
Sept.	938.8	115,059	3,546	122.6	84.5	3.8
Oct.	1,269.4	127,333	4,101	100.3	69.2	3.2
Nov.	1,319.6	132,782	4,233	100.6	69.4	3.2
Dec.	1,213.6	130,570	3,460	107.5	74.1	2.9
Total	14,870.2	1,572,886	47,290	-	-	-
Average consumption per m^3f.b.				106	73.5	3.2

B. Raw material consumption in 1976

Month	Production finished b. (m^3)	Raw adhesive consumption (kg)	Wood consumpt. m^3(st.)	Raw adhesive /m^3f.b. (kg/m^3)	Solid resin /m^3f.b. (kg/m^3)	Wood /m^3f.b. m^3(st.)
Jan.	185.0	19,425	666	105.0	72.5	3.6
Feb.	737.2	89,257	2,709	121.[illegible]	83.5	3.7
March	793.4	85,124	2,840	107.3	74.0	3.6
April	1,344.1	138,485	3,997	103.0	71.1	3.0
May	949.4	122,000	3,135	128.5	88.7	3.3
June	1,59[illegible].3	161,006	3,961	101.1	70.0	2.5
Total	5,599.4	615,297	17,308	-	-	-
Average consumption per m^3f.b.				109.8	76.6	3.1

Annex IX

PRODUCTION COST CALCULATION FOR 1975

1. Direct production costs per m^3f.b.

	Dinars
(a) Wood: 12,392,253 : 14,870 m^3	833.40
(b) Adhesive: 7,388,071 : 14,870 m^3	496.80
(c) Hardener+conditioner: 37,829 : 14,870 m^3	2.53
(d) Electric power: 1,201 688 : 14,870 m^3	80.81
(e) Thermal power: 2,456,623 : 14,870 m^3	165.21
(f) Knives, sanding paper, auxiliary material: as in 1975 414,526 : 14,870 m^3	27.90
Average direct costs per m^3f.b.	1,606.65
Total direct costs: 1,606.65 x 14,870 m^3	23,890,990.-

2. Total fixed costs

(a) Workers salaries + overheads a/	3,942,612.-
(b) Administration, insurance	985,807.-
(c) Repair, maintenance, spare-parts	946,857.-
(d) Depreciation	2,857,128.-
(e) Office materials	678,222.-
(f) Interest on working capital	2,296,341.-
Total fixed costs:	11,706,967.-
Average fixed costs per m^3f.b.	787.29

3. Total costs of production in 1975

23,890,990 + 11,706,967 — Dinars 35,597,957.-

a/ Average labour input = 13.9 man hours per m^3f.b.

Annex X

PRODUCTION COST CALCULATION
AFTER IMPROVEMENT OF PRODUCTION CONDITIONS

A. Basic costs and prices for calculation

1. Purchase prices for wood material in 1976:

	Dinars/m³ (stacked)
(a) Coniferous wood	380.-
(b) Beech (*Fagus silvatica*)	260.-
(c) Birch (*Betula alba*)	260.-
(d) Fuel wood (residues)	170.-
Company's average price for calculations:	260.-

2. Purchase prices for adhesive and hardener in 1976:

	Dinars/kg
(a) Raw liquid adhesive (69 % solid resin)	4.40
(b) Hardener powder	4.50
(c) Ammoniac	1.70
Company's average adhesive price for calculations:	4.40

3. Sales prices for particle board in 1976:

Quality	Dinars / m³			
	10 mm	13 mm	16 mm	19 mm
Extra	2,332.-	2,171.-	1,973.-	1,794.-
I	2,207.-	2,053.-	1,867.-	1,697.-
II	1,980.-	1,829.-	1,615.-	1,525.-
III	600.-	600.-	600.-	550.-

Company's average sales price per m³ f.b. of all thicknesses:

Dinars 1,930.-/m³

B. Production cost calculation

1. Average direct production costs per m^3f.b.

	Dinars
(a) Wood: maximum 2.4 m^3(stacked) x 260.-/m^3(stacked)	624.-
(b) Adhesive: maximum 100 kg raw adhesive (69 % solid resin) x 4.40/kg	440.-
(c) Hardener + conditioner: as in 1975	2.50
(d) Electric power: as in 1975	80.-
(e) Thermal power: as in 1975	165.-
(f) Knives, sanding paper, auxiliary materials: as in 1975	28.-
Average direct costs per m^3f.b.	1,339.50

Total direct costs for production of 19,040 m^3f.b. per year: 1,339.50 x 19,040 = Din. 25,504,080.-

2. Total fixed costs: as in 1975 = Din. 11,706,970.-

3. Total production costs for production of 19,040 m^3f.b. per year: 25,504,080 + 11,706,970 = Din. 37,211,050.-

C. Total sales value per year:

Average sales price per m^3f.b. = Din. 1,930.-

19,040 m^3 x 1,930.- = Din. 36,747,200.-

C-279

77.07.13