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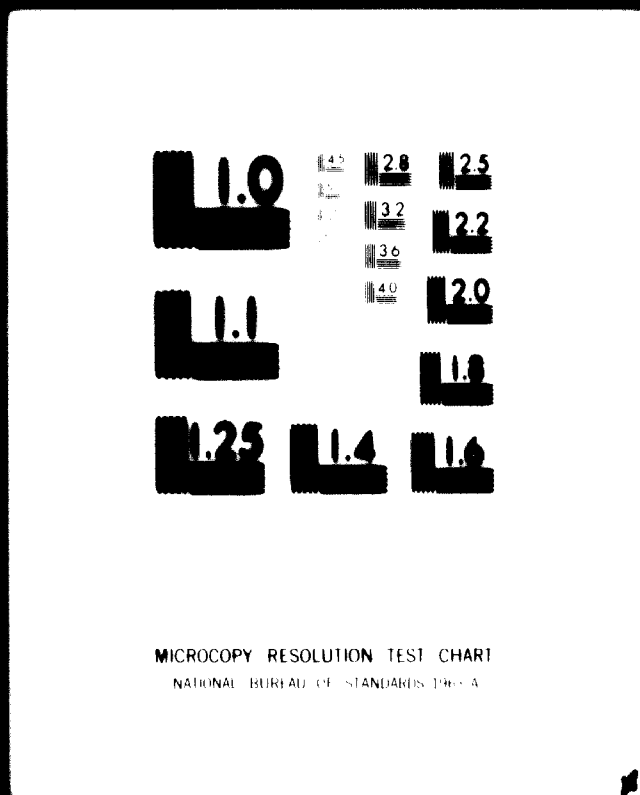
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Development of Forestry and Forest  
Industries in Yugoslavia



MISSION TO YUGOSLAVIA  
(BOSNIA - HERZEGOVINA AND MONTENEGRO)  
ON IMPROVING THE GLUING TECHNOLOGY  
IN THE FURNITURE INDUSTRIES 1/

by

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002589

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Detailed findings and recommendations addressed to the management of the various plants are to be found in Annexes I to XIII.

GENERAL REPORT

The purpose of this mission was to visit a number of furniture, plywood and particle board industries in Bosnia - Herzegovina and Montenegro in order to assess the present situation regarding gluing technology, to discuss immediate problems locally and to advise on improvements.

The mission took place between 1 and 30 November 1971. The undersigned found most valuable help and assistance at all times and he is especially grateful to Messrs. Martinka and Thom of the United Nations Development Programme (UNDP)/ Food and Agriculture Organization of the United Nations (FAO) Special Fund project in Sarajevo, Prof. Skopal of the University of Sarajevo and Ing. Vujisić of Titograd.

The factories visited have been the following:

1. Bosanka Plywood Factory, Blazaj
2. Standard Furniture Factory, Sarajevo
3. Vrbas Wood Industry Combine, Banja Luka
4. Radnik Wood Industry Combine, Bosanska Gradiska
5. Janji - BDI, Donji Vakuf
6. Marko Radovič, Titograd
7. Sik Javorak, Nikšić
8. Polimlje Plywood Factory, Ivangrad
9. Kid Vukman Kruscit, Mojkovac
10. Konjuh Table Factory, Zivinice

It should be mentioned that the planned visit to the table factory "Konjuh" at Zivinice has been cancelled due to bad weather. The problems of this specific firm have been discussed with Prof. Skopal of the University of Sarajevo and suggestions for improvement have been made.

Most of the firms visited have been erected about ten to twenty years ago and have obsolete machinery and equipment. This applies in particular to glue spreading machines and presses which are decisive for the glue economy and for the quality of gluing.

On the glue spreaders, the scored rubber surface of the rollers wears out gradually which consequently leads to asymmetrical and unverifiable glue spreading. The consequence is very often glue penetration and the necessity of prolonging pressing times. Therefore, more attention should be given to the glue spreading machines. The system of exchanging the factories' used rollers for new ones or ones renovated by the suppliers could possibly be adapted in Yugoslavia as is already customary in Germany and Scandinavia.

By acquisitions or renovations of glue spreading machines attention should be given to the hardness of the rubber surface (which should lie between 40 and 60 shores).

Since a long time the USA and recently Central Europe use soft rubbers in glue spreading machines as the softer rubber better adapts to the irregular faults of the veneers, particle boards, among others, and therefore guarantees a more even glue spreading.

The presses in the factories visited are out of date (with the exception of one short-cycle press in the furniture factory Vrbas, Banja Luka). As a rule, they have long press closing times which exclude the use of a quick hardening glue and furthermore could lead to pre-drying or pre-hardening.

This applies in particular to the plywood factories "Bosanka" and "Polimlje" who either have long press closing times or long press loading times. To reach the quickest press loading and closing times, Western countries use pre-pressed plywood. More attention should be paid to this method in Yugoslavia.

German manufacturers of presses report that of the bigger furniture industries nearly all buy short-cycle presses as they improve productivity by shortening press times (to as low as 20 seconds). It is therefore recommended to Yugoslav furniture manufacturers to purchase such presses for veneer gluing.

Other wood-working machines in the factories visited, i.e. veneer peeler, planing, sanding, boring and routing machines are very often in a poor condition. This influences the surfaces of the working pieces to be glued and consequently the consumption of glue as well as the quality of the gluing.

The glues mainly used for manufacturing furniture in Bosnia - Herzegovina and Montenegro are:

Urea formaldehyde (UF)	ca 80 %
Polyvinylacetate (PVAc)	ca 6.5%
Hot melt glue	ca 5.5%
Contact glue	ca 8 % (for upholstered furniture)

In this connexion it should be mentioned that normally UF is extended with wheat flour and water to lower its consumption.

At the factories visited, the extension of UF is undertaken, to a greater or less extent, to reduce the cost of the glue.

This is only admissible if no great demand is put onto the quality of the gluing. The cold water firmness of the glue line is reduced upon excessive extension which tends to increased glue penetration and prolonged pressing times. These negative factors must be controlled as they present an impediment for application of quick pressing cycles and use of thin veneers.

For that reason and for technical reasons the application of china clay as well as of particle board sanding dust should be considered; the more so as the latter is in most factories a waste product. To prevent frequent glue penetration walnut-shell flour can be successfully added. Furthermore, the advantage

of using walnut-shell flour is that the glue mixture is being coloured whereby the quantity of glue supplied is easier to control. Such a colouring of the UF, presently used in none of the firms, can also be carried out with any suitable dyes.

In the firms visited the glue is stored in barrels in the open air. This is economically and technically disadvantageous. First, the handling of the barrels is labour-intensive, uneconomic and therefore expensive, second as urea formaldehyde and phenol formaldehyde change their characteristics at relatively high temperatures (during the summer months), i.e. the viscosity, storing and reacting ability are adversely affected.

It is recommended to store in underground tanks the glue, if possible at 10 to 15°C. The glue then can be delivered in railway tanks or lorries at longer intervals thus reducing cost of transport.

The need for a quicker setting time has been discussed several times. As already mentioned, when using UF, the amount of extender, the glue consumption, the type of glue, the used hardener as well as the temperature influence the setting time.

The most used hardener in the furniture factories is an ammonium chloride solution. A wrong opinion exists that with a variation of the amount of hardener the setting and pressing time could be changed. It is only by a strong reduction of the hardener amount (ammonium chloride or ammonium sulphate) that a noticeable delay of hardening time can be obtained. The risk of insufficient polymerisation of the glue exists which subsequently leads to bad glue lines. An amount of 1 to 2% ammonium chloride (dry) of the UF (dry) should be considered optimum.

A quicker setting time of UF at temperatures under 100°C can be reached if free acids (i.e. formic acid, citric and phosphoric acid) are used as a hardener. However, the pot life of such mixed glue is short—in these cases a separate glue and hardener mix should be kept and combined only in small quantities when actually needed.

For example, with a hardening mixture of ammonium chloride and potassium aluminium sulphate (alum) a quicker hardening mixing glue with a sufficient pot life (one to three hours) can be produced when hardener is added to the resin solution.

The producers of UF should be asked by the consumers to offer them a wider assortment of glues and hardeners.

At present, the furniture manufacturers receive mostly UF which is suitable for manufacturing particle board but less suitable for veneering because of its heavy viscosity. Yugoslav manufacturers should strive to supply a greater variety of other types of glue, as for example phenol formaldehyde (for the particle board industry), hot melt glue and polyvinylacetate.

Usually, the glue technology sections of wood research institutes have the task of giving advice to the consumers on choice of glues, their application, and to make suggestions on controls. In Bosnia - Herzegovina, the industry makes no use of this service.

The controls on raw materials, machines and finished products are mostly insufficient.

To use glues at an optimum capacity, not only the glue should be checked but also the materials to be glued and machines used for gluing.



Varieties of moisture content, room temperatures - and with it wood and glue temperatures - thickness of particle board and veneers, tolerance of dowel and dowel holes, and so on, have been identified in the plants visited; affecting the quality of the gluing.

Improvements are necessary in the maintenance of important regulation and control equipment, drying rooms, air conditioning plants, glue rollers, presses and edge veneering machines.

To reach this goal, every factory should entrust one chemist/technician with the responsibility of controlling the various factors enumerated above and of correcting mistakes.

The list attached (Annex XI) to the report on "Keyed gluing rules" should facilitate the controller in identifying gluing defects.

A more detailed control would be of benefit to each factory in form of better quality of the products. Furthermore, it facilitates the introduction of new types of glue and new gluing techniques which have to be introduced on using high-frequency gluing, or in conjunction with new surface materials.

Name of Firm: "BOSANKA" Plywood Factory  
Place: Blazaj  
Productions: 15000 m<sup>3</sup> plywood  
15000 tons hardboard  
Glue Consumptions: 1000 tons per annum, of which 90% phenol-formaldehyde  
and 10% urea formaldehyde with melamine re-inforcement.  
Glue Used: All locally made.

Present Situation:

a). Machinery

1. The major pieces of equipment are 17 years old and have operated practically continuously since they were installed.
2. The veneer peeler produces veneers with too rough a surface leading to an increase in the glue consumption and fluctuations in glue line thickness.
3. The two dryers lack adequate control in so far as they dry the veneers unevenly. Although the aim is to obtain veneers with moisture contents of 5%-10%, it is believed that the actual moisture content range is far greater (from 1%-15%).
4. The glue spreader's rubber rollers are worn.
5. The closing time of the press lasts 2-3 minutes. It should not exceed 2 minutes to minimize pre-drying of the veneers and drying or even polymerization of the glue.
6. The glue store is not adequate as the temperature in summer can attain 35°C. thus causing a reduction in the shelf life and higher viscosity leading to an increase in the need of water in the mixture etc.
7. The laboratory is well equipped.

b). Glue Technology

1. The technician at the plant stated that the properties of the phenolic resin supplied varied considerably.
2. The glue mixing station is good. The glue technology is good and the hardener used is adequate.

c). Qualifications of Staff

No comments.

Recommendations for Improvement

a). Machinery

- Re 1. New equipment should be installed as soon as financing is assured.
- Re 2. The veneer peeler must be replaced as soon as possible.

cont./...

Re 3. The moisture content of the veneer should be checked more frequently. Workers unloading the line should be trained to deal the variations in veneer moisture content and put aside in the mill veneers that are either too damp or too dry. Moisture meter checks should be carried out every 2-3 hours. Veneers that are dryer than 4% should be stored for self (atmospheric) conditioning. Veneers with more than 6% should be re-dried.

Re 4. The glue spreader's rubber rollers must be replaced.

Re 5. The press must be modified to speed up the closing time. The advice of the equipment manufacturer must be sought on how it can best be achieved.

Re 6. The glue store should preferably be situated in a cellar - underground - to minimize temperature variations. The optimum temperature is between 10°C and 15°C. Liquid phenol formaldehyde should be stored in a tank and not in barrels. Purchase by tanker - railway or lorry - should be envisaged to minimize transport costs and cost of return of empty barrels.

b). Glue Technology

Re 1. The specification of the glue purchased must be obtained from the manufacturer. Tests on the PH value, the dry matter content, the curing time, the pot life, must be carried out on each batch upon receipt; and claims placed immediately on any lot that does not meet the specifications.

NAME OF FIRM: "SARAJEVO" Furniture Factory

PLACE: Sarajevo

PRODUCTION: 15000 sets of furniture (both wood and upholstered)  
60% of value of production is upholstered furniture

GLUE CONSUMPTION: 70 tons Urea Formaldehyde  
8 tons Polyvinylacetate (PVAc)  
6 tons Hot melt  
Neoprene for upholstery

GLUES USED: All locally made (Ureaformaldehyde: 40% MOL. OF 100)  
except for hot melt glue which is imported from east Germany (RANICEL 7002).

PRESENT SITUATION:(a) Machinery:

1. The glue spreader is in very bad condition.
2. The rubber rollers on the spreader are too hard, thus not being able to compensate for any irregularities in veneer or panel thickness.
3. The glue store is not adequate as the temperature in summer can attain 35°C thus causing a reduction in the shelf life of the glue and higher viscosity leading to an increase in the need of water in the mixture etc.
4. There is no laboratory to test the glue quality.
5. The press is inadequate.

(b) Glue Technology:

1. Glue bleeding occurs/<sup>due</sup> to uneven thickness of the glue line as a result of the bad state of the glue spreading machine leading to an increase in glue consumption.
2. The glue mixing formula is not good. It contains too much flour and too much water facilitating glue bleeding and slowing the curing time.
3. The pressing cycle for the PVAc used in solid wood furniture - 5 minutes - is too short for the type of glue used and prevailing room temperatures.
4. The gluing of the edge veneers onto particle board is not good.
5. The relative humidity of the wooden dowels used in jointing is the same as that of the wood. It should be lower.

(c) Qualifications of staff

The control of the quality of the glue mixed and the control of its use is not adequate.

RECOMMENDATIONS FOR IMPROVEMENTS

- (a) Machinery:
- Re. No.1 The glue spreader must be completely overhauled as soon as possible.
- Re. No.2 Rubber rollers with softer rollers (40-60 Shore) should be used. The present ones must be changed.
- Re. No.3 The glue store should preferably be situated in a cellar - underground - to minimize temperature variations. The optimum temperature is between 10°C and 15°C. Liquid urea formaldehyde should be stored in a tank and not in barrels. Purchase by tanker - railway or lorry - should be envisaged to minimize transport costs and cost of return of empty barrels.

Re.4 Because of the need to control fluctuations in the quality of the locally manufactured glues a laboratory with the following minimum equipment should be established:

- (a) A thermostat regulated bath with warm water to test the curing time of the glue mixture.
- (b) A viscosity meter (Ford Becher type) to check viscosity.
- (c) A laboratory balance.

Additional equipment for such a laboratory (equipment that is not essential) is:

- (a) PH meter.
- (b) Drying oven to measure glue solid matter in solution supplied.
- (c) Equipment to measure the free formaldehyde content of the glue supplied (by the sulphite method).

(b). Glue Technology

Re. 1 The repair of the glue spreading machine will enable better control of the glue line thickness, thus reducing the quantity of glue presently used from 180 grs/m<sup>2</sup> to as low as about 120 grs/m<sup>2</sup>. If modern equipment is used and the quality of the particle board is very high, glue consumption can be as low as 80 grs/m<sup>2</sup> reducing the pressing cycle's duration.

Re. 2 The percentage of flour extender should be reduced from the present figure to only 5-10 per cent because of the high price of flour in Yugoslavia - prices which are not nearly as high as that of the urea formaldehyde resin. Walnut shell flour should be used. Kaolin and sanding dust of the particle board sander should also be considered. When the flour content is reduced the water content should also be reduced to reach 5 to 15 percent for a mixture of 5 to 10 percent flour, 10 percent walnut shell flour and 2 to 5 percent particle board sander dust. The main advantage of using walnut shell flour is that it improves flow control and reduces bleeding. The addition of walnut shell flour darkens the colour of the glue mix thus facilitating the visual control of glue line thickness. If no walnut shell flour is added it is recommended to add small quantities of a powdered dye to darken the colour of the glue mixture. The effect of extending with flour on glue line on strength properties is shown in the graph below.

Re. 3 The glue quantity plays an important role. For a consumption of 100, 150 and 200 gr/m<sup>2</sup> and a pressing time of ten minutes the glue line strengths obtained are: 45 Kp/cm<sup>2</sup>, 15 Kp/cm<sup>2</sup> and 5 Kp/cm<sup>2</sup> respectively.

The room temperature also affects the glue line strength. For a pressing time of ten minutes and 100 gr/m<sup>2</sup> glue consumption the glue line strength is as follows:

Temperature °C	25°	20°	15°	10°	5°
Glue line strength Kp/cm <sup>2</sup>	57	45	37	27	20

The moisture content of the wood also affects the glue line strength, as follows (for a consumption of 100 gr/m<sup>2</sup> at 20°C and a pressing time of ten minutes):

Moisture content	9%	13%	16%
Glue line strength Kp/cm <sup>2</sup>	48	18	10

It is recommended that under winter conditions the pressing time be increased to a minimum of ten minutes.

Re. 4 The present edge gluing machine has too few rollers and consequently cannot exert the necessary pressure on the wood panel and the veneer long enough. In purchasing a new machine it should be ascertained that it has a longer pressing line.

The temperature of the glue on application must be between 100 and 220°C at the spreader roller. The profile on the steel roller can wear out. It should be checked to ensure that the glue line is sufficiently thick (about grs. 200-300/m<sup>2</sup>).

The pressure rollers should be checked to ensure that the pressure applied is sufficient (about 5 Kp/cm<sup>2</sup>).

The right angle of the edge of the particle board must be accurate. Small inaccuracies lead to a bad bond.

The ambient temperature of the machine's surroundings must be kept high in winter.

The feeding speed should be about 20-30 meters/minute. The glue reservoir must be cleaned with a spatula once a day.

Re. 5 The relative humidity of the wooden dowels should be 4 to 7% lower than that of the wood to be joint.

(c) Qualifications of staff

The firm should employ a chemist/technologist to carry out the routine quality control tests on the glues, paints and varnishes it uses.

Name of Firm:

"VRBAS" Wood Industry Combine

ANNEX III

Place:

Banja Luka

Production:

100,000 pieces of furniture (wood and upholstered).  
60 upholstered.

Glue consumption:

80 tons urea formaldehyde  
10 tons poly methyl acrylate (PVAc)  
15 tons hot melt glue  
Isoprene (for upholstery)

Glue used:

All but hot melt glue locally produced. Hot melt glue imported from West Germany and Italy.

Present Situation:

a). Machinery

1. The rubber rollers of the glue spreading machine are old, hard and worn out.
2. The planned glue store is well designed.
3. The edge gluing machine is not adequate for the job.
4. There is no glue quality control laboratory.

b). Glue Technology

1. The glue mixing formula is not good. It contains too much flour and too much water facilitating glue bleeding and slowing the curing time.
2. The pressing cycle for PVAc used in solid wood furniture is only 3 minutes. It is far too short for the glue type used and prevailing room temperatures.
3. The relative humidity of the wooden dowels used in jointing is the same as that of the wood. It should be lower.
4. No quality control of the glue quality is presently being done.

c). Qualifications of Staff

No comment.

Recommendations for Improvement

a). Machinery

- Re. 1 Rubber rollers with softer rollers (40-60 Shore) should be used. The present ones must be changed.
- Re. 3 The present edge gluing machine has too few rollers and consequently cannot exert the necessary pressure on the wood panel and the veneer long enough. In purchasing a new machine it should be ascertained that it has a longer pressing line.

./...

Re. 4 Because of the need to control fluctuations in the quality of the locally manufactured glue a laboratory with the following minimum equipment should be established:

- (a) A thermostat regulated bath with warm water to test the curing time of the glue mixture.
- (b) A viscosity meter (Ford Becher type) to check viscosity.
- (c) A laboratory balance.

Additional equipment (that is not essential) for such a laboratory is:

- (a) PH meter
- (b) Drying oven to measure glue solid matter in solution supplied.
- (c) Equipment to measure the free formaldehyde content of the glue supplied (by the sulphite method).

b) Glue Technology

Re. 1 The percentage of flour extender should be reduced from the present figure to only 5-10 percent because of the high price of flour in Yugoslavia - prices which are now nearly as high as that of the urea formaldehyde resin. Walnut shell flour should be used. Kaolin and sanding dust of the particle board sanders should also be considered. When the flour content is reduced the water content should also be reduced to reach 5 to 15 percent for a mixture of 5 to 10 percent flour, 10 percent walnut shell flour and 2 to 5 percent particle board sander dust. The main advantage of using walnut shell flour is that it improves flow control and reduces bleeding. The addition of walnut shell flour darkens the colour of the glue mix thus facilitating the visual control of the glue line thickness. If no walnut shell flour is added it is recommended to add small quantities of a powdered dye to darken the colour of the glue mixture. The effect of extending with flour on glue line on strength properties is shown in the graph (see Annex VIII).

Re. 2 The glue quantity plays an important role. For a consumption of 100, 150 and 300 grs/m<sup>2</sup> and a press time of ten minutes the glue line strengths obtained are: 40 Kp/cm<sup>2</sup>, 15 Kp/cm<sup>2</sup> and 5 Kp/cm<sup>2</sup> respectively.

The room temperatures also affect the strength of the bond. For a pressing time of 10 minutes and 100 grs/m<sup>2</sup> glue consumption the glue line strength is as follows:

Temperature °C	25°	20°	15°	10°	5°
Glue line strength Kp/cm <sup>2</sup>	57	48	37	27	20

The moisture content of the wood also affects the glue line strength, as follows (for a consumption of 100 grs/m<sup>2</sup> at 20° and a pressing time of 10 minutes):

Moisture content	9%	13%	16%
Glue line strength Kp/cm <sup>2</sup>	48	18	10

It is recommended that under winter conditions the pressing time be increased to a minimum of 10 minutes.



Re. 3

The relative humidity of the wooden dowels should be about 5% - 7%, i.e. about 4% to 7% lower than the wood to be glued. This enables the wood to absorb moisture more quickly than the glue line and thus build up pressure in the dowel hole and quicken the drying time. The glue must be spread on the sides of the dowel hole, with a spatula or by placing the head of the glue injector at the top of the hole and not at the bottom as at present. The introduction of the dowel pushes the glue down the hole, spreading it along the walls of the hole. The glue also should be spread on the dowel previous to its introduction. The dowel must fit well into the hole. Its diameter should be smaller by 0.1mm. to 0.2mm. If softwood or particle board is assembled and the moisture content of the dowel is the same, the diameter may be 0.2mm. bigger than that of the hole.

Re. 4

The specification of the glue purchased must be obtained from the manufacturer. Tests on the Ph value, the dry matter content, the curing time, the pot life, must be carried out on each batch upon receipt; and orders placed immediately on any lot that does not meet the specification.

Name of Firm: "RADNIK" Wood Industry Combine

Place: Bosanska Gradiška

Production: Furniture (wood and upholstered). 65% upholstered furniture.

Glue Consumption: 60 tons Urea Formaldehyde  
2 tons Poly Vinyl Acetate (PVAc)  
5 tons Hot Melt glue  
3 tons Neoprene

Glue Used: All locally made except for Hot Melt glues which are partly imported from Italy (PRIMO brand). The balance is locally made by Duga in Belgrade (THERMOFIX brand).

Present Situation:a). Machinery

1. Although the glue spreader is in a better state than those at Verba and Standard, the rollers' grooves need re-cutting.
2. The temperature control of the press needs to be repaired.
3. The glue store is not adequate as the temperature in summer can attain 35°C thus causing a reduction in the shelf life of the glue and higher viscosity leading to an increase in the need of water in the mixture etc.
4. There is no laboratory to test the glue quality.

b). Glue Technology

1. The measurement of the solid components entering the glue mixer is by volume.
2. Far too much water and flour are added to the mixture, leading to a lowering of the strength of the glue.
3. The pressing cycle for the PVAc used in solid wood furniture - 5 minutes - is too short for the type of glue used and prevailing room temperatures.
4. The gluing of edge veneers onto particle board panels is not good.
5. The relative humidity of the wooden dowels used in jointing is the same as that of the wood. It should be lower.

c). Qualifications of Staff

There are no technicians to control the glue technology.

Recommendations for Improvementa). Machinery

Re 1. The common practice in West Germany and Scandinavia is to arrange for a specialized firm to send a set of newly cut rollers to the plant and the worn ones sent to this specialized firm in return. Perhaps

such an arrangement could also be introduced in Yugoslavia. The following firms undertake this type of work :

Adolf Friz, GmbH., Haldenstrasse 94, 7 Stuttgart 50,  
Federal Republic of Germany.

Theodor Nymmen Kg, Maschinenfabrik, Postfach 4240,  
4800 Bielefeld, Federal Republic of Germany.

Re 2. The therm element needs changing. This is a minor job.

Re 3. The glue store should preferably be situated in a cellar - underground - to minimize temperature variations. The optimum temperature is between  $10^{\circ}$  and  $15^{\circ}\text{C}$ . Liquid Urea Formaldehyde should be stored in a tank and not in barrels. Purchase by tanker - railway or lorry - should be envisaged to minimize transport costs and cost of return of empty barrels.

Re 4. Due to the need to control fluctuations in the quality of the locally manufactured glues, a laboratory with the following minimum equipment should be established :

- a). A thermostat regulated bath with warm water to test the curing time of the glue mixture.
- b). A viscosity meter (Ford Becher type) to check viscosity.
- c). A laboratory balance.

Additional equipment (that is not essential) for such a laboratory is :

- d). PH meter
- e). Drying oven to measure solid matter in solution supplied.
- f). Equipment to measure the pre formaldehyde content of the glue supplied (by the sulphite method).

## b). Glue Technology

Re 1. Measurements of powders should be by weight and not by volume.

Re 2. The percentage of flour extender should be reduced from the present figure to only 5%-10% because of the high price of flour in Yugoslavia - prices which are now nearly as high as that of the Urea Formaldehyde resin. When the flour content is reduced the water content should also be reduced to reach 5%-15% for a mixture of 5%-10% flour, 10% walnut shell flour and 2-5% particle board sander dust. The main advantage of using walnut shell flour is that it improves flow control and reduces bleeding. The addition of walnut shell flour darkens the colour of the glue mix, thus facilitating the visual control of glue line thickness. If no walnut shell flour is added it is recommended to add small quantities of a powdered dye to darken the colour of the glue mixture. The effect of extending with flour on glue line on strength properties is shown in the attached graph.

Re 3. The glue quantity plays an important role. For a consumption of 100, 150 and 300  $\text{gr}/\text{m}^2$  and a press time of 10 minutes the glue line strength obtained is 40  $\text{Kp}/\text{cm}^2$ , 15  $\text{Kp}/\text{cm}^2$  and 5  $\text{Kp}/\text{cm}^2$  respectively. The room temperature also affects the strength of the bond. For a pressing time of 10 minutes and 100  $\text{gr}/\text{m}^2$  glue consumption the glue line strength is as follows :

cont./...

Temperature °C	25°C	20°C	15°C	10°C	5°C
Glue line strength Kp/cm <sup>2</sup>	57	48	37	27	20

The moisture content of the wood also affects the glue line strength, as follows (for a consumption of 100 gr/m<sup>2</sup> at 20°C. and a pressing time of 10 minutes) :

Moisture content	9%	13%	16%
Glue line strength Kp/cm <sup>2</sup>	48	18	10

It is recommended that under winter conditions the pressing time be increased to a minimum of 10 minutes.

Re 4. The present edge gluing machine has too few rollers and consequently cannot exert the necessary pressure on the wood panel and the veneer for long enough. In purchasing a new machine it should be ascertained that it has a longer pressing line.

Re 5. The relative humidity of the wooden dowels should be about 5,-6% i.e. about 4,-7% lower than the wood to be glued. This enables the wood to absorb more quickly moisture from the glue line and thus build up pressure in the dowel hole and quicken the drying time. The glue must be spread on the sides of the dowel hole with a spatula or by placing the head of the glue injector at the top of the hole and not at the bottom as at present. The introduction of the dowel then pushes the glue down the hole, spreading it along the walls of the hole. The glue should also be spread on the dowel previous to its introduction. The dowel must fit well in the hole and its diameter should be 0.1mm - 0.2mm smaller. If softwood or particle board is assembled and moisture content of the dowel is the same, the diameter can be 0.2 mm bigger than that of the hole.

c). Qualifications of Staff

A firm of Radnik's size employing 1100 persons should have a quality control laboratory to check glues and varnishes. It should be staffed by a competent technician.

Name of Firm: "JAJJI" - EDI

Place: Donji Vakuf

Production: Windows, doors, panels, assembly gluing.

Glue consumption: 120 tons p.a. Urea Formaldehyde ("Lansur" area Inc)  
7 tons per annum Poly Vinyl Acetate ("Dorin" area Inc).

Present Situation:

a). Machinery

1. The glue spreaders are in very bad condition. They are more than ten years old.
2. The rubber rollers on the spreader are too hard, thus not being able to compensate for any irregularities in veneer or panel thickness.
3. The glue store is not adequate as the temperature in summer can attain 25°C thus causing a reduction in the shelf life of the glue and higher viscosity leading to an increase in the need of water in the mixture, etc.
4. There is no laboratory to test the glue quality.
5. The temperature and pressure control on the two presses are in bad condition.

b). Glue Technology

1. Glue bleeding occurs due to uneven thickness of the glue line as a result of the bad state of the glue spreading machine leading to an increase in glue consumption.
2. The glue mixing formula is not good. It contains too much flour and too much water facilitating glue bleeding and slowing the curing time.
3. The measurement of the solid components entering the glue mixer is by volume.

c). Qualifications of Staff

The control of the quality of the glue mixed and the control of its use is not adequate.

Recommendations for Improvements

a). Machinery

- Re No. 1 The glue spreader must be replaced.
- Re No. 2 Softer rubber rollers (40-60 Shore) should be used.
- Re No. 3 The glue store should preferably be situated in a cellar - under/ground - to minimize temperature variations. The optimum temperature is between 10°C and 15°C. Liquid urea formaldehyde

should be stored in a tank and not in barrels. Purchase by tanker, railway or lorry, should be envisaged to minimize transport costs and cost of return of empty barrels.

Re No.4 See "Radnik".

Re No.5 The equipment for the temperature and press control on the press must be repaired.

b) Glue Technology

Re No. 1 The repair of the glue spreading machine will enable better control of the glue line thickness, thus reducing the quantity of glue presently used from 120 grs/m<sup>2</sup> to as low as about 120 grs/m<sup>2</sup>. If modern equipment is used and the quality of the particle board is very high, glue consumption can be as low as 80 grs/m<sup>2</sup> reducing the pressing cycle's duration.

Re No. 2 The percentage of flour extender should be reduced from the present figure to only 5 - 10 percent because of the high price of flour in Yugoslavia - prices which are now as high as that of the urea formaldehyde resin. Walnut shell flour should be used. Kaolin and sanding dust of the particle board sanders should also be considered. When the flour content is reduced the water content should also be reduced to reach 5 to 15 percent for a mixture of 5 to 10 percent flour, 10 percent walnut shell flour and 2 to 5 percent particle board sander dust. The main advantage of using walnut shell flour is that it improves flow control and reduces bloating. The addition of walnut shell flour darkens the colour of the glue mix thus facilitating the visual control of glue line thickness. If no walnut shell flour is added it is recommended to add small quantities of a powdered dye to darken the colour of the glue mixture. The effect of extending the flour on glue line on strength properties is shown in the graph (see Annex XIII).

Re No. 3 The measurement of the solid components entering the glue mixer should be done by weight and not by volume.

c) Qualifications of Staff

The firm should employ a chemist/technologist to carry out the quality control tests on glue.

**Name of Firm:** P. H. Marko Radovic

**Places:** Titograd

**Productions:** Furniture  
Windows  
Doors

**Glue consumptions:** 80 tons Urea Formaldehyde, trade name "Urofix" manufactured by Hemiski Kombinat in Gorazde.  
2 tons PVAc "Nikol 3" from Nitel in Bežans.  
7-8 tons hot melts, Arak and Svostik, from Italy.

### Present Situation:

#### a). Machinery

1. The glue store is not adequate as the temperature in summer can attain  $35^{\circ}\text{C}$  thus causing a reduction in the shelf life of the glue and higher viscosity leading to an increase in the need of water in the mixture etc.
2. The glue spreader is new and in good condition.
3. The press is adequate.
4. There is no laboratory equipment to test the glue quality.

#### b). Glue Technology

1. The glue mixing formula is not good. It contains too much flour and too much water facilitating glue bleeding and slowing the curing time.
2. The gluing of edge veneer onto particle board panels is too slow (6-12m per minute).
3. The temperature in the rooms where gluing is done is too low in the winter ( $10^{\circ}\text{C}$ ).

#### c). Qualifications of Staff

The control of the quality of the glue mixed and the control of its use is not adequate.

### Recommendations for Improvement

#### a). Machinery

Re 1. The glue store should preferably be situated in a cellar - underground - to minimize temperature variations. The optimum temperature is between  $10^{\circ}\text{C}$  and  $15^{\circ}\text{C}$ . Liquid urea formaldehyde should be stored in a tank and not in barrels. Purchase by tanker - railway or lorry - should be envisaged to minimize transport costs and cost on a ton of empty barrels.

Re 2. Due to the need to control instructions in the quality of the locally manufactured glue a laboratory with the following minimum equipment should be established:

- a). a thermostat regulated bath with warm water to test the curing time of the glue mixture.
- b). a viscosity meter (Ford Becher type) to check viscosity.
- c). a laboratory balance.

Additional equipment for such a laboratory (equipment not essential) is :

- i). PH meter
- ii). Drying oven to measure glue solid matter in solution supplied.
- iii). Equipment to measure the formaldehyde content of the glue supplied (by sulphite methods).

#### b). Glue Technology

Re 1. The percentage of flour extender should be reduced from the present figure to only 5-10% because of the high price of flour in Yugoslavia - prices which are now nearly as high as that of the urea formaldehyde resin. Walnut shell flour should be used. Krollin and sanding dust of the particle board sanders should also be considered. When the flour content is reduced the water content should also be reduced to reach 5-15% walnut shell flour and 2-5% particle board sander dust. The main advantage of using walnut shell flour is that it improves flowcontrol and reduces bleeding. The addition of walnut shell flour darkens the colour of the glue line slightly. If no walnut shell flour is added it is recommended to add small quantities of a mordant dye to darken the colour of the glue mixture. The effect of extending with flour on glue line or strength properties is shown in the graph (see Annex XIII).

Re 2. The gluing of edge veneer onto particle board should be done at a speed of 20-30 meters per minute.

Re 3. Measures should be taken to ensure a temperature of not less than 15°C in places where gluing is carried out.

#### Qualifications of Staff

The chemist/technologist who carries out the control tests on the varnishes should also control the quality of the glue.



Name of Firm: "SIK JAVORAK"  
Place: Nikšić  
Production: Furniture for approximately 800,000 H.D.  
Glue Consumption: 16 tons per annum Urea Formaldehyde  
3 tons PVAc  
0.6 tons Glutin glue  
Glues Used: Urea Formaldehyde "Urefix" made by Hemiski Kombinac  
in Goražde.  
PVAc "Nokol MA207" made by Nitel in Sežana, and  
"Dufix" made by Duga, Belgrade.  
Glutin glue "Tutkala" is locally made.

Present Situation:

a). Machinery

1. There is no mechanical stirrer. Glue mixing is done by hand.
2. Glue spreading is manual, made with a brush. The mechanical spreader does not work.
3. The press is adequate.
4. The machine for making dowels produces slight ones.
5. The glue store is inadequate.

b). Glue Technology

1. The glue mixing formula is not good. The glue mixture contains lumps and too much water and is therefore too thin.
2. Glue bleeding occurs as a result of the low viscosity of the glue mix and the high pressure used (12 Kp/cm<sup>2</sup>).
3. The glue used for edge veneering ("Tutkala") is too slow in setting.

c). Qualifications of Staff

The control of the quality of the glue mixed and the control of its use is not adequate.

Recommendations for Improvement

a). Machinery

Re 1. A mechanical stirrer should be installed. It provides a better disintegration of lumps and a more homogeneous mix.

Re 2.. A four-roller spreading machine should be installed. The hardness of the rubber rollers should be 40-60 shore. They must have adequate profiles. A spreading machine can spread a glue with high viscosity with

more uniformity than can be done with a brush, thus preventing glue bleeding.

Re 3. A machine for making profiled dowels should be installed.

Re 5. The glue store should preferably be situated in a cellar - underground - to minimize temperature variations. The optimum temperature is between 10°C and 15°C. Liquid Urea Formaldehyde should be stored in a tank and not in barrels. Purchase by tanker - railway or lorry - should be envisaged to minimize transport costs and cost of return of empty barrels.

Re 4. A grooved dowel allows for better spreading of the glue on the side under injection in the hole than a slight one. The dowels should have 0.1-0.2mm less in diameter than the hole and the moisture content should be 4 to 7% lower than the wood to be jointed.

b). Glue Technology

Re 1. See "Standard" - Re 2.

Re 2. No water should be added to the glue mix. A higher viscosity of the glue mix prevents glue bleeding. The pressing must be carried out with a **pressure** of not more than 9 Kp/cm<sup>2</sup>.

Re 3. The planned machine for edge veneering with modern Hot Melt is to be taken into action as soon as possible.

c). Qualifications of Staff

There should be a **technician** for control of the glue mix, the spreading, the varnishes and the moisture content in the wood and veneers.

Name of Firm: "POLIMLJE" Plywood Factory.

Place: Ivanograd.

Production: 3,500 m<sup>3</sup> Plywood

Glue Consumption: 190 tons Urea Formaldehyde  
25 tons Phenol Formaldehyde

Glue Used: Urea Formaldehyde adhesive AT 90.  
Phenol Formaldehyde adhesive AT 60.  
Both these glues are from Hemiski Kombinat in Gornji Mladec.

Present Situation:

a). Machinery

1. The major pieces of equipment are 10 years old and virtually worn out.
2. The two dryers lack adequate control in so far as they dry the veneer unevenly. Although the aim is to obtain veneers with moisture content of 5%-10%; it is believed that the actual moisture content range is far greater (from 1%-15%).
3. The glue spreader's rubber rollers are worn.
4. The glue store is not adequate as the temperature in summer can attain 35°C thus causing a reduction in the shelf life of the glue and higher viscosity leading to an increase in the need of water in the mixture etc.
5. There is no laboratory to test the glue quality.

b). Glue Technology

1. The glue mixing station is adequate.
2. No hardener or filler is used for the Phenol Formaldehyde resin. The glue has a relatively low PH value (8.85). Such a glue needs a higher temperature for hardening, which is combined with the risk of over-drying and embrittlement of glue in the mix etc. It may also happen that the face impregnated paper will be hardened prematurely.
3. To protect the edges of the water and boil proof plywood Phenol Formaldehyde adhesive is used. No hardening occurs of the adhesive. This is not adequate as the adhesive remains water soluble, and therefore does not protect the edges of the plywood.

c). Qualifications of Staff

The control of the quality of water and boil proof plywood is adequate. Other controls such as the quality of the glue mix is inadequate.

Recommendations for Improvements

a). Machinery

- Re 1. The glue-spreader's rubber rollers must be replaced.
- Re 2. The moisture content of the veneer should be checked more frequently.

Workers unloading the line should be trained to feel the variations in veneer moisture content and put aside in two piles veneers in veneers that are either too damp or too dry. Moisture meter checks should be carried out every 2-3 hours. Veneers that are dryer than 7% should be stored for self (atmospheric) conditioning. Veneers with more than 9% should be re-dried.

Re 3. As already stated, the glue-sprayer's rubber rollers must be replaced.

Re 4. The glue store should preferably be situated in a cellar - underground - to minimize temperature variations. The optimum temperature is between 10° and 15° C. Liquid Phenol Formaldehyde should be stored in a tank and not in barrels. Purchase by tanker - railway or lorry - should be envisaged to minimize transport costs and cost of return of empty barrels.

Re 5. Due to the need to control fluctuations in the quality of the locally manufactured glues, a laboratory with the following minimum equipment should be established :

- a). A thermostat regulated bath with warm water to test the curing time of the glue mixture.
- b). A viscosity meter (Ford Becher type) to check viscosity.
- c). A laboratory balance.

Additional equipment (that is not essential) for such a laboratory is :

- d). PH meter
- e). Drying oven to measure glue solid matter in solution supplied.
- f). Equipment to measure the pre formaldehyde content of the glue supplied (by the Sulphite method).

#### b). Glue Technology

Re 1. At the glue mixing station the measurement of the solid components entering the glue mixer should be by weight and not by volume.

Re 2. To achieve correct glue flow in the press it is recommended to add some filler as chalk, walnut shell flour, etc. The advice of the glue manufacturer should be requested. Consideration should also be given to the use of an alternative glue, e.g. Penofix from Chromor, Za'rab, with higher PH value and an hardener (similar as in Boranka factory). This change will allow the use of a lower temperature in the press and reduce the risk of pre-curing the glue film used on the face veneers.

Re 3. Advice will be given later. Meanwhile it is recommended that Urea Formaldehyde with 1% ammonium chloride is used as protection for plywood edges. It is possible also to use resorcinol formaldehyde resin which is more resistant to moisture than Urea Formaldehyde resin.

#### c). Qualifications of Staff

For routine tests the enterprise should employ a laboratory technician. This employee should be responsible for intake and operational control of chemicals and testing of finished products.

A fellowship study tour of a responsible and qualified person from this firm should be realized. A visit to glue manufacturers and a modern plywood factory should be included in such a tour.

Name of Firm: KID VUKLAN KRUSCIT  
Place: Hojkovac  
Production: Particle Boards - 10,000 m<sup>3</sup>/annum.  
Glue Consumption: 7,000 tons Urea Formaldehyde  
Glue Used: AF 90 from Hemiski Kombinac in Zagreb.

Present Situation:

a). Machinery

1. Production line is equipped with West German machinery designed by Dr. Schnitzler using Siemmel Kamp press. For the gluing of particles a Draiswerk's glue spreader is used. The machinery is about 12 years old and worn out.
2. The press is now operated with a temperature of 150°C and a pressure of 19 Kp/cm<sup>2</sup>, which is too low for a modern production.
3. It was noticed that no laboratory or equipment for the testing of raw materials, or the finished product, is available.

b). Glue Technology

1. The glue formula is adequate.

c). Qualifications of Staff

- The firm has no technician to carry out the control tests.

Recommendations for Improvements:

a). Machinery

Re 1. It is planned to replace the machinery in the Spring 1972.

Re 2. The new press will operate with a temperature of 180°C and a pressure of 23-24 Kp/cm<sup>2</sup>. This will reduce the pressing cycle from the present time of 3-1/2 minutes to 4-1/2 minutes.

Re 3. Because of the need to control fluctuations in the quality of the locally manufactured glues, a laboratory with the following minimum equipment should be established:

- a). A thermostat regulated bath with warm water to test the curing time of the glue mixture.
- b). A viscosity meter (Ford Becher) to check viscosity.
- c). A Laboratory balance.
- d). Adequate equipment to test the moisture content of the wood.
- e). Adequate equipment to test the moisture content of the particle boards.

Additional equipment (that is not essential) for such a laboratory is :

- f). PH meter.
- g). Drying oven to measure the solid matter in glue in the solution supplied.
- h). Equipment to measure the free Formaldehyde content of the glue supplied (by the Sulphite method).

b). Glue Technology

No changes

c). Qualifications of Staff

A chemist/technologist should be employed to carry out the control tests on the glue, the wood and the final product.

Name of Firm: "KONJUE" Table Factory.  
Place: Zivinice  
Production: Tables - 400,000 pieces per annum.  
Glue Used: PVAc, locally made.

A visit to this enterprise was planned for 22 November but was not realized due to bad weather conditions. The problems of this factory were discussed with Professor Skopal from Sarajevo University and the following advice was given for improvement of the gluing technique:

Present Situation:

The main problem was the warping of table panels after gluing.

Present Method:

Particle Boards of 19mm thickness are laminated onto the face surface with plastic laminate 1.5 to 2.0 mm thickness. The lower surface is veneered with beech veneer 0.8 to 1.2 mm thickness.

Gluing Conditions:

Glue spread	200 g/m <sup>2</sup>
Pressure	6 Kp/cm <sup>2</sup>
Pressure temperature	70°-80°C
Press time approximately	10 minutes.

Advice for Improvements:

- 1). Glue spread should be reduced to 100 to 150 g/m<sup>2</sup>.
- 2). Pressure should be reduced to 2-5 Kp/cm<sup>2</sup>.
- 3). Press temperature should be reduced to 50° to 60°C, or even better to 20° to 30°C.
- 4). Pressing interval should be kept as short as possible.
- 5). Instead of PVAc glue, it is recommended that a Urea Formaldehyde glue with high concentration be tested. A cold fast reacting hardener should be spread in a separate operation.
- 6). The materials for gluing must be carefully conditioned.



KEYED GLUING RULES

1. Rotate your stocks, avoid over-aged glue, store glue in cool dry place.

Ingredients in the Glue Mix

2. Choose the correct type of glue and catalyst for your plant conditions.
3. Determine mixing proportions of ingredients by weight, not volume.
4. Use just enough water to provide proper spreading consistency.
5. Use only fresh, white wheat flour extender with low ash content and low water-taking capacity, and not too much extender.
6. Use shell flour as 10 to 25% of total extender - to prevent bleed-through.

Mixing

7. Keep your mixer clean and in good working order, and remove all traces of cleaning compounds.  
Add the ingredients in the order directed, for best results. When mixing powders, make a heavy mix first - then add water.  
Use water between 60° and 70°F. Do not fill mixer to more than 2 in. above top blade.
8. Operate mixer at 60 to 65 rpm.
9. Do not let mix stand for long periods.

Drying out and plant conditions

10. Do not dry corestock or veneers below 5% - 6% unless they pick up moisture before use.  
Humidify glue room if heating system dries air below 25% relative humidity.
11. In wet seasons, dehumidify plant or keep stock dry in special storage.
12. Maintain plant temperatures at 70°F or higher where urea and resorcinol type adhesives are used; 60°F with polyvinyl adhesives.
13. Allow kiln-dried veneers and corestock to cool before spreading.

Corestock

14. Avoid corestock with worm holes, dents, knots, etc., and do not use dopes and fillers that absorb water.
15. To prevent warping: Do not use woods of different density in the same core. Do not use wide boards in corestock. Avoid rough, rotary-cut veneer cores.
16. To avoid sunken joints in corestock, do not surface cores too soon after edge gluing.
17. Keep planers in adjustment to avoid planer marks and dips in corestock.
18. Do not surface cores unless they will be used within a few days.

Veneers

19. Avoid wavy and warped veneers.
20. Do not use veneers of unequal thickness in crossband or as corestock.
21. To prevent warping: Avoid diagonal grain veneers. Use same species and thickness of veneers, where possible, for faces and backs.
22. Avoid thick tapes or marquetry on face veneers.
23. Use minimum spread when splicing to avoid squeeze-out at splicer joints.

WELD GLUING RULES.... continued

24. Be sure veneers are within the proper moisture content range for the adhesive being used.

Spreaders and Spreading

25. Recover and regrind worn spreader rollers. Replace worn bearings on rolls. Use proper greasing for type of glue and spread required. Be sure glue rollers are aligned with each other and with doctor rollers. Keep spreader rollers clean. Be sure top and bottom rolls apply equal spread.
26. Apply proper spread for adhesive mix being used and condition of stock. Rough, loose-cut and porous stock requires a heavier spread than smooth dense stock.

Handling Spread Veneers

27. Do not wipe glue off crossband by sliding lumber cars on spread veneer. Also avoid wiping glue off gluing area with gloves.

Assembly

28. When spread veneers are warped and loosely piled, consider it an "open assembly".
29. Use a longer assembly period to prevent blisters (hot press), bleedthrough or starved joints (on dense stock). When long assembly is required, use, if necessary, a slower catalyst and longer pressure period.
30. Use a shorter assembly period or slower catalyst to prevent pre-curing. (Where short assembly time is practiced, a fast catalyst may be used.)
31. Be sure that all panels in one press opening are the same thickness.

Caul Boards

32. To avoid pre-cure, cool hot press cauls before assembly.
33. Keep cauls clean, smooth and waxed.

Presses and Pressure

34. Be sure all steam traps are working properly, and clean out channels in the platens if water-logged.
35. Be sure steam pressure is adequate to attain required press temperature, and do not start pressing until press is fully heated.
36. Use automatic loader where necessary, and be sure press closes quickly.
37. Be sure press is not out of line, causing uneven pressure.
38. Be sure press delivers recommended pressure so that all surfaces are brought into intimate contact.
39. Avoid excessive pressures on dense stock unless delayed assembly is used.
40. Do not use high hot press temperatures to attain short pressure periods unless moisture content of stock is carefully controlled.
41. To avoid excessive drying or overcuring, do not leave panels in the hot press during lunch hour or "break" periods, and always remove panels as soon as the press is opened.

**KEYED GLUING RULES .... continued**

**Conditioning of Panels**

42. For quickest cooling or heating, glued panels should be stickered.
43. For gradual cooling of panels, to prevent warping, they should be squarely dead-piled and weighted for 12 hours.
44. Allow a period during which complete cure develops before testing.

Trouble Shooter's Guide For Plywood\* - Furniture Panels - Assembly Period

Gluing Fault	Possible Causes	See Keyed Rules
<b>Blooms or Blisters</b> Mostly in center part of large panels, in all-veneer construction and between core and crossband	Press time too short	2H, 40H, 29H
	Moisture content of stock too high	11H, 29H
	Non-uniform moisture content (wet-spots)	14H
	Assembly time too short	29H
	Spread too heavy (all over or in spots)	17H, 25H
	Press temperature too high	40H
	Presence of defects in the stock	14H, 17H
	Adhesive mix too thin	4H
<b>Pre cure</b> No transfer or spotty transfer of glue from crossband to face or back or to cores. Spreader marks show on crossband.	Adhesive mix too reactive	2, 3
	Spread too light or non-uniform	26, 27, 25
	Assembly time too long	20, 30H
	Hot veneers or cores	13
	Hot cauls	32H
	Press temperature too high	40H
	Porous veneers	26
	Stock of non-uniform thickness	18, 20, 11
<b>Bleed-through</b> Areas difficult to finish, won't take stain, etc., due to excess penetration of glue	Faulty type of extension	6
	Face veneers too high in m.c.	11
	Adhesive mix too thin	4
	Spread too heavy	26
	Assembly period too short	29
<b>Warpage</b> Any variation from flat, true panel	Unbalanced construction	21
	Non-uniform moisture content	10, 11
	Non-uniform spread	19, 20, 25
	Faulty core stock	14, 15, 16
	Press temperature too high	40
	Over-curing in hot press	41
Improper conditioning	42H or 43H, 44C	
<b>Starved joints</b> Weak bond, glue transfers, but very little glue in joint	Foamy mix	4, 8
	Adhesive mix too thin	4
	Spread too light	19, 26
	Assembly time too short	29
	Excessive pressure	39
	Porous stock	26
Faulty type of extension	5, 6	

\* Hot-pressed or Cold-pressed  
C = Cold press only

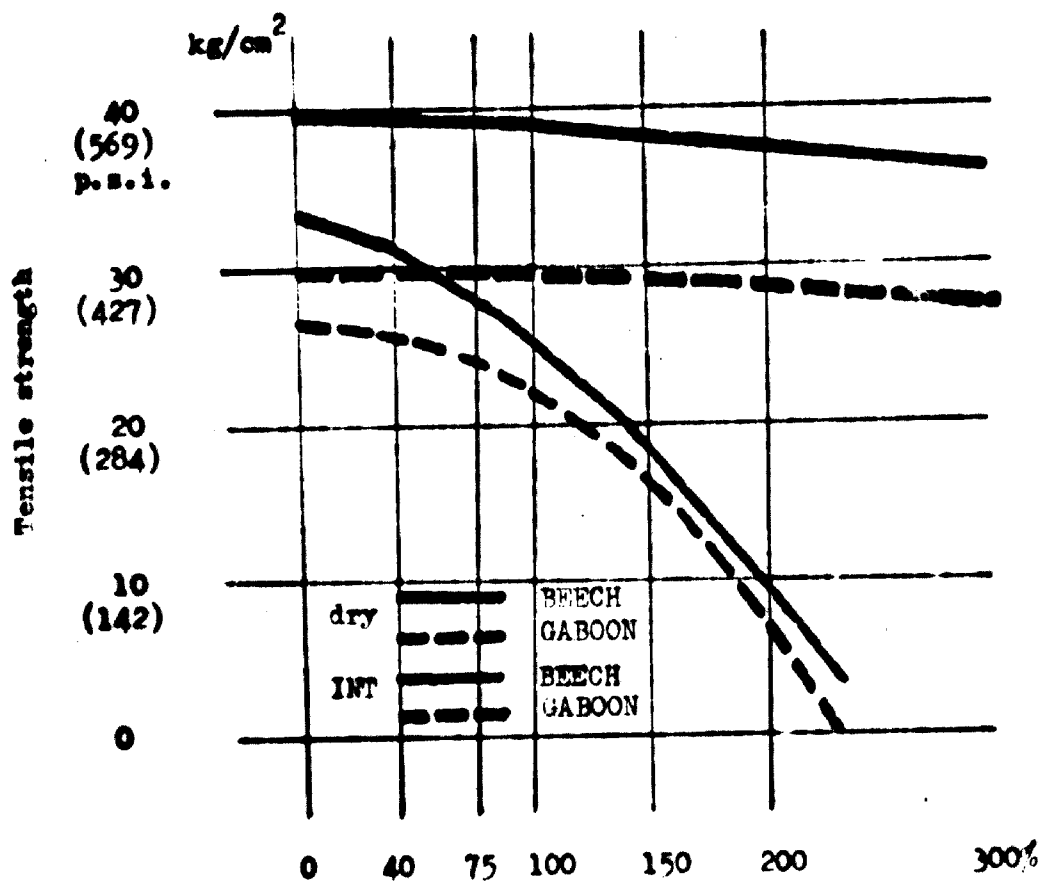
H = Hot press only  
All others applicable to both

Gluing faults	Possible causes	See Keyed Rules
	Insufficient or non-uniform pressure	16, 20, 22, 31, 37, 38
Spotty Bond	Non-uniform spread of adhesive	14, 16, 17, 19, 20, 25
Good in some areas.	Uneven press temperature	34
Poor in others	Assembly time too long	26, 30, 36H
	Face veneers too well sized	23
	Inproper mixing	7, 8, 9
	Careless veneer handling	27
Weak Bond		
Powdery glue line—see also "Precure"	Stock (particularly cores) too dry	10
Green or moist glue line	Adhesive mix not reactive enough	1, 2, 3
	Press temperature too low	24H, 36H, 12H
	Press period too short	30, 40, 12
	Moisture content of stock too high	11, 24
	Spread of adhesive too heavy	26
Face Checking	Stock m.c. too high or too low	10, 11, 24
	Improper conditioning	42H or 43H
	Press temperature too high	40H
	Press period too long	41H
Indentations	Defective equipment	33
Low water resistance	Testing before 4 to 6 days' maturing	44
With good dry strength	Too high or faulty type of extension	5

● Hot-pressed or cold-pressed  
 ○ = Cold press only

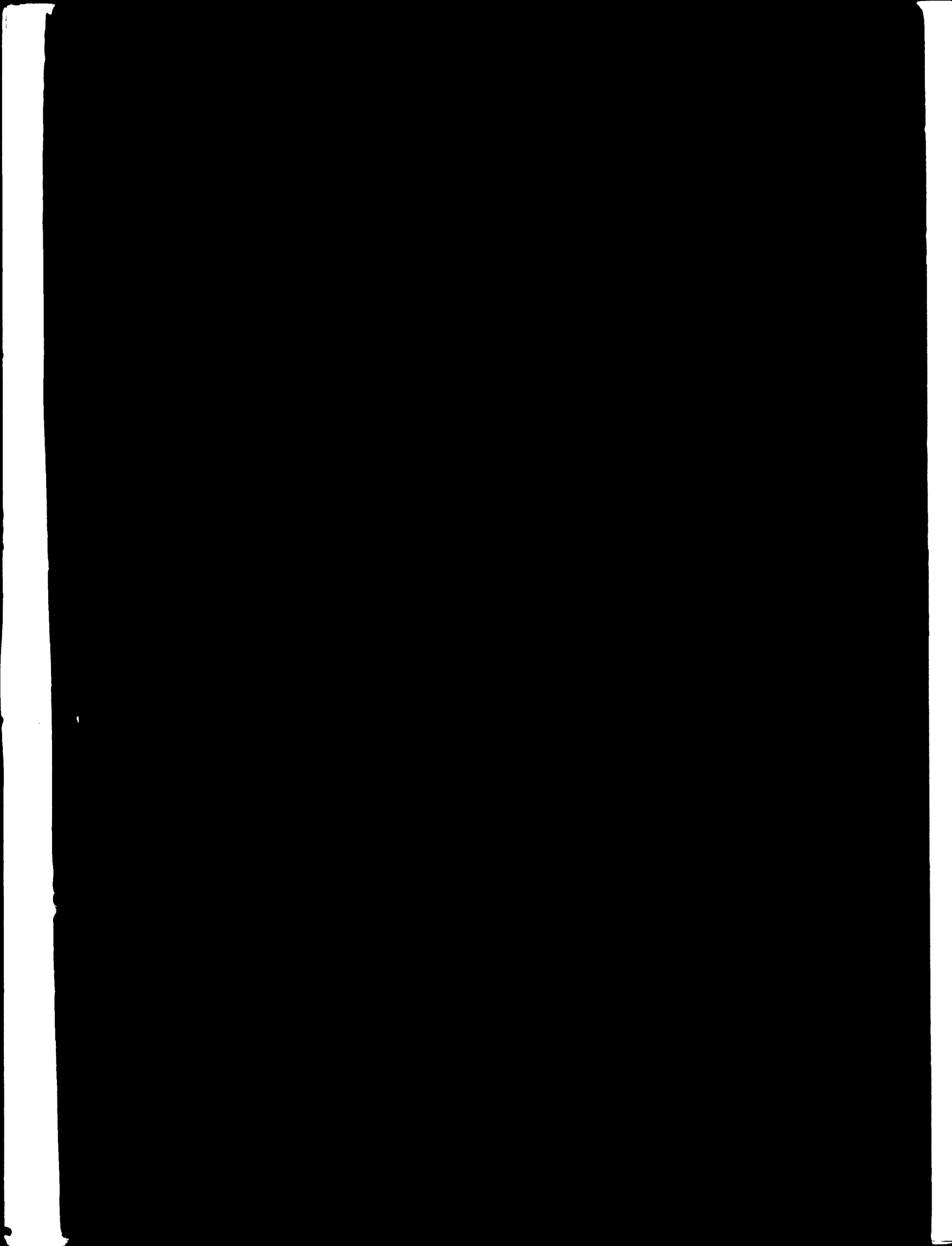
H = Hot press only  
 All others applicable to both

RELATION OF THE BONDING STRENGTH TO THE DEGREE OF EXTENSION

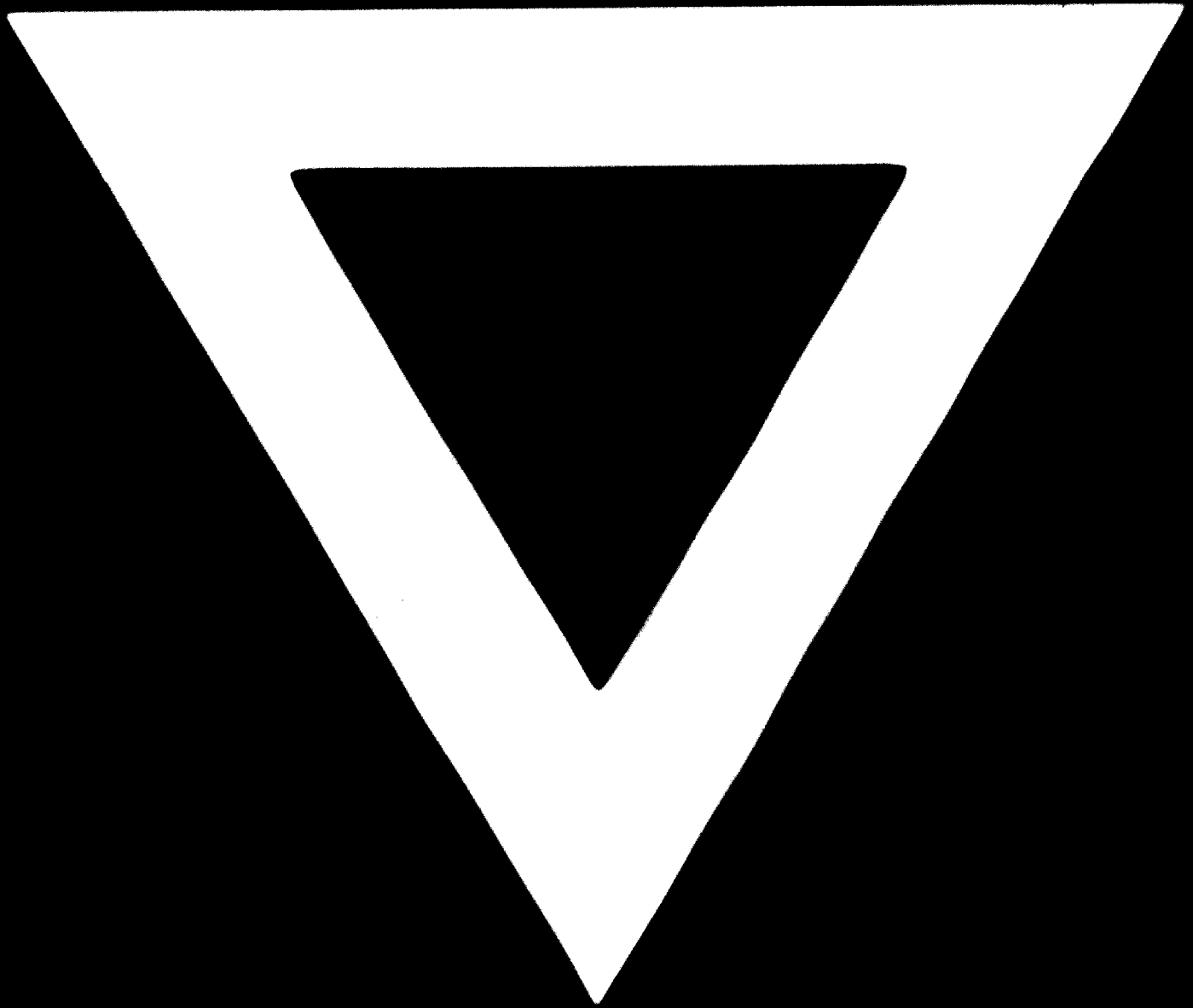


Proportion of wheat flour calculated on solid resin.





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**82.06.24**