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ASSISTANCE TO THE PARTICLE BOARD PLANT OF SIK "VELIMIR JAKIC" IN PLJEVLJA

Technical Report[1]

by

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UNIDO Expert
in the Production of Particle Board

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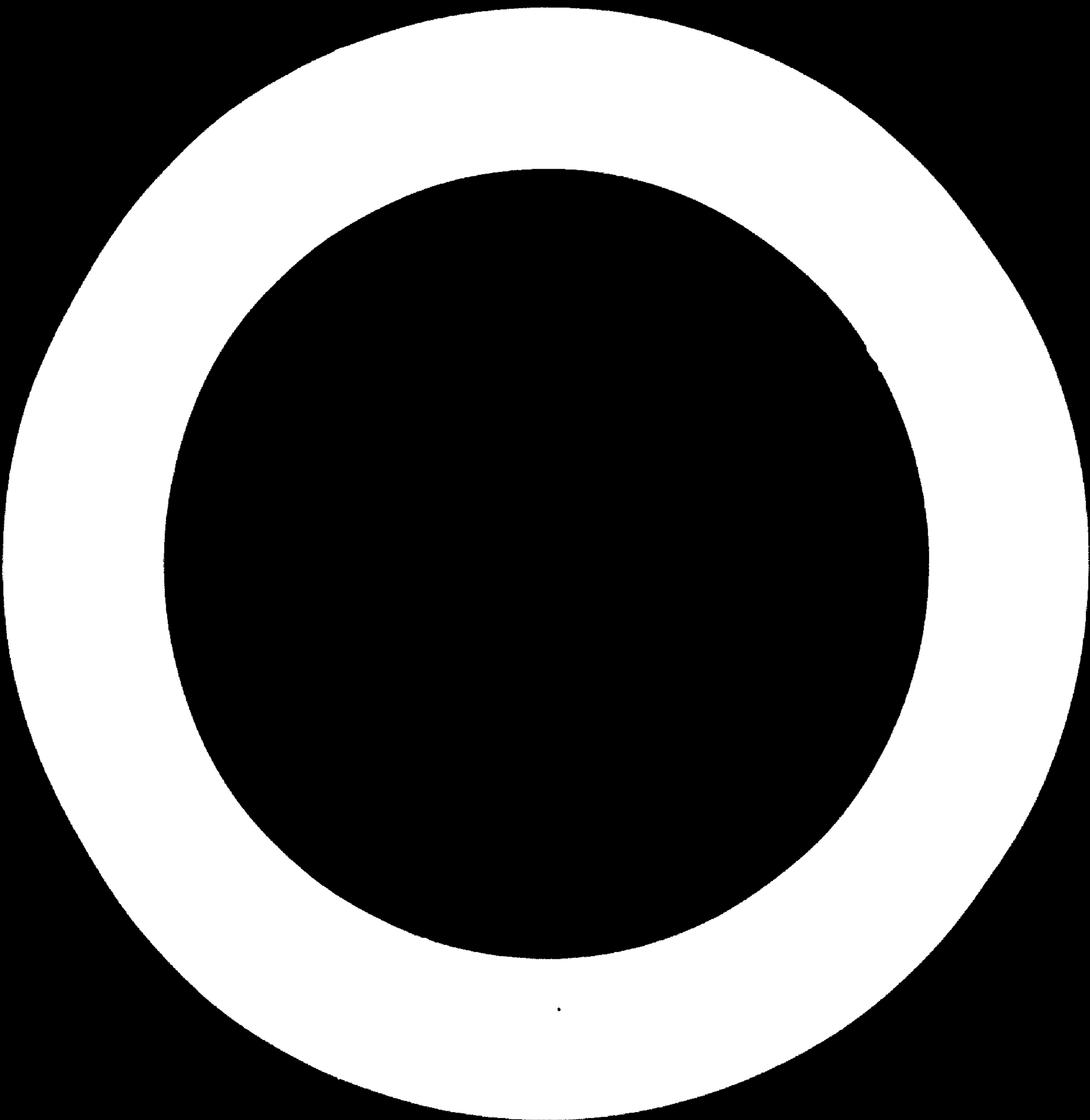

REPORT ON VISIT TO KOMBINAT INDUSTRIJE DRVETA "VELIMIR JAKIC" AT PLJEVLJA - MONTENEGRO

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FOREWORD

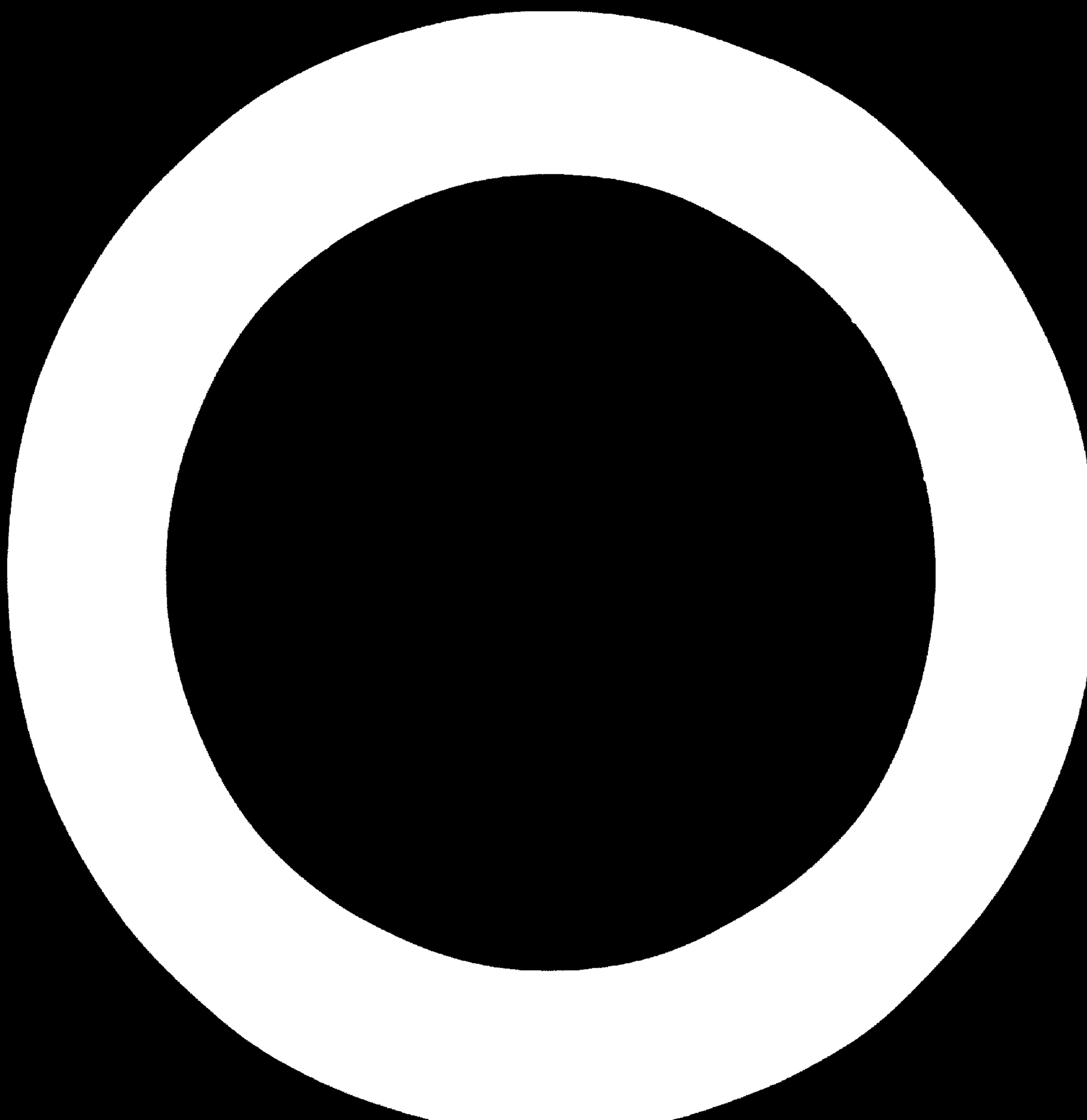
Upon a request of the Government of the Socialist Federal Republio of Yugoslavia for Special Industrial Services, Mr. P.E. Tack has been engaged by UNIDO as an expert in the production of particle board for a total duration of three months, with the possibility of implementing the project in two or three phases.

Purpose of the project: To assist the management of the particle board plants in Mojkovac and Pljevlja, upgrade their production technology, increase productivity and improve the quality of their products.

This report covers the visit to the Sumsko Industrije Kombinat "Velimir Jakić" in Pljevlja, Montenegro, from 25 July to 15 August 1974.

The expert would like to take this opportunity to thank for their help and assistance:

- Ing. Ostojić Diagomir, Technical Director of the Velimir Jakić Enterprise
- Mr. Tomanovic Radoje and Mr. Baebic Slavko of the particle board unit



I. GENERAL

The Sumsko Industrijski Kombinat "VELIMIR JAKIČ" is an important autonomous combinat and forest enterprise having a well diversified and good integration.

The following manufacturing units are combined in the Pljevlja enterprise:

a) a sawmill whose production capacity in 1975 will be 80.000 to 90.000 m^3 of coniferous logs;

b) a particle board plant with an actual yearly production of about 12.000 m^3 boards;

c) a laminating plant for particle boards with a theoretical capacity of 1,200.000 m^2 per year;

d) a unit for the production of windows;

e) a unit for prefabricated housing elements.

The particle board plant, supplied and installed in 1960 by S.A. Siempelkamp, Germany, has already been reconstructed in 1968 by Hermal, Germany. The original three-daylight Siempelkamp press has been replaced by a four-daylight Dieffenbacher press.

Technical data on plant and production

1) Type of board:

Three-layer particle board with rough and coarse surface layers unsuited for economic and quality laminating.

2) Finished board:

Size: 1.750 x 3.660 mm

Thickness range: from 10 up to 22 mm

Specific weight: varying for a 19 mm between 700 and 900 kg/m^3

3) Type of press plant:

System: Caul system

- Dieffenbacher hydraulic press without automatic controls
- Siempelkamp hydraulic system
- Reversible forming line

4) Type of flake preparation:

In three separate preparation lines:

a) One surface layer line;
b) One core layer line;
c) One combined preparation line.

5) Finished board utilisation:

- for laminating in the Combinat's own plant;
- for use in furniture;
- partially for use in prefabricated housing elements by the Combinat's own unit;
- defective boards and partially used ones are sold in the Pljevlja area at reduced prices.

6) Capacity of the plant:

The theoretical maximum capacity of the hydraulic press plant is about 24.000 m^3 (three-shift working - 300 days a year).

The practical yearly capacity is only 12.000 m^3 (three-shift working - 300 days a year).

II. MAJOR IMPRESSIONS AND FINDINGS

2.1 Raw Materials used for Particle Board Manufacture

For surface layer:

- coniferous round wood;
- coniferous saw mill wastes (slabs);
- shavings from joinery unit (light material from the Keller separator).

For core layer:

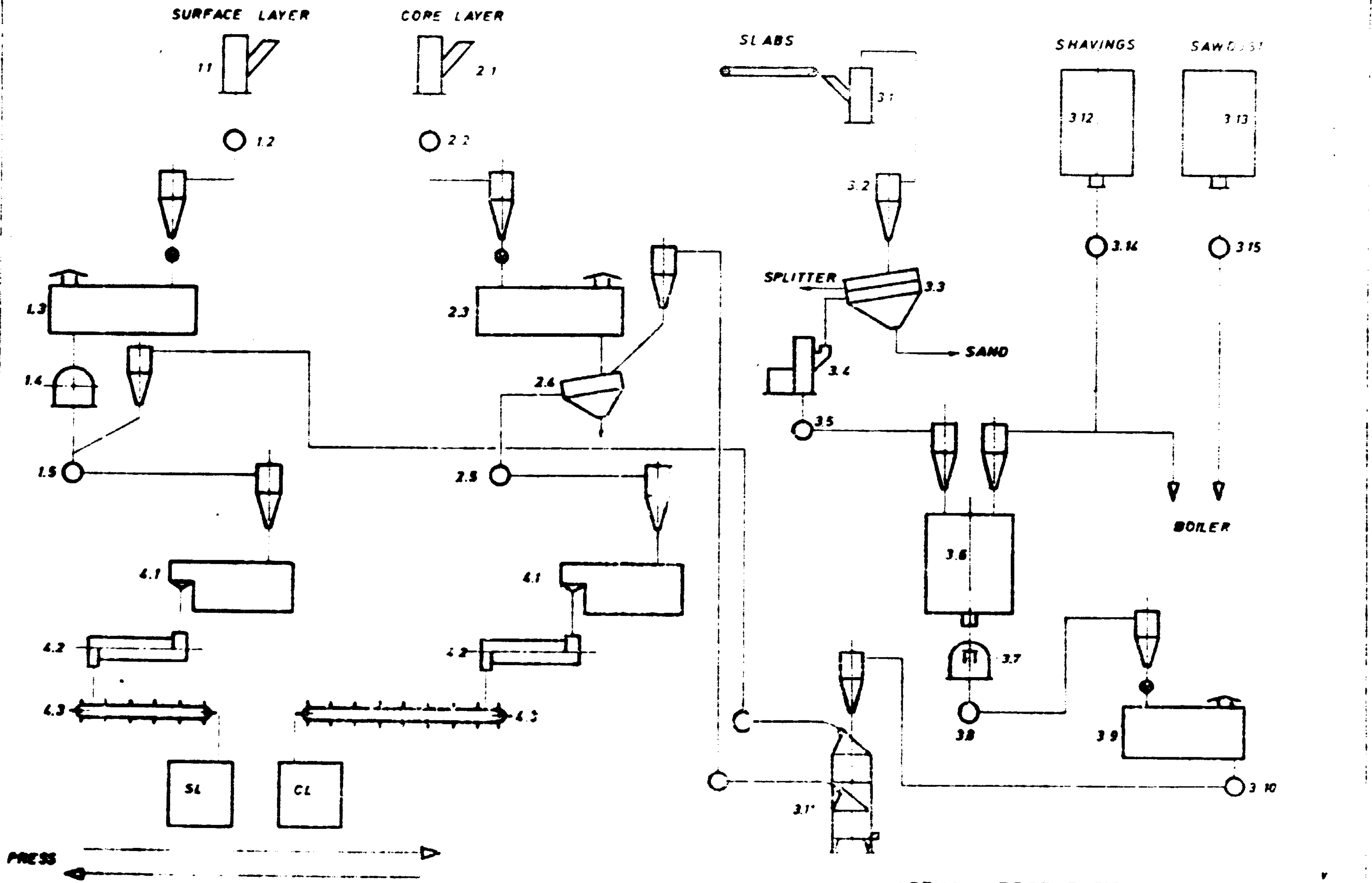
- coniferous and beech round wood;
- coniferous saw mill wastes (slabs);
- shavings from joinery unit (coarse and heavy material from Keller separator).

Summary:

This three layer particle board is mainly manufactured with coniferous wood and wood wastes. Only a low percentage of coniferous round wood is used.

2.2 Technological Description and Working Principle of the Particle Board Plant

As already mentioned, preparation of flakes is done in three different preparation lines (see flowsheet on page 4):



ACTUAL PREPARATION - VELIMIR JAKIČ

1) Surface layer line

Flaking (mainly out of sawmill wastes and sometimes coniferous round wood) is done in an old type Hombak flaker, type PRZ 28 (see item 1.1). A pneumatic conveying device (item 1.2) transports the flakes straight into a bundle drier through its inlet rotary valve. The bundle drier (item 1.3) is an original Porndorf drier (steam heated) but a new bundle has been made locally several years ago. Its drying capacity is around 370.000 Kcal/hour.

At the outlet of the drier, flakes are refined in a Condux mill type CSK 600 equipped with a 60 x 8 mm screen (item 1.4).

After refining, flakes are oonveyed pneumatically (item 1.5) to the dry chips bunker (item 4.1) without any classification or screening. All technological comments will be given in the technical and technological findings (para. 2.3).

2) Core layer line

The machine list of the core layer line and lay-out is almost the same as for the surface layer line except that a vibrating screen type Niagara (item 2.4) is installed between drier outlet (item 2.3) and pneumatic conveyor (item 2.5). The core layer drier has a heating capacity of about 630.000 Kcal/hour.

3) Combined preparation line

This preparation line has been installed during several plant reconstructions in order to recover all kinds of slabs directly at the sawmill. To avoid bundling and transport of these slabs, chipping and flaking is done near the sawmill. Drying, refining and classification is done in the particle board line.

a) Equipment installed near the sawmill

An old disc hogger, type Pallmann (item 3.1) produces irregular chips and many very coarse splitters out of the different kinds of slabs and edgings coming from the sawmill. The chips are transported to a vibrating screen, type 2 stage Niagara (item 3.3), by the centrifugal force of the hogger disc (item 3.2), where heavy splitters and heavy wood pieces are eliminated. Flaking is done in the knife-ring flaker, type Pallmann PZ 12/36 (item 3.4). At the outlet of the knife-ring flaker, a pneumatic conveyor (item 3.5) ensures the long distance transport of the flakes (minimum 200 m) between sawmill and the wet flakes silo in the particle board preparation plant (item 3.6).

b) Equipment installed in the particle board plant

In the wet flakes silo (item 3.6) shavings (dry joinery wastes) can also be added. Its storage capacity is about 25 m^3; underneath the silo the refining of flakes is done in a Condux mill type CSK 500 equipped with a 60 x 4 mm screen (item 3.7).

Refined flakes are afterwards transported by fan to the Schilde bundle drier (capacity about 540.000 Kcal/h) (item 3.9).

Another pneumatic conveyor transports the dried flakes between the drier outlet and the inlet of the pneumatic selector (item 3.10). In the double-stage Keller selector (item 3.11) fine and light material is separated from coarser one. The light material is sent to the surface layer and the coarser one to the core layer preparation line. Very heavy splitters are evacuated through the single outlet rotary valve of the selector.

4) Dosing and gluing

Two horizontal storage bunkers (item 4.1) ensure storage and dosing of dry flakes into the surface and core layer blender (item 4.2). Dosing is done by weight in discontinuous batches. The ratio between wood and prepared glue is kept constant. Glue and wood dosing is driven by the same steering device equipped with variator in order to allow adjustment of the amount of glued particles according the production requirements.

Glue distribution and blending is done in old type Drais blenders (item 4.2). Glue dosing is done by a gear wheel pump and glue distribution by nozzles and compressed air (surface blender eight nozzles and core layer blender ten nozzles). A scraper conveyor (item 4.3) ensures the transport of coated particles between the blender and mat forming station (item 5).

5) Mat forming station

Mat forming is done in two old type mat forming machines, type MAK-Germany. Volumetric and gravimetric mat forming is combined.

6) Forming line and hydraulic press plant

- The forming line is reversible.
- The Caul system is old fashioned and cauls are not sufficiently cooled during the transport between press unloading device and forming line.
- The four-daylight Dieffenbacher hydraulic press does not have a simultaneous closing device. The opening between the daylights is very high (200 mm) and the closing speed of the press is very low.
- Control of press is done by hand (not automatic).

7) Board weighing and trimming

Behind the unloading device of the press, the boards are taken off from the cauls on a weighing frame. Board weights and thicknesses are checked and the boards are then pushed by hand on to the table of the trimming saw.

The non-automatic trimming saw trims the board to its final size 1.750 x 3.660 mm. Trimming wastes are taken off by hand and thrown aside.

8) Board sanding and classification

Sanding is done in an automatic finishing line consisting of:

- an automatic device to introduce the board;
- the first four-drum sander, type B-G;
- a board turning device;
- the second four-drum sander, type B-G;
- a manual two-grade classification system with two hydraulic lifting tables.

Sanding waste is exhausted pneumatically to the boiler house.

Remarks

Board trimming wastes are recovered neither in board production or in boiler house. Sawdust from sawmill and part of the joinery shavings are burned in the boiler house. Two boilers are installed, each equipped with a furnace for coal and wood waste burning.

2.3 General Findings

Preliminary remark

A detailed report on my two-day visit to Sumsko Industrijski Kombinat at Pljevlja has been made in September 1972 during my FAO-mission to Bosnia-Herzegovina and Montenegro and I am astonished to learn that this report with several findings and suggestions for technical and technological improvements never has been handed over to the staff of this enterprise.

However, my investigations during my present (and longer) stay in this plant left me certain major impressions none of which are at variance with the FAO report but some of which perhaps give more emphasis than it did to certain aspects.

My impressions and findings may be outlined as follows:

2.3.1 Availability of sawmill and joinery wastes

Type of wastes available:

Saw mill: - slabs (with moisture contents up to 120 %);
- saw dust (with moisture contents up to 120%).

Joinery: - shavings (with a moisture content of about 8 %);
- off-outs (with a moisture content of about 8 %);

Availability of shavings (coniferous):

Exact calculation of the amounts available daily is very difficult. They are estimated to be three to four tons of dry shavings per day. The moisture content of shavings is about 8%.

The joinery workshop is working normally one, and sometimes, two shifts per day.

The amount of shavings produced will probably increase in 1976 (after the extension of the joinery unit is completed).

Availability of sawdust (coniferous frame saw sawdust):

After the reconstruction of the sawmill in 1975 its capacity [illegible] to [illegible] m³ coniferous logs per year.

The amount of sawdust available in 1975 will be about 12% of [illegible] 9.600 m³. At a density for dry wood of about 425 kg/m³ [illegible] 3.640 tons of dry sawdust per year, or 12 tons of dry [illegible]. The moisture content up to 120 % is calculated on an oven [illegible].

Availability of slabs (coniferous saw mill wastes):

[illegible] 12% to 15% slabs for particle board calculated on the [illegible]. This represents a minimum of:

[illegible] 12% of [illegible].000 m³ = 9.600 m³;

[illegible] at 425 kg/m³ = 3.640 tons dry slabs per year;

or 12 tons of dry slabs per day.

[illegible] moisture content of the slabs is 100% to 120%.

[illegible] (availability in 1975)

	dry weight/year	dry weight/day
Available slabs	3.640 tons	about 12 tons
Available shavings	1.200 tons	about 4 tons
Available sawdust	3.640 tons	about 12 tons
Minimum total	8.480 tons	about 28 tons

[illegible] the capacity of the particle board plant actually reached [illegible], the daily dry wood requirements are 32 tons to a [illegible] of [illegible] tons per day.

If the total recovery of all the wastes enumerated should be [illegible], only a low volume of round wood has to be supplied [illegible] the Combinat if the plant capacity should remain about [illegible] year.

2.3.2 <u>Recovery of sawmill and joinery wastes</u>

I established with pleasure that a main part of the sawmill slabs is already recovered for particle board manufacture.

I wonder why no steps have been taken in order to recover all the highly suitable shavings and sawdust.

In my FAO report of 1972 (page 66), and during my two-day visit in 1972, I suggested to send to Belgium about 200 kg of shavings and sawdust to make laboratory board samples and to prove their suitability to produce a high quality board which presents fine surface layers and offers a good suitability for economic laminating. This suggestion has unfortunately not been accepted and implemented. The sawdust and shavings available are an excellent material for surface layer preparation and present the following advantages:

a) the absence of all kind of bark pieces enabling a light brown and homogeneous aspect of the surface layers of the board to be obtained;

b) no need for flaking and consequently:
   - no use of knives;
   - no need for knife-grinding;
   - no consumption of electric power for flaking;
   - no labour requirement for loading and unloading because transport is done pneumatically.

2.3.3 <u>Competition between pulp and paper industry and particle board plants for raw materials</u>

Already in November 1970, Mr. A.P. Thomson noted in his FAO project working paper:

a) the lack of cooperation between the Yugoslav pulp and paper industry and the other wood-using industries. Both industries are completely autonomous.

c) the many problems of the Yugoslav pulp and paper industry:

- the bad location of some mills with respect to the raw material sources;
- the chronic shortage of softwoods.

The Ivangrad pulp and paper mill uses both coniferous and deciduous (hard) woods and has difficulties getting sufficient supplies.

Experience shows that due to the lack of cooperation between the [illegible] industries and the shortage of raw materials for pulp and paper [illegible] prices (particularly for coniferous wood) are high:

- coniferous wood: about 300 ND/stère
- beech roundwood: about 210 ND/stère.

[illegible] during my stay in both factories (Mojkovac and Pljevlja) [illegible] authorities now intervene more and more often to [illegible] sufficient supply of raw materials to the pulp and paper [illegible] Ivangrad and that no big capacity particle board plants would [illegible] the near future in Montenegro.

Although feasibility studies for new particle board plants show them to be economically sound, the installation of new big plants will [illegible] to the detriment of the pulp and paper industry. This is certainly one of the main reasons why the Velimir Jakič enterprise already could not get full approval on its project to build a new particle plant.

Anyway, even if this approval is obtained, before the new plant [illegible] start production, a minimum of three years will pass and the [illegible] particle plant has to produce boards of good quality using a high amount of the available wastes that have been recovered.

2.3.4 Production, consumption figures and prices

1) Production figures in 1974

January	1.248 m^3	finished boards
February	991 m^3	finished boards
March	827 m^3	finished boards
April	1.020 m^3	finished boards
May	1.214 m^3	finished boards
June	998 m^3	finished boards
TOTAL	6.298 m^3	finished boards

2) Glue consumption

During the first 6 months of 1974 it reached 576.100 kg. This represents an average liquid glue consumption of 91.47 kg/m^3 finished boards or about 62.5 kg solid glue per m^3 finished boards.

3) Classification of finished boards during the first 6 months of 1974

a) extra quality	4.400 m^3	69.8 %
b) class No. I	1.333 m^3	21.2 %
c) class No. II	439 m^3	7.0 %
d) defective boards	126 m^3	2.0 %
TOTAL	6.298 m^3	100.0 %

4) Type of boards produced

10 mm thickness	903 m^3	14.3 %
16 mm thickness	904 m^3	14.7 %
19 mm thickness	4.365 m^3	69.0 %
defective boards	126 m^3	2.0 %
TOTAL	6.298 m^3	100.0 %

[illegible] prices

[illegible] (free factory)

coniferous roundwood: 300 ND/stère
(about 280 to 300 kg dry wood/stère);
- beech roundwood: 210 ND/stère
(about 350 kg dry wood/stère);
- poplar and birch roundwood available in small
quantities, same prices as beech roundwood;
[illegible]s from own sawmill: 70 ND/stère
(about 250 to 260 kg dry wood per stère);
- shavings and sawdust from own units are
supplied free of charge.

[illegible] Electric power: 0.20 ND/kWh

[illegible] Glue prices: (liquid glue at about 68.5 to 69% solid content) free factory 4.55 ND/kg

[illegible] Labour: (total man-hour cost)

1 man-hour: about 20 ND/hour

[illegible]) Coal:

- price of coal: 150 ND/ton
- transport cost: 20 ND/ton
TOTAL 170 ND/ton

Calorific value about 3.000 Kcal/kg coal

[illegible] prices (per m^3 finished board):

[illegible]	19 mm	16 mm	13 mm	10 mm
Extra	1.794 ND	1.973 ND	2.171 ND	2.332 ND
Class No. I	1.697	1.867	2.053	2.207
[illegible] No. II	1.049	1.111	1.214	1.366
[illegible] boards	621	621	621	621

6) Plant efficiency

Labour requirements: 21.10 man-hours per m^3 of finished boards

2.3.5 Lack of technical knowledge, process and laboratory controls

I have been depressed to learn that process and laboratory controls are no longer carried out. It also struck me that the staff of the particle board plant were not really interested to improve the operation of the plant and the quality of the products.

2.4 Technical and Technological Findings

2.4.1 State of existing equipment and technical deficiencies

2.4.1.1 Chipping and flaking equipment installed near the sawmill (Pallmann hogger and PZ 12/36). The whole equipment is old-fashioned, worn out and has to be replaced urgently by new modern equipment.

2.4.1.2 Equipment installed in the particle board plant for preparation of:

a) Surface and core layer line:

- The cutter heads of both the Hombak PFZ 28 flakers are completely worn out and need an urgent overhaul.
- Due to the elimination of the worn out PZ 12/36 machine (see para. 2.4.1.1) flaking is sometimes only done by the two PFZ 28 flakers. To ensure plant capacity the speed of these two Hombak flakers is regulated in such a way that they produce bad flakes at an abnormal high capacity. The advancing speed of the wood against the cutterhead is so high that the cutterhead is warmed up considerably by the high friction of wood against it.

Important advice: The relation between the speed of the wood advancing and knife outset must be respected and never overlooked.

- In the technological flow of both preparation lines, a dosing equipment between each flaker and drier inlet (to feed regularly and continuously the drier) is missing. During each stop of the flaker, for instance for a knife-change, the drier empties and its temperature rises very much so that the first flakes introduced on starting up again become too dry.

  There is an urgent need to install a variator on each drier to adapt the bundle rotation speed to the flakes' moisture content requirements. An automatic steam inlet regulating valve is also indispensable to adapt the drier temperature.
- No dedusting nor classification system for flakes has been foreseen in the surface layer line.
- The Condux mill is not a suitable one to produce homogeneous fine surface layer material and particularly out of very coarse Hombak flakes presenting a high percentage of coarse splitters.

b) Combined preparation line:

- Same remarks for the Condux mill as above.
- The Schilde drier has a two speed motor drive and should be replaced by a variator.
- No granulometric classification or dedusting is done.
- The double stage Keller pneumatic selector is not adjusted properly since all splitters and heavy coarse flakes are exhausted instead of being evacuated underneath the selector.

<u>General remark on both preparation departments:</u>

- Too many pneumatic converyors are installed.

  They require a high electric power consumption, high maintenance costs and time and create air pollution.

c) Gluing equipment:

- The glue kitchen is not automatic. Ingredients, glue and water are checked by weight on a scale. Hardener solution is added by hand.
- The glue blenders are old-type Drais blenders and glue distribution is done by nozzles and compressed air.
- The glue dosing is done by an old gear pump which has to be replaced urgently since the amount of glue dosed by the pump is greatly influenced by the level of glue prepared in the glue container.
- The valves of the prepared glue conveying pipes are not always tight and it happens that, during a breakdown in the press plant and a periodic stop of the blender, glue flows continuously in the blender.
- In the two bunkers for dry flakes, the conveying systems for wooden slabs sometimes cause production stops and losses. They should be replaced by belts.

d) Scraper conveyors:

- These scraper conveyors have to be replaced urgently by special screws with reversible throws: many stops and high production losses are caused by regular breakdowns of chains and scrapers, the distribution of glue coated particles over the whole width of each mat forming station is very irregular and this leads to irregular mat forming and irregular board weight and thicknesses.

e) Mat forming:

- The old MAK mat forming stations do not allow a regular mat forming process.
- Some improvements can be introduced, for example, to replace the wooden slat conveyors by belts, as well as, to eliminate the horizontal wooden slat conveyor.

f) Forming line and press plant

- Press operation is done by hand. Every human influence on press cycles must be eliminated and automatic control equipment must be installed. During several days I have found large differences in the press cycle applied by the various press operators. Because of the manual system no exact press diagram can be obtained on a continuous basis.
- The press loading and unloading speed is too slow (cm/min.). A two speed motor should be installed to gain time and to avoid water evaporation and prepolymerization of the glue coated surface layers during press loading.
- Hydraulic system urgently needs:
  - the replacement of some leaky valves;
  - the installation of a second high pressure pump;
  - the obtainment of original spare parts (Ureca, Dieffenbacher, etc.).
- Press temperature: There is an urgent need to install a temperature regulating valve for the press temperature. All boards are actually made at about 175°C. The temperature cannot be regulated (nor checked exactly) according to the technological requirements (see technological deficiencies).

g) Trimming saw: Trimming wastes are taken off by hand and thrown aside. These wastes could be recovered in the core layer line (see Chapter IV: Recommendations).

h) Finishing line: No special deficiencies or remarks

i) Spare parts: Original spare parts for hydraulic, electric and several other equipments are not available and cause many production losses.

2.4.2 Technological deficiencies

2.4.2.1 Preparation of flakes

a) Surface layer flakes produced by Hombak are:
  - too coarse and contain a high percentage of splitters
  - not properly refined to get a homogeneous and fine surface

b) Core layer flakes produced by Hombak o PZ:
  - are also too coarse and contain hea · splitters
  - are not refined

Conclusion:

Both layer flakes are too coarse and unsuitable to produce a good quality board. This is due to:

- the worn Homback cutterheads;
- the fact that the slabs and sawmill wastes are sometimes too dry after a long storage period in the wood yards;
- the fact that the stroke of the PRZ is sometimes much too short, meaning that wood is fed too fast into the cutterhead. This leads to high friction of wood against cutterhead and to the production of very coarse and irregularly shaped flakes.

The enterprise's staff should decide urgently to overhaul the Homback cutterheads.

c) Flakes produced in the combined preparation line:
  - after inspection of the state of the hogger and particularly the PZ 12/36 mill, I found out that both equipment is worn out and I suggest that this equipment should be replaced by new equipment;
  - during my stay shavings have been fed to this line. The surface layer material produced was markedly better and allowed to produce a much better board surface;
  - I wonder why no shavings and sawdust have been treated in this line since this had been suggested orally and mentioned in my FAO report on my visit to this enterprise in September 1972 (page 64, para. 4.1.1).

[illegible] Drying of flakes

As already mentioned the drier bundle speed cannot be adapted to the technological moisture content requirements. The moisture content of flakes is irregular, sometimes too high or too low. During my stay surface layer material was too dry.

- The moisture content is never controlled. The Sack moisture content meter is out of service and has to be repaired urgently.

[illegible] Dosing, glue consumption and adhesive formulations

- The old gear pump dosing rate is not exact and is influenced by the glue level in the container for prepared glue.
- The ratio wood to prepared glue is constant but the amount of glue with respect to amount of wood cannot be changed. A piston or membrane pump with an adaptable stroke should be installed urgently.
- The old type glue blenders present several technical and technological disadvantages:
  a) the numerous nozzles on each blender require constant control and regular cleaning;
  b) Cool compressed air in sufficient amount and at the required pressure (min. 1.5 to 2 kg/cm^2) must always be available and this involves high electric power consumption, all day round;
  c) The maintenance costs for compressor and the cost to replace the nozzles are high;
  d) High loss of time for cleaning the blenders at least once a week. Statistics show that in such plants a minimum of 16 man-hours a week are required for cleaning each blender of this type;

e) The high friction in the blender creates high temperatures and involves warming-up of the particles. This leads to prepolymerization of the glue on the coated particles and an acceleration of the water absorption into the particles. This phenomenon results in an important decrease of the properties of the boards.

- The glue consumption cannot be checked nor be adapted according production requirements.
- The glue preparation formulations.

  I have been surprised that no exact glue formulations are established.

  It is very surprising to learn the opinion of different operators at the gluing station and I am convinced that every operator makes his own formulation. According to these operators, the glue concentration (amount of water added) is adapted according to several circumstances, for example, climatic conditions, moisture content of wood, subjective influences, etc.

  It is quite normal that in such circumstences no good quality boards are made, the more so as no moisture content control whatsoever is done, neither before nor after gluing.
- The average glue consumption figures (91.47 kg/m^3 of finished boards) over a period of the six last months seems to be normal.
- The following theoretical glue consumption rates have been given by the technologist during the start-up of the plant in 1961 and are still applied:

  for the surfaoc layers: 11.5 to 12.5% solid glue to dry wood

  for the core: 6.5 to 7.5% solid glue to dry wood
- Glue concentration prepared on 16 July 1974:

	Surface layers	Core layers
Summer	46 to 48%	51 to 53%
Winter	48 to 50%	53 to 55%

Recommendations for improving of adhesive formulation, hardener solution and glue consumption rates are given in this report (see para. 4.3 and Appendix I).

2.4.2.4 Press plant

Several technological deficiencies are noticed.

1) The press temperature applied (about 175°C) is much too high.

2) The temperature of the cauls of the forming line is also very high.

3) The press loading speed is very low (6m/minute).

4) There is no automatic operation of the press and consequently no automatic pressing diagram.

Conclusion:

1) The three first deficiencies risk to cause high degradation of the surface quality.

2) The last deficiency leads to irregular and non-constant pressing cycles and pressing diagrams and sometimes to production losses when the operator is not giving permanently his full attention to his work.

Observation and capacity calculation:

- During my stay in this particle board unit 19 mm boards were produced in a total cycle varying from 9'20" to to 10'30".
- By an average total pressing cycle of 10 minutes the theoretical daily production is 64 m^3 in 22 effective working hours per day.
- By an average total pressing of 9'30" the theoretical daily production is 67.70 m^3 in 22 effective working hours per day.

2.4.2.5 Process and laboratory controls

1) No process and laboratory controls are actually done.

2) It is really not understandable that in enterprises like Velimir Jakić (having an extremely well equipped laboratory) no laboratory programme is established. Indeed, all the equipment required including a laboratory press and a modern Wolpert testing equipment is available in a 20 x 15 m beautiful and well organized laboratory building.

3) The enterprise staff should decide urgently that laboratory controls should be made on a continuous basis and that all results should be examined and discussed by the responsible plant staff.

Quality can only be guaranteed when quality controls are made.

Remark:

Former laboratory controls and reports (from 1963) show that in former days good quality boards have been made in the Velimir Jakić plant. Mechanical properties were quite good. Physical properties however have always been low.

2.4.3 Quality of boards

Reference is made to the para. 2.4.2.1 concerning the quality of flakes.

Observations on board quality:

a) The surface layers are coarse not homogeneous and not closed enough for economic coating with melamine paper.

b) The core layer is porous and this results in:
- a high compression rate during and after lamination;
- a high swelling rate during exposure of the boards to influences of the weather.

c) The ability to treat the edges of the board is low.

d) Mechanical and physical properties are never checked in the laboratory of the enterprise.

e) The weight of the boards is very irregular and varies from 92 up to 102 kg for a 19 mm untrimmed board (630 to 710 kg/m^3).

... of specific weight within each board is very ..., due to deficiencies in the mat forming equipment. ... manufactured are suitable for wood veneering. ... of the boards manufactured could be suitable for ... melamine papers.

... tivity

... yearly production capacity attained, calculated over ..., ... m³ per month (or around ...,000 m³ per year), ... of about 40 m³ per day.

... calculations based on my own observations ... the ... show that the actual production capacity ... effective working hours.

... productivity is very low.

... of ...% of production time is lost due to ...

... breakdowns (hydraulic, electric, mechanic, etc.);

... maintenances and repairs (chains, ..., ..., conveyors, etc.);

electric power failures;

shortage of prepared material or other raw materials,

... the enterprise, etc.

... of particle board

The laminating unit is well-equipped and a suitable plant for quality laminating. Its theoretical maximum yearly capacity is ... m² of boards.

... the particle board manufactured in Pljevlja is not suitable for economic laminating due to its bad surface and very coarse core. Only, after a severe control and grading can a small part of the boards manufactured be coated with melamine papers. The actual yearly production is 200,000 m². Due to lack of better boards the production cannot be increased.

b) In order to obtain an acceptable finished board, three melamine impregnated papers (two underlays and one decor) are required. In normal laminating plants only two papers are used.

c) The compression of boards during and after laminating is high due to the very coarse core layer.

d) And, last but not least, notwithstanding the use of three papers and the high specific weight, the finished boards are low quality boards and are sold at lower prices than usual in other well organised Yugoslav laminating plants.

Conclusion:

It is evident that in these circumstances the economic efficiency of this unit is negative.

- A feasibility study made in the enterprise shows that actual break-even point is at a production of 120.000 m² of boards.
- If good quality boards could be manufactured the break even point is 200.000 m² per year.
- There is no doubt that priority must be given to produce suitable particle boards in order to improve very urgently the economic efficiency of this unit.
- A suitable particle board for laminating presents following properties:

  a) a smooth, homogeneous and fine surface;
  b) a compact core and a good internal bond and good edgability;
  c) a low moisture content (6 to 8%);
  d) a specific weight of minimum 725 kg/m³;
  e) regular thicknesses (maximum 0.2 mm deviation).

Remark:

In contrast to the particle board prices, the selling prices of melamine coated boards in Yugoslavia are free and price-fixing is done according quality.

III. [illegible]

1) The [illegible] own sawmill and joinery wastes are already partially recovered in the particle board production. A large amount of sawdust, off-cuts or other wastes are still burned or dumped.

Priority must be given to a recovery programme of all kinds of the enterprise's own wood wastes.

2) In para. 2.3.1, the calculation of the amount of own wood wastes is made and forecasts for 19[illegible] show that about 28 tons per day of oven dry wood wastes will be available. Since these coniferous wood wastes are all suitable for surface layer preparation, this amount could cover the surface layer requirements of a 100 m^3/day capacity plant.

3) The state of some existing equipment is alarming, particularly the flaking equipment. Several other main deficiencies have been noticed in the technical and technological flow of the plant (see para. 2.4.1 and para. 2.4.2).

In order to improve the quality of finished board and to increase actual plant capacity, these deficiencies must be remedied urgently.

4) The flakes actually produced are very coarse, very heterogeneous and contain a very high percentage of very coarse splitter.

5) Actual board quality is low. Boards manufactured are mainly unsuitable for economic melamine coating. Boards manufactured are only suitable for wood veneering if accurately sanded.

In actual circumstances (bad quality flakes, alarming state of some equipment and other technological deficiencies) it is quite impossible to produce good quality boards:

a) with fine surface and core;
b) with properties corresponding to DIN standards;
c) suitable for economic coating with only two melamine papers.

6) It is not understandable that since several months, process and laboratory controls have been discontinued, the more so as an extremely well-equipped laboratory is available in this enterprise (para. 2.4.2.5).

7) Both units (particle board and laminating unit) are not in a healthy economic state although a large amount of suitable and less expensive raw materials owned by the Combinat is available.

8) Plant productivity and efficiency is low due to the enormous production losses. The average daily production attained is only 40 tons of finished boards while the press plant runs at a practical capacity rhythm of 68 m^3 of finished boards during 22 effective working hours per day. A priority programme should be scheduled by the responsible staff of the particle board department, to eliminate the majority of these high production losses (para. 2.4.4).

9) In order to improve considerably board quality, to increase the yearly board production and to recover all kinds of wood wastes available, an urgent programme must be drawn up by the enterprise's staff. It should cover:

- the repair or replacement of some existing equipment;
- the acquisition of some new equipment;
- the establishment of process and laboratory controls;
- a full and close cooperation between the different services of the enterprise.

10) Technological improvements were made during my stay in the Velimir Jakić particle board plant. New adhesive formulations and instructions for controls and pressing diagram have been given to the technical and responsible staff. (See Annex I of this report)

11) Practical information and advices have been given:

- to repair and replace some equipment;
- to improve plant capacity and board quality;
- to recoverfully the enterprise's own wastes.

(See Chapter IV: Recommendations)

[illegible]

a No matter whether it will be decided or not to install a new [illegible] board plant in the Velimir Jakić enterprise, the existing plant must continue to produce during at least the next several [illegible].

[illegible] object should be pursued to reach, in two steps, [illegible] at the already reconstructed particle board plant:

[illegible] increase of [illegible] and efficiency

[illegible] improvement of the actual board quality to [illegible] as possible the economic efficiency of the [illegible] and also the economic efficiency of the [illegible] unit.

[illegible] and efficiency will be increased by full recovery [illegible] and by a higher average daily production of [illegible] quality boards.

[illegible] This main objective can only be reached in the middle/long term provided that:

all enterprise staff members and foremen ensure a close technical and organisational cooperation;

immediate steps are taken to purchase some indispensable new equipment.

[illegible] improvement of the Plant's Productivity and Efficiency

4.2.1 Short term programme

4.2.1.1 Objective of short term programme

a) Increase of average daily capacity from 40 to 60 m³ by means of elimination of different causes of stoppages, breakdowns, losses of production time, etc.

b) Improvement of quality of flakes:
- repair some equipment
- replacement of others

c) Improvement of board quality

d) Recovery of all available shavings and sawdust.

4.2.1.2 Proposal for technical improvement

See flowsheet on page 40.

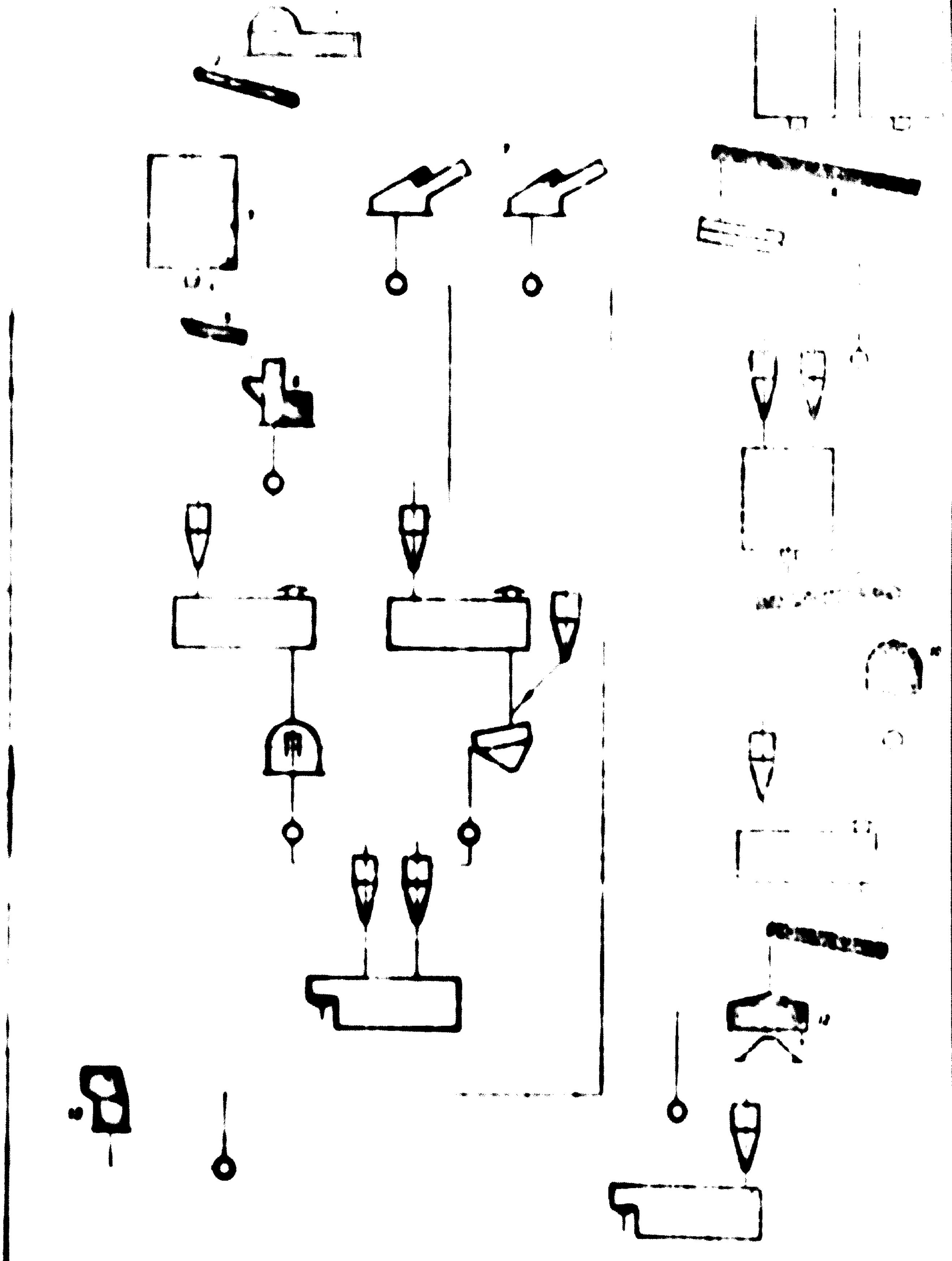
4.2.1.3 Recommendations for short term programme

a) Repair of existing equipment:

- Bamboo cutter heads;
- Driers:
  i) install variator to adapt bundle speed to moisture content requirements;
  ii) install thermometer, thermostat and hot water regulating valve to keep drier temperature within the given limits.
- Dry bunkers:
  i) replace the wooden slat conveyors by belts;
  ii) eliminate electromagnetic coupling and install variator on elevating conveyor.
- Gluing station:
  i) replace old gear pump by plunger or membrane pump with adjustable stroke;
  ii) install an electromagnetic valve between pump and nozzles in order to avoid that glue flows in the blender during production stops.
- Scraper conveyors:
  i) replace the scraper conveyors by special screws with reversible thread (they can be constructed locally).
- Mat forming:
  i) replace the final wooden slats conveyors by belt conveyors;
  ii) eliminate the horizontal wooden slat conveyor in the bunker storage room.

PROPOSAL FOR TECHNICAL IMPROVEMENT ...

... TERM PROGRAM



VELIMIR JAKIĆ

- **Press plant:**
  - i) install a temperature regulating valve with thermostat in order to guarantee the required press temperature;
  - ii) install a big round thermometer on one of the hot platens in order to check press temperature;
  - iii) increase the press loading speed from 6 m/minute to 10 m/minute to decrease long press loading time.

b) **Purchase of new equipment:**

- **Original spare parts:**
  - i) driers : couplings;
  - ii) press and hydraulic circuits : valves, couplings, joints, etc.;
  - iii) electric : special contactors;
  - iv) automatic press command desk with control equipment for automatic pressing diagram;
  - v) new spare motors (this matter has been discussed with Mr. Babić S.)
  - vi) new equipment according to the flowsheet on page 30 and list in next paragraph.

c) Re-introduction of process and laboratory controls.

d) Application of adhesives formulations given in Appendix 1.

[illegible] <u>List of recommended new equipment</u> (short term programme) <u>and estimated prices</u>

[illegible]		IMPORTED PRICE IN DM		SUPPLIED LOCALLY PRICE IN ND
Item 1: 1 hopper	about	80.000.-		-
Item 2: 1 elevating belt conveyor		-	max.	80.000.-
Item 3: 1 silo		-		60.000.-
Item 4: 1 silo extraction device		40.000.-		-
Item 5: 1 vibrating feed chute		10.000.-		-
Item 6: 1 knife ring flaker		80.000.-		-
Item 7: [illegible] flaker cutter heads (repair and knife holders)		30.000.-		-
Item 8: 1 screw conveyor		-		60.000.-
Item 9: 1 screw conveyor		-		50.000.-
Item 10: 1 refining mill		50.000.-		-
Item 11: 1 screw conveyor		-		50.000.-
Item 12: dedusting screen		30.000.-		-
Item 13: 1 mill for recovery of trimming wastes		20.000.-		-
Item 14: 1 press command desk		30.000.-		-
Item 15: spare parts		20.000.-		-
Item 16: [illegible] screw conveyors (mat forming)		-		100.000.-
		max. DM 390.000.-		max. ND 400.000.-

<u>Remark</u>: 1) The prices given are estimated prices.

2) Type of machines are not mentioned in order not to favour some equipment construction firms.

4.2.1.5 Conclusion on available raw materials and capacity of existing equipment

a) Raw material requirements:

<u>Surface layer</u>:

The amount of shavings and sawdust available in 1975 will cover the surface layer requirements.

<u>Core layer</u>:

Available slabs (sawmill wastes) are flaked in the PZ-mill (minimum 12 tons/day in dry condition).

Beech roundwood, branches or other inexpensive wood, forest wastes, etc. have to be flaked in a Hombak flaker.

b) Technical and technological requirements:

i) Driers:

- surface layer: no capacity problems;
- core layer: both Ponndorf driers will work at maximum capacity in winter time.

ii) Hydraulic four-daylight press:

- no problems to reach 65 m^3 daily capacity.

iii) Mat forming stations:

- surface layer: no capacity problems;
- core layer: is working at its maximum "optimum capacity".

4.2.1.6 Recovery of trimming wastes

All board trimming wastes are actually dumped (about 1.500 kg/day). After the installation of a special knife grinding mill (item 13 on flowsheet) this amount of board trimming wastes can be ground and directly re-introduced in the core layer preparation line.

This recovery alone, already represents an economy of an amount of prepared material to produce yearly 600 m^3 of finished boards or, calculated very roughly, about ID 180.000.- per annum.

4.2.2 Medium and long term programme

4.2.2.1 Objective of the medium and long term programme

1) Increase of plant capacity to about 80 m^3 per 22 effective working hours per day;

2) Improvement of quality of board surface and core layers;

3) Complete recovery of all enterprise's available wastes (shaving, sawdust, etc.).

4.2.2.2 Proposal for technical improvement

See flowsheet on page 35

4.2.2.3 Recommendations for the medium and long term programme

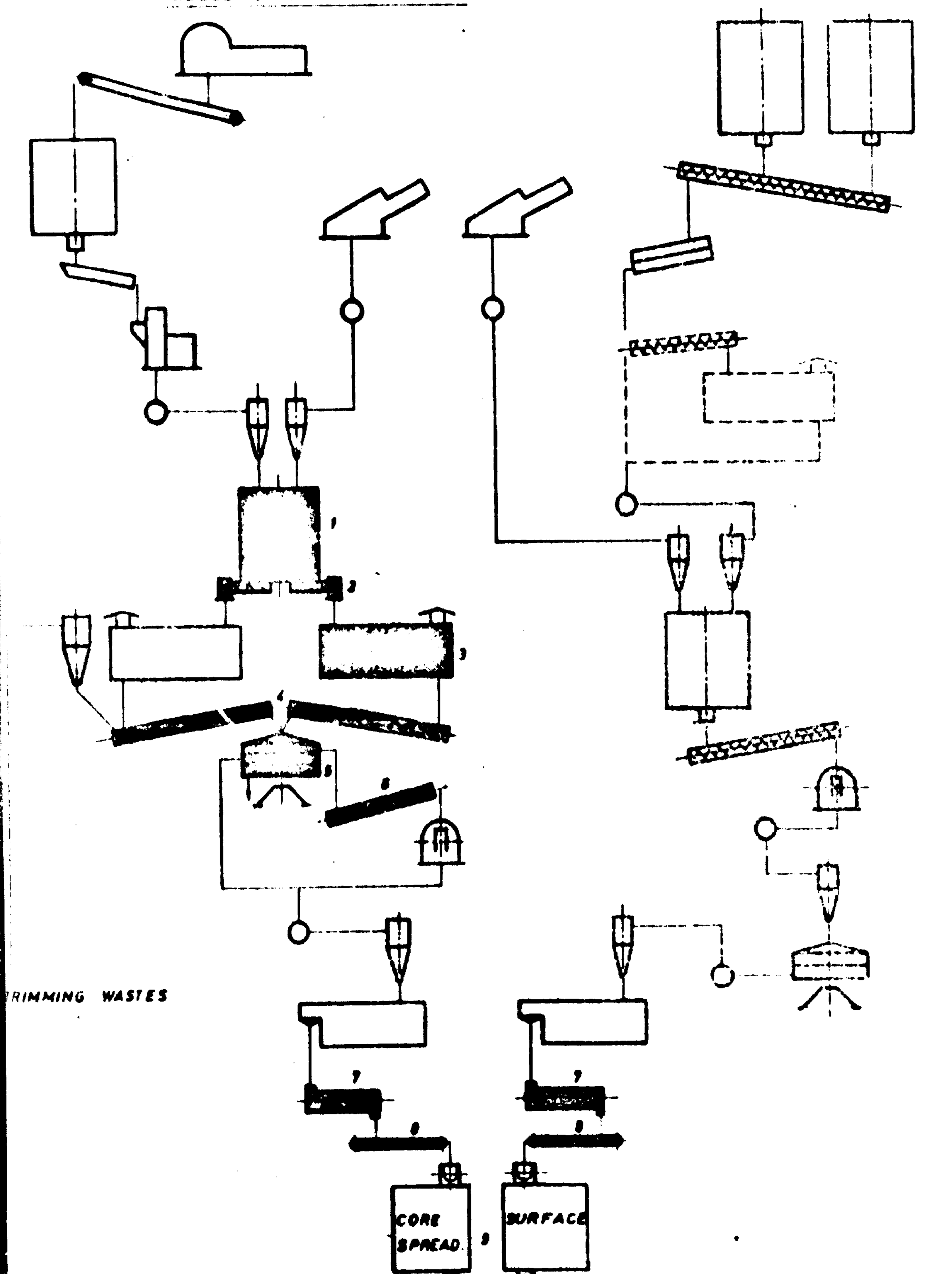
1) Replacement of some existing equipment:
   - the complete gluing station, namely the blenders and glue kitchen;
   - the mat forming station;
   - the small Fonndorf drier to be replaced by a bundle drier of a capacity of about 1,000.000 Kcal/hour.

2) Installation of new equipment: See flowsheet on page 35 and next paragraph with machine list.

4.2.2.4 List of recommended new equipment (medium and long term programme) and estimated prices

LIST OF EQUIPMENT		IMPORTED PRICE IN DM	SUPPLIED LOCALLY PRICE IN ND
Item 1:	1 vertical silo	--	max. 60.000.-
Item 2:	1 silo extraction device	50.000.-	--
Item 3:	1 drier (bundle type)	350.000.-	--
Item 4:	2 screw conveyors	-	100.000.-
Item 5:	1 classification screen	34.000.-	-
Item 6:	1 screw conveyor	-	50.000.-
Item 7a:	complete gluing station (two blenders + glue kitchen)	200.000.-	-
7b:	1 cooling group	-	125.000.-
Item 8:	2 belt conveyors	-	80.000.-
Item 9:	2 mat forming stations	300.000.-	-
Item 10:	spare parts	100.000.-	-
		max. DM 1,034.000.-	max. ND 415.000.-

PROPOSAL FOR TECHNICAL IMPROVEMENT ACCORDING
MIDDLE - LONG TERM PROGRAM



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4.2.3 Eventual long term programme

It is actually quite impossible to make a programme for a third stage or long range programming. Two alternatives remain open:

a) the decision could be taken to install a new plant;

b) the decision could be taken to install a new press line in the existing and reconstructed board plant.

During eventual further visits these alternatives could be discussed.

4.3 Technological Recommendations

Before making technological recommendations a summary of my technological findings is certainly very useful.

a) Deficiencies regarding surface layer quality:

- wood wastes are actually very dry;
- flakes produced are too coarse and thick;
- a sufficient amount of fine material to ensure a fine close surface layer is not available;
- surface layer flakes are too dry (before glue coating);
- the friction in the Drais blender is high. Water is rapidly absorbed by the flakes that are too dry and thick;
- the actual climatic conditions in Pljevlja are "hot and dry";
- the mat forming cycle is long;
- the press loading speed is too slow;
- the press temperature is too high;
- the press closing speed is very slow.

b) Deficiencies regarding core layer quality:

- core layer flakes are too coarse and thick.

Conclusions:

1) It is extremely difficult to elaborate a definitive adhesive formulation which could be applied over a long period of time.

2) Some of those deficiencies can be improved immediately (see short term programme para. 4.2.1.3).

4.3.1 Adhesive formulations

In order to be complete, in Appendix I, three different adhesive formulations are given. They should be applied in accordance with working circumstances.

a) Adhesive formulation No. I

To apply in the actual circumstances as I have found during my stay in July/August 1974.

i.e.: - very dry wood wastes;
- too coarse flakes;
- too low amount of fine material in surface layer;
- too dry flakes before gluing;
- severe climatic conditions;
- low press loading speed;
- too high press temperature;
- slow mat forming cycle.

b) Adhesive formulation No. II

For normal conditions:
- normal wet wood wastes;
- normal quality of flakes;
- moisture content of flakes according to instructions given;
- a press temperature of maximum 150°C;
- an increased press loading speed.

c) Adhesive formulation No. III

For winter time (i.e. wet wood wastes and drying problems).

4.3.2 General technological instructions

The following technological instructions should be pursued:

a) Quality of flakes

- for surface layer: a fine and homogeneous material without coarse and thick flakes;
- for core layer: regular flakes with thickness between 0.3 mm and 0.5 mm.

Remark:

After the overhaul of the Hombak cutterheads, both flakers should work at normal capacity and according the instructions given for knife-setting and stroke.

b) Dedusting

When sawdust and shavings are used in the surface layer, dedusting is recommended (screen 0.25 mm).

c) Moisture content of flakes before gluing

- surface layer 2 to 6%
- core layer 1 to 4%.

d) Moisture content of flakes after gluing

- surface layer 18 to 22%
- core layer 10 to 13%.

Information:

Glue coated surface layer material:

Must be wet after gluing (18 to 22%)

i) To keep enough moisture content in surface layers when press closes. (An amount of water is evaporated during the long mat forming cycle and press loading.)

ii) To get a high densification, i.e. plastification of surface [illegible]

iii) To get close smooth surface.

iv) To get a high thermal conductivity into the core [illegible] pressing.

v) To avoid blowing of fine surface material when press [illegible] ses.

Glue coated core layer material:

Must be dry (10 to max. 11%)

i) To allow short pressing cycles.

ii) To avoid a high water accumulation in the core layer and blistering of boards.

iii) To keep finished board moisture content [illegible] laminating with melamine papers.

e) Glue concentration

Must be adapted to reach the moisture content of glue coated flakes mentioned.
See Appendix 1 - page 41.

f) Glue application figures

- surface layer: 10.5 to 11% solid glue on dry [illegible]
- core layer: 8.5 to 9% solid glue on dry chips weight.

g) Press temperature

- For 16mm and 19mm boards: [illegible]°C to [illegible]°C.
- For 8mm, 12mm and 13mm boards: 175°C to 180°C.

h) Gelation time of prepared glue (at 100°C)

- surface layer: minimum six minutes
- core layer: minimum one and maximum two minutes.

i) pH of the raw boards

Between 5 and 5.5.

[illegible] of hardener solution

[illegible] applied, depends on the pH of the wood and must be adapted to get:

a suitable gelation time (see g) above);
a proper pH of raw boards (see h) above).

Remark: with the type of wood actually available, hot cauls and long pressing cycles, there is no need to use a hardener for the surface layer.

[illegible] pressing diagram

See the examples in Appendix II - page 44.
The influence of pressing diagrams on board properties is very important and has been discussed during my stay in the Velimir Jakić particle board plant.

FINAL CONCLUSIONS AFTER MY STAY IN THE VELIMIR JAKIC PLANT IN [illegible]LJA

1) The enterprise's staff should proceed soon with a complete and efficient internal reorganization of this unit:

a) a psychological reorganization;
b) a technical reorganization;
c) a technological reorganization.

Technical and technological improvements can be made to render this unit economically viable when all services collaborate and assure their help and assistance.

2) Further technical and technological assistance from abroad can only be efficient and useful if the repairs and modifications enumerated in this report are made soon.

APPENDIX 1: ADHESIVE FORMULATIONS

FORMULATION I (See para. 4.3.1 a) - page 37)

	SURFACE		CORE	
	WEIGHT	VOLUME	WEIGHT	VOLUME
liquid glue S : 1.30 kg/dm³ Conc.: about 68.5%	100 kg	77 l	100 kg	77 l
water	65	65	25	25
hardener solution	-	-	5	5
	165 kg	142 l	130 kg	107 l

Glue concentration

- surface 41.5 % solid glue
- core 52.7 % solid glue

Ratio of litre of prepared glue per kg of solid glue

- surface $\frac{142 \text{ l}}{68.5 \text{ kg}} = 2.073$

- core $\frac{107 \text{ l}}{68.5 \text{ kg}} = 1.56$

FORMULATION II (See para. 4.3.1 b) - page 37)

	SURFACE		CORE	
	WEIGHT	VOLUME	WEIGHT	VOLUME
liquid glue S : 1.30 kg/dm³ Conc.: about 68.5%	100 kg	77 l	100 kg	77 l
water	60	60	25	25
hardener solution	-	-	5	5
	160 kg	137 l	130 kg	107 l

Glue concentration

- surface 42.8 % solid glue
- core 52.7 % solid glue

<u>Ratio of litre of prepared glue per kg of solid glue</u>

surface $\frac{137\ l}{68.5\ kg}$ = 2.0

core $\frac{107\ l}{68.5\ kg}$ = 1.56

<u>FORMULATION III</u> (See para. 4.3.1 c) - page 37)

	SURFACE		CORE	
	WEIGHT	VOLUME	WEIGHT	VOLUME
solid glue S : 1.30 kg/dm^3 Conc.: about 68.5%	100 kg	77 l	100 kg	77 l
water	52	52	17	17
hardener solution	-	-	5	5
	152 kg	129 l	122 kg	99 l

<u>Glue concentration</u>

- surface 45 % solid glue
- core 56 % solid glue

<u>Ratio of litre of prepared glue per kg of solid glue</u>

- surface $\frac{129\ l}{68.5\ kg}$ = 1.883
- core $\frac{99\ l}{68.5\ kg}$ = 1.445

<u>HARDENER SOLUTION</u>

Ingredients: 17 kg ammonium chloride powder
83 kg water

Concentration: 17% o. solution weight.

FORMULA TO CALCULATE THE AMOUNT OF LITRES OF PREPARED GLUE PER 5 BATCHES OF THE BUNKER DOSING SCALE

A. dry weight of flakes per batch =

$$\frac{\text{weight of flakes in scale}}{\frac{100 + \text{moisture content}}{100}}$$

B. number of batches (in this example 5)

C. solid glue percentage on dry flakes

D. ratio of volume prepared glue to solid glue weight

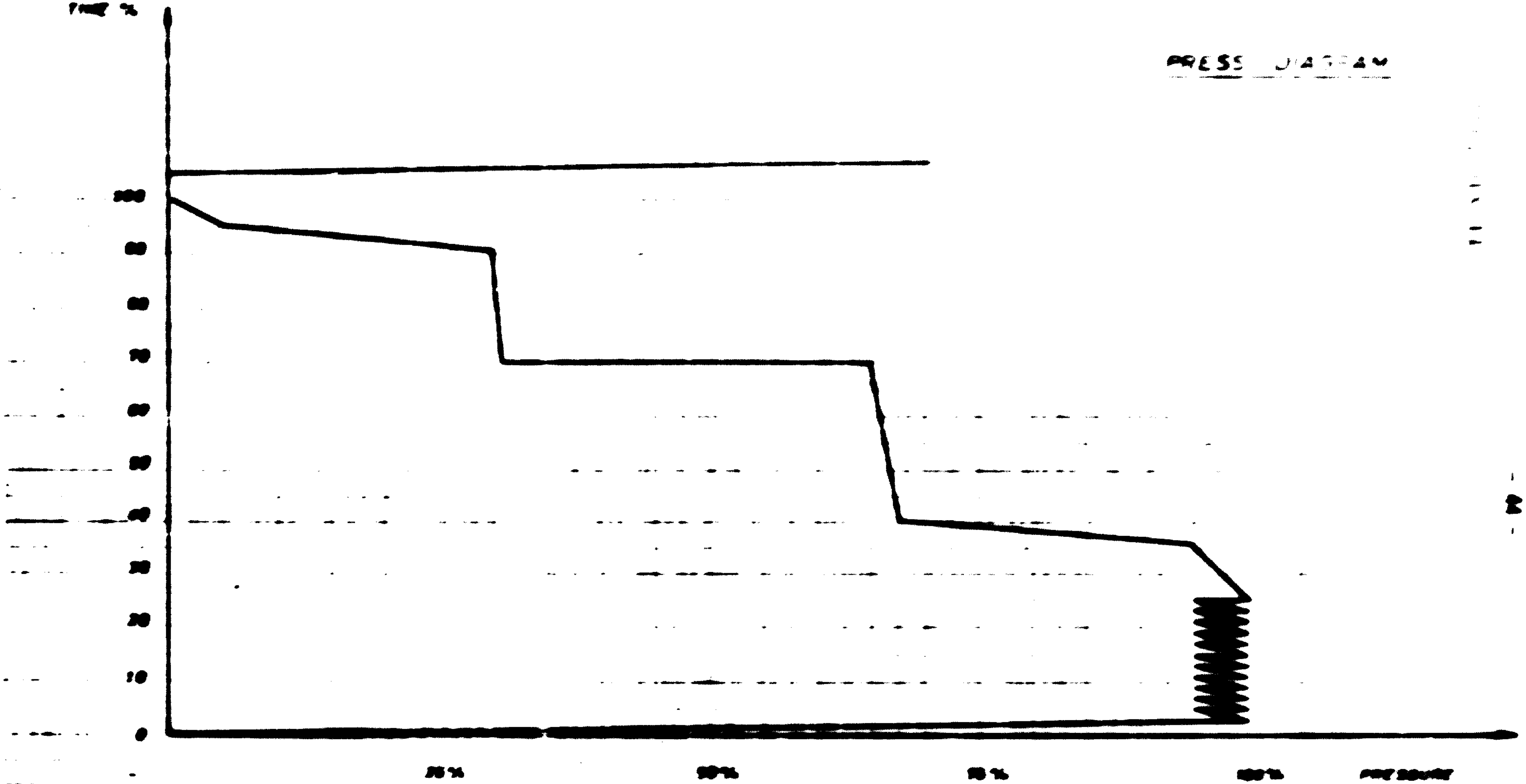
FORMULA: $A \times 5 \times C \times D$

Example

- 5 kg flakes per batch (u = 4%).
- 11 % solid glue on dry flakes.
- ratio = 2 l prepared glue per kg of solid glue

$$\frac{5\ \text{kg}}{1.04} \times 5 \times \frac{11}{100} \times 2.0 = 5.3\ \text{l prepared glue per 5 batches}$$

PRESS DIAGRAM



APPENDIX III: QUALITY CONTROL METHODS

1. LABORATORY CONTROLS ON FLAKES, BOARD AND GLUE

1.1. pH of the flakes

The pH of the chips has to be known regularly to fix and maintain the optimum catalyzing conditions. It can be measured by means of a test paper or a pH-meter.

Working method:

5 g of chips are taken and placed into a cup. Then 50 g of distilled water are added and the particles are left to soak during 10 minutes. From time to time the mixture should be stirred. The water and the particles are then separated by filtration and the pH value is determined.

1.2. pH of the finished boards

The method is the same as that above but 5 g sawdust or sanding dust is used instead of 5 g of flakes.

1.3. Raw liquid

a) Glue viscosity

The glue viscosity is measured by means of the viscosimeter according to the German Industrial Standards (DIN). In any case the temperature of the sample must be recorded.

Working method:

The viscosimeter is filled up until the glue flows over. During this operation, the orifice must be well closed. Then the lid is placed upon the container. Attention must be paid so that no air bubbles remain under the lid. The orifice can now be opened, the glue will not yet flow out the container since the lid prevents it from flowing out. In the moment when the lid is removed a stop-watch is released which is stopped when the outflow is interrupted. By the number of seconds, the viscosity in centipoises can be read from the table on page 37. All apparatus which come into contact with the glue must be carefully and immediately cleaned after having been used. Be careful that the viscosimeter orifice is not damaged. The viscosity of the glue freshly prepared is about 900 to 1100 centipoises at 25°C.

b) Solid content in the glue

Determination of the percentage of dry material contained in the glue. This test is carried out in the drying oven or another drying equipment.

Working method:

2 gr of glue are taken and put into a container made of aluminium foil. This glue is heated during 15 hours at 103°C until a constant weight of the sample is obtained.

Percentage of solid content: $\frac{P\ 2 \times 100}{P\ 1}$

where P 1: initial weight of glue

P 2: dried weight of glue

The solid content must be 68 to 69%.

c) Determination of the specific weight of the glue

This determination gives an approximate idea about the solid content in the glue. This test is much easier and faster than the solid content determination by drying. It should be done after each preparation of liquid glue.

Working method:

About 500 ml of glue are poured into a glass cylinder and the hydrometer apparatus is put into the glue. After complete immobilization of the hydrometer, the direct reading can be made. The temperature of the sample must be recorded. The specific weight should be about 1,255 at 25°C.

Viscosity according to DIN 53.211
In comparison with the Brookfield viscosimeter

Resin temperature: 20°C

The chronometer has to be stopped at the moment of rupture of the liquid flow.

Sec.	Centipoises	Sec.	Cps.	Sec.	Cps.
14	72	68	368	122	698
16	84	70	380	124	712
18	96	72	392	126	726
20	106	74	404	128	740
22	116	76	416	130	752
24	126	78	428	132	764
26	136	80	438	134	776
28	146	82	448	136	790
30	156	84	460	138	804
32	166	86	472	140	818
34	176	88	484	142	832
36	188	90	496	144	846
38	200	92	508	146	860
40	212	94	520	148	874
42	222	96	534	150	888
44	232	98	548	152	902
46	244	100	560	154	916
48	254	102	572	156	930
50	264	104	584	158	944
52	276	106	596	160	958
54	288	108	608	162	972
56	300	110	620	164	986
58	312	112	632	166	1000
60	322	114	646	168	1014
62	332	116	660	170	1028
64	344	118	672		
66	356	120	684		

The viscosimeter has to be cleaned directly after its use. Take care not to damage the outlet of the apparatus.

1.4. Prepared glue

a) Viscosity

See the working method given above for the control of the viscosity. The viscosity should be between 100 and 250 cps.

b) Gelation time

The control itself is done by observing a small quantity of the prepared glue mixture which is set apart in a water bath at 100°C. By this test, it is possible to determine after what time the complete hardening of the glue occurs.

Working method:

The control is done by adding a small quantity of the prepared glue mixture to a glass tube which is plunged immediately in a bath of boiling water. At the same time a stop-watch is started. The glue is continuously stirred with a glass rod. At the moment of gelation, which can be easily observed by the glue sticking to both the rod and the tube, the time is stopped.

2. QUALITY CONTROLS OF THE BOARD

2.1. Density

The density of the board is calculated on the samples used for determination of the bending strength: $D = \frac{W}{V}$

where W = weight of the sample in g

V = volume of the sample

length x width x thickness in cm.

2.2. Thickness

The thickness of the unsanded board is normally checked by the press-operator. Board thickness (at the outlet of the press) is nominal thickness + additional thickness for distance bars (1 or 1,2 mm) with a tolerance of ± 0,3 mm.

2.3. Bending strength (modulus of rupture)

The bending strength is determined on conditioned and sanded boards. The samples are taken from the sanded boards according to the pattern shown on page 41. The bending strength is determined according to DIN 52.362.

Formula:

Bending strength (kg/cm^2) =

$$\frac{3 \times \text{distance between supports (cm)} \times \text{load (kg)}}{2 \times \text{width (cm) of sample} \times (\text{thickness of sample (cm)})^2}$$

2.4. Transverse traction perpendicular to the surface

(Internal bond - tensile strength)

The perpendicular traction is determined on conditioned and sanded boards according to DIN 52.362. The samples are taken from the sanded boards according to the pattern shown on page 41.

Tensile strength (kg/cm^2):

$$\frac{\text{load (kg)}}{\text{sample surface (cm}^2)}$$

2.5. Moisture content

The moisture content is determined on three conditioned and sanded samples of 50 x 50 mm. The samples are weighed and put in a drying oven at 105°C, until a constant weight of the samples is obtained. The moisture content is given by the formula:

$$\text{m.c.} = \frac{\text{initial weight} - \text{final weight}}{\text{final weight}} \times 100$$

2.6. Water swelling

Pressed boards manufactured from particles have a tendency to swell if they are exposed to moist air and when they come in contact with water. The water swelling of boards is determined on conditioned and sanded boards according to DIN 52.364.

Swelling (%):

$$\frac{t_1 - t_0}{t_0} \times 100$$

where t_o is the intitial thickness of the sample;
and t_1 is the thickness of the sample after water immersion.

2.7. Absorption

There are no DIN norms for the absorption test. The weight of the board samples is checked before and after 2 hours and/or 24 hours immersion in water at 20°C.

The percentage absortion =

$$\frac{P_1 - P_o}{P_o} \times 100$$

where P_o is the intitial weight
and P_1 is the weight after water immersion.

2.8. Homogeneity of the board

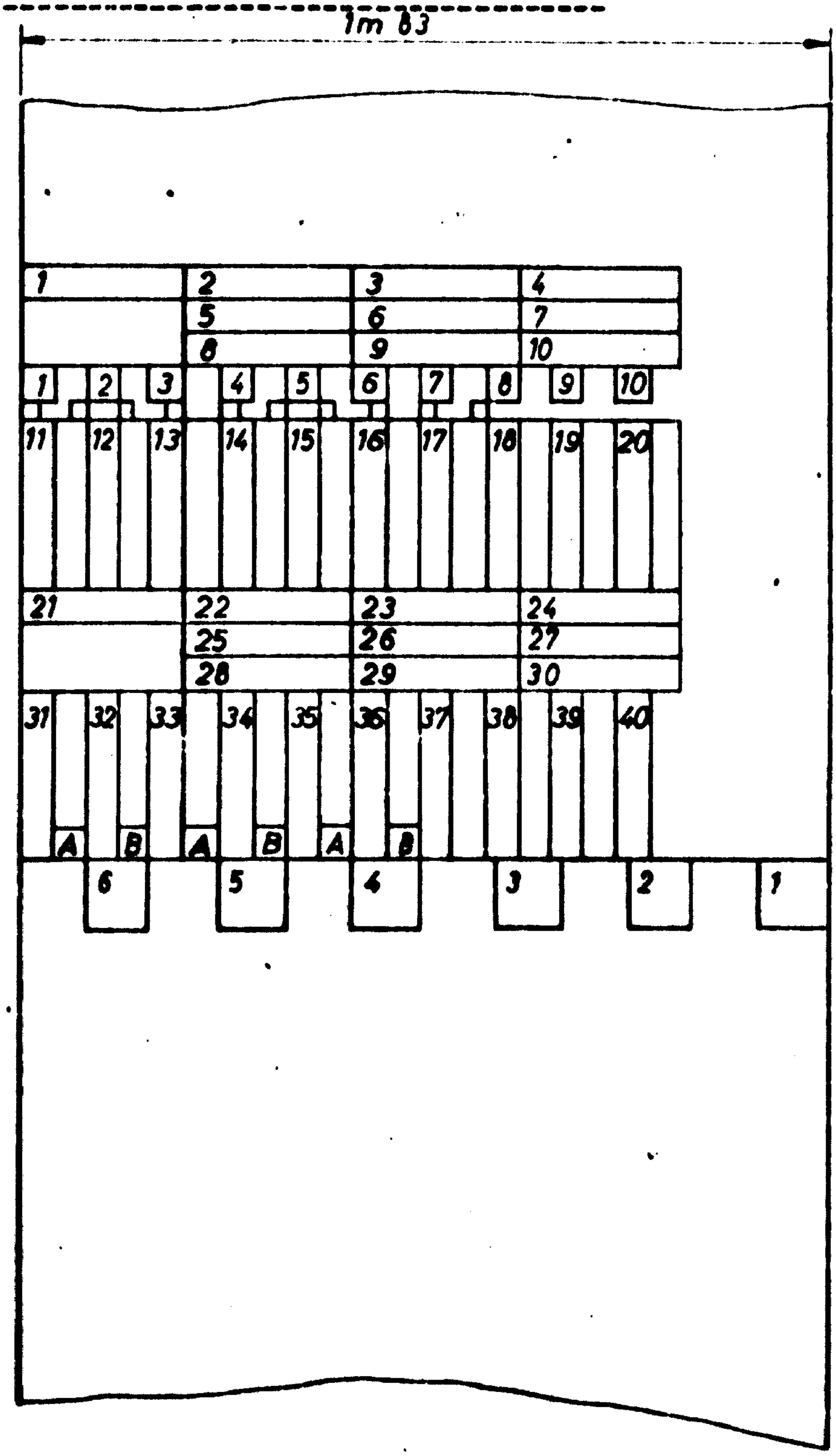
The aim is to control the distribution of materials within the unsanded board. The board is cut into six strips of 1220 x 100 mm in its transverse direction. Each strip is then cut into pieces of 100 x 100 mm and the position of each sample is well marked on the board starting with A1, B1, C1, D1, E1 and F1 from the left side of the board. The samples are then weighed as follows:

- all samples together;
- each sample separately.

First, the average weight of the samples and then the deviation of the weight of each sample in comparison with the average weight of the samples in per cent is determined.

SCHEMA DE PRELEVEMENT DES EPROUVETTES POUR LE CONTROLE STATISTIQUE.

SCHEDULE OF SAMPLING FOR STATISTICAL CONTROL.



A: HUMIDITE / MOISTURE CONTENT.

B: pH

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